Acta Scientific Orthopaedics (ISSN: 2581-8635)

Volume 6 Issue 2 February 2023

Research Article

Handheld Smart Devices Effects on Postural Muscles Related to Upper Cross Syndrome

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DOI: 10.31080/ASOR.2023.06.0686

Received: December 27, 2022

Published: January 25, 2023

Abstract

Background: Upper Cross Syndrome (UCS) is a major postural disorder. Postural muscles changes can be related to sustained prolonged poor posture. As time spent on handheld smart devices (TSSD) is increasing yearly, there is a necessity to study its effects on body posture. Limited literature was found on the effect of TSSD on body posture.

Objectives: The purpose of this study was to examine the relationship between the prevalence of muscular changes associated with UCS and the TSSD among university students in Jordan.

Methods: Two hundred participants were recruited for this study. After obtaining the informed consents, Participants filled a survey and underwent standardized measures including head position measures, Manual Muscles Testing (MMT) and Muscles Length Test. Survey included multiple factors that can be related to postural changes.

Results: There was association between the prevalence of the muscular changes associated with UCS and time spent on the use of handheld smart devices where 8.7% of students who used handheld smart devices for less than one hour a day developed factors that lead to UCS. Marked increase on the prevalence of the muscular changes associated with UCS to be 70.4% among the students who used the handheld smart devices from one hour to three hours a day. The prevalence of the muscular changes associated with UCS was the highest among the students who used the handheld smart devices for more than 3 hours to be 89.1%.

Conclusion: Limiting time spent on handheld smart devices to one hour daily can be helpful in maintaining healthy body posture and physical well-being.

Clinical Implications: Physical therapists can use the findings of this study to educate their patients who suffer from upper quarter muscles dysfunction on the importance of controlling the time spent on handheld smart devices.

Keywords: Body Posture; Handheld smart Devices; Upper Cross Syndrome; Upper Quarter; Time

Introduction

Body posture refers to the alignment of body segment in the hierarchical chain. It can be observed via the relationship among bone segments within and between the axial and appendicular skeletons. Healthy body posture involves proper segments alignment starting with the head and ending by the foot. The proper body posture can be achieved by keeping the joint and bones aligned properly in order to minimize the strain on the back muscles and joints [1].

Poor body posture usually results from a combination of physical and environmental factors, such as having a poor ergonomics while working on a computer or studying [2]. Major physical factors that relate to poor body posture are the weakness or shortening of postural muscles including abdominal, back, hamstring, hip flexor, scapula retractor, and pectoralis muscles. Often, shortening and weakness of the postural muscles happen due to underuse and lack of physical activities, and working in prolonged poor posture [2].

Upper Crossed Syndrome (UCS) is one of the major postural deviations. UCS is a disorder characterized by having a forward posture of the head and shoulders and increased thoracic spine kyphosis. It is a common postural dysfunctional pattern of the upper quarter in the human body due to muscles imbalance. Muscles imbalance includes tightness and over-excitation of the levator scapulae, pectoralis major and upper trapezius associated with weakness and inhibition of serratus anterior, deep neck flexors especially scalene, middle trapezius, lower trapezius and rhomboids muscles [3,4].

Upper Cross Syndrome affects the body posture and mechanics of cervical spine and shoulder girdle resulting in upper quarter and neck pain [5,6]. A study has shown postural changes in shoulder girdle related to UCS where people with UCS had more scapular anterior tilting and internal rotation of shoulder joint compared to people who are not affected by UCS. In the same study, people with UCS had low levels of serratus anterior muscle activity during the loaded forward flexion task [7].

Limited number of epidemiological studies were conducted to determine the prevalence of UCS among young adults. A study was conducted by Mubeen and colleagues in the year 2016 in Pakistan to find the prevalence of UCS among medical students who were between 17 to 25 years old at Lahore University, which revealed a high prevalence of UCS among students. Also, the results indicated that 48.7% of the students suffered from neck pain. In the same study, the researchers found that a 66.8% of subjects were found to have poor studying posture. The study revealed that poor studying posture could be a leading factor to UCS [8].

Additional study was conducted to find the prevalence of neck and shoulder pain among high school male students in Korea. A high prevalence of neck and shoulder pain (NSP) was found among high school children where 79.1% of the students reported NSP. Also, the study mentioned that the average sitting time among the examined group was 10.2 ± 2.7 hour/day, while 59.0% of the students did not sit upright. Only 11.9% of students reported that they stretched regularly throughout the day [9]. This indicates possible relationship between postural status and NSP.

An annual cost due to head and trunk pain (headache, back pain, chest pain, and abdominal pain) ranged between $560 billion to $635 billion in the United States only in the year 2010. It was greater than the annual costs of heart disease ($309 billion), cancer ($243 billion), and diabetes ($188 billion). nearly 30 percent higher than the combined cost of cancer and diabetes [10]. In addition, there are many long-term consequences for UCS including balance disorders, lung issues, migraine, cardiovascular, digestion, and the psychosocial problems [11-13].

The usage of smart devices is increasing on daily basis where the sales of smart devices in increasing yearly [14]. Statistics showed that there was 14.02 billion mobile device worldwide in the year of 2020. The number of mobile devices increased in the year 2022 to be 15.9 billion devices. It is projected that the number of mobile devices to be 18.22 billion in the year 2025. The most smart devices that were sold are the smartphones. It has been shown that 66.5% of mobile devices worldwide are smart phones (Data Portal 2021).

The time spent on the use of smart devices is increasing yearly around the world. Smart devices included desktops and smart phones. Statistics indicated more usage of phone compared to computer as the years go by. In 2011, the average time spent daily on computers was 43 minutes and the average time spent daily on phones was 32 minutes. However, in the year of 2020, the average time spent on computers was 37 minutes and the average time spent on phones was 155 minutes [15]. More than 5.19 billion persons use mobile phones around the world [16]. American spent 3 hours and thirty minutes using the mobile internet daily in the year 2019 [17]. This indicated an increase by 20 minutes compared to the last year [17]. Jordan falls in South-Western Asia. Statistics indicated that 97% of people used phones in the year of 2019 [18].

Kee and colleagues studied the relationship between the smart phone use among addicted teenagers on caniocervical posture [19]. They found that the smartphone- addicted teenagers are more prone to muscular dysfunctions and disturbances in the craniocervical area.

In another study, Jung and colleagues studied the effect of smartphone use on body posture and respiratory function among young adults [20]. They classify subjects into 2 groups. Subjects in the first group they used smart phone more than 4 hours. Subjects in the second group used the smart phone for less than 4 hours. They found that the prolonged use of smartphones was associated with poor body posture and limited respiratory function. Also, Kang and colleagues reported in their study negative effect of smartphones usage on lung forced vital capacity [21]. They attributed the changes in respiratory function to poor body posture while using the smartphones.

A systematic review of the association between mobile touch screen devices and musculoskeletal symptoms was conducted by Toh and colleagues [22]. They reported the presence of limited evidence on the effect of mobile touch screen devices and musculoskeletal symptoms due to low quality experimental and limited number of cross-sectional studies. The findings of this study should motivate the researcher to conduct more studies on the effect of smart devices on body posture.

As pointed out, limited literature was found on the relationship between the muscular changes related to UCS and use of smart devices due to the novelty of the topic in the research field. According to our best knowledge, there are no published studies or reports on the effects of smart devices usage on of muscular changes associated with UCS in Jordan or even in the region. As mentioned previously, the usage of smart devices is increasing tremendously every year. Therefore, the purpose of this study was to examine the relationship between the prevalence of muscular changes associated with UCS including weak deep neck flexor, tight pectoralis, and weak scapula retractor muscles and the usage of smart devices among university students in Jordan.

Subjects

Two hundred subjects were recruited from different universities and students' clubs in Jordan. One subject withdrew from the study due to busy schedule. Subjects were included in this study if they were healthy, had no musculoskeletal pathologies or systemic diseases, and between 18 to 24 years old. Subjects were excluded if they had congenital musculoskeletal deformity, history of spine injury, musculoskeletal surgeries, or were diagnosed with disorders that affect normal growth. All protocols and procedures were approved by the Institutional Review Board at the Hashemite University. Demographic data of subjects is shown in table 1.

Sample size (N)	Age (Av. ± SD) Year	Weight (Av. ± SD) Kg	Height (Av. ± SD) Cm
199 subjects	21.2 ± 1.3	64.6 ± 15.7	166.2± 9.3

Table 1: Demographic data of subjects.

Study design

A cross-sectional observational study.

Methods

- **Assessment of Upper Crossed Syndrome:** Measurement of anterior displacement of the head using Cervical Range of Motion (CROM) (Performance Attainment Associates, 12805 Lake Blvd, Lindstrom, MN 55045, USA). It is a device that measures the distance between the occiput and spinous process of C7 vertebra in order to determine the anterior displacement of the head in centimeters. This tool is valid and reliable [23].
- **Measurement of deep neck flexor muscles strength:** Manual Muscles Testing (MMT) was performed in supine position where the participants were asked to tuck their chin and lift the head off the table simultaneously. Verbal cues included " Make a double chin. Lift your head up to get your chin as close as possible to your chest and do not let me push you down." Manual resistance was applied by the assessor, according to Hislop and Montgomery manual muscles testing, to determine the strength of the deep neck flexor muscles [24].
- **Measurement of pectoralis major muscle flexibility:** Muscle length test was performed in supine with Glenohumeral joint line at the edge of the table. Examined shoulder was placed in 90 degree of scaption and external rotation. Following that, the examined shoulder was taken into horizontal shoulder abduction until the resistance (R1) noted or discomfort reported by the participant. Horizontal shoulder abduction ROM was measured using a universal goniometer (UG) (Baseline, Albany, NY, USA). Based on that, pectoralis muscle flexibility was determined where limited ROM means limited flexibility.
- **Measurement of scapula retractor muscles strength:** MMT was performed in prone position with shoulder at 90 degree of abduction with neutral rotation and elbow at 90 degree of flexion. Instructions to participant were as" lift your elbow toward the ceiling. Hold it (for 3 seconds). Do not let me push it down". Manual resistance was applied by the assessor, according to Hislop and Montgomery manual muscles testing, to determine the level of strength [24].
- **Visual Analog Scale:** Visual Analog Scale was used to determine the presence of musculoskeletal pain.
- **Survey Questionnaire:** A Survey was developed based on the available literature reviews and consulting with physical therapy and epidemiology experts from the academic and professional fields. Pilot survey was tested on 10 students to assess time required to complete it and the ease of completion. Survey is consisted of 21- item questionnaire that required less than 10 minutes for completion. It was divided into 4 sections. Section I addressed the demographic data of the subjects. Section II addressed environmental factors that can affect body posture. Section III addressed biomechanical factors that can affect body posture. Section IV addressed the usage and time spent on smart devices. The time spent on smart devices and factors that can affect body posture were assessed using a 5-point Likert scale.

Procedures

Subjects were selected randomly from universities and students' clubs. Study purpose and procedures were explained to the subjects by the researcher. After signing the informed consent, the subjects were asked to fill a questionnaire in order to determine the possible risk factors of UCS.

To measure the anterior displacement of the head, the subjects were asked to sit on a standard chair with back support. Adjustable lumbar lordosis support was used to support the lower back in sitting. CROM was used to measure the anterior displacement of the head.

Following that, the subjects were asked to assume supine position in order to examine the strength of cervical neck flexor muscles and flexibility of pectoralis major muscle. Subjects were instructed to retract their neck while lifting the head off the table and hold it against resistance that is applied by the assessor. Muscles strength was determined based on the resistance intensity.

To measure the pectoralis muscle flexibility the subjects were asked to stay in supine position with both shoulders abducted to 90-degree and externally rotated. Following that, the assessor provided horizontal shoulder abduction until the resistance (R1) noted or discomfort reported by the patient. Horizontal abduction ROM was measured using a Universal Goniometer (Baseline, Albany, NY, USA). Pectoralis muscle flexibility was determined based on the ROM. Limited ROM means limited pectoralis flexibility.

Finally, subjects were asked to assume prone position in order to measure the strength of shoulder retractor muscles. Subjects shoulders were placed in 90-degree of abduction with neutral rotation and elbow in 90-degree of flexion. The verbal cues to the subjects included " Lift your elbow toward the ceiling. Hold it. Do not let me push it down". Manual resistance was applied by the examiner in order to determine the level of shoulder retractor muscles strength. Examiner palpate the medial angle of scapula for test accuracy.

Results

Percentage was used to summarize the findings of this study. Results revealed a significant relationship between the hours spent on using of handheld smart devices and the prevalence of muscular changes associated with UCS including weak deep neck flexor muscles, tight pectoralis muscle, and weak scapula retractor muscles. There was association between the prevalence of the muscular changes associated with UCS and time spent on the use of handheld smart devices where 8.7% of students who used handheld smart devices for less than one hour a day developed factors that lead to UCS. Marked increase on the prevalence of the muscular changes associated with UCS to be 70.4% among the students who used the handheld smart devices from one hour to three hours a day. The prevalence of the muscular changes associated with UCS was the highest among the students who used the handheld smart devices for more than 3 hours to be 89.1%.

There was a significant relationship between hours spent on handheld smart devices daily and muscles weakness of deep neck flexor, right scapula retractor muscles strength, and left scapula retractor muscles strength (P = 0.000). Looking at the deep neck flexor strength, 47.7% of subjects who reported using handheld smart devices for more than 3 hours had fair deep neck flexor muscles strength and 15.1% of them had normal deep neck flexor muscles strength. However, 2.2% of subjects who reported use of handheld smart device for less than one hour had fair strength of deep neck flexor muscles and 50% of them had normal strength of deep neck flexor muscles (Figure 1). 71% of subjects who reported use of handheld smart device more than 3 hours a day had fair strength and 5.4% of them had normal strength of left scapula retractor muscles. However, 0.0% of subjects who reported use of handheld smart devices less than on hour a day had a fair strength and 39.1% of them had normal strength of left scapula retractor muscles (Figure 2). Seventy-three percent of subjects who reported use of handheld smart devices more than three hours had fair strength and 4.1% of them had normal strength of right scapula retractor muscles. On the other hand, 0.0% of subjects who reported use of the handheld smart devices for less than 1 hour had fair strength and 47.8% of them had normal strength of right scapula retractor muscles (Figure 3).

There was a significant relationship between tightness of right pectoralis muscles and time spent on using handheld smart devices (P = 0.00). 71.6% of subjects who spent more than 3 hours daily on handheld smart devices founded to have tight right pectoralis muscles. In contrast, 37% of subjects who spent less than one hour daily on handheld smart devices found to have tight right pectoralis muscles. Also, there was a significant relationship between tightness of left pectoralis muscles and time spent on using handheld smart devices (P = 0.00). 73% of subjects who spent more than 3 hours daily on handheld smart devices founded to have tight left pectoralis muscles. In contrast, 39.1% of subjects who spent less than one hour daily on handheld smart devices found to have tight left pectoralis muscle.

There was a significant relationship between the hours spent on handheld smart devices and low back pain (P = 0.05). 75.3% of subjects who reported use of handheld smart devices more than 3 hours complained of low back pain compared to 73.8% of subjects who used handheld smart devices for less than 1 hour.

Discussion

Using smart devices have brought so many advantages and disadvantages to the users. However, users must be aware of the optimal length of time to use the handheld smart devices. Using handheld smart devices can influence health, well-being, sleep disturbances, and headache [25,26].

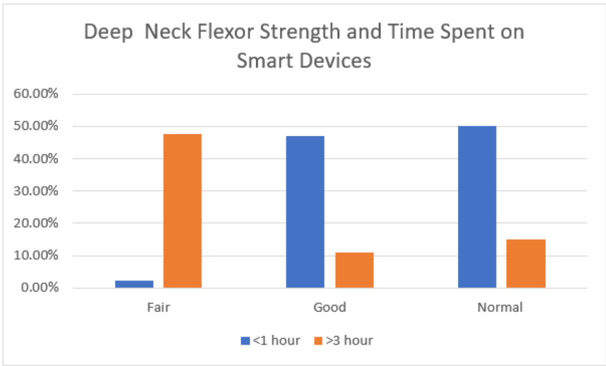

Figure 1: Deep neck flexor muscles strength in relation to time spent on handheld smart devices.

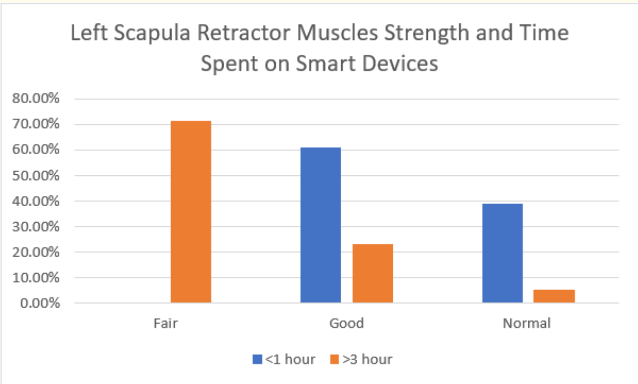

Figure 2: Left scapula retractor muscles strength and time spent on handheld smart devices.

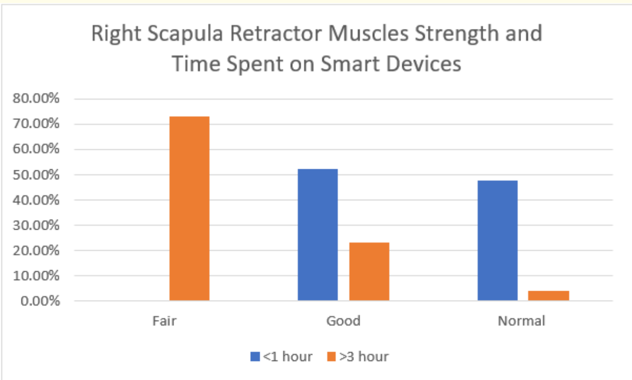

Figure 3: Right scapula retractor muscles strength in relation to time spent on handheld smart devices.

There is a direct relationship between headache and the use of smart screens such as computers, tablets, cell phones, television and video games that can cause eyestrain. The American Optometric Association (2020) has listed the most common symptoms associated with smart eyestrain are headaches, blurred vision, dry eyes and pain in the neck and shoulders. Smart eyestrain is a condition characterized by visual disturbance and/or ocular discomfort related to the use of smart devices and results from a range of stresses on the ocular environment including: glare, defocus, accommodation, fixation disparity, dryness, fatigue, and discomfort (Hall and Coles-Brennan, 2015). Many researchers found that headache was one of the most common smart eyestrain symptoms among student populations [27-30]. Current study supports the mentioned findings where the results revealed a significant relationship between the time spent on social media and headaches among subjects.

There was no significant relationship between forward head posture and use of handheld smart devices in this study. This can be explained by a delayed onset of head posture changes where the muscles shortening precedes the postural changes. In the current study, the researchers evaluated participants at one point of time which limits the ability to predict future changes on body posture that might be related to handheld smart devices usage. A longitudinal cohort study is recommended to find the prolonged changes on body posture associated with use of handheld smart devices.

The findings of the current study recommend to limit the use of handheld smart devices to one hour daily to help in maintaining healthy posture. Physical therapists and other healthcare providers are recommended to educate their patients on the importance of limiting the time spent on handheld smart devices. Also, it is recommended that the physical therapist develop exercise regimens to help in preventing postural changes in clients who are required to use the handheld smart devices for prolonged periods daily.

Conclusion

Limiting time spent on handheld smart devices to one hour daily can be helpful in maintaining healthy body posture and physical well-being.

Clinical Implications

Physical therapists can use the findings of this study to educate their patients who suffer from upper quarter muscles dysfunction on the importance of controlling the time spent on handheld smart devices.

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