Relationship between Craniovertebral Angle with the Long-Term Usage of Electronic Devices among Undergraduates of General Sir John Kotelawala Defence University

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Abstract - Long term usage of electronic devices among undergraduates have become a growing problem all around the world. Prolong usage of these devices can result in malalignment of the normal posture. Forward head posture (FHP) is known as the commonest postural abnormality resulted due to long term usage of smartphones and laptops. The purpose of this study was to determine the relationship between craniovertebral angle with duration of smartphone and laptop usage among undergraduates, Faculty of Allied Health Sciences, General Sir John Kotelawala Defence University. This is a descriptive cross sectional study. 228 undergraduates, within 19- 24 years of age, using smartphones and laptops for more than 1 year were recruited by the consecutive sampling method. Those who had previous cervical injuries/congenital deformities and who didn't grant informed consent were excluded. Self-administered questionnaire was given to collect information. Craniovertebral Angle was measured by lateral view photographs using KINOVEA app. According to the results the mean values of age, BMI and CVA were (21.83±1.57 years), (22.86±4.39kg/m-^{2}), (46.53±5.49degrees). Pearson correlation coefficient was used to quantify the linear relationship of CVA with duration of smartphone, laptop usage and BMI. A statistically significant negative correlation was obtained between CVA and duration of smartphone usage (p = 0.033, r = -0.35), duration of laptop usage (p = 0.003, r = -0.047) and BMI (p > 0.01, r = -0.55). Findings of the study concluded that long term usage of electronic devices could result in reducing the craniovertebral angle. Furthermore, BMI has a statistically significant negative relationship with CVA.

Keywords— Craniovertebral angle, Smartphone usage, Laptop usage

I. INTRODUCTION

Nowadays prolong usage of smartphones and laptops are prevalent among young adults and students, especially including university undergraduates who spend a large amount of time on mobile devices for social leisure or academic purposes. The negative consequences that might be caused by long-term usage of these electronic devices can be highlighted in terms of both the psychological and musculoskeletal systems. In relevant to musculoskeletal system the cervical region, elbow, and wrist joints are mainly affected due to prolong duration in unsupported positions (Yalcinkaya, Sengul Salik and Buker, 2020). Forward Head Posture (FHP) is the commonest postural abnormality related to musculoskeletal system. Craniovertebral Angle is commonly used in anlaysing FHP (Lee, Chung, and Park, 2015). Craniovertebral angle (CVA) is interpreted as the angle formed between the horizontal line passing through the C7 spinous process and the tragus of the ear (Kim, Kim and Son, 2018). Photogrammetry is an extensively used non-invasive technique for postural evaluation (Furlanetto, Sedrez, Candotti and Loss, 2016). With regard to the high reliability and validity of the photogrammetry method, this has been used as the easiest and the simplest way of measuring Craniovertebral Angle for postural evaluation (Furlanetto, Sedrez, Candotti and Loss, 2016). Body Mass Index (BMI) is known as one of the most vital factors which could influence the changes of CVA. Kinovea software has been used in measuring the CVA, which is a valid, precise, and reliable (both inter- and intra-rater) tool in obtaining angles and distance data (Hazar,

Karabicak and Tiftikci 2015). The main objective of this study was to determine the relationship between craniovertebral angle and the duration of smartphone and laptop usage among university undergraduates of Faculty of Allied Health Sciences, Kotelawala Defence University. Specific objectives of the study was to evaluate the relationship between craniovertebral angle with the smartphone usage time duration per day among undergraduates, to evaluate the relationship between craniovertebral angle and laptop usage time duration per day among undergraduates, to determine the difference of craniovertebral angle between males and females, to determine the difference between duration of smartphone/laptop usage among males and females, to evaluate the relationship between craniovertebral angle with BMI and to investigate the compiling factors which influence the smartphone/laptop addiction among undergraduates.

II. METHODOLOGY

A descriptive cross-sectional study was conducted under the consecutive sampling method. In total 228 university undergraduates (158 Female, 70 Males) who fulfilled the inclusion criteria within the age group of 19-24 years were included in the study. Participants who had previous history of cervical spine deformities, injuries to the cervical spine and surgeries were excluded from the study while undergraduates who have been using smartphones and laptops for more than 1 year, aged between 19 to 24 years and who granted written informed consent were included. Ethical clearance was attained from the Ethical Review Committee of General Sir John Kotelawala Defence University. An information sheet containing all the details of the study was distributed among the undergraduates and their consent was obtained via a written consent form prior to the study participation. Demographic characteristics including age, gender, duration of smartphone and laptop usage and most preferred posture of the participants were obtained using a self-administrated questionnaire. The BMI was calculated by measuring the height and the weight of the respondents and craniovertebral angle was measured by a lateral view photograph using the KINOVEA app. Three stations were allocated for data collection with a responsible investigator for each station. Prior to data collection, a pretesting was conducted with 15 randomly selected university undergraduates in order to train the main procedures of three stations. After that data collection was initiated.

Procedure

The Station 1 was responsible for taking the written consent and for screening purpose. A reference number was assigned and the height and the weight of the participants were measured. After reading the information sheet and listening to the study procedure explained by the investigators, participants gave their consent for the participation or denied the participation. Then the self-administrated questionnaires were filled by the participants who gave their consent.

Height measurement

The height of the participants was measured using the stadiometer. They were instructed to remove their footwear and stand in erect position. Then the moveable head part of the stadiometer was kept on the upper most part of the head to take the measurements. Three measurements were taken for each participant and the mean value of those three measurements were taken as the final height of the particular participant.

Weight measurement

With bare foot, participants were asked to step on to the weight scale and instructed to stand straight and to keep both feet on the center of the scale to confirm that the body weight was evenly distributed between both legs. They were asked to keep their hands on either side of thebody. Three measurements were taken and the mean value of those three were taken as the final value of that participant's weight. BMI was then calculated.

Marking the bony landmarks for the required measures were taken at the Station 2. Palpation of the 7th cervical vertebrae, marking the vertebrae and right Tragus using adhesive markers were performed. In this station, participant's spinous process of the 7th cervical vertebrae and the tragus were marked using adhesive markers. The angle between the above-mentioned points were marked in the photo and was taken as the craniovertebral angle.

Palpation and confirmation of the spinous process of the7th cervical vertebrae

The participants were instructed to expose their neck and cervical area to mark the spinous process of the 7th cervical vertebrae. The palpation was done using the flexion-extension method (Povoa, Ferreira & Zanier, 2018; Shin, Yoon & Poon, 2011). The examiner was at the side of the participant and

passively flexed the subject's neck. Then the pulp of the middle finger of the examiner's dominant hand was on the prominent desired vertebrae. Following that subject's neck was passively returned to the neutral position. According to the assumptions, C6 spinous process of the cervical spine is the lower last vertebrae to move freely during the test. The below vertebrae which acts as stationary should be C7.

Palpation of the tragus:

The tragus is a small pointed eminence of the external ear, positioned in front of the concha, and projecting backward over the meatus. The right-side tragus was marked using adhesive markers. The three points were marked using adhesive double-sided tapes of 0.5mm x 0.5 mm and plastic pearls to make the marks visible on the photographs.

Station 3 was responsible for the measurements of the craniovertebral angle and capturing the participant's photographs. In this section, the investigator was responsible in positioning the participant in front of the calibration board and capture the photograph. Calibration board allowed referencing of horizontal and vertical axes of the photographs. A mark was set on a particular place on the floor and participants were instructed to stand on that mark in order to maintain the standardized method of the procedure.

To maintain the same distance between the tripod and the participant, marks were placed in those two positions and made sure that any distance changes were not happened between those two points. The position of the camera and the tripod was also fixed for standardization throughout the data collection procedure. The plumb line was set 1 m away from the participants and the camera was fixed on a tripod which was placed 2m away from the lateral border of the footmark (Akodu, Akinbo and Young, 2018). The height of the camera was adjusted so that the tragus of the participant was the focus point (Yousuf, 2016). When capturing the CVA, the participants were asked to stand comfortably in his/her anatomical position with head in erected position (Akodu, Akinbo and Young, 2018) His/her feet were closed to each other and arms were hanging relaxed on either side of the body. Participants were asked to focus on a relevant point at his/her eye level (Figure 1 and 2). This procedure was repeated three times in order to take the mean values. All photographs were captured by one researcher in order to reduce the bias. Photogrammetry method for the analysis of craniovertebral posture was highly recommended in previous studies as it is an accurate and objective method (Worlikar, Apurva & Mayuri, Rajesh & Shah, Mayuri, 2019).

At the analysis part, all the photographs were transferred to the Kinovea software and angles were measured between the horizontal line passing through the spinous process of 7th cervical vertebrae and the tragus. Angles which were lesser than 49.9° were considered as decreased CVA (Figure 1) wheareas angles which were more than 49.9° were considered as increased CVA (Figure 2).

Collected data were statistically analyzed using IBM SPSS software, version 20. Before the data analysis the normality tests were performed. Parametric tests were used for further analysis since our data distribution stated normal (Barton & Peat, 2014). Pearson's correlation coefficient test was used to determine the relationship between CVA and the duration of using smartphones and laptops and to identify the relationship between CVA and BMI.

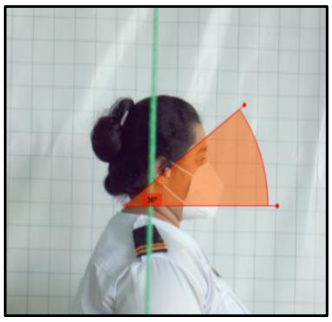


Figure 1. Decreased CVA

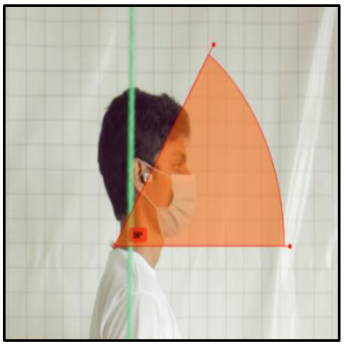


Figure 2. Increased CVA

III. DISCUSSION AND ANALYSIS

The study included 228 participants comprised out of 158 females and 70 males within the age range of 19-24 years. The mean values of age, BMI and CVA were (21.83±1.57years), (22.86±4.39kg/m^{-2}) and (46.53±5.49degrees).

Table 1. Descriptive statistics of the demographic data of the study sample

	N	Minimum	Maximum	Mean	Std. Deviation
Age	228	19.00	24.00	21.83	1.57
BMI	228	12.60	36.41	22.86	4.39
Duration of years using smartphones	227	2.00	8.00	4.93	1.51
Duration of years using laptops	206	1.00	7.00	3.91	1.38

Comparable results were manifested by previous studies which have been aimed to investigate the correlation between craniovertebral angle and smartphone addiction among undergraduates. According to the results of the study conducted by Akodu, Akinbo and Young (2018), the mean CVA value was (51.83 ±5.7degrees). Pearson correlation coefficient was used to quantify the linear relationship of CVA and long-term usage of smartphones, laptops, and BMI.

Table 2 shows the correlation between CVA and duration of years using smartphones. There was a statistically significant negative relationship between CVA and long-term usage of smartphones among the respondents (p = 0.03, r = -0.35).

Table 3 demonstrates the correlation between CVA and duration of years using laptops. A statistically significant negative linear relationship between CVA and long-term usage of laptops among participants (p = 0.03, r = - 0.47).

Table 2. Correlation between CVA and duration of years using smartphones

		CVA	Duration of years using smartphones
CVA	Pearson Correlation	1	-0.35*
	Sig. (2-tailed)		0.03
	N	228	227
Duration of years using smartphones	Pearson Correlation	-0.35*	1
	Sig. (2-tailed)	0.03	
	N	227	227

Table 3. Correlation between CVA and duration of years using laptops

		CVA	Duration of years using laptops
CVA	Pearson Correlation	1	-0.47*
	Sig. (2-tailed)		0.03
	N	228	206
Duration of years using laptops	Pearson Correlation	-0.47*	1
	Sig. (2-tailed)	0.03	
	N	206	206

According to the above statements, it was evident that participants who had lower craniovertebral angles were long-term users of smartphones and laptops, while the participants who had relatively higher craniovertebral angles were short-term users of the above-mentioned devices. A previous research conducted by Park et al (2015) supported the above statement by mentioning that people who use smartphones for a long period of time usually keep their neck flexed downwards to stare at smartphones and to maintain head in the forward posture for a prolong time. According to the study conducted by Kang et al (2012) with the aim of estimating effects of a relatively protruded head and neck posture in computer-based workers, concluded that forward head posture associated with reduced craniovertebral angle was influenced by the prolong laptop usage.

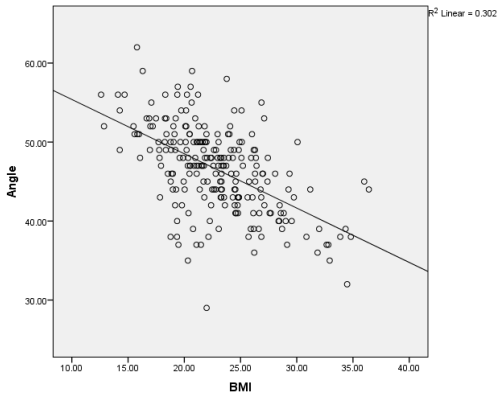
Table 4. Correlation between CVA and BMI

	CVA	BMI

CVA	Pearson Correlation	1	-0.55**
	Sig. (2-tailed)		0.01
	N	228	228
BMI	Pearson Correlation	-0.55**	1
	Sig. (2-tailed)	0.01	
	N	228	228

According to Table 4, a moderately negative significant correlation was observed between CVA and BMI ($p > 0.01$, $r = -0.55$).

Figure 3. Scatter plot demonstration of correlation between CVA and BMI



The findings of the study conducted by Kocur et al (2019) has stated that there is a significant moderately negative correlation among BMI and CVA which strongly relates to the current study results. A significant relationship was obtained between CVA and duration of time using smartphones ($p = 0.02$, $r = -0.15$). A statistically significant relationship was identified between CVA and duration of time using laptops ($p = 0.32$, $r = -0.07$). The independent t-test was used to analyze the association between CVA and gender. It was revealed that there was no statistically significant difference between duration of time using both smartphones ($p = 0.50$, $t = 2.18$) and laptops ($p = 0.55$, $t = 0.58$) in relevant to their gender. Further, no statistically significant difference was observed between craniovertebral angle with regard to their gender ($p = 0.49$, $t = -1.36$).

IV. CONCLUSION

The study concluded a significant negative correlation between craniovertebral angle and the long-term usage of smartphone and laptops among university undergraduates. Further, it emphasized a significant negative correlation between craniovertebral angle and the BMI among the participants. Further studies could be conducted with large scale sample sizes to verify the results. This study results can be used as a warning indication to minimize the excessive usage of smart phones and laptops, and its dependency in undergraduate's population as it has negative impact on musculoskeletal system.

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