Impact of Smartphone Overuse on Craniovertebral Angle and The Level of Upper Limb Function in Adolescence

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ABSTRACT
Background: Smartphones have been the most popular electronic devices, especially among the young population. Smartphones are used for multi-purposes including communication, music, media, internet access, games, some applications, and professional fields. Using the smartphone frequently forces the users to adopt an awkward posture leading to an increased risk of musculoskeletal disorders and pain.
Purpose: To determine the effect of smartphone use on Craniovertebral angle (CVA) and the level of upper limb function.
Materials and Methods: Sixty adolescents of both sexes were enrolled in this study, their ages ranged from 14 to 18 years. They were assigned into two groups of equal numbers; Group (A) using smartphone less than 4 hours/day and group (B) usingsmartphone more than 4 hours per/day. The kinovea software program was used to detect the craniovertebral angle and theQuick-DASH questionnaire was used to measure the level of function of upper extremity.
Result: The study findings, revealed a statistically significant differences in all measured variables of groups A and B ($p < .05$). High significant difference was observed in group B when comparing the findings of groups, A and B ($p < .05$).
Conclusion: the overuse of smartphones has a negative effect on craniovertebral angle, and level of the upper extremities function.

Keywords: smart phone**,** craniovertebral angle, Quick dash questionnaire.

Introduction
The smartphone has become a necessity for the majority of individuals. It is used for both communication and enjoyment **(1).** Smartphone access and ownership among children and teenagers has increased significantly in recent years, particularly the use of several gaming applications **(2).**

Heavy use of smartphone is associated with insomnia, depression, poor sleep quality headache, fatigue, decreased concentration level and forward head posture (FHP). This FHP causes overload on the shoulder and neck muscles, as well as decreased blood circulation, increased pain and fatigue in neck muscles, which accelerates degeneration of cervical spine joints, weakens and fatigue neck muscles**(3,4,5).**

Excessive external flexion force which created by forward head flexion, resulting in a greater strain on neck extensors and nearby connective tissues to counterbalance the increase in external flexion moment caused by forward head flexion**(6,7).**The external moment provided at a joint by gravity is typically balanced by the internal moment generated by soft tissue structures and muscles around the joint. Furthermore, due to the presence of postural malalignments, which is aggravated due to the altered location of the LOG, in order to balance the external torque produced by gravity, greater internal forces are required**(8).**

Although several studies reported the effect of overuse of smart phone on adolescent cervical range of motion and posture, there are no sufficient studies that detect the effect of prolonged use of smartphone on the level of function of the upper extremity so the purpose of the study was determined the effect of smartphone use on Craniovertebral angle, and the level of upper limb function.

Therefore, the findings of this study could clarify the effect of prolonged use of smartphone, that may help the physiotherapists in detecting the problem caused by prolonged use of smartphone and give the necessity precautions and treatment methodology in preventing or alleviating this problem.

METHODOLOGY

This cross-sectional study was conducted in the out-patient clinic of the Faculty of Physical Therapy, Delta University for Science and Technology to assess the effect of prolonged use of smartphone the craniovertebral angle of the cervical spine and level of upper extremityfunction.Sixty adolescents of both sexes using smartphone were participated in this study, they were assigned into two groups of equal number. Thirty adolescents were assigned to group (A) who didn’t use smartphone for prolonged time (less than 4 hours per day) and thirty adolescents were assigned to group (B) who use the smartphone for a prolonged time (more than 4 hours per day continuously).

Considering our study, the participant age ranged from 14 to 18 years, follow normal BMI in relation to their age, Free from any medical diseaseand had a smartphone were recruited. However, participantswere excluded if they had any congenital or acquired spinal deformities, injury in the neck or upper extremity and history of joint inflammation, neurological, musculoskeletal or cardiopulmonary disease that limit their movement,cognitive disorders, vision disorders, BMI higher than the 95th percentile that may lead to forward head posture and Athletic adolescent were also excluded.

PROCEDURES:

Craniovertebral angle was measured from lateral view using kinovea software program, right side sagittal plane photos were captured by the digital camera and saved to a personal computer. Three photographs were taken to limit the possibility of bias caused by the subject's anxiety during photography and to overcome the difference between measurement because of postural swaying in standing position. The resultant images were analyzed using the kinovea software to calculate the craniovertebral angle which is the angle between the horizontal line passing through C7 and a line extending between tragus of the ear and spinous process of C7. The data was gathered and converted to an excel spreadsheet in order to calculate the average angle for each participant. The normal value of craniovertebral angle was 50 degrees,below this degree indicates forward head posture **(9)**

Level of upper extremity function was determined by using the Quick-DASH questionnaire. subjects were asked to complete the Quick-DASH questionnaire to detect the level of upper extremity function. This questionnaire contains 11 items (seven functional and three symptom items), ten of the 11 items need to be completed for the scores to be valid, each item is graded on a 0–5 Likert scale and has 5 response options from 1 (no difficulty to perform, no symptom or no impact) to 5 (unable to do, very severe symptom or high impact). The responses are summed to a raw score and converted to a 0 (no disability) to 100 (most severe disability) score using the following formula [(sum of score/n)-1] × 25, n being the number of completed responses **(10).**

DATA ANALYSIS

Samble size calculation is performed using G*POWER statistical software (version 3.1.9.2) for comparative study between two groups. Based on data of craniovertebral angle derived from a pilot study on 10 adolescents. The calculation revealed that the required sample size for this study was 30 subjects per group. Calculations were made suing a=0.05, power 80% and effect size =0.75 and allocation ratio N2/N1=1.

Statistical analysis was conducted using SPSS for windows, version 26 (SPSS, Inc., Chicago, IL). Prior to final analysis, data were screened for normality assumption, homogeneity of variance, and presence of extreme scores. This exploration was done as a pre-requisite for parametric calculations of the analysis of difference. Preliminary assumption checking revealed that data was normally distributed for all measured variables, as assessed by Shapiro-Wilk test ($p > 0.05$). There was homogeneity of variances ($p > 0.05$) and covariances ($p > 0.05$), as assessed by Levene's test of homogeneity of variances. Accordingly, parametric statistics were used. The independent sample t-test was used to compare whether there is a difference in the dependent variable for the two independent groups. Unpaired t-test was used to compare whether there is a difference in the demographic characteristics for the two groups. The alpha level was set at 0.05.

RESULTS

The demographic characteristics of adolescents showed that there were no significant differences existed between mean values of all measured variables for both groups (P>0.05) as shown in Table 1. While, significant differences were noticed between the two groups in all measured variables which is higher in group (B) (P>0.05), as shown in Table 2.

Table1. General characteristics of adolescents in both groups

	Group A (n=30) $\bar{x}$ ± SD	Group B (n=30) $\bar{x}$ ± SD	*MD*	*P*- value
Age (Years)	14.56 ± 1.54	15.13 ± 1.79	-0.56	0.195^{NS}
Height (cm)	157.76 ± 5.13	159.33 ± 5.62	-1.56	0.264^{NS}
Weight (kg)	53.56 ± 4.36	53.33 ± 3.74	0.23	0.825^{NS}
BMI (kg/m²)	23.08 ± 4.32	22.69 ± 4.94	0.38	0.747^{NS}
Gender				
Boys	24 (80%)	21 (70%)	X^2= 0.80	0.522^{NS}
Girls	6 (20%)	9 (30%)		

P-value: probability value; *Significant at *P*<0.05, MD, mean difference, NS: non-significant, X^2: Chi-squared test

Table 2. Comparison between both groups in all measured variables.

Variable	Group A $\bar{x}$ ± SD	Group B $\bar{x}$ ± SD	*MD*	*P*- value
Craniovertebral angle (CVA)(degrees)	33.06 ± 4.36	39.01 ± 8.19	-5.94	0.001*
Quick-DASH questionnaire (scores)	4.46 ± 1.52	18.85 ± 4.96	-14.38	0.00001*

$\bar{x}$: Mean; SD: Standard deviation, MD: mean difference, P-value: probability value; *Significant at P<0.

DISCUSSION

The current study was conducted to determine the effect of overuse of smartphone on craniovertebral angleand level of upper extremity function in adolescent. Sixty children from both genders were included in this study. Their age ranged from 14-18 years old as there is an increase in the usage of smartphone in children and adolescents at this age**[11].**

Our study showed that there was a significant difference (P=0.001) in group (A) who used the smartphone less than 4 hours per day and group (B) who used the smartphone more than 4 hours per day continuously which was higher in group(B), that subject in group (B)whousedsmartphone more than 4 hourstended to have a smaller craniovertebral angle than group (A) who used smartphone less than 4 hours which reflect high degree of forward head in group (B)

Our finding is consistent with the bulk of the literatures investigated the CVA reported that Adolescents who used their smartphones for a longer period of time had greater FHP than those who used them for a shorter period of time **[12,13,14].**Further studies explained that the load on the cervical spine increases dramatically when the head flexion increases**[15],** and Head forward flexion of varying degrees puts pressure on the cervical spine, which affect the natural curve and surrounding structure of the cervical angle. **[16,17,18]**

The findings of this study are consistent with the results of**[19]**whoreported that the severity of the symptoms in the upper extremity is significantly associated with time for daily using of smartphones, and revealed that an increased duration of use of smartphones increase its negative effects due to faulty posture, pain and muscle fatigue. Moreover, our results are consistent with **[20]** who found that loss of function and muscle fatigue with longer duration of smartphone usage.

Complications and adverse effects of smartphones' excessive usage may include neck and shoulder problems, such as microtrauma to the musculoskeletal structure, De Quervain's tenosynovitis, and weakness of the thumb and wrist as the thumb and wrist weakness may be due to repetitive movement of flexion and extension over the wrist and fingers, which is increased with more duration spent over smartphones, eventually causing fatigue and loss of function **[21,22,23]**. Mobile hand-held device users complain of discomfort in at least one area of the upper extremities, upper back, or neck**[24].**

LIMITATION

Covid-19 had a major impact on the time required for requitement of the adequate number of subjects.

CONCLUSION

The usage of the smartphone more than 4 hours per day continuously in adolescence mayresult in decrease craniovertebral angle andlimitation of the upper extremity functions.

INFORMED CONSENT

A consent form was obtained from children and their parents prior to participation.

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