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THE EFFECTS OF SMARTPHONE ADDICTION ON CHILDREN'S CERVICAL POSTURE AND RANGE OF MOTION

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ABSTRACT

Background: This study examined the effects of smartphones addiction on cervical posture, and compared the cervical range of motion (ROM) between addicted and non-addicted boys and girls 8 to 13 years of age.

Methods: Twenty-four boys and 26 girls were assigned to 2 groups; addicted group (score > 32, n=32) and non-addicted group (score ≤ to 32, n=18). Craniovertebral Angle (CVA) was assessed using side view photographs, forward head posture (FHP) was measured using ImageJ 64 software, and cervical ROM in each direction was measured using a cervical (CROM) device.

Results: A forward multiple regression showed that addiction score and body mass index (BMI) were significant predictors of CVA (R2 =0.31, p<0.001). Twenty-three percent of the variability in CVA was related to addiction score. A forward logistic regression showed that addiction to smartphone use and BMI were significant predictors of having FHP, and participants who were addicted were more than four times as likely to have FHP than those who were not: Odds Ratio (OR) with 95 % confidence interval (CI)=4.5 (1.2, 10.7), p= 0.03. A significant reduction was found in mean cervical angle in addicted versus non-addicted boys (49.4±6.7 vs. 55.5±7.6,η2=0.5, p=0.03) and girls (47.3±6.3 vs. 52.9±6.1,η2=0.9, p=0.02). A significantly more limited cervical ROM found in most neck movements in addicted participants with FHP compared to participants without FHP.

Conclusion: Children who are addicted to smartphones may develop faulty habitual posture due to constant neck flexion downward, which may place them at high risk of spine abnormalities.

Keywords: smartphone use, smartphone addiction, craniovertebral angle, cervical angle, forward head posture, and cervical range of motion.

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INTRODUCTION

With the revolutionary development of smartphone technology, according to the Statistics Portal report the number of smartphone users has reached 222.9 million in the United States of America (USA) and 2.1 billion worldwide [1].Those numbers are expected to increase to an estimated 236 million users in the USA and five billion worldwide by 2019 [1]. Moreover, researchers have found that children in the USA are introduced to smartphones in their first year of life and the frequency of usage increases significantly with age [2]. A U.S. based study examined an urban group of 350 children, finding that by age 4, three-quarters of them owned smartphones [2]. According to Rideout's (2013) [3] research survey, the percentage of young children from age 0 to 8 years in the USA who own smartphones almost doubled from 38% in 2011 to 72% in 2013. It is no surprise, then, that in 2015 teens from 13 to 18 years of age were spending over 4.5 hours per day on smartphones [4].Rideout also reported that the average time children spent on their smartphones every day have increased to 45 minutes in 2017 from five minutes in 2011 [5]. Haug and colleagues (2015) [6] have suggested that the number of time adolescents spends on smartphones could characterize them as addicts [6], and about 50% of adolescents considered themselves to be "addicted" to their smartphones due to this overuse [7,8]. In a recent survey by Miner and Company [9], 57% of parents reported that their children, aged between 2 and 12 years old, preferred a device other than television and used mobile tablets as their first screen instead [9].

The fact that young individuals are spending more time on their smartphones raises concerns regarding possible adverse health effects such as changes in spinal posture, which may cause symptoms of neck pain [10,11]. Over time, constant downward neck flexion for long periods while viewing the phone will likely cause musculoskeletal disorders. This is because frequently flexing the neck downward at 60 degrees can increase the load on the cervical discs from 10 to 60 pounds [12]. Park and colleagues (2015) [13] have found that excessive use of smartphones increases the pressure on the cervical spine, which eventually changes the cervical angle and results in increased levels of pain in the sternocleidomastoid and upper trapezius muscles [13]. This change in the cervical angle can lead to an increase in the posterior curve of the upper cervical vertebrae and a decrease in the lordosis of the lower cervical vertebrae, which is known as forward head posture (FHP) [12, 14, 15]. FHP is when the head moves anteriorly to the vertical line through the center of gravity (COG) [16, 17] while the lower cervical spine is flexed and the upper cervical spine is hyperextended[18]. In addition to having FHP, smartphone users have also been found to have slumped posture [19].

It has been stated that FHP may impact the cervical spine as well as the thoracic spine and shoulder blades, which causing a general imbalance in the musculoskeletal system[10, 13].De-la-Llave-Rincon et al. (2009) [20] found that a reduced craniovertebral angle (CVA), which indicates larger FHP, might cause a reduction in the cervical range of motion (ROM) [20]. Larger FHP was also relatedto a decrease in cervical flexion and right and left cervical rotation[21]. As a result of the increased usage of smartphones among children, there were significant decreases in cervical ROM mobility because of muscular abnormalities of the cervical spine[22]. Also, cervical ROM may be reduced due to the habitual FHP of those who frequently maintain neck flexion[23].

An association between the use of smartphones and FHP has been investigated in previous studies conducted on adult populations [10, 23-26]. However, to our knowledge, no studies have been performed with children in the U.S. from ages 8 to 13 years old, concerning changes in cervical posture due to smartphone addiction. Therefore, the objectives of this research study were to 1) examine the effects of the smartphones addiction, body mass index (BMI), gender, and age on cervical posture; 2) compare cervical ROM between addicted and non-addicted boys and girls, ages from 8 to 13 years, 3) assess the effect of group (addict versus non-addict), BMI, gender, and age on whether or not children have FHP; and 4) compare the cervical ROM in all directions between children who had FHP and those who did not, in both the addicted and the non-addicted groups.

METHODS

Study Design

A cross-sectional study conducted at Loma Linda University.

Participants

Participants were healthy children between 8 and 13 years of age who had BMIs below the 95^{th} percentile and who had been using smartphones for more than six months. The participants were recruited from Southern California. A total of 53 children were recruited for this study; 50 met the criteria, and three were excluded. Children who not fit into the study were excluded if they had experienced any musculoskeletal pain or had neurological diseases, congenital or acquired spinal deformities, neck and trunk hypotonia, cognitive disorders, or vision disorders not corrected by glasses. Participants were also excluded if their BMI was higher than the 95^{th} percentile because obesity increases kyphosis and FHP in school children[27, 28]. In addition to the Centers for Disease Control and Prevention (CDC), a child with a BMI above the 95th percentile is classified as obese. The Institutional Review Board (IRB) of Loma Linda University approved this study (IRB#5160091). The research team provided participants and their parents with a full explanation of the study design, techniques, and methods. Both informed consent and assent forms were signed by parents and their children before starting the study.

Outcome Measures

Smartphone Addiction. Addiction levels to smartphones were measured using the Smartphone Addiction Scale Short Version (SAS-SV) regardless of actual hours spent. This 10-item self-report questionnaire was developed and validated for adolescents by Kwon et al. (2013) [29]. The item uses a six-point Likert-type, which scale from "strongly disagree" to "strongly agree." The SAS-SV covered five content areas: everyday life disturbances, withdrawal, cyberspace-oriented relationships, overuse, and finally tolerance. Participants were defined as smartphone addicts if they scored more than 32 on the SAS-SV questionnaire; otherwise, they were defined as non-addicts (score ≤ 32). This cut-off point was used in the original study that examined the reliability and validity of the SAS-SV [29].

Cranio Aertebral Angle. The CVA was assessed usinga digital camera (SONY Alpha NEX-5R 16.1). The camera was placed 1.5 m away from the participant's right side to take a lateral photographic view of the participant's head and neck in a seated position. The CVA is the angle between the horizontal line passing the 7th Cervical vertebra (C7) and then the line extending from C7 to the tragus of the ear. The resulting FHP was determined using Image J 64 software. A CVA of less than 50º was defined as FHP. This reference angle of 50º was established in a study conducted by Diab and Moustafa (2012) [30]. The assessors who obtained the CVA measurements were blinded to group assignment.

Cervical Range of Motion. The cervical ROM in all directions(flexion, extension, right rotation, left rotation, right lateral flexion, and left lateral flexion) was measured usinga CROM device (CROM instrument, Sammons Preston, Oklahoma, USA). This device has good test-retest reliability (intraclass correlation coefficient (ICC), 0.89 and 0.98) [31].

PROCEDURES

Weight (kg), height (m), and BMI (kg/m^2) were measured to calculate the BMI percentile. Parents answered a demographic questionnaire that included their children's age, gender, ethnicity, school grade level, if they owned their own or were using their parent's smartphone, and the number of hours per day that they had spent using a smartphone device in the past week before participating in the study. The participants answered the SAS-SV questionnaire, and according to their scores were assigned to one of two groups: addicted group (score >32, n=32) or non-addicted group (score ≤32, n=18). Participants had their CVA measured to evaluate the changes in angle between the addicted and non-addicted groups. Each participant was seated on a chair without an armrest, with his/her knee and hip joints flex at 90° and their feet flat on the floor. Participants were then informed to assume the posture they normally adopted while using their smartphones. Afterward, three photographs were taken to calculate the CVA averages. The cervical ROM was measured in all directions (flexion, extension, right rotation, left rotation, right lateral flexion, and left lateral flexion) by using CROM. The CROM device was placed on the participants' heads with the neck in a neutral position. Participants were instructed to move their heads as far as they could without experiencing a feeling of being stretched or having any pain. Three measurements were recorded to calculate an average for each direction (Figure 1).

STATISTICAL ANALYSIS

The required sample size of 50 participants was estimated to obtain a medium effect size of 0.50, a power of 0.80, and a level of significance of less or equal than 0.05. Data were analyzed using SPSS Statistics Software version 22.0 (IBM Corp, Armonk, NY). Mean±SD was calculated for quantitative variables and frequencies (%) for categorical variables. The normality of quantitative variables was assessed using the Shapiro-Wilk test and box plots. The following were compared between addicted and non-addicted participants, separately for the boys and girls, using an independent t-test: mean age (years), height (m), weight (kg), BMI (kg/m^2), number of hours using smartphones, CVA (degree), and cervical ROM (degree) in all directions (flexion, extension, right rotation, left rotation, right lateral flexion, and left lateral flexion). Fisher's Chi-Square test was used to measure the distributionof gender by the group. Forward multiple regression was conducted to examine the effect of addiction score, BMI, gender, and age on a cervical angle. Also, forward stepwise logistic regression was used to assess the impact of gender, age, BMI, and group (non-addicted vs. addicted) on the existence of FHP. Independent t-tests were used to compare the cervical ROM in all directions for the addicted and non-addicted participants with and without FHP. The level of significance was set at p≦0.05 (2-tailed).

RESULTS

The study included 50 participants with a mean age of 10.1±1.7 years and BMI of 18.3+3.0 kg/m^2. Fifty-two percent were females (n=26). There were no significant differences in mean age (years), height (m), weight (kg), BMI (kg/m^2), and several hours spent using smartphones between addicted and non-addicted boys and girls (p>0.05; Table 1). Results of the forward multiple regression showed that addiction score and BMI were significant predictors of CVA (R^2=0.31, $F_{2, 47}$=10.4, p<0.001). Twenty-three percent of the variability in CVA was related to addiction score. Females had lower CVA, but this difference was not statistically significant (p=0.06; Table 2).

Table 1: Mean (SD) of Characteristics of Participants by Gender and Study Group (N=50)

	Boys (N_1=24)			Girls (N_2=26)		
Variable	Addicted (n_1=16)	Non-Addicted (n_2=8)	*p*-value*	Addicted (n_1=16)	Non-Addicted (n_2=10)	*p*-value*
Age (year)	10.4 (1.6)	10.8 (1.5)	0.65	9.9 (1.6)	9.5 (1.8)	0.59
Height (m)	1.4 (0.1)	1.5 (0.1)	0.27	1.4 (0.1)	1.4 (0.1)	0.90
Weight (kg)	37.2 (9.9)	42.1 (6.1)	0.21	35.5 (12.3)	35.0 (11.7)	0.92
BMI (kg/m^2)	18.3 (2.9)	19.3 (2.2)	0.41	18.0 (3.5)	18.0 (3.1)	0.96
Hours/day^°	1.4 (0.6,4.6)	2.6 (0.3,4.0)	0.67	2.1 (0.5,6.0)	2.6 (0.7,3.0)	0.70

Abbreviation: SD, Standard Deviation; BMI: Body Mass Index.

BMI= weight in kilograms (height in meters)^2

* Independent t-test

^Median (min, max), °Mann-Whitney U test

Table 2: Effects of Addiction Score, BMI, Age, and Gender on Cervical Angle (N=50).

Variables	B (95% CI)	t	*p*-value
Addiction Score	-0.3 (-0.5, -0.2)	-4.0	<0.001
BMI	-0.7 (-1.2, -0.1)	-2.5	0.03
Gender	0.2 (-1.2, 5.9)	-1.9	0.06
Age	0.03 (-1.4, 1.0)	0.2	0.82

Abbreviation: BMI: body mass index; CI: confidence interval

Also, a significant difference was found in mean CVA between addicted and non-addicted participants of both genders during sitting: boys (49.4±6.7 vs. 55.5±7.6,η^2=0.5, p=0.03) and girls (47.3±6.3 vs. 52.9±6.1,η^2=0.9, p=0.02). The difference in mean cervical ROM in flexion between addicted and non-addicted boys was clinically significant (63.6±12.9 vs. 69.0±10.3,η^2=0.5, p=0.20). The mean cervical ROM in extension was significantly different between addicted and non-addicted boys (p=0.04). Among boys and girls, there was no significant difference in mean cervical ROM in flexion, right rotation, left rotation, right lateral flexion, and left lateral flexion between those who were and were not addicted (p>0.05; Table 3).

Table 3: Mean (SD) of the Cervical ROM Variables by Group (Addicted vs. non-addicted) and Gender (N=50).

	Boys (N_1=24)				Girls (N_2=26)			
Variable	Addicted (n_1=16)	Non-addicted (n_2=8)	*p*-value*	Effect size	Addicted (n_1=16)	Non-addicted (n_2=10)	*p*-value*	Effect size
CVA-sit	49.4 (6.7)	55.5 (7.6)	0.03	0.9	47.3 (6.3)	52.9 (6.1)	0.02	0.9
CROM-Flex	63.6 (12.9)	69.0 (10.3)	0.16	0.5	55.1 (12.0)	55.0 (7.8)	0.50	0.0
CROM-Ext	65.2 (12.2)	75.0 (15.6)	0.04	0.7	59.8 (12.5)	55.1 (12.5)	0.19	0.4
CROM-R-R	60.6 (11.1)	64.0 (6.6)	0.22	0.4	64.1 (11.9)	60.5 (16.4)	0.26	0.3
CROM-L-R	68.4 (8.7)	69.3 (4.9)	0.41	0.1	64.0 (10.7)	62.7 (12.2)	0.41	0.1
CROM-R-Lat	40.8 (9.9)	39.3 (9.0)	0.36	0.2	40.7 (12.7)	42.4 (7.7)	0.35	0.2
CROM-L-Lat	44.3 (9.0)	46.3 (10.4)	0.32	0.2	45.6 (13.3)	42.9 (9.5)	0.30	0.2

Abbreviation: SD: Standard Deviation; CVA: Craniovertebral Angle; CROM: Cervical Range of Motion; Flex: Flexion; Ext: Extension; R-R: Right Rotation; L-R: Left Rotation; R-L; Right Lateral Flexion; L-L: Left Lateral Flexion

* Independent t-test

Results of the forward logistic regression indicated that excessive smartphone use and BMI are significant predictors of FHP (-2 Log likelihood= 58.5, p<0.01). Participants who were addicted were more than four times more likely to have FHP than those who were not (Odds Ratio [OR] with 95 % confidence interval [CI] =4.5 [1.2, 10.7]; p= 0.03). In addition, participants with a higher BMI tended to have more FHP (OR = 1.4 [1.1, 1.7]; p=0.02).

In the non-addicted group, mean cervical ROM in extension was significantly different between those who had FHP and those who did not (p=0.05; Table 4). However, in the addicted group, mean cervical ROM in right rotationand right lateral flexion were significantly different between participants who had FHP and those who did not (p<0.05; Table 4). Mean cervical ROM in left lateral flexion was lower in participants who had FHP compared to those who did not; however, this was not statistically significant (p=0.07).

Table 4: Mean (SD) of the Cervical ROM Variables by Group (Addicted vs. non-addicted) and FHP (N=50).

	Addicted (N_1=32)				Non-addicted (N_2=18)			
Variable	FHP (n_1=20)	Normal (n_2=12)	*p*-value*	Effect size	FHP (n_1=06)	Normal (n_2=12)	*p*-value*	Effect size
CROM-Flex	58.1 (14.0)	61.3 (11.3)	.25	0.3	61.5 (9.2)	61.1 (12.5)	.47	0.04
CROM-Ext	61.5 (13.4)	64.3 (10.9)	.27	0.2	53.0 (14.5)	69.4 (15.8)	.05	1.1
CROM-R-R	64.0 (6.6)	68.3 (7.6)	.01	1.0	60.2 (2.2)	63.0 (15.7)	.34	0.3
CROM-L-R	64.5 (10.5)	68.8 (8.4)	.12	0.5	67.3 (4.4)	64.7 (11.9)	.30	0.3
CROM-R-Lat	36.8 (9.4)	47.3 (11.1)	.04	1.0	42.7 (8.5)	40.2 (8.4)	.28	0.3
CROM-L-Lat	42.7 (10.8)	48.8 (11.2)	.07	0.6	40.8 (14.5)	46.2 (6.3)	.14	0.5

Abbreviation: SD, Standard Deviation; CVA: Craniovertebral Angle; CROM: Cervical Range of Motion; Flex: Flexion; Ext: Extension; R-R: Right Rotation; L-R: Left Rotation; R-L; Right Lateral Flexion; L-L: Left Lateral Flexion

* Independent t-test

DISCUSSION

This study objective was to evaluate the effects of smartphone addiction, comparing those who were addicted to those who were not, on CVA and cervical ROM among children aged between 8 and 13 years who used smartphones. The CVA and cervical ROM were measured to determine the effects of prolonged usage of smartphones on cervical posture. In both boys and girls, the FHP was more substantialin the addicted group than in the non-addicted group, which was shown by the smaller cervical angles. Also, among those who had FHP and those who did not, the mean cervical ROM was significantly lower in the addicted group than in the non-addicted group.

Furthermore, there was a strong relationship between both smartphone addiction score and BMI with CVA. We found that addiction score and BMI were strong predictors of FHP. Participants who were addicted to their smartphone were four times more likely to develop FHP, and those with higher BMI had larger FHP. Our results were in agreement with Park et al. (2015)[10], who reported that heavy smartphone users tended to have more FHP. Besides, Song et al. (2014)[27] stated that obese school male children developed more FHP compared to normal weight male children.

Our participants in the addicted group tended to have greater FHP, which reduced their cervical ROM mobility in comparison to the non-addicted group. We used a cervical angle of less than 50° as indicative of FHP, as per the guideline of Diab and Moustafa (2012) [30]. Also, participants who were addicted to smartphones had lower CVA, which is in agreement with the findings that were reported by Park et al. (2015)[13], who found that the CVA was significantly higher in adults who used their smartphones frequently than regular users. Our findings are also consistent with the results of Lee et al. (2016) [23], which indicated that among the adult population the CVA was affected by different postures (standing, chair sitting, and floor sitting) and by the amount of time spent using smartphones. CVA results were noted to be lower in the standing position than in other positions. However, in this study, cervical angles were noted as being low in the sitting position only.

In our study, both boys and girls in the addicted group had significantly lower mean CVA than those who were not addicted. Moreover, the lower CVA for boys and girls were clinically significant, as indicated by the large effect size. However, gender differences have been observed in other studies. Ruivo et al. (2014) [15] and Hakala et al. (2006) [33] found that girls had more FHP than boys when the postural alignment of the heads and shoulders were examined in a natural standing position. Chiu et al. (2002) [34] reported similar findings in adults, where females had more FHP than males during computer use. On the other hand, Gold et al. (2011)[35] reported that boys showed greater FHP while typing on smartphonesthan girls did. However, McEvoy et al. (2005) [36] and Van Niekerk et al. (2008)[37] did not find gender differences in children and pre-school children for habitual cervical posture.

It appears that the cases of cervical spine angle abnormalities occurred in participants who consistently flexed their neck forward. Hansraj (2014) [12] showed that the load on the cervical spine increases dramatically as the neck flexion increases. Fredriksson et al. (2002)[38] and Park et al. (2015)[13] found that forward neck flexion at different degrees increases the stress on the cervical spine, which changes the natural curve and surrounding structure of the cervical angle. Therefore, a reduction in the cervical angle may cause cervical dysfunction. Kim et al. (2015) [25] reported that smartphone users complained of mild pain in the neck due to greater flexion of the cervical spine.Quek et al. (2013) [21] found an association betweengreater neck flexion and cervical ROM deficits.

Moreover, Kee et al. (2016) [22] detected limited cervical ROM in children who were addicted to smartphones because of their poor habitual posture. Kim et al. (2016) [39] reported that smartphone users complained of stiffness and imbalance in the muscles around the neck due to continual neck flexion.Constant neck flexion over time developed FHP, which may have resulted in shortening of the posterior cervical muscles and weakening and lengthening of the anterior cervical muscles [17]. FHP not only weakens the middle and lower trapezius, semispinalis capitis, and levator scapulae but also mid-thoracic rhomboid muscle. On the other hand, upper trapezius, sternocleidomastoid (SCM), splenius, and pectoralis major can be shortened [40, 41]. Furthermore, an increase in lower cervical spine lordosis, rounded shoulder, and thoracic spine kyphosis may occur as a result of FHP [42].

This study found that addicted boys had significantly limited cervical ROM in extension only; however, addicted girls had no cervical ROM limitation (Table 3). Cervical ROM in addicted participants who had FHP was significantly limited in right rotation and right lateral flexion when compared to those without FHP. We believe this is probably due to hyperflexion as they regularly view their smartphones. These findings were similar to those of De-La-Llave-Rincon et al. (2009) [20], (20)Moawd et al. (2015) [43], and Kee et al. (2016) [22], who found limitations in cervical ROM in most neck movements except for left lateral flexion. As FHP compresses the cervical facet joints, it may affect the biomechanics of the neck, thus resulting in less cervical ROM mobility, as reported by Shah and Varghese (2016) [44].

However, no significant changes were noted between participants with versus without FHP in cervical ROM in flexion and left rotation. This finding was not consistent with Quek et al. (2013) [21], who found that the use of smartphones in adults affected cervical ROM in flexion. Also, Yoo and colleagues (2009) [45] showed that cervical ROM in the right and left rotation was not significantly limited. They also reported that in individuals with neck pain the cervical ROM in extension tends to be limited, but that this was not found in flexion.

The findings of this study also support the published recommendation by Reid Chassiakos et al. (2016) [8] regarding the effects that smartphone users can have on children and adolescents if it is not monitored properly. They stated that children and their parents need to be educated on the effects of prolonged smartphone usage and on the need for balance between the time spent using smartphones and doing other physical activities. Maintaining proper posture while using smartphones is highly important as well because this could lead to improved cervical spine posture and help prevent future impairment or pain [46].

Limitations

This study has a few limitations. First, the cervicothoracic angle, thoracic kyphosis, and lumbar lordosis were not measured during smartphone use. The spine is a linked system in which the degree of lumbar lordosis and thoracic kyphosis may affect the degree of cervical flexion [47]. Also, this study did not investigate children's levels of activity and their homework loads. Therefore, it is not clear whether school activity levels, extracurricular activities, and workloads at home could affect the spinal development and posture of the participants.

Recommendations

To our knowledge, most previously reported studies focused primarily on adults. Therefore, there is a strong need for more studies on smartphone use among young children and its effects on their overall health. Also, further research is recommended to define if the gender plays a role in cervical posture and to investigate any potential relationship between neck pain and addiction of smart phones in children. Also, the cervical repositioning errors in children who overuse smartphones have not, to our knowledge, been studied. Future studies are also recommended to investigate the effects of smartphone exposure among a younger age group (toddler and preschool) and on different sitting styles. There are other reasons why children might develop FHP that should be investigated, such as backpack use, time spent sitting for schoolwork, video game usage, and poor body image.

CONCLUSIONS

We conclude that smartphone addiction that defined by using SAS-SV questionnaire significantly affects CVA, which may lead to a reduction in cervical ROM mobility among both boys and girls. Because of the increased neck flexion that occurs while viewing smartphones, there might be greater FHP and less cervical ROM mobility eventually. Therefore, it is important to maintain a neutral cervical posture while using smartphones, to avoid neck abnormalities. Also, education regarding proper posture is recommendedto help children preserve their cervical function while using smartphones.

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ABBREVIATIONS

ROM	Range of Motion
FHP	Forward Head Posture
CROM	Cervical Range of Motion Device
SCM	Sternocleidomastoid
CVA	Craniovertebral Angle
SPSS	Statistical Product and Service Solutions
BMI	Body Mass Index
COG	Center of Gravity
SD	Standard Deviation
CI	Confidence Interval

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