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Correlation between craniovertebral angle, rounded shoulder, pectoralis minor tightness and chest expansion among college students

[1]Dr. Manju, [2]Dr. Sharanjeet Saroa, [3]Dr. Gaytri
[1]Physiotherapist, [2]Asstt. Professor, [3]Asstt. Professor,
[1]Physiotherapy,
[1]Prem Physiotherapy and Rehabilitation, Panipat, India

Abstract
The purpose of this study was to investigate the correlation between craniovertebral angle, rounded shoulder, pectoralis minor tightness and chest expansion among college students. Fifty College students with CV angle <49.9º and age group of 18-30 years were included in the study. Participants were selected with convenient sampling method. Measurements were taken to find out the correlation: a) Craniovertebral angle was measured by using electronic head posture instrument. b) Chest expansion was measured by using measuring tape. c) Rounded shoulder posture was measurement by using plumb line. d) Pectoralis minor tightness by using table top test. Our results showed that there was no significant correlation between craniovertebral angle, rounded shoulder, and chest expansion and pectoralis minor tightness in college students. Study findings revealed that greater the measured cranio-vertebral angle, the more ideal will be the alignment of the head and neck; whereas the smaller the cranio-vertebral angle, the more serious will be the degree of forward head posture. Thus, concluded that there was no significant correlation between craniovertebral angle, rounded shoulder, and chest expansion and pectoralis minor tightness in college students.

Keywords: Craniovertebral angle, electronic head posture instrument, forward head posture, rounded shoulder, chest expansion, pectoralis minor muscle tightness.

INTRODUCTION

Forward head posture is defined as "any alignment of the body in which the external auditory meatus is positioned anteriorly to the plumb line through the shoulder joint" and this posture is called as "Text neck", "Scholar's neck" and "Reading neck". The craniovertebral angle is one of the most common angles used for assessing the forward head posture. The tasks of using laptops are expanding day-by-day specifically in education, business, publishing, banking and even entertainment.[1, 2] Smartphone addictions is often directed by an internet overuse problem or internet addiction disorder. Most individuals use smart phones with the head shifted forward and the smart phone placed close to the waist or lap while in a sitting position. Moreover, the maintenance of this position (head shifted forward) decreases the lordosis of the lower cervical vertebrae and creates a posterior curve in the upper thoracic vertebrae to maintain balance- known as the forward head posture.[3] Forward head posture is considered to exist together with hyperextension of upper cervical spine, flattening of lower cervical spine, rounding of the upper back and elevation and protraction of the shoulders.[4] The increasingly common causes of forward head posture are incorrect practice and improper body position during everyday routine activities. For example, forward movement of head while sitting at a desk, working with computer and studying, introduces extra load on the anti-gravity muscles of the neck; so, these muscles are stretched and it can cause fatigue and neck pain.[5] The FHP not only affects the functional movement of neck but also affects breathing. The loss of strength in neck muscles leads to instability of thoracic spine and alters the mechanics of chest expansion.[6] Measurement of chest expansion is one of the important steps in clinical examination of respiratory system and this can be done by chest palpation with hands or more accurately by using of tape measurement. According to this study normal range of chest expansion was (2-5 cm) (mean=3.35cm, SD=0.685) for females and (2 - 5.5cm) (mean=3.38 cm, SD=0.734) for males.[7] Chest expansion can be measured at the axillary level, nipple level and xiphisternum level in sitting position by using a measuring tape. Measurements can be taken at the end of deep inspiration and expiration and the difference between the two values represents the participant's chest expansion.[16] Rounded shoulder is a protrusion of the acromion of the shoulder joint relative to the centerline of gravity of the body, causing stooped posture along with elevation, protraction, and downward rotation of the scapula, and an increased angle between the lower

neck bone and upper spine.[8] Rounded shoulder posture (RSP) is a specific postural abnormality that might cause pain in shoulder joint and pathologic conditions such as subacromial impingement syndrome, adhesive capsulitis, and rotator cuff disease. Rounded shoulder posture (RSP) is corrected by pectoralis muscle stretching or manual release and scapular repositioning or stabilization exercises and wall push-up exercises are frequently used by physical therapist. [9] RSP could lead to muscle imbalance in the form of shortening of the anterior shoulder muscles such as the pectoralis minor and major, serratus anterior, and upper trapezius and lengthening of the posterior shoulder muscles, middle and lower trapezius and rhomboids. This muscle imbalance leads to alteration in the scapular and glenohumeral orientation, as well as kinematics, thus increasing the risk of developing neck, shoulder, and nonspecific arm pain. The rounded shoulder has been involved in the constricted sliding of the cords of the brachial plexus, as a consequence increasing strain on the various nerves passing through the shoulder region, mainly the median nerve. “SICK” scapula described as coracoid pain and malposition, scapular dyskinesis, and prominent inferomedial border of the scapula have been reported.[10] FHP is associated with rounded shoulders, a medially rotated humerus and a protracted scapula resulting in anterior translation of humeral head, tightness of posterior capsule, tightness of the pectoral, upper trapezius, and levator scapulae muscles, and weakness of the lower scapular stabilizers and deep neck flexors. [11] Repetitive upper limb activity that protract and downwardly rotate the scapula may lead to adaptive shortening of pectoralis minor. A pectoralis minor muscle that has been shortened through adaptation will not demonstrate normal flexibility and can lead to increase in scapular anterior tilting and internal rotation which can lead to shoulder impingement syndrome.[12] The craniovertebral angle was defined by Wickens and Kipath. It is found at the intersection of a line drawn from the tragus of the ear through the spinous process of C7 and a horizontal line through C7.[13] Normal craniovertebral angle is 49.9 degrees.1 A previous study states that greater the measured craniovertebral angle, the more ideal is the alignment of the head and neck; whereas the smaller the craniovertebral angle, the more serious is the degree of forward head posture.[14] A previous study by Lau and chiu (2010) evaluated the criterion-related validity of Electronic Head Posture Instrument (EHPI) in measuring the craniovertebral (CV) angle by correlating the measurements of CV angle with anterior head translation (AHT) by lateral cervical radiographs in patients with diagnosis of mechanical neck pain and was found to be a valid and reliable tool for measuring the head posture.[15] For muscle balance the position of scapula is very important, there is a significant relationship between the contraction abilities of the muscles in the shoulder region, and the position of scapula and due to poor posture, the shoulder protraction developed which creates disadvantage for muscle function. The pectoralis minor has also been recognized as a muscle which requires stretching in individuals having rounded shoulder posture. A pectoralis minor muscle that is relatively short due to adaptation would not indicate normal flexibility. Upper extremity is repetitively used for activities that protract and downwardly rotate the scapula may contribute to adaptive shortening of the pectoralis minor muscle and it eventually modify the resting position of the scapula and altering scapular mechanics during elevation. This can lead to an increase in scapular anterior tilting and internal rotation, which can be predisposed condition for shoulder impingement syndrome.[16] Previous study indicates that the prevalence of forward head posture was 63.96%, including male and female students. The forward head posture was found to be correlated with shoulder rolling forward.[5] There is lack of literature addressing the relation between craniovertebral angle, rounded shoulder, pectoralis minor tightness and chest expansion among college students. Thus, the aim of the current study is to investigate the correlation between craniovertebral angle, rounded shoulder, pectoralis minor tightness and chest expansion among college students.

NEED OF THE STUDY.

As we know, defective postures have become common, especially in the head and neck region, such as forward head posture (FHP). Previous studies shows that greater the measured cranio-vertebral angle, the more ideal is the alignment of the head and neck; whereas the smaller the cranio-vertebral angle, the more serious is the degree of forward head posture.10 There are many studies regarding cranio-vertebral angle but there is lack of literature which shows correlation between craniovertebral angle, rounded shoulder, pectoralis minor tightness and chest expansion among college students. Hence the need of study is to evaluate the correlation between craniovertebral angle, rounded shoulder, pectoralis minor tightness and chest expansion among college students.

RESEARCH METHODOLOGY

1.1 Population and sample

Sample size estimate was based on data collected from previous studies.[5,6,20] Fifty College students from Prem Physiotherapy and Rehabilitation College were recruited in this study through convenient sampling and gave their informed consent. Both female and male college students of age group of 18-30 years, and with CV angle <49.9º were included in the study.[6] The participants with history of cervical surgery, cervical injury and thoracic injury,[5] shoulder pathology,[2] scoliosis,[1] torticollis,[1] and respiratory problems [21] were excluded from the study.

1.2 Equipment and data collection

Following measurements were taken to find out the correlation:

a) Craniovertebral angle was measured by using electronic head posture instrument.

b) Chest expansion was measured by using measuring tape.

c) Rounded shoulder posture was measurement by using plumb line.

d) Pectoralis minor tightness by using table top test.

The data was compiled in MS Excel worksheet.

1.3 Test procedure

1. CRANIO-VERTEBRAL ANGLE MEASUREMENT:

Cranio-vertebral (CV) angle was measured using Electronic head posture instrument (EHPI). EHPI is composed of an electronic angle finder, a transparent plastic base, and a camera stand. The electronic angle finder was fixed on a transparent plastic base. The combined Smart Tool Angle Finder and the plastic base (now named as Angle Finder) was mounted on a tripod camera or video camera stand and then the craniovertebral angle was measured between a line joining the spinous process of C7 vertebra with the tragus of the ear and a horizontal line drawn through the C7 spinous process.[15] Adhesive pin markers were used to locate the position of C7 spinous process and the tragus of the ear. The Electronic head posture instrument was put on the standardized marking on the floor, and the tripod stand was adjusted to the position until the bubble of the horizontal indicator and the central marking overlapped. The distance from the participant's shoulder tip to the center of the tripod stand was standardized to 0.3 m while the distance between the operator's eyes and the tripod stand was 0.5 m because this was the longest distance that the tester would reach. [15] The participant was asked to stand with his/her left shoulder in front of the Electronic head posture instrument. The participant was instructed to stand comfortably with his/her weight distributed evenly on both feet and to keep the eyes looking straight forward. The participant was then instructed to flex and extend the head three times and then rest it in a comfortable position as shown in figure1&2. The therapist adjusted the Electronic head posture instrument until the two indicator lines were aligned with the markers. Three readings were taken and an average reading was taken as final reading. [15]

Fig.1: Measurement of CV angle

Fig.2: Measurement of CV angle

2. CHEST EXPANSION MEASUREMENT:

Chest expansion was measured at the axillary level (fig.3), nipple level (fig.4) and xiphisternum level (fig.5) in sitting position by using a measuring tape. Measurements was taken at the end of deep inspiration and expiration and the difference between the two values represents the participant's chest expansion.[16]

Fig.3: chest expansion at axilla level

Fig.4: chest expansion at nipple level

Fig.5: chest expansion at xiphoid level

3. ROUNDED SHOULDER MEASUREMENT:

Rounded shoulder(RS) posture was measured with the participant in standing posture. Plumb line was used to measure rounded shoulder. If the acromion process lies anterior to plumb line (fig.6 &7) then the posture was considered as rounded shoulder posture.[18]

Fig.6 RS as per the plumb line

Fig.7 RS as per the plumb line

4. PECTORALIS MINOR MUSCLE TIGHTNESS MEASUREMENT:

The patient was in supine lying position with his/her hands resting on abdomen and elbow in slight flexion. Then the therapist was measure the linear distance from the plinth to the posterior aspect of the acromion process by using a protractor (fig.8). If the measured distance was greater than 2.5cm (1 inch), it was considered significant for tightness of Pectoralis minor muscle.[17]

Fig.8 Table top test for pectoralis minor tightness

DATA PROCESSING AND STATISTICAL ANALYSIS

Descriptive statistics was analysed with SPSS software. Descriptive statistics like frequency (n) & percentage (%) of categorical data mean & Standard deviation of numerical data was depicted. The Statistical data was analyzed by Pearson's

test to see the correlation between craniovertebral angle, rounded shoulder, pectoralis minor tightness and chest expansion of the participants.

IV.RESULTS AND DISCUSSION

This study was done on 60 college students, the presence of forward head posture was determined in 50 students while on the other hand 10 students with neutral head posture i.e.no forward head posture were not included in the study. 50 students with forward head posture fulfill the inclusion criteria and included in the study. The measured values of craniovertebral, rounded shoulder, chest expansion and pectoral minor muscle tightness arepresented in table no.3.1,3.2,3.3,3.4,3.5 and graph no.3.4 a), 3.5 a).

The Pearson's test was done to correlate the craniovertebral angle, rounded shoulder, chest expansion and pectoralis minor tightness. P value is more than 0.05 therefore result shows no significance correlation between craniovertebral angle, rounded shoulder, chest expansion and pectoralis minor tightness in the table no. 3.1,3.2,3.3,3.4,3.5 and graph no.3.4 a), 3.5 a).

1.CRANIOVERTEBRAL ANGLE:

a) The Mean and SD values of CV angle and chest expansion at axillary level are listed in Table 3.1 There were no significant differences between CV angle and chest expansion at Axillary level as Pearson's correlation value was -0.051 & P value was 0.723 which is greater than 0.5

Table 3.1: Showing the correlation of mean and SD value of CV Angle and Chestexpansion At Axillary level.

Pearson's Correlation	PAIR	
	CV Angle (%)	At Axillary (Avg)
Mean	44.564	89.268
SD	1.699	10.591
N	50	
Correlation	-0.051	
Table Value	0.279	
P Value	0.723	
Result	Not Significant	

b) The Mean and SD values of CV angle and chest expansion at nipple level are listed in Table 3.2 There were no significant differences between CV angle and chest expansion at Nipple level as Pearson's correlation value was -0.140 & P value was 0.331 which is greater than 0.5

Table 3.2: Showing the correlation of mean and SD value of CV Angle and Chestexpansion at Nipple level.

Pearson's Correlation	PAIR	
	CV Angle (%)	At Nipple (Avg)
Mean	44.564	88.035
SD	1.699	9.893
N	50	
Correlation	-0.140	
Table Value	0.279	
P Value	0.331	
Result	Not Significant	

c) The Mean and SD values of CV angle and chest expansion at xiphoid level are listed in Table 3.3 There were no significant differences between CV angle and chest expansion at xiphoid level as Pearson's correlation value was -0.005 & P value was 0.971 which is greater than 0.5

Table 3.3: Showing the correlation of mean and SD value of CV Angle and Chestexpansion at Xiphoid level.

Pearson's Correlation	PAIR	
	CV Angle (%)	At Xiphoid (Avg)
Mean	44.564	80.715
SD	1.699	10.937
N	50	

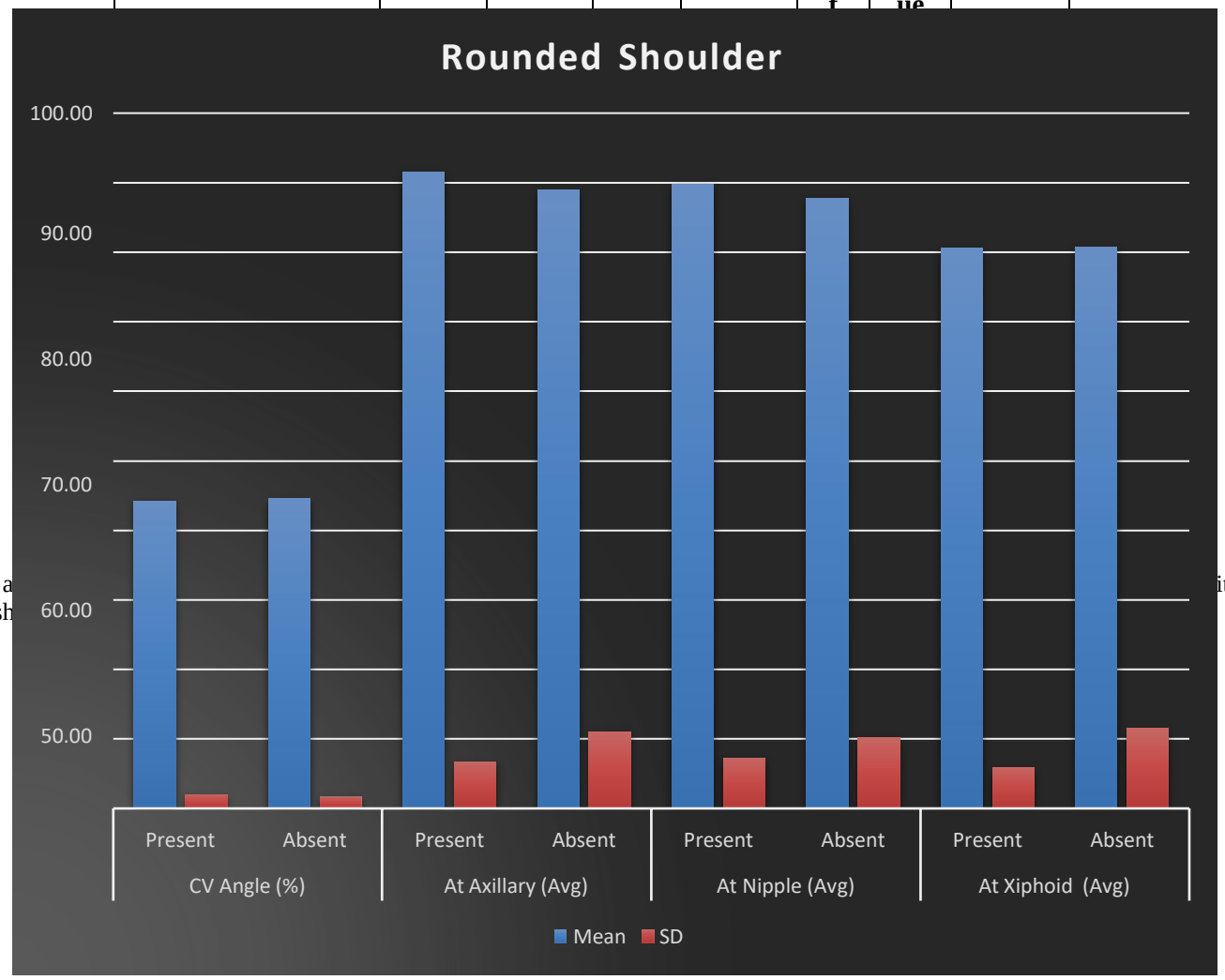
Correlation	-0.005
Table Value	0.279
P Value	0.971
Result	Not Significant

2. ROUNDED SHOULDER : :

a) The values of Mean & SD are listed in Table 3.4 and t test was to find out the significance differences between mean values of Rounded shoulder, CV Angle and Chest expansion at Axillary, Nipple and Xiphoid level and also to find out the relation of rounded shoulders with the CV angle. As the t values are zero and P values are less than 0.05, this indicates no correlation of Rounded shoulders with the CV angle.

Table 3.4: Correlation between Rounded shoulder, CV Angle and Chest expansion at Axillary, Nipple and Xiphoid level.

Rounded Shoulder	Mean	SD	N	Mean Diff.	T Test	P Value	Result



Graph 3.4 a ith Rounded sh

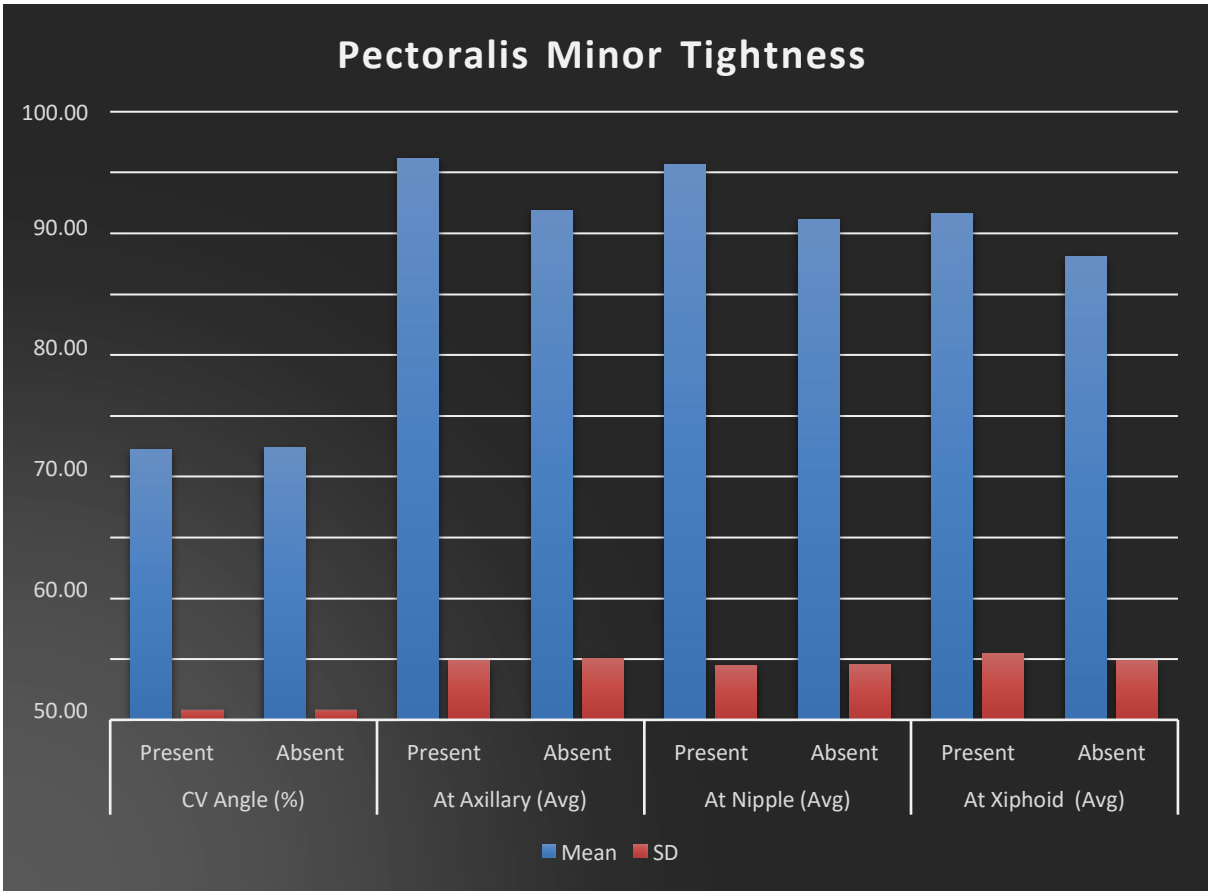
3.PECTORALIS MINOR TIGHTNESS :

a) The Mean & SD values are listed in Table 3.5 and t test was to find out the significance differences between mean values of Pectoralis Minor Tightness, CV Angle and Chest expansion atAxillary, Nipple and Xiphoid level and also to find out the relation of Pectoralis Minor Tightness with the CV angle. As the t values are zero and P values are less than 0.05, this indicates no correlation of Pectoralis Minor Tightness with the CV angle.

Table 3.5: Correlation between Pectoralis minor tightness, CV Angle and Chest expansionat Axillary, Nipple and Xiphoid level.

Pectoralis MinorTightness		**Mean**	**SD**	**N**	**Mean Diff.**	**T Test**	**P Value**	**Result**
CV Angle (%)	Present	44.43	1.71	32	-0.386	-0.768	0.446	Not Significant
	Absent	44.81	1.70	18				
At Axillary(Avg)	Present	92.33	9.74	32	8.492	2.923	0.005	Significant
	Absent	83.83	10.08	18				
At Nipple(Avg)	Present	91.29	8.93	32	9.039	3.424	0.001	Significant
	Absent	82.25	9.02	18				
At Xiphoid(Avg)	Present	83.27	10.87	32	7.085	2.292	0.026	Significant
	Absent	76.18	9.76	18				

Graph 3.5 a): Showing the change in mean and SD value of CV Angle and Chest expansion atAxillary, Nipple and Xiphoid level with Pectoralis minor tightness.



The purpose of this study was to see if there was any association between craniovertebral angle, rounded shoulder, chest expansion and pectoralis minor tightness in college students. In this study, convenient sampling was used. A total of 60 students took part in the study. To assess forward head posture, craniovertebral angle was measured with electronic head posture instrument. To assess rounded shoulder posture, chest expansion and pectoralis minor tightness, a plum line, measuring tape and a table top test were used respectively. This study proved that there was no significant correlation between craniovertebral angle,

rounded shoulder, chest expansion and pectoralis minor tightness in college students,proving the null hypothesis.

The current study included 60 students out of which 50 students who had fulfilled the inclusion criteria were included in the study. The study findings revealed that greater the measured cranio-vertebral angle, the more ideal will be the alignment of the head and neck; whereas the smaller the cranio-vertebral angle, the more serious will be the degree of forward head posture. This study concluded that there was no significant correlation between craniovertebral angle, rounded shoulder, chest expansion and pectoralis minor tightness in college students.

In the Present study, cranio-vertebral angle and rounded shoulder posture showed no significant correlation. Current study is supported by Eun-Kyung Kim, PT, Ph[1], Jin Seop Kim, PT, PhD[2] they conducted a study to examine the correlation between rounded shoulder posture, neck disability indices and the degree of forward head posture. The findings concluded that no significant correlation was detected between craniovertebral angle and rounded shoulder posture in standing and sitting positions. Kim and Kim, assessed the degree of rounded shoulder by the height of the acromion of the dominant shoulder joint that was measured in the supine position. In our study plumb line had been used in standing position to assess rounded shoulder instead of supine position[8].

In the study of Jung Won Kwon, Sung Min Son, Na Kyung Lee, sitting position only was used to check the cranio-vertebral angle, as in sitting position; forward head inclination involves a combination of lower cervical flexion, upper cervical extension, and rounded shoulders, which reduce the average lengths of muscle fibres, contributing to extensor torque around the upper cervical joint. In addition, this abnormal state causes musculoskeletal abnormalities such as decreased scapular upward rotation as well as greater internal rotation and anterior tilting, which may lead to difficulties maintaining an upright sitting posture[28]. In the current study we have used only standing position to check the cranio-vertebral angle.

In the study of Patricia Griegel-Morris, Keith Larson, Krissann Mueller-Klaus and Carol A Oatis, posture was assessed by the three experimenters with subjects standing comfortably and quietly in front of and alongside a plumb line suspended from the ceiling. A standard for normal alignment as described by Kendall and McCreary is frequently used by physical therapists. The points of reference consisting of the lobe of the ear, the seventh cervical vertebra, the acromion process, the greater trochanter, just anterior to midline of the knee, and slightly anterior to the lateral malleolus form a theoretical line around which the body is balanced in perfect skeletal alignment, yielding equal weight distribution and maximum joint stability. As viewed from the sagittal plane, forward-head position (anterior deviation of the ear), rounded shoulders (anterior displacement of the acromion), and increased thoracic kyphosis (an increase in the convexity of the thoracic spine) were observed from the left and right[29].

The results of the current study are also supported by Ashiyat K. Akodu, Sunday R. Akinbo, Queen O. Young, who conducted a study to find the correlation among smartphone addiction, craniovertebral angle, scapular dyskinesis and selected anthropometric variables in physiotherapy undergraduates. The finding of the study suggests that undergraduates are susceptible to smartphone addiction. This can result in a decrease in craniovertebral angle, which, in turn, leads to a forward head posture that invariably causes an increase in scapular dyskinesis in young adults[3].

In the present study, forward head posture and rounded shoulder posture were not significantly correlated. Current study is not supported by Deepika Singla, Zubia Veqar, they conducted a study to explore the association between forward head posture, rounded shoulders and increased thoracic kyphosis. They concluded that forward head posture, rounded shoulders, and increased thoracic kyphosis can exist alone or in any combination. Alteration in the resting scapular position is thought to occur with abnormal alignment of the cervical and thoracic spine. Forward shoulder posture can be associated with FHP, increased thoracic kyphotic posture or both[10].

Hussain SA, Pereira FA, Sajid M, Ahmad I, Saad SM, et al., concluded that significant differences were obtained in readings of forced vital capacity and forced expiratory volume between those with rounded shoulders and those without rounded shoulder (p-value= 0.000 and 0.003 respectively). Postural changes effect vital capacities[30].

Ozge Solakoglu, Peyman Yalcin, Gulay Dincer, found a weak relationship between FHP and expiratory muscle weakness, while no significant relationship was observed between FHP and inspiratory muscle strength[31]. Furthermore, FHP primarily affects the neck muscles and these muscles are usually accessory inspiratory muscles. However, we found no significant correlation between the chest expansion and FHP in our study[31].

When Jae-hyeon Kim, Yeon-woo Jeong, Su-jin Kim, compared the pulmonary functions of a forward head posture group and a control (healthy) group, the FVC in the forward head posture group was 81.95 percent, while the FVC in the control group was 93.54 percent, indicating that the FVC in the forward head posture group was slightly lower than the control group. As the forward head posture causes the shortening and weakening of accessory respiratory muscles such as serratus anterior, pectoralis major, pectoralis minor muscle, as they help them during the inspiration phase of breathing. Pectoralis minor is the muscle that helps the serratus anterior to draw the scapula to the chest and helps to check the gap from the acromion to the treatment table during deep inspiration, as stated in the introduction[32].

In the present study, forward head posture and chest expansion were not significantly correlated. Current study is not supported by Jintae Han, Soojin Park, Youngju Kim, Yeonsung Choi, Hyeonnam Lyu, they conducted a study to check the effect of forward head posture on forced vital capacity and respiratory muscle activity. They concluded that forced vital capacity and forced expiratory volume in 1 second were significantly lower in the forward head posture group than in the normal group. Accessory respiratory muscle activity was also lower in the forward head posture group than in the normal group. In particular, the sternocleidomastoid and pectoralis major activity of the forward head posture group was significantly lower than that of normal

group. Activities of the other muscles were generally decreased with forward head posture, but were not significantly different between the two groups. These results indicate that forward head posture could reduce vital capacity, possiblybecause of weakness or disharmony of the accessory respiratory muscles[33].

In the present study, forward head posture and chest expansion were not significantly correlated. Current study is not supported by Taiichi Koseki, Fujiyasu Kakizaki, Shogo Hayashi, Naoya Nishida, Masahiro Itoh, in 2019, they conducted a study to check the effect of forward head posture on thoracic shape and respiratory function. They concluded that the forward head posture significantly affects the chest expansion and thus alter the respiratory function.[34]

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Research Highlights>

- This study was the first to find correlatation between craniovertebral angle, rounded shoulder and pectoralis minor tightness among college students.
- We evaluated the craniovertebral angle of the students at 3 different levels.
- We evaluated the rounded shoulder of the students.
- We evaluated the pectoralis minor tightness of the students.
- We found no correlation between craniovertebral angle, rounded shoulder and pectoralis minor tightness among college students.