

# Relation of Trunk Muscles Strength and Endurance to Severity of Forward Head Posture in Young Adults: An Observational Study

Bharati Asgaonkar<sup>1</sup>, Samiksha Moharkar<sup>2</sup>

<sup>1</sup>Associate Professor, <sup>2</sup>Postgraduate student (Musculoskeletal Physiotherapy), Physiotherapy School and Centre, TNMC & BYL Nair Charitable Hospital, Mumbai, Maharashtra, India.

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## Abstract

**Background and Objective:** Forward head posture is the common habitual poor posture seen in young adults. This study correlates Trunk muscles strength and endurance with severity of forward head posture in young adults.

**Methods:** A total of 70 individuals with Forward Head Posture and Craniovertebral Angle (CVA) less than 48° were enrolled in the study. The Trunk Muscle Strength was assessed using Hand Held Dynamometer. The Trunk flexor, extensor, side flexors and lower back extensors endurance was assessed using endurance tests. The trunk muscle strength and endurance were then correlated with severity of forward head posture.

**Results:** There was no correlation found between the trunk flexor strength and severity of FHP. But there was statistically significant correlation between the trunk extensor strength and severity of FHP. Also, no correlation was found between the trunk muscles endurance and severity of FHP.

**Conclusions:** Trunk Extensor muscles strength decreases with the decrease in CVA.

**Keywords:** Forward Head Posture, Trunk Muscles, Posture, trunk muscle strength, trunk muscle endurance.

## Introduction

Forward Head Posture (FHP) is defined as the anterior positioning of the cervical spine. [1] It is many of the times associated with pain, fatigue, muscle imbalance and limited range of motion of the cervical spine [2]. It is worth noting that forward head posture not only affects the function of the head and neck musculoskeletal structures, but also affects the whole body postural control [3]. Localized fatigue in the stabilizing spinal musculature may occur with repetitive activity or heavy exertion or

when the musculature is not utilized effectively due to faulty posture. There is a greater chance of injury in the supporting structure of the spine when the stabilizing muscles fatigue. [4] The Craniovertebral Angle (CVA) is defined as the angle of the horizontal line running through the C7 spinous process and the line connecting the C7 spinous process to the tragus of the ear. [5] CVA is commonly used as an indicator of FHP which is due to muscle imbalance, related to pain, fatigue and limited motion of the cervical spine. [2] Yip et al [5] reported that participants with significantly smaller craniovertebral angles had FHP

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**Corresponding Author:** Samiksha Moharkar, Postgraduate student (Musculoskeletal speciality), Physiotherapy School and Centre, TNMC & BYL Nair Charitable Hospital, Mumbai, Maharashtra, India.

**E-mail:** drsamikshamoharkar@gmail.com

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and tended to have increased levels of neck pain. FHP is one of the most commonly found abnormalities that is mostly present in the cervico-thoracic parts of the spine. <sup>(6)</sup> This spinal deviation is often related to prolonged poor sitting posture during driving, reading, or even texting on smart devices. <sup>(6,7)</sup> There have been studies that suggest that the abnormality or deviation of the normal posture in the cervical spine causes the deviation of the curves in other segments of the spine. This may lead to changes in the lengths of the trunk muscles i.e. abdominal and back extensors. And this in all may have an effect on the strength of the muscles which needs to be evaluated. <sup>(8)</sup> Therefore, the assessment of the lumbar strength can be used to avoid primary and secondary traumas. <sup>(9)</sup>

### Objectives

This study was conducted with the aim of determining if the trunk muscle strength and endurance is correlated with the severity of forward head posture in young adults.

### Methods

The study was conducted on a total of 70 young adults with forward head posture (FHP). After the approval from Institutional Ethics Committee (Ethics committee Ref no. - PT/87/ECARP/2021/55, date: 10<sup>th</sup> June 2021), informed consent was obtained. The data collection was commenced in the OPD of P.T. School and Centre, T.N.M.C., Mumbai in 2021. The data collection was done for 6 months. The subjects were screened according to the inclusion and exclusion criteria mentioned in table 1 and informed consent was taken. Each participant participated in a single testing session. The forward head posture was confirmed by measuring the craniovertebral angle (CVA). The strength of trunk muscles were measured using the handheld dynamometer. The endurance of trunk muscles were measured using the tests for the respective group of muscles.

*Craniovertebral Angle:* The angle for forward head posture was measured using the photogrammetry method. <sup>(10)</sup> The angle was measured using the MB Ruler software. <sup>(11)</sup>(Fig 1)



**Figure 1: Assessment of craniovertebral angle (CVA) using the Photogrammetry technique and MB Ruler software.**

*Trunk muscles strength:* The strength for trunk flexor muscles and extensor muscles was measured using the hand held dynamometer. The isometric strength of trunk flexors was assessed in supine position at thirty degree by placing the hand held dynamometer under the suprasternal notch. Subjects were asked to put their hands over the opposite acromion processes. A belt was wrapped just above the lateral malleolus and another belt over the anterior superior iliac spine (ASIS) to prevent lumbar motion. <sup>(10, 13)</sup> (Fig 2). The isometric strength of trunk extensors was assessed in prone position. The dynamometer was placed at the level of T4 and subjects were asked to put their hands on forehead. A belt was wrapped over the posterior superior iliac spine. Subjects were instructed to maximally contract the muscle for five seconds and the peak value was noted in kgs. <sup>(10, 13)</sup> (Fig 3)



**Figure 2: Assessment of trunk flexor muscle strength using the Hand Held Dynamometer.**



**Figure 3: Assessment of trunk extensor muscle strength using the Hand Held Dynamometer.**

*Trunk muscles endurance:*

*Trunk flexor:* This was assessed using Trunk Flexor Endurance Test (TFET). The test was done with participant sitting on a table with his back supported at an angle of 60 degrees. Hips and knees were flexed to 90 degrees and feet were fixed to the table. The arms were crossed across the chest and the subjects were asked to maintain the position while the support was pulled back 10cm at the start of the test. This continued as long as the position was maintained and the duration was noted in seconds using the stop watch. <sup>(14)</sup>(Fig 4)



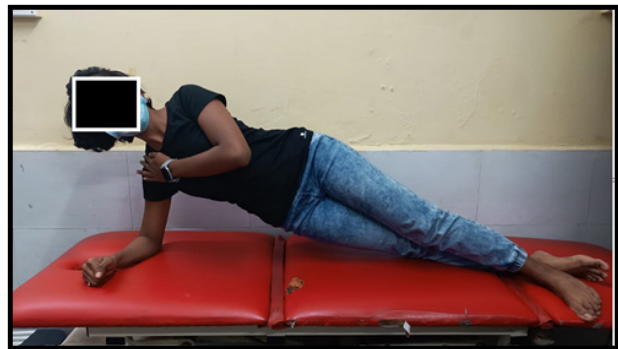
**Figure 4: Assessment of trunk flexor endurance using the Trunk Flexor Endurance Test (TFET)**

*Trunk extensors:* Trunk extensor endurance was assessed using Biering-Sorenson test (BST). The subject was asked to lie prone with his lower body fixed to the table by straps. Upper body was out of the table and extended over a stool. The participant was asked to release the table while upper extremity was held in crossed position on chest. The participant was instructed to maintain the position horizontally as long as possible and the duration of hold was noted. <sup>(15)</sup> (Fig 5)



**Figure 5: Assessment of trunk extensor endurance using the Biering-Sorenson test (BST)**

*Trunk lateral flexors:* Lateral flexors endurance was assessed using side bridge test (SBT). The subject was asked to lie on one side with legs positioned at extension. The upper leg was placed in front of the lower leg. The participants were instructed to lift off their hips and maintain the full body in straight line. The test terminated when the hips returned to the table and the duration was noted in seconds using the stopwatch. Same procedure was done for the other side. <sup>(14)</sup> (Fig 6)



**Figure 6: Assessment of the lateral Flexors using the Side Bridge Test (SBT)**

*Lower Back extensors:* For the lower back endurance prone double straight leg raise test (PDSLRT) was used, the participants were asked to lie in a prone lying position with the hips extended. The hands were held underneath the forehead. The subjects were asked to lift off both legs until the knee clearance was achieved. The test continued as long as the position was maintained and the duration was noted in seconds using the stop watch. <sup>(16)</sup>(Fig 7)



**Figure 7: Assessment of lower back muscle endurance using the Prone Double Straight Leg Raise Test (PDSLRT)**

**OUTCOMES:** The demographic data such as age, sex, height, weight, body mass index (BMI) was taken prior to the tests. (Table 2) Trunk muscle strength was measured using handheld dynamometer in kg. Trunk muscle endurance was measured using the various tests mentioned above. (Table 3)

### Results and Discussion:

The study included 70 participants (48 females, 22 males) with a mean age of  $21.97 \pm 2.53$  years and a mean BMI of  $21.32 \pm 2.22$  kg/m<sup>2</sup>. The mean craniovertebral angle (CVA) was  $45.91 \pm 2.37$  degrees, with a range from 39.29 to 48 degrees. The mean trunk flexor strength was  $8.68 \pm 2.37$  kgs, with a range from 4kg to 15kg. The mean trunk extensor strength was  $10.42 \pm 1.71$  kgs, with a range from 8kg to 17kg. The mean Biering-Sorenson test time was  $60.44 \pm 34.93$  seconds, with a range from 8.46 to 162.19 seconds. The mean trunk flexor endurance time was  $99.10 \pm 63.85$  seconds, with a range from 21.76 to 300 seconds. The mean lateral flexor endurance time for right and left were  $38.94 \pm 22.46$  seconds and  $39.16 \pm 24.74$  seconds, respectively. The mean lower back endurance time using the prone double straight leg raise test was  $47.11 \pm 30.01$  seconds, with a range from 6.49 to 164.21 seconds. (Table 4).

The study examined the correlation between CVA and measures of core strength and endurance using Spearman's rho test. The correlation between CVA and trunk flexor strength was weak and not statistically significant ( $r_s = 0.2161$ ,  $p = 0.07238$ ). The correlation between CVA and trunk extensor strength was weak but statistically significant ( $r_s = 0.36369$ ,  $p = 0.00197$ ). The correlations between CVA and trunk extensor endurance, trunk flexor endurance, and lateral flexor endurance (right and left) were weak and not statistically significant ( $r_s$  ranging from 0.01934 to 0.18095,  $p$  ranging from 0.13385 to 0.87376).

These findings suggest that CVA may play a role in lumbar extensor strength, but the relationship is not strong. Barczyk-Pawelec et al. evaluated the isokinetic strength of the trunk muscles in children with normal and abnormal posture and observed that among the children with poor postures, the abnormal anteroposterior spinal curvatures of the spine was associated with the lower values of isokinetic muscle strength.<sup>(17)</sup> This justifies the relation between CVA and lumbar extensor strength. The results vary from the previous studies and this might be because the present study measured isometric strength as compared to the previous studies that used isokinetic strength.

On the other hand, the lack of a significant correlation between CVA and trunk endurance is somewhat surprising, as previous research has suggested that decreased CVA is associated with decreased muscle endurance in the trunk musculature<sup>(18)</sup> and that the core muscles are important stabilizers of the spine and may be affected by changes in head and neck posture.

To the best of our knowledge this is the first study to focus on correlation between trunk muscle strength, endurance and the severity of forward head posture. Thus, this study in contrast to the previous studies showed that there was no relationship of trunk muscles endurance with severity of forward head posture. This might also be due to the variance in sample population which included more of females (69%,  $n = 48$ ) than males (31%,  $n = 22$ ). Females as compared to males have shown to have lesser trunk muscle endurances.<sup>(19)</sup> The maximum samples in the present study were students. Also, only professional sports players were excluded from the study but the Physical activity as well as the occupation of the samples was not taken into considerations. These factors (physical activity and sedentary lifestyle) have shown to have an impact on back muscle endurance.<sup>(20)</sup>

It should be noted that the present study has some limitations that may have affected the results. For example, the sample size was relatively small, and the study only included young adults with normal BMI, so the findings may not be generalizable to other populations. In addition, the study only used static measures of trunk muscle strength and endurance, and did not assess dynamic movements or functional activities that may be more relevant to everyday activities.

**Table 1: inclusion and exclusion criteria.**

Inclusion Criteria	Exclusion Criteria
<ul style="list-style-type: none"> <li>• 18-30 years of age. Both genders.</li> <li>• Individuals having FHP. [ CVA <math>\leq 48^0</math>]<sup>(12)</sup></li> <li>• Patients with and without neck pain.</li> <li>• Individuals with normal BMI (18.5-24.9kg/m<sup>2</sup>).</li> <li>• Individuals willing to participate.</li> </ul>	<ul style="list-style-type: none"> <li>• Past History of any neurological, orthopedic or cardiopulmonary disease.</li> <li>• Participating in any sport at professional level.</li> <li>• Individuals with spinal deformities.</li> <li>• Symptomatic low back pain.</li> <li>• Any recent Fractures.</li> <li>• Congenital or acquired chest wall deformity.</li> </ul>

**Table 2: Demographic data of subjects.**

DEMOGRAPHICS	MEAN $\pm$ SD
Age	21.97 $\pm$ 2.53
Height	161.51 $\pm$ 7.88
Weight	55.72 $\pm$ 7.635
BMI	21.32 $\pm$ 2.22

**Table 3: descriptive statistical analysis of outcome measures.**

OUTCOME MEASURE	MEAN	S.D.	MINIMUM RANGE	MAXIMUM RANGE
CVA	45.91 <sup>0</sup>	2.37 <sup>0</sup>	39.29 <sup>0</sup>	48 <sup>0</sup>
TFS (kg)	8.68	2.37	4	15
TES (kg)	10.42	1.71	8	17
TFE (sec)	99.10	63.85	21.76	300
TEE (sec)	60.44	34.93	8.46	162.19
SFE (rt)(sec)	38.94	22.46	5.04	100.29
SFE (lt) (sec)	39.16	24.74	3.88	121.07
LBEE (sec)	47.11	30.01	6.49	164.21

**Table 4: correlation of severity of forward head posture (CVA) with trunk muscle strength and endurance.**

CVA Vs	r <sub>s</sub>	p-value	correlation	Significance
TFS	0.223	0.063	Weak positive	Not significant
TES	0.3127	0.0084	Weak positive	significant
TFE	-0.1174	0.334	Weak negative	Not significant
TEE	0.0443	0.715	Weak positive	Not significant
SFE (rt)	0.102	0.400	Weak positive	Not significant
SFE (lt)	0.0933	0.442	Weak positive	Not significant
LBEE	0.1411	0.244	Weak positive	Not significant

### Conclusion

In conclusion, the present study provides some evidence for a weak correlation between CVA and

trunk extensor strength, but no significant correlation between CVA and trunk flexor strength or endurance. Future research is needed to further investigate the relationship between CVA and measures of core

strength and endurance, using larger and more diverse samples and a broader range of outcome measures.

**Conflict of Interest:** The authors declare that they have no conflict of interest.

#### List of Abbreviations:

FHP- forward head posture

BMI- body mass index

CVA- Craniovertebral angle

TFS- trunk flexor strength

TES- trunk extensor strength

TFE- trunk flexor endurance

TEE- trunk extensor endurance

SFE- side flexor endurance

LBEE- lower back extensor endurance

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