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ASSOCIATION OF PEAK EXPIRATORY FLOW RATE WITH FORWARD HEAD POSTURE IN YOUNG ADULTS

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ABSTRACT

Background: Forward Head Posture (FHP) is a postural deviation where the lower neck (C4-C7) bends forward while the upper neck (C1-C3) and head extend backward, creating an exaggerated inward curve. This posture limits diaphragmatic expansion, reducing lung function by restricting breathing mechanics. Accessory muscles are recruited, rib cage mobility is reduced, and diaphragmatic ventilation is impaired, leading to decreased alveolar ventilation.

Objectives: The aim of the study is to investigate the association between Peak Expiratory Flow Rate (PEFR) and Forward head Posture.

Methodology: A cross-sectional analytical study was conducted in Ahmedabad involving 100 young adults aged 18-25 years who voluntarily participated. Individuals with orthopaedic, major neurological, and cardio-respiratory disorders were excluded. Participants exhibiting forward head posture were assessed by measuring their cranio-vertebral angle (CVA). PEFR was measured three times using a peak flow meter. As it requires effort, the highest value was used for analysis.

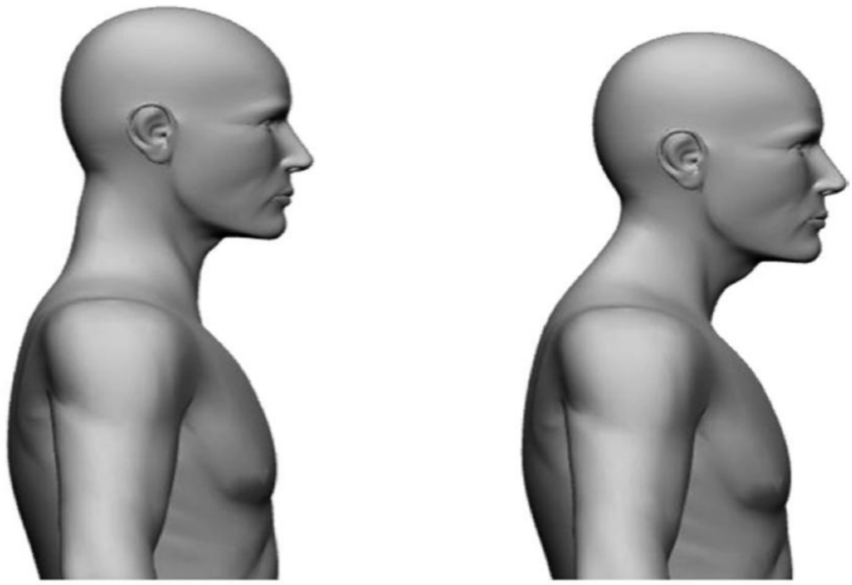
Results: Participants (mean age 21.46±2.19 years, mean BMI 23.33±4.41). Significant association was found between PEFR, CV angle (rho=0.325, p<0.001) and BMI (rho=0.323, p<0.001). No association was found between CV angle and BMI (rho=0.118, p=0.244). Data were analyzed using SPSS v20 with a 5% significance level, employing the Spearman correlation test.

Conclusion: A strong association was observed between PEFR and both CV angle and BMI in young adults. These findings suggest that postural assessment can help predict respiratory function and support integrating posture correction into respiratory care and rehabilitation.

Keywords: Forward Head Posture, Peak Expiratory Flow Rate, Cranio-Vertebral Angle, Young Adults

INTRODUCTION:

With the growing use of smartphones, prolonged screen time has led to increased forward head posture ("text neck") among young adults, causing postural imbalance and reduced respiratory efficiency.(1) Forward Head Posture (FHP) is a bad neck posture characterized by the forward translation of the cervical vertebrae and hyperextension of the upper cervical vertebrae.(2) (Fig:1)



Neutral head posture (NHP) **Forward head posture (FHP)**

FHP is defined as the flexion of the lower cervical spine (C4-C7) and extension of the upper cervical spine (C1-C3), which results in an increase in the cervical curvature, or hyper lordosis.[3] The craniovertebral angle (CVA), formed between the tragus of the ear and the C7 vertebra, serves as a key indicator of FHP. A CVA greater than 50° is generally considered normal, while a smaller angle indicates the presence of FHP.[4]

FHP causes disorganization of cervical and thoracic muscle alignment, limiting diaphragmatic mobility and function. As a result, accessory muscles such as the sternocleidomastoid become overactive, elevating the rib cage and reducing thoracoabdominal mobility.[5,6] These faulty mechanics weaken the inspiratory muscles, decrease chest expansion, and increase the work of breathing, ultimately leading to reduced pulmonary function, including lower vital capacity and diminished inspiratory and expiratory pressures.[5,6]

From a thoracic biomechanics' perspective, FHP alters rib cage morphology and mobility. Individuals with FHP show upper thoracic expansion and lower thoracic restriction, with significantly reduced anteroposterior and lateral mobility during respiration compared to a neutral head posture.[2]

These alterations limit diaphragmatic excursion and rib cage movement, leading to decreased ventilatory volumes such as Inspiratory reserve volume (IRV), Expiratory reserve volume (ERV), Forced Vital Capacity (FVC), and Forced Expiratory Volume in one second (FEV_1). Thus, cervical postural deviations can directly impair thoracic mechanics and overall respiratory efficiency.[2] Such mechanical limitations demonstrate how a cervical postural deviation can directly impair thoracic motion and pulmonary efficiency.

Furthermore, FHP reduces lung function, leading to a decrease in Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV_1), Peak Expiratory Flow Rate (PEFR), and maximal inspiratory and expiratory pressures.[6,7]

Peak Expiratory Flow Rate (PEFR) is defined as the maximum speed of expiration achieved during a forced exhalation, starting from full lung inflation. It reflects the combined performance of the respiratory muscles, airway resistance, thoracic compliance, and the integrity of the expiratory flow pathways.[8] PEFR primarily depends on the strength and coordination of the expiratory muscles, lung recoil, and airway diameter. It is a simple, reproducible, and non-invasive measure of airflow limitation and expiratory muscle efficiency, often used in both clinical and research settings to monitor respiratory function.(9)

From a biomechanical standpoint, efficient expiration requires adequate thoracic expansion, diaphragmatic recoil, and coordinated activation of abdominal and intercostal muscles. In individuals with Forward Head Posture, altered cervical and thoracic alignment restricts the mobility of the rib cage and diaphragm. These postural changes can diminish intra-thoracic pressure generation during forced exhalation, resulting in reduced PEFR.(10)

This study is important due to the increasing prevalence of Forward Head Posture (FHP) among young adults, primarily caused by prolonged screen time and poor postural habits. FHP alters spinal and cervical alignment, which can negatively influence respiratory mechanics and lung function. By examining the association between Forward Head Posture and Peak Expiratory Flow Rate (PEFR), this study aims to determine whether poor posture impacts breathing efficiency.

The findings may support the implementation of simple physiotherapy interventions, such as posture correction exercises, to enhance respiratory function and overall health. Additionally, the study's outcomes could help guide public health initiatives aimed at promoting proper posture and preventing long-term respiratory complications associated with FHP.

METHODOLOGY:

This cross-sectional observational study was performed at SBB College of Physiotherapy, Ahmedabad. The study protocol followed the terms of the Declaration of Helsinki (2013 revision). Written informed consent was obtained from all the participants before enrolment.

The study included 100 participants aged 18–25 years, as defined by the Society for Adolescent Health and Medicine. Individuals of all Body Mass Index (BMI) categories were included according to the WHO-Asian classification. Participants were recruited voluntarily and those who provided informed consent were included in the study. Individuals with major neurological, cardiological, or musculoskeletal disorders were excluded to eliminate potential factors that could affect posture or respiratory function.

PROCEDURE:

Following the collection of demographic data (age, gender, height, weight, BMI, and occupation), the Craniovertebral Angle (CVA) was measured in degrees between a horizontal line passing through the spinous process of C7 and a line connecting the tragus of the ear to the C7 spinous process. The tragus was chosen as a reference point due to its clear visibility and direct relation to skull movement, while C7 was easily identified by palpation. A CVA of less than 50° indicated the presence of Forward Head Posture (FHP). The assessment demonstrated good reliability, with a Cronbach's alpha value of 0.89.(4)

For measuring Peak Expiratory Flow Rate (PEFR), a Cipla Peak flow meter was used. Participants were instructed to inhale deeply, clamp their nostrils to prevent air leakage, and then exhale forcefully and completely into the mouthpiece in a single, strong blow. The mouthpiece was held securely between the teeth and lips to avoid air escape. After each trial, the mouthpiece was cleaned and the device reset to its initial position. Three trials were performed for each participant, and the highest value among the three readings was recorded for analysis.[8]

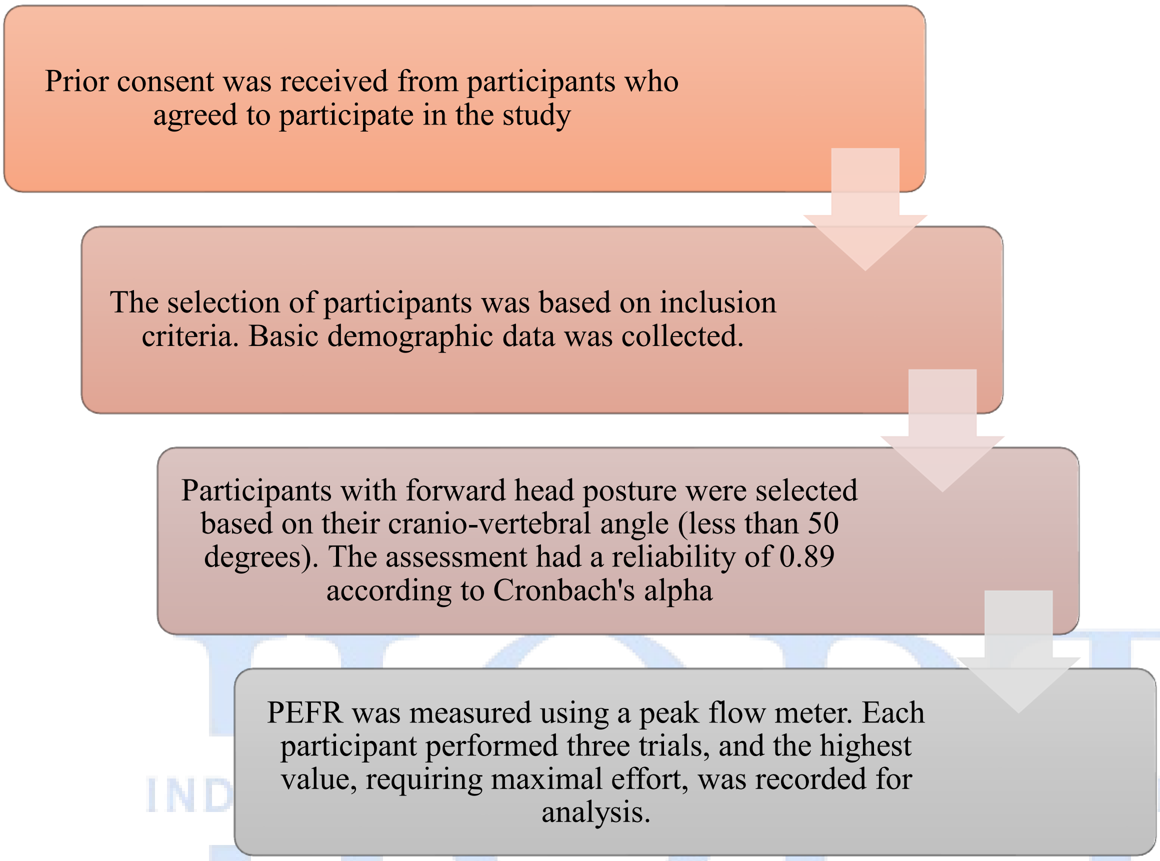


Figure 2: Method of the study

DATA ANALYSIS :

Statistical analysis was performed with Microsoft Excel and SPSS v20. Descriptive statistics of mean and standard deviation were calculated for demographic and variables. Data normality was tested using the Shapiro–Wilk test. As the data did not follow a normal distribution, a non-parametric test was applied. The Spearman's Rank Correlation Coefficient (rho) was used to determine the relationship between Peak Expiratory Flow Rate (PEFR), Craniovertebral Angle (CVA), and Body Mass Index (BMI). A p-value of less than 0.05 was considered for statistical significance.

RESULTS:

A total of 100 participants were included in the study with a mean age of 21.46 ± 2.19 years and a mean BMI of 23.33 ± 4.41 kg/m². The mean height and weight were 161.43 ± 8.18 cm and 60.97 ± 13.59 kg, respectively.

Table 1: Demographic characteristics of the participants

VARIABLE	MEAN±SD
Age (years)	21.46±2.19
Height (m)	1.614 ± 0.082
Weight(kg)	60.97±13.59
BMI(kg/m^2)	23.33±4.41

The mean Peak Expiratory Flow Rate (PEFR) was 348.1 ± 96.87 L/min, representing the average expiratory airflow among the participants. The mean Craniovertebral (CV) angle was 38.74 ± 3.52°, indicating the average postural alignment of the head and neck region.

Table 2: Mean and Standard Deviation of PEFR and CV Angle

Table – 2 presents the mean and standard deviation values of PEFR and CV angle. The mean PEFR value

PARAMETER	MEAN±SD
PEFR	348.1±96.87
CV Angle	38.74±3.52

indicates normal expiratory flow rates within a healthy young adult population, suggesting good lung function. The standard deviation (± 96.87) reflects inter-individual variability in respiratory performance. The mean CV angle denotes a neutral to slightly forward head posture among participants, where a smaller angle corresponds to a more pronounced forward head posture and a larger angle indicates better cervical alignment.

TABLE-3	r-value	p-value	INTERPRETATION
PEFR with CV angle	0.325	p<0.001*	A statistically significant association between PEFR and CV angle, with a moderate positive correlation.
CV angle with BMI	0.118	p=0.244	No statistically significant association between CV angle and BMI, with a weak positive correlation.
PEFR with BMI	0.323	p<0.001*	A statistically significant association between PEFR and BMI, with a moderate positive correlation

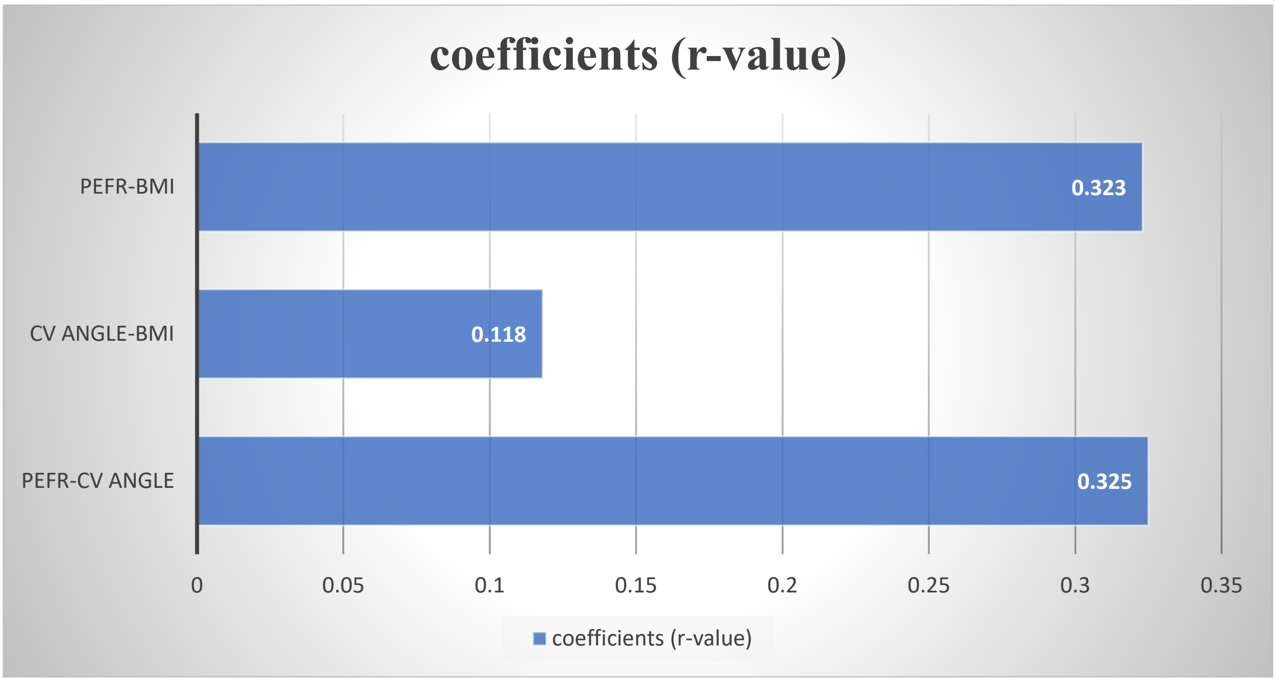
Table 3: ASSOCIATION BETWEEN PEFR, CV ANGLE AND BMI

Table – 3 demonstrates the association between PEFR, CV angle, and BMI using the Spearman correlation test. A moderate positive association was observed between PEFR and CV angle ($r = 0.325$, $p < 0.001$), indicating that participants with a larger CV angle (more upright posture) exhibited higher expiratory flow rates.

This finding suggests that improved head–neck posture is associated with enhanced respiratory efficiency. The association between CV angle and BMI ($r = 0.118$, $p = 0.244$) was not statistically significant, showing that body mass index does not have a notable influence on head–neck posture in this population.

A moderate positive and statistically significant association was also noted between PEFR and BMI ($r = 0.323$, $p < 0.001$), indicating that within the normal BMI range, individuals with slightly higher BMI values may demonstrate greater expiratory flow, possibly due to increased thoracic muscle strength or lung volume. Figure 3, illustrates the correlation coefficients (r-values) showing the strength of association between Peak Expiratory Flow Rate (PEFR), Craniovertebral (CV) angle, and Body Mass Index (BMI).

Figure 3: Regression Coefficients for Association Between PEFR, CV Angle, and BMI



DISCUSSION:

These findings suggest that FHP, as indicated by the CV angle, has a notable impact on respiratory function, specifically PEFR. The significant association between PEFR and CV angle highlights the importance of postural alignment in respiratory efficiency. The lack of a significant relationship between CV angle and BMI implies that posture may not be directly related to body weight in the context of Forward Head Posture. The moderate positive correlation between PEFR and BMI further emphasizes that body composition can influence lung function, though this is separate from the effects of posture.

Parida et al. (2024) found that Forward Head Posture (FHP) restricts diaphragmatic expansion, reducing lung capacity and lowering PEFR. Their study showed that combining diaphragmatic breathing exercises with posture correction significantly improved respiratory outcomes, including increased PEFR and CV angle. Breathing exercises enhanced diaphragmatic mobility, while posture correction realigned the cervical spine to support better respiratory function. However, the study's small sample size and lack of long-term follow-up limit generalizability. Overall, this combined approach effectively improves both posture and respiratory function in adults with FHP.(11)

In the present study, a moderate positive association was found between Craniovertebral (CV) angle and the Peak Expiratory Flow Rate (PEFR). This implies that participants with a larger CV angle (i.e., a less forward head posture) exhibited better expiratory flow. This finding supports the biomechanical hypothesis that a forward head posture (FHP), by altering cervical alignment and upper thoracic mechanics, can impede optimal respiratory function. For instance, Forward Head Posture has been shown to reduce forced vital capacity, inspiratory and expiratory reserve volumes, and peak flow when compared with neutral head posture.(2) FHP may limit diaphragmatic descent, alter rib-cage geometry, and increase reliance on accessory respiratory muscles which are less efficient for ventilation.(6)

Deniz et al.(2024) observed morphological changes such as forward shift of the upper thorax and reduced lower thorax mobility which explain the weaker respiratory performance. Likewise, in the review the effect of forward head posture on dynamic lung volumes in young adults: a systematic review the authors concluded that FHP is associated with reduced dynamic lung volumes and recommended monitoring for pulmonary changes in individuals with FHP.(12)

Solakoğlu et al. (2020) conducted a cross-sectional study titled "The effects of forward head posture on expiratory muscle strength in chronic neck pain patients" and found that forward head posture was negatively correlated with maximal expiratory pressure and chest expansion in patients with chronic neck pain, supporting the association between cervical posture and respiratory muscle performance.(10)

Moreover, FHP increases the activity demand on accessory muscles such as the sternocleidomastoid, scalene, and upper trapezius, while decreasing the effectiveness of the diaphragm and lower intercostal muscles. Han et al. (2016) investigated this phenomenon in their cross-sectional study titled "Effects of Forward Head Posture on Forced Vital Capacity and Respiratory Muscle Activity".(13)

The authors compared individuals with FHP to those with neutral cervical alignment and found that the FHP group exhibited significantly lower Forced Vital Capacity (FVC) and Forced Expiratory Volume in 1 second (FEV_1). Surface electromyography (EMG) revealed decreased activation of the sternocleidomastoid and pectoralis major muscles during deep breathing among FHP participants. These findings indicate that abnormal cervical posture diminishes respiratory muscle coordination and efficiency, contributing to reduced lung capacity and suboptimal ventilation mechanics.

The study found a significant association between the Craniovertebral (CV) angle and Peak Expiratory Flow Rate (PEFR) in healthy young adults, indicating that better head–neck alignment enhances respiratory efficiency. This suggests that even in the absence of musculoskeletal or respiratory disorders, Forward Head Posture (FHP) can adversely affect lung function by limiting diaphragmatic expansion and altering breathing mechanics. These findings are consistent with previous research demonstrating that FHP reduces lung volumes and restricts thoracic mobility.

Clinical Implications:

The study highlights the importance of integrating postural assessment into respiratory care. Postural screening should be included in physical therapy and cardiopulmonary rehabilitation programs, particularly for individuals with sedentary habits or prolonged device use.

Therapeutic interventions such as cervical–thoracic mobilization and postural retraining may improve respiratory outcomes by restoring optimal alignment. Moreover, preventive education emphasizing posture awareness and ergonomic practices in young adults can help maintain respiratory efficiency and reduce the risk of long-term postural dysfunction.

CONCLUSION:

A strong association between PEFR and CV angle was observed in young adults. A strong association was found between PEFR and BMI. Association between PEFR and FHP could guide clinicians to use postural assessments as indicators of respiratory function, integrate postural correction in respiratory care, enhance cardiopulmonary rehab, and support preventive education on posture for at-risk groups, potentially improving overall respiratory health.

Limitations and future directions:

While the findings are meaningful, the cross-sectional design limits causal interpretation. The study's focus on young adults (18–25 years) restricts generalizability to other age groups or individuals with comorbidities. Future research should use longitudinal or interventional designs, include detailed pulmonary measures (FVC, FEV_1, MIP, MEP), and explore biomechanical mechanisms—such as diaphragm movement and rib-cage mobility—that link posture and respiratory function.

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