The relation between forward head posture and active sagittal cervical range of motion in undergraduates

Ahmad Riyono[a*], Fauqi Amalia[b], Fransiskalina Erfarenata[a]

[a] ahmadriyono@vokasi.unair.ac.id

[a] *Department of Health, Faculty of Vocational Studies, Universitas Airlangga, Dharmawangsa Dalam Selatan No.28 – 30, Surabaya, Indonesia, 60286*

[b] *Faculty of Medicine, UIN Sunan Ampel Surabaya, Ir. H. Soekarno No. 682, Surabaya, Indonesia, 60237*

Abstract

Undergraduates' daily routines often involve prolonged sitting during lectures, seminars, and study sessions, potentially leading to postural disorders. Sustained improper posture can result in forward head posture (FHP), particularly in sedentary situations where individuals frequently maintain static positions for extended periods.This study investigated the relationship between FHP and active sagittal cervical range of motion (ROM) in undergraduates. An active sagittal cervical ROM assessment was conducted on undergraduate participants exhibiting a craniovertebral angle (CVA) of less than 48 degrees. Forty-nine volunteers aged 18 to 21 years participated. FHP was assessed using CVA measurements. Volunteers with a CVA greater than 48 degrees were excluded. Cervical flexion and extension were assessed using a goniometer. Each measurement was conducted twice to ensure accuracy, and the mean of the two measurements was calculated. The mean CVA was 40.24 ± 4.013 degrees, the total sagittal cervical ROM was 84.26 ± 9.993 degrees, and the mean values for cervical flexion and extension were 25.38 ± 4.101 degrees and 58.87 ± 8.464 degrees, respectively. A Spearman correlation test indicated a decreased craniovertebral angle correlated with a reduced sagittal cervical range of motion in undergraduates ($r = 0.41$, $p = 0.003$). These results indicate a positive relationship between FHP and active sagittal cervical range of motion in undergraduates

Keywords : FHP; CVA; cervical; ROM; Good Health and Well-Being

1. Introduction

Prolonged improper posture might result in forward head posture (FHP). This is particularly relevant in sedentary situations, where individuals frequently adopt static postures for prolonged periods (H. Lee et al., 2024). Forward head posture (FHP) is prevalent in the contemporary digital era and is characterized by increased screen time and sedentary habits (Abu-Ghosh et al., 2024). FHP is characterized by an excessive curvature of the cervical spine resulting from the extension of the head and upper cervical vertebrae (Cl–C3) and the flexion of the lower cervical vertebrae (C4–C7) (Ahmed et al., 2024). Forward head posture (FHP) is a prevalent postural deviation in the sagittal plane, typically characterized by excessive anterior positioning of the head relative to the shoulders. According to Lin et al. (2022), the prevalence of FHP in the general population is 30–45%. Shibasaki et al. (2025) further reported that FHP is a prevalent postural abnormality among undergraduates aged 18 to 30, with a prevalence rate of 73%. (Kamble et al., 2024). Forward head posture (FHP) is highly prevalent among young adults and university students, with reported rates ranging from 63.3% to 90% (Abu-Taleb et al., 2025). Elhafez et al. (2024) further reported a prevalence of 70%

among young adults, affecting 60% of males and 75% of females. Forward head posture (FHP) correlates with the weakening and elongation of the upper cervical flexors and lower cervical extensors, with the shortening of the upper cervical extensors and lower cervical flexors (Maddah et al., 2025). This demonstrates a reduction in cervical lordosis, modifications in thoracic kyphosis, and alterations in scapular protraction and downward rotation, attributable to rhomboid and middle trapezius weakness, along with pectoralis minor tightness (Bhende et al., 2024).

The cervical spine generally exhibits the greatest sagittal motion of the entire spinal column (Konishi et al., 2019). Quantitative motion research indicates that the sagittal cervical range of motion (ROM) in healthy adults ranges from 117° to 140° (Park et al., 2014). Forward movement of the head and neck, resulting from a sustained flexed head position, may induce sagittal postural defects of the cervical spine (Kang, 2024). Prolonged forward head posture (FHP) can lead to various biomechanical repercussions, including muscle imbalances in the cervical region, characterized by weakening and elongation of the deep neck flexors, along with shortening and tightening of the neck extensors and pectoralis muscles (Elsayed & Alowa, 2025). Muscle overactivity restricts cervical mobility and increases the load on the vertebrae and intervertebral discs, elevating the risk of spinal injury (Abu-Taleb et al., 2025). Stress on the posterior cervical structures alters the length-tension relationship of muscles, further increasing muscle activity and limiting neck ROM (Youssef et al., 2024). Studies have shown that forward head posture (FHP) alters cervical ROM (Quek et al., 2013). Increased forward head posture (FHP) has been correlated with greater impairments in cervical range of motion (ROM), particularly in neck flexion (El-Sadany et al., 2024). Prolonged exposure to FHP can result in lasting spinal deformities, particularly in the neck segments associated with extension (Fatharani et al., 2025). FHP is characterized by a craniovertebral angle (CVA) measuring less than 48–50 degrees (van de Meent et al., 2024). The CVA reflects the sagittal orientation of the cervical spine in the sagittal dimension (Alshahrani et al., 2024). The craniovertebral angle is defined as the angle formed by a line passing through the tragus of the ear and the spinous process of the seventh cervical vertebra, with respect to the horizontal plane. This angle represents the position of the head relative to the position of the C7 vertebra, where a smaller angle represents a more significant forward head position, while a larger craniovertebral angle represents a more erect position with the head closer to the plumb line as the craniovertebral angle is increased (Zárate-Tejero et al., 2024).

This study examined the relationship between forward head posture (FHP) and active sagittal plane cervical range of motion (ROM) in undergraduates. Although numerous studies have investigated the association between FHP and cervical ROM, research specifically involving undergraduate populations remains limited

2. Method

This research performed a quantitative, cross-sectional, observational study in the Department of Health, Faculty of Vocational Studies of Universitas Airlangga, from February to March 2025. After obtaining written informed consent, 49 FHD students aged 18 to 21, including 18 males and 31 females of the Department of Health, were enrolled in the study. The participants have academic schedules that surpass the conventional 40-hour study week and spend their days seated at desks or attending lectures. The participant's FHP is calculated using the craniovertebral angle, defined by the intersection of the C7 spinous process and a line extending from the ear tragus (Alshahrani et al., 2024). The active cervical range of motion for flexion and extension was measured with the goniometer's axis aligned at the seventh cervical vertebra. At the same time, the fixed arm remained perpendicular to the ground. Upon completion of the movement, the movable arm was positioned in alignment with the earlobe (Araujo et al., 2024). The cervical spine exhibits a range of motion of around 80º to 90º in flexion and 70º in extension (Swartz et al., 2005). Forward head posture (FHP) and cervical range of motion (ROM) were assessed with participants in an upright posture. Volunteers were excluded if they exhibited a craniovertebral angle (CVA) greater than 48 degrees. Each measurement was performed twice to ensure precision, and the mean of the two measurements was calculated.

Baseline data were analyzed using SPSS software, and normality was assessed. The Shapiro-Wilk test was employed to evaluate the normality of the measurable data. As the sample exhibited a non-normal distribution, non-parametric statistical tests were conducted. The Spearman correlation test assessed the relationship between forward head posture (FHP) and active cervical range of motion (ROM). A p-value of less than 0.05 at a 95% confidence interval was considered statistically significant.

3. Result

The participants were recruited from the same institution, resulting in a homogeneous sample. The Shapiro-Wilk test was performed to evaluate the data distribution. Table 1 delineates the demographic information of the participants.

Table 1. Basic characteristics of participants (n=49).

Parameter	Mean±SD
Age (years) [#]	19.71±1.080
Height (m) [#]	1.60±0.079
Mass (kg)	60.73±15.420
BMI (kg/m^2) [#]	23.27±4.978
CVA (°)[#]	40.24±4.013
Cervical flexion (°)[#]	25.38±4.101
Cervical extension (°)	58.87±8.464
The sagittal cervical ROM (°)[#]	84.26±9.993

[1]Data are mean± standard deviation. [#]Non-normal data
[2]BMI - body mass index, CVA - craniovertebral angle, ROM – range of motion, cm - centimeter, m - meter, kg - kilogram.

The average BMI of participants shows the overweight criteria according to the Asian-Pacific BMI category. The proportions of participants were 14.28% underweight, 38.77% normal weight, 12.24% overweight, and 34.69% obese. The mean cervical flexion joint ROM is 25.38 degrees below the normative value, whereas the average cervical extension movement is 58.87 degrees. The mean total cervical joint range of motion in the sagittal plane is 84.26 degrees less than that of healthy individuals. The mean FHP assessed by CVA is 40.24 degrees. Table 2 describes the correlation between FHD measured by CVA and the sagittal cervical ROM of participants. Spearman's correlation test assessed the correlation. Mass had a positive correlation with BMI ($p<0.001$). The BMI and mass data did not correlate with cervical flexion, extension, total sagittal cervical range of motion, and FHP assessed by CVA ($p > 0.05$). Cervical flexion and extension exhibit no correlation ($p > 0.05$). Cervical flexion exhibited no correlation with CVA ($p = 0.36$). Nonetheless, a correlation with the sagittal cervical range of motion was seen ($p < 0.001$). Cervical extension demonstrated significant findings in the sagittal cervical range of motion ($p < 0.001$), and FHP was assessed by CVA ($p = 0.002$). FHD assessed by CVA showed a positive correlation with the sagittal plane cervical ($r = 0.41$, $p = 0.003$).

4. Discussion

This study investigated the correlation between FHP and active sagittal cervical ROM in undergraduates. A statistically significant relationship was found between forward head posture (FHP) and active sagittal cervical range of motion (ROM) in undergraduates. Prolonged positioning of the cervical spine, such as hyperextension of the upper cervical spine (C1–C3) and lower cervical spine flexion (C4–C7), can lead to changes in head posture. Over time, these changes may result in poor posture, commonly referred to as forward head posture (FHP) (Kamble et al., 2024). Forward head posture (FHP) is the predominant cervical postural fault in the sagittal plane and has been found to vary in severity across nearly all populations

(Mahmoud et al., 2019). FHP is a postural deformity caused by factors such as excessive head elevation during sleep, prolonged use of computers, laptops, and mobile devices, extended periods of reading, poor occupational ergonomics, insufficient back muscle strength, and nutritional deficiencies, such as inadequate calcium intake (Ahmed et al., 2024). Forward head posture (FHP), characterized by an anteriorly positioned head, often occurs in individuals with cervical issues and is associated with a reduction in the natural curvature of the cervical spine. The loss of the cervical curve is considered a critical factor in various conditions, including mechanical cervical pain (G et al., 2012). This misalignment alters the length-tension relationship of several neck muscles, imposing additional strain on the neck's anti-gravity muscles (Ramezani et al., 2025). If left untreated, FHP may impair muscular system functions and restrict cervical movement (Asadzadeh et al., 2024). The FHP is linked to the weakening and elongation of the upper cervical flexors and lower cervical extensor muscles and the shortening of the upper cervical extensor and lower cervical flexor muscles (Maddah et al., 2025). The forward head posture frequently diminishes and elongates the deep cervical flexors, which are crucial for the stability of the cervical vertebrae. Due to the bending of the lower cervical vertebrae, the upper trapezius, sub-occipitalis, semispinalis, splenius-capitis, sternocleidomastoid, and levator scapula are shortened, leading to excessive stretching of the upper cervical vertebrae (Mahmoudi et al., 2024). Enhanced middle cervical extension and diminished cervical flexion are commonly noted in individuals with FHP (Fernández-De-Las-Peñas et al., 2006). The study indicated that the ROM in the cervical region is reduced in FHP individuals, with a more significant decrease in CVA (Sohn et al., 2010). A limited cervical extension ROM signifies the low contraction reserve of the posterior neck muscular ligament complex (PMLC) (S. H. Lee et al., 2019).

Table 2. Spearmen correlation test between FHD and the sagittal cervical ROM of participants

Parameter	Mass	BMI	Cervical flexion	Cervical extension	The sagittal cervical ROM	CVA
Mass (kg)		r = 0.91 p < 0.001*	r = -0.16 p = 0.272	r = 0.04 p = 0.787	r = -0.04 p = 0.741	r = 0.22 p = 0.124
BMI (kg/m^2)	r = 0.91 p < 0.001*		r = -0.05 p = 0.726	r = 0.07 p = 0.608	r = 0.04 p = 0.753	r = 0.12 p = 0.377
Fleksi cervical (°)	r = -0.16 p = 0.272	r = -0.05 p = 0.726		r = 0.15 p = 0.29	r = 0.53 p < 0.001*	r = 0.13 p = 0.36
Ekstensi cervical (°)	r = 0.04 p = 0.787	r = 0.07 p = 0.608	r = 0.15 p = 0.29		r = 0.89 p < 0.001*	r = 0.42 p = 0.002*
The sagittal cervical ROM (°)	r = -0.04 p = 0.741	r = 0.04 p = 0.753	r = 0.53 p < 0.001*	r = 0.89 p < 0.001*		r = 0.41 p = 0.003*
CVA (°)	r = 0.22 p = 0.124	r = 0.12 p = 0.377	r = 0.13 p = 0.36	r = 0.42 p = 0.002*	r = 0.41 p = 0.003*	

[1]Spearman test, *statistical significance (p<0.05)
[2]BMI - body mass index, CVA - craniovertebral angle, ROM – range of motion, cm - centimeter, kg – kilogram

Body mass index (BMI) served as a metric for body size and was computed using self-reported height and weight (Harris et al., 2025). Fat mass is strongly correlated with BMI compared to body fat percentage (Jeong et al., 2023). Adipose infiltration in skeletal muscles may augment muscle rigidity and diminish flexibility, resulting in a restricted range of motion and a stable posture (Usgu et al., 2021). Obesity leads to abnormal fat distribution in the cervical area, increasing neck circumference (NC). The short neck in obese patients limits cervical spine mobility (Gorgy et al., 2023). Nevertheless, BMI solely accounts for height and weight, neglecting body fat distribution and percentage, necessitating the integration of BMI and body fat percentage measurements for a more comprehensive understanding of body adiposity (Rai et al., 2023). BMI serves as a screening instrument for obesity; however, its diagnostic utility necessitates clinical interpretation through visual assessment or physical examination to validate the existence of excess adiposity (Sweatt et al., 2024).

Our study's limitations include the absence of X-ray examinations to verify cervical alignment and the lack of assessment of participants' muscle characteristics, such as muscle shortening and muscle strength. Additionally, there was an unequal distribution of individuals across BMI categories and gender. Therefore, we recommend conducting further research to address these limitations

5. Conclusion

This study found that individuals with forward head posture (FHP) exhibited reduced active sagittal cervical range of motion (ROM). A positive correlation between FHP and active sagittal cervical ROM was also observed in undergraduates. However, further research is needed to better understand the underlying mechanisms of this association.

6. Funding

None

7. Conflict of interest

The authors have declared the absence of financial support with commercial or personal interests, so no conflict of interest might inappropriately influence the study

8. Acknowledgement

The authors wish to thank the participants in the study

References

Abu-Ghosh, S., Moustafa, I. M., Ahbouch, A., Oakley, P. A., & Harrison, D. E. (2024). Cognitive Load and Dual-Task Performance in Individuals with and without Forward Head Posture. *Journal of Clinical Medicine*, *13*(16). https://doi.org/10.3390/jcm13164653

Abu-Taleb, W., Yamany, A. A., Aneis, Y. M., & Abu El Kasem, S. T. (2025). Effect of adding global postural reeducation to kendall exercises for treating asymptomatic forward head posture: A single-blinded randomized controlled trial. *Journal of Bodywork and Movement Therapies*, *42*(February), 938–947. https://doi.org/10.1016/j.jbmt.2025.01.039

Ahmed, M., Zia, W., Maqbool, K., Tehzeeb, K., & Jabbar, S. (2024). Efficacy of posture correction band vs. McKenzie's exercises on pulmonary function and chest expansion in asymptomatic population with forward head posture. *Journal of Bodywork and Movement Therapies*, *38*(November 2023), 18–23. https://doi.org/10.1016/j.jbmt.2023.12.003

Alshahrani, A., Ghulam, H. S. H., Alqhtani, R. S., Sharyah, Y. H. H. Al, Ahmed, H., Aafreen, A., Khan, A. R., Khan, A., & Ahmad, A. (2024). Cervical Health Parameters in Car Drivers: Assessing the Influence of Driving on Neck Pain, Mobility, Proprioception and Craniovertebral Angle – A Cross-Sectional Study. *Journal of Multidisciplinary Healthcare*, *17*(May), 2013–2020. https://doi.org/10.2147/JMDH.S458364

Araujo, G. G. C., Pontes-Silva, A., Leal, P. da C., Gomes, B. S., Reis, M. L., de Mello Pereira Lima, S. K., Fidelis-de-Paula-Gomes, C. A., & Dibai-Filho, A. V. (2024). Goniometry and fleximetry measurements to assess cervical range of motion in individuals with chronic neck pain: a validity and reliability study. *BMC Musculoskeletal Disorders*, *25*(1). https://doi.org/10.1186/s12891-024-07775-6

Asadzadeh, A., Salahzadeh, Z., Samad-Soltani, T., & Rezaei-Hachesu, P. (2024). An affordable and immersive virtual reality-based exercise therapy in forward head posture. *PLoS ONE*, *19*(3 March), 1–19. https://doi.org/10.1371/journal.pone.0297863

Bhende, R., Shinde, S., & Jain, P. (2024). Effect of Integrated Postural Training in Individuals with Text Neck Syndrome. *Journal of Kinesiology and Exercise Sciences*, *34*(106), 1–18. https://doi.org/10.5604/01.3001.0054.6840

El-Sadany, S. M., Sayed, A. A. A., Kamel, K. M., & Al-Ghitany, S. I. (2024). High intensity laser therapy versus scapular stabilization exercises on ventilatory function in forward head posture. *Advances in Rehabilitation*, *38*(4), 1–9. https://doi.org/10.5114/areh.2024.144671

Fatharani, L. F., Purnamasari, R., Ramadhan, M. R. D., & Adhyatma, G. P. (2025). Prevalence and Characteristics of Forward Head Posture among University Students. *Journal of Public Health and Pharmacy*, *5*(1), 96–104.

https://doi.org/10.56338/jphp.v5i1.5027
Fernández-De-Las-Peñas, C., Alonso-Blanco, C., Cuadrado, M. L., Gerwin, R. D., & Pareja, J. A. (2006). Trigger points in the suboccipital muscles and forward head posture in tension-type headache. *Headache*, *46*(3), 454–460. https://doi.org/10.1111/j.1526-4610.2006.00288.x
G, W., K, C., & L, Y. (2012). Correlations between Cervical Lordosis , Forward Head Posture , Cervical ROM and the Strength and Endurance of the Deep Neck Flexor Muscles in College Students. *Journal of Physical Therapy Science*, *24*, 275–277.
Gorgy, A., Ahmed, A., Atef, M., Mekawy, N., Sami, W., & Nagy, H. (2023). Sternomental displacement and neck circumference: a new look for the neck as a difficult airway predictor in obese surgical patients—a cohort study. *Ain-Shams Journal of Anesthesiology*, *15*(1), 1–8. https://doi.org/10.1186/s42077-023-00355-1
Harris, E. R., Hahn, S. L., & Forney, K. J. (2025). *The Unique Associations of Thin - Ideal Internalization and Internalized Weight Stigma With Body Dissatisfaction Across Body Sizes*. 1–6. https://doi.org/10.1002/jclp.23793
Jeong, S. M., Lee, D. H., Rezende, L. F. M., & Giovannucci, E. L. (2023). Different correlation of body mass index with body fatness and obesity-related biomarker according to age, sex and race-ethnicity. *Scientific Reports*, *13*(1), 1–11. https://doi.org/10.1038/s41598-023-30527-w
Kamble, S., Kothari, P., Kale, P., Joshi, J., Kadam, A., & Palekar, T. J. (2024). Effect of Backward Walking on Treadmill with Inclination in Individuals with Forward Head Posture: A Comparative Study. *Journal of Datta Meghe Institute of Medical Sciences University*, *19*(1), 435–440. https://doi.org/10.4103/jdmimsu.jdmimsu
Lee, H., Oh, B., & Kim, S. C. (2024). Recognition of Forward Head Posture Through 3D Human Pose Estimation With a Graph Convolutional Network: Development and Feasibility Study. *JMIR Formative Research*, *8*, 1–12. https://doi.org/10.2196/55476
Lee, S. H., Son, D. W., Lee, J. S., Sung, S. K., Lee, S. W., & Song, G. S. (2019). Does Extension Dysfunction Affect Postoperative Loss of Cervical Lordosis in Patients Who Undergo Laminoplasty? *Spine*, *44*(8), E456–E464. https://doi.org/10.1097/BRS.0000000000002887
Maddah, T., Daneshmandi, H., Alizade, M. H., & Rahmati, M. B. (2025). The investigation of relationship between allergic rhinitis with forward head posture and anxiety in children. *BMC Pediatrics*, *25*(1), 3–7. https://doi.org/10.1186/s12887-025-05473-3
Mahmoudi, M., Hovanloo, F., Shahpar, F. M., & Barati, A. (2024). A period of backwards walking affects the craniovertebral angle, proprioception, balance, and foot pressure on forward head posture of female students. *Journal of Bodywork and Movement Therapies*, *40*(November 2023), 1844–1851. https://doi.org/10.1016/j.jbmt.2024.10.040
Quek, J., Pua, Y. H., Clark, R. A., & Bryant, A. L. (2013). Effects of thoracic kyphosis and forward head posture on cervical range of motion in older adults. *Manual Therapy*, *18*(1), 65–71. https://doi.org/10.1016/j.math.2012.07.005
Rai, R., Ghosh, T., Jangra, S., Sharma, S., Panda, S., & Kochhar, K. P. (2023). Relationship Between Body Mass Index and Body Fat Percentage in a Group of Indian Participants: A Cross-Sectional Study From a Tertiary Care Hospital. *Cureus*, *15*(10), 4–11. https://doi.org/10.7759/cureus.47817
Ramezani, E., Riazi, F., Nezhad, S. A. M., & Kiani, A. (2025). Assessing the measurement characteristics of cervical joint repositioning error in individuals with and without forward head posture. *Journal of Bodywork and Movement Therapies*, *42*(December 2024), 831–837. https://doi.org/10.1016/j.jbmt.2025.01.047
Sohn, J. H., Choi, H. C., Lee, S. M., & Jun, A. Y. (2010). Differences in cervical musculoskeletal impairment between episodic and chronic tension-type headache. *Cephalalgia*, *30*(12), 1514–1523. https://doi.org/10.1177/0333102410375724
Swartz, E. E., Floyd, R. T., & Cendoma, M. (2005). Cervical spine functional anatomy and the biomechanics of injury due to compressive loading. *Journal of Athletic Training*, *40*(3), 155–161.
Sweatt, K., Garvey, W. T., & Martins, C. (2024). Strengths and Limitations of BMI in the Diagnosis of Obesity: What is the Path Forward? *Current Obesity Reports*, *13*(3), 584–595. https://doi.org/10.1007/s13679-024-00580-1
Usgu, S., Ramazanoğlu, E., & Yakut, Y. (2021). The relation of body mass index to muscular viscoelastic properties in normal and overweight individuals. *Medicina (Lithuania)*, *57*(10), 1–17. https://doi.org/10.3390/medicina57101022
van de Meent, I., Koomen, L., de Boer, R., Le Clercq, L., Janssen, D., Boute, M., Maat, A., van Dellen, E., & Cahn, W. (2024). Forward head posture associated with reduced cardiorespiratory fitness in psychotic disorders compared to autism spectrum disorder and healthy controls. *Scientific Reports*, *14*(1), 1–12. https://doi.org/10.1038/s41598-024-67604-7
Zárate-Tejero, C. A., Rodríguez-Rubio, P. R., Brandt, L., Krauss, J., Hernández-Secorún, M., Hidalgo-García, C., & Lucha-López, O. (2024). Measuring Craniovertebral Angle Reference Values in Adults Using Kinovea Software. *Applied Sciences (Switzerland)*, *14*(19). https://doi.org/10.3390/app14198639