Original article

Reference values of cranio-vertebral angle in healthy young adults: a cross-sectional study

Valores de referência do ângulo craniovertebral em jovens adultos: um estudo transversal

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ABSTRACT | INTRODUCTION: Cranio-vertebral angle (CVA) is an important landmark to rule out any postural abnormality in cervical spine, which demonstrates its biomechanical importance, since its alignment can affect head position, neck muscle activities, respiratory functions, spinal mobility, etc. **OBJECTIVE:** The objective of this study was to estimate reference value of this angle in healthy young adults. **MATERIALS AND METHODS:** A cross-sectional study was conducted in 300 healthy young individuals aged between 21 to 35 years. Data was collected through purposive sampling. The participants were excluded if they suffered from any trauma, head injury, tumour, fall or cancer, or any sort of neurological or cardio-pulmonary disorder. Participants were divided into three groups according to age (Group A = 21-25 years; Group B = 26-30 years; Group C = 31-35 years). CVA was assessed using MB Ruler Software and photogrammetry technique. **RESULTS:** Data was analysed using SPSS version 20.0. Kolmogorov-Smirnoff test was used to detect normality of data. Reference values of CVA were depicted according to age groups (Within median and inter-quartile range). Kruskal-Wallis test depicted statistically significant difference between groups (p-value = 0.001). Spearmann Correlation was used to assess associations of CVA with age (ƒ=-0.578, p-value= 0.001). **DISCUSSION:** This is the first study which evaluates age-specific reference values for CVA. Since the results depict different reference values for different age groups further studies within this domain can utilize CVA reference values according to the age group of participants. **CONCLUSION:** CVA is important in assessment of Forward Head Posture (FHP) but a single reference value cannot be utilised for all the age groups. Specific age groups require assessment of CVA at specific values.

KEYWORDS: Young Adult. Cervical Vertebrae. Forward Head Posture. Photogrammetry. Posture.

RESUMO | INTRODUÇÃO: O ângulo craniovertebral (ACV) é um marco importante para descartar qualquer anormalidade postural na coluna cervical, o que demonstra sua importância biomecânica, uma vez que seu alinhamento pode afetar a posição da cabeça, as atividades musculares do pescoço, as funções respiratórias, a mobilidade da coluna, etc. **OBJETIVO:** O objetivo deste estudo foi estimar o valor de referência deste ângulo em jovens adultos saudáveis. **MATERIAIS E MÉTODOS:** Um estudo transversal foi conduzido em 300 indivíduos jovens saudáveis, com idade entre 21 e 35 anos. Os dados foram coletados por amostragem intencional. Os participantes foram excluídos caso tivessem sofrido qualquer trauma, traumatismo craniano, tumor, queda ou câncer, ou qualquer tipo de distúrbio neurológico ou cardiopulmonar. Os participantes foram divididos em três grupos de acordo com a idade (Grupo A = 21-25 anos; Grupo B = 26-30 anos; Grupo C = 31-35 anos). O Ângulo craniovertebral foi avaliado usando o software MB Ruler e a técnica de fotogrametria. **RESULTADOS:** Os dados foram analisados utilizando o SPSS versão 20.0. O teste de Kolmogorov-Smirnoff foi utilizado para detectar a normalidade dos dados. Os valores de referência de ACV foram apresentados de acordo com as faixas etárias (dentro da mediana e do intervalo interquartil). O teste de Kruskal-Wallis apresentou diferença estatisticamente significativa entre os grupos (valor de *p* = 0,001). A correlação de Spearmann foi utilizada para avaliar a associação de ACV com a idade (ƒ=-0,578, valor de *p* = 0,001). **DISCUSSÃO:** Este é o primeiro estudo que avalia valores de referência para ACV específicos para cada idade. Como os resultados apresentam valores de referência diferentes para diferentes faixas etárias, estudos futuros neste domínio podem utilizar valores de referência para ângulo craniovertebral de acordo com a faixa etária dos participantes. **CONCLUSÃO:** O ângulo craniovertebral é importante na avaliação da Posição Anterior da Cabeça, mas um único valor de referência não pode ser utilizado para todas as faixas etárias. Faixas etárias específicas requerem avaliação do ângulo craniovertebral com valores específicos.

PALAVRAS-CHAVE: Jovem Adulto. Vértebras Cervicais. Posição Anterior da Cabeça. Fotogrametria. Postura.

Submitted May 2nd, 2025, Accepted Sept. 24th, 2025,
Published Dec. 4th, 2025
J. Physiother. Res., Salvador, 2025;15:e6225
https://doi.org/10.17267/2238-2704rpf.2025.e6225 | ISSN: 2238-2704
Assigned editor: Ana Lucia Goes

How to cite this article: Srivastava A, Sharma D. Reference values of cranio-vertebral angle in healthy young adults: a cross-sectional study. J Physiother Res. 2025;15:e6225. https://doi.org/10.17267/2238-2704rpf.2025.e6225

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1. Introduction

Postural Analysis is a generalised tool frequently used in healthcare settings to provide treatment, prevention or imparting a diagnosis. Assessment of posture of an individual is not only important for yielding appropriate diagnosis and decision making in healthcare sector but also tends to decrease the load on utility of these services and adopting time-dependent strategies[1]. Especially in developing countries where there are limited resources available for healthcare facilities, hands on assessment tends to be a significant challenge faced worldwide[2]. This accounts for the necessity of appropriate diagnostic regimes to be followed especially in assessment of postural abnormalities[3]. One of the most crucial aspects of postural assessment is the assessment of cervical spine, which significantly contributes to various biomechanical and physiological parameters within the body[4,5]. This region is crucially important as its abnormality can lead to various dysfunction or impairments relevant to not only musculoskeletal but neurological systems as well[6]. Estimation of degree of forward head posture (FHP), which is a commonly found abnormality of the cervical, and its comorbidities is a crucial part of this assessment[7]. An appropriate, reliable and feasible method of assessing this, is the estimation of cranio-vertebral angle (CVA)[8,9].

This CVA is estimated by assessing the degree of forward translation of the head with respect to cervical vertebrae (specifically C7 vertebrae) by marking the C7 vertebrae and using a lateral aspect photograph of the patient to assess this angle using any goniometer or software[9,10]. Earlier researches used plumb line method to evaluate this angle while other researches recently have used the photogrammetry method[10,11]. Some of the recent studies published, have assessed this angle using various newly developed tools that are valid and reliable for this purpose[8,12]. Since this method of assessment is low cost incurring, can be easily measured within the available resources, can even be utilised in low-income investment settings and is the most common method of CVA analysis, it requires estimation of normative reference values. There has always been a crucial discussion regarding the normative or reference value of this angle. Some articles suggested that CVA less than 48 degrees must be considered as Forward Head Posture8 while some consider CVA less than 50 or 52 degrees as an appropriate marker for this angle[12,13].

Since FHP is a commonly found abnormality which can have moderate to severe consequences like impairments within gait and postural parameters or musculoskeletal disorders, its estimation can provide better outcomes in patients[6,7]. Thus, generalisation of the degrees of CVA is necessary for evaluation and prediction of the presence/absence of FHP. By far, there are no cutoff values of this angle which pertains to estimation of this postural abnormality. Understanding of normative reference value for the purpose of classification of FHP patients and their symptoms is necessary for effective treatment strategies. Thus, the basic aim behind conducting this study was to evaluate the normative values of this CVA.

2. Methods

2.1 Ethics & registration

The study was registered under the Clinical Trial Registry with registration number CTRI/2023/10/058581. It was ethically approved by the Institutional Human Ethical Committee (CSJMU/R&D/1487/2023) and was conducted with strict adherence to the ethical guidelines as mentioned in the Declaration of Helsinki (revised, 2013) and the STROBE's checklist[14].

2.2 Study design

This was a cross-sectional study.

2.3 Study setting

Participants were recruited from Chhatrapati Shahu Ji Maharaj University (CSJMU), Kanpur.

2.4 Study participants

Healthy young individuals.

2.5 Inclusion & exclusion criteria

Healthy Individuals aged between 21 to 35 years without any symptoms of pain or decreased mobility at the cervical and thoracic spine were included within the study. Individuals suffering from any sort of trauma, head injury, tumour, fall or cancer which directly or indirectly impacts the cervical spine, or any history of neurological or cardio-pulmonary disorder or participants with any musculoskeletal impairment or injury within the last six months were excluded.

2.6 Sample size & sampling

Considering the prevalence of FHP to be 85.5%[15] and Zα to be 1.96 with 5% precise value and 30% drop out rate, the sample size extracted was 248 which was cumulated to be 300. Purposive sampling method was adopted and Informed consents were obtained from all participants at the time of enrolment.

2.7 Outcome

The CVA was measured with the help of photogrammetry method, using a digital camera placed at a distance of one meter from the shoulder level of participants using a tripod stand. To assess the degree, MB Ruler software (Markus Bader-Software Solutions, triangular screen ruler)[16] was used, which is a reliable and valid software for detection of CVA[8].

2.8 Procedure

On obtaining consents, the participants were assessed for demographic details including age, height and weight. 300 healthy individuals were recruited within the study. They were divided into three distinctive categories (100 in each Group; Group A aged between 21-25 years; Group B with individuals aged between 26-30 years and Group C individuals aged between 31-35 years). To assess the CVA, participants were asked to stand in front of a wall, and a digital camera was placed at the sagittal view of participants at a distance of 1m from the shoulder. In order to collect participant's photograph, at first, C7 vertebrae was palpated by assessors and was marked using a stick-on marker, then the participant was allowed to be comfortable in that position for 30 seconds. It was made sure that the participant wore loose clothing that allowed sufficient visibility of the C7 vertebrae and the stick-on marker. The photographs obtained were then transferred to MB Ruler software for estimation of degree of CVA. A reference line was drawn on the photograph, intersecting the C7 vertebrae and marker within the application and a line was drawn from the tragus of the ear to the C7 vertebrae. The angle between this reference line and line from the tragus was obtained as CVA.

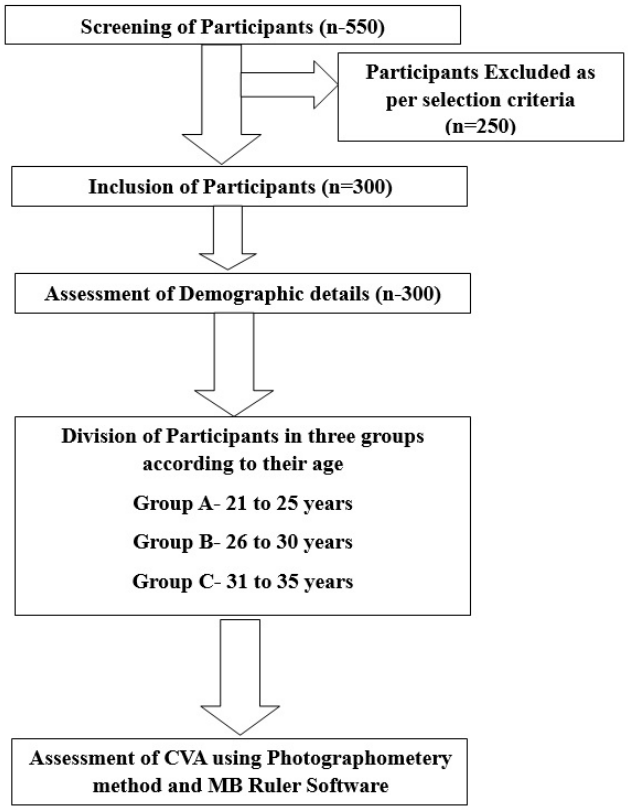
2.9 Statistical analysis

The data collected was analysed using SPSS (Statistical Package for Social Sciences) version 20.0. Normality was tested using the Kolmogorov-Smirnoff Test. Kruskal-Wallis Test was used to measure the difference between the three groups. Spearmann Correlation Coefficient was used to assess association between CVA and other variables. The significance level was set at p-value ≤ 0.05.

3. Results

Figure 1 represents the study flowchart.

Figure 1. Flowchart of the study



Source: the authors (2025).

Data followed not-normal distribution. Table 1 represents the normality of data analysis.

Table 1. Normality of data

S. No.	Variables	Median	IQR	*p*-value
1.	Age (in years)	28	21-36	0.001
2.	Height (in cm)	169	151-188	0.001
3.	Weight (in kg)	70	52-101	0.001
4.	BMI (in kg/m^2)	24.7	18.40-35	0.001
5.	CVA (in degrees) (overall)	51.10	48-58.90	0.001

Source: the authors (2025).
Abbreviations: IQR - Interquartile range; CVA - Cranio-vertebral angle; BMI - Body mass index.

Reference values for the three age groups were discussed in terms of median and IQR range in table 2.

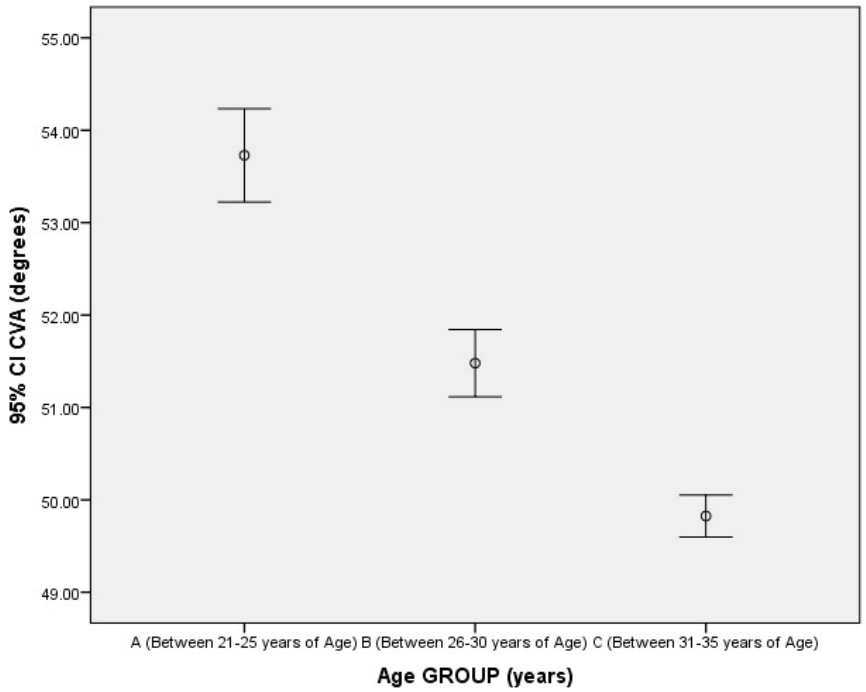
Table 2. Median values of CVA (in degrees)

S. No.	Variables	Median	IQR
1.	Overall CVA (in degrees) (n= 300)	51.10	48-58.90
2.	CVA (Aged between 21-25 years) (n=100)	53.95	49.90-58.90
3.	CVA (Aged between 26-30 years) (n=100)	51.20	48.70-55.30
4.	CVA (Aged between 31-35 years) (n=100)	49.80	48-52.35

Source: the authors (2025).
Abbreviations: IQR - Interquartile range; CVA - Cranio-vertebral Angle.

To estimate the difference between these groups, Kruskal Wallis Test was implied which showed significant difference between the three groups with mean rank values as Group A being 216.35, Group B 150.85 and of Group C being 84.31, χ^2= 115.93 and p-value = 0.001. Difference between specific groups depicted in figure 2.

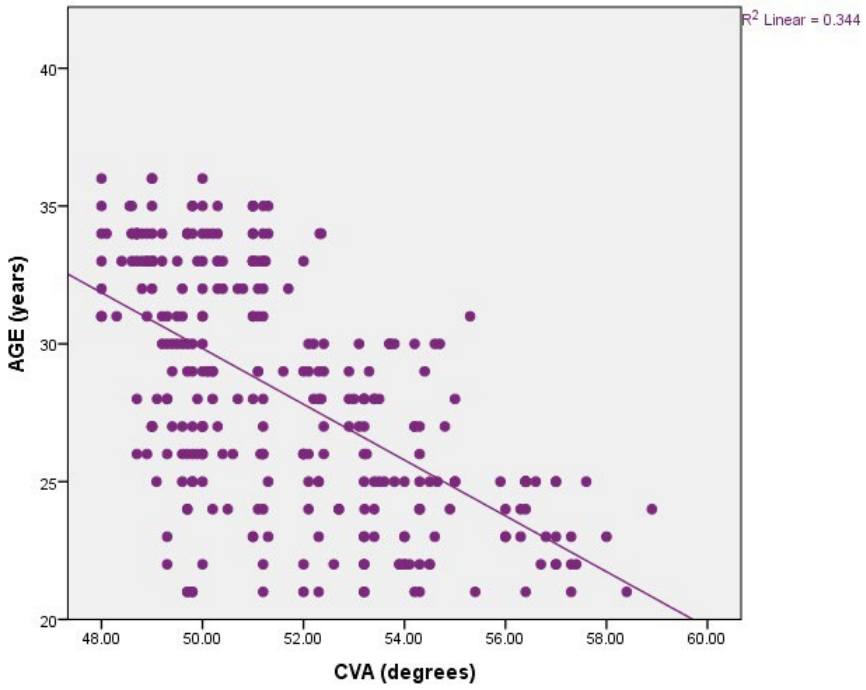
Figure 2. Difference between specific age groups (in years)



Source: the authors (2025).

Figure 3 represents the Spearmann correlation describing a significant and negative correlation between age and CVA of participants (ρ= -0.578, p-value= 0.001).

Figure 3. Correlation between age (in years) and median CVA values (in degrees)



Source: the authors (2025).

4. Discussion

Specific age groups require assessment of CVA at specific values. For example, people falling between the age of 21 to 25 years must be evaluated according to 53 to 54 degrees of CVA, between the age of 26 to 30 years according to 51 to 52 degrees and between 31 to 35 years as 49 to 50 degrees of CVA. Estimation of this cut-off value can help in appropriate assessment of cervical posture and evaluation of abnormalities as well. Reference values tend to provide a basis for investigations and prescribing a value for estimation of normal and abnormal cut-off values. This study is by far the first to evaluate the reference cut-off values of CVA with respect to age of healthy individuals. Through this study it was found that the mean angle values differ according to age groups in healthy individuals. The results depicted that participants between the ages 31 to 35 years had a lesser median value of the CVA which could possibly be explained by the fact that with age there are certain deteriorations that impact the musculoskeletal system[17]. Another justification for this could be the involvement of individuals more towards postural misalignment and over exertion being faced by individuals within this age group[7,11,12]. Along with musculoskeletal changes within the body, this age group was seen to be associated with longer exposure towards the screen time, lesser involvement in physical activities and higher amount of stress factors.

The study also depicted that there was statistically significant difference between the median values of different age groups which marks its importance for a reference in future studies working within the same domain. There were many studies which utilized CVA with different ranges to define FHP[8,12,13]. Especially after the pandemic, where individuals are more exposed to prolonged desktop jobs and screen usage irrespective of their job profiles, creates an overburdened and exertional force over the cervical posture of an individual[18], it becomes essential to evaluate the normative reference values. Previous literature also found that population within different age groups had varied symptoms and were prone to different comorbidities which may include frequently losing balance for short durations, pain and stiffness at the neck region, lack of alertness, slouched posture, etc[5,6,8,11,15].This study depicts the importance of studying various degrees of CVA in patients with respect to their age group reference values.

Understanding the importance of this region, primarily for the presence of any abnormality, can have multiple effects at shoulder complex, head region, scapular region, upper back and the chest region as well[5] and evaluation of this angle using CVA through the method implied within this study has been proved to be cost effective and easily replicable to detect and regulate the working of cervical spine in accordance to other structures and landmarks present in this region[10-12]. Biomechanically, it is a crucial angle to evaluate the position of the cervical spine with respect to the head superiorly and the thoracic spine inferiorly[7]. Apart from its location, the ease of assessment of this angle is another factor which makes it important and feasible for the physiotherapists to know about the cervical spine without involvement of heavy machinery and high-cost equipment that require a definite space and surroundings[11].

Hence, this study emphasizes that researchers working within this area should utilise different reference values for different age groups. The strength of this study is that it provides age group specific reference of CVA that can be utilised in treating and assessing individuals for better outcomes and better planning of physiotherapy regimes. However, this study had a few limitations as well. Activities like smoking and drinking as well as their duration of usage were not surveyed during general assessment of participants which might influence the results of the study and symptoms felt by the participants. The evaluation of CVA was performed in standing position from lateral angle only. Since there are studies that utilize testing of CVA in different positions, the positions for estimation of CVA can be modified at different angles and different focuses[10]. Thus, it is highly recommended that in future, studies must be conducted focusing over the demands and problems of individuals in these specific age groups, studies including higher sample sizes and studies that focus on treatment strategies respective to specific age groups, studies which evaluate other age groups as well can be done in order to find similar reference values.

5. Conclusions

Specific age groups require assessment of CVA at specific values. For example, people falling between the age of 21 to 25 years must be evaluated according to 53 to 54 degrees of CVA, between the age of 26 to 30 years according to 51 to 52 degrees and between 31 to 35 years as 49 to 50 degrees of CVA. Estimation of this cut-off value can help in appropriate assessment of cervical posture and evaluation of abnormalities as well.

Authors' contributions

The authors declared that they have made substantial contributions to the work in terms of the conception or design of the research; the acquisition, analysis or interpretation of data for the work; and the writing or critical review for relevant intellectual content. All authors approved the final version to be published and agreed to take public responsibility for all aspects of the study.

Competing interests

No financial, legal, or political conflicts involving third parties (government, private companies, and foundations, etc.) were declared for any aspect of the submitted work (including but not limited to grants and funding, advisory board participation, study design, manuscript preparation, statistical analysis, etc.).

Indexers

The Journal of Physiotherapy Research is indexed by DOAJ, EBSCO, LILACS and Scopus.

References

1. Jacquier-Bret J, Gorce P. Prevalence of Body Area Work-Related Musculoskeletal Disorders among Healthcare Professionals: A Systematic Review. Int J Environ Res Public Health. 2023;20(1):841. https://doi.org/10.3390/ijerph20010841

2. Muhunzi D, Kitambala L, Mashauri HL. Big data analytics in the healthcare sector: Opportunities and challenges in developing countries. A literature review. Health Informatics J. 2024;30(4):14604582241294217. https://doi.org/10.1177/14604582241294217

3. Gomes LCR, Horta KOC, Gonçalves JR, Santos-Pinto A. Systematic review: craniocervical posture and craniofacial morphology. Eur J Orthod. 2014;36(1):55-66. https://doi.org/10.1093/ejo/cjt004

4. Segatto E, Segatto A, Braunitzer G, Kirschneck C, Fanghänel J, Danesh G, et al. Craniofacial and cervical morphology related to sagittal spinal posture in children and adolescents. Biomed Res Int. 2014:638238. https://doi.org/10.1155/2014/638238

5. Nishida N, Izumiyama T, Asahi R, Jiang F, Ohgi J, Yamagata H, et al. Analysis of individual differences in pelvic and spine alignment in seated posture and impact on the seatbelt kinematics using human body model. PLoS One. 2021;16(7):e0254120. https://doi.org/10.1371/journal.pone.0254120

6. Lindenmann S, Tsagkaris C, Farshad M, Widmer J. Kinematics of the Cervical Spine Under Healthy and Degenerative Conditions: A Systematic Review. Ann Biomed Eng. 2022;50(12):1705-33. https://doi.org/10.1007/s10439-022-03088-8

7. Chu ECP, Lo FS, Bhaumik A. Plausible impact of forward head posture on upper cervical spine stability. J Family Med Prim Care. 2020;9(5):2517-20. https://doi.org/10.4103/jfmpc.jfmpc_95_20

8. Joshi R, Poojary N. The Effect of Muscle Energy Technique and Posture Correction Exercises on Pain and Function in Patients with Non-specific Chronic Neck Pain Having Forward Head Posture—a Randomized Controlled Trail. Int J Ther Massage Bodywork. 2022;15(2):14-21. https://doi.org/10.3822/ijtmb.v15i2.673

9. Gallego-Izquierdo T, Arroba-Díaz E, García-Ascoz G, Val-Cano MDA, Pecos-Martin D, Cano-de-la-Cuerda R. Psychometric Proprieties of a Mobile Application to Measure the Craniovertebral Angle a Validation and Reliability Study. Int J Environ Res Public Health. 2020 Sep 8;17(18):6521. https://doi.org/10.3390/ijerph17186521

10. Titcomb DA, Melton BF, Bland HW, Miyashita T. Evaluation of the Craniovertebral Angle in Standing versus Sitting Positions in Young Adults with and without Severe Forward Head Posture. Int J Exerc Sci. 2024;17(1):73–85. https://doi.org/10.70252/GDNN4363

11. Akodu AK, Akinbo SR, Young QO. Correlation among smartphone addiction, craniovertebral angle, scapular dyskinesis, and selected anthropometric variables in physiotherapy undergraduates. J Taibah Univ Med Sci. 2018;13(6):528–34. https://doi.org/10.1016/j.jtumed.2018.09.001

12. Alowa Z, Elsayed W. The impact of forward head posture on the electromyographic activity of the spinal muscles. J Taibah Univ Med Sci. 2021;16(2):224–30. https://doi.org/10.1016/j.jtumed.2020.10.021

13. Kang KW, Kwon YH, Son SM. Ultrasound Measurement of the Transverse Abdominis, Internal Oblique, and External Oblique Muscles Associated with Forward Head Posture and Reduced Cranio-Vertebral Angle. Medical Science Monitor. 2021;27:e928987. https://doi.org/10.12659/MSM.928987

14. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. J Clin Epidemiol. 2008;61(4):344-9. https://doi.org/10.1016/j.jclinepi.2007.11.008

15. Vakili L, Halabchi F, Mansournia MA, Khami MR, Irandoost S, Alizadeh Z. Prevalence of common postural disorders among academic dental staff. Asian J Sports Med. 2016;7(2):e29631. https://doi.org/10.5812/asjsm.29631

16. Kadu DV, Shetye JV. Reliability of "MB-Ruler Software" to Measure Craniovertebral Angle Using the Photographic Method. J Health Allied Sci. 2022;12(03):307–11. https://doi.org/10.1055/s-0041-1741415

17. Liu J, Liu P, Ma Z, Mou J, Wang Z, Sun D, et al. The effects of aging on the profile of the cervical spine. Medicine. 2019;98(7):e14425. https://doi.org/10.1097/MD.0000000000014425

18. Mei Y, Lin YF, Gong Z, Yan B, Liang Q. Prevalence of incorrect posture among school adolescents after the COVID-19 pandemic: a large population-based scoliosis screening in China. J Orthop Surg Res. 2025;20:156. https://doi.org/10.1186/s13018-025-05479-8