RESEARCH ARTICLE

Neck flexor endurance, craniovertebral angle and neck motion association with and without neck pain: a cross-sectional analytical study

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Abstract

Objective: To compare the deep neck flexor endurance, craniovertebral angle and cervical range of motion in individuals with and without mechanical neck pain.

Method: The analytical, cross-sectional study was conducted from September 12, 2022, to February 27, 2023, at the Sindh Institute of Physical Medicine and Rehabilitation, Karachi, and comprised adults of either gender aged 18-35 years. Those having nonspecific neck pain were in group A, while group B included healthy individuals without neck pain. The groups were compared in terms of deep neck flexor endurance, craniovertebral angle and cervical range of motion. Data was analysed using SPSS 21.

Results: Of the 100 participants, 50(50%) were group A; 25(50%) males and 25(50%) females with mean age 23.64±3.99 years and mean body mass index 21.43±3.16kg/m^2. The remaining 50(50%) subjects were in group B; 25(50%) males and 25(50%) females with mean age 23.52±3.97 years and mean body mass index 21.93± 4.43kg/m^2. Group A showed a significant difference in all range of motion values except rotation. The association of craniovertebral angle and deep neck flexor endurance with neck pain was not significant (p>0.05).

Conclusion: Neck pain was not found to be associated with craniovertebral angle, neck rotation and deep neck flexor endurance. However, cervical flexion, extension, left flexion and right flexion were found associated with neck pain. The association of neck pain with age and body mass index was not significant.

Keywords: Neck ache, Posture, Movement, Endurance. (JPMA 76: 525; 2026)

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Introduction

Neck pain is considered the fourth leading cause of disability.[1] According to a study in 2017, globally 28.6 million people continue to live with disability, with the highest point prevalence being in Western Europe and East Asia.[2] A large number of neck pain case were reported from East Asia, South Asia and Western Europe in 2017.[2] A study on the global burden of the disease shows that the neck pain is a continuously rising problem, with an increase in 21% of point prevalence till 2016.[3] People with neck pain often do not have complete resolution of symptoms, and >50% of patients develop recurrence 1-5 years later in their life.[4] Neck pain can occur due to some specific pathology, but mainly it has a nonspecific, or mechanical, cause.[5] Increasing age and female gender are the factors behind the increase in the incidence and prevalence of neck pain.[6]

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Deep neck flexors (DNF) are known as the important stabilisers of the neck. Weakness of DNF muscles can cause altered posture.[7] Cervical lordosis and postural support to the cervical spine are due to DNF muscles.[8] DNF endurance (DNFE) is correlated with neck pain.[9] There is a limitation in evidence related to any relationship between craniovertebral angle (CVA) and DNF muscle performance.[10]

Forward head posture is one of the reasons that subjects people to mechanical neck pain.[11] Smaller CVA is predictive of neck pain.[12] Studies have shown contradictory results, concluding that forward head posture is not associated with neck pain.[13,14] Forward head posture alters biomechanics and results in increased stress over the cervical spine, causing cervical extensors to work more to meet the demand. This causes an imbalance in muscle performance and neck pain.[15] Literature shows contradictory results regarding the predictors of neck pain.[9,12] The current study was planned to compare DNFE, CVA and cervical range of motion (ROM) in individuals with and without mechanical neck pain.

Subjects and Methods

The comparative, analytical, cross-sectional study was conducted from September 12, 2022, to February 27, 2023, at the Sindh Institute of Physical Medicine and

Rehabilitation, Karachi, after approval from the ethics review board of Dow University of Health Sciences (DUHS), Karachi. The sample was raised using non-probability, purposive sampling technique. Those included were adults of either gender aged 18-35 years. Those with nonspecific neck pain were placed in group A, while healthy individuals without neck pain were placed in group B. Individuals having pain in the thoracic or scapular region, any cognitive or neurological deficit, red flags of neck pain (progressive symptoms, weight-loss, night sweats, diplopia, dizziness), history of any fracture and malignancy in the cervical region, history of any spinal surgery, history of any cervical trauma, symptoms of cervical radiculopathy or myelopathy, and any psychological illness were excluded.

While group A patients were specifically asked to volunteer, an open invitation was placed on the institutional notice board for participation in group B. Informed consent was taken from all the participants. A physiatrist screened all the participants, and those who responded negatively when asked about neck pain were included in group B.

Data was collected using a self-designed questionnaire. All anthropometry assessments were performed by a physiotherapist. The numerical pain rating scale (NPRS) was used to assess the intensity of pain in group A patients.[16] Cervical active ROM (AROM) was assessed using a linear goniometer, while CVA was assessed by a modified goniometer and DNFE by a deep flexor endurance test.[17]

For flexion, the subject was in a seated position with feet resting on the floor. The examiner placed the goniometer stationary arm perpendicular to the floor, the axis at the ear lobe, and the moving arm at the base of the nares. The subject was asked to perform active cervical flexion, and the examiner noted the reading. For extension, the subject was in a seated position with feet resting on the floor. The examiner placed the goniometer stationary arm perpendicular to the floor, the axis at the ear lobe, and the moving arm at the base of the nares. The subject was asked to perform active cervical extension, and the examiner noted the reading. For lateral flexion, the subject was in a seated position with feet resting on the floor. The examiner placed the goniometer stationary arm perpendicular to the floor, the axis at the spinous process of C-7 vertebrae, and the moving arm posterior to the midline of the skull. The subject was asked to actively bring the ear to the shoulder of the same side, and the examiner noted the reading. For rotation, the subject was in a seated position with feet resting on the floor. The examiner placed the goniometer stationary arm at the imaginary line connecting two acromion processes, the axis at the top of the subject's head, and the moving arm at the nose. The subject was asked to perform active cervical rotation, and the examiner noted the reading.[17]

For NFE assessment, the examiner assessed the participant in a lying position on the couch with arms placed at the side. The participant was asked to tuck the chin, and lift the head above the couch about 2.5cm for at least 35 seconds. The examiner placed the hand under the neck to feel the contraction of muscles. The test ended on completing 35 seconds or when the participant lost chin tuck. The readings were taken thrice to calculate the average to reduce the risk of bias.[9] CVA was measured by using a modified goniometer in which a rod was attached at the half circle of the goniometer posteriorly. It is a reliable method for assessing CVA.[11,18] The CVA was measured in degrees with the tragus of the ear as a reference point, and the spinous process of the C7 vertebra as another reference point. Angle <50° was considered an indicator of forward head posture.[19]

The possible bias was avoided with a specific exclusion criterion which avoided the inclusion of all the possible confounding variables that could affect the results, and by taking three readings of DNFE assessment to ensure the accuracy of the results.

The sample size was calculated using OpenEpi based on a mean intergroup difference of 4.1919, with 80% power, 95% confidence interval (CI), and 1:1 group ratio. The sample was inflated by >100% to cover up for a possibly low response rate.[20,21]

Data was analysed using SPSS 24. Quantitative data was expressed as mean±standard deviation, while categorical variables were reported as frequencies and percentages. Binary logistic regression was applied to evaluate associations between continuous predictors and the presence of neck pain. A comparison of neck pain with AROM, CVA and DNFE between the groups was done using an independent t-test. P<0.05 was considered significant.

Results

Of the 100 participants, 50(50%) were group A; 25(50%) males and 25(50%) females with mean age 23.64±3.99 years and mean body mass index (BMI) 21.43±3.16kg/m^2. The remaining 50(50%) subjects were in group B; 25(50%) males and 25(50%) females with mean age 23.52±3.97 years and mean BMI 21.93± 4.43kg/m^2. Overall, 74(74%) of the subjects had normal BMI, 13(13%) were obese and 13(13%) were underweight (Table 1).

Mean CVA in group A was 38.82±7.61 compared to 42.58±7.68 in group B. The mean DNFE for group A was 23.92±9.86 compared to 28.14±7.51 for group B. All cervical ROM values were lower in group A compared to group B, and the difference was significant except left flexion

Table-1: Categorical variables of the subjects (n=100).

Variables	n (%)
Gender	
Male	50 (50)
Female	50 (50)
Body mass index (BMI) category	
Underweight	13 (13)
Normal	13 (13)
Overweight	74 (74)
Pain intensity	
Mild pain	68 (68)
Moderate pain	25 (25)
Severe pain	7 (7)
Neck pain	
With pain	50 (50)
Without pain	50 (50)
DNFE endurance	
Weakness	75 (75)
Normal Endurance	25 (25)
Posture	
Forward head posture	81 (81)
Normal Posture	19 (19)

DNFE: Deep neck flexor endurance.

Table-2: Cervical parameters among individuals with and without neck pain.

Variables	With neck pain[B] (n=50)	Without neck pain[B] (n=50)	*p*-value*	95% confidence interval
CV angle	38.82±7.61	42.58±7.68	0.01	0.72-6.79
DNF endurance	23.92±9.86	28.14±7.51	0.03	0.73-7.70
Cervical Flexion	60.58±15.84	69.46±12.42	<0.001	3.23-14.52
Cervical Extension	46.12±11.48	55.52±10.51	<0.001	5.02-13.77
Left flexion	43.04±9.46	44.34±9.72	0.50	-2.50-5.10
Left rotation	59.04±15.04	74.04±10.07	<0.001	9.91-20.9
Right flexion	42.64±10.35	45.74±7.45	0.03	-0.47-6.67
Right rotation	57.22±14.23	74.96±9.74	<0.001	12.89-22.58

Note: [B] Values represented as mean and standard deviation; *Values represent as level of significance with independent *t*-test; DNF: Deep neck flexor, CV: Craniovertebral.

Table-3: Association of neck pain with age and body mass index (BMI).

Variables	With neck pain[B]	Without neck pain[B]	*p*-value*
Age (years)	23.64±3.99	23.52±3.97	0.88
Body Mass Index (kg/m^2)	21.43±3.16	21.93±4.43	0.51

Note: [B] Values represented as mean and standard deviation; *Values represent as level of significance with Independent *t*-test.

Table-4: Cervical parameters among individuals with and without neck pain.

Parameters	Beta	S.E	*p*-value**	OR	95% CI
CVA	0.66	0.52	0.20	1.94	0.69-5.43
DNF endurance	0.53	0.46	0.25	1.71	0.68-4.30
Flexion	-0.04	0.01	0.004	0.95	0.92-0.98
Extension	-0.07	0.02	<0.001	0.92	0.88-0.96
Right flexion	-0.03	0.02	0.09	0.96	0.91-1.00
Right rotation	-0.11	0.02	<0.001	0.89	0.84-0.93
Left flexion	-0.01	0.02	0.49	0.98	0.94-1.02
Left rotation	-0.09	0.02	<0.001	0.90	0.86-0.94

DNF: Deep neck flexor, CVA: Craniovertebral angle, OR: Odds ratio, CI: confidence interval.

(Table 2). The association of neck pain with age and BMI was not significant (Table 3).

Cervical flexion, cervical extension, right rotation and left rotation showed a significant but weak negative relationship with neck pain, while cervical left/right flexion, CVA and DNFE had no significant association (p>0.05). Moreover, the odds ratio (OR) of CVA and DNFE showed that greater values were moderately and positively associated with neck pain, but the OR of cervical ROM showed that the large values of cervical ROM were moderately and negatively associated with neck pain (Table 4).

Discussion

The current study focussed on cervical muscle flexibility, DNFE and good posture, comparing individuals with and without neck pain. The results showed that there was a difference in all outcomes except left flexion between the groups. However, neck pain had no significant relationship with cervical side flexion, CVA and DNFE.

Literature review showed that neck pain is more common in adults compared to younger age groups even though there are studies showing that neck pain can occur at any age.[22,23] The current study also supported this evidence and proved that there was no relationship between neck pain and age.

Increased BMI is one of the causes of postural abnormalities.[20] Studies have found that individuals having high BMI are at risk of developing more musculoskeletal disorders and have a poorer prognosis than individuals with normal BMI.[24] In the current study, BMI was found not to be associated with neck pain. This result might be due to the fact that the number of individuals within each BMI category varied, and so the comparison might contain a bias.

The intensity of pain affects treatment strategies.[25] Studies have shown that females have a higher rate of intense pain than males, as females show less pain thresholds.[25] The current study did not find any association between pain intensity and gender, which might be due to the presence of more cases of mild pain (68%).

Males tend to be less flexible than females of the same age group across the life span, and that is why males have more tightness in muscles compared to the females. It happens because the male population is more involved in physical activity, which results in microtrauma and anatomical joint structure variation in both genders.[26] Literature shows that cervical flexion is associated with neck pain.[27] The current study showed mean cervical flexion to be more in females than in males, supporting the literature. Individuals with

neck pain had less ROM of flexion compared to the healthy individuals.

Extension of the neck is the movement of the cervical spine bending backward. Studies have shown contradictory results regarding the extension movement of the cervical spine associated with neck pain.[22] The current study recorded mean cervical extension to be more in females than males, and individuals with pain had lower ranges than healthy individuals. Extension was found to be associated with neck pain.

Neck rotation is the horizontal plane movement, and studies have shown rotation of the neck to the left and right directions is not associated with neck pain.[21] In contrast, the current study showed that rotation of movement was associated with neck pain. This might be due to differences in study participants, and the mean of rotation ranges was greater in females than males.

Side flexion of the neck is the movement of the cervical region such that the ear touches the same side shoulder, and a study has shown that side flexion either left or right to have no association with neck pain. However, the current study showed more flexibility on the right side than on the left in both genders.

CVA is the angle used to determine the forward head posture. Dae Hun Kim et al. concluded that individuals with forward head posture have less CVA, and experience pain.[20] A study conducted by Edrish et al. among young adults found a moderate to good negative correlation between CVA and neck pain.[11] In contrast, the current study found no association of CVA with neck pain.

In this study, patients with neck pain were assessed for pain with NPRS, which is a scale for the subjective measurement of pain. It comprises a 10cm straight horizontal line with the extremes labelled "no pain" and "worst possible pain". Mild pain score is ≤5cm on the NPRS scale, while moderate pain score ranges 6-7cm, and ≥8cm is considered severe.[28] In the current study, the NPRS score of most patients with neck pain was under the mild pain category, while only a few patients had severe pain. The current study showed mean NPRS value to be 2.6±2.87 in patients with non-specific neck pain. A previous study reported mean NPRS value to be 4.9±2.0 in patients with non-specific neck pain.[28]

The present study showed there was a non-significant association between CVA and neck pain. The mean CVA among males 38.64±7.4 compared to 42.76±7.8 for females. This difference in angles between genders might be due to the physical activity of males, and flexibility in females.

Compared to another study,[11] the current findings showed that forward head posture was associated with neck pain. This variation might be due to the difference in age group of the samples in the two studies.

The current study has limitations as the findings are limited to neck pain of nonspecific cause. The manual performance of DNFE assessment could have chances of error. The average value of three readings was considered to overcome this error. Finally, the cross-sectional design of the study limited the ability to establish a causal relationship.

Conclusion

Neck pain was not found to be associated with CVA, neck rotation and DNFE. However, cervical flexion, extension, left flexion and right flexion were found associated with neck pain. The association of neck pain with age and BMI was not significant.

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Conflict of Interest: None.

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References

1. Baig AA, Zaki L, Hassan R. Neck pain and hamstring tightness: a less known connection. Pak J Med Res. 2023;62:43-4.
2. Shin DW, Shin JI, Koyanagi A, Jacob L, Smith L, Lee H, et al. Global, regional, and national neck pain burden in the general population, 1990–2019: an analysis of the global burden of disease study 2019. Front Neurol. 2022;13:95101.DOI: 10.3389/fneur.2022.95101
3. Ahangar-Sirous R, Alizadeh M, Nejadghaderi SA, Noori M, Khabbazi A, Sullman MJ, et al. The burden of neck pain in the Middle East and North Africa region, 1990–2019. Heliyon. 2023;9:e19867.DOI: 10.1016/j.heliyon.2023.e19867
4. Ward MC, Koyfman SA, Bakst RL, Margalit DN, Beadle BM, Beitler JJ, et al. Retreatment of recurrent or second primary head and neck cancer after prior radiation: executive summary of the American Radium Society appropriate use criteria. Int J Radiat Oncol Biol Phys. 2022;113:759-86. DOI: 10.1016/j.ijrobp.2022.03.041
5. Siddiqui M, Akhter S, Baig AA. Effects of autogenic and reciprocal inhibition techniques with conventional therapy in mechanical neck pain: a randomized controlled trial. BMC Musculoskelet Disord. 2022;23:704. DOI: 10.1186/s12891-022-05616-4
6. Verhagen A. Physiotherapy management of neck pain. J Physiother. 2021;67:5-11. DOI: 10.1016/j.jphys.2020.11.003
7. Tavares LF, Gadotti IC, Carvalho BG, Fernandes AP, Padilha Silva J, Barbosa GA, et al. Are neck pain, disability, and deep neck flexor performance the same for the different types of temporomandibular disorders? Cranio. 2024;42:770-8. DOI: 10.1080/08869634.2022.2102453
8. Park JH, Lim OB. Relationship between the craniovertebral angle, cervical lordosis, and cervical muscles. J Korean Soc Phys Med. 2022;17:41-8.
9. Kocur P, Choszczewski D, Lewandowski J, Goliwąs M. Assessment of stiffness of the superficial neck muscles in female office workers with impaired endurance of deep neck flexors: a case-control study. Physiother Q. 2023;31:114-20. DOI: 10.5114/pq.2023.120522

10. Kang K, Korea S. Correlation between craniovertebral angle and muscle activity according to body movements in forward head posture. Cranio. 2024;13:1-9.
11. Contractor ES, Shah SS, Shah SJ. To study correlation between neck pain and craniovertebral angle in young adults. Int Arch Integr Med. 2018;5:81-6.
12. Mostafaee N, HasanNia F, Negahban H, Pirayeh N. Evaluating differences between participants with various forward head posture with and without postural neck pain using craniovertebral angle and forward shoulder angle. J Manipulative Physiol Ther. 2022;45:179-87.DOI: 10.1016/j.jmpt.2021.11.005
13. Sarig Bahat H, Levy A, Yona T. The association between forward head posture and non-specific neck pain: a cross-sectional study. Physiother Theory Pract 2023;39:1736-45. DOI: 10.1080/09593985.2022.2034524
14. Lin G, Zhao X, Wang W, Wilkinson T. The relationship between forward head posture, postural control and gait: a systematic review. Gait Posture. 2022;98:316-29. DOI: 10.1016/j.gaitpost.2022.09.006
15. Lee HJ, Jeon DG, Park JH. Correlation between kinematic sagittal parameters of the cervical lordosis or head posture and disc degeneration in patients with posterior neck pain. Open Med. 2021;16:161-8.DOI: 10.1515/med-2021-0210
16. Farrar JT, Young JP Jr, LaMoreaux L, Werth JL, Poole RM. Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. Pain. 2001;94:149-58. DOI: 10.1016/S0304-3959(01)00349-9
17. Reese N, Bandy W. Joint range of motion and muscle length testing 2nd ed. Canada: Saunders Elsevier, 2009.
18. LeResche L. Defining gender disparities in pain management. Clin Orthop Relat Res. 2011;469:1-7. DOI: 10.1007/s11999-010-1759-9
19. Dean AG, Sullivan KM, Soe MM. OpenEpi: open-source epidemiologic statistics for public health. 2013.
20. Peltonen M, Lindroos AK, Torgerson JS. Musculoskeletal pain in the obese: a comparison with a general population and long-term changes after conventional and surgical obesity treatment. Pain. 2003;104:549-57. DOI: 10.1016/S0304-3959(03)00117-5
21. Elsayed WH, Alowa ZA. Impact of forward head posture correction on craniovertebral angle, neck disability, and spinal electromyography: a randomized controlled trial. J Back Musculoskelet Rehabil. 2024;37:1-10. DOI: 10.3233/BMR-230344
22. Kim DH, Kim CJ, Son SM. Neck pain in adults with forward head posture: effects of craniovertebral angle and cervical range of motion. Osong Public Health Res Perspect. 2018;9:309-12. DOI: 10.24171/j.phrp.2018.9.6.04
23. Petre L. The incidence of diseases that affect joint mobility in a group of subjects from Romania. Ann Roum Anthropol. 2023;23:60-6.
24. Shariat A, Cardoso JR, Cleland JA, Danaee M, Ansari NN, Kargarfard M, et al. Prevalence rate of neck, shoulder and lower back pain in association with age, body mass index and gender among Malaysian office workers. Work. 2018;60:191-9. DOI: 10.3233/WOR-182717
25. Vallerand AH, Polomano RC. The relationship of gender to pain. Pain Manag Nurs. 2000;1:8-15.DOI: 10.1053/jpmn.2000.5830
26. Boonstra AM, Stewart RE, Köke AJ, Oosterwijk RF, Swaan JL, Schreurs KM, et al. Cut-off points for mild, moderate, and severe pain on the numeric rating scale for pain in patients with chronic musculoskeletal pain. Front Psychol. 2016;7:1466. DOI: 10.3389/fpsyg.2016.01466
27. Ruhe A, Fejer R, Walker B. On the relationship between pain intensity and postural sway in patients with non-specific neck pain. J Back Musculoskelet Rehabil. 2013;26:401-9.DOI: 10.3233/BMR-130395
28. Edmondston SJ, Wallumrød ME, MacLéid F, Kvamme LS, Joebges S, Brabham GC. Reliability of isometric muscle endurance tests in subjects with postural neck pain. J Manipulative Physiol Ther. 2008;31:348-54. DOI: 10.1016/j.jmpt.2008.04.002

Author Contribution:

SQ & AAMB: Concept, design, data acquisition, analysis, interpretation, drafting, revision, final approval and agreement to be accountable for all aspects of the work.

SIA: Concept, design, data acquisition, analysis, interpretation and agreement to be accountable for all aspects of the work.