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Original Article

Correlation of Forward Head Posture with Refractive Error Among Undergraduate Students of Allied Health Sciences in Sarhad University of Science and Information Technology, Peshawar

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ABSTRACT

Background: Forward head posture is a common postural deviation among university students and may be influenced by prolonged near-work, poor ergonomics, and visual impairment. Refractive error may contribute to compensatory head-neck positioning adopted to improve visual clarity during academic activities. Objective: To determine the relationship between forward head posture and refractive error among undergraduate students of Allied Health Sciences at Sarhad University of Science and Information Technology, Peshawar. Methods: A descriptive cross-sectional study was conducted among 332 undergraduate students selected through convenience sampling. Demographic data and visual status were recorded using a structured questionnaire, and forward head posture was assessed through craniovertebral angle measurement using a goniometer. Postural status was categorized as normal, mild forward head posture, or moderate/severe forward head posture. Data were analyzed in SPSS version 20 using descriptive statistics, cross-tabulation, chi-square testing, odds ratio estimation, and correlation analysis. Results: Forward head posture was identified in 210 students (63.3%), while refractive error was present in 186 students (56.0%). Among students with refractive error, 73.1% demonstrated forward head posture compared with 50.7% among those without refractive error. A significant association was observed between refractive error and forward head posture (chi-square = 17.71, $p < 0.001$), and students with refractive error had higher odds of postural deviation (OR = 2.65, 95% CI: 1.67-4.19). Craniovertebral angle showed a significant negative correlation with refractive error ($r = -0.312$, $p = 0.001$). Conclusion: Refractive error was significantly associated with greater forward head posture among undergraduate students. Combined vision screening, ergonomic education, and postural interventions may help reduce musculoskeletal risk in this population. Keywords: forward head posture, refractive error, craniovertebral angle, university students, posture, ergonomics

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INTRODUCTION

Proper posture reflects a state of musculoskeletal equilibrium in which body segments are aligned in a manner that minimizes stress on muscles, ligaments, joints, and other supporting structures while permitting efficient movement and physiological function. When this alignment is disturbed, compensatory loading patterns may develop across the cervical and thoracic regions, predisposing individuals to pain, fatigue, reduced mobility, and progressive postural dysfunction. Among the postural deviations observed in young adults, forward head posture (FHP) has become particularly prominent in student populations because of prolonged sitting, sustained near-work, and frequent use of smartphones, tablets, and laptops during academic activities (1-4). FHP is characterized by anterior translation of the

head relative to the trunk, typically accompanied by upper cervical extension and lower cervical flexion, resulting in an altered biomechanical relationship between the skull, cervical spine, and shoulder girdle. Even small anterior displacement of the head increases the effective moment arm acting on the cervical spine, thereby increasing muscular demand and mechanical strain on cervical structures. Over time, this altered loading has been associated with neck pain, shoulder discomfort, cervicogenic headache, reduced cervical range of motion, and impaired functional endurance of postural musculature (2-4).

The burden of FHP among university students appears substantial. Contemporary studies have shown that postural abnormalities are highly prevalent in students exposed to prolonged device use, poor workstation ergonomics, and sedentary study habits, with reported frequencies of FHP often approaching or exceeding half of the student population in some settings (1,5-8). This pattern is clinically important because university years represent a period during which repetitive academic behaviors become habitual and may establish long-term musculoskeletal risk. Students in allied health sciences may be especially vulnerable because their academic routines often combine classroom learning, extended reading, screen-based assignments, and clinical observation, all of which may encourage sustained neck flexion and suboptimal visual working distances (5-8). Although ergonomic factors are well-recognized contributors, posture is not determined solely by musculoskeletal behavior; it is also shaped by sensory inputs that influence body orientation and movement control.

Visual function is one such determinant. Refractive error, including myopia, hyperopia, and astigmatism, remains one of the most common causes of impaired visual clarity worldwide and is especially relevant in young adults engaged in prolonged reading and screen-based work (9,12). When visual acuity is reduced, individuals may unconsciously modify their head and neck position to improve focus, enlarge retinal image clarity, or compensate for blurred distant or near vision. Such compensatory strategies may include leaning forward, protruding the chin, tilting the head, or reducing viewing distance during writing, reading, or device use. If repeated over long periods, these behaviors may contribute to maladaptive head-neck alignment and reinforce FHP (10,11,13-15). In this way, refractive status may interact with mechanical and ergonomic exposures rather than acting as an isolated visual variable.

This relationship is biologically plausible because posture is maintained through continuous integration of visual, vestibular, and proprioceptive input. Visual acuity and ocular feedback contribute to spatial orientation, balance regulation, and head stabilization, and disturbances in visual input may provoke compensatory postural adjustments intended to optimize environmental perception (10,11). Prior literature has suggested that visual strain, reduced viewing distance, and visually demanding tasks are associated with altered cervical posture and increased neck muscle loading, while ergonomic interventions and correction of visual factors may help reduce postural stress in student populations (13-18). However, much of the available evidence has focused either on the prevalence of FHP or on the burden of refractive errors independently, and relatively few studies have examined their direct relationship within a single university-based sample, particularly in undergraduate students enrolled in allied health sciences programs in Pakistan. This is an important gap because students experiencing unrecognized visual deficits may be at increased risk of adopting persistent compensatory postures that later manifest as musculoskeletal complaints.

Given the growing academic reliance on digital devices and near-work tasks, understanding whether refractive error is associated with FHP has practical implications for early screening, interdisciplinary prevention, and campus health services. If visual impairment contributes to postural deviation, then physiotherapy-led postural education alone may be insufficient without simultaneous attention to visual status, viewing behavior, and workstation ergonomics. Conversely, early recognition of both conditions may support integrated strategies involving physiotherapists, optometrists, ophthalmologists, and academic institutions to reduce long-term cervical strain and improve student well-being. Therefore, the present study was undertaken to determine the relationship between refractive error and forward head posture among undergraduate students of Allied Health Sciences at Sarhad University of Science and

Information Technology, Peshawar. It was hypothesized that students with refractive error would demonstrate greater postural deviation, reflected by lower craniovertebral angle values, than students without refractive error (16-18).

MATERIALS AND METHODS

This study used a descriptive cross-sectional design to investigate the relationship between refractive error and forward head posture among undergraduate students enrolled in the Sarhad Institute of Allied Health Sciences, Sarhad University of Science and Information Technology, Peshawar, Pakistan. The cross-sectional approach was selected because it allowed simultaneous assessment of visual status and postural alignment within the target population and was appropriate for estimating prevalence patterns and examining the strength and direction of association between the study variables at a single point in time. Data collection was conducted over a six-month period from March 2025 to August 2025 within the academic environment of the institute.

The source population comprised undergraduate students registered in allied health sciences programs at the study site, with an estimated total population of approximately 2400 students. Sample size was determined using the Raosoft sample size calculator at a 95% confidence level, 5% margin of error, and 50% response distribution, yielding a required sample of 332 participants. Participants were recruited through non-probability convenience sampling. Students were approached in classrooms and other academic areas, informed about the purpose and procedures of the study, and invited to participate voluntarily. Those who expressed willingness to participate were screened for eligibility before enrollment.

Eligibility criteria were defined a priori to improve sample homogeneity and reduce major sources of bias. Students aged 18 to 32 years who were enrolled in undergraduate allied health sciences programs and were able to understand and respond to the study procedures were included. Students were excluded if they had a recent history of neck pathology, spinal pathology, or any condition likely to independently alter cervical posture irrespective of routine academic exposure. Students from departments outside Allied Health Sciences were also excluded. Participation was entirely voluntary, and informed consent was obtained from each participant before data collection. Confidentiality was maintained by recording data in anonymized form and restricting analysis to study variables only. Participants were informed that they could decline or withdraw from the study at any stage without academic or personal consequence.

Data were collected in two sequential phases. In the first phase, participants completed a structured questionnaire developed for this study. The questionnaire captured demographic information, including age, sex, and academic program, along with information related to visual status and academic activity patterns relevant to near-work exposure. To improve consistency in administration, all participants received the same instructions and completed the questionnaire under researcher supervision. The questionnaire responses were reviewed at the time of collection to identify incomplete fields and reduce avoidable missing data. Refractive error was operationally recorded as a dichotomous study variable based on participant-reported visual status and categorized as present or absent for the purpose of analysis.

In the second phase, each participant underwent postural assessment for forward head posture using the craniovertebral angle (CVA), which served as the primary postural outcome variable. CVA was assessed clinically with a goniometer under direct supervision using a standardized standing or sitting position with the participant instructed to assume a natural, relaxed posture while looking straight ahead. The angle was determined from the lateral profile of the cervical region using established surface landmarks for head-neck alignment, and the observed value was recorded in degrees. Lower CVA values were interpreted as representing greater forward head posture. For categorical analysis, postural status was classified as normal posture when CVA was greater than 50 degrees, mild forward head posture when CVA was between 45 and 50 degrees, and moderate to severe forward head posture when CVA was less

than 45 degrees. This operational categorization permitted both continuous analysis using the raw CVA value and grouped analysis for prevalence reporting.

Several steps were taken to improve internal validity and reduce systematic error. Standardized instructions were used during questionnaire administration and postural assessment to minimize information bias. Eligibility criteria excluded participants with recent cervical or spinal pathology to reduce confounding from pre-existing musculoskeletal conditions. The same assessment approach and classification thresholds were applied to all participants to improve measurement consistency. Because convenience sampling may introduce selection bias and self-reported visual status may be affected by reporting error, interpretation of the findings was restricted to association rather than causation. In addition, demographic variables including age, sex, and academic program were summarized to characterize the sample and permit contextual interpretation of the findings.

Data were entered, cleaned, and analyzed using Statistical Package for the Social Sciences (SPSS) version 20. Descriptive statistics were computed for all variables. Categorical variables were summarized as frequencies and percentages, whereas continuous postural measurements were analyzed using appropriate summary statistics. The prevalence of forward head posture and refractive error was calculated across the sample. Association between refractive error status and categorized postural status was examined using cross-tabulation. The relationship between CVA and refractive error was evaluated through correlation analysis, with the coefficient and p-value reported to quantify the strength, direction, and statistical significance of the relationship. A two-tailed p-value of less than 0.05 was considered statistically significant. Data were reviewed before analysis for completeness and consistency, and only completed records were included in the final analysis to preserve data integrity. All study procedures were documented uniformly to support reproducibility of the methods.

RESULTS

A total of 332 undergraduate students from the Sarhad Institute of Allied Health Sciences were included in the final analysis. Female students constituted 58.4% of the sample, while 41.6% were male. The largest age stratum was 18–22 years (61.4%), followed by 23–27 years (28.9%) and 28–32 years (9.7%). By academic program, Doctor of Physical Therapy students represented the largest subgroup (37.9%), followed by Radiology (25.3%), Medical Laboratory Technology (21.7%), and other allied health disciplines (15.1%) (Table 1).

Table 1. Demographic Characteristics of Participants (n = 332)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	138	41.6
	Female	194	58.4
Age group	18–22 years	204	61.4
	23–27 years	96	28.9
	28–32 years	32	9.7
Academic program	DPT	126	37.9
	Radiology	84	25.3
	Medical Laboratory Technology	72	21.7
	Other allied programs	50	15.1

Assessment of craniovertebral angle showed that only 122 students (36.7%) had normal posture, whereas 210 students (63.3%) demonstrated some degree of forward head posture. Mild forward head posture was the most frequent category, affecting 138 students (41.6%), while 72 students (21.7%) had moderate-to-severe forward head posture. These findings indicate that nearly two-thirds of the sample exhibited measurable anterior head displacement on postural screening (Table 2).

Table 2. Distribution of Craniovertebral Angle and Forward Head Posture (n = 332)

Postural status	Craniovertebral angle (CVA)	Frequency (n)	Percentage (%)
Normal posture	>50°	122	36.7
Mild forward head posture	45°–50°	138	41.6
Moderate/severe forward head posture	<45°	72	21.7
Total		332	100.0

Refractive error was present in 186 students (56.0%), whereas 146 students (44.0%) reported no refractive error. Among students without refractive error, 74 of 146 (50.7%) demonstrated forward head posture. In contrast, among those with refractive error, 136 of 186 (73.1%) exhibited forward head posture. This represented an absolute difference of 22.4 percentage points. Cross-tabulation showed a statistically significant association between refractive error and forward head posture (chi-square = 17.71, $p < 0.001$), with a small-to-moderate effect size (phi = 0.231). Students with refractive error had 2.65 times higher odds of exhibiting forward head posture compared with those without refractive error (OR = 2.65, 95% CI: 1.67–4.19) (Table 3).

Table 3. Association Between Refractive Error and Forward Head Posture

Refractive status	Normal posture n (%)	Forward head posture n (%)	Total (n)	Chi-square	p-value	Odds ratio (95% CI)
No refractive error	72 (49.3)	74 (50.7)	146			
Refractive error present	50 (26.9)	136 (73.1)	186			
Total	122 (36.7)	210 (63.3)	332	17.71	<0.001	2.65 (1.67–4.19)

Correlation analysis further demonstrated a statistically significant negative relationship between craniovertebral angle and refractive error (r = -0.312, p = 0.001). The 95% confidence interval for the correlation coefficient ranged from -0.406 to -0.211, indicating that refractive error was associated with lower craniovertebral angle values and therefore greater severity of forward head posture (Table 4).

Table 4. Correlation Between Craniovertebral Angle and Refractive Error

Variables	Correlation coefficient (r)	95% CI	p-value	Interpretation
Craniovertebral angle vs refractive error	-0.312	-0.406 to -0.211	0.001	Significant negative correlation

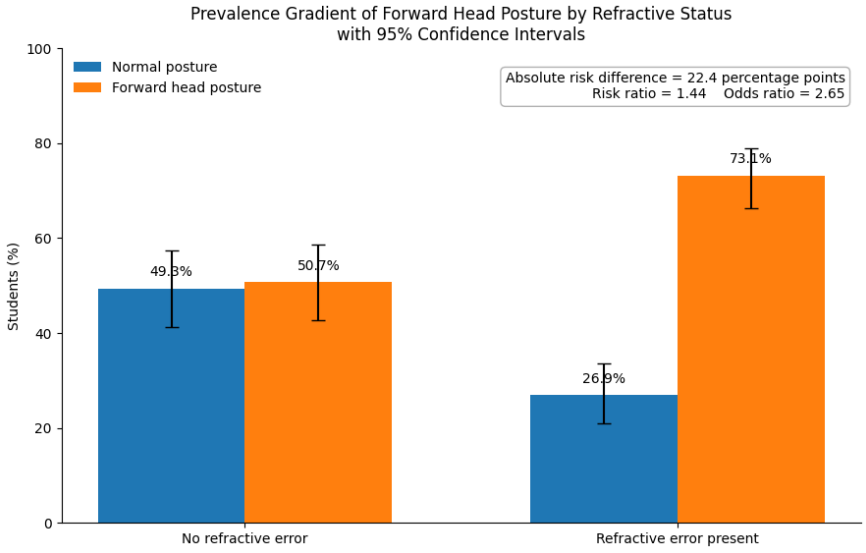

Figure 1. Prevalence gradient of forward head posture by refractive status with 95% confidence intervals. The proportion of students with forward head posture increased from 50.7% in those without refractive error to 73.1% in those with refractive error, while normal posture declined from 49.3% to 26.9%. This corresponds to an absolute excess burden of 22.4 percentage points, a risk ratio of 1.44, and an odds ratio of 2.65, demonstrating that refractive error was associated with a clinically meaningful shift toward postural deviation rather than a marginal difference in distribution alone.

DISCUSSION

The present study examined the relationship between refractive error and forward head posture among undergraduate students of allied health sciences and found a statistically significant association between

the two variables. Of the 332 participants, 63.3% demonstrated some degree of forward head posture, and the burden of postural deviation was substantially greater among students with refractive error than among those without refractive error. Specifically, 73.1% of students with refractive error exhibited forward head posture compared with 50.7% of those without refractive error, while the odds of forward head posture were 2.65 times higher in students with refractive error. In addition, the negative correlation between craniovertebral angle and refractive error ($r = -0.312$, $p = 0.001$) indicates that refractive error was associated not merely with the presence of postural abnormality, but also with greater severity of anterior head displacement. These findings support the hypothesis that visual impairment may contribute to compensatory head-neck positioning in students exposed to prolonged near-work and screen-based tasks.

The overall prevalence of forward head posture observed in this study is consistent with previous reports showing that cervical postural deviation is common among student populations. Cross-sectional studies in school and university settings have documented considerable burdens of forward head posture, particularly among young individuals with sustained academic or device-related visual demands, suggesting that this problem begins early and may persist into higher education if not addressed (19-21). The predominance of mild forward head posture in the current sample is also clinically relevant because this pattern may represent an early stage of biomechanical adaptation rather than fixed deformity, which means that timely intervention through ergonomic correction, exercise, and visual assessment may still be effective. The present findings therefore reinforce the view that postural screening should not be restricted to symptomatic individuals, especially in educational environments characterized by prolonged sitting and near-visual work.

A key contribution of this study is the demonstration that refractive error may be an important correlate of forward head posture in university students. This is in agreement with previous work among spectacle-wearing or visually strained young adults, where altered viewing behavior and compensatory head protrusion were associated with smaller craniovertebral angles and poorer cervical alignment (22-24). Students with blurred vision may unconsciously reduce viewing distance, lean the head anteriorly, or maintain prolonged chin-forward posture in order to improve visual clarity during reading, board work, or digital screen use. Over time, such adaptations may increase cervical extensor demand and alter muscle recruitment patterns, thereby reinforcing faulty posture. The present findings extend these observations by showing that the relationship persists in a relatively large undergraduate sample drawn from allied health sciences, a population in which visual and postural demands coexist routinely.

The observed association is also biomechanically plausible. Forward head posture changes the alignment of the cervical spine, increases the moment arm of the head, and places greater mechanical load on cervical muscles and passive structures. Studies on smartphone use, head posture, and cervical muscle activity have shown that reduced craniovertebral angle is associated with increased strain across the cervical region and may contribute to pain, fatigue, and functional limitations in young adults (24,28-30). When refractive error is superimposed on these existing academic exposures, students may be more likely to adopt visually compensatory positions that accelerate this biomechanical burden. In this context, refractive error should be viewed not as an isolated ocular issue, but as a potential contributor to musculoskeletal loading patterns during study-related activities.

The relationship between vision and posture is further supported by sensory-motor literature. Visual input plays a central role in orientation, body alignment, and postural control, and disturbances in visual feedback can modify how the body stabilizes the head and trunk during everyday activities. Experimental evidence has shown that visual feedback significantly contributes to seated postural regulation, supporting the idea that impaired or suboptimal visual input may influence head-neck alignment even in the absence of overt vestibular or neurological disease (26). Similarly, clinical observations in patients with cervical dysfunction have suggested that cervical abnormalities and visual complaints may coexist through shared biomechanical and neurophysiological pathways, although causal direction remains

uncertain (27). The current findings fit within this broader framework, suggesting that abnormal visual demands may influence cervical posture through both compensatory behavior and altered sensory integration.

From a clinical and educational perspective, these findings have practical implications. University students are rarely evaluated in an integrated manner for visual and postural health, despite the fact that both are affected by sustained near-work, prolonged screen exposure, and poor ergonomics. The present results suggest that screening for refractive error may be relevant when assessing students with forward head posture, just as postural evaluation may be valuable in students presenting with visual strain or habitual leaning during academic work. Interdisciplinary strategies involving physiotherapists, optometrists, ophthalmologists, and academic institutions may therefore be more effective than isolated interventions. Ergonomic education, regular vision testing, correction of refractive error, and postural exercise programs may collectively reduce cervical strain and help prevent progression toward symptomatic musculoskeletal disorders.

This study has several strengths, including a relatively adequate sample size, direct postural assessment using craniovertebral angle, and analysis of both categorical and correlational relationships. However, some limitations should be acknowledged. The cross-sectional design precludes causal inference, and the use of convenience sampling may limit generalizability beyond the study institution. Refractive error was classified from participant-reported visual status rather than direct optometric verification, which may have introduced misclassification bias. In addition, potentially relevant confounders such as daily screen time, duration of spectacle use, severity and type of refractive error, ergonomic behavior, body mass index, and neck pain status were not included in the analysis. These factors may partly explain variation in craniovertebral angle and should be incorporated into future studies. Prospective and multicenter studies using objective ophthalmic assessment and multivariable modeling would provide stronger evidence regarding whether refractive error independently contributes to forward head posture or functions mainly through associated study behaviors.

Overall, the present findings indicate that refractive error is significantly associated with forward head posture in undergraduate students and may represent a modifiable contributor to postural dysfunction in academically demanding environments. Because mild forward head posture accounted for the largest proportion of abnormal cases, early preventive efforts may be particularly valuable at this stage. Future research should determine whether correction of refractive error, combined with ergonomic and physiotherapeutic intervention, produces measurable improvement in craniovertebral angle, neck symptoms, and functional study posture over time.

CONCLUSION

Forward head posture was highly prevalent among undergraduate students of allied health sciences, and its occurrence was significantly greater in those with refractive error. Students with refractive error showed higher odds of postural deviation and lower craniovertebral angle values, indicating greater anterior head displacement. These findings support the view that visual status should be considered during postural assessment of students exposed to prolonged near-work and screen-based learning. Early vision screening, ergonomic education, and timely postural correction may help reduce musculoskeletal strain and prevent progression of cervical dysfunction in this population.

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