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Original Article

Effectiveness of Chin Tuck Versus Scapular Retraction Exercises Combined With Posture Education in Students With Smartphone-Related Forward Head Posture: A Randomized Controlled Trial

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ABSTRACT

Background: Smartphone-related forward head posture is increasingly common among students and may contribute to neck pain, rounded shoulders, neck fatigue, upper-back tightness, and functional disability. Chin tuck and scapular retraction exercises are frequently prescribed with posture education, but comparative evidence regarding their outcome-specific effects remains limited. Objective: To compare the effects of chin tuck exercises versus scapular retraction exercises, both combined with posture education, on pain intensity and neck-related disability among students with smartphone-related forward head posture. Methods: This randomized controlled trial included 126 students aged 18–30 years with smartphone-related forward head posture. Participants were allocated equally to chin tuck plus posture education or scapular retraction plus posture education for eight weeks. Pain intensity was assessed using the Numeric Pain Rating Scale, and disability was assessed using the Neck Disability Index at baseline and after intervention. Group comparisons, within-group changes, Mann–Whitney U tests, and regression analyses were performed. Results: Both groups showed significant pre–post improvements in pain and disability. NPRS improvement was greater in the scapular retraction group than in the chin tuck group, 2.08 ± 0.49 versus 1.84 ± 0.60, $p = .016$. NDI improvement was greater in the chin tuck group than in the scapular retraction group, 14.40 ± 6.94 versus 7.25 ± 5.18, $p < .001$. Conclusion: Both interventions improved symptoms and disability, with scapular retraction showing slightly greater pain reduction and chin tuck showing greater disability improvement. Baseline disability imbalance warrants cautious interpretation. Keywords: Forward Head Posture; Chin Tuck Exercise; Scapular Retraction; Posture Education; Smartphone Use; Neck Pain; Neck Disability Index; Randomized Controlled Trial.

INTRODUCTION

Forward head posture is a common postural deviation characterized by anterior translation of the head relative to the trunk, usually accompanied by lower cervical flexion, upper cervical extension, increased thoracic kyphosis, rounded shoulders, and altered scapular positioning. This malalignment increases mechanical loading on the cervical spine and surrounding soft tissues, particularly during prolonged static activities that require sustained neck flexion. Smartphone use has become one of the most frequent contributors to this posture among students because mobile devices are commonly held below eye level, encouraging repetitive or sustained cervical flexion during reading, texting, gaming, online learning,

and social media use. Biomechanical and epidemiological evidence indicates that prolonged smartphone exposure is associated with neck pain, upper-limb discomfort, altered cervical posture, and musculoskeletal symptoms in young adults and university students (1,2).

University students are a particularly vulnerable population because academic, social, and recreational smartphone use often overlap, leading to prolonged screen time and reduced postural variation during the day. Recent studies have reported that longer mobile-phone use is associated with reduced neck muscle endurance, increased neck pain, and greater risk of musculoskeletal symptoms among students (3,4). Smartphone-related postural strain may also contribute to headache, neck fatigue, upper-back tightness, rounded shoulders, sleep disturbance, and reduced concentration, all of which can interfere with study performance and daily function. These clinical features make smartphone-related forward head posture not only a postural concern but also a functional rehabilitation problem that requires targeted preventive and therapeutic strategies (5,6).

The development of forward head posture is commonly linked to imbalance between deep and superficial cervical musculature. Prolonged anterior head translation may weaken or inhibit the deep cervical flexors, including the longus capitis and longus colli, while increasing activity and tightness in superficial muscles such as the sternocleidomastoid, upper trapezius, levator scapulae, and suboccipital muscles. These changes can reduce cervical stability, impair postural endurance, and increase pain sensitivity during sustained smartphone use. Chin tuck exercises are frequently used in physiotherapy practice to activate the deep cervical flexors, restore neutral cervical alignment, and reduce excessive anterior head positioning. Previous work has suggested that deep neck flexor strengthening and cervical stabilization exercises can improve forward head posture, craniovertebral angle, cervical muscle endurance, pain, and disability in individuals with postural neck problems (7,8).

Scapular retraction exercises are also commonly prescribed because forward head posture frequently coexists with rounded shoulders, thoracic kyphosis, and altered scapular mechanics. The scapula provides a functional link between the cervical spine, thorax, and upper limb, and impaired scapular positioning may increase cervical and shoulder loading during prolonged sitting and device use. Exercises targeting scapular stabilizers, including the middle trapezius, lower trapezius, rhomboids, and serratus anterior, may improve thoracic posture and shoulder alignment, indirectly reducing cervical strain. Randomized and comparative rehabilitation studies have shown that scapular stabilization and thoracic extension exercises may improve pain, disability, respiratory function, cervical range of motion, and craniovertebral alignment in individuals with forward head posture and work-related postural dysfunction (9,10).

Although both chin tuck and scapular retraction exercises are clinically plausible interventions for smartphone-related forward head posture, their mechanisms differ. Chin tuck exercises directly target cervical alignment and deep neck flexor control, whereas scapular retraction exercises primarily influence thoracic and shoulder girdle posture with indirect effects on the cervical region. Posture education may further support both interventions by improving ergonomic awareness, encouraging appropriate smartphone positioning, and reducing sustained flexed-neck behavior. However, comparative evidence remains limited regarding which exercise approach, when combined with posture education, produces greater improvement in neck pain and functional disability among students with smartphone-related forward head posture. This gap is clinically important because physiotherapists need practical, low-cost, and evidence-informed exercise prescriptions that can be implemented in student populations with high smartphone exposure.

Therefore, this randomized controlled trial was conducted to compare the effectiveness of chin tuck exercises versus scapular retraction exercises, both combined with posture education, in students with smartphone-related forward head posture. Using the Numeric Pain Rating Scale and Neck Disability Index as outcome measures, the study aimed to determine whether the two exercise approaches differed in their effects on neck pain intensity and neck-related functional disability after an eight-week

intervention. The research hypothesis was that there would be a significant difference between chin tuck exercises and scapular retraction exercises in improving pain and disability among students with smartphone-related forward head posture.

MATERIALS AND METHODS

This study was designed as a randomized controlled trial comparing two exercise-based physiotherapy interventions for smartphone-related forward head posture among university-level students. The trial used a parallel two-group design in which eligible participants were allocated in a 1:1 ratio to receive either chin tuck exercises combined with posture education or scapular retraction exercises combined with posture education. The design was selected because the objective was to compare the effects of two active rehabilitation approaches on pain intensity and neck-related disability over a defined intervention period.

The study was conducted at Al-Razi Institute of Allied Health Sciences, Lahore, Pakistan. The intervention and assessment period lasted eight weeks and included participant recruitment, baseline assessment, group allocation, supervised exercise instruction, posture education, and post-intervention reassessment. Students using smartphones for prolonged daily periods were screened for eligibility. Participants were included if they were male or female students aged 18–30 years, used a smartphone for more than three hours per day, presented with forward head posture on clinical postural assessment, and provided written informed consent for participation. Participants were excluded if they had a history of neck trauma, cervical or spinal surgery, neurological disease, congenital spinal deformity, or neck pain requiring ongoing physiotherapy treatment outside the study protocol.

Eligible participants were enrolled through convenience recruitment from the study setting and were then randomly assigned into two equal groups using simple randomization. A total of 126 participants were included, with 63 participants allocated to Group A and 63 participants allocated to Group B. Group A received chin tuck exercises combined with posture education, while Group B received scapular retraction exercises combined with posture education. Both groups received the intervention over the same eight-week period under researcher guidance to maintain consistency in delivery and follow-up. All participants were informed about the study purpose, procedures, expected participation requirements, and voluntary nature of involvement before enrollment. Written informed consent was obtained, and confidentiality of participant information was maintained throughout the study.

The intervention in Group A focused on chin tuck exercises as a cervical stabilization strategy. Participants were instructed to perform controlled posterior translation of the head while maintaining an upright posture, with emphasis on avoiding excessive cervical flexion or extension and encouraging activation of the deep cervical flexor muscles. The intervention in Group B focused on scapular retraction exercises as a shoulder-girdle and thoracic postural correction strategy. Participants were instructed to perform controlled retraction of the scapulae with an upright trunk position, emphasizing symmetrical shoulder positioning and avoidance of compensatory cervical or lumbar movements. Both groups received posture education addressing correct sitting posture, neutral head and neck alignment, avoidance of prolonged static neck flexion, appropriate smartphone height, regular postural breaks, and awareness of rounded shoulder posture during device use. The same general educational content was provided to both groups so that the comparative difference between interventions remained focused on the exercise component.

Pain intensity was measured using the Numeric Pain Rating Scale, an 11-point self-reported scale ranging from 0 to 10, where 0 represents no pain and 10 represents the worst imaginable pain. Neck-related functional disability was measured using the Neck Disability Index, scored from 0 to 50, with higher scores indicating greater disability. Baseline measurements were recorded before the start of the intervention, and post-intervention measurements were recorded after completion of the eight-week program. The primary outcome variables were change in NPRS score and change in NDI score from

baseline to post-intervention. Improvement scores were calculated by subtracting post-intervention values from baseline values, so that higher improvement scores represented greater reduction in pain or disability. Additional participant variables included gender, marital status, daily smartphone use category, exercise type, postural characteristics, headache, rounded shoulders, pain after smartphone use, sleep disturbance, study limitation, neck fatigue, upper-back tightness, concentration difficulty, stiffness, break-taking behavior, compliance, perceived pain outcome, perceived posture improvement, discomfort reduction, and willingness to continue exercises.

To reduce measurement and performance bias, both groups were assessed using the same outcome tools, at the same assessment points, and over the same intervention duration. The posture education component was kept consistent between groups. Baseline demographic and clinical characteristics were compared between groups to identify pre-intervention imbalance. Because baseline NPRS and NDI scores differed between intervention groups, interpretation of between-group improvement was planned with attention to baseline severity, and regression analysis was used to examine whether exercise type, daily smartphone use, compliance, and age predicted improvement outcomes. Compliance was recorded as part of follow-up monitoring because adherence to therapeutic exercise can influence rehabilitation response.

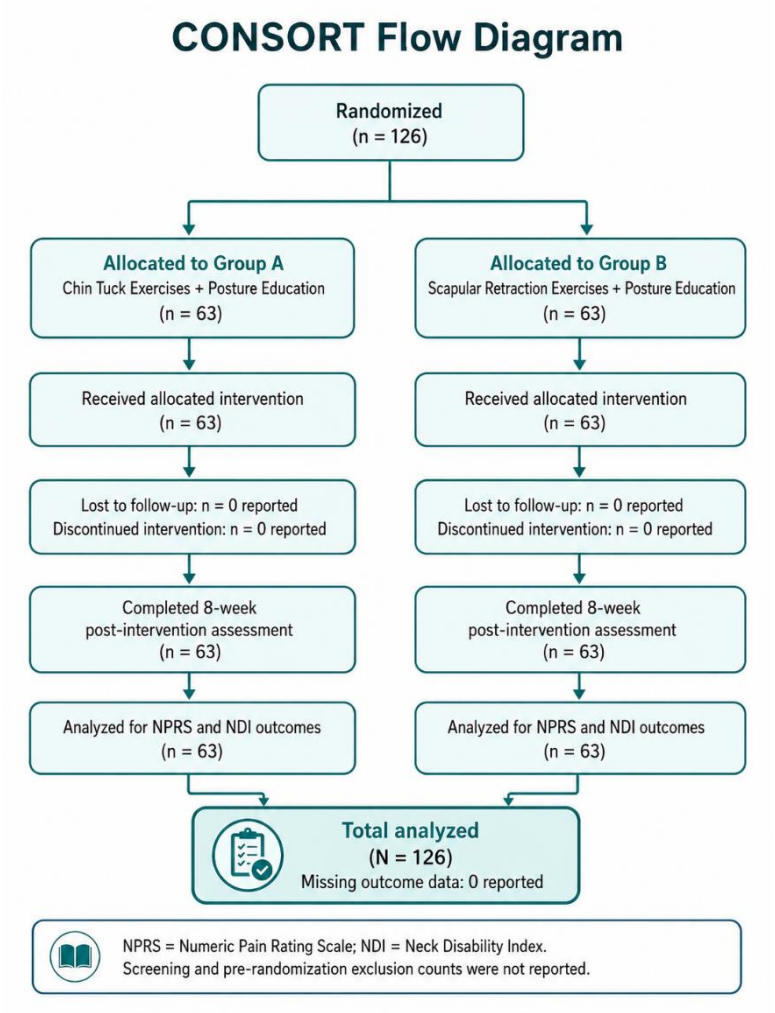

Figure 1 CONSORT Flowchart

Data were entered and analyzed using SPSS version 25. Descriptive statistics were calculated for demographic, clinical, and outcome variables. Categorical variables were summarized as frequencies and percentages, while continuous or score-based variables were summarized using means, standard deviations, minimum values, and maximum values. Normality of NPRS and NDI variables was assessed using Kolmogorov–Smirnov and Shapiro–Wilk tests. Baseline between-group comparisons were

performed to assess comparability of groups before intervention. Within-group pre–post changes were examined for NPRS and NDI, and between-group differences in improvement scores were analyzed using appropriate parametric or nonparametric tests according to data distribution. Mann–Whitney U testing was used for nonnormally distributed improvement comparisons between exercise groups. Multiple regression analysis was performed to evaluate predictors of NPRS and NDI improvement, with exercise type, daily smartphone use, compliance, and age entered as independent variables. A p-value of less than 0.05 was considered statistically significant. Missing data were handled through available-case or listwise analysis according to the requirements of each statistical procedure.

Ethical approval was obtained from the Ethical Review Committee of Al-Razi Institute of Allied Health Sciences, Lahore, Pakistan, before initiation of the study. All participants provided written informed consent before data collection. Participation was voluntary, and participants were informed that they could withdraw from the study without penalty. Data were handled confidentially and were used only for research purposes. Reproducibility and data integrity were supported through standardized eligibility criteria, uniform baseline and post-intervention assessment procedures, use of validated clinical outcome measures, equal intervention duration across groups, consistent posture education content, and statistical analysis based on the predefined comparison of pain and disability outcomes between the two exercise interventions.

RESULTS

A total of 126 students with smartphone-related forward head posture were included in the analysis, with 63 participants allocated to the chin tuck plus posture education group and 63 participants allocated to the scapular retraction plus posture education group. No missing values were reported for the principal outcome variables, including baseline and post-intervention Numeric Pain Rating Scale scores and Neck Disability Index scores. Most participants were female, single, and reported prolonged daily smartphone use. Forward head posture, rounded shoulders, neck fatigue, upper-back tightness, stiffness, headache, and pain after smartphone use were highly prevalent at baseline, indicating that the enrolled sample represented students with clinically relevant postural and musculoskeletal complaints associated with smartphone exposure.

Table 1. Baseline Demographic and Clinical Characteristics of Participants

Variable	Category	Total, n (%)	Chin Tuck, n	Scapular Retraction, n	p-value
Gender	Male	50 (39.7)	21	29	.145
	Female	76 (60.3)	42	34	
Marital status	Single	124 (98.4)	63	61	.154
	Married	2 (1.6)	0	2	
Neck position	Forward head	122 (96.8)	60	62	.310
	Slight flexion	4 (3.2)	3	1	
Headache	Yes	85 (67.5)	27	58	<.001
	No	41 (32.5)	36	5	
Rounded shoulders	Yes	124 (98.4)	62	62	1.000
	No	2 (1.6)	1	1	
Neck fatigue	Yes	125 (99.2)	63	62	.315
	No	1 (0.8)	0	1	
Upper-back tightness	Yes	122 (96.8)	61	61	1.000
	No	4 (3.2)	2	2	
Daily smartphone use	2–4 h	9 (7.1)	—	—	—
	4–6 h	79 (62.7)	—	—	—
	>6 h	38 (30.2)	—	—	—

The baseline profile showed a high symptom burden among participants. Forward head posture was present in 122 participants (96.8%), rounded shoulders in 124 participants (98.4%), neck fatigue in 125 participants (99.2%), and upper-back tightness in 122 participants (96.8%). Pain after smartphone use was reported by all participants, while headache was reported by 85 participants (67.5%). Smartphone exposure was also substantial, with 79 participants (62.7%) reporting 4–6 hours of daily use and 38

participants (30.2%) reporting more than 6 hours of daily use. The groups were similar for gender, marital status, neck position, rounded shoulders, neck fatigue, and upper-back tightness; however, headache differed significantly between groups, being more frequent in the scapular retraction group than in the chin tuck group.

Table 2. Overall Pre- and Post-Intervention Outcome Scores

Outcome Variable	N	Baseline Mean ± SD	Post-Intervention Mean ± SD	Mean Change	Baseline 95% CI	Post-Intervention 95% CI
NPRS	126	4.21 ± 0.71	2.25 ± 0.44	1.96	4.09 to 4.34	2.18 to 2.33
NDI	126	21.47 ± 7.96	10.64 ± 1.25	10.83	20.07 to 22.87	10.42 to 10.86

Across the total sample, both pain and disability improved after the eight-week intervention period. Mean NPRS decreased from 4.21 ± 0.71 at baseline to 2.25 ± 0.44 after intervention, representing a mean reduction of 1.96 points. Mean NDI decreased from 21.47 ± 7.96 to 10.64 ± 1.25, representing a mean reduction of 10.83 points. These findings indicate that the combined exercise and posture education programs were associated with clinically meaningful improvement in both neck pain intensity and neck-related functional disability.

Table 3. Baseline Comparability of Intervention Groups

Variable	Chin Tuck, Mean ± SD (n = 63)	Scapular Retraction, Mean ± SD (n = 63)	Mean Difference	t	df	p-value	Cohen's d (95% CI)
Age category	1.32 ± 0.47	1.41 ± 0.50	-0.10	-1.11	123.61	.271	-0.20 (-0.55 to 0.15)
NPRS before intervention	4.08 ± 0.79	4.35 ± 0.60	-0.27	-2.16	124	.033	-0.39 (-0.74 to -0.03)
NDI before intervention	25.57 ± 7.94	17.37 ± 5.51	8.21	6.74	110.50	<.001	1.20 (0.82 to 1.58)

Baseline comparisons showed no significant difference between groups for age category. However, the groups differed significantly at baseline for both pain and disability. The scapular retraction group had higher baseline NPRS scores than the chin tuck group, 4.35 ± 0.60 versus 4.08 ± 0.79, with a small-to-moderate standardized difference. In contrast, the chin tuck group had substantially higher baseline disability than the scapular retraction group, 25.57 ± 7.94 versus 17.37 ± 5.51, with a large standardized difference. This baseline imbalance is important for interpretation because greater absolute NDI improvement in the chin tuck group may partly reflect higher initial disability and greater room for improvement.

Table 4. Within-Group Pre–Post Changes in NPRS and NDI

Group	Outcome	Baseline Mean ± SD	Post-Intervention Mean ± SD	Mean Change ± SD	95% CI	t	df	p-value	Cohen's d for Paired Change (95% CI)
Chin tuck + posture education	NPRS	4.08 ± 0.79	2.24 ± 0.43	1.84 ± 0.60	1.69 to 1.99	24.31	62	<.001	3.06 (2.47 to 3.65)
Chin tuck + posture education	NDI	25.57 ± 7.94	11.17 ± 1.51	14.40 ± 6.94	12.65 to 16.14	16.47	62	<.001	2.08 (1.63 to 2.51)
Scapular retraction + posture education	NPRS	4.35 ± 0.60	2.27 ± 0.45	2.08 ± 0.49	1.96 to 2.20	34.01	62	<.001	4.29 (3.49 to 5.07)
Scapular retraction + posture education	NDI	17.37 ± 5.51	10.11 ± 0.54	7.25 ± 5.18	5.95 to 8.56	11.12	62	<.001	1.40 (1.05 to 1.75)

Both intervention groups demonstrated statistically significant within-group improvements in pain and disability after eight weeks. In the chin tuck group, NPRS decreased by 1.84 points and NDI decreased by 14.40 points. In the scapular retraction group, NPRS decreased by 2.08 points and NDI decreased by 7.25 points. The magnitude of paired change was large for both outcomes in both groups, indicating that each intervention was associated with meaningful improvement. However, the pattern of response differed by outcome: scapular retraction showed slightly greater absolute reduction in pain intensity, whereas chin tuck showed greater absolute reduction in disability.

Table 5. Between-Group Comparison of Improvement Scores

Outcome	Chin Tuck Mean ± SD	Scapular Retraction Mean ± SD	Mean Difference	95% CI	t	df	p-value	Hedges' g	Mann–Whitney U	z	Nonparametric p-value
NPRS improvement	1.84 ± 0.60	2.08 ± 0.49	-0.24	-0.43 to -0.05	-2.45	118.72	.016	-0.43 (-0.78 to -0.08)	2389.50	2.43	.015
NDI improvement	14.40 ± 6.94	7.25 ± 5.18	7.14	4.98 to 9.30	6.55	114.72	<.001	1.16 (0.78 to 1.53)	786.50	-5.86	<.001

Between-group analysis showed an outcome-specific response pattern. NPRS improvement was significantly greater in the scapular retraction group than in the chin tuck group, with a mean difference of -0.24 points and a small-to-moderate standardized effect favoring scapular retraction. Conversely, NDI improvement was significantly greater in the chin tuck group than in the scapular retraction group, with a mean difference of 7.14 points and a large standardized effect favoring chin tuck. The

nonparametric Mann–Whitney U tests supported the same pattern, with significant between-group differences for both NPRS improvement and NDI improvement. These findings should be interpreted in light of baseline imbalance, particularly the higher baseline NDI score in the chin tuck group.

Table 6. Multiple Regression Analysis Predicting NPRS Improvement

Predictor	B	SE B	Standardized β	t	p-value
Constant	1.03	0.41	—	2.49	.014
Exercise type	0.21	0.09	.19	2.25	.026
Daily smartphone use	0.20	0.09	.21	2.29	.024
Compliance	-0.34	0.26	-.11	-1.29	.198
Age category	0.23	0.11	.20	2.20	.029

The regression model for NPRS improvement was statistically significant and explained 18.4% of the variance in pain reduction. Exercise type, daily smartphone use, and age category were significant predictors of NPRS improvement, while compliance was not statistically significant in this model. This corrected model indicates that the earlier interpretation of compliance as a significant predictor of pain improvement should not be retained unless a different verified model is provided.

Table 7. Multiple Regression Analysis Predicting NDI Improvement

Predictor	B	SE B	Standardized β	t	p-value
Constant	20.51	4.97	—	4.13	<.001
Exercise type	-7.03	1.10	-.50	-6.38	<.001
Daily smartphone use	0.32	1.07	.03	0.30	.765
Compliance	1.57	3.16	.04	0.50	.620
Age category	-1.31	1.27	-.09	-1.03	.305

The regression model for NDI improvement was statistically significant and explained 26.6% of the variance in disability reduction. Exercise type was the only statistically significant predictor of NDI improvement, while daily smartphone use, compliance, and age category were not significant. The negative coefficient for exercise type reflects the coding direction of the intervention variable and should be interpreted with reference to group coding. Based on the group means, NDI improvement was greater in the chin tuck group than in the scapular retraction group. However, because baseline NDI was substantially higher in the chin tuck group, this finding should be presented cautiously and ideally confirmed using a baseline-adjusted model.

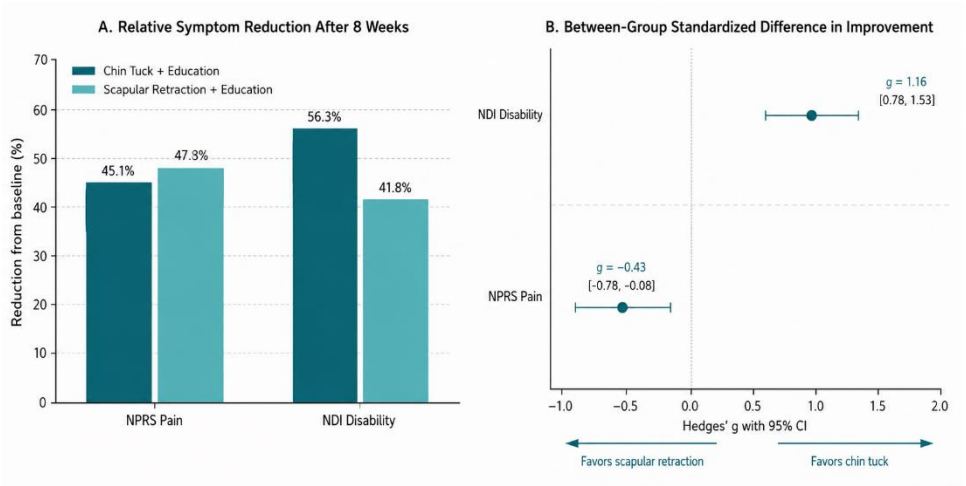

Figure 2 Outcome-Specific Response Pattern to Exercise-Based Posture Rehabilitation

The panelled figure demonstrates a clinically divergent response across pain and disability outcomes. Relative pain reduction was comparable between groups, with NPRS decreasing by 45.1% in the chin tuck group and 47.8% in the scapular retraction group, while disability reduction showed a stronger gradient favoring chin tuck, with NDI decreasing by 56.3% compared with 41.8% in the scapular retraction group. The standardized between-group effect confirmed this outcome-specific pattern: NPRS improvement favored scapular retraction with Hedges' g = -0.43, 95% CI -0.78 to -0.08, whereas NDI

improvement favored chin tuck with Hedges' g = 1.16, 95% CI 0.78 to 1.53. This pattern suggests that scapular retraction may provide slightly greater short-term pain relief, while chin tuck may produce larger functional disability improvement, although the disability finding should be interpreted cautiously because the chin tuck group had higher baseline NDI severity.

Overall, both exercise programs combined with posture education produced significant improvements in pain and disability among students with smartphone-related forward head posture. The corrected results do not support a simple conclusion that one intervention was superior for all outcomes. Instead, the findings suggest an outcome-specific treatment response: scapular retraction showed greater improvement in pain intensity, whereas chin tuck showed greater improvement in neck-related disability. Because the groups were not fully balanced at baseline, especially for NDI, future interpretation and discussion should emphasize adjusted analysis and cautious clinical inference rather than absolute superiority.

DISCUSSION

The present randomized controlled trial compared chin tuck exercises and scapular retraction exercises, both delivered with posture education, among students with smartphone-related forward head posture. The findings showed that both intervention groups experienced significant improvements in neck pain and neck-related disability after eight weeks, indicating that exercise-based postural rehabilitation combined with education may be clinically useful for students exposed to prolonged smartphone use. However, the corrected analysis demonstrated an outcome-specific response pattern rather than uniform superiority of one intervention. Scapular retraction exercises produced slightly greater improvement in pain intensity, whereas chin tuck exercises produced greater improvement in Neck Disability Index scores. This distinction is important because pain reduction and functional disability improvement may reflect overlapping but not identical mechanisms in students with forward head posture.

The high baseline burden of symptoms in this study supports the clinical relevance of smartphone-related postural dysfunction in university students. Forward head posture was present in 96.8% of participants, rounded shoulders in 98.4%, neck fatigue in 99.2%, upper-back tightness in 96.8%, and pain after smartphone use in all participants. Most students reported prolonged smartphone exposure, with 62.7% using smartphones for 4–6 hours daily and 30.2% for more than 6 hours daily. These findings are consistent with previous evidence showing that prolonged smartphone use is associated with neck pain, upper-limb symptoms, reduced neck muscle endurance, and musculoskeletal discomfort among students and young adults (1–4). The pattern observed in the present trial also supports the biomechanical explanation that sustained viewing of handheld devices below eye level increases cervical flexion demand, promotes anterior head translation, and contributes to fatigue of cervical and shoulder-girdle muscles (5,6).

Both exercise programs produced statistically significant within-group improvements in NPRS and NDI, which suggests that structured exercise and ergonomic education can reduce the symptomatic and functional impact of smartphone-related forward head posture. The chin tuck group improved from 4.08 ± 0.79 to 2.24 ± 0.43 on NPRS and from 25.57 ± 7.94 to 11.17 ± 1.51 on NDI. The scapular retraction group improved from 4.35 ± 0.60 to 2.27 ± 0.45 on NPRS and from 17.37 ± 5.51 to 10.11 ± 0.54 on NDI. These results align with prior studies reporting beneficial effects of cervical stabilization, deep neck flexor strengthening, scapular stabilization, and postural correction exercises in individuals with forward head posture and neck pain (7–10). The consistent within-group improvement across both interventions suggests that correcting postural habits and strengthening relevant muscle groups may be more effective than education alone for students with persistent smartphone-related symptoms.

The greater reduction in disability observed in the chin tuck group may be explained by the direct role of chin tuck exercises in restoring cervical alignment and improving deep cervical flexor control. Forward head posture is commonly associated with weakness or reduced endurance of the deep cervical

flexors and compensatory overactivity of superficial muscles such as the sternocleidomastoid, upper trapezius, levator scapulae, and suboccipital muscles. By encouraging controlled posterior translation of the head over the cervical spine, chin tuck exercises may reduce excessive anterior head loading, improve segmental cervical control, and decrease mechanical strain during prolonged sitting and smartphone use. Previous studies have similarly reported that deep cervical flexor strengthening and cervical stabilization exercises can improve craniovertebral angle, neck flexor endurance, pain, and functional limitations among individuals with forward head posture (7,8).

In contrast, the slightly greater NPRS improvement in the scapular retraction group suggests that shoulder-girdle and thoracic postural correction may contribute meaningfully to short-term pain relief. Forward head posture often coexists with rounded shoulders and altered scapular orientation, which can increase load transfer through the cervical and cervicothoracic regions. Scapular retraction exercises target the rhomboids and middle trapezius and may improve shoulder alignment, thoracic extension tendency, and scapulothoracic control. These changes may reduce perceived cervical and upper-back strain during static sitting and smartphone use. The findings are compatible with previous work showing that scapular stabilization and thoracic extension exercises can improve pain, disability, respiratory function, cervical mobility, and posture in populations with forward head posture or work-related postural dysfunction (9,10).

The between-group findings should nevertheless be interpreted cautiously because baseline values were not fully balanced. Baseline NPRS was significantly higher in the scapular retraction group, while baseline NDI was substantially higher in the chin tuck group. This imbalance is particularly important for NDI, where the chin tuck group had greater baseline disability and therefore greater potential for absolute improvement. Although the between-group difference in NDI improvement favored chin tuck exercises, part of this difference may reflect baseline severity, regression to the mean, or greater room for measurable improvement. For this reason, the findings should not be interpreted as definitive evidence of overall superiority of chin tuck exercises unless confirmed by baseline-adjusted analysis. A more appropriate interpretation is that chin tuck exercises appear more strongly associated with functional disability reduction, whereas scapular retraction exercises appear slightly more favorable for pain reduction in the available unadjusted improvement analysis.

The regression analysis further supported the relevance of intervention type but also highlighted the need for careful interpretation. Exercise type significantly predicted both NPRS and NDI improvement. Daily smartphone use and age category were significant predictors of NPRS improvement, whereas compliance was not significant in the corrected NPRS regression model. For NDI improvement, exercise type was the only significant predictor among the variables entered. These results suggest that the type of exercise may influence rehabilitation response, but the predictive models explained only part of the variance in outcomes. Other potentially relevant factors, including baseline postural angle, exercise technique quality, psychosocial stress, sleep pattern, workstation ergonomics, physical activity level, and objective adherence, were not fully measured and may have contributed to treatment response.

The clinical implication of this study is that both chin tuck and scapular retraction exercises can be considered useful components of rehabilitation programs for students with smartphone-related forward head posture. Rather than selecting one exercise universally, physiotherapists may consider the dominant clinical presentation. Students with greater functional limitation, poor cervical control, or marked forward head posture may benefit particularly from chin tuck exercises and deep cervical flexor training. Students with prominent rounded shoulders, upper-back tightness, scapular protraction, or pain related to shoulder-girdle strain may benefit from scapular retraction exercises as part of a broader postural correction program. In practical settings, a combined program including cervical stabilization, scapular stabilization, thoracic mobility, and posture education may be more comprehensive than either exercise alone.

This study has several limitations. The sample was recruited from a student population aged 18–30 years, which limits generalizability to older adults, workers, patients with chronic neck disorders, or individuals with structural cervical pathology. The diagnosis of forward head posture was based on clinical assessment rather than objective photographic or radiographic measurement such as craniovertebral angle. Baseline imbalance in NPRS and NDI between groups limits the strength of causal conclusions from unadjusted change-score comparisons. The intervention protocol would be strengthened by more detailed reporting of exercise frequency, repetitions, duration, progression, supervision, home practice, and adherence verification. The study also lacked long-term follow-up, so it remains unclear whether improvements were sustained after completion of the eight-week intervention. Future trials should use concealed allocation, assessor blinding where feasible, objective postural measurements, baseline-adjusted analysis, standardized intervention fidelity monitoring, and longer follow-up to confirm the comparative effects of cervical and scapular exercise strategies.

Despite these limitations, the study contributes useful clinical evidence by directly comparing two commonly used exercise approaches in students with smartphone-related forward head posture. The corrected results indicate that both interventions are beneficial, but they may influence pain and disability differently. This outcome-specific response pattern provides a more clinically useful message than a simple superiority claim and supports individualized exercise prescription based on the student's dominant impairment profile.

CONCLUSION

Both chin tuck exercises and scapular retraction exercises combined with posture education produced significant improvements in neck pain and neck-related disability among students with smartphone-related forward head posture after eight weeks of intervention. The corrected findings suggest an outcome-specific treatment response: scapular retraction exercises showed slightly greater reduction in NPRS pain scores, while chin tuck exercises showed greater improvement in NDI disability scores. However, the greater disability improvement in the chin tuck group should be interpreted cautiously because this group had substantially higher baseline NDI scores. Overall, exercise-based posture rehabilitation appears beneficial for students with smartphone-related forward head posture, and clinical exercise selection should consider whether the main treatment target is pain relief, functional disability reduction, cervical control, or scapular-postural correction.

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