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IMPACT OF STRUCTURED STRETCHING PROGRAM ON CERVICAL PAIN AND POSTURE AMONG SMARTPHONE USERS

Original Research

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ABSTRACT

Background: Smartphone use has become a routine part of academic and daily life, particularly among university students. Prolonged mobile phone use often encourages sustained neck flexion, poor posture, and repeated strain on cervical muscles, which may contribute to neck pain and functional limitation. Therapeutic stretching and proprioceptive neuromuscular facilitation are commonly used physiotherapy approaches for reducing muscle tightness and improving cervical mobility, but their comparative effectiveness among smartphone users requires further clinical attention.

Objective: To compare the effects of stretching exercises and proprioceptive neuromuscular facilitation techniques on pain intensity and neck disability among university students with neck pain associated with smartphone use.

Methods: This single-blinded comparative experimental study was conducted among university students from medical science departments at Government College University Faisalabad over six months. A total of 80 participants aged 18–30 years with neck pain and smartphone use of at least six hours per day were recruited through convenience sampling and randomly allocated into two equal groups. Group A received structured cervical stretching exercises, while Group B received proprioceptive neuromuscular facilitation techniques for eight weeks. Pain intensity was measured using the Numeric Pain Rating Scale, and neck-related disability was assessed through the Neck Disability Index at baseline and after intervention. Data were analyzed using SPSS, with within-group and between-group comparisons performed after normality testing.

Results: Among 80 participants, 28 were aged 18–20 years and 52 were aged 21–23 years. Each group included 6 males and 34 females. In Group A, mean pain decreased from 1.45 ± 0.60 to 0.78 ± 0.83, while mean disability decreased from 25.35 ± 10.14 to 13.60 ± 7.66. In Group B, mean pain decreased from 2.00 ± 0.91 to 0.60 ± 0.71, while mean disability decreased from 37.05 ± 15.02 to 12.75 ± 5.85. Between-group analysis showed significant post-treatment differences for NPRS and NDI scores, with $p = 0.001$.

Conclusion: Both interventions improved cervical pain and neck disability among smartphone-using university students, but proprioceptive neuromuscular facilitation produced greater improvement than stretching exercises. PNF may be considered a useful physiotherapy option for managing smartphone-associated neck pain and functional limitation.

Keywords: Cell Phone; Disability Evaluation; Exercise Therapy; Neck Pain; Posture; Proprioceptive Neuromuscular Facilitation; Students.

INTRODUCTION

Neck pain is increasingly recognized as a common musculoskeletal problem that affects daily comfort, functional ability, study performance, work productivity, and overall quality of life. Although it may appear to be a minor complaint in the beginning, persistent cervical discomfort can gradually interfere with routine activities such as reading, driving, computer work, sleep, and prolonged sitting. Neck discomfort and neck pain are frequently reported in the general population, and their occurrence is often linked with postural strain, repetitive movements, muscular fatigue, and prolonged static positioning (1). In many individuals, the problem develops slowly rather than suddenly, making it easy to ignore until pain, stiffness, or functional limitation becomes more noticeable. The cervical region is highly sensitive to mechanical stress because it supports the weight of the head while allowing a wide range of movement. Poor posture, repeated neck flexion, sudden jerking movements, and sustained muscle loading can place excessive strain on the cervical muscles, ligaments, joints, and intervertebral structures (2). Stress and psychological tension may further increase muscle tightness around the neck and shoulder region, contributing to stiffness and discomfort. While most cases of neck pain are mechanical and posture-related, cervical pain may also be associated with more serious conditions such as cervical spondylosis or spinal stenosis, where degenerative changes or narrowing of the spinal canal may compress neural structures and produce pain, weakness, or neurological symptoms (3,4). Therefore, early identification of posture-related cervical pain is important before it progresses into chronic disability or more complex musculoskeletal dysfunction (5).

In recent years, smartphone use has become one of the most common contributors to sustained poor neck posture. Smartphones are now used for communication, education, entertainment, professional tasks, and social interaction, often for several hours each day. This change in daily behavior has increased concern regarding the biomechanical effects of prolonged mobile phone use on the cervical spine. During smartphone use, individuals commonly bend the head forward and look downward for extended periods. This posture, often described as “text neck,” shifts the head away from its neutral alignment and increases the mechanical load on the cervical spine (5). Although the neutral head position is generally close to zero degrees of flexion or extension, smartphone users frequently adopt a forward-flexed position that places continuous strain on the posterior cervical muscles and supporting structures (6,7). The degree of cervical flexion during smartphone use may vary according to sitting position, screen height, duration of use, and personal habits. Research has indicated that neck flexion during mobile phone activity may range from mild to marked flexion, approximately between 15 and 60 degrees, depending on user behavior and the nature of the activity (6). As the angle of forward head posture increases, the compressive forces on the cervical spine also increase. Over time, this repeated loading may contribute to muscle imbalance, reduced flexibility, altered spinal alignment, increased trigger point sensitivity, and postural deviation. Prolonged smartphone use may also lead to sustained activation and fatigue of the cervical and upper thoracic muscles, particularly when the neck remains flexed for long periods without rest or corrective movement (6). These changes may gradually result in pain, stiffness, reduced range of motion, and functional disability (8).

Conservative physiotherapy interventions play an important role in managing posture-related neck pain among smartphone users. Stretching exercises are commonly used to reduce muscular tightness, improve flexibility, restore soft tissue length, and support better alignment of the cervical and shoulder region (7). A structured stretching program may be particularly useful because it provides planned, repeated, and progressive movement rather than irregular or unsupervised exercise. When performed correctly and within a comfortable range, stretching may help reduce tension in overactive muscles, improve cervical mobility, and promote awareness of proper posture during daily smartphone use. Proprioceptive neuromuscular facilitation techniques may also assist in improving range of motion, reducing muscle stiffness, and enhancing neuromuscular control through combined patterns of stretching and muscle contraction (7). However, in routine clinical and community settings, there remains a need to determine how effectively a structured stretching-based program can address cervical pain and postural changes specifically among smartphone users (9). Despite the growing recognition of smartphone-related neck pain, many users continue to consider it a temporary discomfort rather than a preventable musculoskeletal concern. Existing literature highlights the relationship between poor mobile phone posture, forward head position, cervical muscle strain, and neck disability, but there is still a practical need for simple, accessible, and structured exercise strategies that can be applied in young and adult smartphone users. A focused stretching program may offer a low-cost and non-invasive approach for reducing cervical pain and improving posture, especially in individuals who spend prolonged time using mobile phones. This study was therefore designed to answer the research question of whether a structured stretching program has a beneficial effect on cervical pain and posture among smartphone users. It was hypothesized that participants receiving a structured stretching program would show improvement in cervical pain, postural alignment, and related functional limitation. The objective of the study was to determine the impact of a structured stretching program on cervical pain and posture among smartphone users, with the rationale that early physiotherapeutic correction of muscle tightness and poor alignment may help reduce pain, prevent disability, and promote healthier smartphone-use habits.

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METHODS

This study was conducted as a single-blinded comparative experimental study to determine the effect of therapeutic stretching interventions on cervical pain and related functional limitation among smartphone-using university students. The study population consisted of students enrolled in medical science departments, including Doctor of Physical Therapy, Bachelor of Eastern Medicine and Surgery, and Orthotics and Prosthetics at Government College University Faisalabad, a government-sector university. A convenience sampling technique was used to recruit eligible participants, and the total sample included 80 students. After enrollment, the participants were randomly allocated into two equal groups, with 40 participants in Group A and 40 participants in Group B. The overall duration of the study was six months, while the active intervention period for each participant was eight weeks. Participants were selected according to predefined eligibility criteria. University students of either gender, aged between 18 and 30 years, who had cervical pain and reported using a smartphone for at least six hours per day were included in the study. Students were excluded if they had a recent history of cervical trauma, musculoskeletal injury affecting the neck or upper limb, any cervical implant or current use of a cervical collar/orthosis, diagnosed psychological illness that could influence pain reporting or participation, or unwillingness to provide informed consent. These criteria were applied to ensure that the enrolled participants had smartphone-associated neck pain without major confounding conditions that could independently affect cervical pain, posture, or disability (10).

Data were collected after obtaining informed consent from all eligible participants. Baseline assessment was performed before the start of the intervention, and follow-up assessment was completed after eight weeks of treatment. The study was described as single-blinded because the outcome assessor was kept unaware of the participants' group allocation. Due to the nature of the exercise-based interventions, blinding of participants and therapists was not practically possible. Pain intensity was measured using the Numeric Pain Rating Scale, while cervical functional limitation was assessed using the Neck Disability Index. Both tools were applied at baseline and after completion of the eight-week intervention period to evaluate within-group improvement and between-group differences in treatment response (11). Group A received a structured cervical stretching exercise program. The program included neck side bending, neck rotation, upper trapezius stretching, levator scapulae stretching, and chin tuck exercises (7). For neck side bending, participants were instructed to sit or stand upright with relaxed shoulders and gently move the ear toward the shoulder until a mild stretch was felt on the opposite side of the neck. The stretch was held for 30 seconds and repeated three times on each side. For neck rotation, participants slowly turned the head toward one side while attempting to align the chin with the shoulder, held the position for 30 seconds, and repeated it three times on each side. The upper trapezius stretch was performed by gently pulling the head toward the opposite shoulder to produce a comfortable stretch along the lateral neck and upper shoulder region, with the stretch held for 30 seconds and repeated three times bilaterally. The levator scapulae stretch was performed by rotating the head to one side and then directing the chin toward the armpit, followed by gentle overpressure to stretch the opposite posterior-lateral neck region. This position was also held for 30 seconds and repeated three times on each side. Chin tuck exercises were performed in a sitting or standing position with the spine upright, where participants gently retracted the chin as if making a double chin, held the position for 10 seconds, and repeated the exercise 10 times. This exercise was included to support deep neck flexor activation and postural correction (12).

Group B received proprioceptive neuromuscular facilitation techniques for neck pain, mainly using contract-relax and hold-relax methods (8). In the contract-relax technique, the participant was positioned comfortably in sitting or lying, and the target cervical muscle group was placed near the available end range. The participant then performed an isometric contraction against manual resistance for approximately 10 seconds, followed by relaxation. After relaxation, the therapist gently moved the neck into a further comfortable stretch and maintained the position for approximately 30 seconds. The procedure was repeated in multiple cycles, with gradual progression according to participant tolerance. In the hold-relax technique, the cervical region was first moved passively to the point of mild stretch and held for approximately 30 seconds. The participant then performed an isometric contraction against therapist resistance for about 10 seconds, followed by relaxation and a further passive stretch into the newly gained range. This cycle was repeated progressively while ensuring that the stretch remained pain-free and controlled (13). All data were entered and analyzed using Statistical Package for the Social Sciences software. Descriptive statistics were calculated for demographic and clinical variables. Quantitative variables were presented as mean and standard deviation when normally distributed, while non-normally distributed variables were summarized using median and interquartile range where required. Categorical variables were presented as frequencies and percentages. The normality of continuous data was assessed before applying inferential tests. Within-group comparisons from baseline to post-intervention were performed using the paired-samples t-test for normally distributed data or the Wilcoxon signed-rank test for non-normally distributed data. Between-group comparisons were performed using the independent-samples t-test for normally distributed variables or the Mann–Whitney U test for non-normally distributed variables. A p-value of less than 0.05 was considered statistically significant (8).

Ethical principles were followed throughout the study. Permission for data collection was obtained from the relevant institutional authority/ethical review committee of Government College University Faisalabad before participant recruitment; however, the ethical approval reference number was not provided in the available study information and should be inserted if available. Participation was completely voluntary, and written informed consent was obtained from each participant before enrollment. Participants were informed about the purpose of the study, the nature of the intervention, their right to withdraw at any stage, and the confidentiality of their personal

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information. It was ensured that the exercise interventions were performed within a safe and comfortable range to avoid physical, psychological, or social harm.

RESULTS

A total of 80 participants completed the study and were equally allocated into two treatment groups, with 40 participants in the stretching exercise group and 40 participants in the PNF technique group. The demographic distribution was identical in both groups. In each group, 14 participants were aged 18–20 years, representing 35.0% of the group, while 26 participants were aged 21–23 years, representing 65.0%. Overall, 28 participants were aged 18–20 years and 52 participants were aged 21–23 years. Gender distribution was also similar between the groups, with 6 males and 34 females in each group. In the total sample, 12 participants were male and 68 were female, showing that females represented the larger proportion of the study population. Within-group analysis showed a reduction in neck pain intensity after the intervention in both groups. In the stretching exercise group, the mean pre-treatment pain intensity score was 1.45 ± 0.60, which decreased to 0.78 ± 0.83 after eight weeks of intervention. The mean reduction in pain score was 0.68, and the paired-samples t-test showed a statistically significant difference between pre- and post-treatment pain scores, with $t = 6.153$, $df = 39$, and $p < 0.001$. In the PNF technique group, the mean pain intensity score decreased from 2.00 ± 0.91 before treatment to 0.60 ± 0.71 after treatment. The mean reduction in pain score was 1.40, and the change was statistically significant, with $t = 10.929$, $df = 39$, and $p = 0.001$.

A reduction in neck disability was also observed in both groups after the eight-week intervention period. In the stretching exercise group, the mean pre-treatment Neck Disability Index percentage was 25.35 ± 10.14, which decreased to 13.60 ± 7.66 after treatment. The mean reduction in disability score was 11.75 percentage points. The paired-samples t-test showed a statistically significant pre- to post-treatment difference, with $t = 10.211$, $df = 39$, and $p = 0.021$. In the PNF technique group, the mean Neck Disability Index percentage decreased from 37.05 ± 15.02 at baseline to 12.75 ± 5.85 after treatment. The mean reduction in disability score was 24.30 percentage points, and the within-group difference was statistically significant, with $t = 13.578$, $df = 39$, and $p = 0.010$. Between-group analysis after eight weeks showed a statistically significant difference in post-treatment pain scores between the two groups. The independent-samples t-test showed $t = 3.514$, $df = 78$, $p = 0.001$, with a mean difference of -2.10, standard error difference of 0.598, and 95% confidence interval ranging from -3.29 to -0.91. Post-treatment neck disability scores also showed a statistically significant difference between the groups. The independent-samples t-test showed $t = -4.375$, $df = 78$, $p = 0.001$, with a mean difference of -6.50, standard error difference of 1.485, and 95% confidence interval ranging from -9.457 to -3.543.

Both stretching exercises and PNF techniques showed statistically significant improvement in neck pain and neck disability after eight weeks of treatment. The PNF technique group showed a larger numerical reduction in pain intensity and disability scores from baseline to post-treatment compared with the stretching exercise group.

Table 1: Demographic Statistics

		Group A		Group B	
		Frequency	**Percent**	**Frequency**	**Percent**
Age	18-20	14	35.0	14	35.0
	21-23	26	65.0	26	65.0
	Total	40	100.0	40	100.0
Gender	Male	6	15.0	6	15.0
	Female	34	85.0	34	85.0
	Total	40	100.0	40	100.0

Table 2: Pre- Post Comparison of Neck Pain (Paired Sample t test)

		Mean	**N**	**Std. Deviation**	**Std. Error Mean**	**t**	**df**	**Sig. (2-tailed)**
Group A	Pre Pain intensity	1.4500	40	.59700	.09439	6.153	39	0.000

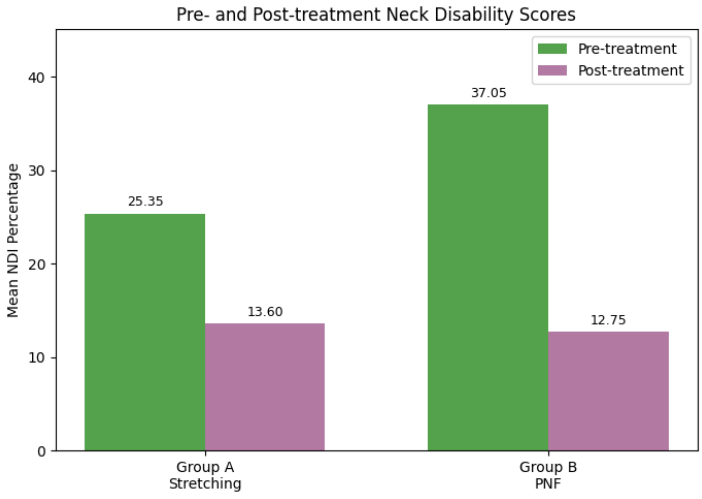
	Post Pain intensity	.7750	40	.83166	.13150			
Group B	Pre Pain intensity	2.0000	40	.90582	.14322	10.929	39	0.001
	Post Pain intensity	.6000	40	.70892	.11209			

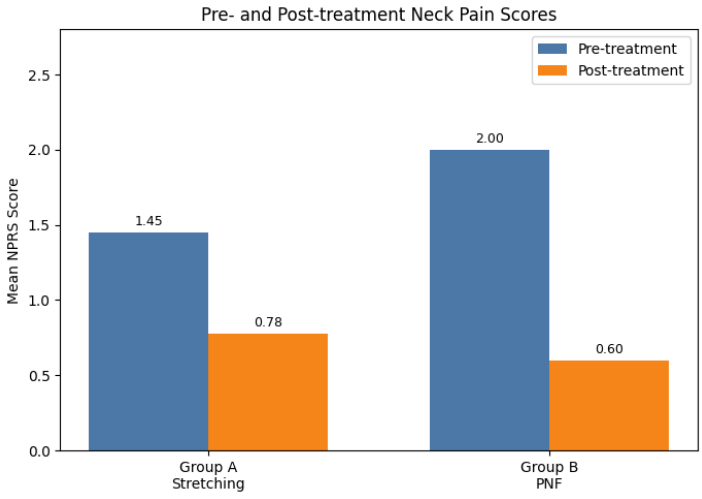
Table 3: Pre- Post Comparison of Neck Disability (Paired Sample t test)

		Mean	N	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Group A	Pre Disability %	25.3500	40	10.14144	1.60350	10.211	39	0.021
	Post Disability %	13.6000	40	7.66209	1.21148			
Group B	Pre Disability %	37.0500	40	15.02127	2.37507	13.578	39	0.010
	Post Disability %	12.7500	40	5.84742	.92456			

Table 4: Between groups analysis for Post treatment NPRS & NDI (Independent t test)

Variable	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% CI Lower	95% CI Upper
NPRS Score	3.514	78	.001	-2.10	0.598	-3.29	-0.91
NDI Total Score	-4.375	78	.001	-6.50	1.485	-9.457	-3.543





DISCUSSION

The present study evaluated the effects of stretching exercises and proprioceptive neuromuscular facilitation techniques on cervical pain and neck-related disability among university students who used smartphones for prolonged periods. The findings showed that both interventions produced statistically significant improvement in pain intensity and neck disability after eight weeks of treatment. However, the PNF group demonstrated a greater numerical reduction in pain and disability scores compared with the stretching exercise group. These findings suggested that both forms of therapeutic exercise had clinical value, but PNF techniques appeared to provide

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comparatively stronger improvement in the studied population (14). The reduction in neck pain after both interventions may be explained by improvement in soft tissue flexibility, reduction in cervical muscle tightness, and better neuromuscular control around the neck and shoulder region. Smartphone users commonly maintain the cervical spine in a prolonged flexed posture, which may increase the load on the posterior cervical muscles and contribute to fatigue, stiffness, and pain. In such cases, stretching exercises may reduce muscular tension and improve tissue extensibility, while PNF techniques may provide additional benefit through the combined effect of isometric contraction, relaxation, and assisted stretching. This mechanism may explain why the PNF group showed greater improvement than the stretching group in pain and disability outcomes (15,16).

The findings were consistent with previous evidence in which neuromuscular facilitation-based exercise was compared with traditional neck exercise therapy in patients with chronic non-specific neck pain. In that study, neck muscle strength was measured using an isometric device, while pain was assessed through a visual analogue scale. The neuromuscular facilitation exercise group showed a greater percentage improvement in pain than the traditional exercise therapy group, with reported mean percentage differences of 78.1% and 31.3%, respectively (9). The present study showed a similar pattern, as PNF techniques produced a larger reduction in pain and disability than stretching exercises alone. Although the previous study used different assessment methods and involved chronic non-specific neck pain rather than smartphone-associated cervical pain, the direction of findings supported the potential role of neuromuscular facilitation techniques in improving cervical symptoms (17,18). Another study investigated the effect of PNF neck muscle patterns on cervical range of motion and quality of life among postoperative head and neck cancer patients. That study reported a statistically significant reduction in Neck Disability Pain Index and Vanderbilt Head and Neck Symptom Survey scores after treatment, with a p-value of 0.0001 (10). Although the clinical population was different from the present study, the findings were relevant because they demonstrated that PNF-based cervical exercises could improve neck-related symptoms and functional outcomes. The present study also found significant improvement in neck disability after PNF intervention, supporting the view that PNF may be useful in restoring cervical mobility and reducing functional limitation. However, direct comparison should be made cautiously because postoperative cancer rehabilitation involves different impairments, tissue conditions, and recovery patterns compared with smartphone-related mechanical neck pain (19-21).

The results also aligned with earlier biomechanical observations that muscle strain, poor posture, repetitive movement, and prolonged static positioning may contribute to neck pain and discomfort (2). In the present study, the participants were young university students who used smartphones for at least six hours per day, making sustained cervical flexion and postural loading highly relevant contributors to their symptoms. The improvement observed after stretching and PNF techniques indicated that addressing muscle tightness and postural stress may reduce pain and improve functional capacity. However, the study did not directly measure postural alignment, despite posture being part of the broader study focus. Therefore, the effect of these interventions on actual postural correction remained uncertain and should not be overinterpreted (22,23). The superiority of PNF techniques in this study was also supported by recent evidence in which the hold-relax technique was found to be more effective than post-isometric relaxation for reducing neck pain and improving cervical extension and lateral flexion, while both approaches showed similar effects on neck disability (4). Although the comparison in the present study was between PNF and stretching exercises rather than between different PNF-related techniques, the greater improvement in the PNF group supported the clinical usefulness of neuromuscular facilitation methods in cervical pain management. These findings indicated that PNF may be particularly beneficial when the therapeutic aim is not only to stretch tight muscles but also to improve muscle activation, relaxation response, and controlled cervical movement (24,25).

From a clinical perspective, the findings suggested that structured exercise interventions could be beneficial for young adults with smartphone-associated neck pain. Stretching exercises may be easier to teach, require minimal supervision, and can be performed independently as part of a home program. PNF techniques, on the other hand, may require more guidance from a trained physiotherapist but may offer additional improvement in pain and disability when applied correctly. For university students and other prolonged screen users, incorporating cervical mobility exercises, muscle stretching, postural correction, and regular breaks from sustained phone use may help reduce discomfort and prevent progression toward chronic neck disability (26,27). One strength of the study was its comparative interventional design, which allowed the effects of two commonly used physiotherapy approaches to be examined in the same target population. The equal allocation of participants into two groups, use of pre- and post-intervention assessment, and application of recognized outcome tools such as the Numeric Pain Rating Scale and Neck Disability Index improved the clinical relevance of the findings. The single-blinded assessment also reduced the risk of assessor-related bias. In addition, the study focused on a practical and increasingly common problem among university students, making the findings relevant to modern lifestyle-related musculoskeletal health.

Despite these strengths, several limitations were present. Convenience sampling limited the generalizability of the findings to the wider population. The sample was collected from one university in a single city, and the majority of participants were female, which may have influenced the overall pattern of results. The absence of a no-treatment control group also made it difficult to separate the true treatment effect from natural recovery, behavioral change, or increased awareness of posture during the study period. Baseline pain and disability values also appeared different between the two groups, which may have influenced the magnitude of improvement. Future studies should consider baseline adjustment methods, such as analysis of covariance, when comparing post-treatment outcomes. Another important limitation was the lack of objective postural assessment. Although the study focused on cervical pain and posture among smartphone

users, the reported outcomes mainly included pain intensity and neck disability. Posture-related outcomes such as craniovertebral angle, forward head posture measurement, photographic posture analysis, cervical range of motion, or ergonomic behavior scores should be included in future studies. The study also did not report long-term follow-up, so it remained unclear whether the improvements were maintained after completion of the intervention. In addition, treatment frequency, level of supervision, home exercise adherence, and smartphone-use behavior during the study period were not clearly described, although these factors could strongly influence clinical outcomes.

Future research should use a randomized controlled trial design with a larger and more diverse sample recruited from multiple institutions or cities. A control group should be included to determine the comparative effectiveness of stretching and PNF techniques against usual activity or ergonomic education alone. Future studies should also include objective postural measurements, cervical range of motion, muscle endurance testing, and follow-up assessment to determine whether improvement is sustained over time. Monitoring smartphone use duration, posture habits, and exercise adherence would further strengthen the evidence and help identify which participants are most likely to benefit from each intervention. The study demonstrated that both stretching exercises and PNF techniques were associated with improvement in cervical pain and neck disability among smartphone-using university students. The PNF technique group showed greater improvement than the stretching exercise group, suggesting that neuromuscular facilitation may be a useful physiotherapeutic approach for managing smartphone-associated neck symptoms. However, due to limitations in sampling, lack of a control group, absence of objective posture measurement, and short-term assessment, the findings should be interpreted with caution. Further well-designed trials are needed before firm clinical recommendations can be made.

CONCLUSION

This study concluded that both structured stretching exercises and proprioceptive neuromuscular facilitation techniques were beneficial in reducing cervical pain and improving neck-related functional ability among smartphone-using university students. However, PNF techniques appeared to produce greater improvement than stretching exercises alone, suggesting that they may be a more effective physiotherapy approach for managing smartphone-associated neck discomfort and disability. These findings highlight the practical value of incorporating guided PNF-based interventions into rehabilitation programs for young adults who experience neck pain due to prolonged mobile phone use.

AUTHOR CONTRIBUTION

Author	Contribution
Virsha Riaz	Conceptualization, Methodology, Formal Analysis, Writing - Original Draft, Validation, Supervision
Dr Narmeen Haseeb	Methodology, Investigation, Data Curation, Writing - Review & Editing
Zunaira Mehdi	Investigation, Data Curation, Formal Analysis, Software
Dr Sana Hafeez	Software, Validation, Writing - Original Draft
Kashaf Waseem	Formal Analysis, Writing - Review & Editing
Dr. Muhammad Sadeem Khalid	Writing - Review & Editing, Assistance with Data Curation
Dr Rafia Imtiaz	Review & Editing, Assistance with Data Curation

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