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Research paper

To Compare the Effect of Pilates Method Versus Muscle Energy Technique Along with Conventional Therapy for Forward Head Posture in Collegiate Students

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KEYWORDS

Pilates

Muscle Energy Technique

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Forward Head Posture

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Craniovertebral Angle

Cervical Range of Motion

ABSTRACT

Introduction: Forward Head Posture (FHP) is a prevalent postural deviation among young adults, often attributed to prolonged screen use, sedentary behaviour, and poor ergonomic habits. This condition results in musculoskeletal imbalances such as weakened deep cervical flexors and overactive cervical extensors, contributing to pain, limited cervical range of motion, and functional impairments.

Objective: To compare the effects of the Pilates method versus Muscle Energy Technique (MET), both combined with conventional physiotherapy, in managing FHP among collegiate students.

Methodology: Fifty-four collegiate students diagnosed with FHP were randomly assigned into two groups. Group A (n = 27) received Pilates-based exercises with conventional therapy, while Group B (n = 27) underwent MET alongside conventional therapy. Both groups were treated three times per week over eight weeks. Outcome measures included the Numerical Pain Rating Scale (NPRS), Neck Disability Index (NDI), Craniovertebral Angle (CVA), and Cervical Range of Motion (CROM), assessed at baseline, week 4, and week 8.

Results: Both groups demonstrated statistically significant improvements within their respective interventions across all outcome measures ($p < 0.05$). However, between-group analysis revealed that Group A (Pilates) achieved superior results in pain reduction, postural correction (CVA), functional improvement (NDI), and cervical mobility (CROM). The differences between groups were statistically significant ($p < 0.05$), favouring the Pilates method.

Conclusion: Although both the Pilates method and MET are effective in the treatment of FHP, Pilates demonstrated greater effectiveness in reducing pain, improving posture, and enhancing cervical function. These findings support the inclusion of Pilates-based rehabilitation in physiotherapy protocols targeting FHP in young adults.

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1. Introduction

In today's technology-driven era, poor postural habits have become increasingly prevalent due to prolonged screen exposure and sedentary lifestyles. One of the most common postural deviations is Forward Head Posture (FHP)—a musculoskeletal condition characterized by the anterior displacement of the cervical spine relative to the body's centre of gravity. This dysfunction, widely observed across age groups, results primarily from sustained improper positioning during daily tasks involving smartphones, laptops, or other digital devices.[1]

Biomechanically, FHP leads to muscular imbalances: shortening and overactivation of cervical extensor muscles, such as the upper trapezius (UT), and simultaneous weakening of the deep cervical flexors.[2][3] The condition is further exacerbated by tightness in the pectoralis major and minor and weakness of scapular retractors like the middle and lower trapezius and rhomboids.[4] Over time, these imbalances contribute to maladaptive motor patterns, pain, fatigue, and limited cervical range of motion.[5] FHP is highly prevalent among the younger population, especially students and professionals who spend extended hours using digital screens. Studies reveal that up to 70% of young adults experience FHP, with 60% of males and 75% of females affected.[6] A cross-sectional study by Singh et al. (2020) observed a 73% prevalence of FHP among university students, linking it to prolonged static postures and forward-leaning behaviours during reading or screen use.[7]

The mechanical load on the cervical spine increases drastically with forward head inclination—every 15° of head tilt increases the load by approximately 5 kg, leading to excessive strain on cervical discs, ligaments, and joints.[8] These changes contribute not only to postural dysfunction but also to conditions such as cervical disc herniation, temporomandibular joint dysfunction, and chronic lower back pain.[9]

From a clinical perspective, FHP is marked by flexion of the lower cervical spine, extension in the upper cervical segments, and rounding of the shoulders.[10] These alterations reduce thoracic mobility, impair respiratory function, and shift the centre of gravity forward—compromising balance and increasing fall risk.[11]

Anatomically, the condition is associated with shortening of the occipital extensors (e.g., semispinalis capitis, SCM, suboccipital) and elongation of occipital and cervical flexors (e.g., longus capitis, longus colli), contributing to reduced muscle performance and joint integrity. The altered alignment of the sagittal cervical spine also disturbs scapular kinematics and increases the likelihood of Upper Cross Syndrome, characterized by rounded shoulders, scapular winging, and thoracic hyperkyphosis.[12]

Despite the high prevalence and functional impact of FHP, there is still a gap in the literature regarding consistently effective treatment approaches.[13] However, exercise therapy remains one of the most promising interventions. Pilates, developed by Joseph Pilates, has been recognized for improving neuromuscular control, posture, and movement efficiency through principles such as cantering, breathing, and controlled movement. Clinical Pilates has been shown to significantly improve craniovertebral angle, postural alignment, and the strength and endurance of deep cervical flexors.[14][15]

Another widely accepted intervention is the Muscle Energy Technique (MET)—a manual therapy involving patient-initiated muscle contractions to restore joint mobility, correct muscle imbalances, and reduce pain.[16] The Post-Isometric Relaxation (PIR) variant of MET is particularly effective in lengthening hypertonic muscles without forceful manipulation and is commonly used to address muscle stiffness in FHP. Manual therapy modalities, including MET, can temporarily alleviate symptoms and improve cervical mobility; however, long-term correction relies on consistent exercise-based rehabilitation.[17]

Aim of the study

The study aims to evaluate and compare the effect of Pilates method versus Muscle Energy Technique along with conventional therapy for Forward head posture in collegiate students.

Objective of the study

- To assess the impact of the Pilates method along with conventional therapy to reduce pain, disability, range of motion, and forward head posture in collegial students.
- To assess the impact of Muscle energy technique along with conventional therapy to reduce pain, disability, range of motion, and forward head posture in collegial students.
- To assess which technique is more effective or beneficial to reduce pain, disability, range of motion, and forward head posture in collegiate students.

2. Materials and Methods

Ethical consideration

This study was conducted after receiving approval from the Institutional Ethics Committee of Shri Guru Ram Rai Institute of Medical and Health Sciences, reference no. (SGRR/IEC/27/25). Additionally, a NO Objection Certificate was obtained from the Shri Guru Ram Rai Institute of Medical and Health Sciences. The study was also prospectively registered with the Clinical Trials Registry of India under the registration number (CTRI/2025/05/086756), in compliance with national research standards. All the participants were given a detailed explanation about the study. Participation was voluntary, and written informed consent was obtained before participation. The participants were also informed about their right to withdraw at any time without any consequences." Participants' identities were anonymized using a code number, and data was stored securely. The thesis was submitted for copyright protection and is registered with the Copyright Office, Government of India under the diary number(15687/2025-CO/L).

Sample size: "54"

The sample size is calculated using G* Power software (version 3.1.9.7) at effect size = 0.47, with power = 0.80, alpha = 0.05, number of measurements 4 for 2 groups.

Sample Technique

Purposive Sampling techniques

Sample Selection

Inclusion Criteria

Participants were selected based on specific inclusion criteria to ensure homogeneity within the study population. Individuals aged between 18 and 28 years with a craniovertebral angle measuring less than 50° were considered eligible. Additional criteria included the presence of neck pain experienced within the past three months and a pain intensity ranging between 3 and 7 on the Numerical Pain Rating Scale (NPRS). Participants also demonstrated restricted cervical range of motion (ROM), defined as flexion, extension, and lateral flexion less than 45°, and cervical rotation less than 70°.

Exclusion Criteria

Participants were excluded from the study if they presented with any condition that could interfere with the outcomes or safety of the intervention. This included individuals with a diagnosis of rheumatoid arthritis, cervical instability, or a history of trauma or surgery involving the cervical spine within the past year. Participants with cervical radiculopathy, cervical disc pathology, or congenital spinal deformities were also excluded. Furthermore, individuals currently using analgesics or corticosteroids for pain management were not included in the study.

Outcome Measures

Numerical Pain Rating Scale, the Neck Deformity Index, the craniovertebral angle, CROM

Intervention Protocol

All participants were informed about the study's purpose and procedures, screened according to inclusion and exclusion criteria, and gave written informed consent. Eligible subjects (n = 54) were randomly allocated into two groups: Group A (n = 27) received Pilates exercises with conventional therapy, and Group B (n = 27) received Muscle Energy Technique (MET) with conventional therapy. Both groups followed an 8-week intervention (3 sessions/week) at the Department of Physiotherapy, SMIH. Assessments were conducted at baseline, after 4 weeks, and post-intervention.

Group A – Pilates Intervention

Participants in Group A received a structured Pilates program alongside conventional physiotherapy for Forward Head Posture (FHP), conducted over 8 weeks (3 sessions/week) at the Department of Physiotherapy,

SMIH. Each session lasted 40–45 minutes and began with a moist hot pack applied to the cervical region for 10–15 minutes for muscle relaxation.

In the initial session, participants were taught to activate deep stabilizing muscles (transversus abdominis and multifidus) and instructed in the five fundamental Pilates principles: Lateral costal breathing, Pelvic (centering) placement, Ribcage placement, Scapular (shoulder blade) placement, Head and neck alignment.
Participants then performed six beginner-level mat Pilates exercises (2 sets of 8–10 repetitions each), focusing on posture correction, spinal alignment, and breathing control:

Double Leg Stretch: Lying on the back with one knee pulled into the chest and the other leg extended, participants alternated leg positions while maintaining abdominal engagement. This targets spinal and hip flexors and enhances core control. (Fig. 1)

Shoulder Bridge: Performed lying on the back with knees bent, lifting the pelvis off the mat segmentally from the tailbone to the shoulder blades, then lowering back down. This strengthens the glutes, hamstrings, and spinal extensors. (Fig. 2)

Arm Opening: In a side-lying position, the top arm is opened outward in a controlled arc, encouraging thoracic rotation, spinal mobility, and chest expansion. (Fig. 3)

Breaststroke Prep: Lying prone, participants extended the upper back while lifting the chest and arms off the mat. This improves posture and strengthens spinal extensors and scapular stabilizers. (Fig. 4 A & B)

Diamond Press: Also performed prone, with hands forming a diamond under the forehead. The upper chest is lifted without straining the neck, targeting mid-back muscles and postural endurance. (Fig. 5 A & B)

Arm Circles: Lying on the back, arms are lifted and moved in controlled circular motions while maintaining a stable spine and engaged core, enhancing shoulder mobility and trunk control. (Fig. 6 A, B & C)

All exercises emphasized neutral spine alignment, core co-activation, and breath coordination. The intensity was customized based on each participant's fitness, fatigue, and pain levels.

After Pilates exercises, participants performed neck isometric exercises in a seated position. They applied manual resistance using their hand on the front, sides, and back of the head, resisting movement while keeping the neck in neutral. Each direction was held for 5 seconds, 2 sets of 5 repetitions per session.

Fig. 1 Double-leg stretch Pilates

Fig. 2 Shoulder bridge Pilates

Fig. 3 Arm opening pilates

Fig. 4 (A & B) Breaststroke Pilates

Fig. 5 (A & B) Diamond Press Pilates

Fig. 6 (A ,B & C) Arm circles Pilates

Group B – Muscle Energy Technique (MET) Intervention

Participants in Group B received Muscle Energy Technique (MET) alongside conventional physiotherapy for Forward Head Posture (FHP), conducted over 8 weeks (3 sessions/week) at the Department of Physiotherapy, SMIH. Each session lasted 40–45 minutes and began with a moist hot pack application to the cervical region for 10–15 minutes to promote muscle relaxation.

MET is a manual therapy technique involving active muscle contraction against a controlled counterforce, followed by relaxation and passive stretching to restore muscle length and joint mobility. In this study, MET was applied in the supine position to four targeted muscles: suboccipitalis, upper trapezius, levator scapulae, and pectoralis major, performed for 3–5 isometric repetitions per session.

Suboccipitalis: The therapist passively brought the neck into flexion just short of craniocervical flexion. The subject gently pushed the head back into extension (submaximal effort) for 7–10 seconds, followed by relaxation and stretching into the new barrier. (Fig. 7)

Upper Trapezius: The therapist moved the neck into flexion, side flexion, and rotation, while depressing the shoulder just short of resistance. The subject gently shrugged the shoulder upward against resistance for 7–10 seconds, then the stretch was advanced. (Fig. 8)

Levator Scapulae: With the subject supine, the therapist brought the head into full flexion, side flexion, and rotation away from the target side while depressing the shoulder. The subject gently pushed the head backward and slightly toward the treated side, along with a resisted shoulder shrug (20% effort), for 7–10 seconds before the stretch was advanced. (Fig. 9)

Pectoralis Major: For clavicular fibers, the arm was abducted to 45°, and for sternal/costal fibers, to 140°, with external rotation. The subject was instructed to push the arm gently toward the ceiling against resistance for 7–10 seconds, followed by stretching to a new barrier. (Fig. 10 A & B) After MET, participants performed neck isometric exercises in a seated position, applying hand resistance to the front, sides, and back of the head while maintaining a neutral neck position. Each direction was held for 5 seconds, 2 sets of 5 repetitions per session.

Fig. 7 Met Suboccipitalis Muscle

Fig. 8 Met Upper Trapezius

Fig. 9 Levator Scapulae

Fig. 10 (A & B) Met Pectoralis

3. Data Analysis

Data was analyzed using the Statistical Package for the Social Sciences (SPSS) software, Version 26. The normality of the data for 54 participants was assessed using the Shapiro- Wilk test. The data, when analyzed individually for each group as well as cumulatively, were found to be normally distributed; hence, parametric tests were used for within-group analysis. A paired sample t-test was employed for within-group comparisons, while the independent t-test was used for between-group comparisons.

4. Result

A total of 54 participants were randomly allocated into two equal groups (n=27 each) receiving either Pilates or Muscle Energy Technique (MET) along with conventional physiotherapy. Both groups demonstrated statistically significant improvements ($p < 0.001$) in all outcome measures—pain (NPRS), craniovertebral (CV) angle, neck disability (NDI), and cervical range of motion (ROM)—from baseline to 8 weeks. The MET group showed reductions in NPRS (5.19 ± 1.12 to 1.95 ± 1.07), NDI (23.95 ± 5.71 to 16.57 ± 4.72), and improvements in CV angle (42.24° to 47.48°) and cervical ROM across all directions. Similarly, the Pilates group showed reductions in NPRS (4.95 ± 1.47 to 2.05 ± 1.16), NDI (24.38 ± 5.41 to 17.14 ± 3.80), and CV angle (41.86° to 47.48°), with significant ROM improvements. However, between-group comparisons at 8 weeks revealed no statistically significant differences in any outcome ($p > 0.05$), including NPRS ($p = 0.784$), CV angle ($p = 0.901$), NDI ($p = 0.668$), and all ROM measures ($p > 0.05$). This suggests both interventions were equally effective in improving FHP-related parameters, with no superior method identified.

Table 1 Normality and distribution of demographic characteristics of all participants (n = 54) (Shapiro-Wilk Test was used)

Demographic Characteristics	Mean±SD	95% CI	Skewness	Kurtosis	p-value
Age (year)	22.43 ± 2.84	21.54 –23.31	0.125	-0.952	0.205*
Gender (n= Male: Female)	1.45:0.50	1.30 – 1.61	0.199	-2.061	0.001

Abbreviations: SD = Standard Deviation; CI = Confidence Interval, p-value is the level of significance set at (>0.05)
Interpretation: All the demographic characteristics were found to be normally distributed except Gender.

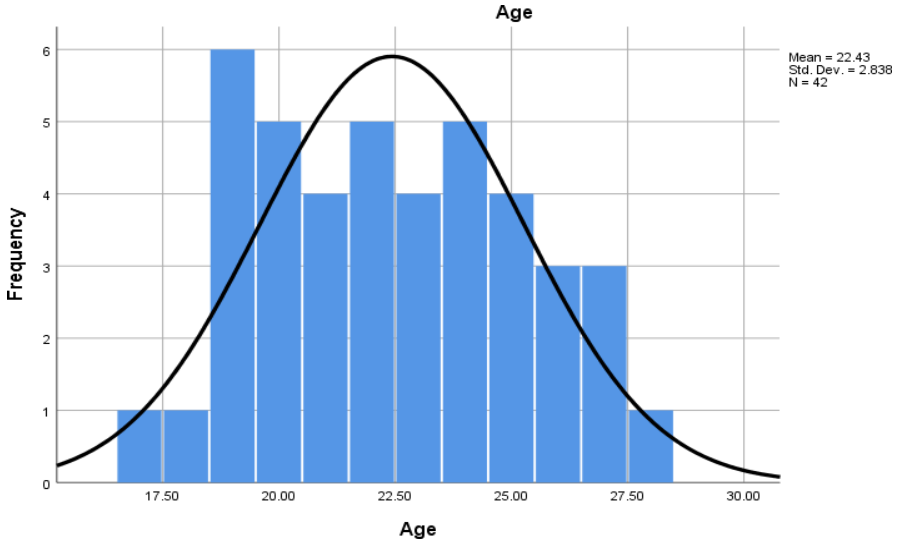

Fig. 11 Histogram of the age

Interpretation: The Fig. shows the distribution of age among participants, which appears leptokurtic in nature, and there is mild positive skewness observed in the distribution.

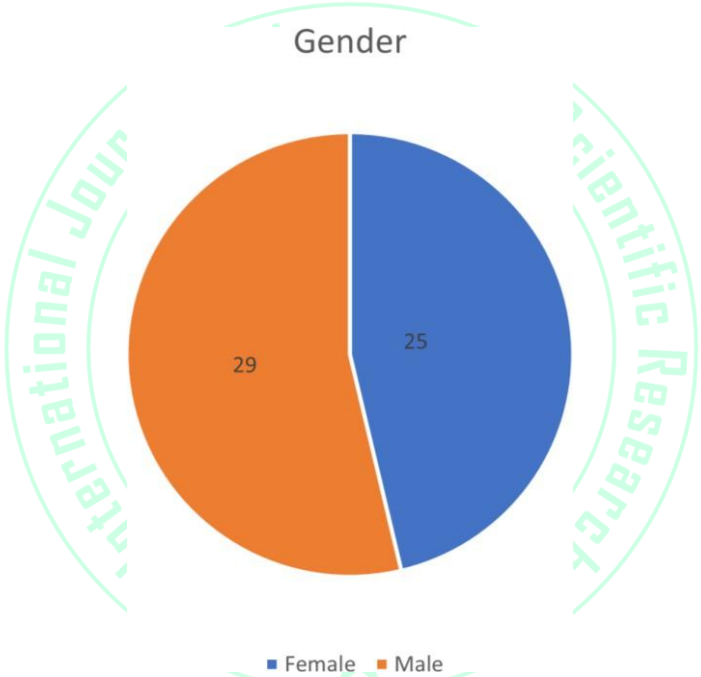

Fig. 12 Pie chart of gender distribution in all participants

Interpretation: The pie chart illustrates the gender distribution of patients in the study. Out of 54 participants, 29 were male and 25 were female, indicating a slightly higher proportion of male patients.

Table 2 Within-group comparison of all the outcome measures at baseline, after 4 weeks & after 8 weeks for the MET group

S. No.	Variables	Baseline (Mean±SD)	At 4 weeks (Mean±SD)	At 8 weeks (Mean±SD)	p-value
1.	NPRS	5.19 ± 1.12	3.43 ± 1.12	1.95 ± 1.07	0.001
2.	CV Angle	42.24 ± 1.92	44.86 ± 1.56	47.48 ± 1.25	0.001
3.	NDI	23.95 ± 5.71	19.90 ± 4.84	16.57 ± 4.72	0.001
4.	Cervical Flexion	36.10 ± 4.02	41.81 ± 3.49	46.76 ± 3.51	0.001
5.	Cervical Extension	44.38 ± 5.05	51.62 ± 2.82	55.90 ± 1.97	0.001
6.	Cervical Lateral Flexion Right	37.29 ± 2.26	38.95 ± 2.11	40.86 ± 2.06	0.001
7.	Cervical Lateral Flexion Left	36.62 ± 2.13	39.33 ± 2.03	41.05 ± 2.18	0.001
8.	Cervical Rotation Right	69.00 ± 1.95	71.29 ± 1.31	72.71 ± 1.45	0.001
9.	Cervical Rotation Left	68.29 ± 1.93	69.95 ± 2.01	72.24 ± 1.61	0.001

Abbreviations: SD = Standard Deviation; CI = Confidence Interval; NPRS = Numeric Pain Rating Scale; CV Angle = Cranio-Vertebral Angle; NDI = Neck Disability Index, Level of significance (p-value) set at 0.05

Interpretation: All variables showed statistically significant improvement over time (p = 0.001). Pain and disability scores (NPRS and NDI) decreased, while the CV angle and cervical range of motion in all directions improved progressively from baseline to 4 and 8 weeks, indicating effective intervention outcomes.

Table 3 Within-group comparison of all the outcome measures at baseline, after 4 weeks & after 8 weeks for the Pilates group

S. No.	Variables	Baseline (Mean±SD)	At 4 weeks (Mean±SD)	At 8 weeks (Mean±SD)	p-value
1.	NPRS	4.95 ± 1.47	3.57 ± 1.12	2.05 ± 1.16	0.001
2.	CV Angle	41.86 ± 1.96	44.29 ± 1.90	47.48 ± 0.98	0.001
3.	NDI	24.38 ± 5.41	21.76 ± 4.62	17.14 ± 3.80	0.001
4.	Cervical Flexion	36.19 ± 3.97	40.57 ± 3.67	45.90 ± 3.46	0.001
5.	Cervical Extension	44.95 ± 5.09	51.76 ± 2.98	55.95 ± 2.09	0.001
6.	Cervical Lateral Flexion Right	37.43 ± 2.75	39.71 ± 2.63	41.10 ± 2.61	0.001
7.	Cervical Lateral Flexion Left	37.05 ± 2.94	39.52 ± 2.58	40.81 ± 3.08	0.001
8.	Cervical Rotation Right	69.52 ± 2.77	71.38 ± 2.20	73.57 ± 1.75	0.001
9.	Cervical Rotation Left	68.38 ± 2.64	70.76 ± 2.14	72.81 ± 1.89	0.001

Abbreviations: SD = Standard Deviation; CI = Confidence Interval; NPRS = Numeric Pain Rating Scale; CV Angle = Cranio-Vertebral Angle; NDI = Neck Disability Index, Level of significance (p-value) set at 0.05.
Interpretation: All variables showed statistically significant improvement over time (p = 0.001). Pain intensity (NPRS) and disability (NDI) progressively decreased, while the CV angle and cervical range of motion in all directions showed consistent and meaningful increases from baseline to 4 and 8 weeks, indicating a positive impact of the intervention.

Table 4 Between-group comparison of NPRS, CV Angle, and NDI at baseline, after 4 weeks & after 8 weeks

S. No.	Outcome Measures	Baseline Mean Diff. (CI Diff.)	At 4 weeks Mean Diff. (CI Diff.)	At 8 weeks Mean Diff. (CI Diff.)	p-value
1.	NPRS	0.24 (-0.57, 1.05)	-0.14 (-0.84, 0.55)	-0.09 (-0.79, 0.60)	0.784
2.	CV Angle	0.38 (-0.82, 1.59)	0.57 (-0.51, 1.65)	0.01 (-0.70, 0.70)	0.901
3.	NDI	-0.42 (-3.89, 3.03)	-1.85 (-4.80, 1.09)	-0.57 (-3.24, 2.09)	0.668

Abbreviation: NPRS = Numeric Pain Rating Scale; CV Angle = Cranio-Vertebral Angle; NDI = Neck Disability Index; CI = Confidence Interval; Diff: Difference, Level of significance (p-value) set at 0.05
Interpretation: At post-intervention (8 weeks), none of the outcome measures showed statistically significant differences between the groups. The p-values for NPRS (0.784), CV angle (0.901), and NDI (0.668) were all above 0.05, indicating no meaningful between-group effects. Although there were slight changes in mean differences over time, the 95% confidence intervals for all three outcomes included zero at each time point, further supporting the absence of statistically significant group differences.

Table 5 Between-group comparison of Cervical Range of Motions at baseline, after 4 weeks & after 8 weeks

S. No.	Outcome Measures	Baseline Mean Diff. (CI Diff.)	At 4 weeks Mean Diff. (CI Diff.)	At 8 weeks Mean Diff. (CI Diff.)	p-value
1.	Cervical Flexion	-0.10 (−2.59, 2.40)	1.24 (−0.99, 3.47)	0.86 (−1.32, 3.03)	0.430
2.	Cervical Extension	-0.57 (−3.74, 2.59)	-0.14 (−1.95, 1.67)	-0.05 (−1.31, 1.22)	0.940
3.	Cervical Lateral Flexion Right	-0.14 (−1.71, 1.43)	-0.76 (−2.25, 0.73)	-0.24 (−1.70, 1.23)	0.744
4.	Cervical Lateral Flexion Left	-0.43 (−2.03, 1.17)	-0.19 (−1.64, 1.26)	-0.24 (−1.42, 1.90)	0.774
5.	Cervical Rotation Right	-0.52 (−2.02, 0.97)	-0.10 (−1.23, 1.03)	-0.86 (−1.86, 0.15)	0.092
6.	Cervical Rotation Left	-0.10 (−1.54, 1.34)	-0.81 (−2.11, 0.49)	-0.57 (−1.67, 0.52)	0.297

Abbreviation: CI = Confidence Interval; Diff = Difference, Level of significance (p-value) set at 0.05
Interpretation: At the end of the 8-week intervention period, none of the cervical range of motion outcomes showed statistically significant differences between the two groups. The post-intervention p-values for cervical flexion (0.430), extension (0.940), lateral flexion right (0.744), lateral flexion left (0.774), and rotation left (0.297) were all well above the 0.05 threshold, indicating no meaningful difference in improvement between groups. Cervical rotation to the right had a p-value of 0.092, which approached significance but still did not meet the conventional cut-off. These findings suggest that while both groups may have experienced some degree of improvement, the changes were not significantly different when comparing the groups statistically at the 8-week mark.

5. Discussion

The present study aimed to compare the effectiveness of Pilates Method and Muscle Energy Technique (MET), both integrated with conventional physiotherapy, in the management of Forward Head Posture (FHP) among collegiate students aged 18–28 years. Participants were selected based on specific inclusion criteria such as reduced craniovertebral (CV) angle (<50°), neck pain within the past three months, restricted cervical ROM,

and an NPRS score between 3–7. A total of 54 eligible participants were randomly divided into two groups: Group A (Pilates + conventional therapy) and Group B (MET + conventional therapy). Both groups received treatment three times per week over 8 weeks, with outcome measures assessed at baseline, 4 weeks, and 8 weeks, including NPRS, CV angle, NDI, and cervical ROM.

Group A underwent a Pilates exercise program consisting of six core mat exercises (double leg stretch, shoulder bridge, arm opening, breaststroke, diamond press, and arm circles), which emphasized neutral spine alignment, deep core activation, and controlled breathing. These were preceded by a moist hot pack and followed by neck isometric exercises in all directions. Pilates focused on stretching tight anterior muscles (like pectorals and neck extensors) and strengthening posterior stabilizers (deep neck flexors, shoulder retractors, and spinal extensors), based on modern Pilates principles such as lateral costal breathing, pelvic placement, and scapular control.

Group B received MET, targeting four key muscles implicated in FHP: suboccipitalis, upper trapezius, levator scapulae, and pectoralis major. The MET involved isometric contractions against therapist resistance for 7–10 seconds, followed by passive stretching into a new barrier, performed in the supine position. The protocol was standardized across sessions and also included neck isometric exercises and pre-treatment moist heat application.

The findings revealed statistically significant improvements ($p < 0.001$) in all outcome measures within both groups after 8 weeks. Group B (MET) showed improvements in pain (NPRS: 5.19 → 1.95), neck disability (NDI: 23.95 → 16.57), and CV angle (42.24° → 47.48°), alongside notable gains in ROM, particularly flexion and extension. Similarly, Group A (Pilates) showed comparable improvements in NPRS (4.95 → 2.05), NDI (24.38 → 17.14), and CV angle (41.86° → 47.48°), with increases in ROM across all cervical movements.

Despite these significant intra-group improvements, between-group comparisons revealed no statistically significant differences across any of the measured variables ($p > 0.05$). This suggests that both Pilates and MET, when combined with conventional physiotherapy, are equally effective in addressing the clinical features of FHP. These results are consistent with prior studies such as Mahajan et al. (2012) and Sajjad Ali et al., which support MET's effectiveness in improving cervical joint function, and with studies by Rydeard et al. and Kloubec et al., which highlight Pilates' role in postural correction and neuromuscular coordination.

These findings align with those of Mahajan et al. (2012) and Sajjad Ali et al., who found MET to be effective in reducing cervical pain and improving mobility via neuromuscular re-education. The effectiveness of Pilates in enhancing posture and spinal mobility is supported by studies from Rydeard et al. and Kloubec, who demonstrated that mat Pilates improves muscle balance, postural awareness, and functional alignment through core stability and controlled breathing.

Neha Kulkarni et al. (2025) conducted an experimental study comparing the effects of MET applied to the levator scapulae vs. the anterior scalene in individuals with Forward Head Posture (FHP). Thirty participants (aged 18–30) with a craniovertebral angle (CVA) <48° were randomly divided into two groups. Group A received MET to the levator scapulae; Group B received MET to the anterior scalene. Both groups also received conventional physiotherapy, three times a week for four weeks. Both groups showed significant improvements in posture (CVA) and proprioception (JPE) ($p = 0.001$).

Nesa Shadi et al. (2024) conducted a quasi-experimental study to compare the effects of Pilates exercises (PE), corrective exercises (CE), and Alexander's technique (AT) on upper cross syndrome (UCS) in adolescent girls aged 13–16 years. Forty-five participants with UCS were randomly divided into three groups: Group 1 (Pilates), Group 2 (corrective exercises), and Group 3 (Alexander's technique). Each group trained for 60 minutes, three times a week, for six weeks.

The lack of significant differences between groups may be explained by the distinct yet complementary mechanisms of action of both techniques. While MET provides immediate relief through muscle relaxation and passive stretching, Pilates enhances motor control and postural correction through active engagement and proprioceptive training. Therefore, the clinical application of either technique can be tailored based on individual goals—MET for short-term symptom management and Pilates for long-term neuromuscular control.

Interestingly, though not statistically significant, MET showed slightly greater reductions in pain and disability scores, while Pilates showed more favourable improvements in ROM, especially in flexion and rotation. These trends may reflect variability in individual response based on muscle imbalances or exercise familiarity. Thus, while both interventions are effective, their therapeutic emphasis might suit different clinical goals— MET for immediate symptom relief and Pilates for long-term postural correction and motor re-education.

Clinically, these findings support the integration of either Pilates or MET in physiotherapy protocols for FHP. Therapists may choose based on patient preference, resource availability, and clinical expertise. MET

may be more feasible in hands-on, clinic-based settings, whereas Pilates can be adapted for group sessions or home-based programs, promoting self-management.

This study had several limitations, including a small sample size, short-term intervention, and lack of long-term follow-up. Also, external factors like screen time, daily posture habits, and physical activity levels were not controlled, which may affect generalizability. Future research should focus on larger samples, longer durations, and comparative studies on combined approaches to assess sustained effects and individual variability.

6. Clinical Relevance

This study provides valuable evidence supporting the use of both Pilates and Muscle Energy Technique (MET) as effective, non-invasive physiotherapeutic interventions for managing Forward Head Posture (FHP) in young adults. With the increasing prevalence of FHP due to sedentary lifestyles, prolonged screen time, and poor postural habits among students and office workers, early and accessible intervention strategies are crucial for preventing long-term musculoskeletal complications.

The results demonstrate that both Pilates and MET, when combined with conventional therapy, lead to significant improvements in pain relief, postural alignment, cervical mobility, and functional ability. Although both interventions were found to be equally effective, their distinct therapeutic approaches allow flexibility in clinical decision- making. MET may be more suitable in manual therapy-based clinical environments, providing rapid symptom relief through therapist-assisted muscle reconditioning. In contrast, Pilates offers a self-directed, active rehabilitation approach, making it ideal for patients who can commit to structured home exercise programs focused on core stability, body awareness, and neuromuscular control.

From a practical perspective, this study highlights that clinicians can confidently prescribe either MET or Pilates depending on the patient's condition, rehabilitation goals, resource availability, and treatment setting. The findings advocate for the integration of posture-correction programs into early physiotherapy care, especially for populations at risk due to modern occupational demands.

Furthermore, this study supports the growing emphasis in physiotherapy on functional, individualized treatment plans that go beyond symptomatic relief and address the underlying biomechanical and neuromuscular contributors to postural dysfunction.

7. Conclusion

This study concludes that both Pilates and Muscle Energy Technique (MET), when integrated with conventional physiotherapy, are effective in significantly reducing pain and disability, improving postural alignment (CV angle), and enhancing cervical range of motion in individuals with Forward Head Posture (FHP). Although both groups showed meaningful clinical improvements over the 8-week intervention period, there were no statistically significant differences between the two approaches across any outcome measures. These findings suggest that Pilates and MET provide comparable therapeutic benefits and can be used interchangeably based on patient preference, therapist expertise, and clinical setting. Further research with larger sample sizes and long-term follow-up is recommended to explore sustained outcomes and potential subgroup differences.

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Conflict of Interest

There is no conflict of interest reported among all authors of this experimental research.

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