Immediate effect of thoracic spinal manipulation versus passive stretching on upper trapezius pain in university students: A randomized controlled trial

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ABSTRACT

Background: Pain disorders in the upper trapezius muscle are often experienced by students due to non-ergonomic postures and excessive duration of device use. Interventions such as spinal manipulation and stretching exercises are non-invasive interventions often used to reduce pain and improve muscle function.

Objectives: This study compares the effectiveness of two interventions in reducing trapezius muscle pain among university students.

Methods: This randomized controlled trial involved 40 physiotherapy students divided equally into two intervention groups. Group I received thoracic spinal manipulation, and Group II received passive stretching. Each intervention was administered in a single 15-minute session. Pain intensity was measured using the Numeric Rating Scale (NRS) before and immediately after treatment. Data were analyzed using the Wilcoxon Signed-Rank test for within-group comparisons and the Mann–Whitney U test for between-group analysis, with an alpha level of 0.05.

Results: The Wilcoxon test revealed a significant decrease in pain within both groups (Group I: median pre 4.5 [3.63–5] to post 2.5 [1.50–3.38], $p = 0.000$, $r = 0.879$; Group II: median pre 4.25 [3–5] to post 1 [0.13–3], $p = 0.000$, $r = 0.84$), indicating a significant effect of both interventions. The Mann–Whitney U test showed no statistically significant difference in pain reduction between the two groups (median pain difference = 2 [1–3] for both, $U = 186.5$, $Z = -0.375$, $p = 0.707$, $r = 0.06$).

Conclusions: Both thoracic spinal manipulation and passive stretching were effective in reducing upper trapezius pain immediately after a single session, but no significant difference was found between the two interventions. These findings suggest that both approaches provide comparable short-term benefits; however, further research with larger samples, multiple sessions, and more extended follow-up periods is needed to confirm their long-term efficacy.

Keywords: spinal manipulation, stretching exercise, trapezius muscle.

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INTRODUCTION

Pain is an uncomfortable sensation that occurs as a result of the body's response to stimuli that damage tissues or potentially cause injury. In muscles, pain is a painful sensation that arises due to tension, injury, or excessive activation of the muscles, resulting in a lack of oxygen and the accumulation of lactic acid (Tournaire & Theau-Yonneau, 2007). Neck pain is one of the most common musculoskeletal complaints and has a high prevalence rate among the adult population, including university students. Based on studies and data from the Global Burden of Disease Study, the prevalence of neck pain globally reaches 27% and is the fourth cause of disability in the world (Safiri et al., 2020). In Indonesia, based on data from the Ministry of Health and previous studies, the incidence of neck pain ranges from 17 to 24% in prevalence, with the majority of the population being of productive age and students (Ladhina & Wahid, 2023). Some of the leading causes of neck pain reported include poor posture while sitting or working, excessive use of devices or computers, psychological stress and strain, and increased activation of the neck muscles (Hogg-Johnson et al., 2008). One posture problem strongly associated with neck pain is Forward Head Posture (FHP).

Forward Head Posture (FHP) is a deviation in cervical posture characterized by head protrusion or head positioning more anterior to the shoulders in the sagittal plane with a craniovertebral angle lower than 50 degrees (Ramalingam et al., 2019). Recent studies have shown that FHP has become a common condition across different age groups and continues to increase in various populations. Based on a study conducted in adults, the average cranio-vertebral angle in the male group aged 22-44 years was 48.8 degrees, while in the female group aged 23-66 years, it was 47.6 degrees (Worlikar & Shah, 2019). Previous studies have also reported a prevalence of FHP of 66% among individuals aged 20-60 years (Ramalingam et al., 2019).

One of the muscles highly affected in FHP-related complaints is the upper trapezius, a superficial muscle located in the posterior part of the neck and upper back, with important functions in scapula movement, shoulder stabilization, and contributing to cervical extension and rotation movements (Ludewig & Braman, 2012). Excessive tension in the upper trapezius muscle can cause active localized pain, trigger points, limitation of motion, and referred pain to the head and upper shoulder area (Ludewig & Braman, 2012). Pain in the trapezius is particularly prevalent among adults with sedentary habits, poor posture, and prolonged use of computers or smartphones (Cagnie et al., 2007; Kim, 2015). A previous study reported that around 54% of office workers experience complaints in the upper trapezius muscle due to work that requires a static sitting position and repetitive shrugging activities (Cagnie et al., 2007). Additionally, the lack of stretching and muscle relaxation habits is also a contributing factor to the onset of these complaints (Kim, 2015). Pain in this muscle not only causes local disturbances but also has the potential to reduce quality of life, interfere with daily activities, and trigger secondary psychological complaints such as stress and chronic fatigue (Kim, 2015).

In physiotherapy, two common approaches to alleviate muscle pain are spinal manipulation and stretching exercises. Spinal manipulation is a manual therapy technique involving high-velocity, low-amplitude thrusts applied to the spinal joints—cervical, thoracic, or lumbar—to restore mobility and reduce pain. A systematic review demonstrated that spinal manipulation provides significant short-term reductions in pain and disability in patients with neck pain, although the long-term effects remain uncertain (Huisman et al., 2013). Previous research involving 457 participants demonstrated that thoracic spine manipulation significantly reduced neck pain and disability, with a reported pain reduction score of 12.46 (Tsegay et al., 2023). Similarly, a randomized controlled trial demonstrated that thoracic spine manipulation, combined with exercise, improved pain and disability more effectively than exercise alone in patients with mechanical neck pain (Masaracchio et al., 2019).

Stretching exercise, on the other hand, is a safe, non-invasive intervention aimed at lengthening muscles and connective tissue to improve flexibility and Range of Motion. Based on previous literature, stretching exercise has several benefits, such as reducing pain, increasing flexibility and ROM, improving blood circulation, and reducing muscle tension (Zvetkova et al., 2023). When compared to other interventions, stretching exercise is considered safer as it has lower side effects, is flexible, and improves flexibility and ROM. A systematic review also confirmed that stretching and strengthening exercise programs effectively reduce pain intensity and improve function in patients with neck pain (Louw et al., 2017). While the effects of stretching are not immediately apparent because they require a more extended period, they can be sustained in the long term (Albazee et al., 2024).

Although both spinal manipulation and stretching exercises are widely used in clinical practice, there is limited randomized controlled evidence in young adult populations directly comparing their superiority, immediate effects, and clinical significance for trapezius muscle pain. This gap creates uncertainty for physiotherapists in selecting the most effective intervention to address posture-related musculoskeletal complaints in university students (Albazee et al., 2024; Langevin et al., 2016). The null hypothesis (H0) states that there is no significant difference in pain reduction between spinal manipulation and stretching exercise. The alternative hypothesis (H1) states that there is a significant difference in pain reduction between the two interventions. Therefore, the objective of this study is to compare the immediate effects of spinal manipulation and stretching exercise on upper trapezius muscle pain in university students, thereby providing evidence to guide physiotherapy clinical decision-making.

METHODS

Study Design and Participants

This study used a randomised controlled trial design with two intervention groups and a pre-test-post-test design. The research flowchart follows the CONSORT guidelines as shown in Figure 1.

The study population consisted of 150 students from the Physiotherapy Study Programme at Universitas Muhammadiyah Surakarta. Based on the initial screening results, 62 students reported experiencing neck pain complaints and met the initial criteria for participation. After a further selection process, 22 students were eliminated because they did not meet the inclusion criteria, leaving 40 respondents who were eligible and expressed their willingness to participate by signing informed consent.

The procedure for recruiting participants was carried out using the consecutive (sequential) sampling method, which recruits all individuals who meet the inclusion criteria until the desired sample size is reached. Based on the results of the sample size calculation (power analysis), the minimum number of samples required to detect a medium to large effect size ($d = 0.7$) with a significance level of $\alpha = 0.05$ and a power of 0.8 is approximately 33 participants per group (±66 participants in total). However, due to the limited number of participants that met the criteria, this study included 40 participants (n = 20 per group). This sample size limitation is further described in the limitations. Inclusion criteria were: students with pain complaints in the upper trapezius muscle and no history of neurological disorders or spinal trauma. Exclusion criteria included: a history of severe musculoskeletal or neurological disorders, and current use of medications that could influence posture or neck muscle tone.

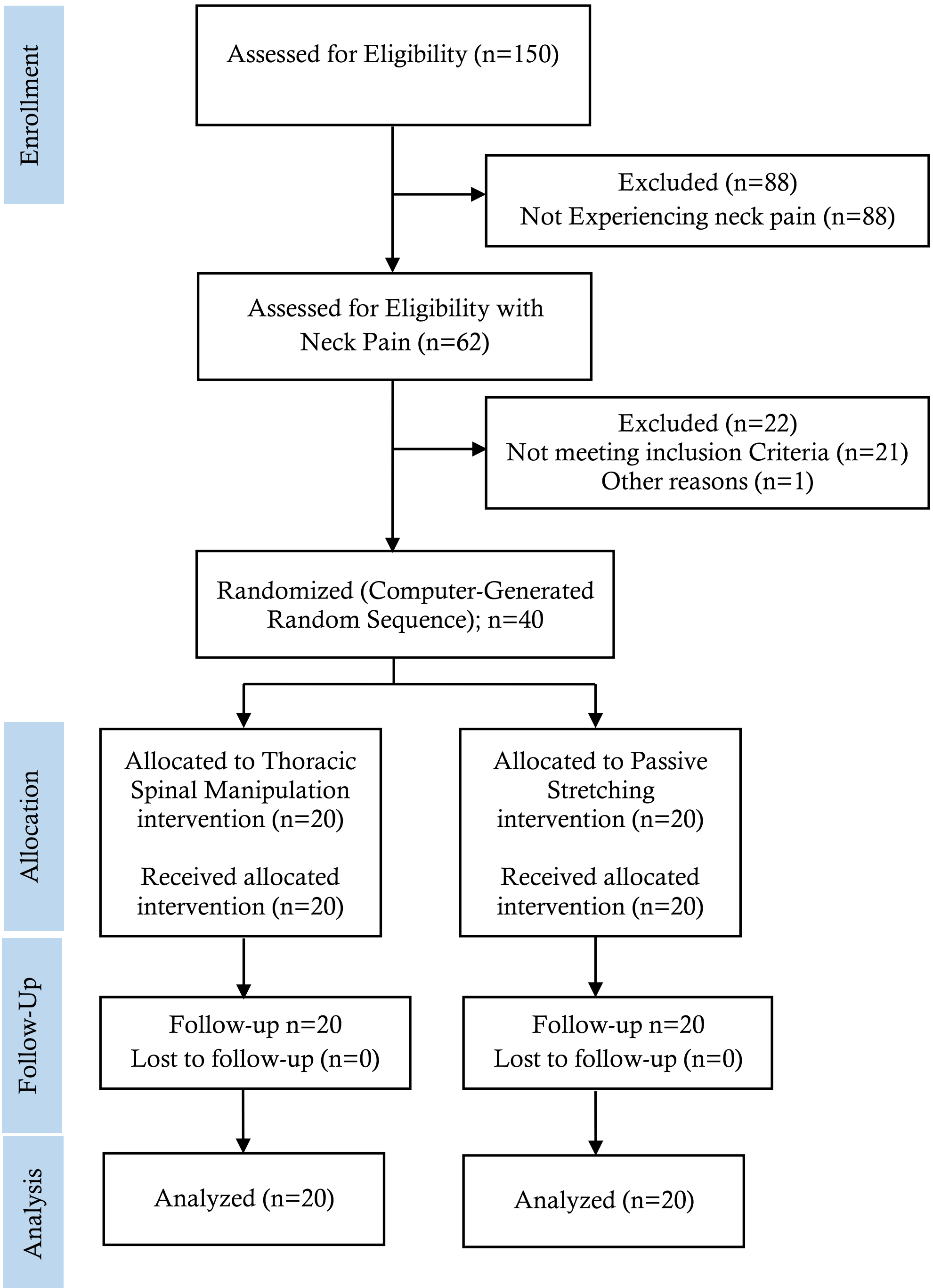

Figure 1. Flow diagram of participant recruitment, allocation, follow-up, and analysis

The randomisation process was conducted using a computer-generated random sequence to ensure random distribution between groups. Participants were then allocated into two intervention groups, Group I (Thoracic Spinal Manipulation) and

Group II (Passive Stretching), each consisting of 20 participants. To maintain internal validity, the allocation process was conducted by an independent researcher who was not involved in the implementation of the intervention. The intervention's implementation also took place in a separate room to prevent potential contamination bias.

In addition, outcome assessors were blinded to group allocation to ensure measurement objectivity. Due to the different characteristics of the interventions (Thoracic Spinal Manipulation and Passive Stretching), blinding of participants and implementing therapists was not possible. This study was not prospectively registered with a clinical research registry, and this is recognised as one of the limitations of this study.

Ethical approval statement

The study was approved by the Health Research Ethics Commission (KEPK) of the Faculty of Health Sciences, Universitas Muhammadiyah Surakarta, under ethical clearance number 725/KEPK-FIK/XII/2024. All research procedures adhered to established ethical guidelines to ensure participant protection and data integrity.

Intervention Procedures and Outcome Measurements

The interventions were conducted in a single session lasting approximately 15 minutes per participant. Each participant was randomly assigned to one of two intervention groups: (1) Thoracic spinal manipulation (HVLA) and (2) Passive stretching of the neck muscles. Licensed physiotherapists administered both interventions, with a minimum of five years of clinical experience, to ensure treatment consistency and minimize therapist-related bias.

The thoracic spinal manipulation is applied as shown in Figure 2. In this group, participants were positioned in a supine position, and the manipulation was delivered by a certified physiotherapist with over eight years of clinical experience. The procedure included high-velocity low-amplitude thrusts (HVLA) applied to the upper (T1–T3), middle (T4–T6), and lower (T7–T9) thoracic segments, with 2–3 thrusts per level using a low-amplitude, high-speed motion (Dunning et al., 2012). Additionally, the Nelson Manipulation was applied at the cervicothoracic junction, involving rotational and side-flexion positioning to enhance segmental mobility. The technical description of the Nelson technique was adapted from Physiotutors Manual Therapy. The clinical effectiveness of thoracic and cervicothoracic HVLA manipulation has been supported by several randomized controlled trials, which reported significant improvements in cervical range of motion, pain reduction, and functional outcomes compared with non-thrust mobilization (Dunning et al., 2012; Hanney et al., 2017; McDevitt et al., 2015). The therapist recorded the number of thrusts and the participant's response, including audible cavitation, reported discomfort, and pain.

In the passive stretching group, participants were seated in an upright position. Stretching targeted the sternocleidomastoid (SCM) and upper trapezius muscles, which play a critical role in neck pain and forward head posture dysfunctions (Lindstrøm et al., 2011). Each stretch was maintained for 30 seconds and repeated three times per side, with 10-second rest intervals between repetitions. The sequence included neck flexion, flexion combined with contralateral rotation, and lateral flexion toward the opposite side, as shown in Figure 3. The total duration of the stretching session was approximately 10–12 minutes, performed passively by the physiotherapist, ensuring the range reached the point of mild discomfort without pain. Total session duration was approximately 10–12 minutes. This stretching protocol was selected based on evidence demonstrating its effectiveness in improving soft tissue flexibility and reducing pain in mechanical neck disorders (Ylinen et al., 2005).

Figure 2. Spinal Manipulation Intervention on the (a) Lower; (b) Middle; (c) Upper; (d) Nelson Maneuver Technique

Figure 3. Stretching Exercise Intervention (a) Flexion; (b) Flexion and Rotation; (c) Side Flexion

Both interventions were conducted in separate treatment rooms to prevent inter-group contamination. The procedures were standardized through prior training sessions with the therapists to ensure consistency across participants.

Outcome Measures and Time Points

The primary outcome of this study was pain intensity, assessed using the Numeric Rating Scale (NRS; 0–10), where 0 indicates no pain and 10 represents the worst imaginable pain. Measurements were performed immediately before (pre-intervention) and within five minutes after intervention (post-intervention).

The secondary outcomes included changes in craniovertebral angle (CVA) and thoracic curvature. The CVA was obtained through photographic analysis using the Angle Meter smartphone application, while thoracic curvature was assessed with a scoliometer. All post-intervention measurements were taken immediately after the intervention was completed to ensure temporal consistency across all outcomes.

Research Instruments

The research instruments consisted of the Numeric Rating Scale (NRS), a digital Angle Meter smartphone application, and a scoliometer, along with auxiliary tools such as a digital scale, stadiometer, stopwatch, and adjustable chair. The Numeric Rating Scale (NRS) was utilized to evaluate subjective pain intensity, as it is one of the most sensitive and reliable self-report measures of pain. It demonstrates strong responsiveness to changes in pain levels (Ferreira-Valente et al., 2011). In addition, other studies have shown a strong correlation between NRS results and other measurement tools such as the VAS or Verbal Rating Scale (VRS) (Jensen et al., 1986).

The craniovertebral angle (CVA) was measured using photogrammetric analysis with the Angle Meter digital application, which has demonstrated excellent reliability, with an intra-rater ICC ≈ of approximately 0.88 and an inter-rater ICC ranging from 0.83 to 0.89 (Gallego-izquierdo et al., 2020). Similarly, Mylonas et al. (2025) reported very high intra- and inter-rater reliability (ICC up to 0.98) for digital CVA measurements, validating the use of smartphone-based tools in postural assessment (Mylonas et al., 2025)—specifically, the measurement of the craniovertebral angle, as shown in Figure 4. Participants were instructed to stand in a relaxed, natural posture while reflective anatomical markers were placed on the tragus of the ear and the spinous process of C7. The camera was positioned at a distance of 1.5 meters, aligned with the sagittal plane, and adjusted to a height of shoulder level. A horizontal reference line through C7 was used to form the craniovertebral angle, with the line connecting C7 to the tragus (Carrasco-Uribarren et al., 2023).

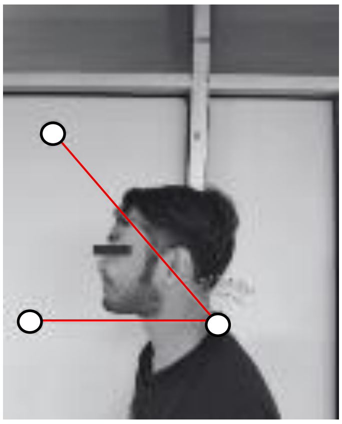

Figure 4. Measurement of Craniovertebrae Angle with Angle Meter Application

The scoliometer was used to measure the thoracic vertebral curvature as an indicator of trunk rotation. It is a non-invasive, portable, and reliable tool widely used for scoliosis screening. Studies have demonstrated its excellent intra-rater reliability (ICC = 0.86–0.97) and good inter-rater reliability (r = 0.81–0.82) for thoracic spine assessment (Bonagamba et al., 2010). Also, previous study confirm that the scoliometer is effective in early screening and has a good predictive value for identifying idiopathic scoliosis cases that need further examination (Beauséjour et al., 2013).

Data Analysis

Data collection began with a two-month observation phase assisted by experts, followed by participant selection through informed consent and a one-day intervention session. Data analysis was performed using SPSS version 20. The analysis procedures included: (1) descriptive analysis to summarize participant characteristics such as age, gender, duration of digital device use, pain intensity, and spinal curvature; (2) normality testing of pre-intervention and change (delta) scores using the Shapiro–Wilk test; (3) within-group analysis comparing pre- and post-intervention pain intensity using the paired t-test for normally distributed data or the Wilcoxon signed-rank test for non-normal data; and (4) between-group comparative analysis of pre–post changes (Δ = post - pre) using the independent t-test or Mann–Whitney U test depending on data distribution. All analyses were two-tailed with a significance level of $\alpha = 0.05$.

RESULTS

Table 1 presents data on the characteristics of the research subjects. Regarding age characteristics, in treatment group I, which was the group experiencing spinal manipulation intervention, seven samples were aged 19 years (35%), nine samples were aged 20 years (45%), three samples were aged 21 years (15%), and 1 sample was 22 years (5%). In treatment group II, which received the stretching exercise intervention, 10 samples were from individuals aged 19 years (50%), nine samples were from individuals aged 20 years (45%), and 1 sample was from an individual aged 21 years (5%). Each group consisted of 20 individuals (100%).

Table 1. Subject Characteristics

Characteristics	Group I		Group II	
	N	%	N	%
Age (years)				
19	7	35	10	50
20	9	45	9	45
21	3	15	1	5
22	1	5	0	0
Gender				
Male	4	20	3	15
Female	16	80	17	85
Duration of Device Use (hours)				
<5	5	25	4	20
5-6,5	5	25	5	25
>6,5	10	50	11	55
Body Mass Index (BMI)				
Underweight (<18,5)	3	15	0	0
Normal (18,5-24,9)	11	55	11	55
Overweight (25-29,9)	2	10	5	25
Obesity (≥30)	4	20	4	20
Total	20	100	20	100
Craniovertebrae Angle				
Mean ± SD Pre Test	55,20±5,63		52,40±6,15	
Mean ± SD Post Test	55,40±4,75		51,55±5,78	
Pain Level (NRS)				
Median (IQR) Pre Test	4,5 [3,63-5,00]		4,25 [3,00-5,00]	
Median (IQR) Post Test	2,5 [1,50-3,38]		1 [0,13-3,00]	

In terms of gender distribution, treatment group I consisted of 4 male subjects (20%) and 16 female subjects (80%), while treatment group II included three male subjects (15%) and 17 female subjects (85%). Regarding the average duration of digital device usage, treatment group I comprised five subjects (25%) who used devices for less than 5 hours, five subjects (25%) with usage between 5 and 6.5 hours, and 10 subjects (50%) with usage exceeding 6.5 hours per day. In treatment group II, four subjects (20%) reported using less than 5 hours, five subjects (25%) used between 5 and 6.5 hours, and 11 subjects (55%) used more than 6.5 hours. Based on Body Mass Index (BMI), treatment group I included three underweight subjects (15%), 11 with normal weight (55%), two overweight (10%), and 4 with obesity (20%). Treatment group II consisted of 11 subjects (55%) with a normal BMI, 5 (25%) who were overweight, and 4 (20%) classified as obese. For craniovertebral angle (CVA), the mean pre-test value in treatment group I was 55.20°, increasing slightly to 55.40° post-test. In contrast, treatment group II exhibited a decrease in CVA from 52.40° pre-test to 51.55° post-test. Regarding pain intensity measured by the Numeric Rating Scale (NRS), treatment group I showed a reduction from a pre-test median of 4.5 to a post-test median of 2.5. In contrast, treatment group II experienced a reduction from 4.25 to 1.

Table 2 shows the results of the Shapiro–Wilk test for normality of pain intensity data in each treatment group. For Group I, the Shapiro–Wilk statistic was W = 0.865 with p = 0.010, indicating a significant deviation from normality ($p < 0.05$). For Group II, the Shapiro–Wilk statistic was W = 0.908 with p = 0.059, which does not meet the conventional significance threshold ($p \geq 0.05$); therefore, the null hypothesis of normality cannot be rejected for Group II. Because at least one of the groups (Group I) exhibits a non-normal distribution, the overall assumption of normality for parametric between-group comparisons is violated. Consequently, non-parametric methods were used for subsequent analyses: the Wilcoxon Signed-Rank test for within-group (pre–post) comparisons and the Mann–Whitney U test for between-group comparisons.

Table 2. Normality Test Results

Treatment Group	Shapiro-Wilk (W)	p-value
Group I	0,865	0,010
Group II	0,908	0,059

Table 3 presents the results of the Levene Test for assessing the equality of variances in pain difference (Δ) between treatment groups. The Levene Statistic was F = 6.477 with a corresponding p-value of 0.015, indicating a statistically significant difference in variances across the groups ($p < 0.05$). Since the data for the pain difference did not meet the assumption of homogeneity of variance, subsequent between-group analyses were performed using the Mann–Whitney U test, which is appropriate for non-parametric data and unequal variances.

Table 3. Levene Test Test Results

Treatment Group	Levene Statistic (F)	p-value
Pain Difference (Δ)	6,477	0,015

Table 4. Wilcoxon Test Results

Treatment Group	Median (Pre)	Median (Post)	W (Z)	p-value	Effect Size (r)
Group I	4,5 [3,63-5,00]	2,5 [1,50-3,38]	-3,933	0,000	0,879
Group II	4,25 [3,00-5,00]	1 [0,13-3,00]	-3,753	0,000	0,84

Table 4 presents the results of the Wilcoxon Signed-Rank Test used to examine the differences in pain intensity before and after the intervention within each treatment group. For Group I, the median pain score decreased from 4.5 [3.63–5.00] at pre-test to 2.5 [1.50–3.38] at post-test, with a test statistic of Z = –3.933 and $p < 0.001$, indicating a statistically significant reduction in pain following the intervention. Similarly, Group II showed a reduction in median pain score from 4.25 [3.00–5.00] at pre-test to 1 [0.13–3.00] at post-test, with a Z score of –3.753 and a p-value of < 0.001, also demonstrating a significant improvement. The calculated effect sizes (r) were 0.879 for Group I and 0.84 for Group II, both of which indicate a significant effect according to Cohen's classification ($r > 0.5$). These findings suggest that both interventions produced a substantial and statistically significant decrease in pain intensity within their respective groups.

Table 5 presents the results of the Mann–Whitney U test, which was used to compare the differences in pain reduction (Δ) between Group I and Group II. The analysis revealed a median pain difference of 2 [1–3] for both groups, with a test statistic of U = 186.5, Z = –0.375, and a corresponding p-value of 0.707. Since the p-value was greater than 0.05, there was no statistically significant difference in pain reduction between the two treatment groups. Additionally, the effect size (r = 0.06) indicates a minimal practical effect, suggesting that both interventions yielded comparable outcomes in terms of pain reduction. These findings suggest that while both treatments were effective in reducing pain within each group (as indicated by the Wilcoxon test), the magnitude of improvement did not differ significantly between groups.

Table 5. Mann-Whitney U Test

Variabel	Group I Median (IQR)	Group II Median (IQR)	U	Z	p-value	Effect Size (r)
Pain Difference (Δ)	2 [1,00-3,00]	2 [1,00-3,00]	186,5	-0,375	0,707	0,06

In summary, the results of the statistical analyses indicate that although both interventions produced a significant and clinically meaningful reduction in pain intensity within each group, there was no significant difference in the magnitude of improvement between the two treatments. These findings suggest that both intervention methods were equally effective in alleviating pain among participants. Therefore, the subsequent discussion will focus on interpreting these outcomes in relation to previous research, possible physiological mechanisms underlying the observed effects, and the clinical implications of comparable treatment efficacy.

DISCUSSION

This study investigated the effects of spinal manipulation and stretching exercises on pain intensity and craniovertebral angle (CVA) among physiotherapy students with Forward Head Posture (FHP), while also exploring contributing factors such as age, gender, body mass index (BMI), and duration of device use. The main findings revealed that both interventions led to a decrease in pain intensity—spinal manipulation from 2.52 to 1.32 and stretching from 2.95 to 1.42 on the NRS scale—and an improvement in CVA from 45.5° to 47.5°, indicating postural enhancement. However, no statistically significant difference was found between the two groups ($p > 0.05$), suggesting comparable short-term effectiveness. Although the results did not reach statistical significance, both interventions achieved clinically meaningful improvements in pain reduction and posture correction.

The improvement in CVA observed in this study aligns with previous findings, which demonstrate that postural correction through spinal manipulation, stabilization, and stretching exercises can enhance cervical alignment and reduce muscle tension (Acet et al., 2025; Lee et al., 2015). Similarly, activation of the deep neck flexor muscles has been shown to improve neck stability and postural control (Apriliani, Yusrin, & Pristianto, 2021). Other studies also reported that integrative interventions, such as neuromuscular reeducation or ultrasound-assisted therapy, significantly improved CVA (Saraswati et al., 2024). Despite these findings, Wibisono et al. (2022) reported that changes in CVA were not always associated with pain reduction, highlighting the influence of habitual postures and prolonged smartphone use on FHP independent of treatment.

Regarding pain reduction, this study supports evidence that both spinal manipulation and stretching exercises are practical for managing musculoskeletal discomfort. Spinal manipulation may reduce pain through neuromodulation and improved local circulation (Chihwan & Donggeon, 2020). Previous research has shown a marked decrease in pain intensity after chiropractic intervention in cases of low back pain (Fagundes Loss et al., 2020; Wulandari, 2020). Stretching exercises similarly reduce pain by improving muscle flexibility, elasticity, and blood flow, thus alleviating tension in the neck and shoulder region (Arooj et al., 2022; Mardiyana et al., 2022). The comparable pain reduction between both interventions in this study suggests that either can be utilized as a short-term management strategy for FHP-related neck discomfort.

The analysis of contributing factors revealed that most subjects were aged 19–20 years, a population prone to FHP due to sedentary lifestyles and prolonged device use (Arooj et al., 2022; Naz et al., 2018; Singh et al., 2020). Although age may contribute to FHP prevalence, it is not the dominant determinant compared to postural habits and ergonomics (Savitri & Faidlullah, 2022). Female students were more frequently affected, consistent with reports linking lower cervical strength and greater neck mobility to higher FHP risk (Karthik et al., 2022; Mahmoud et al., 2019; Sarraf & Varmazyar, 2022). Device use exceeding 5 hours daily also showed strong associations with FHP, corroborating previous findings that prolonged head flexion (>15°) induces mechanical strain on the cervical spine (Lee et al., 2015; Maharani & Dewi, 2019; Shah & Sheth, 2018). In contrast, BMI exhibited inconsistent relationships with FHP, where higher BMI may contribute to postural imbalance (Kocur et al., 2019; Mahmoud et al., 2019; Noviati, 2022), though other studies found ergonomic factors to be more influential (Pangestu et al., 2021; Karthik et al., 2022).

From a critical perspective, several factors could explain the absence of statistically significant differences between the two interventions. First, the limited sample size (n = 8) may have reduced the statistical power to detect minor effect differences. Second, the single-session intervention design may not have been sufficient to produce lasting neuromuscular adaptations. Third, non-specific treatment effects, such as the placebo effect, therapist influence, or participants' expectations, might have contributed to the perceived improvements. Moreover, sample characteristics—predominantly female physiotherapy students—limit generalizability to other populations. The use of subjective measures (NRS, CVA via photographic analysis) may also introduce measurement bias compared to objective assessments, such as pressure pain threshold or range of motion.

Limitations of the study

These limitations highlight the need for cautious interpretation of the findings. Future studies should employ a larger, randomized sample size based on power analysis, include multiple intervention sessions, and conduct follow-up evaluations over 1–4 weeks to examine sustained effects. The inclusion of a sham or control group would help control for non-specific effects. Objective outcome measures—such as electromyography, cervical ROM, or proprioception tests—should be incorporated to enhance internal validity and reproducibility.

Clinically, although the statistical difference between interventions was not significant, the observed reduction in pain and improvement in posture remain meaningful. In practice, both spinal manipulation and stretching exercises may serve as accessible, low-cost short-term interventions for managing mild FHP and neck discomfort in young adults. However, for long-term correction, combined programs involving postural reeducation, ergonomic modifications, and habit changes are recommended.

CONCLUSIONS

In this randomized pilot study involving physiotherapy students (n = 40), both single-session thoracic spinal manipulation and passive stretching exercises demonstrated immediate reductions in pain intensity and improvements in the craniovertebral angle (CVA). However, no statistically significant difference was found between the two interventions, suggesting comparable short-term efficacy. Given the small sample size, single-session design, and short-term outcome assessment, these findings should be interpreted with caution. Future studies with larger sample sizes, multiple treatment sessions, extended follow-up periods, and objective assessment tools are recommended to validate the clinical relevance and long-term effectiveness of these interventions.

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DATA AVAILABILITY

All data supporting the findings of this study are included in the article and its supplementary materials. Additional datasets are available from the corresponding author upon a reasonable request.

FUNDING

This research was conducted independently, without receiving funding from any institution, including government, private sector, or non-profit organizations.

CONFLICT OF INTEREST

The author hereby declares that this research is free from conflicts of interest with any party.

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