Improving Kyphotic Postures and Neck Pain in Young Adults: A Meta-Analysis of Exercise-Based Interventions

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ABSTRACT

The study aimed to review the findings concerning the effects of exercises on Cobb angle and pain in patients suffering from cervical pain caused by thoracic kyphosis. Two investigators separately conducted a systematic review of the electronic literature from 2018 till 2022. PubMed, MEDLINE, Web of Science, Science Direct, Cochrane Central Register of Controlled Clinical Trials, Google Scholar, and Scopus were among the electronic databases that were accessed. This meta-analysis included 5 studies, published between 2019 and 2022. A sample size of 261 patients; included in 5 studies were estimated on Cobb angle and pain. The between-groups pooled random SMD for Cobb angle and pain showed a larger effect size of -2.146 and -1.126, respectively. The findings suggested that physical therapy exercise may result in larger changes among the Cobb angle and neck pain of kyphotic patients.

Key Words: *Exercise, Physical therapy, Cobb angle, Pain, Thoracic kyphotic angle, Conservative management.*

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INTRODUCTION

Musculoskeletal disorders affect around 1.71 billion people globally.[1] The prevalence of spinal deformities rises with age, reaching an estimated 30 to 68% in the elderly,[2] among which kyphosis is highly prevalent. The Cobb angle is used to identify thoracic kyphosis, an anteroposterior curve of the thoracic spine in the sagittal plane. Thoracic hyperkyphosis is characterised by a Cobb angle greater than 40 degrees.[3] The disease not only affects older population but is also prevalent among the children with an estimated prevalence of 13.06%.[4] The most noticeable symptom of hyperkyphosis is a rounded back caused by an excessive forward curvature of the spine.[5] Through the cervicothoracic connection, the thoracic spine sustains the cervical spine and thus, affects its kinematics.[6] In thoracic hyperkyphosis, the upper trapezius and pectoralis muscles are tense, whereas the cervical flexors and lower trapezius muscles are weakened, resulting in mechanical disequilibrium.[7] Since alterations in sagittal thoracic orientation have been shown to affect the mechanical stress of the cervical spine and since decreased thoracic mobility has already been linked to shoulder and neck pain, it is plausible that thoracic articular therapy would restore local kinematics while also alleviating neck pain.

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In a study by Lau *et al*., it was shown that there was an inverse relationship between pain intensity and increasing thoracic angle,[8] although there was a significant association between neck discomfort and a greater upper thoracic angle.[9]

Treatment for kyphosis depends on the progression and severity of the deformity, the occurrence of neurological or cardiopulmonary complications, aesthetic concerns, and the deformity's degree while also taking into account the spine's residual growth.[10] In the following situations, surgery for kyphosis is advised: alterations in the patient's neurologic condition, kyphotic angle $\geq$30°, and greater than 50% anterior vertebral height loss. Medical therapy for kyphosis consists of exercise, medication, and bracing.[11] Sagittal spinal curvatures can be improved by systematic and sustained exercise.[12]

A number of physical therapy treatments are available for the management of kyphosis that include kinesiotaping, Schroth method, mobilisation, manipulation, strengthening and stretching exercises. According to a systematic evaluation of seven randomised controlled studies, exercise therapies aimed at increasing back extensor muscle strength resulted in modest improvements in clinical indices of kyphosis.[12] Several randomised trials of spinal strengthening therapies had shown improvements in clinical assessments of kyphosis. Another study on hyperkyphosis in older adults published in 2017 found that spine strengthening exercise and postural training effectively reduced both clinical and radiographic measures of kyphosis in both men and women over the age of 65.[13]

Kyphotic posture and neck pain are prevalent among young adults, and can have a significant impact on their quality of life. However, the existing literature on exercise-based interventions for these conditions is incomplete. Moreover, there is not a single study that conducted a meta-analysis to analyse the effects of conservative management on Cobb angle among kyphotic patients with cervical pain. Therefore, this study aimed to fill this gap in literature by conducting a meta-analysis of exercise-based interventions for improving kyphotic posture and neck pain in young adults. By combining the findings of several studies, this meta-analysis will provide a more comprehensive and precise estimate of the effect of exercise-based interventions. This will help guide healthcare professionals in selecting the most effective interventions for young adults with these conditions and provide directions for any future research. The aim of this meta-analysis was to determine the impact of exercise on thoracic kyphosis angle and chronic neck discomfort in kyphotic patients.

METHODOLOGY

Two independent investigators conducted a comprehensive search using the key terms kyphosis or Cobb angle or thoracic kyphosis angle or neck pain and exercise or physical activity or physical therapy or conventional physical therapy or physiotherapy or physical rehabilitation or Schroth method across 5 databases, including PEDro, PubMed, Web of Science, Cochrane and Library.

The PICOS approach was used to construct this question (population, intervention, comparison, outcome measurements, and research design). The meta-analysis included RCTs that would include patients with thoracic kyphosis and chronic neck pain, studies comparing physical therapy with a placebo or no intervention, and studies examining the effects of such treatment on TKA and pain that were written in English. Studies providing patient data on respiratory diseases, static, and dynamic balance were excluded.

From 2019 to 2022, two reviewers utilised the predetermined method to find studies for the current meta-analysis. The information that was extracted comprised the participants' age and gender, sample size, and the interventions used in the experimental and control groups dosage used, outcome measurements, and results (Table I). The assessment of the risk of bias in the domains of selection, performance, detection, attrition, and reporting biases was performed using the Cochrane collaboration tool.[14]

Data was run in MedCalc statistical software, version 18.11.3. In random-effects model, the pooled impact was calculated using the continuous measurement standardised mean difference (SMD) method (I^2 at 95% CI). Hedges' *g* statistics, SMD tables, and forest plots were used to evaluate the data. Cohen's rule of thumb interpreted the findings, which indicated the values of 0.2, 0.5, and 0.8 to be of low, medium, and large effects, respectively. Cochrane's Q statistic was used to determine the level of heterogeneity. The number was divided by Cochrane's Q value to calculate I^2 and the degrees of freedom (Df) were removed to obtain a percentage value (I^2= Q-Df/Q) of 0–100%, where 0% denoted no heterogeneity between the studies and higher values denoted a higher degree of variability. I^2 was used in order to make interpretation on the basis of random- and fixed-effect model ($I^2 \leq 50$ fixed effect, $I^2 \geq 50$ random effect).

RESULTS

This meta-analysis included 5 studies, all of which were published between 2019 and 2022. A sample size of 261 patients, included in 5 studies, were analysed in which the effects of physical therapy based management approaches for kyphosis associated with neck pain were estimated on Cobb angle and pain. After the search, n= 214 original articles were included initially. Further evaluation of the initially included articles led to the exclusion of duplicate and all those articles in which physical therapy management approaches were estimated after joint fusion surgeries and in which other variables were assessed, hence n=47 articles remained. Finally, after the further analysis, all articles published before 2019 and not available in the English language and for which no full-text was available even after contacting the authors and all paid articles were excluded. Hence, n=5 studies were included for analysis (Figure 1).

Five randomised controlled studies' findings demonstrated that the physical therapy intervention considerably decreased Cobb angle in comparison to the control group. Standardised mean difference suggested an effect size of -2.146 in the random-effects model (I^2 = 96.17%; p< 0.001) depicting a large effect size suggesting beneficial effects of physical therapy on Cobb angle among thoracic kyphotic patients with cervical pain (Table II).

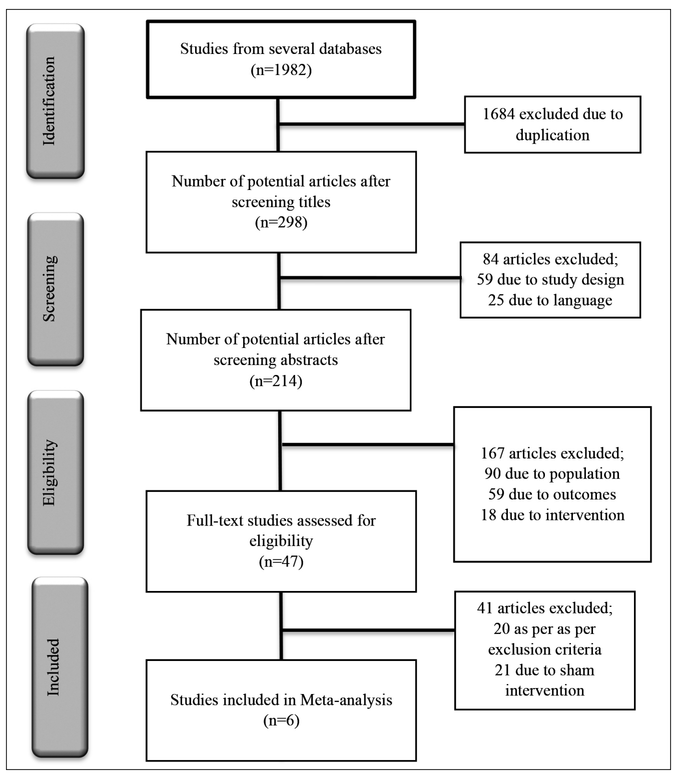

Figure 1: Flow of included studies.

Table I: Characteristics and features of the included studies.

Reference study	n	Population	Study design	Age	Kyphosis angle	Intervention arm	Control group	Outcome
Mustafa *et al.*, 2022[6]	80	Thoracic hyperkyphosis and chronic nonspecific neck pain	RCT	EG=25.05 ± 3 CG=24 ± 4.2	≥ 55°	10-week, three sessions each week, 30 sessions of physical pain reduction methods, manipulation of thoracic spine, MFR and exercises + traction	10-week, three sessions each week, 30 sessions of physical pain reduction methods, manipulation of thoracic spine, MFR and exercises	Thoracic Cobb angle, NDA
Dhiman *et al.*, 2021[15]	60	Patients with Thoracic kyphosis & forward head posture	RCT	EG=26.93 ± 4.44 CG=28.96 ± 3.82	-	Four alternate days/week, hot packs, stretching and strengthening exercises were performed.	Hot pack and postural guidance were given for four weeks on alternate days.	Thoracic Cobb angle, NDA
Avellanet *et al.*, 2021[16]	41	Nonspecific cervical pain and dorsal kyphosis	RCT	EG=38.05 ± 8.72 CG=39.69 ± 10.6	>45°	20 minute session/ week for a duration of 5 weeks was provided involving stretching and strengthening exercises of the cervical and dorsal area	Posture Plus Force (P+) group wore garment in day time for 2 to 4 hours/ day, for 12 consecutive week	Thoracic Cobb angle, NDA
Bezalel *et al.*, 2019[17]	EG=25 CG=25	Scheuermann kyphosis	RCT	10-17 years	-	Schroth therapy exercises	five classic anti-gravitation exercises	Thoracic Cobb angle
Ahmadi *et al.*, 2019[18]	EG=14 CG=16	Hyperkyphosis with neck pain	RCT	18 to 22 years	>42°	Water-Based Corrective Exercises, eight-week involved three sessions per week	No treatment	Thoracic Cobb angle, NDA

EG, Experimental group; CG, Control group; NDI: Neck disability index; MFR, Myofascial release.

Table II: SMD of Cobb angle with 95% CI.

Author	Sample size (Exp)	Sample size (Control)	Total	Standardised mean difference	SE	95% Confidence Interval	t	p	Weight (%) Fixed	Weight (%) Random
Moustafa *et al.*, 2022[6]	40	40	80	-3.437	0.351	-4.135 to -2.739			19.31	20.34
Dhiman *et al.*, 2021[15]	30	30	60	-2.445	0.339	-3.123 to -1.766			20.68	20.4
Avellanet *et al.*, 2021[16]	21	20	41	-0.354	0.309	-0.979 to 0.271			24.87	20.52
Bezalel *et al.*, 2019[17]	25	25	50	0.0377	0.278	-0.522 to 0.598			30.61	20.63
Ahmadi *et al.*, 2019[18]	14	16	30	-4.877	0.723	-6.358 to -3.395			4.54	18.11
Total (fixed effects)	130	131	261	-1.467	0.154	-1.770 to -1.163	-9.522	<0.001	100	100
Total (random effects)	130	131	261	-2.146	0.813	-3.746 to -0.546	-2.641	0.009	100	100
Q		104.3339								
DF		4								
Significance level		p <0.0001								
I^2 (inconsistency)		96.17%								
95% CI for I^2		93.41 to 97.77								

Table III: SMD of pain with 95% CI.

Author	Sample size (Exp)	Sample size (Control)	Total	Standardised mean difference	SE	95% Confidence Interval	t	p	Weight (%) Fixed	Weight (%) Random
Moustafa *et al.*, 2022[6]	40	40	80	-1.976	0.271	-2.515 to -1.436			25.00	20.67
Dhiman *et al.*, 2021[15]	30	30	60	-1.124	0.275	-1.674 to -0.574			24.33	20.63
Avellanet *et al.*, 2021[16]	21	20	41	0.0753	0.306	-0.545 to 0.695			19.54	20.28
Bezalel *et al.*, 2019[17]	25	25	50	-0.124	0.279	-0.684 to 0.437			23.64	20.59
Ahmadi *et al.*, 2019[18]	14	16	30	-2.667	0.495	-3.681 to -1.652			7.48	17.83
Total (fixed effects)	130	131	261	-0.981	0.135	-1.248 to -0.715	-7.243	<0.001	100	100
Total (random effects)	130	131	261	-1.126	0.472	-2.056 to -0.196	-2.383	0.018	100	100
Q		46.6718								
DF		4								
Significance level		p <0.0001								
I^2 (inconsistency)		91.43%								
95% CI for I^2		82.97 to 95.69								

Table IV: The Cochrane collaboration's tool for assessing the risk of bias in included studies.

Studies	Random allocation	Allocation concealment	Participants blinding	Outcome assessment blinding	Incomplete outcome data	Selective reporting
Mustafa *et al.*, 2022[6]	+	+	+	+	+	+
Dhiman *et al.*, 2021[15]	+	?	?	?	+	+
Avellanet *et al.*, 2021[16]	+	?	?	?	-	+
Bezalel *et al.*, 2019[1]	+	+	+	+	+	+
Ahmadi *et al.*, 2019[18]	+	-	-	-	+	+

−Bias at high risk, +Bias at low risk, ?Unknown risk of bias.

The results of five randomised controlled trials suggested that the physical therapy intervention in comparison to the control group considerably reduced the Cobb angle. As per the Cohen's rule of thumb, a larger pool effect on SMD of -2.146 in random-effects model was obtained in the treatment group, as displayed in Table II. Moreover, forest plot at 95% CI was drawn to reflect the pool effects in the random effect model, as illustrated in Figure 2.

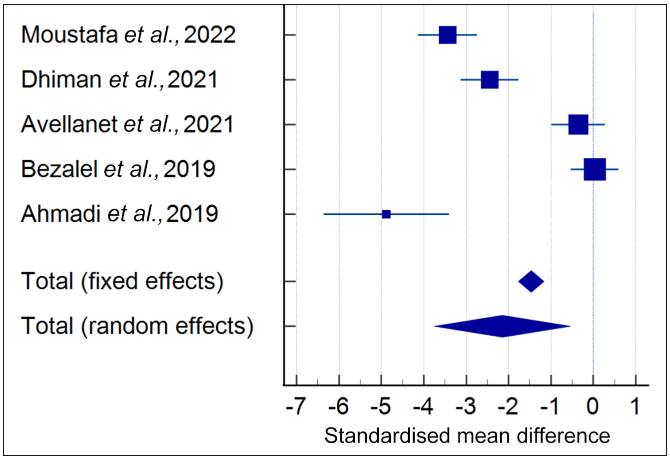

Figure 2: Pool effect of studies determining the effects of exercises on Cobb angle among thoracic kyphotic patients with cervical pain.

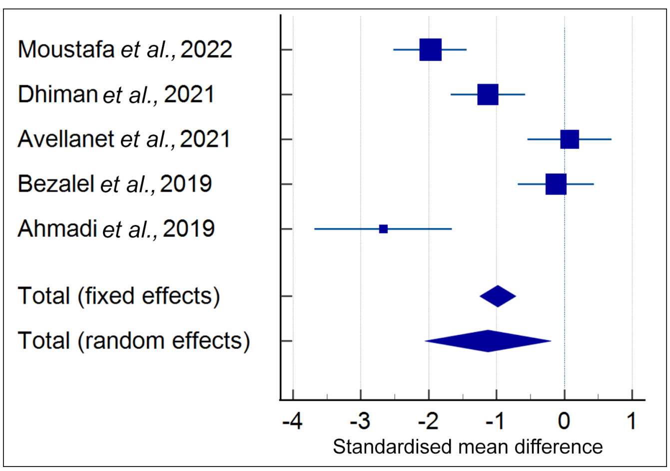

Figure 3: Pool effect of studies determining the effects of exercises on pain among thoracic kyphotic patients with cervical pain.

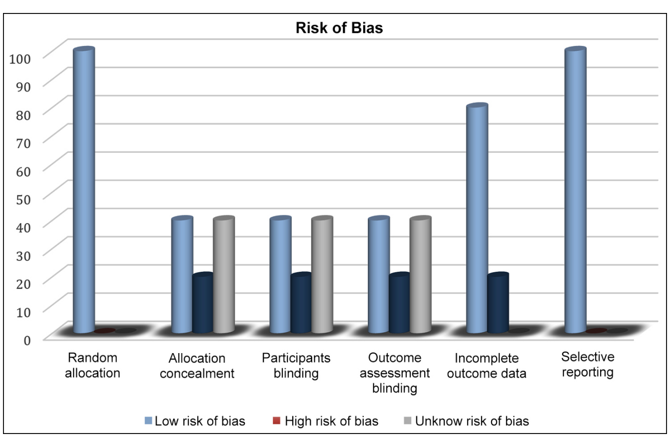

Figure 4: Cochrane risk of bias.

Five randomised controlled studies' findings demonstrated that the physical therapy intervention considerably decreased pain in comparison to control group. Standardised mean difference suggested an effect size of -1.126 in random-effects model (I^2 = 91.43%; p <0.0001) that depicted a large effect size suggesting beneficial effects of physical therapy on pain among thoracic kyphotic patients with cervical pain (Table III).

The results of five randomised controlled trials suggested that the physical therapy intervention in comparison to the control group considerably reduced the pain. As per the Cohen's rule of thumb, a larger pool effect on SMD of -1.126 in a random effect model was obtained in treatment group, as displayed in Table II. Moreover, forest plot at 95% CI was drawn to reflect the pool effects in the random effect model, as illustrated in Figure 3.

Author's judgment of risk of bias analysis based on guidelines of Cochrane are provided in Table IV, Figure 4. Randomisation was done in all studies suggesting a low risk of bias.[6,15-18] Two studies revealed low risk of bias,[6,16] two studies depicted unknown risk of bias,[15,16] and only one study showed high risk of bias.[18] Two studies did not mention about either participant or assessors' blinding,[15,16] and in one study, blinding was not done.[18] All studies reflected low reporting bias risk.[6,15-18]

DISCUSSION

The purpose of this meta-analysis was to investigate the effectiveness of exercise-based interventions in improving kyphotic postures and neck pain in young adults. The study of five trials included in this meta-analysis revealed evidences that physical therapy delivered effective results, as measured by greater effect size in this article. A significant decrease in Cobb angle was found among all the participants, with an effect size of -2.146 (CI -3.746 to -0.546, p=0.0001; random-effects model). Besides that, the impact of physical therapy on reducing pain had also been reflected on larger effect size in this study and had revealed an effect size of -1.126 (CI -2.056 to -0.196, p=0.018) signifying a positive effect of physical therapy in reducing pain as well. The findings are consistent with the previous research on the benefits of physical therapy for correcting postural abnormalities and reducing pain in young adults. A randomised controlled trial by Lee *et al*. showed that a 12-week exercise programme significantly improved thoracic kyphosis and reduced neck pain in the young adults.[19] In 2020, a study was conducted on the effects of a combination of Schroth and Pilates exercises on various parameters in adolescents with idiopathic scoliosis, including the Cobb angle, angle of trunk rotation (ATR), chest expansion, flexibility, and quality of life (QoL). The study found that the combined exercises resulted in significant improvements in these parameters for adolescents with mild to moderate idiopathic scoliosis.[20] Another study published in 2021 showed a low SMD of 0.31 at 95% CI on hyperkyphosis patients.[21] There is scarcity of literature concerning the impact of different exercise regimes on cervical muscle strength and pain of thoracic kyphotic patients. As indicated in the study by Moon *et al.* in 2021, corrective exercises are more effective than the resistance exercises and traditional physical therapy in improving cervical muscle strength, and Cobb angle.[22] The significance of clinical based rehabilitation for kyphotic patient is indeed of utmost importance as the changes in thoracic curvature can disturb the mechanics of proximal and distal joints,[23] leading to cervical conditions in patients.

There are very few clinical trials in recent times that have analysed the effects of exercise on both kyphosis and cervical pain. Hence, the study did have some limitations. Due to the small number of research, the authors were unable to conduct sensitivity analysis on studies that solely recruited patients with hyperkyphosis. Sixty percent of the included studies either did not blind or mentioned blinding of outcome assessors. Additionally, the majority of the studies did not discuss negative outcomes, which raised questions about biased reporting. Future investigations should comprehensively assess the safety of exercise and other interventions in this population, even though only a few minor adverse events have been noted. The authors came across pertinent studies that fit the inclusion criteria but were deficient in some details.

CONCLUSION

Physical therapy exercise may result in larger changes among the Cobb angle and neck pain of kyphotic patients. More clinical trials need to be conducted on a larger sample size to get more generalised results.

COMPETING INTEREST:
The authors declared no competing interest.

AUTHORS' CONTRIBUTION:
MJS: Article writing and literature search.
FZ: Result analyses and literature search.
SA: Technical guidance and proofreading.
All authors approved the final version of the manuscript to be published.

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