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Effect of Various Therapeutic Intervention on Pulmonary Function in Individual with Kyphotic Osteoporosis- A Systematic Review

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Abstract

Background: The excessive forward curvature of the thoracic spine, known as age-related hyper kyphosis, is a predictor of poor health outcomes and has been linked to challenges with physical function tasks. Acute osteoporosis-related pain episodes can cause periods of limited mobility and serious cardiac dysfunction in the elderly.

Objective: This study's goal is to evaluate the effect of various therapeutic intervention on pulmonary function in individual with kyphotic osteoporosis.

Methods: Following worldwide databases were searched for this systematic review: PubMed, Cochrane Library, and Google Scholar. The keywords "Kyphosis", "Osteoporosis" and "Respiratory function" are utilized. Title abstract phrases, related keywords, and Boolean operators ('OR' and 'AND') were all used in conjunction with the 'Advanced' search'. Duplicate records were eliminated from computerized systems using Mendeley Desktop software.

Result: Total 466 studies were found after doing an advance search in four databases: Google scholar, Cochrane Library, PubMed. Due to duplication, 259 records were eliminated using Mendeley Desktop software. The titles and abstracts of the remaining 207 studies were reviewed based on the eligibility criteria. Following the initial scanning, 104 records were rejected as not satisfying the inclusion requirements. The remaining 103 full-text papers were reviewed and from these articles, 97 articles were removed for the reasons. Total of 6 studies were included in the qualitative analysis.

Conclusion: Because of these results, the review conclude that exercises centred on the complete curvature of the spine can help adolescents with thoracic kyphosis by strengthening and improving the function of the back muscles and enhance pulmonary function.

Keyword: *Kyphosis, osteoporosis, physical exercise, rehabilitation*

1. INTRODUCTION

The aging population is expected to continue to grow, reaching 1.5 billion people by 2050, according to reports from the World Health Organization (WHO). The senior population has been greatly impacted by musculoskeletal health, one of the determinants ensuring health. Age-related musculoskeletal alterations include the altered alignment of the spine, which includes a propensity to increase thoracic kyphosis (TK), sagittal vertical axis, and pelvic angle. When the thoracic spine's kyphotic curve surpasses 40◦, thoracic kyphosis is diagnosed (Yang, S. *et al.*, 2024). It is shown that the increased TK may be associated with osteoporosis, weak trunk muscles, and decreased physical activity in the elderly population (Jonely, H. *et al.*, 2023). It has been suggested that elderly people with Thoracic Hyper Kyphosis (THK) have numerous impairments in the musculoskeletal, neuromuscular, and sensory systems as compared with the elderly without THK (Eftekhari, E. *et al.*, 2024). The increase in the degree of thoracic kyphosis can be considered as one of the most important clinical manifestations of osteoporosis (Renno, A. C. *et al*., 2005).

The thoracic spine's increased anterior curvature, known as age-related hyper kyphosis (ARH), is often seen in older women and is linked to aging (Tarasi, Z. *et al.*, 2019). Because of changes in the alignment of the vertebral column, older women with ARH frequently experience physical performance issues (Jang, H. J. *et al.*, 2015). This impacts the patients' quality of life in connection to their health. ARH also restricts the movement of the rib cage, which is attached to the thoracic spine, which causes problems with pulmonary function (Lombardi, I. *et al.*, 2005; Jang, H. J. *et al.* 2015).

According to Renno, A.C. *et al.,* (2005), accentuated TK causes the thoracic cage to change shape, the thorax to enlarge, the gap between the pubis and xiphisternum to decrease, and the rib cage to shift into a position that encloses the abdominal cavity. Spinal deformities cause the rib cage to shrink as a result of growth abnormalities, compress the lungs, and limit movement (Katzman, W. B. *et al.,* 2015). This lowers lung swelling and contraction, which in turn lowers chest muscular activity and weakens the respiratory muscles. The reduction in respiratory function observed in osteoporotic patients is said to be caused by these alterations (Renno, A. C. *et al.,* 2005; Park, J. W. *et al.,* 2020). Cardiopulmonary function disorder develops as the distortion gradually grows, while a minor deformation of the spine has no discernible effect on cardiopulmonary function (Park, J. W. *et al.,* 2020).

A number of studies have demonstrated a strong correlation between the severity of the spinal deformity and abnormal pulmonary function, and pulmonary problems have been more commonly reported in adolescents with spine curvature > 45° (Ghanbarzadeh, M. *et al*., 2009). Osteoporosis is a serious public health concern that poses a serious risk to the elderly. Patients with kyphosis exhibit abnormal pulmonary capacity, which has been revealed by pulmonary function testing (PFT) (Lombardi, I. *et al*., 2005).

It is thought that exercise has an important role in management of the physical and psychological consequences of osteoporosis. Improvements in posture may reduce the level of pain, lessen the risk of falls and increase respiratory function. Consequently, an improvement in respiratory function and aerobic fitness may affect physical activity levels and result in improvement in quality of life (Renno, A. C. *et al.,* 2005). The purpose of this systematic review was to determine the effects of various therapeutic intervention on respiratory function in individual with kyphotic osteoporosis.

2. METHODOLOGY

2.1. Methods

This systematic review were carried out in accordance with the Preferred Reporting Items for Systematic Reviews (PRISMA) (Figure 1) guidelines (Moher, D. *et al*., 2009).

2.2. Data Sources and Search Strategy

The information was gathered using three electronic databases: Google Scholar, Cochrane Library, and PubMed (MEDLINE). Search methodology confined the search to human subjects and the English language. In every pertinent research investigation, the risk of cardiac arrest in young adult has been examined. The keywords "Kyphosis", "Thoracic Hyper kyphosis" and "Osteoporosis" and "Respiratory function" are utilized. Title abstract phrases, related keywords, and Boolean operators ('OR' and 'AND') were all used in conjunction with the 'Advanced' search option. Duplicate records were eliminated from computerized systems using Mendeley Desktop software. Editorials, case studies, meta-analyses, systematic reviews, and reviews were not included.

2.3. Study selection

The complete text was examined following the title and abstract screening. Studies can be included if they satisfy the following criteria: they must include a full text that is available in English. Studies were rejected if (a) none of the groups were original articles, or (b) exercise training was given. Data Extraction To fulfil the study's objectives, data from the included research was gathered. To integrate the data that had been retrieved, the authors then assessed inconsistencies, such as data presentation that was unclear or deficient. Adjusted relative risk (RR) estimates and 95% confidence intervals (CIs) were required for inclusion.

2.4. Data Extraction

As required by the study's objectives, findings were retrieved from included studies. The following characteristics were collected from each study: research ID (first author and year), sample size, measurement, and the results. The authors then discussed differences such as unclear or missing data presentation in order to reconcile the extracted information.

2.5. Data Analysis

When available in the original articles, measurements were tabulated. Continuous outcomes were reported as means, standard deviations and ranges. According to Jang, H. J. *et al.,* 2015 vital capacity (VC) and forced expiratory volume (FEV_1) were not significantly different between the 2 groups before and after the intervention ($p>0.05$), whereas the chest expansion length was statistically different between the groups ($p<0.05$). In Park, J. W. *et al*., 2020 study FVC (3.97±0.79) pre to post (4.09±0.78) with p value (<0.01), FEV_1 (L/sec) (3.69±0.62) pre value to post value (3.77±0.62) with the p value (0.03) and PEF (L/sec) (5.05±1.12) to (5.14±1.19) with p value (0.09)

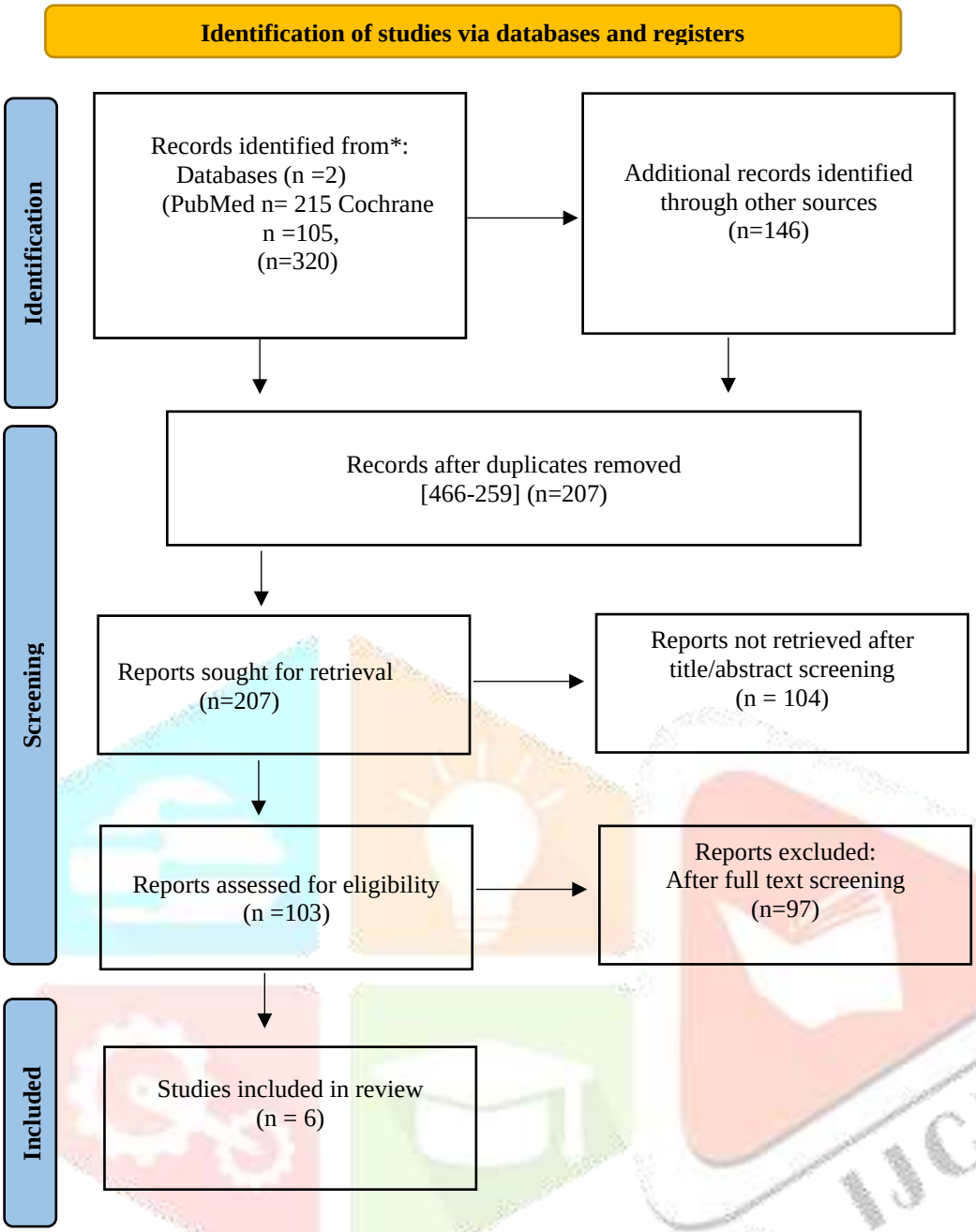

Figure 1. PRISMA flow diagram

3. RESULTS

3.1. Search Results

After doing a preliminary search across four databases—Google Scholar, Cochrane Library, PubMed—a total of 466 studies were discovered. Using Mendeley Desktop, 259 records were removed because of duplication. Based on the eligibility requirements, the titles and abstracts of the remaining 207 studies were examined. 104 records were discarded as not meeting the inclusion requirements after the first scanning. After reviewing the remaining 103 full-text papers, 97 of them were excluded for the reasons indicated in Figure 1. Six studies in total were included in the systematic review and qualitative analysis.

3.2. Characteristics of Included Studies

In this review four studies are experimental study, one is randomized controlled trial study, one is pilot study (Table 1). These studies were conducted in Korea, Saudi Arabia (2), Iran, Brazil, South Korea.

4. DISCUSSION

This systematic review evaluates the effect of various therapeutic intervention on pulmonary function in individual with kyphotic osteoporosis. The association between osteoporosis and aging and inactivity is well known. Due to

the growing number of people with osteoporosis in our region of the world, particularly among women, extra care is needed to prevent respiratory weakening in these patients and to avoid negative effects on the health of the elderly population and the general public. The public should be made aware of the value of regular respiratory muscle training in order to reduce the effects of kyphosis posture in the elderly osteoporotic population.

Following the intervention, there was an improvement of 3.45° in thoracic kyphosis in the typical posture and 3.50° in the optimal posture. Jang, H. J. *et al.,* (2015) study, which sought to improve several musculoskeletal impairments in older women with hyper kyphosis, found that a 12-week complex exercise program that included upper and lower extremity joint and muscle strength and flexibility exercises reduced thoracic kyphosis by 5° in the ideal posture and 6° in the typical posture. Furthermore, a 24.27% improvement in chest expansion—a measure of the rib cage's movement during chest functions—was discovered. But before and after the intervention, there were no appreciable differences in VC or FEV_1 between or between groups.

Previous studies show that kyphotic posture has a negative effect on respiratory efficiency. strengthening exercises for the back extensor muscles help to correct kyphotic posture and muscle action lost due to abnormal kyphosis (Aldajah, S. *et al*., 2014). The stretching of the muscles causes the contracted muscles of the anterior thorax to lengthen and aids mobility of the ribs, leading to an increase in chest expansion, which positively affects inspiration. These results are in agreement with the study by Cimen, O. B. *et al.,* (2003).

Due to the application of muscle energy techniques and self-stretching exercises to relax the pectoral muscles, the kyphosis angle had a substantial impact on thoracic kyphosis. An exercise rehabilitation regimen for individuals with spinal hypertropia can be developed using the findings of this study, which therefore demonstrates a connection between spinal hyperflexion and respiratory function (Park, J. W. *et al*., 2020). In women with osteoporosis, a negative connection ($p<0.05$) was seen between the percentage of FEV_1 and thoracic kyphosis (Lombardi *et al*., 2005).

This systematic review assesses the effects of several treatment interventions on pulmonary function in people with kyphotic osteoporosis. To determine the impact of different types of exercise, we examined experimental, randomized controlled trial, and pilot studies. Using Prisma guidelines to review all six of the 466 papers is the systematic review's main strength. There are a number of limitations to this systematic review, including the fact that only one randomized controlled trial study was included and that we only included one pilot research for analysis because there were not enough trials.

5. CONCLUSION

Various exercise programs in this review produced a significant improvement in the posture and respiratory function of patients with osteoporosis. It is recommended that older women with hyper kyphosis perform specific exercise sessions aimed at correcting their thoracic posture in order to improve their back muscle strength and rib cage mobility.

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Table 1

Sr. No.	Author	No. of Participants	Measurement	Intervention	Results
1	Jang, H. J. *et al*., 2015	41	Thoracic kyphosis angle Craniovertebral angle Chest function (vital capacity, forced expiratory volume and chest expansion length)	Experimental group- performed the thorax correction exercises (twice a week for 8 weeks) Control group- general exercise	Improving the mobility of the rib cage and postures through specialized exercises focused on thorax posture correction in elderly women with hyper kyphosis
2	Dajah, S. A.*et al*., 2015	20	Thoracic spine range of motion Chest expansion Dyspnoea Peak expiratory flow rate	Breathing and thoracic extension exercises three times a week for 6 weeks	Strengthening exercise programme produced a significant improvement in the posture and respiratory function of patients with osteoporosis
3	Park, J. W. *et al*., 2020	30	Thoracic kyphosis Respiratory function, forced vital capacity (FVC), forced expiratory volume (FEV1), Peak expiratory flow rate	Muscle energy technique and the self-stretching exercise	Both interventions improve the pulmonary function of subjects with thoracic kyphosis
4	M. Ghanbarzadeh *et al*., 2009	34	Chest radiography Pulmonary function test Peak expiratory flow rate 6-min walk test	Physical exercise program for 4 months	The physical exercise improving pulmonary capacity and residual volume, and performance of 6MWT, and decreasing the perceived effort, Heart rate, and respiratory rate
5	Aldajah, S. B. *et al*., 2014	20	Upper spine range of motion Chest expansion Dyspnoea Peak expiratory flow rate	Strengthening exercises using 50% of 1 RM weights for 40 min of resistive diaphragmatic exercise and thoracic muscles strengthening exercise, 3times/week/ 6 weeks	Diaphragm exercise and thoracic strengthening exercise programs improve respiratory functions and decreases dyspnoea
6	Renno, A. C. *et al*., 2005	14	Respiratory function Thoracic kyphosis angle Quality of life	Exercise program comprising of three sessions per week/8weeks	Increases of between 12% and 23% in respiratory pressures, increase of 13% in submaximal exercise tolerance and a small increase of approximately 5% in the magnitude of thoracic curvature