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The Effects Of Thoracic Core Conditioning Exercises With Stretch Pole And Thoracic Mobility Exercises On Pulmonary Function, Chest Expansion And Quality Of Life In Young Older Adults - A Comparative Study

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ABSTRACT

Introduction: Young old groups consist of the populations between 65 and 75 years of age. The aim of the study was comparing the effects of thoracic core conditioning exercises with stretch pole and thoracic mobility exercises on PEFR, chest expansion at axilla and xiphoid level and quality of life using WHOQOL-BREF scale.
Material and Method: Forty-two participants who satisfied the inclusion criteria were recruited for intervention and divided into two groups: Group-A: thoracic core conditioning exercises with stretch pole and Group-B: thoracic mobility exercises. The exercise session consisted of 4 days in week for 4 weeks. Outcome measures were taken pre and post treatment.
Result: Intra group analysis by Wilcoxon test in both groups shows statistically significant improvement on PEFR, Chest expansion and Quality of life (p value≤0.005). While inter group analysis by Mann-Whitney test showed statistically significant difference in PEFR, chest expansion. (p value≤0.005).
Discussion and conclusion: Both exercises protocols are equally effective in improving quality of life whereas the participants who received thoracic core conditioning exercises with stretch pole shows better result in terms of PEFR and chest expansion.
Key words: Older adults, PEFR, Chest expansion, WHOQOL-BREF, stretch pole.

INTRODUCTION

“The term "elderly" refers to individuals who are 65 years of age or older.”[1] (WHO) Three groups have been classified as follows:1) Young-old: This group includes individuals aged 65 to 75 years.2) The middle-old age group includes individuals aged between 75 and 85 years.3) Old-old: This group comprises individuals aged above 85 years.[2]
The aging process impacts various organs and tissues, leading to a gradual decline in their functions. Older adults with comparable levels of chronic airflow obstruction often face more significant exercise limitations than their younger counterparts. This disparity can be attributed to age-related declines in lung function, diminished cardiac capacity, reduced muscle strength and endurance, sensory deficits, impaired coordination, and increased reliance on medications.[3] Numerous studies suggest that both static and dynamic lung function measurements tend to decline with advancing age.[4-6] This decline may result from a loss of lung elastic recoil, diminished alveolar support, increased stiffness of the rib cage, weakened respiratory muscles, and reduced efficiency in pulmonary gas exchange associated with aging.[7] The stiffness of the rib cage tends to increase withage,likelyduetoseveralage-relatedfactorsincluding:i)decalcificationoftheribs,ii)calcificationofthe rib cartilage, iii) changes in the rib-vertebral joints, iv) alterations in chest shape, and v) narrowing of

the intervertebral disc spaces.[8] Aging-related physiological changes in pulmonary function include a reduction in vital capacity, a decline in peak expiratory flow, an increase in residual volume, a decrease in inspiratory reserve volume, and lower arterial oxygen saturation levels.[9] Many older adults experience a decline in thoracic mobility, which refers to the movement capability of the chest wall, rib cage, and thoracic spine. This restriction in thoracic mobility can limit functional mobility and adversely impact pulmonary function, including respiration.[10]

Thoracic core conditioning or core instability strength training involves exercises that focus on abdominal and thorax muscles and maintain posture. These exercises aim to enhance abdominal and spinal muscle strength, spinal function, and balance performance.[11] According to Kritika et al. (2014) study analysis revealed that participants who engaged in one week of thoracic core conditioning exercises, with or without the use of a stretch pole, experienced significant short-term improvements in chest expansion, perceived intensity of breathlessness, and functional performance. Notably, the group that performed thoracic core conditioning exercises with the stretch pole showed a greater percentage of improvement.[12] Chest mobility exercises are a crucial technique in conventional chest physiotherapy, aimed at enhancing chest wall mobility and improving ventilation. Numerous studies support the effectiveness of these exercises as an intervention to boost both chest wall mobility and pulmonary function.[15-16.]

It is being supported by enough evidence that human ageing has an impact on lung functions which may reduce quality of life. In past literature only a few studies have been conducted on how to improve chest excursion and pulmonary function in healthy older adults. Limited literature shows beneficial effects of core conditioning exercises with stretch pole over simple core conditioning exercises. Also, some studies found the promising results of thoracic mobility exercises on pulmonary functions and quality of life.

But in past no study has been conducted on which therapy, thoracic core conditioning using stretch pole or thoracic mobility exercises is more beneficial in terms of pulmonary functions and quality of life. Considering this as a gap in literature, itneeds to conduct a study to compare the effects of thoracic core conditioning exercises with stretch pole and thoracic mobility exercises on pulmonary function, chest expansion and quality of life on young older adults.

OBJECTIVES

- To determine the effects of thoracic core conditioning exercises with stretch pole on pulmonary function (PEFR), chest expansion and quality of life (WHOQOL-BREF) in young older adults.
- To determine the effects of thoracic mobility exercises on pulmonary function (PEFR), chest expansion and quality of life (WHOQOL-BREF) in young older adults.
- To compare the effects of thoracic core conditioning exercises with stretch pole and thoracic mobility exercises on pulmonary function (PEFR), chest expansion and quality of life (WHOQOL-BREF) in young older adults.

REVIEW OF LITRETURE

Yokoyama et al. (**2011**) conducted a study on the effect of the core conditioning exercises using the stretch pole on thoracic expansion difference in healthy middle –aged and elderly persons, 14 healthy middle aged and elderly females participated in study. Participants were randomly allocated to core conditioning with the stretch pole (SP group) or core conditioning without it (control [C] group). The exercises were regularly performed twice a day for one week. Chest Expansion at axillary and 10th rib level taken as Outcome measurement. Results showthe post intervention value of core conditioning with stretch pole group (SP group) were higher than the Core conditioning without stretch pole (C group) at both axillary and 10th rib levels. These results indicate that CC using stretch pole improves thoracic mobility.[18]

Ekstrum et al. (**2009**) conducted a study on the effects of a thoracic mobility and respiratory exercise program on pulmonary function and functional capacity in older adult in this study 37 volunteer participated in twice daily home exercise program for 6 weeks Pulmonary function measure for FEV1, FVC, PEF, Physical Performance test (PPT), Quality of life test SF36 taken as Outcome measurement. The study concluded that after doing 6 weeks of thoracic mobility and respiratory exercises older adults demonstrated an increase in CWE and physical performance.[28]

MATERIAL AND METHEDOLOGY

- Study design: Experimental study.
- Sampling design: Convenient sampling method
- Study population: Young older adults.
- Study setting: Various old age homes inVadodara.
- Study duration: 1year (2022-2023)
- Sample size: The sample size was calculated by using G-Power software version 3.1.9.4.] The calculated sample size is 42(21 each group)

Selection Criteria:

Participants were selected based onthe following criteria:

Inclusion Criteria: -

1. Age: 65-75 age group
2. Both genders
3. Chest expansion = At axilla level ≤ 1.5cm
   At xiphoid level ≤ 2 cm
4. Ability to communicate & follow command.

Exclusion Criteria: -

1. Current smokers
2. Previous history of any thoracic surgeries
3. History of any musculoskeletal deficit which impacts on exercise protocol and outcome measures like adhesive causalities, severe osteoporosis, etc.
4. History of neurological pathology which impact on exercises protocol and outcome measures like stroke, Parkinson disease, ataxia, etc.
5. History of cardiovascular disease which impact on exercise protocol and outcome measures like unstable angina, recent mi, decompensate heart failure, etc.
6. History of any respiratory disease which impacts on exercise protocol and outcome measures like chronic bronchitis, asthma, etc.
7. Any pathology and deformity related to spine like disc protrusion, spondylolisthesis, kyphosis, scoliosis, etc.
8. BMI ≥ 30 kg/m2
9. Uncontrolled hypertension and diabetes Mellitus
10. Pain while exercising
11. All contraindications of pulmonary function test
12. Not willing to participate.

Materials Used:

1. Stretch pole (Cylinder-shaped tube, diameter-15 cm, length-78 cm)
2. Incentive Spiro meter (3 ball Spiro meter, QU-MED)
3. Peak expiratory flow meter (Cipla breathe-o meter)
4. Non elastic measure tape
5. Scale (WHOQOL-BREF)
6. Pen and Paper
7. Sterilium
8. Cotton
9. Towel
10. Disposable mouthpiece
11. Nose clip
12. Assessment form
13. Consent form

Outcome Measures:

1. Peak Expiratory flow rate (PEFR) Participant was in relaxed sitting position. Therapist would reset the meter by sliding the marker all the way to zero on the scale. The participant was instructed to take a full deep breath. The mouthpiece was then placed in the participant's mouth and the therapistinstructed him to breath out as fast as possible and as hard as possible in single breath. The marker was sliding outward on the numbered scale, indicated the peak expiratory flow rate for that attempt. The procedure was repeated two more times with the remaining 1 min between the attempts and the best reading out of the three attempts was used for data analysis.[17]

2. Chest expansion [ICC= 0.95-0.97][18]

Participants were instructed to wear thin, loose-fitting shirts to allow full mobility, they were asked to stand comfortably with hands at their sides. The same position was used for both pretest and posttest analyses. Each participant was given verbal instructions and demonstration prior to testing. Measurements were taken at two thoracic levels: the axillary level for the upper thorax and the 10th rib level for the lower thorax. A flat tape was initially placed around the participant's axillary level. With the arms down, then the participant was asked to inhale as deeply as possible (Inspiration-maximum) while the measuring tape was drawn taut, then the thoracic circumference was measured. The tape was then released, and the participant was asked to exhale as much as possible (Expiration-maximum) then the thoracic circumference was measured again. The same process was repeated for the 10th rib level. The thoracic extension difference was calculated by deducting Expiration-maximum from Inspiration-maximum. All measurements were performed three times, and the average value was used for further analyses. Measurement was conducted prior to and following the intervention period.

3. WHOQOL- BREF [ICC=0.78-0.82][19]

Quality of life was evaluated using the WHOQOL-BREF scale, which has been evaluated and validated. This questionnaire includes four domains: physical health, psychological well-being, social relationships, and environment, with a total of 26 questions. Each domain is rated using five different Likert-style response scales: "very poor to very good" (evaluation), "very dissatisfied to very satisfied" (evaluation), "none to extremely" (intensity), "none to complete" (capacity), and "never to always" (frequency). Each domain consists of questions with scores ranging from one to five. Following WHO guidelines, raw scores for each domain were calculated by summing the individual item values, which were then converted into a score ranging from 0 to 100, with 100 being the highest and 0 the lowest.

Procedure:

After taking approval from institutional ethical committee study conducted. Participants who fulfilled the inclusion criteria were selected from the population. Participants were explained about the purpose of the study. Written consent was obtained from the participants before starting the study. The demographics in the form of (weight, height, BMI, etc.) were collected from all the participants.

Participants were divided into 2 groups as per convenient sampling method.

Group –A = Thoracic Core conditioning exercises with stretch pole

Group – B = Thoracic mobility Exercises

Both the groups were given treatment for one session for four days per week for four weeks. Outcome Measures were taken on the first day before starting the treatment and on the last day after complete treatment.

Group-A: Thoracic Core Conditioning Exercises With Stretch Pole Protocol

Following collection of baseline measures, participants were instructed the thoracic core conditioning exercises with stretch pole protocol:

The Stretch Pole is a cylinder-shaped tube, made of materials like a special Styrofoam with a length of 78 cm and diameter of 15 cm.

Typical exercises given to participants using the Stretch Pole consist of 3 preliminary motions followed by the Basic Seven exercises.

The Preliminary motions consist of,

1. Maintenance of shoulder abduction
2. Maintenance of external rotation of hip joint
3. Maintenance of unilateral shoulder abduction and contra lateral external rotation of hip joints.

The main motions consist of,

1. Floor polishing motion
2. Scapular adduction and abduction
3. Shoulder abduction and abduction
4. Internal and external rotation of hips
5. Slight knee extension-flexion
6. Swaying
7. Abdominal breathing

Participants in Group A were positioned supine on the stretch pole and performed the above-mentioned Basic Seven including preparatory motions.

The participants were asked to perform the exercises four days in week for four weeks.

Group – B: Thoracic mobility Exercises.

Participants were instructed in the thoracic mobility exercises protocol with three exercises:

(A) Side-lying(B)Supine, and (C)Doorway/corner stretch.

A. Side Lying:

1) Lie on your side with a towel roll or bolster placed under your rib cage and bring your arm over your head (or as far as you can) 10 times.
2) Bring your arm over your head and take a large, slow breath. Hold for 3 seconds. Blow your air out and bring your arm back to your side. Do this 10 times.
3) Take 5 long, slow breaths into your incentive Spiro meter with a 30 second break between each breath.
4) Repeat on the other side.

B. Supine:

1) Lie on your back with a small towel roll along your spine and take slow, deep breaths using the incentive Spiro meter. (5 times).
2) Raise your arms up over your head as far as you can and hold in this position for 2 minutes practicing your deep breaths.

C. Doorway/corner stretch: Stand facing a doorway or corner with arms up at a 90-degree angle. Lean forward until you feel a stretch. Hold this stretch for 30 seconds and repeat 3 times.

Statistical Methods: Data was entered in excel sheet and analysis was done using SPSS software 20.0.1.1 and Microsoft excel 2007. Prior to the statistical test data was screened for normal distribution by Shapiro-Wilk test. Data was not normally distributed for PEFR, Chest expansion at Axilla level and Xiphoid level, and WHOQOL-BREF Scale. So, Nonparametric tests were applied for PEFR, Chest Expansion and WHOQOL-BREF Scale within group and between group analysis. Data was analyzed at 5% level of significance with confidence interval (CI) at 95%. Within group analysis was done by Wilcoxon test and between group analysis was done by Mann-Whitney test.

RESULT

A total of 42 participants were included in the study, with 21 participants assigned to the thoracic core conditioning exercises with stretch pole group (Group A) and 21 participants in the thoracic mobility exercises group (Group B). Baseline data (Table 1) revealed that the average age of Group A was 70 (±4.09), while the mean age of Group B was 70.23 (±3.59). Additionally, 61% of participants in Group A were male, compared to 48% in Group B.

Table 1: Baseline data of participants in both groups

CATEGORIES	GROUP-A	GROUP-B	p VALUE
	MEAN±SD	MEAN±SD	
Age (Years)	70±4.09	70.23±3.59	0.84
HEIGHT(Cm)	163.9±7.27	162.52±7.69	0.533
WEIGHT(Kg)	59.76±6.33	63.47±9.51	0.144
BMI(Kg/M^2)	22.26±2.08	23.97±2.73	0.206

The Wilcoxon test was utilized for intra group comparison of pre-treatment and post-treatment mean values of PEFR and Chest Expansion at axilla and xiphoid levels, as well as all domains of the WHOQOL-BREF scale. The results in (Table 2) revealed significant differences in all parameters ($p < 0.05$) in Group A.

Table.2: Intra group comparison of PEFR and chest expansion and whoqol-bref domains in group A

Parameters	Pre-Treatment MEAN±SD	Post-Treatment MEAN±SD	Z Value	P Value
PEFR(L/Min)	314.09±56.79	336.66±60.71	-4.028	0.000
Axilla Level (Cm)	1.138±0.224	1.704±0.44	-3.860	0.000
Xiphoidlevel(Cm)	1.6±0.412	2.157±0.441	-3.754	0.000
Physical Domain	56.38±10.39	62.38±9.35	-2.956	0.003
Psychological Domain	61.71±9.73	68.52±8.65	-3.084	0.002
Social Domain	80.33±8.91	82.8±8.55	-2.555	0.011
Environmental Domain	72.52±7.2	79.19±7.96	-3.095	0.002

Similarly, the Wilcoxon test was used for intra group comparison of pre-treatment and post-treatment mean values of PEFR and Chest Expansion at axilla and xiphoid levels, and all domains of the WHOQOL-BREF scale. The results in (Table 3) showed significant differences in all parameters ($p < 0.05$) except for the Physical domain of the WHOQOL-BREF ($p > 0.05$).

Table.3 : Intragroup comparison of PEFR, chest expansion and whoqol-bref domains in group b.

Parameters	Pre-Treatment MEAN±SD	Post-Treatment MEAN±SD	Z Value	P Value
PEFR(L/Min)	301.71±48.63	311.52±45.79	-3.199	0.001
Axilla Level (Cm)	1.05±0.27	1.23±0.31	-2.948	0.003
Xiphoid level (Cm)	1.37±0.33	1.68±0.4	-3.210	0.001
Physical Domain	57±9.7	59.38±8.37	-1.802	0.072
Psychological Domain	59.04±13.12	67.38±10.27	-3.115	0.002
Social Domain	75.28±12.45	78.85±10.57	-2.041	0.041
Environmental Domain	71.9±12.46	75.14±11.12	-2.549	0.011

For intergroup comparison of PEFR, Chest Expansion, and all domains of the WHOQOL-BREF between Group A and Group B, the Mann-Whitney test was employed. Results in (Table 4) demonstrated significant differences in PEFR and chest expansion ($p < 0.05$), with greater improvements observed in the Thoracic Core Conditioning exercises with Stretch Pole group (Group A) compared to the Thoracic Mobility exercises group (Group B). However, no significant difference was found in any of the four domains of the WHOQOL-BREF scale ($p > 0.05$).

Table.4: Inter group comparison of PEFR, chest expansion and whoqol-bref domains.

Parameters	Group-A	Group-B	Z	P
	MEAN±SD	MEAN±SD	Value	Value
PEFR(L/Min)	22.57±17.75	9.8±9.27	-2.498	0.012
Chest expansion axilla Level	0.566±0.359	0.185±0.226	-3.523	0.000
Xiphoid level	0.557±0.355	0.309±0.325	-2.311	0.021
Physical Domain	5.47±6.15	2.952±5.472	-1.619	0.105
Psychological Domain	6.8±7.87	14.907±17.731	-1.739	0.082
Social Domain	2.47±3.64	3.571±7.586	-0.6	0.548
Environmental Domain	6.666±7.241	3.238±4.57	-1.546	0.122

DISCUSSION

This study was designed to compare the effects of thoracic core conditioning exercises with stretch pole and thoracic mobility exercises on pulmonary function (PEFR), chest expansion and quality of life using WHOQOL BREF scale in young older adults. Young older adults (age: 65-75) were recruited for this study. Total 42 participants (21=Group A: Thoracic core conditioning exercises with stretch pole, 21= Group-B: Thoracic mobility exercises) were recruited in the study.

The result of the present study supports alternative hypothesis which states that there is significant difference in PEFR (Z=-2.498, p=0.012), Chest expansion at Axilla level (Z=-3.523, p=0.000) and Xiphoid level (Z=-2.311, p=0.021) which is more in Group A than Group B but there is no significant difference in any domain of WHOQOL-BREF scale Physical domain (Z=-1.619, p=0.105), Psychological domain (Z=-1.739, p=0.082), Social domain (Z=-0.600, p=0.548) and Environmental domain (Z=-1.546, p=0.122) between both groups.

Previous research has indicated that respiratory muscle stretching has a comparable impact on chest wall compliance, leading to a reduction in chest wall stiffness. Studies have shown that when thoracic muscles are stretched to their full range, the respiratory system is able to operate at its maximum capacity.[20-22] Stretching activates muscle spindles and, through the alpha-gamma linkage mechanism, increases their sensitivity during muscle contraction. As a result, stretching a contracted muscle serves as a strong stimulus for muscle spindles, enhancing the force generated by the muscles during respiration and improving the Peak Expiratory Flow Rate (PEFR). (Matthews P 1964) [23] Edmondston and Waller (2011) observed that when individuals assume a hunched posture while standing, there is a decrease in thoracic spine extension. This indicates a strong correlation between thoracic expansion and thoracic spine extension.[24] Shigeki Yokoyama et al. (2012) presented a fundamental exercise program featuring ten exercises, which include preliminary movements for thoracic core conditioning exercises utilizing a stretch pole. These exercises are thought to promote thoracic expansion by facilitating relaxation of respiratory muscles. Core conditioning exercises are designed to stretch the thoracic muscles, helping to reduce muscle tension and promote relaxation in the muscles involved in breathing.[18] Kritica Boruah et al. (2014) also supported the idea in their study that lying supine with the spine on the stretch pole can reduce hypermutation of the sacrum. When integrated with core conditioning exercises, this position can reposition the spine and respiratory muscles, especially the thorax, facilitating easier thoracic extension while lying supine on the stretch pole. This enhanced thoracic mobility aligns with the outcomes of the current study, wherein elderly participants in the study group engaged in exercises involving deep breathing on the stretch pole. This proper breathing pattern likely contributed to improvements by alleviating tightness, reducing chest wall resistance, and lowering the work of breathing, which ultimately enhanced thoracic mobility and pulmonary function.[12] Hetal and Ashok (2020)concluded that their study showed significant improvements in maximum breathing capacity, Peak Expiratory Flow Rate (PEFR), exercise capacity, Rate of Perceived Exertion (RPE), and posture after respiratory muscle stretch gymnastics training in the elderly population.[25] Rekha K et al.(2020) supported the present study and concluded that stretch pole exercises have a significant effect, Both clinically and statistically, there were improvements observed in Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), and their ratio among smartphone users.[26] In their study, Roger Engle et al.(2019) emphasized the importance of enhancing chest wall compliance to promote increased activity levels in older individuals. They suggested that improvements in chest expansion and respiratory function contribute to enhancing the quality of life in this population.[27]

The comparison of quality of life between Group A and Group B revealed no significant differences across any domain. Therefore, it can be concluded that both exercise protocols are equally effective in improving quality of life. However, further research is needed to explore the effects of thoracic core conditioning exercises with stretch poles and to identify which population would benefit most from this type of program.

CONCLUSION

In conclusion, this study shows both thoracic core conditioning exercises with stretch pole and thoracic mobility exercises are effective in improving PEFR, chest expansion at axilla and xiphoid level and quality of life. Both groups are equally effective in improve quality of life whereas the participants who received thoracic core conditioning exercises with stretch pole shows better result in terms of PEFR and chest expansion.

FUTURE RECOMMENDATIONS

It is recommended to explore the effects of thoracic core conditioning exercises with a stretch pole on other parameters of pulmonary function. Additionally, further randomized controlled trials are needed to assess the long-term effects of these exercises in various pulmonary conditions.

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