RESEARCH PAPER

Comparison Of Effect Of Pilates Breathing Exercise And Abdominal Breathing Exercise On Chest Mobility And Cardiorespiratory Fitness In Smokers – A Comparative Study

Hapsha Parwin Khan [1], Riya [2], Simran [3], Syndrella Rose Stanley [4], Jayanti Kumari [5], Kavya Mittal [6]

[1] Assistant professor at IMT Pharmacy College, Odisha, India

[2]Assitant Professor at Ramchandra Vidyapeeth, Saharsa, Bihar

[3]Clinical Physiotherapist at F95 Physiotherapy and Research Centre

[4]Junior Physiotherapist at Ian Institute of Rehabilitation and Research

[5]Assistant Professor at Jai Narayan College of Paramedical, Bhopal, JNCT Professional University, Bhopal, Madhya Pradesh, India

[6]Clinical Physiotherapist, Back2Motion Advance Physiotherapy Centre

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ABSTRACT

Background-Smoking negatively impacts respiratory function, leading to reduced chest expansion and diminished cardiorespiratory endurance. Pilates and diaphragmatic both breathing exercises are non-invasive and cost-effective interventions that can play a crucial role in respiratory rehabilitation, while Pilates places a strong emphasis on the lateral (side-to-side) expansion of the rib cage during breathing.

Objective: This study aimed to compare the effectiveness of Pilates breathing exercises and diaphragmatic breathing exercises on chest expansion and cardiorespiratory fitness in smokers.

Methodology: A total of 88 participants were divided into two groups: Group A practiced Pilates breathing, and Group B practiced diaphragmatic breathing along with pursed-lip breathing. The interventions were performed over a period of 12 weeks (4 days/week), and outcomes were assessed using chest expansion measurements at axillary, xiphoid, and nipple levels, along with the 6-minute walk test (6MWT) for cardiorespiratory endurance.

Result: Both groups showed significant improvement in chest expansion and cardiorespiratory fitness. However, Group A demonstrated greater enhancement in chest expansion and the 6-minute walk test.

Conclusion- The present study showed that both groups, that is, group A (Pilates breathing exercise) and group B (diaphragmatic breathing), have improvement in their chest expansion and better results on the 6-minute walk test. So we conclude that using Pilates breathing is an effective, simple, and affordable way to improve respiratory health and endurance in young smokers...

Keywords: Smokers, Pilates breathing exercise, Diaphragmatic breathing exercise, Chest expansion, 6MWT.

How to cite this article: Khan HP, Riya, Simran, Stanley SR, Kumari J, Mittal K. Comparison Of Effect of Pilates Breathing Exercise and Abdominal Breathing Exercise On Chest Mobility And Cardiorespiratory Fitness in Smokers – A Comparative Study. Int J Drug Deliv Technol. 2026;16(3s): 514-523; DOI: 10.25258/ijddt.16.3s.65

Source of support: Nil.

Conflict of interest: None

**Author for Correspondence: hapshakhan12@gmail.com*

INTRODUCTION

Worldwide, tobacco use is linked to an abnormally high death rate and is a public health deteriorator. One of the main avoidable causes of death is cigarette smoking, which typically starts in youth. Prevention and early quitting smoking are top public health priorities [1-3]. By 2030, cigarette smoking is expected to be the cause of roughly ten million deaths annually worldwide. Additionally, smoking cigarettes is a major cause of a number of health issues, particularly in regions like the Eastern Mediterranean, where smoking is very common. [4-6] The number of cigarettes smoked has a high correlation with the health hazards linked with smoking.[7] Smoking cigarettes increases the risk of addiction, disease, or even death. By evaluating biochemical and cardiorespiratory markers, Koubaa et al.5 evaluated the detrimental consequences of hookah use in sedentary adult participants when compared to cigarette users. This study supports the data showing that using cigarettes and hookah was linked to exposure to dangerous substances, had detrimental effects on cardiovascular function, and antioxidant defense capability. According to numerous earlier studies, smoking a hookah produces negative effects that are comparable to those of smoking cigarettes. [8-10] Compared to nonsmokers, smokers experienced a noticeably greater loss in fitness and lung function, which was not explained by variations in age or physical activity. [11] The largest risk factor for the deterioration of lung function is smoking. According to multiple authors, smoking lowers the forced expiratory volume in this situation, in one second (FEV1), the Tiffeneau index (FEV1/FVC), and forced vital capacity (FVC) in both sexes. [12-14] The two PF metrics that are most frequently used are forced expiratory volume in one second (FEV1) and forced vital capacity (FVC). Lung age is a factor that depends on FEV1 and is thought to be a powerful inducement to stop smoking. Abnormally low FVC and FEV1 are typically the first signs of tobacco smokers' severely altered PF. [15-16] Adult or teenage cigarette smokers typically have lower PF than their non-smoking counterparts because cigarette smoking speeds up the age- 3 related reduction in PF. [17-19] Among college students, the epidemic of cigarette smoking spreads quickly. More work is needed to shield young adults from the risks associated with smoking; therefore, measures for smoking prevention and cessation assistance are desperately needed.[20] Despite the fact that smoking cessation is a major health concern, little is known about how smoking affects both pulmonary health and university students' functional performance (FP). This is partly due to the fact that there aren't many studies assessing PF and FP in young smokers and college smokers. [21] Breathing exercise has the capability to increase chest expansion and cardiorespiratory fitness.

Pilates, developed by Joseph Pilates in the early 1900s, emphasizes breathing as a fundamental component of movement control. The primary technique used is lateral (posterior-lateral) breathing, which focuses on expanding the rib cage sideways rather than allowing the abdomen to rise. During both inhalation and exhalation, the transversus abdominis and pelvic floor muscles are actively engaged to maintain core stability.

Inhalation directs the breath into the sides of the rib cage while keeping the abdominal wall gently drawn inward, preventing excessive thoracic or abdominal expansion that may reduce core activation. Exhalation is emphasized, as it promotes contraction of the oblique muscles and transversus abdominis, increases intra-abdominal pressure, and enhances spinal stability. Pelvic floor activation further supports the deep core musculature (the "T-zone"). Pilates breathing improves rib cage mobility, diaphragmatic function, and respiratory muscle strength. Evidence suggests that regular Pilates training increases thoracoabdominal expansion and may enhance cardiorespiratory fitness, including improvements in VO_2 max, heart rate variability, and pulmonary function, especially when combined with controlled breathing techniques.

Diaphragmatic breathing, also known as abdominal or belly breathing, focuses on strengthening the diaphragm—the primary muscle responsible for approximately 80% of inspiration. Effective diaphragmatic function promotes efficient ventilation with lower oxygen demand compared to accessory muscle breathing, which increases the work of breathing and reduces efficiency. This technique involves slow, deep nasal inhalation with visible anterior abdominal expansion, emphasizing smooth and controlled breathing. Diaphragmatic breathing supports secretion mobilization, improves coughing effectiveness, enhances relaxation, increases postural awareness, and promotes thoracic and shoulder girdle mobility.

In individuals with COPD, immediate benefits include improved ventilation and oxygenation, reduced respiratory rate, increased tidal volume, and better oxygen saturation. However, in severe cases, it may cause paradoxical chest wall movements or increased dyspnea. Studies in obese young adults show improved chest expansion after training, though pulmonary function parameters (FEV_1, FVC) may not significantly change. Additional benefits include reductions in blood pressure and heart rate, contributing to improved cardiorespiratory health. A related technique, pursed-lips breathing, involves prolonged exhalation through partially closed lips and is commonly used in COPD to reduce hyperinflation, lower breathing frequency, improve gas exchange, and increase tidal volume, although relief of dyspnea varies among individuals.

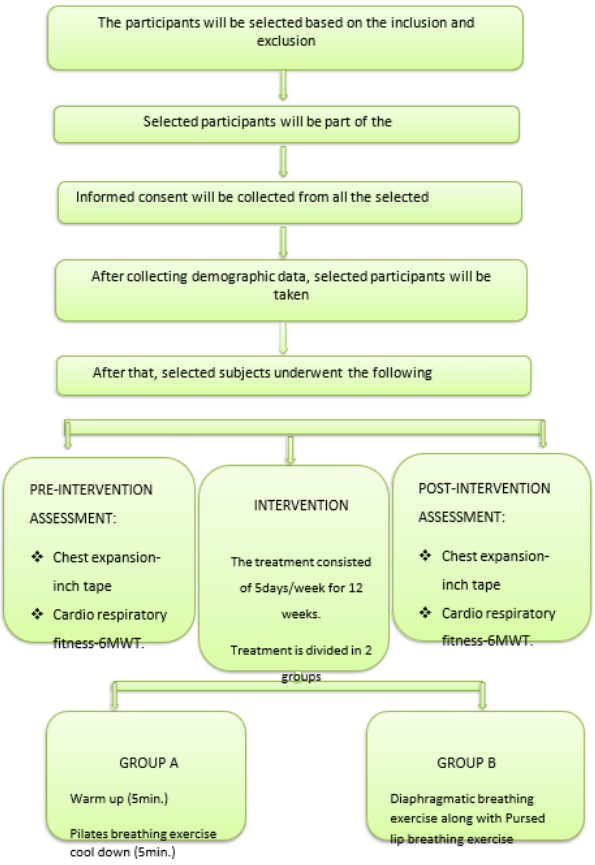
MATERIALS & METHODOLOGY

Study Design: comparative study
Study Area: NIMS University, Rajasthan, Jaipur.
Study Period: Jan 2025 to March 2025 3.4 Study Population: students
Sample size- A total of 88 participants were selected in our study based on inclusion and exclusion criteria
Sampling Technique: Random sampling technique

Selection Criteria

INCLUSION CRITERIA:
Normolipidemic.
Both genders.
Young adults are active smokers.
Age (18 -25).
Cigarette smokers: Duration- for 1 or more years. No of cigarettes –3 to 5 cigarettes per day.
EXCLUSION CRITERIA:
COPD
.
RLD.
Hypertension
Any kind of neuromuscular or musculoskeletal disease.
Any previous thoracic or abdominal surgery

Method of Collection of Data



INTERVENTION PROTOCOL

GROUP A: PILATES LATERAL BREATHING:

Participants of group A received Pilates lateral breathing exercises, which are divided into 3 phases.

TABLE - PILATES LATERAL BREATHING

WARM-UP (5 Minutes)	**PILATES BREATHING (15-20 minutes)**	**COOL-DOWN (5 minutes)**
Gentle shoulder rolls 10 reps, 1 set (5 backward and 5 forward) Neck side bend 10 reps, 1 set (5 each side) Arm swing 10 reps, 1 set	Divided into 4 weeks According to the progression of the position.	Gentle trunk rotation 10 reps 1 set (5 each side) Neck rotation 10 reps, 1 set (5 each side)

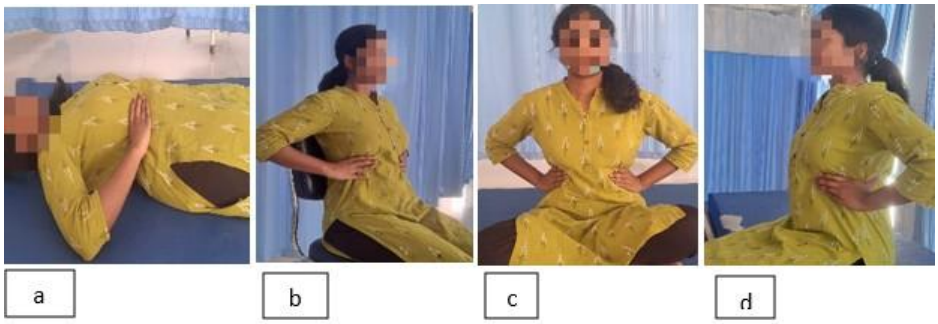


FIGURE 3.10.1 PILATES BREATHING EXERCISES

GROUP-B: DIAPHRAGMATIC BREATHING EXERCISE:

Participants of group B received the Diaphragmatic breathing exercise along with pursed lip breathing.

PURSED LIP BREATHING: Pursed-lip breathing is a straightforward yet highly effective technique designed to enhance breathing efficiency, alleviate shortness of breath, and promote relaxation, beneficial for individuals suffering from various cardiopulmonary diseases or those recovering from surgery. This technique should be done along with a diaphragmatic breathing exercise. As we instruct, while inhaling, take deep breaths and do full exhalation with pursed lips

FIGURE 3.10.2 DIAPHRAGMATIC BREATHING EXERCISE

GROUP A	GROUP B
Awareness and technique learning 8-10breaths/set, 2-3sets	Awareness and technique learning 5-10breaths/set, 5-10min./session
Control and core engagement 10-12breaths/set, 2-3sets	Control and core engagement 5-10breaths/set, 10-15min./session
Functional integration and postural focus 10-15breaths/set, 2-3sets	Functional integration and postural focus 10breaths/set, 10-15min./session
Maintenance 15-20breaths/set, 2-3sets	Maintenance 15-20breaths/set, 10-20min./session

OUTCOME MEASURES

CHEST EXPANSION: Measured by using an inch tape.
Axillary Level (Upper chest)
Nipple Level (Mid chest)
Subcostal Level (Lower chest)

MEASUREMENT OF CARDIORESPIRATORY FITNESS: According to the guidelines established by the European Respiratory Society (ERS) and the American Thoracic Society (ATS), we conducted the 6-Minute Walk Test (6MWT) to evaluate cardio-respiratory fitness.

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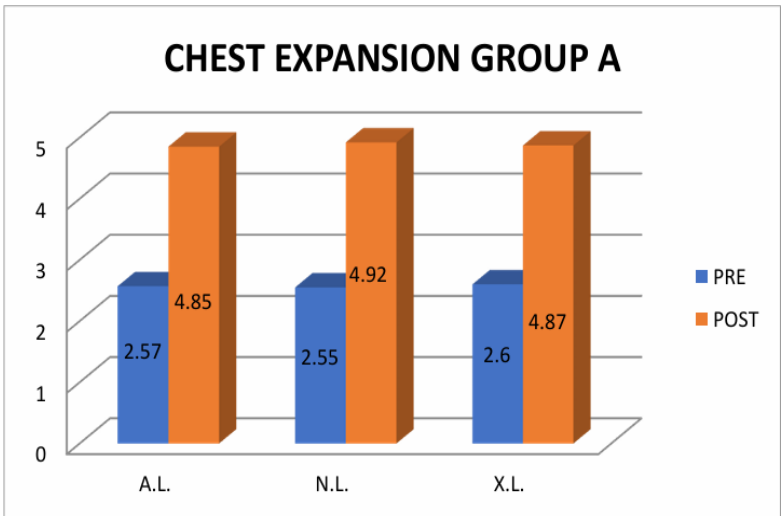
STATISTICAL ANALYSIS

IBM SPSS version 30.0 was used to calculate all the statistical analyses. A paired t-test was used to compare within the groups (pre and posttest), and an unpaired t-test was used to compare both the groups that is group A and group B.

WITHIN-GROUP ANALYSIS

TABLE 1 CHEST EXPANSION OF GROUP A

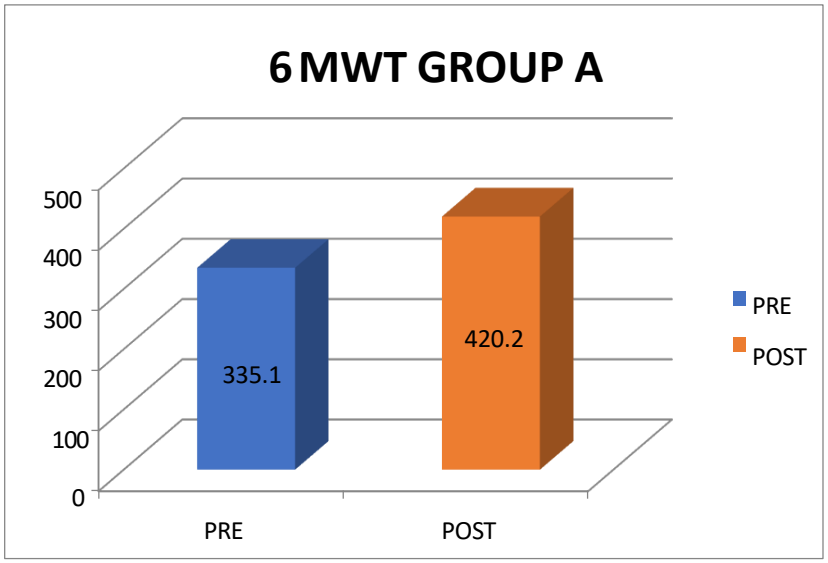
VARIABLES	MEAN		SD		P VALUE	T VALUE	INFERENCE
CHEST EXPANSION	PRE	POST	PRE	POST			
AXILLARY LEVEL	2.57	4.85	0.818	0.876	<0.0001	26.68	significant
NIPPLE LEVEL	2.55	4.92	0.873	0.714	<0.0001	26.38	significant
XIPHISTERNAL LEVEL	2.60	4.87	0.895	0.754	<0.0001	24.17	significant



GRAPH 1: CHEST EXPANSION GROUP A

TABLE 2: 6-MINUTE WALK TEST OF GROUP A

VARIABLES	MEAN		SD		P VALUE	T VALUE	INFERENCE
	PRE	POST	PRE	POST			
6MWT	335.1	420.2	49.23	48.81	<0.0001	27.34	significant

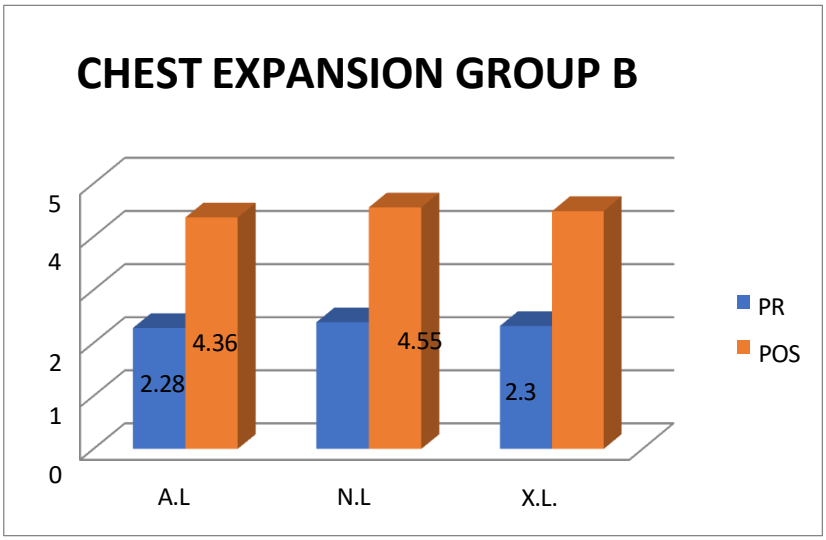


GRAPH 2: 6-MINUTE WALK TEST OF GROUP A

TABLE 3: CHEST EXPANSION OF GROUP B

VARIABLES	MEAN		SD		P VALUE	T VALUE	INFERENCE
CHEST EXPANSION	PRE	POST	PRE	POST			
AXILLARY LEVEL	2.28	4.36	0.625	0.668	<0.0001	24.64	significant
NIPPLE LEVEL	2.39	4.55	0.772	0.708	<0.0001	25.66	significant

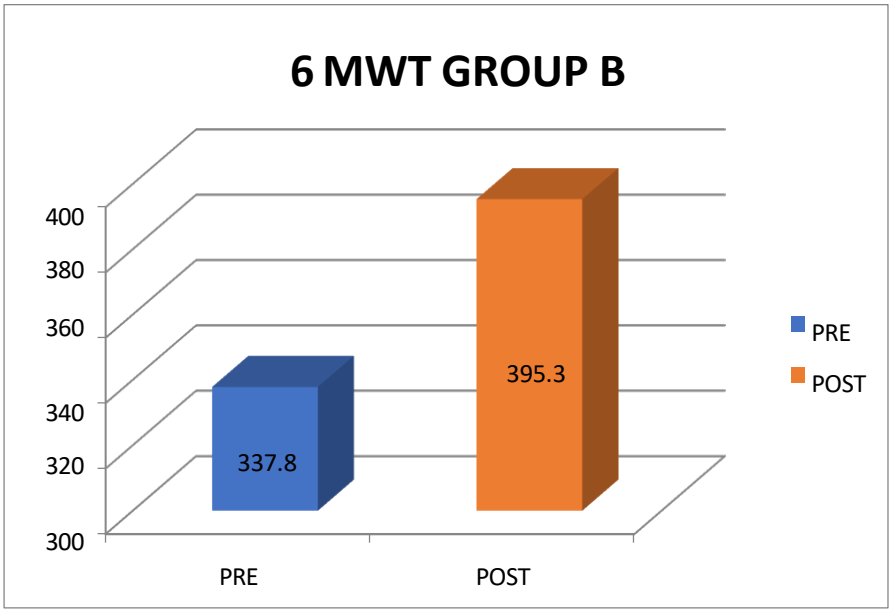
XIPHISTERNAL LEVEL	2.32	4.48	0.621	0.575	<0.0001	26.57	significant



GRAPH 3: CHEST EXPANSION OF GROUP B

TABLE 4: 6-MINUTE WALK TEST OF GROUP B

VARIABLES	MEAN		SD		P VALUE	T VALUE	INFERENCE
	PRE	POST	PRE	POST			
6MWT	337.8	395.3	37.06	32.21	<0.0001	17.08	significant

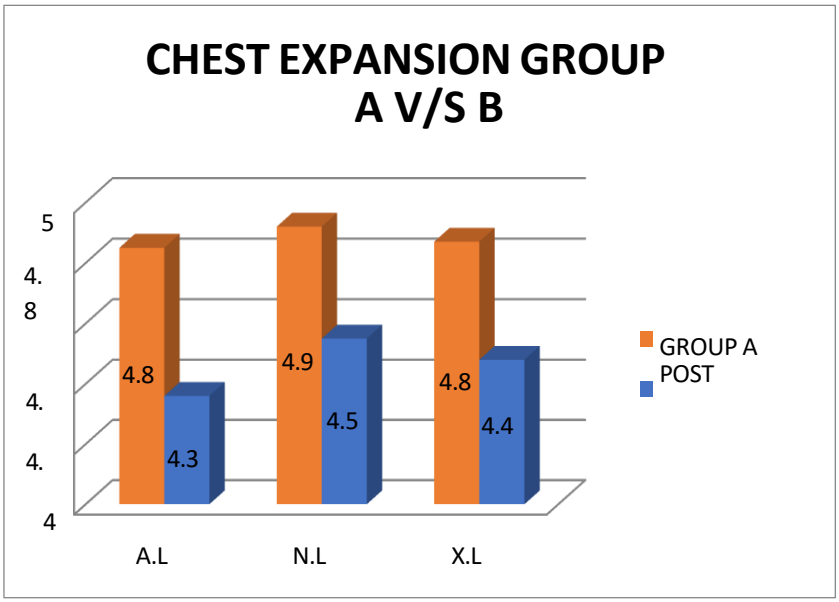


GRAPH 4: 6-MINUTE WALK TEST OF GROUP B

BETWEEN-GROUP COMPARISON:

TABLE 5: CHEST EXPANSION COMPARISON OF GROUP A AND GROUP B

VARIABLES	GROUP A MEAN±SD	GROUP B MEAN±SD	P VALUE	T VALUE	INFERENCE
AXILLARY LEVEL	4.85±0.876	4.36±0.668	0.004	2.90	significant
NIPPLE LEVEL	4.92±0.714	4.55±0.708	0.02	2.36	significant
XIPHISTERNAL LEVEL	4.87±0.754	4.48±0.575	0.009	2.65	significant

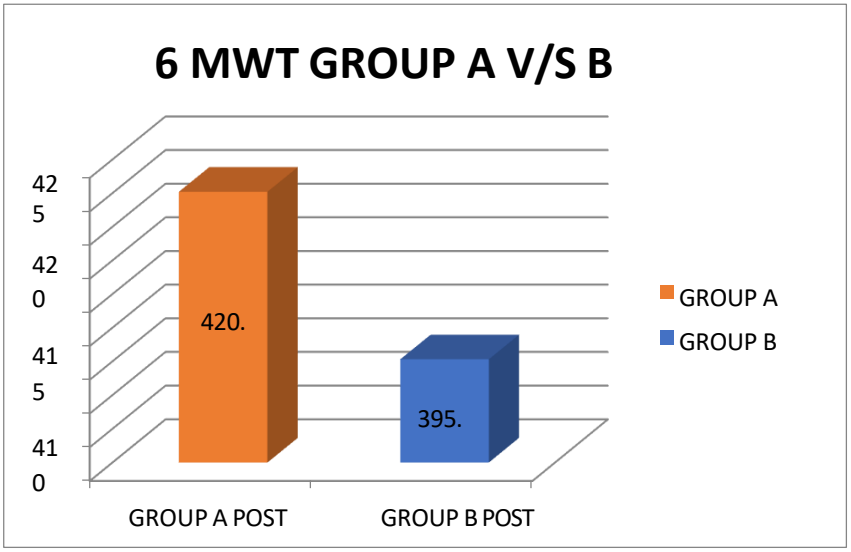


GRAPH 5: CHEST EXPANSION COMPARISON OF GROUP A AND GROUP B

6-MINUTE WALK TEST:

TABLE: 6 6- MINUTE WALK TEST COMPARISON OF GROUP A AND GROUP B

VARIABLES	GROUP A MEAN±SD	GROUP B MEAN±SD	P VALUE	T VALUE	INFERENCE
6 MWT	420.2±48.81	395.3±32.21	0.006	2.79	significant



GRAPH 6: 6- MINUTE WALK TEST COMPARISON OF GROUP A AND GROUP B

DISCUSSION:

According to the result, both groups, that is, group A (Pilates breathing exercises) and group B (Diaphragmatic breathing exercises), have shown improvement. Still, group A showed more improvements ($p<0.05$) in all outcome measures, that is, chest expansion and the 6-minute walk test. This suggests that Pilates breathing enhances respiratory function and supports overall physical performance and well- being, making it a valuable practice for individuals looking to improve their fitness and health.

This study comprehensively explored the effects of Pilates breathing exercises on chest expansion and cardiorespiratory fitness among individuals with compromised respiratory health, specifically focusing on smokers. Given the known health challenges faced by this population, such as reduced lung capacity and impaired respiratory function, the research sought to assess how targeted Pilates breathing techniques could potentially improve their overall respiratory performance. These techniques, which emphasize controlled inhalation and exhalation, are believed to enhance lung capacity and efficiency, contributing to better respiratory health.

Pilates breathing is a specific technique that emphasizes the importance of controlled inhalation and exhalation to enhance overall respiratory function. During the inhalation phase, we focus on expanding the rib cage laterally, allowing for greater lung capacity and oxygen intake, which is followed by a deep, methodical exhalation. This engages the core muscles and promotes stability throughout the body. The mechanics of Pilates breathing not only improve the efficiency of the diaphragm but also engage the intercostal muscles located between the ribs. By activating these muscles, we can achieve greater thoracic mobility, which is crucial for optimal movement and flexibility. The significance of this particular breathing technique becomes even more pronounced when contrasted with traditional abdominal breathing methods.

The research conducted by Niehues et al. also established a clear relationship between increased abdominal strength and improved breathing mechanics. This correlation is important and also relates to our study, as it supports the idea that strengthening the core can lead to more effective breathing patterns. The significant improvements observed in our study reinforce this connection and further validate the mechanisms by which Pilates can contribute to better health outcomes for chronic smokers.

The current study incorporated a structured breathing program designed to ensure that participants adhered to a consistent practice schedule. As a result, the participants experienced notable improvements in their CRF levels. As in a previous systematic review, conducted by Rafaela Almeida Gonçalves Pessôa and her research team examined 12 randomized controlled trials. Their analysis led to the conclusion that engaging in Pilates can significantly enhance cardiovascular respiratory fitness (CRF) among healthy adults, provided that participants practice the exercise for a minimum cumulative duration of 1440 minutes. Their finding underscores the critical role of both duration and regularity in achieving significant, measurable health benefits. The systematic approach to maintaining regular practice aligns with the minimum duration highlighted by Pessôa and their team

Gauri Wakde et al. conducted a comprehensive study examining the effects of Pilates breathing on patients diagnosed with Chronic Obstructive Pulmonary Disease (COPD). Their research demonstrated that the practice of Pilates breathing resulted in several significant improvements, including increased chest expansion, enhanced functional capacity, and better scores related to dyspnea. These outcomes closely align with the findings of our present study, which suggests that the practice of Pilates breathing not only facilitates more effective diaphragmatic activity but also contributes to the stabilization of the lumbar spine. This stabilization, in turn, plays a crucial role in improving respiratory mechanics, allowing for more

efficient and effective breathing. Thus, it proved that Pilates breathing may serve as an effective intervention for anyone struggling with respiratory issues.

As in our study, both groups have shown improvements, but pilates breathing exercise has a more beneficial result in comparison with diaphragmatic breathing exercise. The same thing was suggested in one study (Mi-Sook Ha and colleagues) where they utilized electromyography (EMG) analysis to investigate the effects of abdominal breathing exercises on muscle activity. Their findings revealed that these exercises indeed resulted in increased muscular activation of the transverse abdominis; however, they did not produce a statistically significant impact on chest expansion. Their conclusion relates to our present condition, and this proves that Pilates breathing techniques not only significantly enhance muscular activity in the core but also promote substantial chest expansion.

Karina M. Cancelliero-Gaiad and her team conducted a comparative study on the effectiveness of diaphragmatic breathing versus Pilates breathing in two distinct groups: healthy individuals and those suffering from chronic obstructive pulmonary disease (COPD). Their research demonstrated that diaphragmatic breathing resulted in immediate benefits, specifically improving respiratory rate and oxygen saturation levels shortly after practice. In contrast, Pilates breathing was shown to promote longer-term enhancements in respiratory volumes, indicating that its effects accumulate over time. As same thing we observed in our study, we didn't find any significant difference at 4 weeks. After the 6th week, we found that participants engaging in Pilates breathing experienced progressive improvements in their respiratory fitness, which became more pronounced with continued practice. Our findings suggest that while diaphragmatic breathing may be effective for quick relief and immediate respiratory benefit, but pilates breathing offers a more sustainable approach for enhancing overall respiratory health and function in the long run.

Liliane PS Mendes and her research team conducted a comprehensive investigation into the impacts of two specific breathing techniques diaphragmatic breathing and pursed-lips breathing on chest wall kinematics in patients suffering from chronic obstructive pulmonary disease (COPD). They revealed that both breathing methods were effective in increasing the volume of the chest wall. The same thing was observed in our present study, there was significant improvement in diaphragmatic breathing exercise.

So, from the above discussion, we concluded that pilates breathing exercises should be kept as an important key component in exercise protocol, as this provides more beneficial results and increases the respiratory function, such as increased chest expansion, thoracic mobility in smokers, and also increased endurance capacity in smokers

CONCLUSION:

The present study demonstrated that both Group A (Pilates breathing) and Group B (diaphragmatic breathing) showed improvements in chest expansion and 6-minute walk test (6MWT) performance. However, the Pilates breathing group exhibited significantly greater improvements in chest expansion at the xiphoid, axillary, and nipple levels, indicating enhanced respiratory muscle strength and better breathing mechanics.

In conclusion, Pilates breathing is an effective, simple, and cost-efficient method to enhance respiratory function and endurance in young smokers.

CONFLICT OF INTEREST:

None

FUNDING:

None

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