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EFFECTS OF CHAIR-BASED AEROBIC EXERCISE ON PULMONARY FUNCTION AND FUNCTIONAL CAPACITY IN INDIVIDUALS WITH TYPE-2 DIABETES MELLITUS

Prapti Patel^{1*}, Dr. Gira Thakrar²

¹*MPT Student, JG College of Physiotherapy, Ahmedabad, Gujarat, India

²Senior Lecturer, JG College of Physiotherapy, Ahmedabad, Gujarat, India

***Corresponding Author:** praptipatel337@gmail.com

ABSTRACT

Background: Type-2 diabetes mellitus (T2DM) is a chronic metabolic disorder often associated with reduced pulmonary function, decreased functional capacity, and impaired quality of life. Aerobic exercise improves cardiovascular and pulmonary outcomes; however, conventional standing or treadmill-based exercise may not be feasible for elderly or mobility-limited individuals. Chair-based aerobic exercise is a low-impact, safe, and accessible alternative, yet its effects on pulmonary function and functional capacity in individuals with T2DM are not well documented.

Objective: To evaluate the effects of chair-based aerobic exercise on pulmonary function and functional capacity in individuals with T2DM.

Methods: A study was conducted on 30 individuals with T2DM, aged 45–60 years, divided into an experimental group ($n = 15$) and a control group ($n = 15$) for four weeks. The experimental group participated in chair-based aerobic exercise, while the control group performed walking. Pulmonary function parameters, including forced vital capacity (FVC), forced expiratory volume in one second (FEV1), and FEV1/FVC ratio, were assessed using spirometry. Functional capacity was evaluated using the six-minute walk test (6MWT). Outcomes were measured before and after intervention. Pre- and post-intervention values were analyzed using paired t-tests, with significance set at $p < 0.05$.

Results: Among participants (53.3% males, 46.7% females), the experimental group showed significant improvements in FVC, FEV1, FEV1/FVC ratio, and 6MWT distance following chair-based aerobic exercise ($p < 0.001$). The control group showed no significant pulmonary function improvement, but minimal significant 6MWT improvement ($p < 0.001$). Between-group comparison revealed greater improvements in pulmonary function and functional capacity in the experimental group ($p < 0.001$).

Conclusion: Chair-based aerobic exercise is a safe, effective, and low-cost intervention improving pulmonary function and functional capacity in T2DM. It can be implemented in clinical and community-based rehabilitation programs.

Keywords: T2DM, chair-based aerobic exercise, pulmonary function, functional capacity, 6MWT

INTRODUCTION

According to the WHO classification, the degree of hyperglycemia, which increases the risk of microvascular damage, is the primary characteristic of diabetes. Diabetes-related microvascular problems, a higher risk of macrovascular issues, and a lower quality of life are all linked to reduced life expectancy. Diabetes is mainly classified into Type 1 and Type 2 diabetes mellitus. Type 1 diabetes, also known as insulin-dependent diabetes or juvenile-onset diabetes, occurs due to cellular-mediated autoimmune destruction of the β -cells of the pancreas. Type 2 diabetes, also known as insulin-independent diabetes or adult-onset diabetes, is characterized by insulin resistance or relative insulin deficiency. Individuals with Type 2 diabetes mellitus are usually obese or may develop obesity in later stages.^{1,2} Microvascular diabetic complications result from chronic hyperglycaemia and the formation of pro-inflammatory glycosylated proteins, which subsequently deposit within small blood vessels, leading to microangiopathy. The pulmonary alveolar–capillary network represents the largest microvascular organ in the body; therefore, the lungs can potentially be affected by diabetic microangiopathy. Epidemiological and clinical studies have reported reduced lung function in adults with diabetes. Additionally, patients with diabetes have an increased risk of developing respiratory infections or heart failure, which may further contribute to decreased lung function.^{3,5} According to a number of studies, people with Type 2 diabetes mellitus demonstrate lower pulmonary function parameters, including forced vital capacity (FVC), forced expiratory volume in one second (FEV₁), and the FEV₁/FVC ratio, when compared with non-diabetic individuals. These impairments are believed to result from chronic hyperglycaemia-induced inflammation, non-enzymatic glycation of lung connective tissue, diabetic microangiopathy, and reduced chest wall compliance, collectively leading to decreased lung elasticity and ventilatory capacity.^{6,8} Reduced pulmonary function in individuals with Type 2 diabetes mellitus has been associated with decreased exercise tolerance and impaired functional capacity. The six-minute walk test (6MWT), a validated and reliable measure of submaximal functional capacity, has demonstrated significantly reduced walking distances in individuals with Type 2 diabetes mellitus compared to healthy controls.

Decreases in functional capacity may make it more difficult to carry out everyday tasks and have a detrimental effect on this population's quality of life.^{9,10} Aerobic exercise is a key component of the non-pharmacological management of Type 2 diabetes mellitus and is strongly recommended for improving glycaemic control, cardiovascular fitness, and physical function. Previous study suggests that regular aerobic exercise improves exercise tolerance and functional capacity in individuals with Type 2 diabetes mellitus. However, conventional aerobic exercise modalities such as treadmill walking or outdoor ambulation may not be feasible for elderly individuals or those with obesity, musculoskeletal pain, balance impairments, or reduced mobility.^{11,13} Chair-based aerobic exercise has emerged as a safe, low-impact, and accessible alternative that enables individuals with limited mobility to participate in rhythmic aerobic activity while minimizing joint stress and fall risk. Previous studies have demonstrated the effectiveness of chair-based aerobic exercises in improving cardiovascular fitness and pulmonary function in various clinical populations. Despite these benefits, limited research has explored the specific effects of chair-based aerobic exercise on pulmonary function and functional capacity in individuals with Type 2 diabetes mellitus.^{14,15} Therefore, the present study aims to evaluate the effects of chair-based aerobic exercise on pulmonary function parameters and functional capacity in individuals with Type 2 diabetes mellitus.

METHODOLOGY

Study Design: Experimental study

Study setting: Various residential area of Ahmedabad

Study duration: 4 Week

Study method: Purposive sampling

Participants: Study was conducted on 30 individuals with T2DM aged 45-60 years. They were divided into two groups: An experimental group(n=15) and a control group(n=15).

The inclusion criteria included:

- Type-2 DM Patients
- Middle-aged adults: 45 to 60 years
- Having Type-2 DM for more than 5 years

- HbA1C level : 6.5% to 8%

The exclusion criteria included:

- Cardiovascular conditions (coronary artery disease, heart valve disease, angina, cardiomyopathies, peripheral artery disease).
- Neurological conditions (Parkinson's disease, Stroke, Cerebellar ataxia).
- Patient taking insulin injection
- Smokers
- Uncontrolled hypertension, hypotension or blood glucose level.
- surgical problem in lower limb (within 6 months to 1 year)
- Subject engrossed in sports, gyming activities or any structured physical therapy program within 6 months.
- Intervention/Procedure:** After obtaining ethical clearance from the institute. Select the patients based on the inclusion and exclusion criteria by convenient sampling. Explain about the entire procedure to the patient and take consent for the same. Patients are divided into two groups:
 - Group-1(experimental) - Chair-based aerobic exercise+ walking for 30 minute.
 - Group-2(control) - walking for 30 minute.

CHAIR-AEROBICS 30 TO 35 MINUTES / 3 SESSIONS PER WEEK FOR 4 WEEKS

EXERCISE	WEEK 1&2	WEEK 3&4
Alternate heel raises with bilateral biceps curl	8 to 10 rep for 2 sets	10 to 13 rep for 2 sets
V-steps with bilateral hammer curls	8 to 10 rep for 2 sets	10 to 13 rep for 2 sets
Lateral step touch with bilateral biceps curl	8 to 10 rep for 2 sets	10 to 13 rep for 2 sets
Toe touch with alternate elbow extension	8 to 10 rep for 2 sets	10 to 13 rep for 2 sets
Knee lift with raised hand claps	8 to 10 rep for 2 sets	10 to 13 rep for 2 sets
Knee extension with front hand raise	8 to 10 rep for 2 sets	10 to 13 rep for 2 sets
Diagonal leg raises with hand swing	8 to 10 rep for 2 sets	10 to 13 rep for 2 sets



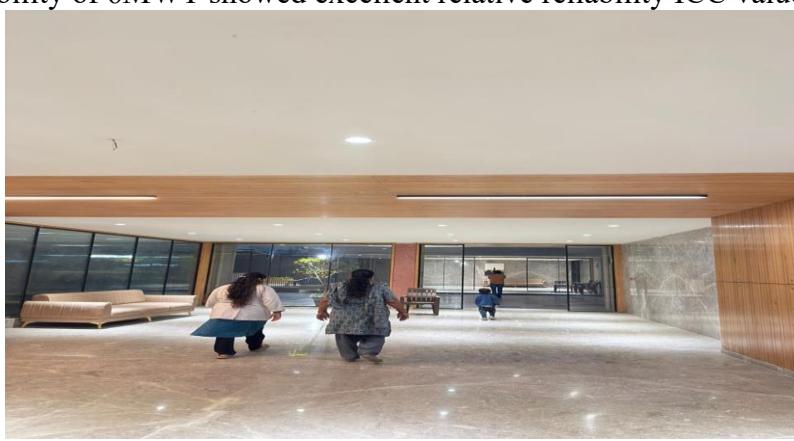


Outcome Measures:

PULMONARY FUNCTION: The pulmonary function test (PFT) test is An outcome measure designed to assess Lung function. • The tool is used to measure PFT is spirometer. • Reliability of Spirokit showed excellent relative reliability (ICC = 0.978- 0.999) With MDC %- 0.02% TO 3.79% • The variables analysed included the following: • Forced vital capacity (FVC) • Forced expiratory volume in the first second (FEV1) • FEV1/FVC index Patient torso and head should be erect. • For better FVC Value: Patient should take a slow breathe to full inhalation followed by a brief hold and then sustained exhalation with maximum effort without coughing or quitting the procedure. Patient should be encouraged and coached during expiration to achieve a complete FVC. • Patient is allowed more than three attempts to achieve. • Ideal spirometry should include atleast two reproducible curve with a difference of less than 5% and best accepted curve is the one that has largest sum of FEV1 and FVC 16



PHYSICAL CAPACITY (6MWT): The 6MWT is a widely used functional test to assess aerobic capacity and endurance. • Reliability of 6MWT showed excellent relative reliability ICC value: 0.92 17



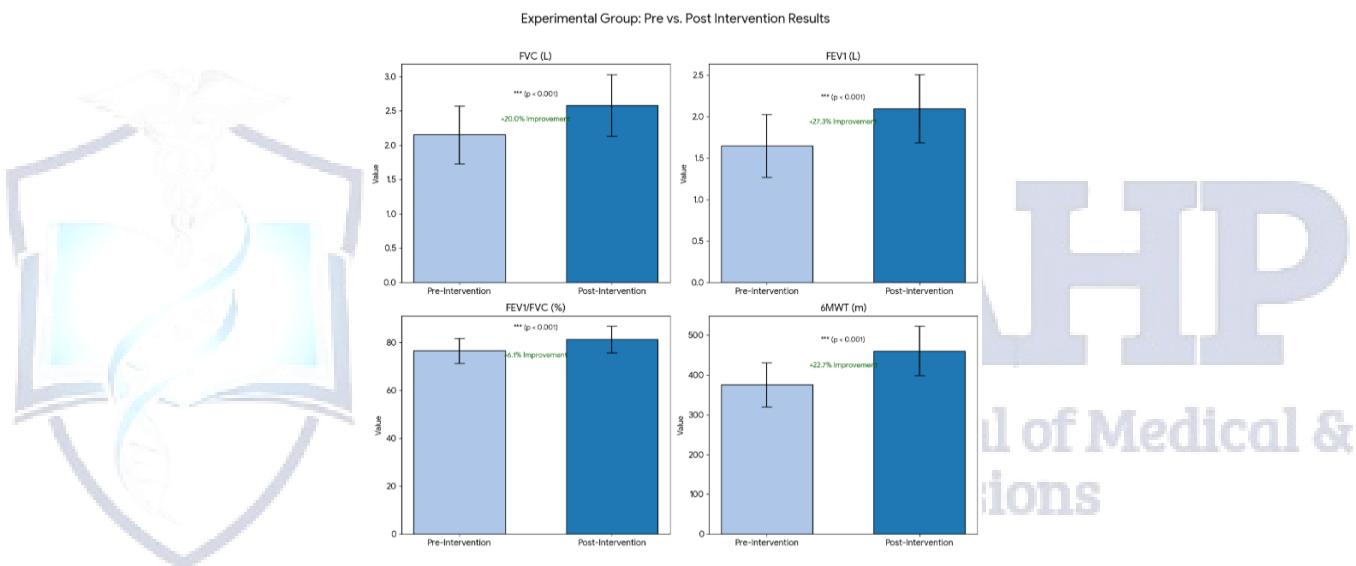
Statistical Analysis: SPSS Software was used for this study. Within group analysis paired t-test was used. Between group analysis independent t-test was used.

RESULTS

EXPERIMENTAL GROUP: From 30 participants with type-2 diabetes mellitus (53.3% males and 46.7% females), within group analysis using the paired t-test showed statistically significant improvements in the experimental group for FVC, FEV1, FEV1/FVC ratio, and 6MWT distance following chair aerobic exercise ($p < 0.001$). (graph-1)

Experimental group	Pre	Post	p-value
FVC	2.93 ± 0.16	3.26 ± 0.15	$p < 0.001$
FEV1	2.35 ± 0.14	2.68 ± 0.12	$p < 0.001$
FEV1/FVC	80.20 ± 1.15	82.20 ± 1.01	$p < 0.001$
6MWT	438.67 ± 16.42	486.33 ± 17.47	$p < 0.001$

TABLE-1 PRE AND POST MEAN \pm SD VALUES OF EXPERIMENTAL GROUP

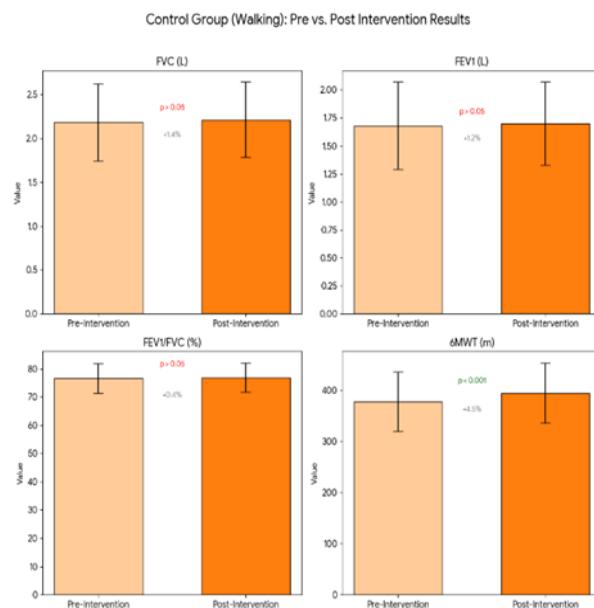


GRAPH-1 PRE AND POST MEAN \pm SD VALUES OF EXPERIMENTAL GROUP

CONTROL GROUP: The control group demonstrated no significant improvement in pulmonary function parameters ($p > 0.05$), with only a minimal but significant improvement in 6MWT distance ($p < 0.001$). (graph-2)

Experimental group	Pre	Post	p-value
FVC	2.92 ± 0.17	2.96 ± 0.14	$p = 0.054$
FEV1	2.31 ± 0.17	2.37 ± 0.12	$p = 0.033$
FEV1/FVC	79.13 ± 2.67	80.13 ± 0.99	$p = 0.145$
6MWT	434.27 ± 18.95	436.13 ± 19.26	$p < 0.001$

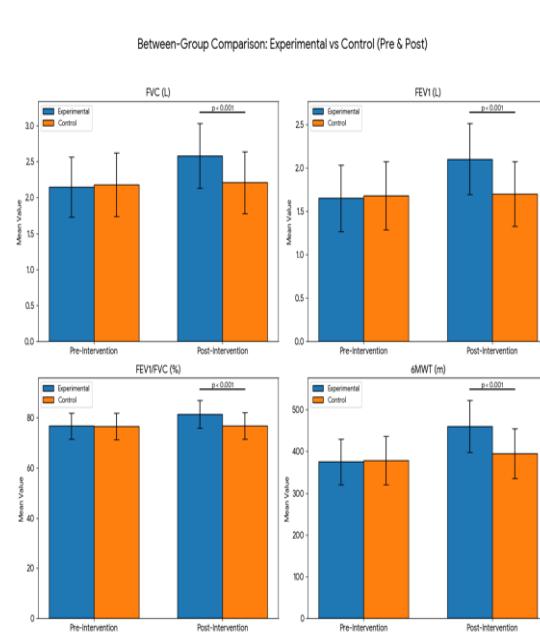
TABLE-2 PRE AND POST MEAN AND SD VALUES OF CONTROL GROUP



GRAPH-2 PRE AND POST MEAN AND SD VALUES OF CONTROL GROUP

BETWEEN GROUP COMPARISON : Between group comparison using the independent t-test revealed significantly greater improvements in pulmonary function and functional capacity in the experimental group compared to the control group ($p < 0.001$).

Between group	Pre	Post	p-value
FVC	3.26 ± 0.15	2.96 ± 0.14	$p < 0.001$
FEV1	2.68 ± 0.12	2.37 ± 0.12	$p < 0.001$
FEV1/FVC	82.20 ± 1.01	80.13 ± 0.99	$p < 0.001$
6MWT	486.33 ± 17.47	436.13 ± 19.26	$p < 0.001$

TABLE-3 PRE AND POST MEAN \pm SD VALUES OF BETWEEN GROUPGRAPH-3 PRE AND POST MEAN \pm SD VALUES OF BETWEEN GROUP

DISCUSSION

The effects of chair-based aerobic exercise on pulmonary function and functional capacity in people with Type-2 diabetes mellitus was investigated in this study. The results show that a 4 week chair-based aerobic exercise training significantly increased functional capacity as determined by the six-minute walk test and significantly improved lung function parameters such as FVC, FEV₁, and the FEV₁/FVC ratio. By contrast, walking exercise participants in the control group showed no significant changes in pulmonary function and very moderate improvements in functional capacity. Pulmonary functions improvement seen in the experimental group could be explained by the constant and coordinated limb motions made during chair-based aerobic exercise, which are often accompanied by controlled breathing patterns. Exercises like these are expected to enhance respiratory muscle activation, chest expansion, and overall ventilatory efficiency.

People having Type-2 diabetes are known to have lower lung volumes and airflow due to microvascular alterations, persistent hyperglycemia, and decreased lung tissue flexibility. By enhancing pulmonary circulation and respiratory mechanics, regular aerobic exercise—even when seated—may reduce these consequences. Significant improvement in FEV₁ and the FEV₁/FVC ratio after the intervention indicate better expiratory performance and improve airway function. These results support the body of research showing that aerobic exercise improves airway dynamics and strengthens respiratory muscles, both of which have a positive impact on lung function. Additional benefits of chair-based exercise may include posture support and a reduces balance issues, which enable individuals to exercise more regularly and confidently. The experimental group show greater improvement than control group in terms of functional capacity, as measured by the six-minute walk test. This improvement is a result of improved oxygen consumption, muscular efficiency, and cardiovascular endurance. Large muscle groups are repeatedly activated during chair-based aerobic training, which may improve aerobic conditioning and functional performance. Chair-based aerobic training may be more successful in improving functional capacity in this group, even though the control group showed a statistically significant improvement in walking distance.

The studies shows the usefulness of chair-based aerobic exercise as a safe and feasible form of exercise for people with Type-2 diabetes, especially those who have impaired exercise tolerance, limited mobility, or balance problems. It is appropriate for both clinical and community-based settings because of its low-impact design, which reduces joint stress while yet offering sufficient cardiovascular activity. When evaluating these results, some restrictions should be taken into account. The study was carried out during a brief period of time and had a rather small sample size. Furthermore, changes in metabolic indicators including glycaemic control and long-term consequences were not assessed. To further demonstrate the advantages of chair-based aerobic exercise, future studies should include larger populations, longer intervention times, and more outcome measures. In conclusion, chair-based aerobic exercise may be included in regular physiotherapy sessions and rehabilitation programs since it seems to be a practical and accessible strategy for enhancing pulmonary function and functional ability in people with Type-2 diabetes mellitus.

LIMITATIONS OF THE STUDY

- Physical activity levels outside the supervised exercise sessions were not monitored, which could have influenced the outcomes.
- Blinding of participants and assessors was not performed, which may have introduced potential bias.

FUTURE IMPLICATIONS

- Future studies should include a larger sample size to improve the generalizability of the findings.
- Long-term intervention studies are recommended to evaluate the sustained effects of chair-based aerobic exercise on pulmonary function and functional capacity.
- Further research should assess metabolic outcomes such as HbA1c, fasting blood glucose, lipid profile, and insulin sensitivity along with functional parameters.
- Comparative studies between chair-based aerobic exercise and other exercise modalities may help determine the most effective intervention for individuals with Type-2 diabetes mellitus.
- Inclusion of quality-of-life measures and psychosocial outcomes may provide a broader understanding of the benefits of chair-based aerobic exercise.

- Home-based and community-based chair exercise programs should be explored to improve accessibility and long-term adherence.

CONCLUSION

Chair-based aerobic exercise is a safe, and effective intervention for improving pulmonary function and functional capacity in Type-2 diabetes mellitus. This low-cost exercise can be effectively implemented in clinical and community-based rehabilitation programs.

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