

# A Study on the Effect of Exercise on Pulmonary Function in Type 2 Diabetes patients.

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## Abstract

**Background:** This study aimed to investigate the effect of exercise on pulmonary function in patients with type 2 diabetes. A total of 100 type 2 diabetic patients (aged 18 – 65 years) were recruited from Diabetes and Endocrinology Hayatabad Medical Complex Peshawar. All participants underwent a standard six-minute walk test, before and after regular aerobic exercise training twice a day for three months. Lung function tests were carried out before and after exercise program to measure maximum voluntary ventilation (MVV), forced vital capacity (FVC), forced expiratory volume in one second (FEV1) and peak expiratory flow rate (PEFR). Data analysis showed that, after exercise program, statistically significant improvements in pulmonary function tests were observed with increased FVC, FEV1, and PEFR as compared to baseline values. Results of this study suggest that regular aerobic exercise have a beneficial effect on pulmonary functioning in type 2 diabetic patients.

**Objectives:** To investigate the effect of exercise on pulmonary functioning in type 2 diabetic patients.

And To compare the pulmonary functions before and after regular exercise sessions in type 2 diabetic patients and To identify the effect of exercise on the maximum voluntary ventilation (MVV), forced vital capacity (FVC), forced expiratory volume in one second (FEV1), and peak expiratory flow rate (PEFR) in type 2 diabetic patients.

## Methods

This study was conducted at Diabetes and Endocrinology Hayatabad Medical Complex, Peshawar, Pakistan from may-2018 to may 2019 This study was a randomized controlled trial One hundred patients with type 2 diabetes, aged 18–65 years, were recruited for this study. Procedure. All participants underwent a standard six-minute walk test before and after

**3 months of regular aerobic exercise program twice a day. Pulmonary function tests (PFTs) were performed before and after exercise program to measure the maximum voluntary ventilation (MVV), forced vital capacity (FVC), forced expiratory volume in one second (FEV1), and peak expiratory flow rate (PEFR) Data analysis. Data were analyzed using SPSS 22.0 software. The independent sample t-test was used to compare the parameters between the baseline and post-intervention scenario. A p-value of <0.05 was considered as statistically significant.**

## **Results**

**The results of this study showed that there were statistically significant improvements in all PFT parameters after regular exercise program. The mean FVC was found to be increased from  $2.45 \pm 0.45\text{L}$  at baseline to  $2.71 \pm 0.51\text{L}$  post-intervention (p-value <0.001). Similarly, the mean FEV1 was increased from  $2.02 \pm 0.38\text{L}$  at baseline to  $2.25 \pm 0.44\text{L}$  post-intervention (p-value <0.001). Also, the mean PEFR was increased from  $5.02 \pm 0.86\text{L/sec}$  at baseline to  $5.78 \pm 0.91\text{L/sec}$  post-intervention (p-value <0.001). Furthermore, the mean MVV was found to be increased from  $17.03 \pm 2.88\text{L/min}$  at baseline to  $19.29 \pm 3.33\text{L/min}$  post-intervention (p-value <0.001).**

## **Conclusion**

**The results of this study indicate that regular aerobic exercise have beneficial effects on pulmonary functioning in type 2 diabetic patients with enhanced pulmonary functions observed in all measured parameters i.e., FVC, FEV1, PEFR and MVV. Therefore, regular aerobic exercise should be recommended in type 2 diabetic patients in order to improve their pulmonary functioning.**

**Keywords: Exercise, Pulmonary Function, Type 2 Diabetes, Forced Vital Capacity (FVC), Forced Expiratory Volume in One Second (FEV1), Peak Expiratory Flow Rate (PEFR), Maximum Voluntary Ventilation (MVV)**

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## **Introduction**

Diabetes is one of the most costly and common endocrine diseases that affect people around the world. According to the World Health Organization (WHO), approximately 422 million people are living with diabetes mellitus. Of these, 90-95% have type 2 diabetes (WHO, 2018)<sup>1</sup>. It is associated with various complications such as cardiovascular diseases, acute and chronic kidney failure, lower extremity amputations, and cerebrovascular problems, which leads to added healthcare costs (Kahn et al., 2006; Monami et al., 2011)<sup>2,3</sup>. Exercise is an essential constituent in the management of type 2 diabetes and is important for improving physical and psychological health (Sallis and Owen, 1998). Exercise training plays an important role in the control and management of diabetes, and it also offers numerous health benefits (Spinetti et al., 2011)<sup>4</sup>. It has

been reported that regular physical activity can reduce the risk of coronary heart disease in individuals with diabetes mellitus and also improve glycemic control (Marwick et al., 2002)<sup>5</sup>. One of the most often neglected components of physical activity is its effect on the pulmonary system. Respiratory fitness is associated with improved mortality and morbidity in individuals with diabetes (Amenu et al., 2017)<sup>6</sup>. The pulmonary system consists of conducting airways, gas exchange regions and a stair-case of airspaces: alveoli and bronchioles (Macklem, 2006). Pulmonary function tests (PFTs) assess the ability to move air out of the lungs in order to measure affected lung functions (Enright et al., 1997)<sup>7</sup>. The most common PFT's used to assess the status of the pulmonary system include: forced vital capacity (FVC), forced expiratory volume in one second (FEV1), peak expiratory flow rate (PEFR) and maximum voluntary ventilation (MVV). Forced vital capacity (FVC) and FEV1 are the two most sensitive measures of restrictive lung disease, whereas the PEFR reflects the airway obstruction status (Ambepitiya et al., 2005)<sup>8</sup>. To the best of our knowledge, limited studies have been conducted to explore the effects of aerobic exercise in patients with type 2 diabetes. Moreover, the impact of exercise on pulmonary function in diabetic patients has not been well-studied yet. Therefore, this study was designed to investigate the effect of exercise on pulmonary functioning in patients with type 2 diabetes<sup>9</sup>.

## Methods

One hundred patients with type 2 diabetes, aged 18–65 years, were recruited from Diabetes and Endocrinology Hayatabad Medical Complex, Peshawar, Pakistan for this study. from may 2018 to may 2019 Written informed consent was provided by all participants prior to data collection. The demographic characteristics of the participants are given in Table 1.

## Data analysis

Data was analyzed using SPSS 22.0. The independent sample t-test was used to compare the parameters between baseline and post-intervention scenarios. A p-value of <0.05 was considered to be statistically significant.

## Results

The results of this study showed that there were statistically significant improvements in all PFT parameters after regular exercise program. The mean FVC was found to be increased from  $2.45 \pm 0.45$ L at baseline to  $2.71 \pm 0.51$ L post-intervention (p-value <0.001). Similarly, the mean FEV1 was increased from  $2.02 \pm 0.38$ L at baseline to  $2.25 \pm 0.44$ L post-intervention (p-value <0.001). Also, the mean PEFR was increased from  $5.02 \pm 0.86$ L/sec at baseline to  $5.78 \pm 0.91$ L/sec post-intervention (p-value <0.001). Furthermore, the mean MVV was found to be increased from  $17.03 \pm 2.88$ L/min at baseline to  $19.29 \pm 3.33$ L/min post-intervention (p-value <0.001).

Table 1. Demographic characteristics of participants

Mean $\pm$ SD	No. (%)
Age (years)	40.40 $\pm$ 6.26
Gender	
Male	63(63.0)
Female	37(37.0)

Table 2. Comparison of pulmonary functions before and after regular exercise in type 2 diabetic patients

Mean $\pm$ SD		
Before	After	
FVC (L)	2.45 $\pm$ 0.45	2.71 $\pm$ 0.51
FEV1 (L)	2.02 $\pm$ 0.38	2.25 $\pm$ 0.44
PEFR (L/sec)	5.02 $\pm$ 0.86	5.78 $\pm$ 0.91
MVV (L/min)	17.03 $\pm$ 2.88	19.29 $\pm$ 3.33
P-value	<0.001	<0.001

Table 3. Difference in pulmonary function parameters before and after regular exercise

Parameter	Difference
FVC (L)	0.26
FEV1 (L)	0.23
PEFR (L/sec)	0.76
MVV (L/min)	2.26
p-value	<0.001

Excluded criteria included age > 65 years, uncontrolled type 2 diabetes mellitus (HbA1c > 8.0%), a history of acute myocardial infarction, cardiopulmonary diseases, known history of pulmonary diseases i.e. COPD and pulmonary tuberculosis during the past year, any endocrine illnesses other than diabetes, psychological illnesses, and any past history indicating that the subject did not have the physical ability to participate in the study effectively.

### Procedure

All participants underwent a standardized six-minute walk test (6MWT) at baseline and after regular exercise program. The 6MWT is an appropriate test to monitor physical performance, identify patients at risk of poorer breathing function, and estimate the effect of physical activity on pulmonary functions (Cipriano et al., 2008). Subsequently, pulmonary function tests (PFTs) were also performed before and after the exercise program to measure the maximum voluntary ventilation (MVV), forced vital capacity (FVC), forced expiratory volume in one second (FEV1), and peak expiratory flow rate (PEFR). The exercise program was designed based on the American College of Sports Medicine (ACSM) guidelines for exercise in individuals with type 2 diabetes (Thomas et al., 2010). The exercise intervention consisted of regular aerobic exercise (i.e., 40-60 minutes of jogging at 50% of heart rate reserve) twice a day for three months. In this study, heart rate reserve (HRR) was calculated using the formula  $HRR = [(HR_{max} - HR_{resting}) \times \% HRR] + HR_{resting}$ , where  $HR_{max} = 220 - \text{age}$  and  $HR_{resting} = 50-60\text{bpm}$ . The 6MWT and PFTs were repeated after 3 months (post-intervention).

### Discussion

The study was aimed to investigate the effect of exercise on pulmonary functioning in type 2 diabetic patients. Results of the study showed that there were statistically significant improvements in all measured PFT parameters, including FVC, FEV1, PEFR, and MVV, after regular aerobic exercise program. Therefore, this study suggested that regular exercise have beneficial effects on pulmonary functioning in type 2 diabetic patients. The benefits of exercise on pulmonary functioning in type 2 diabetic patients have been reported to arise from improved airway mechanics and better gas exchange. Aerobic exercise may improve airway mechanics by increasing the muscle strength needed to sustain inhalation cycles, leading to stronger inspiratory and expiratory muscles, leading to higher FVC and FEV1. Similarly, the benefits of exercise on gas exchange in diabetic patients may be due to improved respiratory muscle performance and better oxygen utilization due to enhanced mitochondrial efficiency. The findings of this study are in agreement with several other studies that have reported beneficial effects of regular exercise on pulmonary function in type 2 diabetic patients [9,11,13,15]. Moreover, the findings of the current study have the applicability in regards to the health benefits of regular physical activity for diabetic patients. It has been found that exercising regularly can reduce the risk of type 2 diabetes and its associated complications [16,17]. Furthermore, regular physical activity can also improve insulin sensitivity and reduce the risk of cardiovascular diseases [18,19]. Therefore, it can be concluded that regular physical activity should be recommended for type 2 diabetic patients in order to improve their pulmonary functioning. This study demonstrated that regular aerobic exercise has beneficial effects on pulmonary functioning in type 2 diabetic patients with improved parameters including FVC, FEV1, PEFR, and MVV. Therefore, it can be recommended that diabetic patients should be encouraged to perform regular aerobic exercise in order to improve their pulmonary functioning.

## Conclusion

The results of this study indicate that regular aerobic exercise plays a positive role in improving pulmonary function in type 2 diabetic patients, with significantly improved pulmonary functions observed in all measured parameters i.e., FVC, FEV1, PEF, and MVV. Therefore, regular aerobic exercise should be recommended in type 2 diabetic patients in order to improve their pulmonary functioning.

## Limitations

One of the limitations of this study is the sample size. Although 100 patients with type 2 diabetes were recruited for the study, the sample size is still small and limited and it may not be representative of the population. Moreover, this study is only conducted on type 2 diabetic patients so it is not certain that the results will be generalizable to the whole population. Additionally, other confounding factors, such as diet and lifestyle, may affect the results, which were not evaluated in this study.

## Future finding

Future studies should investigate the effect of other forms of exercise, such as resistance training and stretching, on pulmonary function in type 2 diabetic patients. Additionally, further studies are needed to assess the long-term outcomes of aerobic exercise on pulmonary function in diabetic patients.

**Muhammad Hussain afridi:** Literature Review,

**Anila basit:** Data collection statistical analysis.

**Nowsherwan:** Data Interpretation, Proof reading

**Shah zeb:** Manuscript drafting,

**Muhammad abbas khan:** Expert opinion and manuscript revision

**Shahid wasim:** manuscript drafting.

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