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Spirometry Assessment of Pulmonary Functions in Patients with Type 2 Diabetes Mellitus: A Cross Sectional Observational Real World Study

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ABSTRACT:

Objective & AIM: The purpose of this cross-sectional case-control study was to examine spirometric lung functions in subjectswith type 2 diabetes (T2D) and to establish a correlation between spirometric dysfunction and the length of diabetes along with the metabolic control of diabetes.

Materials & Methods: Eighty T2DM patients participated in this cross-sectional study and underwent spirometry testing. The following parameters were assessed in order to investigate the restrictive pattern of lung functioning. Evaluations were conducted on forced vital capacity (FVC) in liters, forced expiratory volume in one second (FEV1), and FEV1/FVC. Glycated hemoglobin (HbA1c) and lung function metrics were also examined in relation to the length of diabetes.

Results: The participants' average age was 62.41±8.71 years, their average HbA1c level was 8.42±1.92%, and their average diabetes duration was 7.04±0.91 years. 32 of the participants were men, making about 64% of the total population. Sixty-one percent of the individuals had diabetes for more than five years.The results of this study showed that moderate restriction had greater FBG levels than the other two. With an intergroup p value of 0.00, the values in the aforementioned parameters are 132.42±19.31 (Normal), 191.43±58.36 (Moderate), and 185.31±11.81 (Mild), as shown in table 2. In a similar vein, it was found that moderate restriction had greater PPBG levels than the other two.A slight and non-significant negative association between the FVC and FEV1 and HbA1c was seen (p=0.31, p=0.42). FEV1/FVC, on the other hand, demonstrated a marginally significant negative connection with (r=-0.583; p=0.04).

Conclusion: According to the study, lung function significantly declined in diabetic individuals, which may be the result of untreated consequences from the disease.

Keywords: Pulmonary functions, Spirometry,Type 2 diabetes mellitus, Forced vital capacity, Glycated hemoglobin.

Introduction:

A major economic burden in developing nations like India is caused by type 2 diabetes mellitus (T2DM), a global health concern [1]. About 537 million individuals between the ages of 20 and 79 worldwide have diabetes in 2021, and 74.2 million people in India have type 2 diabetes, making India the country with the second-highest number of people with diabetes worldwide [2]. Additionally, it has been projected that for the following 25 years, the population will rise by 124.9 million [3].

Uncontrolled type 2 diabetes causes macrovascular problems including coronary artery disease and stroke as well as microvascular problems like diabetic kidney disease, peripheral neuropathy, and retinopathy. Microvascular problems start to develop or progress within 5–10 years, and they manifest 15–20 years after diabetes first manifests [4].

Numerous investigations have demonstrated that patients with type 2 diabetes have significant pulmonary microcirculation abnormalities and lung fibrotic alterations [5,6]. Furthermore, a number of research assessed the diabetic population's aberrant respiratory functioning [7, 8]. T2DM patients' lungs exhibit significant histological alterations, including a typical thickening of the capillary basal lamina of pulmonary tissue and alveolar epithelial cells, which reduces lung capacity and pulmonary elastic recoil. Lung diffusion is further hampered by thickening of the basement membrane and a reduction in pulmonary capillary volume.

Additionally, T2DM patients experience pulmonary injury as a result of glycosylation of lung connective tissue [9]. Prior research revealed that patients with type 2 diabetes had a significant drop in forced expiratory volume (FEV1) and forced vital capacity (FVC) [10]. Therefore, we have assessed the relationship between glycated hemoglobin (HbA1c) levels and the duration of the disease as well as the pulmonary function tests in T2DM patients.

Materials & Methods:

Study type:80 diabetes individuals participated in this cross-sectional, observational, real-world investigation.Patients with diabetes who have been receiving therapy for longer than three months were chosen at random from the outpatient division.

Inclusion criteria:The study comprised T2DM patients of both sexes who were between the ages of 40 and 80. The study included the patient who provided informed permission.

Exclusion criteria: The study excluded T2DM individuals who had pulmonary TB, bronchial asthma, COPD, or were currently smokers.

Study procedure: The standard autoanalyzer was used to determine the fasting and postprandial blood sugar levels, and the anthropometric characteristics were noted. To estimate HbA1c, a high-performance liquid chromatography method was employed. Winspiro PRO MIR was used to measure the pulmonary function test in T2DM patients in accordance with the American Thoracic Society/European Respiratory Society's recommendations [11]. The diabetic patients completed the procedure three times for a total of fifteen minutes, and the three best results were taken into account for analysis. The following factors were assessed in order to measure pulmonary functions: The following metrics were assessed: FEV1/FVC, FEV1 (forced expiratory volume in 1 second), and FVC in liters.

Statistical analysis: The mean±SD for categorical variables was used to represent the data. The diabetic patients were classified as having normal, moderate, and mild lung function restriction based on the results of the spirometry evaluation. The diabetic patients' blood glucose, HbA1c, FVC, FEV1, and FEV1/FVC levels were compared using a one-way ANOVA and Tukey's multiple comparison. The relationship between the lung function indicators and the length of diabetes was assessed using Pearson correlation. A value of $P<0.05$ indicates statistical significance.

Results:

The participants' average age was 62.41±8.71 years, their average HbA1c level was 8.42±1.92%, and their average diabetes duration was 7.04±0.91 years. 32 of the participants were men, making about 64% of the total population. Sixty-one percent of the individuals had diabetes for more than five years. Thirteen percent of patients have had diabetes for more than ten years. Just 9% of people had diabetes for less than three years. In terms of HbA1c levels, 22 (27.5%) patients had HbA1c values less than 7%, and fifty-eight (72.5%) patients had values greater than 7%.

The average FEV1/FVC was 91.34±8.12, the average FEVI was 2.31±0.23 (L/s), and the average FVC was 3.25±0.43 L. Forty two (52.5%) of the fifty diabetes individuals had normal lung functions, twenty seven (33.8%) had mild restriction, and eleven (13.7%) had significant restriction. Table 1 displays the data.

Table 1: Spirometry evaluation of lung functions in diabetic patients

Pulmonary functions	**Values (mean**±SD)**&No of patients N(%)**
FVC (L)	3.25±0.43
FEV1/FVC (L)	91.34±8.12
FEVI (L/s)	2.31±0.23
Mild restriction	27 (33.8%)
Moderate restriction	11 (13.7%)
Normal	42 (52.5%)

The comparison of spirometry and diabetic parameters in diabetic individuals with pulmonary limitations is shown in Table 2. The results of this study showed that moderate restriction had greater FBG levels than the other two. With an intergroup p value of 0.00, the values in the aforementioned parameters are 132.42±19.31(Normal), 191.43±58.36(Moderate), and 185.31±11.81(Mild), as shown in table 2. In a similar vein, it was found that moderate restriction had greater PPBG levels than the other two. With an intergroup p value of 0.00, the values in the aforementioned parameters are 210.21±38.45(Normal), 294.24±81.14 (Moderate), and 272.53±44.83(Mild), as shown in table 2. Furthermore, the intergroup p value was 0.01 and the HbA1c readings were 7.11±0.27(Normal), 8.72±0.26(Moderate), and 8.04±0.31(Mild).

Table 2: Comparison of diabetic and spirometry parameters in diabetes patients with pulmonary restrictions

Parameter	**Pulmonary functions**	**Mean**	P Value
FBG (mg/dl)	Normal	132.42±19.31	0.00*
	Mild	185.31±11.81	
	Moderate	191.43±58.36	

PPBG (mg/dl)	Normal	210.21±38.45	0.00*
	Mild	272.53±44.83	
	Moderate	294.24±81.14	
HbA1C (%)	Normal	7.11±0.27	0.01
	Mild	8.04±0.31	
	Moderate	8.72±0.26	
FVC (L)	Normal	2.51±0.29	0.003*
	Mild	2.14±0.42	
	Moderate	1.32±0.21	
FEV1 (one second)	Normal	2.43±0.31	0.005*
	Mild	1.96±0.52	
	Moderate	1.53±0.29	
FEV1/FVC	Normal	92.36±13.41	0.002*
	Mild	89.64±10.62	
	Moderate	81.32±15.93	

One-way ANOVA, *denotes p value<0.05 (Significant)

Moderate restriction had lower FVC levels than the other two, according to the study's findings. According to table 2, the values in the previously described parameters are 2.51±0.29 (Normal), 1.32±0.21 (Moderate), and 2.14±0.42 (Mild), with an intergroup p value of 0.03. Likewise, moderate restriction was shown to have lower FEV1 levels than the other two. According to table 2, the values in the previously indicated parameters are 2.43±0.31 (Normal), 1.53±0.29 (Moderate), and 1.96±0.52 (Mild), with an intergroup p value of 0.002. Additionally, the FEV1/FVC ratio values were 89.64±10.62 (Mild), 81.32±15.93 (Moderate), and 92.36±13.41 (Normal), with an intergroup p value of 0.002.

No statistically significant correlation were found between PFT and the duration of diabetes. According to the study finding a statistically non-significant FVC values were documented (p=0.16). Furthermore statistical non-significant correlation but a positive connection were observed in FEV1 and FEV1/FVC. This findings were presented in table 3.

Table 3: Correlation of pulmonary function test parameters with **duration of diabetes**

Parameters	**Pearson's correlation**	P Value
FVC	-0.327	0.16^{NS}
FEV1	0.1231	0.31^{NS}
FEV1/FVC	0.173	0.64^{NS}

NS: Non-significant, p>0.05

A slight and non-significant negative association between the FVC and FEV1 and HbA1c was seen (p=0.31, p=0.42). FEV1/FVC, on the other hand, demonstrated a marginally significant negative connection with (r=-0.583; p=0.04). Table 4 displays the findings.

Table 4: Correlation of pulmonary function test parameters with **glycated hemoglobin**

Parameters	**Pearson's correlation**	P Value
FVC	-0.141	0.31NS
FEV1	-0.129	0.42NS
FEV1/FVC	-0.583	0.04*

NS: Non-significant, p>0.05; *denotes significant p<0.05

Discussion:

The study's primary goal was to assess how T2DM affected lung functioning. The pulmonary functions of the diabetes individuals were impaired, resulting in dyspnea, wheezing, shortness of breath, and easy fatigability. Along with impaired pulmonary functioning, diabetes is a significant risk factor for the development of coronary heart disease. A reliable method for identifying anomalies in patients with pulmonary problems is spirometry. It assesses lung flows and volumes and looks for patterns of restriction and obstruction in lung functions [12].

Although the cause of decreased lung function in diabetes patients is not well understood, histological study shows that patients with chronic hyperglycemia have fibrosis and thickness of the basal lamina [13]. Furthermore, pulmonary problems were significantly correlated with microangiopathy caused by protein glycation during diabetes and biochemical alterations in the lung connective tissue (collagen and elastin) [14]. Additionally, long-term hyperglycemia decreased lung volume, pulmonary carbon monoxide diffusion capacity, and elastic lung recoil [14].

According to the current report, the study participants' mean duration of diabetes is 6.12±1.76 years. In a research by Kumari et al. [15], the mean duration of diabetes was 6.15±3.56 years, which is comparable to what we found. According to our observations, Sixty-one percent of the individuals had diabetes for more than five years. Thirteen percent of patients have had diabetes for more than ten years. Just 9% of people had diabetes for less than three years. Similarly, in Roselin et al. [16], 24 patients had diabetes for less than five years, 37 patients had it for six to ten years, and 45 patients had it for ten years or more.

Among the diabetic patients in this study, the mean HbA1c level was 8.42±1.92%. The mean HbA1c in the study by Kumari et al. [15] was 9.75±2.62. The current study is consistent with theirs, in terms of HbA1c levels, 22 (27.5%) patients had HbA1c values less than 7%, and fifty-eight (72.5%) patients had values greater than 7%.

The mean forced vital capacity value of 109 ml/year was found to be gradually declining in a study conducted by Mittal et al. [17] and Davis et al. [18]. When compared to the controls, type 2 diabetics' FEV1/FVC% increased, and this increase was statistically significant. According to the elevated FEV1/FVC%, type 2 diabetes patients' pulmonary function impairment was mostly restricted. According to Davis et al. [18], individuals with type 2 diabetes had significantly lower FVC and FEV1 as well as reduced lung volumes and airflow blockage due to long-term diabetes consequences.

Forty two (52.5%) of the fifty diabetes individuals had normal lung functions, twenty seven (33.8%) had mild restriction, and eleven (13.7%) had significant restriction. According to a research by Nemagouda et al. [19], 13.46% of patients had normal lung functions, 60% of patients had mild limitation, and 28.9% of patients had moderate restriction.

In 2012, Mario Cazzola and colleagues discovered that human isolated bronchi provided molecular insight into the obstructive character of pulmonary disease in diabetes [14]. Thus, airway blockage may be exacerbated by hyperglycemia. According to a 2002 study by Engstrom G. et al., diabetic microangiopathy affects the lungs [15]. Autopsy results in human diabetes participants demonstrated centrilobular emphysema, thickening of alveolar epithelia, pulmonary microangiopathy, and thickening of the pulmonary capillary basal lamina. According to studies by Lee et al. [20], type 2 diabetes mellitus can result in microangiopathy and pulmonary problems because of alterations in collagen and elastin.

One helpful test for determining the frequency of limitation patterns in lung functions is spirometry. Spirometry metrics such as FVC and FEV1 were lower in the diabetic group with Type 2 diabetes mellitus than in the control group, although the ratio of the two (FEV1/FVC%) was higher. These outcomes can be explained by the fact that diabetic individuals' connective tissue is non-enzymatically glycosylated. According to the current study [22], pulmonary functions and the length of diabetes mellitus were negatively correlated, and there was a linear relationship between lengthening duration and FEV1/FVC%, which is suggestive of a restrictive lung disorder brought on by poor glycemic control in diabetics.

Conclusion:

Complications associated with diabetes might potentially affect the lung. Compared to diabetic patients with normal lung functioning, those with mild limitation had lower FVC, FEV1, and FEV1/FVC values. The development of pulmonary problems was significantly correlated with elevated HbA1c levels.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

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Ethical Statement:

The study was conducted in accordance with the Declaration of Helsinki, and because it was retrospective in nature, the Institutional Review Board (IRB) waived the informed consent requirement.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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