Original Research Article

A Cross-Sectional Study to Assess Pulmonary Functions in Patients with Type 2 Diabetes Mellitus

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ABSTRACT

Introduction: Type 2 diabetes mellitus is a chronic metabolic disease marked by poor glucose metabolism and insulin resistance. Although diabetes-related cardiovascular and renal complications have historically received the majority of attention in research and clinical care, the effects of diabetes on pulmonary functions are becoming more widely acknowledged. There appears to be a reciprocal relationship between type 2 diabetes (T2DM) and pulmonary function, whereby respiratory health is influenced by diabetes and vice versa. **Aims and Objective:** To assess of pulmonary functions in subjects with type 2 diabetes mellitus (T2DM) and compare them with age and sex-matched healthy controls. **Methodology:** A pre-made questionnaire, anthropometric measurements, systemic and general examinations, and computerized spirometer pulmonary function tests were all part of the methodology. **Results:** Significant reductions in a number of pulmonary function test parameters were found statistically in T2DM patients, suggesting a restrictive pattern of pulmonary function in this population. **Conclusion:** The results emphasized the need to comprehend how diabetes affects lung health by highlighting the relationship between T2DM and pulmonary function. These findings add to the body of knowledge being researched to help T2DM patients with their respiratory health. **Key-words:** Type 2 Diabetes Mellitus, Pulmonary Functions, Spirometry

INTRODUCTION

According to estimates from the World Health Organization, there are over 180 million diabetics globally, and by 2030, that number is predicted to have doubled. The incidence and prevalence of diabetes mellitus (DM) among Asian Indians are concerningly rising. (1)

Diabetes is a major contributor to kidney failure, blindness, cardiovascular disease, and amputation of lower limbs. Type 2 diabetes (T2D) and its complications are thought to have been the cause of 4.2 million deaths globally in 2019. (2)

For many years, there has been interest in the relationship between diabetes mellitus (DM) and reduced lung function. Numerous studies have demonstrated the link between diabetes and compromised pulmonary function. (3), (4), (5), (6), (7), (8), (9) Davis et al. (3)made a noteworthy observation that the lung is a target organ in diabetes, highlighting the substantial effect that glycemic exposure has on reduced lung function in people with type 2 diabetes. (10)

Numerous theoretical models have been put forth to explain the pathological alterations that diabetic patients' lungs may experience. Diabetes may have an impact on the development of pulmonary complications by altering collagen and elastin, which are vital elements of the lung's structural integrity, as shown by Ljubic et al. (11) This implies that the respiratory system may experience functional impairments as a result of the structural alterations brought on by diabetes.

Furthermore, a different theory suggests that there is more nonenzymatic glycation of peptides and proteins in the extracellular matrix. This process is thought to be a major factor in the pathological changes seen in the lungs of diabetics, and it happens in response to prolonged increases in blood glucose levels. Protein glycation may cause aberrant cross-linking and stiffness in the lung tissues, which may be a factor in the decline in lung function.

Comprehensive patient care requires an understanding of the complex relationship between diabetes and impaired lung function. It not only clarifies the possible mechanisms for this association but also emphasizes how crucial glycemic management is to reducing the negative effects on lung health. To improve respiratory health in diabetics, more research is needed to determine the exact molecular and cellular pathways via which diabetes affects lung function. This will open the door to targeted interventions and preventive measures.(12)

AIMS AND OBJECTIVE

The main and objective of study is to assess of pulmonary functions in patients with type 2 diabetes mellitus (T2DM) and compare them with age and sex-matched healthy controls.

MATERIALS AND METHODS

Participants in the study:

From the outpatient department (OPD), 125 participants with type 2 diabetes mellitus who were between the ages of 35 and 65 and had had the disease for more than a year were chosen at random. The control group consisted of an equal number of healthy individuals who were matched by age and sex. Before being included in the study, participants gave their informed consent.

Criteria for Exclusion:

Exclusions from the study included physical disabilities such as kyphoscoliosis that affect lung function, acute or chronic respiratory diseases, occupational exposure to respiratory deterrents, and a history of smoking (current, ex-smoker, or passive smoker). People who could not complete pulmonary function tests were not allowed either.

Data collection:

Following an explanation of the study to the participants, a pre-made questionnaire was given out to collect data on their personal, sociodemographic, and medical histories.

Anthropometric measurements and general and systemic examinations were performed on the diabetic and control groups. Body Mass Index (BMI) was calculated using the formula: weight (kg) / height (m^2).

Test for Pulmonary Function;

The RMS Helios 401 computerized spirometer was used to perform the pulmonary function test in accordance with the American Thoracic Society/European Respiratory Society (ATS/ERS) guidelines. Control and diabetic subjects performed the maneuver three times at a 15-minute interval. The best outcome from the three trials was taken into account for analysis. The following criteria were evaluated: Forced vital capacity (FVC), FEV1, or forced expiratory volume in one second, Ratio of FEV1/FVC in percentage (%), Forced expiratory flow from FVC (FEF25–75) between 25-75%, slow vital capacity (SVC), Maximal Voluntary Ventilation (MVV)

For every parameter, the expected values for age, height, and weight were taken into account.

Analytical Statistics:

The statistical package for social sciences, or SPSS, was used to perform the analysis. Mean and standard deviation were computed for continuous variables, and Student's t-test was used for comparisons. The chi-square test was utilized to analyze categorical variables, and a p-value of less than 0.05 was deemed statistically significant.

RESULTS

In all, 239 participants were involved in this study; 125 of them had diabetes mellitus, and the remaining 114 were controls.

The average age of those with type 2 diabetes was 52.10 ± 8.67 years, while that of the control group was 49.82 ± 7.23 years. Demographic characteristics (Age, height, Weight, and BMI) of the control group (Group I) and diabetes mellitus subjects (Group II) are given in table 1.

Table 1: Demographic Parameters

Parameters	Group A (114)	Group B (125)	p-value
Age (years)	49.82 ± 7.23	52.10 ± 8.67	0.27
Height (cm)	161.74 ± 10.89	165.23 ± 9.76	0.14
Weight (kg)	68.15 ± 10.92	70.87 ± 11.78	0.013
BMI (kg/m2)	24.57 ± 3.81	26.89 ± 3.49	0.043
Gender	Male – 61 Female - 53	Male – 66 Female - 59	

We compare two groups, Group A (114 individuals) and Group B (125 individuals), using the data that has been provided across a number of parameters. An explanation of the altered data is provided below:

Age:

The mean age of Group A is 49.82 years with a standard deviation of 7.23, and the mean age of Group B is 52.10 years with an 8.67 standard deviation.

Height:

Group A has a mean height of 161.74 cm with a standard deviation of 10.89, while Group B has a mean height of 165.23 cm with a standard deviation of 9.76.

Weight:

Group A has a mean weight of 68.15 kg with a standard deviation of 10.92, whereas Group B has a mean weight of 70.87 kg with a standard deviation of 11.78.

Body Mass Index, or BMI:

The average BMI for Group A is 24.57 kg/m² with a 3.81 standard deviation, while the average BMI for Group B is 26.89 kg/m² with a 3.49 standard deviation.

Distribution of Gender:

In Group A, there are 61 males and 53 females, while in Group B, there are 66 males and 59 females.

Graph 1: Graphical representation of P value of Demographic Parameters

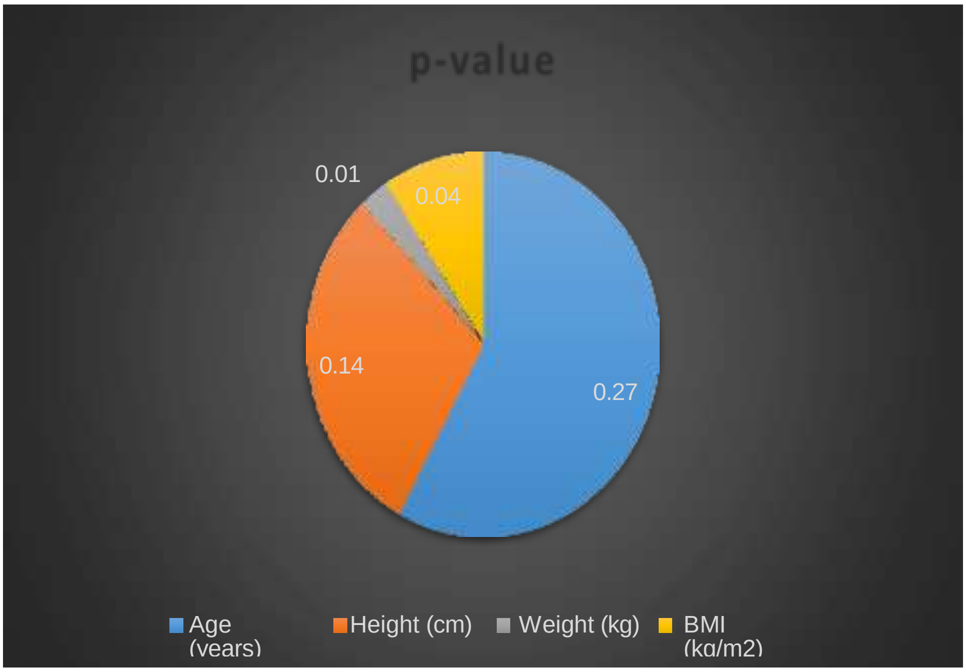

Table 2: Comparison of pulmonary function test parameters between Group A & Group B

S.No	PFT parameter	Group A (N=114)	Group B (N=125)	p-value
1	FVC	2.32 ± 0.71	1.87 ± 0.92	0.0002
2	FEV1	1.86 ± 0.53	1.35 ± 0.76	0.0003
3	FEV1/FVC	80.25 ± 3.91	97.43 ± 14.05	0.0002
4	FEF 25-75%	2.34 ± 0.68	1.54 ± 0.95	0.0002
5	SVC	2.41 ± 0.69	2.26 ± 0.82	0.04
6	MVV	89.47 ± 7.85	68.20 ± 17.88	0.0003

Forced Vital Capacity (FVC):

Group B displays a lower mean FVC of 1.87 liters with a standard deviation of 0.92, compared to Group A's 2.32 liters with a 0.71 standard deviation.

Forced expiratory volume (FEV1):

With a standard deviation of 0.76 and a mean FEV1 of 1.35 liters, Group B has a lower FEV1 than Group A, which has a mean FEV1 of 1.86 liters and 0.53 standard deviation.

FEV/FVC Ratio:

Group A's mean FEV1/FVC ratio is 80.25%, whereas Group B's is noticeably higher at 97.43%.

FEF 25-75%:

While Group B displays a lower mean of 1.54 liters per second with a standard deviation of 0.95, Group A has a mean 2.34 with a standard deviation of 0.68.

SVC:

Group A has a slightly higher mean SVC of 2.41 liters with a standard deviation of 0.69 compared to Group B, which has a mean SVC of 2.26 liters with a standard deviation of 0.82.

Maximal voluntary ventilation (MVV):

Group A demonstrates a mean MVV of 89.47 liters with a standard deviation of 7.85, whereas Group B demonstrates a mean MVV of 68.20 liters with a standard deviation of 17.88.

Graph 2: Graphical representation of p value of Comparison of pulmonary function test parameters between Group A and Group B

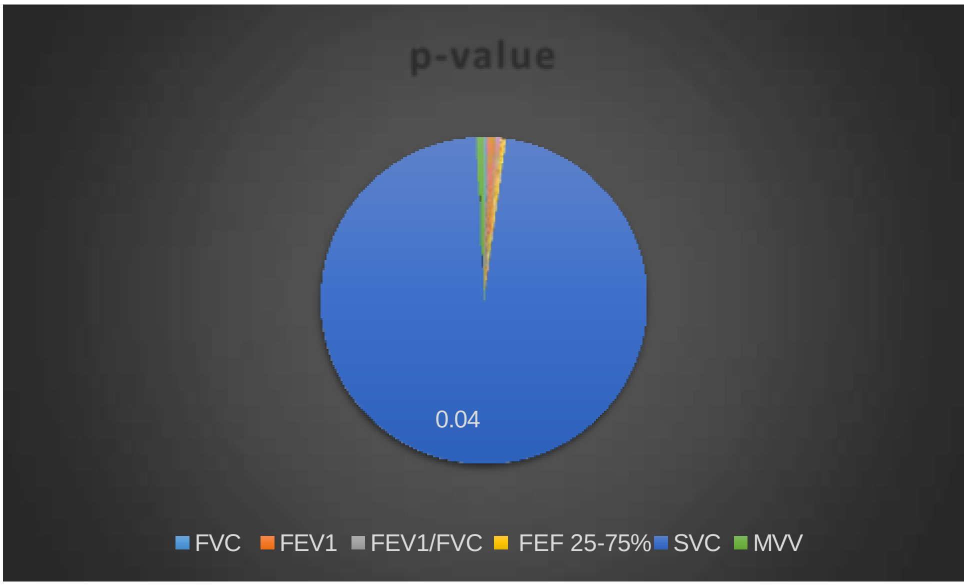

Table 3: Respiratory pattern between Group A & Group B

Pulmonary function pattern	Group A (N=114)		Group B (N=125)		Chi Square	p Value
Restrictive	2	1.6	73	57.5	77.3	0.001
Obstructive	7	6	10	8.1	0.301	0.575
Mixed pattern	4	3.3	11	8.4	3.58	0.05
Normal	101	89.1	31	26	91.04	0.0001

Restrictive Pattern:

Group B has 73 people (57.5%) with restrictive pulmonary function defects, compared to 2 people (1.6%) in Group A.

According to the Chi-Square test, there is a significant difference in restrictive patterns between the groups (p-value = 0.001, Chi Square = 77.3).

Obstructive Pattern:

10 people (8.1%) in Group B have obstructive pulmonary function defects, compared to 7 (6%) in Group A.

Regarding obstructive patterns, the Chi-Square test indicates that there is no significant difference between the groups (Chi Square = 0.301, p-value = 0.575).

Mixed Pattern:

Group B has 11 individuals (8.4%) with mixed patterns, while Group A has 4 individuals (3.3%) with mixed patterns.

A marginally significant difference in mixed patterns between the groups is shown by the Chi-Square test (Chi Square = 3.58, p-value = 0.05).

Normal Pulmonary Function:

Group B has 31 people (26%) in the normal category, whereas Group A has 101 people (89.1%) with normal pulmonary function.

The distribution of normal pulmonary function differs significantly between the two groups, according to the Chi-Square test (Chi Square = 91.04, p-value = 0.0001).

DISCUSSION

The results of this study demonstrate a significant decline in a number of pulmonary function test parameters in people with type 2 diabetes mellitus, with the exception of the FEV1/FVC ratio, which stayed mostly stable when compared to a healthy control group ($p<0.05$). The Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), and Maximum Voluntary Ventilation (MVV) values notably showed the greatest declines.

Additionally, compared to the control group, the data showed a significantly higher FEV1/FVC ratio in the subjects with diabetes mellitus, indicating a restrictive pattern of pulmonary function in diabetics. This finding implies that individuals with type 2 diabetes may experience limitations in their lung capacity, particularly in terms of the volume of air forcefully expelled during forced exhalation.

It is noteworthy that, when compared to the control group, the results did not reach statistical significance even though there was a decline in the subjects' Slow Vital Capacity (SVC) among those with diabetes. This implies that although there might be a tendency for people with diabetes to have lower slow vital capacity, more investigation may be required to clarify the practical significance of this finding.

The study's findings are consistent with previous research that found that people with type 2 diabetes mellitus had reduced vital capacity and a restrictive pulmonary pattern. These collective findings underscore the importance of monitoring pulmonary function in diabetic individuals, as compromised respiratory parameters may contribute to an increased risk of respiratory complications and diminished overall health. To better understand the underlying mechanisms and potential treatments for pulmonary dysfunction in people with type 2 diabetes mellitus, more studies and clinical investigations are necessary.

In a prospective study involving Europid patients with type 2 diabetes, Davis et al. found that the FVC, FEV1, VC, and PEF spirometry measures continued to decline at annual rates of 68, 71, and 84 ml/year and 171/min, respectively. The means of all spirometry measurements were lowered by more than 9.5% when expressed as a percent predicted value. (3)

The findings of this study were consistent with those of Lange et al.'s investigation, which discovered that diabetic subjects' lung function was significantly lower than that of control subjects', and that this reduction was more pronounced in insulin-treated subjects than in those receiving oral hypoglycemic agents, diet, or both. (13)

Recent studies conducted by Piyush et al (14), Shah et al (1), and Aparna (15) concluded that mean values of FVC, FEV1, and FEF25-75%, were significantly reduced in patients of type 2 DM. Furthermore, Keerthi et al. (16) also noted that diabetic subjects had lower MVV values. On the other hand, an investigation conducted on human isolated bronchi by Cazzola et al. revealed the obstructive pattern of pulmonary pathology in individuals suffering from diabetes mellitus. (17)

Spirometry readings in the Indian diabetic population revealed a variable pattern, with 60% obstructive, 30% restrictive, and 23% mixed. This was determined by Rajan et al. (18)

CONCLUSION

In order to compare people with type 2 diabetes mellitus (T2DM) and age- and sex-matched healthy controls, the study evaluated pulmonary functions in T2DM patients. Significant reductions in a number of pulmonary function test parameters were found statistically in T2DM patients, suggesting a restrictive pattern of pulmonary function in this population. The study's conclusions emphasized the significance of keeping an eye on pulmonary function in diabetics and the demand for more investigation to learn about the underlying causes and possible therapies for pulmonary dysfunction in T2DM patients. The findings also demonstrated the mutual relationship between T2DM and pulmonary function, highlighting the necessity of gaining a thorough understanding of the ways in which diabetes affects respiratory functions.

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