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Original Research Article

Evaluation of pulmonary function among type 2 diabetes mellitus patients on treatment in a tertiary care center, South India.

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Abstract: Diabetes is a multisystem disease that can produce both microvascular and macrovascular problems. The presence of significant microvascular circulation and connective tissue in the lungs indicates that the lungs might be a "target organ" in diabetic patients. Diabetes is not directly linked to any specific pulmonary pathology, hence diabetic patients don't get routinely screened for lung disease. However, this depends on duration of diabetes and glycaemic control. Patients can develop multi organ manifestations secondary to micro/macrovascular complications, which inturn affects the connective tissue and circulation of lung leading to multiple pulmonary disorders. The study's goal was to investigate pulmonary function in patients with diabetes mellitus using spirometry, as well as the correlation between pulmonary function with disease duration and Hba1c level.The hospital-based cross-sectional observational study was undertaken from August 2022 to December 2023. Total of 140 diabetes patients were recruited. All patients were subjected to PFT by spirometry after complete clinical history with particular emphasis, physical examination, imaging by chest X ray to rule out pre-existing lung diseases and HbA1c. In this study, out of 140 diabetics 83 were male and 57 were female with the mean age of 55.63 years. The results of the present study showed 66.3% abnormal PFT with 39.2% restriction (mean FVC-75.12), 12.1% obstruction (mean FEV1-68.066), 15% mixed pattern. Negative correlation was found with duration of diabetes and PFT which is statistically significant. This study shows significant abnormality of PFT with restrictive pattern as predominant followed by mixed and obstructive patterns. In this study significant reduction in pulmonary function has been noted with duration of diabetes and HbA1c. There is a negative correlation between pulmonary function with duration of diabetes and HbA1C.Hence this study shows that as duration of diabetes increases, lung function decreases.

Keywords: Diabetes Mellitus, Hba1c, Pulmonary Function Test

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Introduction:

India has emerged as the world's diabetes capital. Diabetes is anticipated to become the seventh largest contributing factor to mortality by the year 2030, in accordance to the WHO. Diabetes mellitus is an important and rapidly expanding public health concern. Diabetes mellitus is an incurable lifelong disease that affects numerous systems and causes terrible complications that lead to severe impairment and death (Arnalich et al., 2000; James et al., 2003; Meo et al., 2009). Multiple studies have identified an association between diabetes and reduced lung function (Primhak et al., 1987; Innocenti et al., 1994; Schnack et al., 1996; Davis et al., 2004; Irfan et al., 2011; Uz-Zaman et al., 2014; Tesema et al., 2020). In patients

with diabetes mellitus lungs are target organ, and hyperglycemia is a strong predictor of reduced lung function in diabetes mellitus patients.

In people with diabetes, multiple complications may affect the lungs. (Ljubić et al., 1998) proved that diabetes can cause lung problems due to modifications in collagen and elastin. Elevated non enzymatic glycation of extracellular matrix proteins and peptides in persistently elevated levels of blood glucose may have a role in the degenerative changes in lung tissue in DM patients. (Dalquen et al.,1999). Several pathogenic alterations can impact the lungs of diabetic patients. The pathophysiology of impaired lung function in diabetics is unclear, but there have been reports of histological abnormalities in diabetic individuals' lungs, including fibrosis(Fariña et al., 1995). Decreased spirometric values cannot reveal a specific underlying illness. There have been preliminary observations regarding histopathologic irregularities in lung tissue of diabetics, notably basal lamina thickness (Weynand et al., 1999)

Diabetes patients' lung function is thought to be compromised as a result of biochemical changes in lung connective tissue network constituents, especially collagen and elastin, in addition to microangiopathy resulting from non-enzymatic glycosylation of proteins caused by chronic hyperglycemicemia (Weir et al., 1988; Sandler et al.,1990; Soulis et al., 1997). The pulmonary functional abnormalities resulting by these changes are clinically reflected as a decrease in lung elastic recoil, lung volumes, and lung capacity for carbon monoxide diffusion. structural consequences of the lung associated with these metabolic alterations include thickness of alveolar epithelial basal lamina and nodular fibrosis.
(Vracko et al., 1979). One study identified autonomic and phrenic neuropathy as a cause of changes in bronchial responsiveness and respiratory muscle function (Villa et al., 1988).
Diabetes affect lung function and underlying mechanisms are:

1. Chronic inflammation: Diabetes is associated with chronic inflammation throughout the body, including in the lungs. Inflammatory processes can damage lung tissues, leading to impaired lung function.

2. Microvascular changes: Diabetes can cause microvascular damage and impaired blood flow to various organs, including the lungs. Reduced blood flow can affect oxygen exchange and nutrient supply to lung tissues, impacting their function.

3. Type 2 diabetes links to obesity and metabolic syndrome, leading to respiratory issues like sleep apnea, hypoventilation, and lung function impairment due to excess weight and altered metabolism.

4. Respiratory infections: Individuals with diabetes may have an increased susceptibility to respiratory infections, such as pneumonia.

Diabetes' effect on lung function can differ based on various factors like duration, severity, glycemic control, comorbidities, and lifestyle. Regular monitoring of lung function through pulmonary function tests and close collaboration with healthcare professionals can help in identifying any changes or complications early on and implementing appropriate management strategies. Numerous research have been conducted to study respiratory conditions linked with diabetes. However, pulmonary function decrease and its relationship with glycemic control in diabetic patients on treatment has not been sufficiently addressed in the literature. Hence this study is proposed to assess the lung function impairment in diabetic patients.

Materials and methods:

A cross sectional observational investigation was carried out in the Department of Pulmonary Medicine and General Medicine(Diabetic clinic) at Chettinad Hospital and Research Institute. IHEC approval had been obtained before the start of the study. All patients who took part in the trial gave written consent

Sample Size and Sampling Technique:

Cross sectional observation study was used and the study included 140 diabetic individuals who visited Diabetic Clinic. Study was conducted between 1st Jan 2023 to 31 st Dec 2023.

Sample size calculation

Prevalence of lung function abnormalities in diabetic patients -79% (p) based on article published in African Journal of Diabetes Medicine in 2018.

- 95% confidence interval – 1.96(z)
- Precision Error – 7%(e)
- Non-response/unable to do spirometry rate- 10%

Sample size-Cross sectional study

N = z^2 p(q)/e^2

N = 1.96^*79*(1-79)/0.07^2 = 131

N + non response rate (10%) = 144

Final sample size = 140

Inclusion criteria:

Diabetes mellitus patients visiting out-patient department (diabetic clinic) in Department of General Medicine, CHRI.

Exclusion criteria:

1)Contraindication to spirometry according to ATS guidelines.

2)Pre-existing Lung Disease.

3)Smokers (current, ex-smoker).

4)Occupational exposure to organic and inorganic dusts and bio-mass fuel exposure.

5)Haemodynamically unstable.

6)Obese and over weight (BMI $\geq$ 24 kg/m2).

All patients were subjected to PFT by spirometry after complete clinical history with particular emphasis, physical examination, imaging by chest X ray to rule out pre-existing lung diseases and HbA1c.

Pulmonary function test:

Pulmonary function tests (PFTs) were performed out according to ATS & ERS guidelines for subject maneuver, method, and level of control (Miller et al. 2005). The whole technique was demonstrated to the attendees. Subjects were instructed to take maximum inhalation & exhale into mouthpiece as quickly, rapidly, and thoroughly as possible. To maximize effort, the participants were instructed to continue exhaling at the completion of the operation. Minimum of three acceptable Forced Vital Capacity (FVC) maneuvers were done, with the ideal manoeuvre chosen and accepted. The measurements included FVC, FEV1, and FEV1/FVC ratio.

Results:

Total 140 diabetic patients recruited in the trial were selected for evaluation.

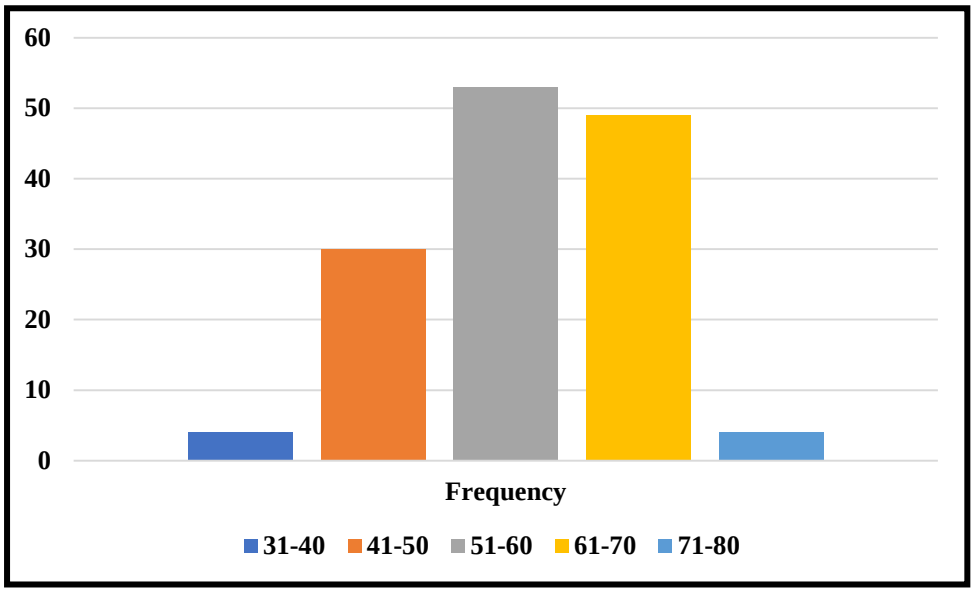
Demographic profile:

Age distribution:

Table: 1 Distribution of Age in years

Age	Frequency	Percentage
31-40	4	2.8%
41-50	30	21.42%
51-60	53	37.85%
61-70	49	35%
71-80	4	2.8%
31-80	140	100%

Figure 1: Distribution of age in years



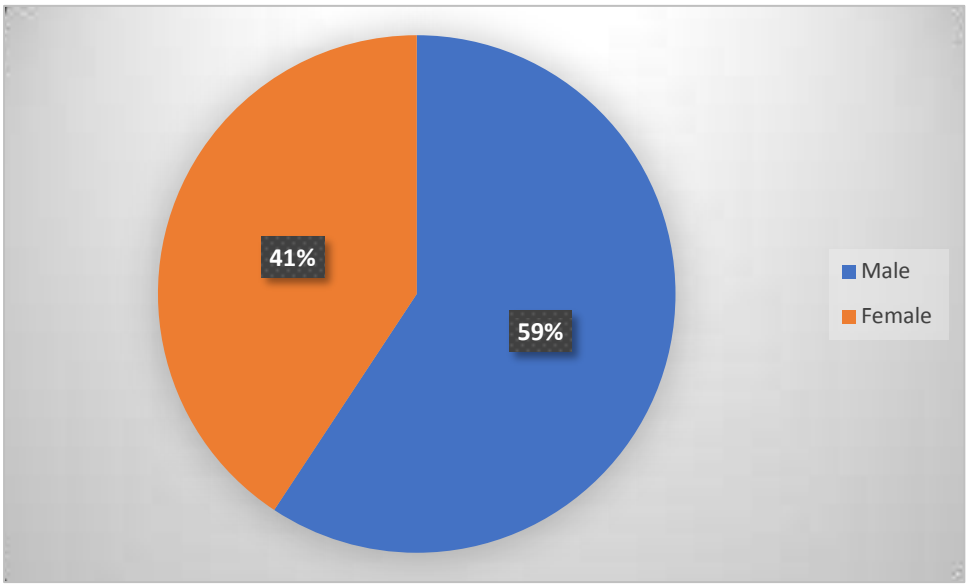
The mean age was 55.63. In this study, the majority of patients (37.85%) were between the ages of 51 and 60(37.85%), and 35% falling between the ages of 61 and 70. (table-1)

Gender distribution:

Table: 2 Distribution of Gender

Gender	Frequency	Percentage
Male	83	59.28%
Female	57	40.71%

Figure 2: Gender distribution



In our study, 83 (59.28%) of the 140 patients were males and 57 (40.71%) were females. (table-2)

Bmi distribution:

Table:3 BMI Distribution	
BMI	
MEAN	21.77
SD	1.85
Median	22.34
Range	17.9-24.6

Mean BMI was 21.77 and range of BMI was 17.9-24.6. (table-3)

Glycaemic variables:

Table: 4 Distribution of Glycaemic variables

Variables	**Mean**
FBS	184.25
PPBS	241.03
HBA_1C	10.54

Mean value of FBS was 184.25, mean PPBS was 241.03, mean HbA1c was 10.54%. (table-4)

Pulmonary function test:

Table: 5 Mean distribution of PFT

Pulmonary Function Test	**Mean**
FEV_1	78.61
FVC	77.52
FEV_1/FVC	91.57

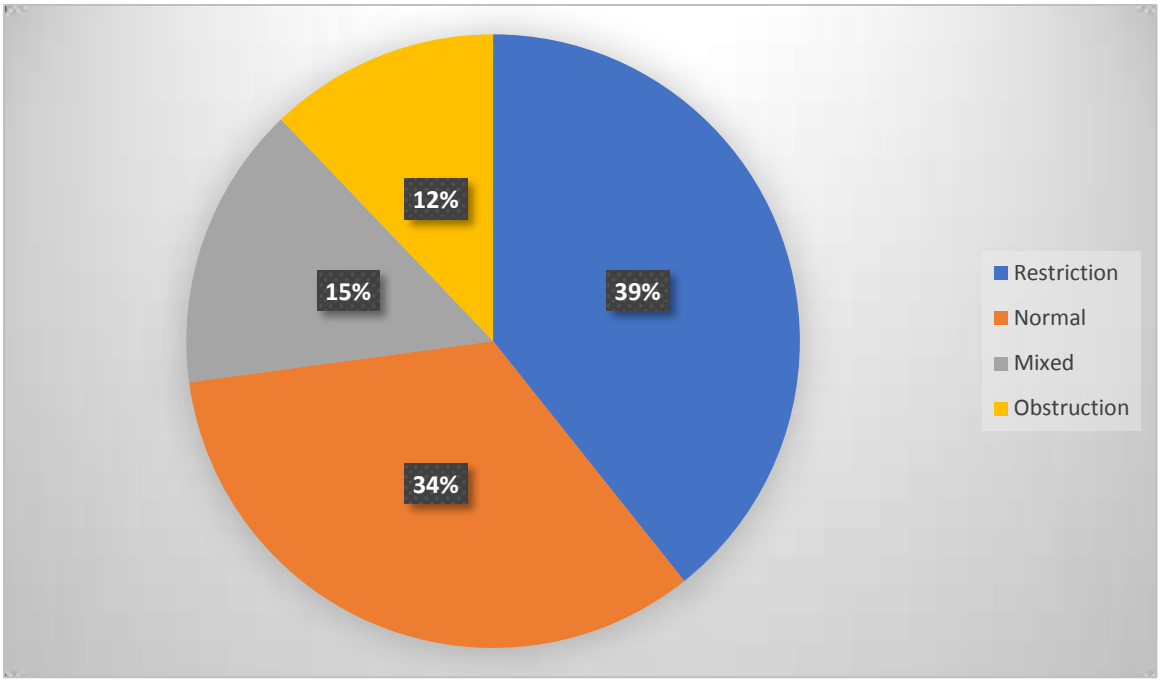
Mean values of FEV1, FVC and FEV1/FVC were 78.61%, 77.52% and 91.57% respectively. (table-5)

Interpretation of spirometry:

Table: 6 Distribution of Spirometry Interpretation:

Interpretation	**Frequency**
Normal	47(33.5%)
Restriction	55(39.2%)
Mixed	21(15%)
Obstruction	17(12.1%)
Total	140

Figure 3: Spirometry Interpretation



In our study, 47(33.5%) patients had normal spirometry, 55(39.2%) patients had restriction pattern followed by mixed pattern in 21(15%) of the patients and obstructive pattern in 17(12.1%) of the patients. (table-6)

Discussion:

The purpose of this study was to evaluate the pulmonary function of patients with diabetes mellitus. In the current study, 140 newly diagnosed and old diabetics were included. Spirometric results were consistently lower in diabetics. Our findings support prior research that found lower lung functioning in diabetes.

A major community-based study of type 2 diabetic individuals in Western Australia found reduced FVC and FEV1 levels. They additionally stated that lower lung capacity and airflow limitation are likely long-term outcomes of type 2 diabetes. (Davis et al., 2000)

(Lange et al., 1989; Boulbou et al., 2003) found that diabetes participants had decreased FVC and FEV1 compared to control people. (Asanuma et al., 1985) found that Japanese diabetics had lower FVC and FEV1 than control individuals. Similarly, (Cazzato et al., 2004) did a cross-sectional study to test pulmonary function in children with the IDDM (insulin-dependent diabetes mellitus), and discovered diabetics had considerably worse FVC and FEV1 than controls. Similarly, (Makkar et al., 2000) investigated lung function on people with IDDM and discovered that these individuals have lower FVC and FEV1 than to the match control.

In the current study, all indicators decreased as diabetes duration increased. However, statistical testing found that this was not significant, with the exception of the FVC projected %. People with diabetes more than five years had more significant decline in FVC. This

revealed that longer periods of diabetes were related with more severe spirometric abnormalities. Several other research supported this.

(Rosenecker et al., 2001) found diabetic patients' FVC and FEV1 declined dramatically throughout a five-year trial period, although people without diabetes showed no significant decrease. (Agarwal et al., 2019) found that as diabetes duration increased, the restrictive profile became more evident.

Similar to our study, (Mittal et al., 2023) healthy control subjects had normal lung function, while diabetic patients had restrictive pattern (73 out of 125), mixed patterns (11), and obstruction (10).

Supporting our findings, (S, A., et al., 2013) discovered substantial declines in pulmonary function parameters such as FVC, FEV1, FEV1/FVC in patients with type II diabetes. Out of 30 patients with type 2 diabetes, 12 had restrictive pattern. Patients who had poor blood sugar control (HbA1c > 7) showed reduced alveolar diffusion, which was independent of diabetes duration.

Conclusion:

This study shows significant abnormality of PFT with restrictive pattern as predominant followed by mixed and obstructive patterns. In this study significant reduction in pulmonary function has been noted with duration of diabetes and HbA1c. There is a negative correlation between pulmonary function with duration of diabetes and HbA1C.Hence this study shows that as duration of diabetes increases, lung function decreases. All diabetic patients, those with uncontrolled diabetes in particular, should have routine pulmonary function screenings and monitoring in order to identify respiratory impairments early on and provide appropriate treatment.

Long-term patient follow-up and a larger sample size are required; possibly, advanced equipment like oscillometry can be employed.The pathophysiology for complications in lung due to diabetes is an important area to be studied prospectively in larger population.

Limitations:

1.Sample size is low.

2.Follow up of patients could not be done for longer duration.

3.Further advanced investigations like oscillometry and DLCO could not be done.

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Conflict of Interest:
The authors declare no conflict of interest.

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