International Journal on Science and Technology (IJSAT)
E-ISSN: 2229-7677 ● Website: www.ijsat.org ● Email: editor@ijsat.org

A Study On Association of Pulmonary Function Test in Type-2 Diabetes Mellitus Patients

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ABSTRACT

Background: Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder characterised by long-term hyperglycaemia and microvascular complications of various organ systems. Pulmonary impairment is not generally recognised as a complication of diabetes, but a growing body of evidence suggests that chronic hyperglycaemia may adversely affect lung structure and function through microangiopathy, non-enzymatic glycation of connective tissue proteins and chronic inflammation.

Aim: To measure the Forced Expiratory Volume in one second (FEV1), Forced Vital Capacity (FVC) and FEV1/FVC ratio in T2DM patients to assess pulmonary function and to find their association with T2DM.

Materials and Methods: The study was conducted for a period of six months in the department of biochemistry and respiratory medicine, Era's Lucknow medical college and hospital, Lucknow. It was a hospital based cross sectional study. A total of 130 participants were recruited, 72 patients with T2DM and 58 healthy controls. Fasting Blood Glucose (FBG) and HbA1c levels were measured by fully automated analyser and pulmonary function was evaluated by spirometry for FEV1, FVC and FEV1/FVC ratio. Statistical comparisons between groups were performed using Student's t-test and correlation analyses were performed between pulmonary parameters and duration of diabetes.

Results: The mean fasting blood glucose (198 ± 52.7 mg/dL) and HbA1c (9.7 ± 2.0%) levels in T2DM patients were significantly higher than that of the controls ($p < 0.001$). Mean pulmonary function parameters were lower in diabetic patients (FEV1: 79 ± 14.99, FVC: 91 ± 15.16, FEV1/FVC: 112 ± 10.98) than in controls (FEV1: 88 ± 5.6, FVC: 98 ± 6.0, FEV1/FVC: 113 ± 9.41). Although the reductions were not statistically significant, negative correlations were found between pulmonary function indices and the duration of diabetes. Restrictive ventilatory defects were more common than obstructive defects in patients with T2DM.

Conclusion: Type 2 Diabetes Mellitus is associated with decline in pulmonary function and restrictive ventilatory abnormalities are more common than obstructive patterns. Poor lung function is related to high glycaemic indices and long disease duration. These findings support pulmonary function evaluation

as part of the routine assessment of patients with T2DM. Further larger prospective studies are warranted to evaluate the extent of pulmonary involvement and its clinical impact.

Keywords:

Type 2 Diabetes Mellitus, Pulmonary Function Test, Spirometry, FEV1, FVC, FEV1/FVC Ratio, HbA1c, and Lung Function.

1. INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a collection of metabolic conditions affecting 12% of the middle-aged population. The state of diabetes leads to several health consequences, affecting both large and small blood vessels, resulting in significant microvascular and macrovascular disorders. As a result, it has become a major worldwide public health threat. The intricacy of the matter escalates further when recognising that a considerable percentage of people, perhaps as much as fifty percent, are oblivious to their diabetes condition, since blood glucose levels in T2DM might exceed acceptable limits without obvious clinical signs.

Despite the fact that the lungs are often not seen as organs impacted by diabetes, their extensive circulatory network and rich presence of collagen and elastin fibres render pulmonary tissues susceptible to the effects of prolonged hyperglycemia. Furthermore, patients exhibiting poor glycaemic regulation and extended metabolic dysfunction are at a heightened risk of experiencing pulmonary damage.

The metabolic condition marked by insulin resistance and deficiency, leading to increased blood glucose levels, contributes to the disruption of collagen and elastin cross-linking. As a result, the flexibility of the lungs diminishes owing to this phenomenon. Hyperinsulinemia promotes the growth and increase of primary human airway smooth muscle cells, as well as their enhanced reactivity and contractile ability, which may elucidate the link between wheezing and type 1 diabetes. Insufficient studies have been performed to ascertain whether subcutaneous insulin treatment independently exacerbates the decline in pulmonary function linked to type 2 diabetes mellitus. Pulmonary function assessments (PFTs), which include diffusing capacity, lung volumes, and spirometry, represent the conventional approach for assessing pulmonary performance. These assessments aim to detect and delineate the advancement of illness that results in deteriorating pulmonary function.

Globally, diabetes mellitus (DM) has surfaced as a significant health crisis due to reasons like population growth, an ageing population, sedentary habits, obesity, unregulated urban development, industrialisation, and environmental pollution. Diabetes mellitus affects all internal functions, creating a considerable financial strain on people and communities. The worldwide incidence of diabetes mellitus is 463 million, with 374 million individuals suffering from impaired glucose tolerance, and an extra 232 million unaware of their diabetic status. Increased blood glucose levels and the length of the illness are critical risk determinants in the onset of several micro-angiopathic consequences. Uncontrolled diabetes-induced dysglycemia promotes an elevation of reactive oxygen species, resulting in disturbances in signalling pathways that cause various vascular impairments. Moreover, unmanaged diabetes can trigger numerous complications affecting various organ systems, including the cardiovascular and respiratory systems. The susceptibility of the respiratory system, especially the lungs, to microvascular problems associated with diabetes is well established. Previous studies have emphasised the metabolic and micro-

angiopathic alterations that influence elastic recoil characteristics, eventually leading to pulmonary damage in individuals with diabetes.Diabetes mellitus (DM) is a persistent ailment that presents a considerable public health issue worldwide. A recent national study released by the Indian Council of Medical Research (ICMR) has disclosed a concerning rise in diabetes rates in India. Despite the existence of evidence connecting irregular respiratory function to diabetes, the exact ramifications of this association have to be conclusively determined. Respiratory metrics act as vital indications of lung health and mortality risk in diabetic patients, even in the absence of definitive categorisation. Significantly, the International Diabetes Federation and American Diabetes Association do not formally acknowledge lung diseases as consequences of diabetes. The probability of diabetic microangiopathy impacting alveolar capillaries is significantly increased, resulting in the glycosylation of lung collagen and elastin throughout extended periods of hyperglycemia that may remain undetected in clinical environments. Research has shown a decline in respiratory metrics among diabetic individuals, with the duration of the disease significantly influencing the emergence of these complications. Diabetes mellitus is associated with many alterations in the respiratory system, including compromised respiratory muscle performance and irregularities in the thoracic wall. Diabetic individuals may have autonomic neuropathy, which may affect their respiratory control. The regulation of airway diameter by the parasympathetic system may be impaired in diabetes mellitus. Research has investigated pulmonary function in individuals with type 1 diabetes, demonstrating decreased measurements in indices such as FEV1, vital capacity, and carbon monoxide transfer in patients on insulin therapy compared to control cohorts. Nonetheless, there exists a paucity of studies on pulmonary function irregularities in patients diagnosed with type 2 diabetes.

Pulmonary function tests (PFTs) have traditionally been used to evaluate respiratory health and are essential for diagnostic and prognostic applications. These assessments seek to distinguish among typical function, obstructive pulmonary disorders, restrictive pulmonary disorders, and ailments impacting alveolar-capillary diffusion. The respiratory difficulties associated with diabetes mellitus are not well understood and significantly affect patients' quality of life. Consequently, this research aims to evaluate pulmonary functions in individuals with type 2 diabetes mellitus and juxtapose them with control participants.

Respiratory ailments associated with diabetes may lead to changes in lung capacity, diffusion, flexibility, and the functionality of respiratory muscles. Numerous histological alterations are seen in patients with diabetes. Ljubic et al. and further scholars have shown that diabetes may induce lung problems via modifications in collagen and elastin.

Furthermore, several studies suggest that increased non-enzymatic glycation of proteins and peptides in the extracellular matrix at persistently high glucose concentrations may significantly contribute to the degenerative changes in the lungs of diabetic patients. Autonomic neuropathy impacting respiratory muscles may present in these people.

Type 2 diabetes mellitus is characterised by persistent hyperglycemia and irregular metabolism of carbs, proteins, and lipids. These metabolic anomalies stem from impaired insulin secretion, altered tissue sensitivity to insulin, or the simultaneous presence of both factors. Notwithstanding the considerable emphasis on diabetes consequences such cardiovascular problems, nephropathy, diabetic retinopathy,

and neuropathy, pulmonary complications are still little defined. Recently, there has been an increasing focus on considering the lung as a target organ for diabetic microangiopathy.

The lung is affected in diabetic microangiopathy, as shown by histological observations of basal lamina thickening and fibrosis.Owing to its dense micro-vascular network and plentiful connective tissue, the lung is vulnerable to microangiopathic phenomena and non-enzymatic glycosylation of tissue proteins triggered by persistent hyperglycaemia. This designates the lung as a "target organ" in individuals with diabetes, influencing normal lung mechanics and gas exchange reliant on the integrity of pulmonary connective tissue and microvasculature. Any irregularities in these anatomical elements may result in atypical pulmonary function tests (PFT).

The association between diabetes and compromised pulmonary function has been noted, underscoring the need for more research. Diabetes mellitus correlates with heightened concentrations of systemic inflammatory mediators and indicators, which, together microangiopathy, lead to alterations in lung matrix proteins and consequent deterioration of pulmonary functioning.

Chronic inadequate management of blood glucose is likely to alter the regulation of inflammatory pathways associated with respiratory function deterioration. This deficiency mostly presents as a limitation, resulting in a significant reduction in the capacity to assimilate carbon monoxide.

The current research has been designed to investigate the potential correlation between pulmonary function tests and patients with T2DM.

AIM & OBJECTIVES OF THE STUDY

Aim

To study the association of Pulmonary Function Test [FEV1/FVC] in Type 2 Diabetes Mellitus patients.

Objectives

- To record the pulmonary function test in T2DM patients**.**
- To find association of pulmonary function test with T2DM.

RESEARCH QUESTION

- Does Type 2 Diabetes Mellitus affect Pulmonary Function Test [FEV1/FVC]?

2. REVIEW OF LITERATURE

Type 2 diabetes mellitus is a chronic condition that affects the way your body metabolizes glucose, a type of sugar that is your main source of energy. T2DM can cause serious health complications, such as heart disease, nerve damage, kidney problems, and vision loss. The symptoms of T2DM patients may include increased thirst, frequent urination, hunger, fatigue, blurred vision, slow-healing wounds, and frequent infections. Type 2 diabetes can be diagnosed with a blood test that measures your blood glucose level. The treatment of type 2 diabetes may involve lifestyle changes, such as eating a healthy diet, exercising regularly, losing excess weight, and quitting smoking[17].

Abdulsaid *et al*. (2023) conducted an observational study in Basrah City, Iraq, with a total of 182 participants who were divided into two groups: 100 healthy individuals (group 1) and 82 patients

diagnosed with type 2 diabetes mellitus (group 2). Pulmonary function tests (PFTs) were carried out using a medical spirometer, and various haematological tests were done for each participant. The results indicated a significant decrease ($p > 0.05$) in forced expiratory volume in the first second (FEV1), forced vital capacity (FVC), peak expiratory flow (PEF), and maximal voluntary ventilation (MVV) in group 2, along with a notable increase in estimated lung age (ELA). The prevalence of restrictive pulmonary disorders was higher at 24.39% compared to obstructive (10.9%) and combined (2.43%). The study revealed that pulmonary function tests were notably impacted by type 2 diabetes mellitus, with a higher occurrence of different respiratory disorders in group 2 than in group 1, particularly an increase in restrictive patterns. No significant variances were observed in FEV1, FEV1%, and PEF between the two groups. Statistical analysis further highlighted variations in the prevalence of respiratory disorders (obstructive, restrictive, and combined cases) between group 1 and group 2. In group 1, the percentage of obstructive diseases was 5%, while in group 2 it was 10.9%. Additionally, the occurrence of restrictive diseases in group 2 (24.39%) surpassed that in group 1 (9%). Group 1 did not have any combined cases, whereas group 2 had a prevalence of 2%. The proportion of normal respiratory cases in group 1 was higher at 86% compared to the 62.19% observed in diabetic group[1].

HB Maan *et al.* (2021) conducted a research study with the objective of evaluating the impact of glycated haemoglobin (HbA1c) and the duration of diabetes on the lung function of individuals with type 2 diabetes, as well as determining whether a longer duration of diabetes or elevated HbA1c levels pose a greater risk for impairing lung function. The study included a total of 202 participants, with 101 patients diagnosed with type 2 diabetes mellitus (T2DM) and 101 control subjects matched in terms of age, gender, height, and weight. The findings demonstrated a significant negative correlation between HbA1c levels and various lung function measures, such as Vital Capacity (VC), Forced Vital Capacity (FVC), Forced Expiratory Volume in the First Second (FEV1), Forced Expiratory Flow 25% (FEF-25%), Forced Expiratory Flow 50% (FEF-50%), and Forced Expiratory Flow 75% (FEF-75%). Furthermore, individuals with diabetes of 5-10 years and over 10 years exhibited significantly lower values for FEV1, FEV1/FVC%, FEF-50%, and FEF-75% compared to the control group[5].

T Saxena and P Joshi (2020) found that the significance of the value was notably high in relation to forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), FEV1/FVC ratio, and peak expiratory flow rate (PEFR) when comparing the cases with the controls[8].

In a recent study conducted by Rani *et al*. (2019), it was demonstrated that individuals with type 2 diabetes exhibit a reduction in pulmonary function parameters such as FVC, FEV1, and PEFR, suggesting a restrictive pattern of lung pathology. The study revealed a negative correlation between decreased lung functions (FVC and FEV1) and the duration of diabetes. The findings indicated a significant decrease in FVC ($\rho < 0.0001$), FEV1 ($\rho < 0.0001$), and PEFR ($\rho < 0.0001$), but an increase in FEV1/FVC ($\rho < 0.0001$) among diabetic patients compared to the control group. Furthermore, a negative correlation was observed between FVC and FEV1 when correlated with the duration of diabetes, while no significant correlation was found between PEFR and diabetes duration. Specifically, FVC exhibited a more substantial decrease compared to FEV1, with a mean percentage predicted value of 27.3% for FVC, and 21.5% and 20.8% for FEV1 and PEFR, respectively[9].

3. MATERIALS AND METHODS

Place of study: The study was conducted in the Department of Biochemistry and Respiratory Medicine in Era's Lucknow Medical College and Hospital, Lucknow
Study Design: Cross-sectional
Subjects: T2DM Patients
Time Period: 6 months

Clinical setting: OPD of Department of Respiratory Medicine, Era's Lucknow Medical College and Hospital**.** Diagnosed and confirmed T2DM patients were recruited from the patients visiting OPD of Respiratory Medicine.

Inclusion criteria

a) Diagnosed T2DM patients of both genders.
b) Patients between the age group of 25-75 yrs.

Exclusion criteria

a) Nephrotic syndrome
b) Renal failure
c) Thyroid disorder
d) Hypercholesterolemia
e) Obstructive and restrictive lung disease

SAMPLE SIZE CALCULATION

The sample size for the present study is calculated on the basis of FVC litre (% of predicted) mean and standard deviation following the studies of Salim, *et al.* (2014) by taking 95% power of study with 5% level of significance[31].

The formula used is-

$n = rH/r(SD)^2[Z_{\beta}+Z_{1-\alpha/2}]^2/d^2$

The computed minimum sample size is 104 subjects.

BIOCHEMICAL ANALYSIS

Fasting blood glucose (FBS) & HbA1c were estimated in the blood samples of the recruited subjects.
All the samples were analysed in Hospital Lab Services of Era's Lucknow Medical College and Hospital on the VITROS 5600 fully auto analyser.
All the patients also performed pulmonary function test using spirometer (Vyntus IOS) available in Department of Respiratory Medicine.

4. RESULTS

We have conducted this study by recruiting 130 subjects in 2 groups i.e. 58 subjects in control group (normal healthy person) and 72 Type 2 Diabetes Mellitus patients in study group.

GENDER DISTRIBUTION

Male and female ratio was 30:28 in control group and 44:28 in T2DM group respectively (Fig.1&2).

The biochemical and pulmonary function parameter data is presented through the arithmetic mean and standard deviation. A comparison was conducted between the mean values of pulmonary function parameters in T2DM patients and normal healthy controls using Student's t-test.

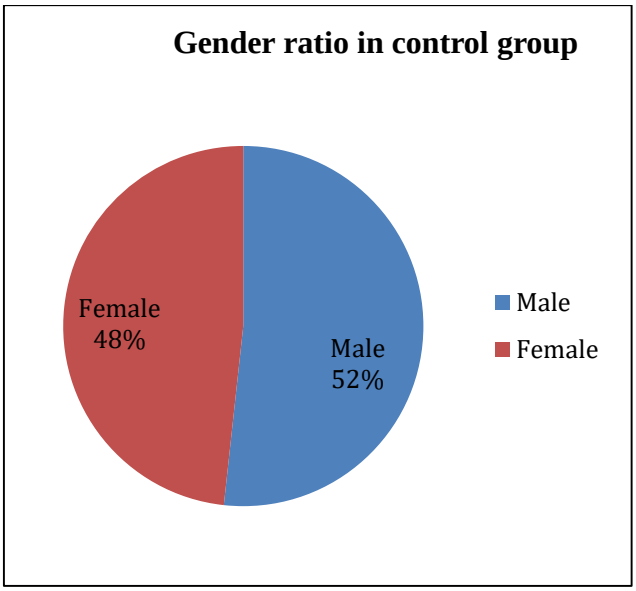

Fig.1: Gender Ratio in Control Group

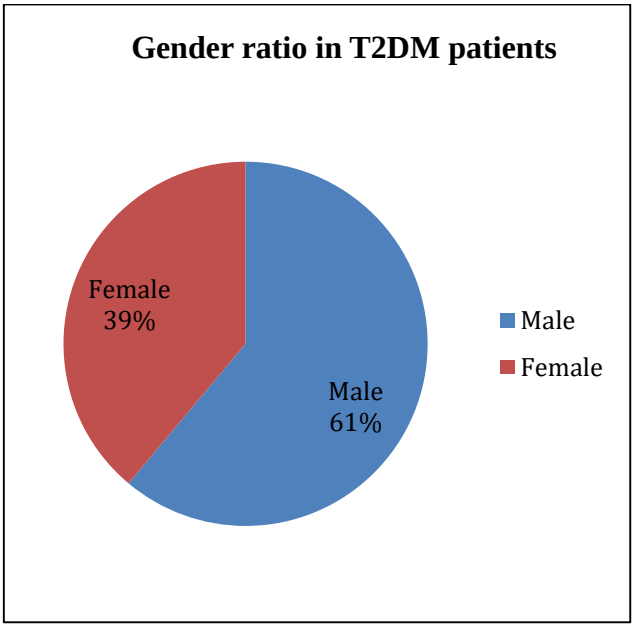

Fig.2: Gender Ratio of Type 2 DM Patients

ANALYSIS OF AGE

In control group the mean age was observed 44.86 years(range 20 to 60 years) while in the Type 2 Diabetic Mellitus group the mean age was observed 51.77 years (range 39 to 74) Table 1. In control group, minimum and maximum age was recorded as 20 and 60 respectively, while in T2DM group it was 39 and 74 respectively.

Table 1: Analysis of age in study participants

	CONTROL (mean ± SD)	**TYPE 2 DM patients (mean ± SD)**
AGE (Years)	44 ± 13.6	51 ± 10.13
RANGE	20-60	39-74

Table 2: Age distribution of study participants

Age (Years)	**No. of Control**	**No. of T2DM Patients**
20-30	09	02
31-40	15	09
41-50	14	20
51-60	13	26
61-70	06	14
71-80	01	01

In T2DM group, we observed minimum subjects (n=1) in 70-80 years age range and maximum subjects (n=26) in 50-60 years age range in Table No. 2.

COMPARISON OF FASTING BLOOD GLUCOSE

In our study, we observed the mean value of fasting blood glucose in the study population. Fasting blood glucose levels in Control group and T2DM patients were recorded as 93±7.4 and 198±52.7 respectively. Significant increase ($p<0.001$) in fasting blood glucose levels was observed in T2DMpatients as compared to control group in figure no 3 and tables no 3.

Table 3: Fasting Blood Glucose Levels in Various Subjects

	Control (mean ± SD)	**T2DM Patients (mean ± SD)**
Fasting Blood Glucose (mg/dl)	93±7.4	198±52.7

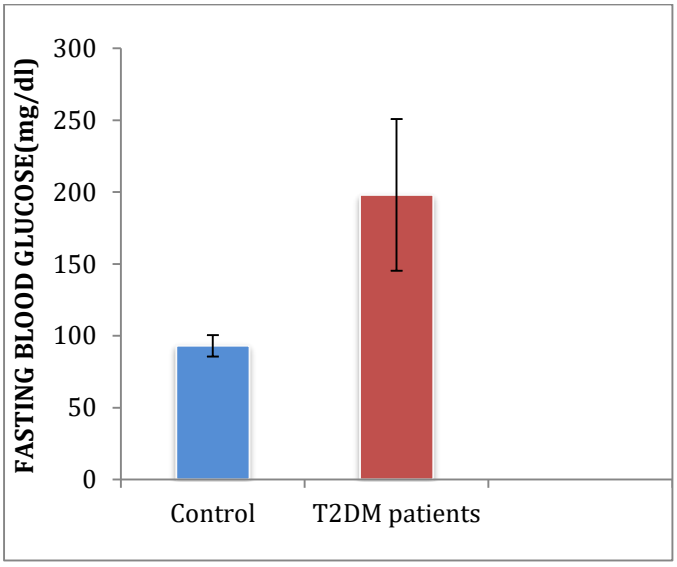

Figure No. 3: Fasting Blood Glucose Levels in various Subjects

COMPARISON OF HbA1C

In our study, we observed the mean value of HbA1Cin the study population. HbA1C values in Control group and T2DM patients were recorded as 5.44±0.61 and 9.7±2 respectively. Significant increase ($p<0.001$) in HbA1C values was observed in T2DMpatients as compared to control group in figure no 4 and tables no 4.

Table 4: HbA1c values in various subjects

	CONTROL (mean ± SD)	**T2DM Patients (mean ± SD)**
HbA1c (%)	5.44±0.61	9.7±2.0

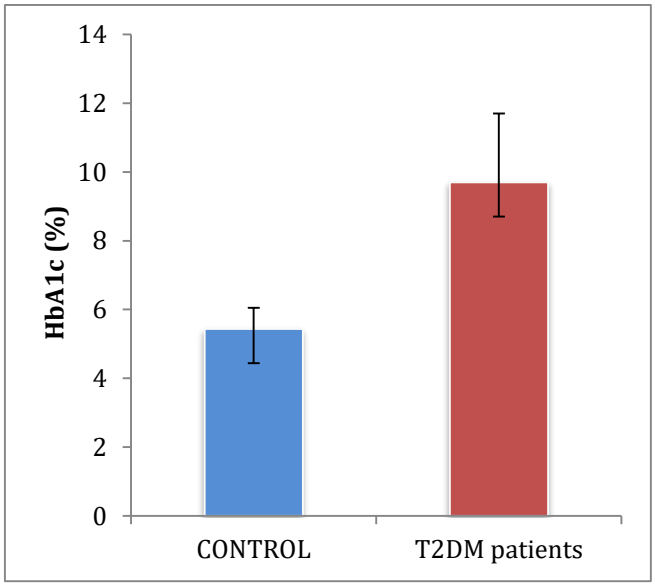

Figure No. 4: HbA1c values in various subjects

PULMONARY FUNCTION TESTS

Spirometry was done in all the normal healthy controls and T2DM patients in Department of Respiratory Medicine. FEV1, FVC and FEV1/FVC ratio was recorded. In normal healthy controls FEV1, FVC and FEV1/FVC ratio was observed as 88±5.6, 98±6 and 113±9.41 respectively, while in T2DM patients FEV1, FVC and FEV1/FVC ratio was observed as 79±14.99, 91±15.16 and 112±10.98 respectively. Non-significant ($p<0.05$) changes were observed for FEV1, FVC and FEV1/FVC ratio in T2DM patients as compare to normal healthy control as shown in table no 5 and figure no 5.

Table No: 5. Pulmonary Function Tests in controls and T2DM patients

	Control (mean ± SD)	**T2DM Patients (mean ± SD)**
FEV1	88±5.6	79±14
FVC	98±6	91±15.16
FEV1/FVC Ratio	113±9.4	112±10.98

In our study, we observed the mean value of FEV1% in the study population. FEV1%values in Control group and T2DM patients were recorded as 88±5.6 and 79±14.99 respectively. Non-significant ($p<0.05$) change in FEV1% values was observed in T2DMpatients as compared to control group.

In this study, we recorded the mean value of FVC% in the study population. FVC% values in Control group and T2DM patients were recorded as 98±6 and 91±15.16 respectively. Non-significant change ($p<0.05$) in FVC% values was observed in T2DMpatients as compared to control group.

Similarly, non-significant change in FEV1/FVC% ratio was observed in diabetic group (112±10.98) as compared to the controls (113±9.41).

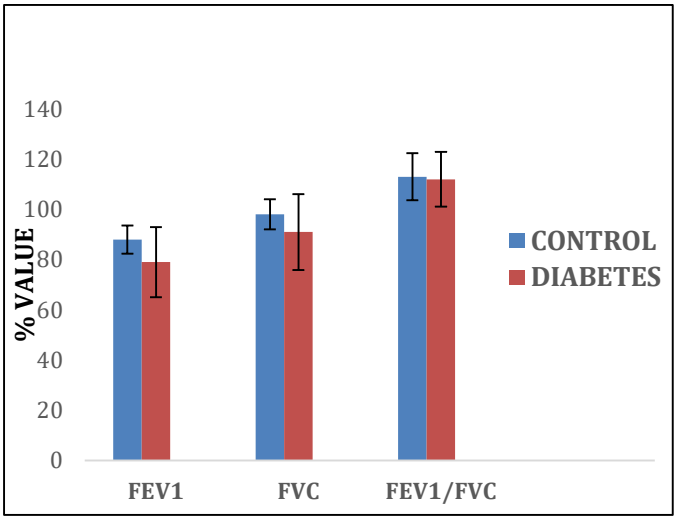

Figure No. 5: Pulmonary Function Tests in controls and T2DM patients

CORRELATION BETWEEN FVC AND DURATION OF DIABETES

Upon analyses of FVC values with the duration of diabetes in the T2DM patients, and plotting the correlation graph, we observed a negative correlation (**r= -0.119)** as demonstrated in figure no. 6.

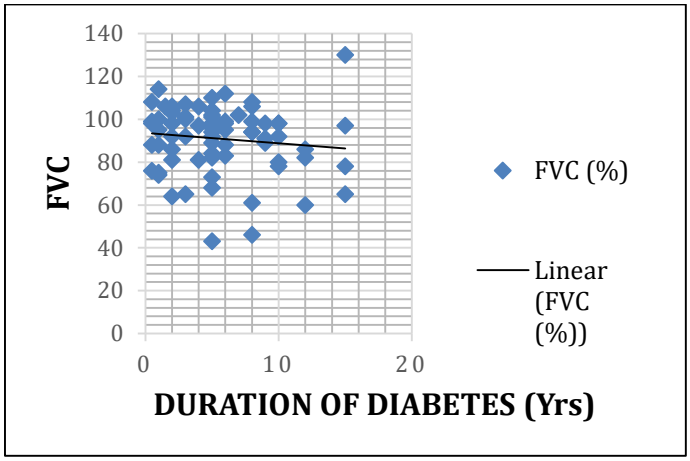

Figure 6: Correlation between FVC and duration of diabetes

CORRELATION BETWEEN FEV1 AND DURATION OF DIABETES

Upon analyses of FEV1 values with the duration of diabetes in the T2DM patients, and plotting the correlation graph, we observed a negative correlation (**r= -0.085**) as demonstrated in figure no. 7.

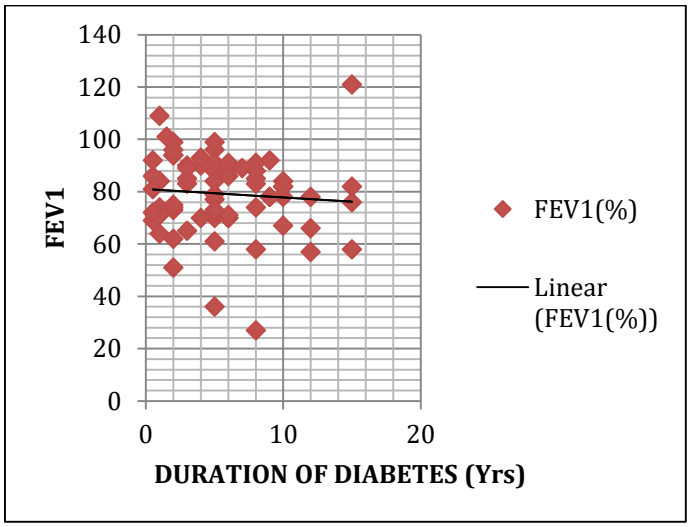

Figure 7: Correlation between FEV1 and duration of diabetes

CORRELATION BETWEEN FEV1/FVC RATIO AND DURATION OF DIABETES

Upon analyses of FEV1 values with the duration of diabetes in the T2DM patients, and plotting the correlation graph, we observed a negative correlation (**r= -0.216**) as demonstrated in figure no. 8.

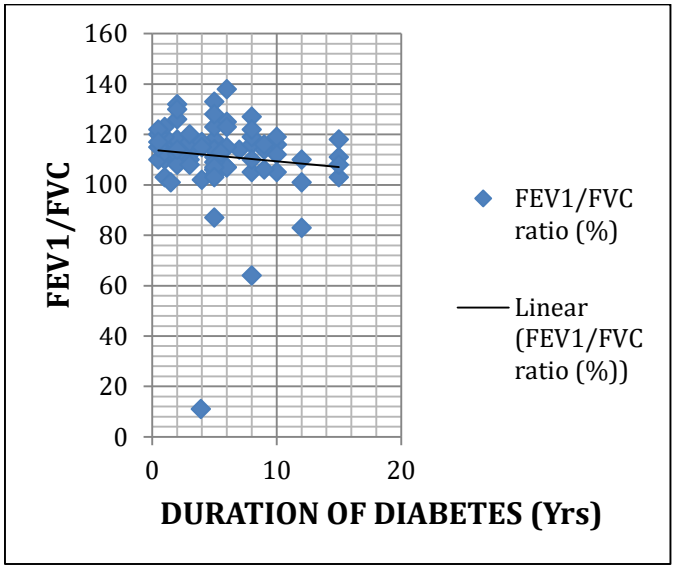

Figure 8: Correlation between FEV1/FVC ratio and duration of diabetes

VENTILATORY FUNCTION PATTERN

Spirometry is the predominant assessment for pulmonary function. It is extensively used for evaluating pulmonary function, diagnosing respiratory ailments, and tracking lung health. In 2005, the American Thoracic Society (ATS) and the European Respiratory Society (ERS) together established technical guidelines for performing spirometry.

In obstructive lung diseases, FEV1 is diminished, FVC remains normal, and the FEV1/FVC ratio is reduced. Obstructive pulmonary disease may arise from ailments including asthma, bronchitis, and COPD, among others.

In restrictive lung conditions, both FEV1 and FVC are diminished, resulting in a normal FEV1/FVC ratio. Restrictive lung disease may arise from ailments like fibrosis, interstitial lung disease, pneumoconiosis, sarcoidosis, obesity, pregnancy, and surgical loss of lung tissue, among others.

The outcomes of lung function tests demonstrated the ventilatory function pattern within the research cohort. In the control group, we identified one individual with obstructive pulmonary function and two individuals with restrictive pulmonary function, while the T2DM group had eight individuals with obstructive pulmonary function and twelve individuals with restrictive pulmonary function.

Table No 6: Ventilatory function pattern in study participants

	Control Group (n=58)	**Diabetic Group (n = 72)**
Obstructive pulmonary function	1	8
Restrictive pulmonary function	2	12

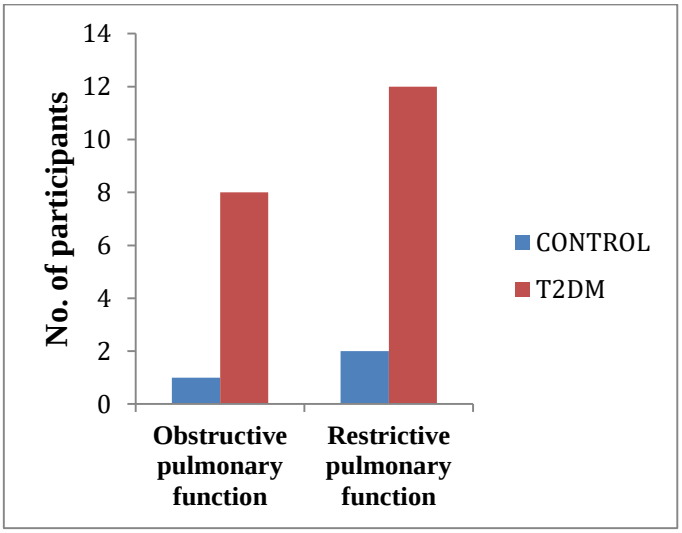

Figure 9: Ventilatory Function Pattern in Study Participants

5. DISCUSSION

The current investigation aimed to determine the potential correlation between diabetes and lung function. We enlisted 58 healthy individuals and 72 patients with T2DM who met the specified inclusion and exclusion criteria.

All spirometric parameters, namely FVC, FEV1, and FEV1/FVC, exhibited a mean reduction in the diabetes cohort relative to the control group, which was statistically validated with a P value <0.01.
The percentage forecast of the spirometric measures indicated a reduction in the diabetes cohort relative to the control group.

The findings of Abdulsaid et al. indicate that the mean PFT value in T2DM patients was markedly lower compared to the control group. A significant reduction in forced expiratory volume in the first second (FEV1) and forced vital capacity (FVC) was seen in group 2. The incidence of restrictive pulmonary conditions was higher (24.39%) than that of obstructive (10.9%) illnesses. The pulmonary function tests were notably affected by type 2 diabetes mellitus, resulting in increased occurrences of various respiratory disorders in the T2DM cohort compared to healthy individuals, marked by a rise in restrictive patterns. This investigation revealed no correlation between HbA1c levels and pulmonary function test outcomes at the time of assessment.

Our research indicates that among individuals with T2DM, the metrics of FEV1, FVC, and FEV1/FVC were reduced relative to the control cohorts. Our research examines the correlation of pulmonary function tests in individuals with T2DM, similar to the investigation conducted by Abdulsaid et al. (2023).

The research conducted by Maan et al. in 2021 demonstrates a statistically significant reduction in results and offers insights into the correlation between HbA1c levels, illness duration, and compromised lung function in T2DM. Furthermore, the results indicated that elevated HbA1c levels of > 8% are associated with a heightened risk of impaired lung function and act as a marker for lung injury in individuals with diabetes. Consequently, our findings indicate that elevated HbA1c levels in T2DM patients might be a critical indicator of detrimental effects on the lungs. The results indicate that elevated

HbA1c levels or inadequate blood sugar regulation may adversely affect pulmonary function in persons with T2DM. Furthermore, poorly controlled diabetes with high HbA1c value has a more substantial deleterious impact on pulmonary function than the duration of diabetes alone. The relationship between diabetes and pulmonary function is seen as significant because of its possible clinical consequences.

Our research further illustrates that in individuals with T2DM, there is a notable decline in pulmonary function test results along with elevated HbA1c levels.

As per study of Saxena and Joshi (2020) the p value was found highly significant for FVC, FEV1 and FEV1 /FVC between the cases and the controls($p<0.05$) showing that these pulmonary functions were reduced significantly in the cases but, the FEV1 /FVC ratio was not significantly affected by the duration of disease.

A recent investigation by Rani et al. (2019) shown that pulmonary function metrics (FVC and FEV1) are diminished in individuals with type 2 diabetes, suggesting restrictive lung pathology. A detrimental relationship was discovered between diminished lung capacities (FVC and FEV1) and the length of diabetes duration.

The Kaur and Agarwal 2016 study group noted a significant decline in all pulmonary function test measures (FVC%, FEV1%, and FEV1/FVC) among diabetics relative to the control group. Consequently, a combined obstructive-restrictive pattern of pulmonary impairment is seen in individuals with diabetes. A robust positive connection was seen between fasting blood glucose and FEV1/FVC in individuals with diabetes.

Our research reveals that there are no significant alterations in pulmonary function tests among the diabetes cohort when compared with the healthy group.

6. CONCLUSION

The findings and observations from our research allow us to deduce;

1. The incidence of T2DM grows with advancing age.
2. Markedly increased fasting blood glucose and HbA1c levels were seen in T2DM patients relative to the healthy group.

A negligible reduction in FVC, FEV1, and the FVC/FEV1 ratio was seen in T2DM patients relative to the healthy group.

Restrictive pulmonary function occurs more often than obstructive pulmonary function in persons with T2DM.

A comprehensive population research may provide greater understanding of lung impairment and disease advancement, and may assist in establishing a definitive link between diabetes mellitus and pulmonary illness.

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