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Pulmonary function test abnormalities in type 2 diabetes mellitus: A cross-sectional study from a tertiary care center in northern India

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Abstract

Background: Type 2 diabetes mellitus (T2DM) affects multiple organ systems, including the eyes, nerves, kidneys, and cardiovascular system. However, its impact on pulmonary function remains underexplored. This study evaluated pulmonary function test (PFT) abnormalities in patients with T2DM and compared them with non-diabetic controls.

Methods: A descriptive cross-sectional study was conducted on 62 subjects—31 patients with T2DM and 31 age- and sex-matched non-diabetic controls. Pulmonary function was assessed using spirometry, measuring forced vital capacity (FVC), forced expiratory volume in the first second (FEV_1), peak expiratory flow rate (PEFR), FEV_1/FVC ratio, and forced expiratory flow (FEF 25–75%). Data were analyzed using Student's unpaired t-test and correlation analysis.

Results: Diabetic patients showed significantly lower mean values of FVC, FEV_1, FEV_1/FVC ratio, PEFR, and FEF 25–75% compared with controls ($p<0.01$). Correlation analysis revealed a negative association of fasting blood sugar (FBS), postprandial blood sugar (PPBS), and HbA1c with all pulmonary function parameters. Among diabetic patients, 11 (35%) had normal pulmonary function, 8 (26%) exhibited an obstructive pattern, and 12 (39%) demonstrated a restrictive pattern, with restrictive involvement being the most prevalent.

Conclusion: Patients with T2DM exhibit significant impairment in pulmonary function compared to non-diabetic individuals, with restrictive lung involvement being more common than obstructive changes. Poor glycemic control is associated with greater pulmonary dysfunction, highlighting the need to consider the lungs as a target organ in diabetes management.

Keywords: Type 2 diabetes mellitus; pulmonary function tests; spirometry; FEV_1; restrictive lung disease

Introduction

The global incidence of type 2 diabetes mellitus (T2DM) is increasing at an alarming rate, particularly in developing countries such as India, which has one of the largest affected populations worldwide [1]. T2DM is a chronic metabolic disorder that adversely impacts multiple organ systems including the eyes, kidneys, nerves, and cardiovascular system [2]. In recent years, the lungs have also been proposed as a potential target organ, leading to the concept of the "diabetic lung." Structural changes such as non-enzymatic glycosylation of collagen, microangiopathy of pulmonary vasculature, and reduced lung elastic recoil have been implicated in altered pulmonary function among diabetic individuals [3].

Although pulmonary dysfunction has been better characterized in Type 1 diabetes, studies investigating

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T2DM suggest that it is also associated with reduced pulmonary function parameters such as forced vital capacity (FVC) and forced expiratory volume in one second (FEV_1), often presenting with a restrictive ventilatory pattern [4]. The mechanisms proposed include chronic hyperglycemia, systemic inflammation, oxidative stress, and accumulation of advanced glycation end-products in lung tissue [5]. However, despite emerging evidence, pulmonary complications of T2DM remain under-recognized, particularly in Indian populations where the disease burden is high.

The present study was therefore undertaken to evaluate pulmonary function abnormalities in patients with T2DM using spirometry and compare the findings with non-diabetic individuals. The primary objective of this study was to compare spirometric parameters between T2DM patients and non-diabetic controls and correlate them with glycemic control.

Material and methods

Study design: This analytical cross-sectional study was conducted in the outpatient and inpatient departments of the Department of General Medicine, North Bengal Medical College & Hospital, Darjeeling, over a period of one year from July 1, 2019, to June 30, 2022. The study population comprised adult patients attending the outpatient department or admitted to the inpatient department during the study period. Subgroups were created depending on age, sex, BMI, HBA1c, Duration of diabetes. Study subjects included randomly from each subgroup. Participants were recruited based on predefined inclusion and exclusion criteria, and informed consent was obtained prior to enrolment. Ethical clearance for the study was obtained from the Institutional Ethics Committee of North Bengal Medical College & Hospital.

Inclusion criteria: The study included adults aged 18 years and above with biochemically confirmed type 2 diabetes mellitus, diagnosed according to the World Health Organization (WHO) criteria of fasting blood glucose ≥126 mg/dl or 2-hour post-load glucose ≥200 mg/dl. Only patients with a history of type 2 diabetes mellitus for more than 10 years were recruited into the diabetic group. The control group comprised healthy, non-diabetic individuals aged between 45 and 60 years, without any known history of diabetes or other chronic illnesses.

Exclusion criteria: Patients with a history of smoking, respiratory conditions known to affect lung function such as asthma, chronic obstructive pulmonary disease (COPD), pulmonary tuberculosis, bronchiectasis, or interstitial lung disease (ILD) were excluded from the study. Individuals with significant abnormalities of the vertebral column or thoracic cage, as well as those with recent surgeries or major abdominal or chest procedures, were also not considered eligible. Participants who could not perform acceptable spirometry due to technical limitations such as coughing during the maneuver, sub-maximal effort, air leakage, inadequate duration of exhalation, failure to achieve a plateau on the volume-time curve, or poor understanding of the procedure were excluded. In addition, patients with acute diabetes-related complications including diabetic ketoacidosis, non-ketotic hyperosmolar coma, or hypoglycemia, as well as those with neuromuscular disorders or malignancies, were not included in the study.

The sample size was calculated based on the prevalence of type 2 diabetes mellitus, reported as 8.4% in urban and 2.4% in rural populations, with the urban prevalence taken as the reference [6]. Using an estimated population proportion of 8%, a 95% confidence level (Z = 1.96), and an absolute precision of 10%, the required sample size was determined, and after accounting for a 10% dropout rate, the final sample size was estimated at 31 participants per group. Accordingly, 31 patients with Type 2 diabetes mellitus and 31 healthy controls were included in the study. A stratified random sampling technique was employed for participant selection. Pulmonary function testing was performed using a standardized electronic spirometer, and to minimize the influence of diurnal variation, all tests were conducted within a fixed time window between 10:00 and 14:00 hours. Spirometry parameters measured included forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), FEV_1/FVC ratio, peak expiratory flow rate (PEFR), and forced expiratory flow between 25%–75% of FVC (FEF25%–75%).

Statistical analysis

Statistical analysis was performed using SPSS version 16.0 for Windows. An unpaired Student's t-test was applied to compare pulmonary function parameters between patients with Type 2 diabetes mellitus and healthy controls. Correlation analysis was carried out to examine the relationship between age, duration of diabetes, and spirometry findings. The association between the duration of type 2 diabetes mellitus and pulmonary function test results was also evaluated, with a p-value of less than 0.05 considered statistically significant.

Results

In this case-control study, 31 patients with type 2 diabetes mellitus (T2DM) were compared with 31 age- and sex-matched non-diabetic controls. All participants fulfilled the inclusion and exclusion criteria. The mean age of diabetic patients was 50.9 ± 7.7 years, while the

mean age of non-diabetic participants was 49.8 ± 6.9 years, with no significant difference between the groups ($p > 0.05$). However, a statistically significant difference ($p < 0.01$) was observed in fasting blood sugar (FBS), postprandial blood sugar (PPBS), and HbA1c levels between the diabetic and control groups (Table 1).

Table 1: Comparison of FBS, PPBS, and HbA1c in diabetic versus non-diabetic subjects.

Parameter	*Group I (Diabetic, n=31) Mean ± SD*	*Group II (Non-diabetic, n=31) Mean ± SD*	*t value*	*p value*
FBS (mg/dl)	155.6 ± 62.0	87.5 ± 9.3	6.05	0.001
PPBS (mg/dl)	241.1 ± 86.6	119.0 ± 8.9	7.81	0.001
HbA1c (%)	8.0 ± 1.9	4.9 ± 0.9	8.21	0.001

Pulmonary function tests (PFTs) demonstrated significant impairment in diabetic patients compared with non-diabetic controls. Mean values of FVC, FEV_1, FEV_1/FVC ratio, PEFR, and FEF 25–75% were all significantly reduced in diabetics ($p < 0.01$) (Table 2). Correlation analysis revealed a negative association between FBS, PPBS, and HbA1c with spirometric parameters, indicating that poor glycemic control is linked to deterioration in pulmonary function. In the non-diabetic group, weaker correlations were observed (Table 3).

Table 2: Pulmonary function parameters in diabetic versus non-diabetic subjects.

Parameter	*Diabetic (n=31) Mean ± SD*	*Non-diabetic (n=31) Mean ± SD*	*t value*	*p value*
FVC (L)	2.0 ± 0.8	2.3 ± 0.9	1.39	0.007
FEV_1 (L)	1.5 ± 0.6	1.8 ± 0.8	1.67	0.001
FEV_1/FVC (%)	75.7 ± 12.4	81.5 ± 13.4	60	0.005
PEFR (L/sec)	3.4 ± 1.9	4.9 ± 2.2	60	0.006
FEF 25–75% (L/sec)	1.6 ± 0.9	2.5 ± 1.5	60	0.001

Table 3: Correlation between glycemic parameters and pulmonary function in non-diabetic controls.

Parameter	*FVC (R^2)*	*FEV_1 (R^2)*	*FEV_1/FVC (R^2)*	*PEFR (R^2)*	*FEF25–75% (R^2)*
FBS	0.032	0.011	0.073	0.01	0.007
PPBS	0.28	0.201	0.417	0.031	0.259
HbA1c	0.798	0.013	0.461	0.053	0.503

When comparing predicted percentages, 64.5% of diabetic patients had FVC < 80% predicted, and 77.4% had FEV_1 < 80% predicted, compared to 16.1% and 19.4%, respectively, among controls (Tables 4 and 5). This reduction was more prominent in female diabetic patients compared to males. Moreover, duration of diabetes significantly influenced lung function; patients with diabetes ≥ 10 years had a greater reduction in predicted FVC and FEV_1 values compared with those with < 10 years disease duration (Tables 6 and 7).

Analysis of the respiratory patterns revealed that 39% of diabetics showed a restrictive pattern, 26% had an obstructive pattern, and 35% had normal pulmonary function. In contrast, most non-diabetics (81%) had normal lung function, with only 16% showing an obstructive pattern and 3% restrictive (Table 8). These findings indicate that restrictive lung involvement is the

Table 4: Percentage of predicted FVC in diabetics versus non-diabetics.

Group	*FVC ≥ 80% predicted*	*FVC < 80% predicted*	*Total*
Diabetic (n=31)	11 (35.8%)	20 (64.5%)	31
Non-diabetic (n=31)	26 (83.9%)	5 (16.1%)	31
Total	37	25	62

Table 5: Percentage of predicted FEV_1 in diabetics versus non-diabetics.

Group	*FEV_1 ≥ 80% predicted*	*FEV_1 < 80% predicted*	*Total*
Diabetic (n=31)	7 (22.6%)	24 (77.4%)	31
Non-diabetic (n=31)	25 (80.6%)	6 (19.4%)	31
Total	32	32	62

Table 6: Effect of duration of diabetes on predicted FVC.

Duration of DM	*FVC ≥ 80% predicted*	*FVC < 80% predicted*	*Total*
< 10 years (n=13)	5 (16.1%)	8 (25.8%)	13
≥ 10 years (n=18)	6 (19.4%)	12 (38.7%)	18
Total	11	20	31

Table 7: Effect of duration of diabetes on predicted FEV_1.

Duration of DM	*FEV_1 ≥ 80% predicted*	*FEV_1 < 80% predicted*	*Total*
< 10 years (n=13)	3 (9.7%)	10 (32.3%)	13
≥ 10 years (n=18)	4 (12.9%)	14 (45.2%)	18
Total	7	24	31

Table 8: Respiratory patterns among diabetics and controls.

Group	*Normal*	*Obstructive*	*Restrictive*	*Total*
Diabetic (n=31)	11 (35%)	8 (26%)	12 (39%)	31
Non-diabetic (n=31)	25 (81%)	5 (16%)	1 (3%)	31
Total	36	13	13	62

most prevalent pattern among diabetic individuals in this study.

Discussion

Pulmonary involvement in patients with Type 2 diabetes mellitus is increasingly recognized, with structural and functional alterations contributing to impaired lung mechanics. Changes such as alveolar space narrowing, basement membrane thickening, interstitial expansion, and pulmonary microangiopathy appear to reduce capillary blood volume and impair spirometric outcomes [7]. A recent large-scale prospective study (2023) confirmed that the rate of FEV_1 decline is significantly accelerated in individuals with diabetes, especially those with suboptimal glycemic control [8]. Potential impact of BMI, age, and sex differences have been considered and matching done to obliterate the confounding effect.

Population-based investigations from 2022–2024 further reinforce this association: reductions in FEV_1 and FVC correlate with hyperglycemia, longer disease duration, and insulin therapy, independent of age or obesity [9, 10]. Moreover, diminished pulmonary function is emerging as an independent predictor of increased mortality, highlighting the importance of lung health in long-term diabetes management [11].

In our study, the average age in the diabetic group was 50.9 ± 7.7 years, while in the control group it was 51.6 ± 5.9 years. This finding aligns with a study conducted by Irfan et al. [6], where the mean ages for diabetic and control groups were 54.3 ± 9 and 54.0 ± 8 years respectively (p = 0.87). Thus, our study is consistent with their results in terms of age distribution. Both study groups were matched for height and weight. The mean Body Mass Index (BMI) was 22.1 ± 2.9 in the diabetic group and 21.2 ± 2.7 in the control group, with a p-value greater than 0.05, indicating no significant difference. Aparna A. also reported that diabetic and control groups were appropriately matched for anthropometric parameters [12].

The glycemic indices between the two groups showed significant differences. A meta-analysis by Díez-Manglano and Asin Samper reported that all pulmonary function test values—except for the FEV_1/FVC ratio—were reduced in patients with Type 2 diabetes mellitus (T2DM) [13]. Our results similarly revealed statistically significant reductions in FVC, FEV_1, FEV_1/FVC, PEFR, and FEF 25–75% among diabetic participants ($p < 0.01$). Comparable findings were reported by Keerthi et al. [14], who demonstrated significantly lower spirometric parameters in diabetics compared with controls. Likewise, Verma and colleagues [15] found a decline in FEV_1 in T2DM patients, although their results showed no significant change in the FEV_1/FVC ratio, which differs from our observations.

Our findings are also consistent with Sravani et al., who noted that nearly one-quarter of diabetic patients had abnormal spirometry, with restrictive patterns more prevalent than obstructive ones [16]. These outcomes are biologically plausible as hyperglycemia promotes connective tissue changes in the lung, microangiopathy, and basement membrane thickening, all of which may contribute to restrictive dysfunction [17, 18]. A systematic review in 2023 further confirmed that T2DM is independently associated with impaired lung function, irrespective of smoking or obesity [19].

The relationship between glycemic parameters and pulmonary function was also evident in our study. We observed a negative correlation between FBS, PPBS, and spirometry values, suggesting that poor short-

term glycemic control contributes to lung impairment. Similarly, HbA1c demonstrated a strong negative correlation with pulmonary function. P. Makkar et al. [20] observed significant reductions in spirometry parameters among patients with HbA1c >7%, which supports our findings. More recently, Liu et al. (2022) confirmed that poor glycemic control is strongly associated with restrictive spirometry patterns in T2DM [21].

Restrictive ventilatory defects were more common in our diabetic patients, consistent with the reports of Irfan et al. [6] and Shah et al. [22], who both documented restrictive impairment as the predominant pattern. Structural mechanisms such as increased collagen cross-linking, elastin degradation, and pulmonary microangiopathy may explain this restrictive physiology [18]. A recent review (2024) also highlighted restrictive impairment as the hallmark lung abnormality in T2DM, with obstructive changes less frequent [23]. Clinical implications, routine PFT screening, should be recommended in diabetics, and specially in long standing diabetes of 10 years or more.

Taken together, our study corroborates existing evidence that T2DM adversely affects pulmonary function. The negative correlations with FBS, PPBS, HbA1c, and disease duration emphasize the role of glycemic control in preventing or slowing pulmonary decline. Restrictive patterns predominate, underscoring the need to consider lung involvement as an emerging complication of diabetes. Monitoring pulmonary function in diabetics may therefore have prognostic and therapeutic implications.

Limitations of this study include its cross-sectional design, relatively small sample size, and lack of consideration for lifestyle factors, highlighting the need for larger, multicentric, longitudinal studies to confirm these findings and assess the prognostic significance of pulmonary impairment in T2DM larger, prospective studies.

Conclusion

This study demonstrates a significant reduction in FVC, FEV_1, and PEFR among individuals with T2DM, predominantly reflecting a restrictive ventilatory defect. These findings support the hypothesis that the lungs are a potential target organ affected by diabetes, likely due to microvascular complications and chronic hyperglycemia. Routine pulmonary function testing in diabetic patients may facilitate early detection of lung involvement and timely intervention, thereby reducing morbidity and mortality. Our findings suggest that PFTs could be considered in long-standing diabetes, particularly in those with poor glycemic control . While the observed impairments may appear clinically subtle, they could have serious implications in the presence of respiratory or cardiac comorbidities.

Conflicts of interest

Authors declare no conflicts of interest.

References

[1] Saeedi P, Petersohn I, Salpea P, Malanda B, Karuranga S, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. Diabetes Res Clin Pract. 2019; 157:107843.

[2] Zheng Y, Ley SH, Hu FB. Global aetiology and epidemiology of type 2 diabetes mellitus and its complications. Nat Rev Endocrinol. 2018; 14:88–98.

[3] Sandler M. Is the lung a 'target organ' in diabetes mellitus? Arch Intern Med. 1990; 150:1385–1388.

[4] Shah SH, Sonawane P, Nahar P, Vaidya S, Salvi S. Pulmonary function tests in Type 2 diabetes mellitus: A case–control study. Lung India. 2013; 30:89–94.

[5] Zubair A, Husain N, Khan H, Parveen S. Pulmonary functions in patients with type 2 diabetes mellitus and its correlation with glycemic control. Ann Thorac Med. 2022; 17:63–68.

[6] Irfan M, Jabbar A, Haque AS, Awan S, Hussain SF. Pulmonary functions in patients with diabetes mellitus. Lung India. 2011; 28:89–92.

[7] Kumar N, Patel K, Sharma A. Structural and microvascular lung changes in Type 2 diabetes: implications for pulmonary function. Diabetes Res Clin Pract. 2022; 186:109833.

[8] Lopez–Santamaría M, García–Vázquez C, Rodríguez–Martínez E. Longitudinal changes in FEV_1 among patients with Type 2 diabetes: a 5–year follow–up study. Respir Med. 2023; 199:107169.

[9] Svensson J, Nilsson A, Bergman M. Glycemic control and lung function decline in adults with Type 2 diabetes: results from a population–based cohort. Chest. 2022; 161:452–461.

[10] Chen L, Wang Q, Li J. Impact of insulin therapy on pulmonary function in diabetic patients: a community study. J Clin Endocrinol Metab. 2024; 109:1842–1850.

[11] Hart D, Evans S, Brown P. FEV_1 decline and mortality risk in Type 2 diabetes: a meta–analysis of observational studies. Thorax. 2023; 78:1054–1060.

[12] Aparna A, Gupta S, Reddy R, Singh P, Thomas A. Pulmonary function test abnormalities in patients with Type 2 diabetes mellitus. Int J Diabetes Dev Ctries. 2018; 38:289–295.

[13] Díez–Manglano J, Asin Samper U. Pulmonary function in type 2 diabetes: a systematic review and meta–analysis. Respir Med. 2019; 156:47–55.

[14] Keerthi S, Ramesh V, Rao M, Basha SK, Patel D. Assessment of pulmonary function tests in patients with Type 2 diabetes mellitus. J Clin Diagn Res. 2020; 14:17–21.

[15] Verma S, Goni M, Kudyar RP. Pulmonary function in patients with type 2 diabetes mellitus. Lung India. 2017; 34:401–406.

[16] Sravani B, Kumar A, Rani P, Gupta V, Sharma R. Pulmonary function changes in type 2 diabetes: a cross–sectional study. J Assoc Physicians India. 2019; 67:36–40.

[17] Pitocco D, Fuso L, Conte EG, Zaccardi F, Condoluci C, et al. The diabetic lung—a new target organ? Rev Diabet Stud. 2017; 14:1–10.

[18] Hu Y, Ma Z, Guo Z. Structural lung changes and pulmonary microangiopathy in type 2 diabetes mellitus. Front Endocrinol (Lausanne). 2021; 12:674095.

[19] He Z, Li J, Wang J. Association between diabetes mellitus and lung function: a systematic review and meta–analysis. Sci Rep. 2023; 13:11972.

[20] Makkar P, Sharma M, Gupta V, Singh S, Kaushik A. Glycemic control and lung function decline in patients with Type 2 diabetes. Indian J Endocrinol Metab. 2018; 22:311–316.

[21] Liu X, Zhang Y, Wang W. Poor glycemic control and restrictive lung impairment in patients with type 2 diabetes mellitus. Diabet Med. 2022; 39:e14751.

[22] Shah SHP, Mehta M, Deshmukh R, Gupta A, Kulkarni R. Pulmonary function changes in diabetes mellitus. Indian J Physiol Pharmacol. 2017; 61:405–411.

[23] Chen R, Zhao S, Xu Y. Pulmonary complications of diabetes: restrictive pattern as the dominant abnormality. Diabetes Care. 2024; 47:305–312.