# Evaluation of Pulmonary Function Parameters in Children with Type 1 Diabetes Mellitus

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**Abstract:** *Background*: Type 1 Diabetes Mellitus (T1DM) is a chronic autoimmune condition characterized by insulin deficiency. Emerging evidence suggests that type 1 diabetes mellitus (T1DM) may contribute to pulmonary dysfunction in children.

*Objectives*: To evaluate pulmonary function changes in children with T1DM and assess the relationship of pulmonary function test (PFT) changes with glycemic control.

*Methods*: A total of 62 children aged 6–16 years were enrolled, including 32 with type 1 diabetes mellitus (T1DM) and 30 healthy, age-matched controls. Spirometry parameters (FVC, FEV1, FEV1/FVC, PEFR) and diffusion capacity (DLCO) were assessed. Diabetic children were subgrouped based on glycemic control (HbA1c < 9.5 vs. > 9.5).

*Results*: Children with T1DM had significantly lower FVC ($p < 0.001$), FEV1/FVC ($p < 0.005$), and DLCO ($p < 0.03$) compared to the control group. FEV1 and PEFR differences were not statistically significant. Among diabetic children, FEV1/FVC was significantly reduced in those with an HbA1c level greater than 9.5 ($p = 0.003$).

*Conclusion*: Children with T1DM demonstrate early pulmonary impairment, especially restrictive changes with mixed ventilatory defects and decreased diffusion capacity. Routine spirometric screening may aid early detection of respiratory complications in pediatric diabetes.

**Keywords:** Pulmonary function test, diabetes mellitus, children, spirometry, DLCO, glycemic control.

## INTRODUCTION

Diabetes mellitus is a metabolic disorder characterized by chronic hyperglycemia resulting from either insulin deficiency or insulin resistance. Type 1 Diabetes Mellitus (T1DM) is prevalent in the pediatric population and is caused by autoimmune destruction of pancreatic β-cells [1, 2]. While long-term complications of diabetes affecting the kidneys, eyes, and nerves are well documented, its impact on lung function is increasingly recognized [3, 4]. Pulmonary microangiopathy and non-enzymatic glycation of collagen and elastin in lung tissue may contribute to decreased lung compliance and diffusion abnormalities [3, 5]. However, data on lung involvement in children with T1DM, especially from India, remains sparse [2, 6]. This study evaluates changes in pulmonary function in children with T1DM and explores the associations with glycemic control.

### Objectives

The primary objective of this study was to evaluate the changes in pulmonary function in children diagnosed with Type 1 Diabetes Mellitus (T1DM). Additionally, the study aimed to assess the relationship between these pulmonary function test (PFT) changes and the degree of glycemic control, thereby exploring whether poor glycemic regulation contributes to pulmonary dysfunction in this population.

## MATERIALS AND METHODS

This comparative observational study was conducted at BLDE Medical College Hospital, Vijayapura, from May 2023 to December 2024. Sixty-two children aged 6–16 years were enrolled, comprising 32 patients with T1DM and 30 healthy controls matched for age and gender. Ethical approval was obtained from the Institutional Ethics Committee (Ref: BLDE(DU)/IEC/961/2022-23), and informed written consent was obtained from parents or legal guardians.

Children aged between 6 to 16 years with a confirmed diagnosis of Type 1 Diabetes Mellitus were included in the study. An equal number of age- and gender-matched non-diabetic children were selected as controls. All participants were required to be free from acute or chronic respiratory illnesses, cardiopulmonary conditions, and any history of major thoracic or abdominal surgery. Additionally, children with known complications of diabetes, such as retinopathy,

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nephropathy, or neuropathy, were excluded to ensure advanced systemic complications did not confound the pulmonary function changes assessed.

All participants underwent spirometry testing to measure Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV1), the FEV1/FVC ratio, Peak Expiratory Flow Rate (PEFR), and Diffusion Capacity for Carbon Monoxide (DLCO). The spirometer was calibrated daily and operated within the ambient temperature range of 20°C to 25°C. Each test was performed three times, and the best result was selected for analysis. Data were recorded and analyzed using SPSS version 20. Continuous variables were reported as mean ± standard deviation, and group comparisons were performed using the Independent t-test or the Mann-Whitney U test, where appropriate. A p-value of less than 0.05 was considered statistically significant.

## RESULTS

A total of 62 children were enrolled in the study, with 32 children in the T1DM group and 30 in the control group. In the T1DM group, 56.25% (n = 18) were males and 43.75% (n = 14) were females, whereas in the control group, 63.3% (n = 19) were males and 36.6% (n = 11) were females. No significant difference was observed in gender distribution (p = 0.29) or age group (p = 0.16) between the groups (Table **1**).

However, a significant association was observed for maternal and family history of diabetes (p = 0.03), both present only in the T1DM group, suggesting a potential genetic predisposition. Radiographic abnormalities were seen in 9.3% (n=3) of T1DM subjects and 3.3% (n=1) of controls.

Spirometry findings showed that FVC (2.03 ± 0.47 vs 2.2 ± 0.86, p < 0.001), FEV1/FVC (80.14 ± 16.7 vs 91.30 ± 6.83, p < 0.005), and DLCO (9.96 ± 1.24 vs 11.10 ± 0.89, p < 0.03) were significantly reduced in T1DM patients compared to controls, indicating possible restrictive and diffusion impairments. FEV1 (1.72 ± 0.52 vs 2.10 ± 0.71, p = 0.08) and PEFR (4.8 ± 0.7 vs 3.84 ± 0.52, p = 0.10) were not significantly different (Table **2**).

Among diabetic children, those with HbA1c > 9.5 showed a significantly lower FEV1/FVC ratio (80.76 ± 19.8 vs 79.63 ± 7.07, p = 0.003) compared to those with HbA1c < 9.5. Other parameters, including FVC, FEV1, PEFR, and DLCO, did not show statistically significant differences between the glycemic control subgroups (Table **3**).

## DISCUSSION

The findings of our study indicate that children with Type 1 Diabetes Mellitus exhibit measurable impairments in pulmonary function, particularly in

**Table 1: Baseline Characteristics of the Study Population**

| Parameter | T1DM Group (n=32) | Control Group (n=30) | p-value |
|---|---|---|---|
| Male, n (%) | 18 (56.25%) | 19 (63.3%) | 0.29 |
| Female, n (%) | 14 (43.75%) | 11 (36.6%) | |
| <10 years, n (%) | 20 (62.5%) | 15 (50%) | 0.16 |
| >10 years, n (%) | 12 (37.5%) | 15 (50%) | |
| Maternal History of DM, n (%) | 4 (12.5%) | 0 | 0.03* |
| Family History of DM, n (%) | 4 (12.5%) | 0 | 0.03* |

**Table 2: Comparison of Spirometry Parameters Between Groups**

| Parameter | T1DM (Mean ± SD) | Control (Mean ± SD) | p-value |
|---|---|---|---|
| FVC | 2.03 ± 0.47 | 2.20 ± 0.86 | <0.001** |
| FEV1 | 1.72 ± 0.52 | 2.10 ± 0.71 | 0.08 |
| FEV1/FVC | 80.14 ± 16.71 | 91.30 ± 6.83 | <0.005** |
| PEFR | 4.80 ± 0.70 | 3.84 ± 0.52 | 0.10 |
| DLCO | 9.96 ± 1.24 | 11.10 ± 0.89 | <0.03* |

**Table 3: Spirometry Parameters in T1DM Group by Glycemic Control (HbA1c)**

| Parameter | HbA1c < 9.5 (Mean ± SD) | HbA1c > 9.5 (Mean ± SD) | p-value |
|---|---|---|---|
| FVC | 2.02 ± 0.37 | 1.96 ± 0.50 | 1.01 |
| FEV1 | 1.59 ± 0.30 | 1.65 ± 0.37 | 0.54 |
| FEV1/FVC | 79.63 ± 7.07 | 80.76 ± 19.8 | 0.003** |
| PEFR | 3.65 ± 0.52 | 3.84 ± 0.44 | 0.48 |
| DLCO | 9.80 ± 0.91 | 10.05 ± 1.40 | 0.18 |

parameters associated with lung volume and gas exchange. These results align with prior research suggesting that chronic hyperglycemia may lead to non-enzymatic glycation of lung tissue, resulting in reduced lung compliance, microangiopathy, and decreased diffusion capacity [3, 5].

The significant reduction in FVC and DLCO observed in our study supports the theory of restrictive lung changes associated with type 1 diabetes mellitus (T1DM). While FEV1 and PEFR did not differ significantly, the FEV1/FVC ratio was notably decreased, particularly in children with poorer glycemic control (HbA1c > 9.5), a pattern typically seen in obstructive lung disease, suggesting an impact on airway dynamics. These results are comparable to those reported in studies by Van den Borst *et al*. [7] and Cazzato *et al*. [6], which demonstrated early pulmonary involvement in children with diabetes.

The presence of maternal and family history of diabetes in T1DM cases, but not in controls, may point toward a hereditary or genetic component influencing disease onset. Our findings reinforce the importance of considering respiratory assessments in the routine follow-up of pediatric diabetic patients.

Despite these findings, our study is limited by its small sample size and cross-sectional design. Environmental factors, physical activity levels, and nutritional status— which could affect pulmonary function—were not controlled. Longitudinal studies with larger cohorts are needed to validate our observations further.

## CONCLUSION

This study demonstrates that children with T1DM have a higher likelihood of developing restrictive pulmonary patterns with mixed ventilatory defects and decreased diffusion capacity, as evidenced by significantly lower FVC and DLCO values. Poor glycemic control may further exacerbate the decline in airway function. These results support the integration of pulmonary function testing into the routine evaluation of pediatric T1DM patients, allowing for early detection and intervention of emerging respiratory complications.

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