Section: General Medicine

Original Research Article

IMPACT OF TYPE 2 DIABETES MELLITUS ON PULMONARY FUNCTION: A CROSS-SECTIONAL STUDY COMPARING DIABETIC PATIENTS WITH HEALTHY CONTROLS

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Abstract

Background: Type 2 diabetes mellitus (T2DM) is known for its systemic effects, but its impact on pulmonary function remains underexplored. This study aimed to evaluate and compare pulmonary function in patients with T2DM against age-, sex-, and BMI-matched healthy controls. **Materials and Methods:** A cross-sectional study was conducted involving 100 patients with T2DM and 100 healthy controls. Participants underwent spirometry testing to measure Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), Peak Expiratory Flow Rate (PEFR), Forced Expiratory Flow between 25% and 75% of FVC (FEF25-75), and Maximal Voluntary Ventilation (MVV). Correlations between glycaemic control (measured by HbA1c) and spirometry parameters were analyzed, along with the impact of age and duration of diabetes. **Result:** Diabetic patients exhibited significantly lower percentage predicted values for FVC, PEFR, and FEF25-75 compared to controls, indicating a restrictive pattern of lung disease. The percentage predicted MVV was lower in controls than in diabetic patients. The FEV1/FVC ratio showed variable differences between groups. HbA1c levels were significantly correlated with FVC and FEV1, and longer duration of diabetes was associated with greater impairment in PEFR and FEF25-75. **Conclusion:** T2DM is associated with a restrictive pattern of lung disease, as evidenced by decreased FVC, FEV1, PEFR, and FEF25-75. Glycaemic control, as indicated by HbA1c levels, plays a significant role in pulmonary function, though the impact of age and diabetes duration may be more pronounced. These findings highlight the importance of early detection and management of respiratory complications in diabetic patients.

INTRODUCTION

Diabetes mellitus, a chronic metabolic disorder characterized by persistent hyperglycemia, poses significant health challenges due to its systemic effects. The disease, which manifests primarily as type 1 or type 2 diabetes, has been widely recognized for its impact on various organ systems, leading to complications that significantly affect patient quality of life. While the cardiovascular, renal, and neurological consequences of diabetes are well-established, the implications for pulmonary function remain less clearly defined and are the subject of ongoing research.[1,2]

Emerging evidence suggests that diabetes may adversely affect pulmonary health, with potential implications for lung function and respiratory performance. Diabetic patients have been observed to experience a range of pulmonary issues, including altered lung mechanics and reduced pulmonary function. These findings have led researchers to consider the lungs as another potential target organ for diabetes-related complications. However, the precise mechanisms through which diabetes influences respiratory health and the extent of its impact on the lungs require further investigation.[3]

Age is a crucial factor that can significantly influence pulmonary function, both in healthy individuals and those with chronic conditions. The aging process is associated with a natural decline in lung capacity, muscle strength, and overall respiratory efficiency. These age-related changes can manifest as decreased forced expiratory volume, reduced lung elasticity, and weakened respiratory muscles, all of which contribute to diminished respiratory performance. In

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individuals with chronic diseases such as diabetes, these age-related declines may be further exacerbated, potentially leading to more pronounced respiratory complications.[4,5]

In patients with type 2 diabetes, the interplay between aging and the disease itself may result in compounded effects on lung function. As individuals with diabetes age, they may experience accelerated declines in pulmonary performance compared to their non-diabetic counterparts. This interaction between diabetes and age could have significant implications for managing respiratory health in this population, underscoring the need for targeted interventions and strategies to address these combined effects.[6,7]

This study aims to investigate the impact of age on pulmonary function in individuals with type 2 diabetes, focusing on the differences in respiratory performance between younger and older diabetic patients. By examining these differences, the study seeks to enhance our understanding of how age-related factors interact with diabetes to influence lung health. Such insights could be instrumental in developing more effective management approaches for respiratory complications in diabetic populations, ultimately improving patient outcomes and quality of life.

The investigation will involve a comparative analysis of pulmonary function between younger and older patients with type 2 diabetes. This approach will provide valuable information on how aging may modify the effects of diabetes on the respiratory system. Additionally, the study will explore potential mechanisms underlying any observed differences, such as changes in lung structure, respiratory muscle strength, and overall lung function.

Understanding the combined impact of age and diabetes on pulmonary health is crucial for advancing our knowledge of diabetes-related complications and developing appropriate management strategies. The results of this study have the potential to inform clinical practice, guiding the development of targeted interventions and preventive measures to address respiratory issues in diabetic patients, particularly as they age. By shedding light on these interactions, the study aims to contribute to the broader goal of improving respiratory health and overall well-being in individuals living with type 2 diabetes.

MATERIALS AND METHODS

Study Design: A cross-sectional study was conducted to evaluate and compare lung function in individuals with type 2 diabetes mellitus (T2DM) against age-, sex-, and BMI-matched healthy controls. This design allowed for an examination of respiratory performance across the two groups within a defined age range and with controlled variables.

Materials: The study utilized several key materials for data collection and analysis. Lung function was measured using the RMS 401 spirometer equipped with Helios software. Anthropometric measurements were taken with a stadiometer and a weighing scale. Data management and statistical analysis were performed using Microsoft Excel and SPSS version 15.0, respectively.

Inclusion Criteria

Participants in both the diabetic and control groups were selected based on the following criteria: they were aged between 30 and 60 years, included both males and females, had no history of smoking, and had no previous history of respiratory disease aside from T2DM in the diabetic group. At the time of examination, participants were required to be free from respiratory abnormalities, which included symptoms such as nasal itching, running nose, nasal congestion, cough, breathlessness, hoarseness of the throat, sneezing, and signs of sinusitis.

Exclusion Criteria

Individuals were excluded from the study if they had a history of hypertension or other respiratory or cardiovascular diseases, aside from T2DM. Additionally, those with a previous history of lung disease or current signs and symptoms of respiratory infection were excluded. Participants who had been hospitalized in the past six months for respiratory symptoms were also excluded from the study.

Study Procedures: Participants were recruited from the community and provided informed consent before taking part in the study. Initial baseline assessments included the collection of demographic information, medical history, and anthropometric measurements such as height, weight, and BMI. A blood sample of 3 ml was drawn for the estimation of fasting blood sugar (FBS) and glycosylated hemoglobin (HbA1c). Pulmonary function was assessed using the RMS polyrite spirometer, with three measurements taken at 15-minute intervals and the best result recorded. The spirometric parameters measured included Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), the FEV1/FVC ratio, Forced Expiratory Flow between 25% and 75% of FVC (FEF25-75%), and Maximal Voluntary Ventilation (MVV). After the pulmonary function tests, participants consumed breakfast, and a blood sample was collected two hours later for postprandial blood sugar (PPBS) estimation.

RESULTS

The study included 100 patients with type 2 diabetes mellitus (T2DM) with a mean age of 47.09 years (range: 31-57) and 100 healthy controls with a mean age of 44.04 years (range: 35-55). All diabetic patients were well-controlled on oral hypoglycaemic agents, with mean fasting blood sugar (FBS) and postprandial blood sugar (PPBS) levels within acceptable ranges.

Age-related decline in pulmonary function [Figure 1] was evident in both diabetic and non-diabetic individuals, with significant reductions observed as age increased. Diabetic patients exhibited lower pulmonary function compared to controls, despite maintaining good glycemic control. Among the

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spirometry parameters, FVC, FEV1, PEFR, and FEF25-75 were most adversely affected by diabetes. A longer duration of diabetes was associated with greater impairment in PEFR and FEF25-75.

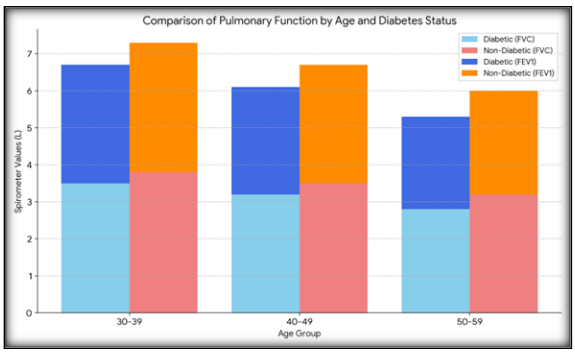

Figure 1: Comparison of spirometry parameters among the study population with age distribution.

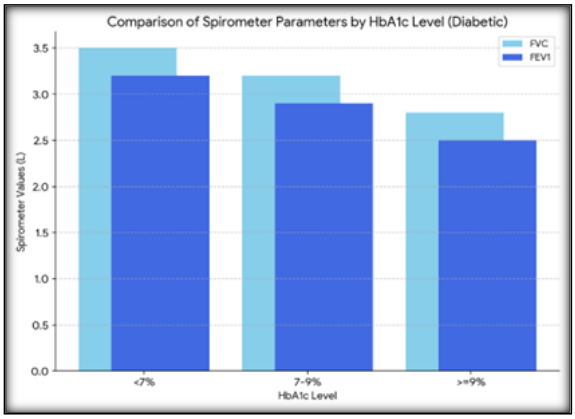

Figure 2: Comparison of FVC and FEV1 with HbA1C level among the study population.

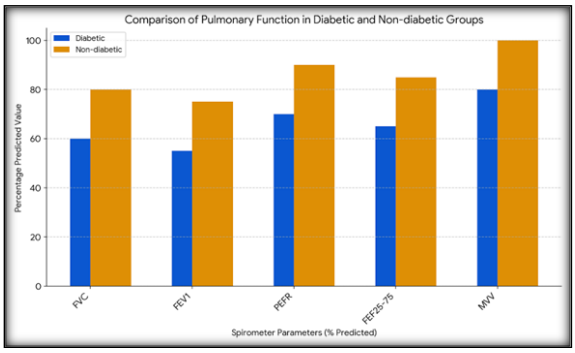

Figure 3: Comparison of Spirometry Parameters Between Diabetic and Non-Diabetic Groups

While HbA1c levels were correlated with FVC and FEV1 [Figure 2], the overall effect of glycemic control on pulmonary function was less pronounced than the effects of age and duration of diabetes. The impact of diabetes on pulmonary function varied across different age groups, with younger diabetic patients experiencing more rapid declines in lung function compared to older individuals. Although HbA1c was correlated with FVC and FEV1, this relationship was not consistently strong, suggesting that other factors such as age and duration of diabetes may have a more substantial influence on pulmonary function. Additionally, other factors such as obesity, hypertension, and smoking may also contribute to respiratory dysfunction in diabetic patients.

Pulmonary function tests [Figure 3] revealed that diabetic patients had significantly lower percentage predicted values for Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), Peak Expiratory Flow Rate (PEFR), and Forced Expiratory Flow between 25% and 75% of FVC (FEF25-75) compared to the control group. In contrast, the percentage predicted Maximal Voluntary Ventilation (MVV) was significantly lower in the control group compared to the diabetic patients. The FEV1/FVC ratio showed variable differences between the two groups, with not all differences reaching statistical significance.

Correlation analysis indicated a weak correlation between declining spirometric values and both FBS and PPBS levels. However, a significant Pearson correlation coefficient was observed between HbA1c levels and percentage predicted FVC and FEV1. Body Mass Index (BMI) also showed a significant correlation with percentage predicted FVC. Regression analysis demonstrated a significant association between the duration of diabetes and impairments in percentage predicted PEFR and FEF25-75.

DISCUSSION

The aim of this study was to evaluate ventilatory function in patients with type 2 diabetes mellitus (T2DM) and to compare it with that of age- and sex-matched healthy controls. The findings from our research underscore a significant decline in pulmonary function parameters among diabetic patients, which is consistent with and extends previous research in this field.

Our study's results indicate that patients with T2DM have notably lower percentage predicted values for Forced Vital Capacity (FVC) and Peak Expiratory Flow Rate (PEFR) compared to healthy controls. This observation supports the notion of a restrictive pattern of lung disease in diabetic patients, a finding that aligns with the studies by Sanjeev et al,[6] and Maurizio et al.[7] These studies have previously documented similar declines in FVC among diabetic individuals, suggesting that diabetes may impair lung capacity and overall respiratory efficiency. The reduced FVC in our diabetic cohort suggests that the disease could lead to restrictive lung disease, characterized by a reduced lung volume and compromised lung expansion.

In addition to FVC, the observed decrease in PEFR among diabetic patients is consistent with the results of Wendy A. Davis et al,[8] and Vinay Agarwal et al.[9] These studies also noted a reduction in PEFR, further supporting the presence of a restrictive lung disease pattern in diabetes. PEFR, which measures the maximum speed of expiration, is an important indicator of airway function and overall lung health.

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The lower PEFR values in our diabetic patients suggest that diabetes may compromise airway function, potentially due to alterations in lung mechanics and muscle strength.

Regarding the FEV1/FVC ratio, our study observed a rough decrease in this parameter among diabetic patients, although the differences did not reach statistical significance. This finding is in line with the study by Vinay Agarwal et al,[9] which also reported a predominantly restrictive pattern of lung disease in diabetic patients. The FEV1/FVC ratio is a critical measure in distinguishing between obstructive and restrictive lung diseases. While our data did not show a statistically significant decrease in this ratio, the trend observed suggests that diabetes may predominantly lead to restrictive lung changes rather than obstructive patterns.

The correlation analysis revealed a significant relationship between HbA1c levels and declining FVC and FEV1 values. This finding suggests that poor glycaemic control may contribute to impaired pulmonary function in diabetic patients. This correlation is consistent with previous research that has demonstrated a link between hyperglycemia and respiratory dysfunction.[10,11] Elevated HbA1c levels, indicative of poor long-term glucose control, were associated with worse lung function in our study. This correlation highlights the importance of glycemic control in maintaining respiratory health and suggests that efforts to manage blood sugar levels could be beneficial in preserving lung function.

Overall, our study underscores the significant impact of T2DM on pulmonary function. The restrictive pattern of lung disease observed, characterized by decreased FVC, FEV1, and PEFR, aligns with the findings of previous studies and emphasizes the detrimental effects of diabetes on respiratory health. The significant correlation between HbA1c and spirometric parameters further underscores the role of glycemic control in influencing lung function.

Future research in this area should focus on several key aspects. Longitudinal studies could provide insights into the progression of pulmonary dysfunction over time in diabetic patients, offering a clearer understanding of how lung function deteriorates with chronic diabetes. Additionally, research should aim to elucidate the underlying mechanisms linking diabetes to respiratory impairment. This could involve investigating potential pathological changes at the cellular and tissue levels that contribute to lung dysfunction in diabetes.[12] Identifying these mechanisms could lead to targeted interventions aimed at mitigating respiratory complications in diabetic patients.

Intervention studies are also needed to develop and evaluate strategies for improving pulmonary function and reducing respiratory complications in diabetic individuals. Such interventions might include therapeutic approaches, lifestyle modifications, and management strategies tailored specifically to address the respiratory challenges faced by diabetic patients.

Expanding the scope of future research to include additional respiratory parameters, such as respiratory pressures, diffusion capacity, and non-volitional tests, could provide a more comprehensive understanding of respiratory muscle strength and lung function in diabetic patients.[13] Larger sample sizes would also enhance the robustness of the analyses and allow for more generalizable conclusions regarding the relationship between diabetes and pulmonary function. Future studies should consider expanding assessments to include additional respiratory parameters and utilize larger sample sizes to gain a more thorough understanding of the relationship between diabetes and pulmonary function. By addressing these areas, researchers can enhance our understanding of diabetes-related respiratory impairments and develop more effective strategies for managing this important aspect of diabetes care.

CONCLUSION

In conclusion, this study highlights a significant reduction in spirometric parameters among patients with type 2 diabetes mellitus, emphasizing the adverse impact of the disease on respiratory function. The findings indicate that poor glycemic control is associated with impaired lung function, reinforcing the need for effective management of blood sugar levels to preserve respiratory health. The observed decline in pulmonary function among diabetic patients can be attributed to several factors, including diffuse microangiopathy, demyelination, and chromatolysis of axons and Schwann cells within the phrenic nerve tissue. These pathological changes contribute to reduced respiratory muscle strength, as evidenced by decreased Maximal Voluntary Ventilation (MVV), PEFR, and FEF25-75 values. Additionally, thickening of the alveolar epithelium and pulmonary capillary basal lamina, coupled with reduced lung recoil, likely contributes to the reduction in spirometric parameters observed in our study. The findings emphasize the importance of early detection and proactive management of respiratory complications in diabetic patients. Routine spirometry tests could serve as a valuable screening tool to identify individuals at risk for respiratory dysfunction, allowing for timely interventions to prevent severe complications and improve quality of life.

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