e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(5); 2065-2071

Original Research Article

One Year Cross-Sectional Study of Pulmonary Function Abnormalities and Type 2 Diabetes Mellitus

Upendra Kumar Sahani[1], Vinayanand Jha[2]

[1]Assistant Professor, Department of Medicine, Darbhanga Medical College and Hospital, Laheriasarai, Bihar.

[2]Associate Professor, Department of Medicine, Darbhanga Medical College and Hospital, Laheriasarai, Bihar.

Received: 16-03-2023 / Revised: 30-03-2023 / Accepted: 30-04-2023

Corresponding author: Dr Upendra Kumar Sahani

Conflict of interest: Nil

Abstract

Background: One of the most prevalent chronic disease worldwide, diabetes mellitus is on the rise as people's lifestyles change, resulting in decreased physical activity and rising obesity rates. India will have the highest rate of diabetes worldwide in 2025, according to a WHO survey. Since type II diabetes makes up 90 to 95% of all cases of diabetes and its prevalence is rising. In its early stages, it is frequently asymptomatic and might go years without being identified. Despite lungs facing extensive microvascular networks, investigations on the relationship between diabetes and poor pulmonary function are conflicting.

Methods: An equal number of individuals who were not diabetic and 90 diabetic patients participated in a cross-sectional study. Both groups rates of pulmonary function test (PFT) abnormalities were estimated. Taking into account additional risk variables for deteriorated lung function, logistic regression was utilised to identify independent relationship between diabetes and its consequences.

Results: 52 (58%) of non-diabetic patients and 71 (79%) (95% CI= 69.0 - 86.0) of 90 diabetic patients had abnormal PFT (p=0.02). While 29 (32%) of the diabetic people had an obstructive pattern (95% CI= 22.9-43.0), 42 (47%) of them had a restrictive pattern (95% CI= 36.0-57.4). In a multivariate study, only age, female sex, and BMI showed a significant correlation with abnormal PFT, but the presence of diabetes, age, female sex, glycosylated haemoglobin, and body mass index (BMI) did not.

Conclusion: The presence of diabetes and impaired lung function did not independently correlate. Ageing, having a higher BMI, and being a woman all stood alone as risk factors for pulmonary dysfunction.

Keywords: Chronic diseases, glycosylated Hemoglobin, BMI, PFT.

Introduction

Type 2 diabetes (T2DM) affects about 17% of Indian adults, making it the nation with the highest percentage of diabetics worldwide. Poor glycemic management is widely known to cause both microvascular and macrovascular problems. The effects of diabetes on the lung, another organ with a rich microvascular network, have not been

studied with much interest, despite the fact that the functional disturbances that result from pathophysiologic alterations in the microvasculature have been extensively studied in the kidneys, retina, and nerves.

Although some studies have demonstrated that people with T2DM have considerably impaired pulmonary function [1,2], a solid link between diabetes and abnormalities in lung function has not been established. We therefore sought to establish the relationship between pulmonary function and diabetes as well as the relationship between impaired pulmonary function and microvascular complications.

Material and Methods

This was a cross sectional comparative study carried out in Department of Medicine, Darbhanga Medical College and Hospital, Laheriasarai, Bihar from April 2022 to February 2023.

90 adults under 60 with T2DM who attended outpatient department or were admitted to the wards throughout the study period were eligible to participate, and a similar number of non-diabetic adults who were matched for age and gender served as the comparison controls. Exclusion criteria for the study included those with active tuberculosis, type 1 diabetes, glomerular filtration rates <60 ml/min, pulmonary tumours, respiratory infections (upper and lower respiratory tract infections), occupational lung diseases, chronic bronchitis, bronchiectasis, restrictive airway conditions like scoliosis, pregnant women, and smokers.

The diabetic subjects underwent a baseline assessment for microvascular complications such as nephropathy, retinopathy, and neuropathy by the same ophthalmologist using spot albumin to creatinine ratio, direct ophthalmoscopy, and all subjects (defined clinically by absence of deep tendon reflexes in the legs, diminished sensation including touch as assessed by cotton wool, pinprick or pressure sensation, distal vibratory sensation as assessed by graduated tuning fork of 128 Hz, and joint position sense). They were then separated into individuals with microvascular complications and those without, based on these evaluations (45 subjects each).

Blood urea, serum creatinine, fasting lipid profiles, postprandial blood glucose, glycosylated haemoglobin (HbA1c), and fasting lipid profile were all examined biochemically. The Ndd Easyone Pro computerised spirometer was used by a qualified spirometrist to administer a pulmonary function test to each study participant in accordance with American Thoracic Society (ATS) standards. All of the participants were instructed to sit upright and complete three rounds of spirometry at intervals of 15 minutes; the best three results were averaged. The following parameters were measured and their percentage predictive values were calculated: Forced Vital Capacity (FVC), Forced Expiratory Volume in One Second (FEV1), FVC Ratio, Peak Expiratory Flow Rate (PEFR), and Forced Expiratory Flow at 25 to 75% of Vital Capacity. A single breath carbon monoxide (CO) diffusion test was used to measure the alveolar ventilation (VA), the DLCO/VA ratio, and the lung's ability to diffuse carbon monoxide (DLCO).

A sample size of 90 was chosen for diabetic participants assuming a prevalence of pulmonary function impairment in 25% of patients with T2DM and a precision of 9%. For comparison, an equal number of controls were employed.

For continuous variables, mean and standard deviation were used to express the clinical characteristics of the study participants, whereas percentages were used for dichotomous and categorical data. Simple logistic regression was used to identify associations, and those with significant or

almost significant p values ($p<0.2$) were chosen for multivariate analysis. The ENTER technique was used for multivariate analysis, and a p value of 0.05 or less was regarded as significant. The entire data set was imported into Microsoft Excel, and SPSS version 20 for Windows was used for the statistical analysis.

Results

Patients with an obstructive anomaly were defined as having a FEV1/FVC ratio of less than 80%, whereas patients with a FEV1/FVC ratio of more than 80% were classified as having a restrictive abnormality or having normal pulmonary function. The latter group was labelled as having restrictive anomaly if the DLCO was less than 75% of anticipated.

Table 1 shows the baseline characteristics of the diabetic patients and the non-diabetic controls.

Ninety diabetic individuals were included in this study; 71 (79%) of these patients had abnormal PFTs (95% CI= 69.0–86.0); 42 of these patients (47%) had a restrictive pattern of abnormality (95% CI= 36.0–57.4), and 29 patients (32%) had an obstructive pattern (95% CI= 22.9–43.0). A restrictive aberration (95% CI = 22-41.8; p=0.002) and an obstructive pattern (95% CI = 18-37.2) were both seen in 52 (58%) of the patients without diabetes.

Table 1 : Baseline characteristics of diabetic and non-diabetic patients in the study

Characteristic	Diabetic patients (n=90)	Controls (n=90)
Age (years)	49±8	49±8
Body mass index (kg/m^2)	24±4.6	24±5
Fasting blood glucose (mmol/L)	9.3±3.2	5±0.6
Postprandial blood glucose (mmol/L)	15.9±5	6.8±1.1
HbA1c(%)	8.7±1.7	5.4±0.4
Blood urea (mmol/L)	3.7±1.4	3.2±0.8
Serum creatinine (mmol/L)	71±27	71±18
Total cholesterol (mmol/L)	4.7±1.0	4.7±1.0
LDL cholesterol (mmol/L)	3.1±1.0	3.1±0.9
Triglycerides (mmol/L)	1.9±0.7	1.7±0.7

All values are mean ± S.D.

In a univariate study, the following factors—aside from diabetes—were substantially linked to abnormal PFTs: female gender, BMI, age, and HbA1c. However, only female gender, age, and BMI remained significant relationships with PFT abnormalities in multivariate analysis (Table 2).

Table 2: Logistic regression analysis of (Univariate and multivariate) of risk factors associated with PFT abnormalities

Risk factors	Univariate		Multivariate	
	OR (95% CI)	P value	OR (95% CI)	P value
Diabetes	2.73(1.41-5.26)	0.003	1.69(0.50-5.65)	0.399
Age	1.05(1.01-1.10)	0.017	1.06(1.01-1.11)	0.013*
Sex (female)	4.20(1.83-9.61)	0.001	4.04(1.64-9.90)	0.002*
BMI	0.95(0.89-1.01)	0.129	0.92(0.85-0.99)	0.043*
HbA1c	1.31(1.09-1.57)	0.004	1.11(0.81-1.51)	0.507

*Significant association on multivariate analysis [Risk factors with significant or near significant association ($p<0.2$) on univariate analysis were included in multivariate analysis].

Table 3: Univariate and multivariate analysis of association between risk factors and PFT abnormalities among diabetic patients (n=90)

Risk factors	Univariate		Multivariate	
	OR (95% CI)	P value	OR (95% CI)	P value
Microvascular complications	2.64(0.90-7.73)	0.076	1.96(0.54-7.13)	0.308
Age	1.01(0.95-1.08)	0.745		
Sex	3.45(1.04-11.41)	0.043	3.72(1.05-13.23)	0.042*
BMI	0.95(0.86-1.06)	0.363		
HbA1c	1.21(0.88-1.66)	0.235	1.06(0.73-1.53)	0.743
Duration of diabetes	1.01(1.0-1.02)	0.239	1.00(1.0-1.01)	0.384
Hypertension	1.55(0.40-6.0)	0.525		
Total cholesterol	1.01(0.99-1.02)	0.282		
Triglycerides	1.00(0.99-1.01)	0.666		
HDL	1.00(0.94-1.06)	0.980		
LDL	1.02(1.00-1.03)	0.021	1.02(1.0-1.03)	0.071*

The study comprised 90 diabetic adults, and 45 of them experienced microvascular problems, including 23 cases of isolated neuropathy, 13 cases of isolated retinopathy, 6 cases of combined neuropathy and retinopathy, and 3 cases of combined neuropathy and nephropathy. Compared to 71% of diabetics without microvascular difficulties, 87% of those with microvascular complications had an abnormal PFT (p=0.12). The most common anomaly found in diabetic patients with microvascular problems and PFT abnormalities was restrictive (62%).

To ascertain whether there was any correlation between different risk variables and PFT abnormalities in the diabetic group, we conducted univariate and multivariate analyses (Table 3). In diabetic individuals, there was no correlation between microvascular problems and PFT abnormalities [OR 1.96 (95% CI: 0.54-7.13); p=0.308]. After taking into account many variables, only female sex was found to be significantly associated with PFT abnormalities in diabetics, although LDL cholesterol had a nearly significant association (p=0.071).

Discussion

According to this study, 79% of diabetic individuals had pulmonary function impairments, with the majority showing a restrictive pattern. There was a significant overall decline in pulmonary function as well as declines in specific metrics like FEV1, FVC, and PEFR when compared to controls. Additionally, it was discovered that diabetes individuals' DLCOs were lower, indicating a serious impairment of alveolar gas exchange. However, there was no proof of an independent relationship between diabetes and PFT abnormalities in this investigation. However, it was discovered that females had a greater likelihood of acquiring an abnormal PFT.

In diabetic patients, high LDL and BMI also appeared to be linked to pulmonary dysfunction.

Our study population's prevalence and distribution of PFT anomalies match those of several other researchers [1,3,4]. Notably, a study from India revealed a restricted pattern in 48% of diabetes individuals, which is very comparable to our conclusion [5].The basal lamina thickening and fibrosis, which eventually result in restrictive lung abnormalities, are part of the suggested

mechanism [6]. The considerable decrease in DLCO seen in diabetic patients with pulmonary function issues may also be explained by these alterations.

We were unable to find a direct link between diabetes and abnormal pulmonary function, despite a statistically substantial rise in PFT abnormalities in diabetic individuals compared to controls. The majority of previous research sought to compare the spirometry characteristics between diabetic and non-diabetic individuals, but very few of them performed an adjusted analysis like the one used in this study. Notably, a sizable cross-sectional and prospective investigation on peers with and without diabetes produced some intriguing findings [7]. Similar to our findings, researchers were able to demonstrate that diabetes adults had significantly poorer lung function than non-diabetic adults (as demonstrated by lower FEV1 and FVC). Contrary to our findings, this reduction was unrelated to age, HbA1c, or the length of diabetes, among other risk variables. Furthermore, they were able to show that diabetes patients experience a faster fall in FVC than non-diabetic individuals due to the prospective design and relatively strong follow up. On the other hand, a prospective investigation on Danish people was unable to duplicate the distinct disparities in lung function loss over a 15-year follow-up period between diabetic and non-diabetic patients [8]. These contradictory findings, even in prospective studies, show that although the prevalence of poor lung function in diabetics is substantially higher, it has been difficult to establish a causal relationship between the two. Our findings confirm the problem's complexity.

Shravya *et al*. showed a larger risk for females to develop pulmonary dysfunction, and we were able to confirm their findings [9].

The relationship between a PFT anomaly and a high BMI, which this study concluded, hasn't always held true in other studies. While findings from a study conducted in Nigeria revealed that people with a high BMI were more likely to have restrictive anomalies of lung function in T2DM [10]. Spirometric anomalies and BMI in diabetes individuals did not correlate, according to a Trinidadian study [11].

Despite the fact that PFT abnormalities were linked to microvascular problems in our study's subjects, the association was not statistically significant. Similarly, some investigations that used DLCO measures failed to find any correlation between microvascular problems and such a relationship [12-14].

However, Asanuma and colleagues have demonstrated that decreased DLCO in diabetes patients is related to microvascular problems, thus raising questions about the possibility of lung microangiopathy and its potential consequences on pulmonary function [15]. Since diabetes must also damage the microvasculature of the lung, the theoretically possible link between lung dysfunction and other microvascular problems remains unclear.

Concerning the impact of glycaemic management and duration of diabetes on pulmonary function abnormalities, studies are inconsistent and ambiguous in this area. Despite the fact that a lower DLCO has been linked to poor glycaemic control in a number of studies, our study's findings and those of others, including those by Davis *et al*. and Shah *et al*., have identified no connection between PFT abnormalities and glycaemic state [16-19]. While we were unable to show an independent connection with the length of diabetes, Kumari and colleagues found that the restricted pattern of lung dysfunction got worse as the duration of diabetes increased. The heterogeneity of the parameters

employed to evaluate lung function abnormalities, as well as the dearth of good follow-up information on glycaemic management, may help to explain discrepancies in results to some extent.

The primary advantage of this study over the majority of prior studies on this topic from India is the considerably bigger sample size that was examined. Furthermore, unlike many other researchers, we used rigorous statistical techniques to test the hypothesis that diabetes and PFT abnormalities are independently correlated. However, the cross-sectional design might have limited the amount of follow-up data that was available. A prospective strategy might have produced more reliable findings regarding the relationship between disease duration and glycemic control. Furthermore, because age, gender, and BMI did not independently correlate with PFT abnormalities in diabetic patients, it is possible that other undisclosed and untested factors contributed to the excess PFT abnormalities in these patients.

Conclusion

As a result, we have only been able to show that diabetic individuals have a much higher prevalence of PFT abnormalities than healthy non-diabetic people. The findings of this study emphasise the need for carefully planned prospective studies with sufficient follow-up to determine whether diabetes directly causes abnormalities in pulmonary function and whether these abnormalities closely resemble other well-known microvascular complications of diabetes like nephropathy, neuropathy, and retinopathy.

References

1. Shah S, Sonawane P, Vaidya S, Salvi S, Nahar P. Pulmonary function tests in type 2 diabetes mellitus and their association with glycemic control and duration of the disease. Lung India. 2013; 30:108-112.
2. Uz-Zaman S, Banerjee J, Singhamahapatra A, *et al*. Assessment of lung function by spirometry and diffusion study and effect of glycemic control on pulmonary function in type 2 diabetes mellitus patients of the eastern India. J Clin Diagn Res. 2014; 8: BC 01-04.
3. Irfan M, Jabbar A, Haque A, Awan S, Hussain S. Pulmonary functions in patients with diabetes mellitus. Lung India. 2011; 28:89-92.
4. Kumari K, Nataraj SM, Devaraj HS. Glycemic control and pulmonary function tests in type 2 diabetes Mellitus patients: Do they correlate? Ind J Publ Hlth Res Dev. 2013; 4:124-128.
5. Singh Y, Kumari S. The pulmonary function tests in patients with diabetes mellitus and non-diabetes people of Ajmer, Rajasthan. Int J Basic Appl Med Sci. 2015; 5:8–13.
6. Weynand B, Jonckheere A, Frans A, Rahier J: Diabetes mellitus induces a thickening of the pulmonary basal lamina. Respiration 1999; 66:14 –19.
7. Yeh H, Punjabi NM, Wang NY, *et al*. Cross-sectional and prospective study of lung function in adults with type 2 diabetes: The Atherosclerosis Risk in Communities (ARIC) study. Diabetes Care. 2008; 31:741–6.
8. Lange P, Parner J, Schnohr P, Jensen G. Copenhagen City Heart Study: longitudinal analysis of ventilatory capacity in diabetic and non-diabetic adults. Eur Respir J. 2002; 20:1406–1412.
9. Keerthi G S. Deterioration of pulmonary functions in type 2 diabetes mellitus. IOSR J Pharm Biol Sci. 2012; 1:39–43.
10. Adeyeye OO, Ogbera OA, Dada AO, Bamisile RT, Brodie M A. Correlates of abnormal pulmonary function tests in persons with type 2 diabetes mellitus. J Pulm Resp Med. 2014; 05:1-4.

11. Nayak BS, Sakamuri SM, Guerra C, *et al*. Evaluation of pulmonary dysfunction among persons with type 2 diabetes in Trinidad. Int J Res Dev Pharm L Sci. 2013; 2:317-320.
12. Agarwal AS, Fuladi AB, Mishra G, Tayade BO. Spirometry and diffusion studies in patients with type-2 diabetes mellitus and their association with microvascular complications. Indian J Chest Dis Allied Sci. 2010; 52:213–216.
13. Sinha S,Guleria R, Misra A, *et al*. Pulmonary functions in patients with type 2 diabetes mellitus and correlation with anthropometry and microvascular complications. Indian J Med Res. 2004; 119:66–71.
14. Boulbou MS, Gourgoulianis KI, Klisiaris VK, *et al*. Diabetes mellitus and lung function. Med Princ Pract. 2003.21;12:87–91.
15. Asanuma Y, Fujiya S, Ide H, Agishi Y. Characteristics of pulmonary function in patients with diabetes mellitus. Diab Res Clin Pract. 1985; 1:95–101.
16. Anandhalakshmi S, Manikandan S, Ganeshkumar P, Ramachandran C. Alveolar gas exchange and pulmonary functions in patients with type II diabetes mellitus. J Clin Diagn Res. 2013.7:1874–1877.
17. McKeever TM, Weston PJ, Hubbard R, Fogarty A. Lung function and glucose metabolism: an analysis of data from the Third National Health and Nutrition Examination Survey. American J Epidemiol. 2005; 161:546–556.
18. Davis WA, Knuiman M, Kendall P, Grange V, Davis TME. Glycemic exposure is associated with reduced pulmonary function in type 2 diabetes: The Fremantle Diabetes Study. Diabetes Care. 2004; 27:752–757.
19. Davis TME, Knuiman M, Kendall P, Vu H, Davis WA. Reduced pulmonary function and its associations in type 2 diabetes: The Fremantle Diabetes Study. Diab Res Clin Pract. 2000; 50:153–159.