Print ISSN: 2321-6379
Online ISSN: 2321-595X

Original Article

Assessment of Spirometric Parameters in Patients with Type 2 Diabetes Mellitus in a Tertiary Care Hospital of North East India: A Cross-sectional Study

A Saha[1], Debasish Chakraborty[2], S Saha[3]

[1]Junior Resident, Department of Physiology, Agartala Government Medical College, Agartala, Tripura, India, [2]Professor, Department of Physiology, Agartala Government Medical College, Agartala, Tripura, India, [3]Senior Resident, Department of Physiology, Agartala Government Medical College, Agartala, Tripura, India

Abstract

Background: Diabetes mellitus (DM) is a group of metabolic disorders occurs due to defects in insulin secretion, insulin action, or both. Pulmonary complications of DM have been poorly characterized with conflicting results. Because of its large reserve, substantial loss of the microvascular bed can be tolerated without developing any signs and symptoms. As a result, pulmonary diabetic microangiopathy may be under recognized clinically.

Aims and Objectives: The aim of the study was to estimate the changes spirometric parameters in Type 2 DM (T2DM) patients and to assess the effect of duration of the disease and the status of glycemic control of the patients on their pulmonary function.

Materials and Methods: Spirometry was done in 120 T2DM patients aged between 30 and 60 years, attending the Diabetes and Nutritional clinic of A.G.M.C over a period of 3 months by using Spirometry –model SPM –A. The spirometric parameters recorded were- forced vital capacity (FVC), forced expiratory volume in 1st s (FEV_1), FEV_1 to FVC ratio (FEV_1/FVC), forced expitatory flow at 25–75% of the lung volume (FEF_{25-75}), peak expiratory flow rate and maximum voluntary ventilation. Data were entered in computer using Microsoft Excel. Descriptive statistics and other suitable statistical tests such as χ^2 test were used as per applicability. A probability value <0.05 was considered as significant.

Results: Statistical analysis was carried out using SPSS software and results were statistically analyzed and correlated. FVC (P = 0.012) and FEV_1 (P = 0.024) values were significantly decreased in diabetic patients. However, FEV1/FVC values were significantly increased (P = 0.042) in patients with T2DM. Significant correlation was found between FVC and FEV_1/FVC with duration of illness and FEV_1/FVC with glycosylated hemoglobin.

Conclusion: T2DM, a systemic disease, also affects lungs causing restrictive type of ventilatory changes probably because of glycosylation of connective tissues, reduced pulmonary elastic recoil, and inflammatory changes in lungs. As spirometry is a reliable, valid, and simple test, the diabetics are suggested to undergo pulmonary function testing periodically.

Key words: Forced expitatory $flow_{25-75}$, Forced expiratory volume in 1st s, FEV_1/FVC, Forced vital capacity, Peak expiratory flow rate and maximum voluntary ventilation, Spirometry, T2DM

INTRODUCTION

Diabetes is the most common metabolic disorder which is on increasing trend globally.[1] It is accompanied by wide spread biochemical, morphological, and functional abnormalities which may precipitate certain complications that affect the neural, cardiovascular, renal systems, and also organs and tissues such as skin, liver, collagen, and elastic fibers. The microvascular complications appear early, within 5–10 years and macrovascular complications appear within 15–20 years from the onset of diabetes.[2]

Pulmonary complications of diabetes mellitus (DM) have been poorly characterized with conflicting results. The alveolar capillary network in the lung is a large microvascular unit and may be affected by microangiopathy.

Access this article online

www.ijss-sn.com

Month of Submission : 12-2022
Month of Peer Review : 01-2023
Month of Acceptance : 01-2023
Month of Publishing : 02-2023

Corresponding Author: Debasish Chakraborty, Department of Physiology and Academic In-charge, Agartala Government Medical College, Agartala - 799 006, Tripura, India.

However, because of its large reserve, substantial loss of the microvascular bed can be tolerated without developing dyspnea. As a result, pulmonary diabetic microangiopathy may be under recognized clinically. It has also been suggested that pulmonary dysfunction may be one of the earliest measurable non-metabolic alterations in diabetes.[3]

The respiratory diseases associated with diabetes may result in changes in pulmonary volumes, diffusion, and elastic properties of lungs as well as the performance of respiratory muscles chronic low-grade inflammation, decrease in pulmonary diffusion capacity. Several histopathological changes are also seen in diabetics. Few researchers suggest that diabetes could lead to the development of pulmonary complications due to collagen and elastin changes. While others suggest that increased non-enzymatic glycosylation of proteins and peptides of the extracellular matrix at chronic high circulating glucose levels may also have an important role in the pathological changes of the lungs in DM patients. This process results in impaired collagen and elastin cross linkage with a reduction in strength and elasticity of connective tissues. These abnormalities in the structural components can lead to the development of abnormalities in the pulmonary function such as a reduction in the vital capacity, total lung capacity, lung compliance, reduction of central, and peripheral airflows, acceleration of the ageing process.[4-6] Alteration in the pulmonary connective tissue by thickening of the alveolar and capillary endothelial basement membranes might cause modifications of alveolar surfactants altering its function and pulmonary microangiopathy which brings about reduction in diffusing capacity and the muscle endurance.[7]

Spirometry is a basic, widely used pulmonary function test. It typically assesses the lung volumes and flow and is ideally suited to describing the effects of obstruction or restriction on lung function. It is now regarded as an integral component of any respiratory medical surveillance program.[8,9]

Pulmonary damage at an early stage in patients with DM is subclinical and rarely present with complaints.[10] Spirometry non-invasively quantifies the physiological reserves in a large micro-vascular bed that is not clinically affected by diabetes. Lung functions may provide useful measures of the progression of systemic microangiopathy in diabetic patients.[11]

Thus, this study was undertaken to assess the pulmonary function in patients with Type 2 DM and to correlate the lung function with duration of diabetes and to find out whether it is obstructive or restrictive pattern.

MATERIALS AND METHODS

Primary Objective

The primary objetive of the study was to estimate the changes in spirometric parameters in Type 2 DM (T2DM) patients.

Secondary Objectives

The secondary bjectives of the study are as follows:

1. To assess the effect of duration of the diabetes on spirometric parameters
2. To assess the effect of glycemic status of the patients on their spirometric values.

A hospital-based and cross-sectional study was done in 120 Adults with T2DM attending diabetes and nutritional clinic OPD of Agartala Government Medical College (AGMC) and Govind Ballabh Pant (GBP) Hospital, Agartala. Ethical clearance was obtained from the Ethical Committee of AGMC and GBPH. The study subjects were evaluated by general history, clinical examination, and blood glycosylated haemoglobin (HbA1c) level. The study was conducted between the periods from October 2022 to November 2022.

Inclusion Criteria for the Cases

The following criteria were included in the study:

1. Patients aged between 30 and 60 years
2. Diagnosed cases of T2DM as given by the American diabetes association
    a. Symptoms of diabetes plus random blood glucose concentration ≥11.1 mmol/l (200 mg/dl) or
    b. FBS ≥7.0 mmol/l (126 mg/dL) or
    c. HbA1c ≥6.5% or
    d. PPBS ≥11.1 mmol/l (200 mg/dL) during an OGTT.
3. No recent history of respiratory illness
4. Cooperative and willing to participate in the study.

Exclusion Criteria for the Cases

The following criteria were excluded from the study:

1. Already existing chronic complications of diabetes such as retinopathy, neuropathy, and nephropathy
2. Present or past history of respiratory illness that might affect lung function such as bronchiectasis, tuberculosis, bronchial asthma, interstitial lung diseases, and COPD
3. History of occupational exposure to any substance that could affect lung function
4. Individuals with unacceptable spirometry techniques. Unacceptable spirometry means any effort in which FEV1 or FVC could not be measured due to:
    - Cough
    - Sub maximal effort

- Obstructed teeth
- Air escape
- Effort sustained for <6 s duration
- Failure to attain a volume time curve
- Lack of understanding the procedure
- Recent surgery
- Diabetics who have cardiac and liver disease on history (history of jaundice) and clinical examination (icterus, ascites, hepatomegaly, and spleenomegaly) basis

5. Known case of cardiovascular disorders such as hypertension, coronary artery disease, and congestive cardiac failure
6. Presence of any other concomitant diseases as per previous records disrupting cardiovascular homeostasis such as thyroid disorders, pheochromocytoma, chronic renal failure due to any cause, respiratory disorders, and dyselectrolytaemia
7. History of smoking, alcoholism, or intake of any drugs such as vasodilators, diuretics, anti-arrhythmic, beta-blockers, alpha-agonist, or Alpha-blockers
8. Those who are not willing to participate in the study.

Study Tools

- Spirometry-model SPM –A
- Sphygmomanometer-Mercury deluxe BP apparatus manufactured by diamond allied products SSI no- UAN-MH33A0014692
- Stethoscope
- Height measuring stand-Bioplus; height −200 cm
- Weighing machine
- Investigating materials and Kit for estimation of blood sugar and HbA1c.
- Case study format.

Recording of Spirometry

After taking detailed history and relevant clinical examination, informed consent was taken. Then, we recorded the anthropometric parameters such as height and weight and body mass index (BMI) was calculated. After demonstrating the technique for carrying out spirometry, subjects were made to undergo the tests.

All the tests were conducted according to American Thoracic Society/European Respiratory Society guidelines in a quiet room in sitting position by the Spirometer SPM-A for 3 times at every 15 min interval and best of three was taken into account.

The participants were made to relax in comfortable loose clothing. They were made to sit comfortably and nose clip was applied on the nose. The spirette was kept in the mouth with the lips sealing around it and was instructed to breathe calmly and care was taken not to block or bite the spirette. They were asked to do tidal breathing and fill the lungs completely and then asked to exhale as hard and fast as possible until the lungs were completely empty and inhale as hard and fast as possible till the end of the test. This test was repeated 2–3 times and the best value was taken for the result.

The forced vital capacity (FVC), forced expiratory volume in 1 s (FEV_1), peak expiratory flow rate (PEFR), FEV1/FVC, FEF 25–75%, and maximum voluntary ventilation (MVV) were recorded.

RESULTS

A total of 120 T2DM patients had participated in this study. Among them 37% were female and 63% were male as shown in Figure 1. Mean age group was 42.24 ± 5.46 years. Age-wise distribution of study participants is shown in Figure 2. Mean HbA1c level was 9.51 ± 2.65%. HbA1c level of the patients is shown in Figure 3. Duration of disease among the study participants is shown in Figure 4. The lung function parameters FVC, FEV_1, $FEF_{25–75}$, PEFR and MVV all were found to be decreased among the study participants [Table 1]. FEV_1/FVC values were increased among Type 2 DM patients [Table 1]. However, changes in FVC ($P = 0.012$), FEV_1 ($P = 0.024$), and FEV_1/FVC ($P = 0.042$) were statistically significant. Mean values of the spirometric parameters are shown in Figure 5 and Table 1. A Significant negative correlation ($r = −0.3208$, $P = 0.004$) was found between FVC and duration of diabetes as shown in Figure 6. There was a significant positive correlation ($r = 0.090$, $P = 0.012$) between FEV_1/FVC and HBA1c level as shown in Figure 7.

DISCUSSION

DM is accompanied by wide spread biochemical, morphological, and functional abnormalities. Pulmonary

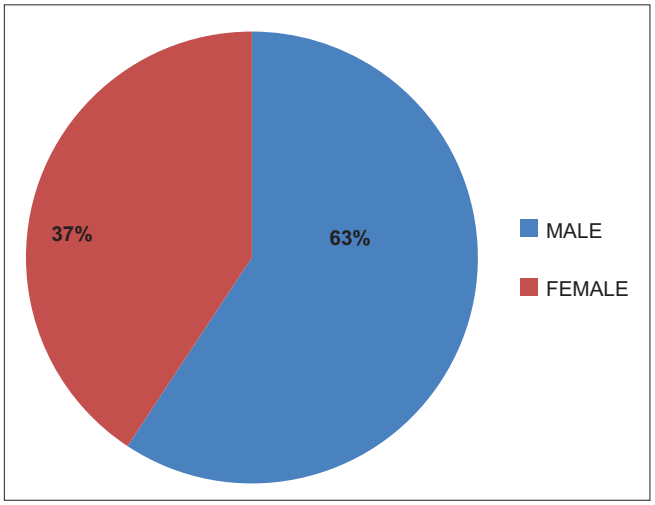

Figure 1: Gender-wise distribution of study participants

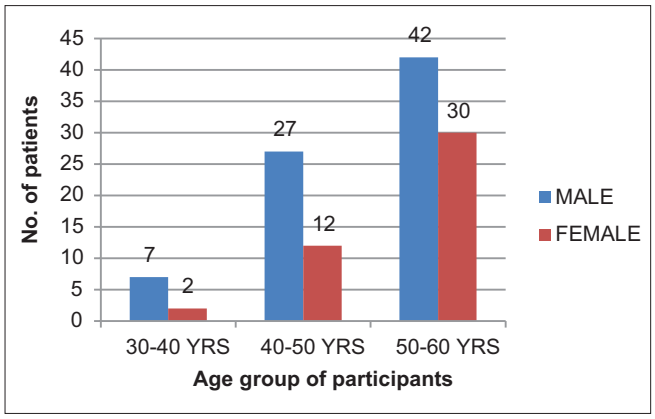

Figure 2: Age-wise distribution of patients

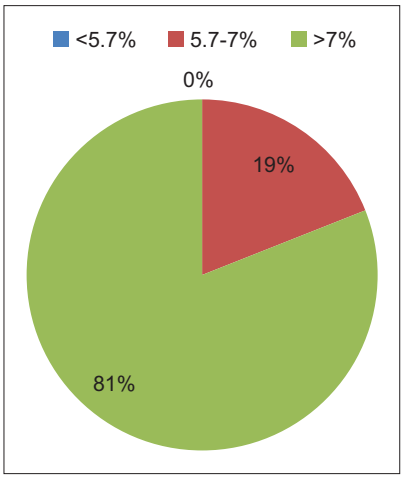

Figure 3: HbA1c of the study participants

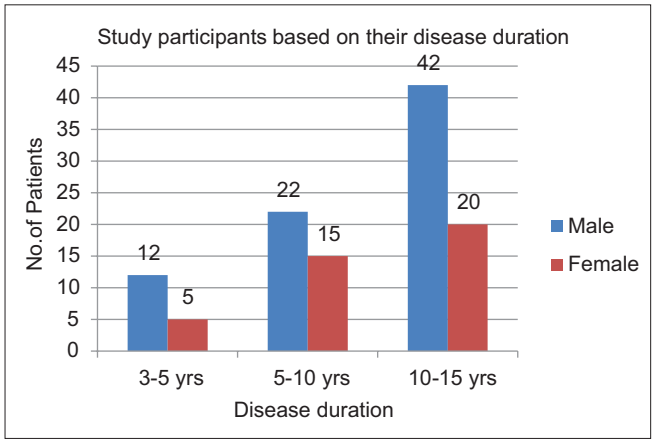

Figure 4: Disease duration of the study participants

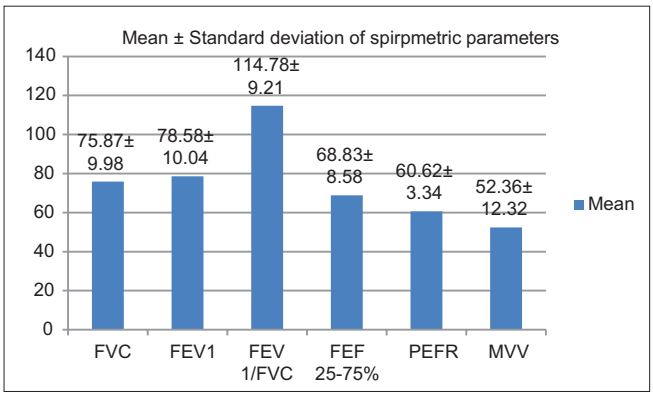

Figure 5: Mean ± Standard deviation of the spirometric parameters

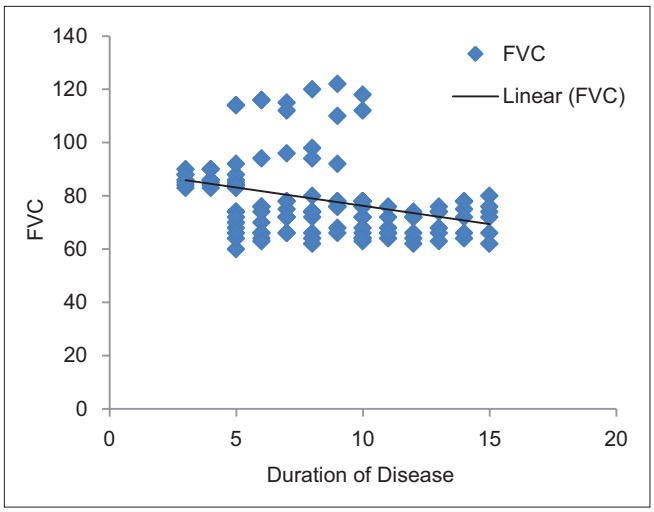

Figure 6: Correlation of forced vital capacity with duration of disease

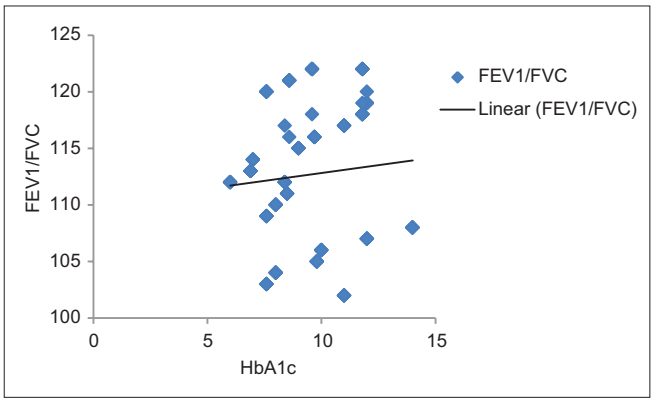

Figure 7: Correlation between forced expiratory volume in 1/forced vital capacity and HbA1c

complications of DM have been poorly characterized with conflicting results. In our study we have found that there was a significant reduction in FVC, and FEV_1 values in patients with T2DM. However, FEV_1/FVC was significantly higher in those patients. These findings indicated restrictive type of changes in lung function among Type 2 diabetic people. We have also found significant negative correlation of FVC with duration of diabetes and a positive correlation between FVC/FEV_1 and HBA1c level.

Finding of this study was in accordance with Davis *et al.*, who conducted a large community based study in Western Australia in Type 2 diabetic patients and demonstrated that

Table 1: Spirometric parameters of the study participants

S. No.	Spirometric parameters	Mean±SD	*P*-value
1.	FVC	75.87±9.98	0.012*
2.	FEV1	78.58±10.04	0.024*
3.	FEV1/FVC	114.78±9.21	0.042*
4.	FEF 25–75%	68.83±8.58	0.752
5.	PEFR	60.62±3.34	0.236
6.	MVV	52.36±12.32	1.302

**P* value is significant (<0.05). FVC: Forced vital capacity, FEV1: Forced expiratory volume in 1st s, FEF: Forced expitatory flow, PEFR: Peak expiratory flow rate, MVV: Maximum voluntary ventilation

FVC, FEV_1, and PEF were decreased in Type 2 diabetic patients.[12] Meo *et al*., in their study on Saudi diabetic patients showed significant reduction in FVC, FEV_1, and PEF, as compared to their matched controls. They also showed a strong association with a dose-effect response of duration of disease and decreased pulmonary functions impairment in their diabetic patients and observed restrictive pattern of airway disease when the duration of diabetes is longer than 10 years.[13]

Rosenecker *et al*. demonstrated that in patients with diabetes, FVC, and FEV_1 declined significantly over the 5-year study period, whereas patients without diabetes did not show a significant decline during this period.[14] In Kanya Kumari *et al*., study spirometric findings showed that as the duration of diabetes increased the restrictive profile was more prominent.[15]

Agarwal *et al*. found spirometric values (FVC, FEV_1, and FEV_1/FVC) were consistently lower in subjects with T2DM. The effect on FVC predicted % was found to be more pronounced in subjects whose duration of DM was more than 5 years.[2] Tangadhuri. *et al*. showed in their study that the pulmonary functions FVC, FEV_1, PEF, and $FEF_{25-75\%}$ were decreased in Type-2DM compared to controls.[16]

A study by van den Borst *et al*. stated that irrespective of BMI, duration of disease, smoking, and glycemic control, there was a statistically significant impairment in pulmonary function of diabetics than in normal individuals.[17] Kumari *et al*. concluded that pulmonary function parameters such as FEV_1 at the 1st s (FEV_1), FVC, FEV_1/FVC, PEFR, and $FEF_{25-75\%}$ had significant changes in diabetic cases than healthy individuals.[15] Yeh HC and Punjabi NM suggested that pulmonary function such as FVC and FEV_1 was significantly lower in diabetics than non-diabetics.[18]

Several histopathological changes in lung tissues were seen in patients with Type 2 diabetes. Some researchers like Ljubic *et al*.[19] showed that diabetes could lead to the development of pulmonary complications due to collagen and elastin changes. While others suggest that increased non-enzymatic glycosylation of proteins and peptides of the extracellular matrix at chronic high circulating glucose levels may also have an important role in the pathological changes of the lungs in DM patients.[11] This process results in impaired collagen and elastin cross linkage with a reduction in strength and elasticity of connective tissues. These abnormalities in the structural components can lead to the development of abnormalities in the pulmonary function such as a reduction in the vital capacity, total lung capacity, lung compliance, reduction of central and peripheral airflows, and acceleration of the ageing process. Alteration in the pulmonary connective tissue by thickening of the alveolar and capillary endothelial basement membranes might cause modifications of alveolar surfactants altering its function and pulmonary microangiopathy which brings about reduction in diffusing capacity and the muscle endurance.

CONCLUSION

Our study showed that pulmonary function was compromised in T2DM and the changes were of restrictive pattern. As the duration of diabetes increases, the restrictive lung impairment becomes more prominent. Therefore, the patients with Type 2 diabetes are needed to undergo pulmonary function testing periodically. Strict glycemic control and regular breathing exercises to strengthen respiratory muscles are necessary to improve the pulmonary function in Type 2 diabetics.

Limitations of the Present Study

The sample size in the present study is relatively small. Also, unknown and subclinical complications, which are unaccounted for, may contribute to spirometric changes.

ACKNOWLEDGMENT

We are thankful to the entire department of Physiology and Department of Medicine for their cooperation. We are also thankful to the patients who were agreed to participate in the study. Our sincere thanks to the Department of Community Medicine for their valuable input.

REFERENCES

1. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care 2014;37:S81-90.
2. Agarwal A, Grover A. Pulmonary function test in patients of Type 2 diabetes mellitus. Int J Res Med Sci 2019;7:2240-45.
3. Nemagouda SK. Spirometric abnormalities in patients with Type 2 diabetes mellitus. J Evol Med Dent Sci 2019;8:3014-8.
4. Kaur S, Agarwal N. Pulmonary function tests in Type 2 diabetes mellitus. Arch Med Health Sci 2016;4:35-9.

5. Shah S, Sonawane P, Nahar P, Vaidya S, Salvi S. Pulmonary function tests in Type 2 diabetes mellitus and their association with glycemic control and duration of the disease. Lung India 2013;30:108-12.
6. Mathew J. Clinical evaluation pulmonary function test in Type II diabetes mellitus. Int Arch Integr Med 2019;6:37-42.
7. Suguna S, Vinodha R. A study of pulmonary function test in Type II diabetes mellitus-spirometry based. Int J Physiol 2018;6:1-6.
8. Rajani M, Manoj DK, Ram R, Achuthan V. Study of pulmonary function tests in Type 2 diabetes mellitus. Pulmonol 2013;15:201.
9. Chidri SV, Vidya G. Assessment of pulmonary functions in Type 2 diabetes mellitus: Its correlation with glycemic control and body mass index. Natl J Physiol Pharm Pharmacol 2020;10:553-6.
10. EI-Azeem AA, Hamdy G, Amin M, Rashad A. Pulmonary function changes in diabetic lung. Egypt J Chest Dis Tuberc 2013;62:513-7.
11. Gajbhiye R, Tambe A. Pulmonary function test in Type II diabetics. Glob J Biol Agric Health Sci 2014;3:20-2.
12. Davis WA, Knuiman M, Kendall P, Grange V, Davis TM. Fremantle Diabetes Study. Glycemic exposure is associated with reduced pulmonary function in Type 2 diabetes: The Fremantle Diabetes Study. Diabetes Care 2004;27:752-7.
13. Meo SA, Al-Drees AM, Arif M, Al-Rubean K. Lung function in Type 2 Saudi diabetic patients. Saudi Med J 2006;27:338-43.
14. Rosenecker J, Hofler R, Steinkamp G, Eichler I, Smaczny C, Ballmann M, *et al*. Diabetes mellitus in patients with cystic fibrosis: the impact of diabetes mellitus on pulmonary function and clinical outcome. Eur J Med Res 2001;6:345-50.
15. Kumari DH, Nataraj SM, Devaraj HS. Correlation of duration of diabetes and pulmonary function tests in type 2 diabetes mellitus patients. Int J Biol Med Res 2011;2:1168-70.
16. Thangadhurai A. Assessment of pulmonary function tests in Type 2 Dm. IOSR J Dent Med Sci 2018;17:23-6.
17. van den Borst B, Gosker HR, Zeegers MP, Schols AM. Pulmonary function in diabetes: A metaanalysis. Chest 2010;138:393-406.
18. Yeh HC, Punjabi NM, Wang NY, Pankow JS, Duncan BB, Cox CE, *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.
19. Ljubic S, Metelko Z, Car N, Roglic G, Drazic Z. Reduction of diffusion capacity for carbon monoxide in diabetic patients. Chest 1998;114:1033-5.

How to cite this article: Saha A, Chakraborty D, Saha S. Assessment of Spirometric Parameters in Patients with Type 2 Diabetes Mellitus in a Tertiary Care Hospital of North East India: A Cross-Sectional Study. Int J Sci Stud 2023;10(11):111-116.

Source of Support: Nil, **Conflicts of Interest:** None declared.