

RESEARCH ARTICLE

Effect of duration of diabetes on pulmonary functions in non-smoker type-2 diabetes mellitus

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ABSTRACT

Background: Diabetes mellitus (DM) is a lifestyle disorder associated with long-term damage to various organs. Abnormal respiratory functions have found to be associated with diabetes, yet the significance of this association is not convincingly proven. **Aims and Objectives:** The concept of undertaking this project is to know the extent of damage done to the respiratory system by DM and its relation with the duration of diabetes. **Materials and Methods:** In our study, 70 non-smoker type 2 DM patients attending the medicine outpatient department in our hospital were selected. Approval of the Institutional Ethical Committee was taken before commencement of the study. Same number of normal healthy subjects was taken as the control group. The patients are divided into three groups by the duration of diabetes. Spirometry was performed using an electronic spirometer and various lung volumes and capacities were recorded. **Results:** *P* value was highly significant for forced vital capacity (FVC), forced expiratory volume in 1 s (FEV₁), FEV₁/FVC, and peak expiratory flow rate (PEFR) between the cases and the controls (i.e., <0.05). *P* value was highly significant for FVC, FEV

INTRODUCTION

Diabetes mellitus (DM) is a lifestyle disease causing a huge health problem throughout the world. The recently published national study – the Indian Council of Medical Research – India diabetes (ICMR) study has shown an alarming rise in diabetes cases in our country.^[1] Type 2 diabetes is the more common form and is associated with long-term damage to

various organs. Its complications may be due to macro- or micro-vascular changes. Abnormal respiratory functions have found to be associated with diabetes, yet the significance of this association is not convincingly proven.^[2,3] Respiratory parameters are also important risk factor for pulmonary morbidity as well as mortality in diabetes, although it has not been clearly categorized. Lung disorders are not part of the complications of diabetes by the International Diabetes Federation and American Diabetes Association.^[4,5] Alveolar capillaries have a high chance to be affected in diabetic microangiopathy. Glycosylation of collagen and elastin of lung is seen in chronic hyperglycemia which may remain undiagnosed clinically. It was reported by researchers that respiratory parameters are reduced in diabetes, and duration of disease plays a very key role in its pathogenesis.^[6,7] Therefore, the study was undertaken to evaluate possible

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correlation of respiratory parameters with blood sugar status and duration of disease. There are not many studies in our country which involve the assessment of respiratory parameters and relationship with the duration of disease. The aim of this project is to study the effects of duration of hyperglycemia on respiratory parameters which will be assessed by means of spirometry so we can fill the above epidemiological statistical gap and add to the information, regarding the burden of respiratory complications of DM.

MATERIALS AND METHODS

The project was conducted in 2 months period, i.e., months of August and September. Seventy non-smoker type 2 DM patients attending the medicine outpatient department in our hospital were selected.

Diabetes patients were selected according to below guidelines:

1. Fasting blood glucose ≥ 126 mg/dL (7.0 mmol/L) or
2. HbA1C $\geq 6.5\%$ (48 mmol/mol).

(As per the guidelines provided by the American Diabetes Association).^[8]

They were selected into three groups according to the disease duration, i.e.,

1. <5 years
2. 5–10 years and
3. >10 years

(On the basis of their history and medical records).

Same number of healthy subjects of the matched sex and age group and socioeconomic status preferably from their own family was taken as the controls, after matching anthropometric criteria. Inclusion and exclusion criteria were followed on the basis of history, medical records, and physical examination.

Inclusion Criteria

Non-smoker Type 2 DM patients of 40–60 years were included in the study.

Exclusion Criteria

Patient is not in the above inclusion criteria. Patients with respiratory illness, smokers, drug users, tobacco chewers, neuromuscular disorders, cancer, major thoracic surgery, and gross abnormalities of thoracic cage were excluded from the study. Oral and written consent was taken from all the subjects.

Approval of the Institutional Ethical Committee was taken before commencement of the study.

Name, age, and sex were recorded. Anthropometric measurements were carried out. Height was measured using

the height measuring stand (stadiometer) to the nearest centimeter and weight was measured by digital weighing machine to the nearest kilogram.

Electronic spirometer was used to perform spirometry (SCHILLER SPIROVIT SP-1). The instrument was daily calibrated. The ambient temperature range of 15–30°C was maintained throughout. The technique of executing the various tests was based on the operating manual of the instrument, as well as the American Thoracic Society/European Respiratory Society guidelines for the spirometry.^[9] The subjects were made to practice before finally performing the test. The test was performed in the sitting position and the nose is closed by nose clip. The subject is asked to repeat the test 3 times and is given rest in between the readings; finally, the best reading is noted. The forced vital capacity (FVC), forced expiratory volume in 1 s (FEV₁), peak expiratory flow (PEF), FEV₁/FVC ratio, and slow vital capacity (SVC) were recorded.

All tests were carried out between 10 AM and 3 PM to minimize diurnal variations.

Statistical Analysis

The data were analyzed using the SPSS software (Version 20). The results are presented in mean $\pm$ SD and percentages. The comparison is done using unpaired Student's *t*-test. *P* < 0.05 is considered statistically significant.

RESULTS

Seventy cases of non-smoker Type-2 DM were recorded along with 70 age- and sex-matched controls. Out of this, 37 were male and 33 were female. The mean age was 50.9 years with SD of 6.95, as shown in Table 1.

As per Table 2, *P* value was highly significant for FVC, FEV₁, FEV₁/FVC, and peak expiratory flow rate (PEFR) between the cases and the controls (i.e., <0.05) showing that these pulmonary functions were reduced significantly in the cases, but the SVC was not significantly reduced in the cases.

The cases were divided according to the duration of their diabetes into three groups and compared.

1. <5 years
2. 5–10 years, and
3. 10 years

Table 1: Demography pattern of cases

Variables	Value
Number of females	33
Number of males	37
Age in years (mean $\pm$ SD)	50.9 $\pm$ 6.95

As per Table 3, *P* value was highly significant for FVC, FEV₁, SVC, and PEFR between <5 years and 5–10 years duration of diabetes (i.e., <0.05), showing that these pulmonary functions were reduced significantly, but the FEV₁/FVC ratio was not significantly affected by the durations specified.

As per Table 4, *P* value was significant for FVC and FEV₁ on comparing the groups <5 years and >10 years duration of diabetes (i.e., <0.05), showing that these pulmonary functions were reduced significantly with duration, but the FEV₁/FVC ratio, SVC, and PEFR were not significantly affected by the duration of diabetes.

As per Table 5, *P* value was not significant for FVC, FEV₁, FEV₁/FVC ratio, SVC, and PEFR between 5 and 10 years–>10 years duration of diabetes groups, showing that there was no significant association between these duration groups.

DISCUSSION

Our study aims to show reduced pulmonary functions in diabetics in comparison to their age- and sex-matched controls. There are many studies which show reduced pulmonary functions in diabetics.^[6,9–14] The exact cause of the changes in pulmonary parameters in diabetics is not known, but there are several theories explaining reduced pulmonary parameters in DM. These are – diabetes-induced thickening of the basal lamina of the lung,^[15] microangiopathy of pulmonary capillaries and arteriole,^[16] glycosylation of collagen, leading to loss of lung elasticity, neuropathy of lung muscles, and mild inflammation of lung tissues.^[17] There are studies which show that neuropathy is the causative factor for respiratory muscle dysfunction in diabetes causing reduction of pulmonary volumes.^[18]

Table 2: Comparison of PFT between cases and controls

Variables	Case mean±SD	Control mean±SD	<i>P</i> -value
FVC (L)	2.52±0.81	2.81±0.29	0.006
FEV ₁ (L)	2.03±0.65	2.54±0.27	0.000
FEV ₁ /FVC (%)	82.03±11.38	89.96±5.8	0.000
SVC (L)	2.39±0.93	2.58±0.31	0.100
PEFR (L/s)	4.18±1.88	4.97±0.82	0.000

FVC: Forced vital capacity, FEV₁: Forced expiratory volume in 1 s, PEFR: Peak expiratory flow rate, SVC: Slow vital capacity

Table 3: Effect of duration on PFT

Variables	<5 (<i>n</i> =39) mean±SD	5–10 years (<i>n</i> =19) mean±SD	<i>P</i> -value
FVC (L)	2.80±0.82	2.16±0.59	0.001
FEV (L)	2.26±0.70	1.73±0.47	0.001
FEV ₁ /FVC (%)	83.57±10.54	78.35±14.20	0.165
SCV (L)	2.70±0.93	1.91±0.73	0.001
PEFR (L/s)	4.77±1.92	3.25±1.61	0.003

FVC: Forced vital capacity, FEV₁: Forced expiratory volume in 1 s, PEFR: Peak expiratory flow rate

A study done by Aparna showed that FVC, FEV₁, and PEFR were significantly reduced diabetics and the FEV₁/FVC% was increased in type 2 diabetics which was similar to our study, except that the SVC was increased and FEV₁/FVC% was decreased in our study.^[19]

In our study, the duration of study has significant association with FVC and FEV₁ on comparison between subjects with duration <5 years and 5–10 or >10 years which is in accordance with Karale *et al.*^[15] The SVC and PEFR were significantly associated when subjects with <5 years duration were compared with >10 years duration diabetes. This showed that it was predominantly a restrictive change according to the durations compared.

In their study, Kopf *et al.* showed the relation of duration with restrictive lung disease in type-2 DM patients. Reduced FVC was found in long term and newly diagnosed diabetic patients, while the number of patients with reduced FVC was lower in healthy controls and pre-diabetic patients who match to our findings as mentioned above.^[20]

In a recent study done by Rani *et al.* showed that the pulmonary function parameters (FVC, FEV₁, and PEFR) are reduced in type 2 diabetes, indicating a restrictive pattern of lung pathology. A negative correlation between reduced lung functions (FVC and FEV₁) was observed with duration of diabetes.^[18]

The findings of all parameters of PFTs are not significant if the 5–10 years duration group is compared to >10 years duration. These findings are pointing toward the observation

Table 4: Effect of duration on PFT

Variables	<5 (<i>n</i> =39) mean±SD	>10 years (<i>n</i> =12) mean±SD	<i>P</i> -value
FVC (L)	2.80 ± 0.82	2.18 ± 0.73	0.022
FEV (L)	2.26 ± 0.70	1.79±0.46	0.011
FEV ₁ /FVC (%)	83.57±10.54	82.83±8.17	0.800
SCV (L)	2.70±0.93	2.13±0.85	0.065
PEFR (L/s)	4.77±1.92	3.73±1.47	0.06

FVC: Forced vital capacity, FEV₁: Forced expiratory volume in 1 s, PEFR: Peak expiratory flow rate

Table 5: Effect of duration on PFT

Variables	5–10 years (<i>n</i> =19) mean ±SD	>10 years (<i>n</i> =12) mean ±SD	<i>P</i> -value
FVC (L)	2.16±0.59	2.18±0.73	0.95
FEV (L)	1.73±0.47	1.79±0.46	0.73
FEV ₁ /FVC (%)	78.35±14.2	82.83±8.17	0.27
SVC (L)	1.91±0.73	2.13±0.85	0.46
PEFR (L/s)	3.25 ± 1.61	3.73 ± 1.47	0.40

FVC: Forced vital capacity, PEFR: Peak expiratory flow rate, SVC: Slow vital capacity

that – more the difference in the duration of diabetes, more are the changes in pulmonary functions observed. The findings are consistent with some studies.^[19,21-24]

Strength and Limitation of the Study

The changes are more in favor of restrictive lung disease. The mean values of all the respiratory parameters such as FVC, FEV₁, FEV₁/FVC%, SVC, and PEFR during spirometry are reduced significantly in cases as compared to controls.

If the duration of diabetes is more, it shows significant reduction in mean values of respiratory lung volume parameters as seen when compared to newly diagnosed (<5 years duration) DM as the restrictive profile of the former is more prominent.

Many other lung tests besides spirometry, such as DL_{CO}, chest computed tomography, and lung tissue staining, can also add valuable information about respiratory changes in Type-2 DM patients and its relation to the duration of disease. Detailed lung functions including diffusion studies can be investigated for better understanding of the lung dysfunctions.

Further studies with a larger sample size needed to determine the associations more assertively.

CONCLUSION

With our study, we can conclude that Type 2 DM affects the lungs and shows significant changes in PFTs in comparison to matching controls and duration of diabetes has significant effect on respiratory parameters too. The changes are in accordance with some of the previous studies.

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