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Original Research Article

Assessment of pulmonary functions in type 2 diabetes mellitus patients

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ABSTRACT

Background: Several studies have demonstrated that pulmonary functions in type 2 diabetes mellitus patients (T2DM) have possible associations between pulmonary function abnormalities and diabetic renal micro-angiopathy, and retinopathy. We aim to assess pulmonary functions in T2DM patients.
Methods: We conducted a cross-sectional study among T2DM patients visiting the outpatient department (OPD) of Pulmonary Medicine. T2DM patients aged between 40 to 65 years of either sex were recruited and spirometry was done.
Results: Total 340 T2DM patients (162 males and 178 females) participated in study. The mean age of the patients was 56.24±6.87 and 51.59±7.15 years in uncontrolled (n=78) and controlled diabetics (n=262) respectively. Non-significant change in body mass index (BMI) was observed in uncontrolled diabetics (26.49±4.35) as compared to controlled diabetics (25.77±3.72). Significant increase ($p<0.001$) in fasting blood glucose and glycated haemoglobin (HbA1c) was recorded in uncontrolled diabetics (241.10±49.79, 9.21±1.14) as compared to controlled diabetics (93.17±8.40, 5.72±0.60). Significant change ($p<0.001$) in mean FEV1, mean FVC values and Mean FEV1/FVC ratio (%) were noted in uncontrolled diabetics (2.21±0.57, 3.50±0.48, 62.69±12.18) as compared to controlled diabetics (2.47±0.42, 3.68±0.37, 67.01±8.43). Results suggested that obstructive and restrictive lung impairment was more in uncontrolled diabetics (35.9%, 6.4%) as compared to controlled diabetics (13.4%, 3.8%).
Conclusion: Current study indicates that obstructive rather than restrictive impairment of lung function was significantly associated with T2DM.

Keywords: Type 2 diabetes mellitus, Pulmonary function, FEV1/FVC ratio, Spirometry

INTRODUCTION

There is an alarming increase in the incidence and prevalence of diabetes mellitus particularly in Asian Indians. The major morbidities in type 2 diabetes mellitus (T2DM) are due to its micro-angiopathic and macro-angiopathic complications, which affect eyes, kidneys, nerves, heart, and major vessels. In type 2 diabetes, mellitus, lung function has been investigated in several clinical studies.[1,2] The prevalence of diabetes for all age groups worldwide was 2.8% in 2000 and is estimated to reach 4.4% by 2030.[3]

A study on pulmonary functions in patients with T2DM, suggested possible association between pulmonary function abnormalities and diabetic renal micro-angiopathy, retinopathy and diabetic control.[4] Several pathological changes may affect the lungs in patients with T2DM, Collagen and elastin changes, which may occur due to small vessel involvement, can lead to significant structural changes.[5]

Increased non-enzymatic glycation 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 T2DM patients.[6] Another study suggested a relationship between pulmonary complications and other chronic complications in diabetes. Reduced forced vital capacity (FVC) was detected in 16.0% of patients with longstanding diabetes and 12.8% in patients with newly diagnosed disease.[7]

In a Japanese study it was observed that there were no significant variables affecting chronic obstructive pulmonary disease (COPD) in the non-elderly group. In the elderly group, male sex, low BMI, insulin therapy, and increased C-peptide immune-reactivity levels were significant variables for COPD. In the non-elderly group, pack-years was a significant variable for reduced FEV1/FVC ratio.[8]

Recent study indicates reduced pulmonary function as an independent risk factor for incident diabetes in Koreans. Results demonstrated that forced vital capacity (FVC; % predicted) and forced expiratory volume in 1 second (FEV_1; % predicted) were significantly correlated with incident diabetes in a graded manner after adjustment for sex, age, smoking, exercise, and metabolic parameters.[9]

In present study, we aim to assess pulmonary function impairment in T2DM patients.

METHODS

Study design and place

Present study is a cross-sectional prospective study. Study was conducted in the department of physiology in collaboration with pulmonary medicine, Era's Lucknow Medical College and Hospital, Lucknow. Prior approval from Institutional ethics committee was taken for the study.

Subject recruitment

Type 2 Diabetes Mellitus patients, attending the OPD of pulmonary medicine, Era's Lucknow Medical College, Lucknow, fulfilling the criteria were recruited. Informed consent was obtained from all study participants.

Inclusion criteria

Patients of type 2 diabetes mellitus aged between 40 to 65 years of either sex, T2DM patients for more than six months' duration, and patients willing to give informed written consent were included.

Exclusion criteria

Subjects with current smoking habit or a smoking history; those diagnosed to have any acute or chronic respiratory disease such as emphysema, cystic fibrosis, and asthma; pregnant women; subject having any other endocrine disorders e.g. hypo and hyperthyroidism, Cushing's syndrome, Grave's disease, and Addison's disease; and subjects in any occupation affecting pulmonary functions were excluded.

Biochemical analysis

3 ml blood was drawn from all the study participants for biochemical analysis. Whole blood was used to estimate HbA1c, and plasma fasting blood glucose was estimated using fully automated analyser VITROS 5600 in the Hospital Lab service of institute.

T2DM patients were divided into controlled and uncontrolled as per American Diabetes Association criteria (2013).[10] Patients with HbA1C ≤7% were considered controlled and with HbA1C >7% were considered uncontrolled diabetic.

Spirometry

Spirometry was performed in all study participants. Forced expiratory volume in one second (FEV_1), forced vital capacity (FVC), and the ratio of the forced expiratory volume in 1 second to the forced vital capacity in percentage (FEV_1/FVC%) were measured using the Medikro Spirostar (M9479) Finland Machine. A minimum of three performances were recorded. FEV_1, FVC and FEV_1/FVC% readings were noted. All the readings were interpreted according to ATS/ERS standard 2019.[11]

Statistical analysis

Comparisons were made between uncontrolled and controlled diabetic groups and among different airway pattern groups. Data has been represented as numbers and percentages for categorical and as mean±standard deviation for continuous data. Univariate analysis was done using Chi-square test for categorical evaluations. Independent samples 't'-test and analysis of variance (ANOVA) was performed for continuous evaluations. For post-hoc assessment, Tukey's HSD test was used.

RESULTS

Present study was conducted by recruiting 340 T2DM patients. Among T2DM patients, 162 (47.65%) were males and 178 (52.35%) were females. Mean age of patients was 52.66±7.31 years. Based upon the HbA1C value and fasting blood glucose levels, subjects were categorised into uncontrolled and controlled diabetics. Patients having HbA1C value less than 7% and fasting blood glucose levels less than 120 mg/dl were considered as controlled diabetics, while patients having HbA1C value more than 7% and fasting blood glucose levels more than 120mg/dl were considered as uncontrolled diabetics.

Out of 78 patients among uncontrolled diabetics, 36 were male (46.2%) and 42 were female (53.8%), while among

262 controlled diabetics, 126 were male (48.1%) and 136 were female (51.9%). Majority of females were found in uncontrolled diabetics (53.8%) as well controlled diabetics (51.9%) as compared to males, however this increase was statistically non-significant (χ^2=0.132, p<0.716) (Table 1 and Figure 1).

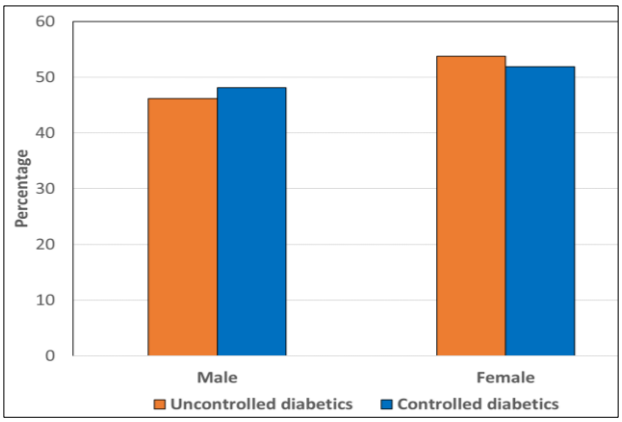

Figure 1: Comparison of gender profile of study groups.

Mean age of uncontrolled and controlled diabetics was recorded as 56.24±6.87 years, and 51.59±7.15 years, respectively. Increased age in uncontrolled diabetics was found significantly (t=5.280, p<0.001) higher as compared to controlled diabetics (Table 1 and Figure 2).

Majority of patients in uncontrolled group (61.5%) had BMI ≥25 kg/m^2 while majority of those in controlled group (51.9%) had BMI <25.0 kg/m^2. Mean BMI of uncontrolled and controlled group of patients was 26.49±4.35 kg/m^2 and 25.77±3.72 kg/m^2. Statistically, there was no significant difference between the two groups for BMI (p>0.05). Also there was no significant difference (p=0.150) in BMI between uncontrolled diabetics (26.49±4.35) and controlled diabetics (25.77±3.72) (Figure 3).

Fasting blood glucose levels were found highly significantly (p<0.001) increased in uncontrolled diabetics (241.10±49.79) as compared to controlled diabetics (93.17±8.40), similarly HbA1c values were also found highly significantly (p<0.001) increased in uncontrolled diabetics (9.21±1.14) as compared to controlled diabetics (5.72±0.60) (Table 2 and Figures 4 and 5).

Significant increase was found pulmonary functions tests; FEV_1, FVC and FEV1/FVC ratio in controlled diabetics as compared to uncontrolled diabetics (Table 3). Increased FEV1 values (L), FVC (L) and FEV1/FVC ratio (%) were recorded as 2.47±0.42, 3.68±0.37 and 67.01±8.43 respectively in controlled diabetics as compared to 2.21±0.57, 3.50±0.48 and 62.69±12.18 in uncontrolled diabetics, which were statistically significant (p<0.001) (Figures 6 and 7). These findings indicate the presence of impaired lung function in T2DM patients. Pulmonary function parameters demonstrate restrictive and obstructive airway pattern among uncontrolled and controlled diabetics.

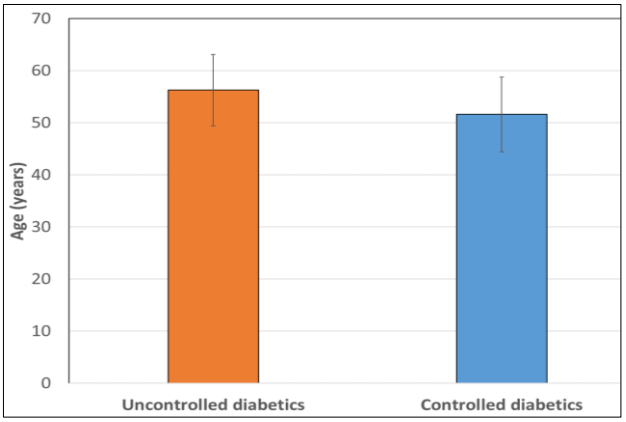

Figure 2: Comparison of mean age of study groups.

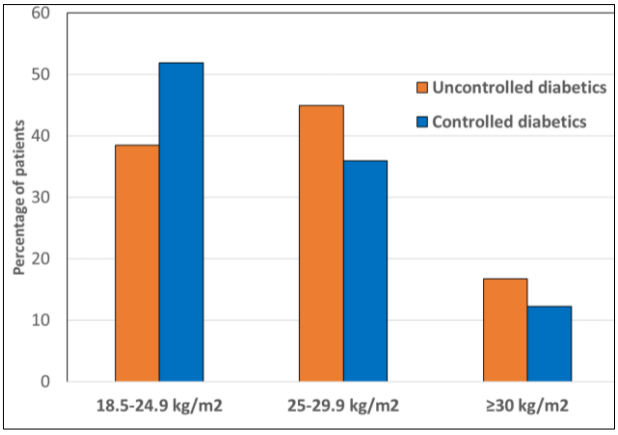

Figure 3: Comparison of BMI profile of study groups.

Table 1: Demographic profile and body mass index of study groups.

Characteristics	Uncontrolled diabetes (n=78) (%)	Controlled diabetes (n=262) (%)	Statistical significance
Age (years) (mean±SD) (range)	56.24±6.87 (40-65)	51.59±7.15 (40-65)	t=5.280; p<0.001
Gender			
Male	36 (46.2)	126 (48.1)	χ^2=0.132; p=0.716
Female	42 (53.8)	136 (51.9)	
Body mass index (kg/m^2)			
18.5-24.9	30 (38.5)	136 (51.9)	χ^2=4.637; p=0.098
25.0-29.9	35 (44.9)	94 (35.9)	

Continued.

Characteristics	Uncontrolled diabetes (n=78) (%)	Controlled diabetes (n=262) (%)	Statistical significance
≥30	13 (16.7)	32 (12.2)	
Mean BMI±SD (kg/m²)	26.49±4.35	25.77±3.72	t=1.443; p=0.150

Table 2: Comparison of HbA1c and fasting blood sugar levels between study groups.

Parameters	Uncontrolled diabetes (n=78)	Controlled diabetes (n=262)	Statistical significance
HbA1c (%) (mean±SD)	9.21±1.14	5.72±0.60	t=35.75; p<0.001
Fasting glucose (mean±SD) (mg/dl)	241.10±49.79	93.17±8.40	t=46.09; p<0.001

Table 3: Comparison of pulmonary function parameters between study groups.

Parameters	Uncontrolled diabetes (n=78)	Controlled diabetes (n=262)	Statistical significance
FEV1 (L) (mean±SD)	2.21±0.57	2.47±0.42	t=4.493; p<0.001
FVC (L) (mean±SD)	3.50±0.48	3.68±0.37	t=3.522; p<0.001
FEV1/FVC ratio (%) (mean±SD)	62.69±12.18	67.01±8.43	t=3.555; p<0.001

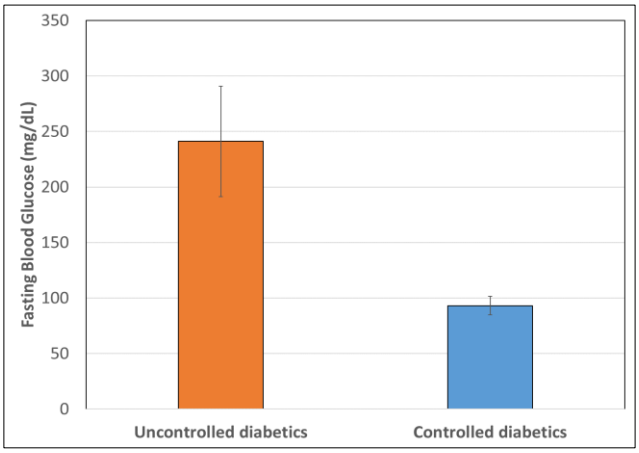

Figure 4: Comparison of fasting blood glucose levels between study groups.

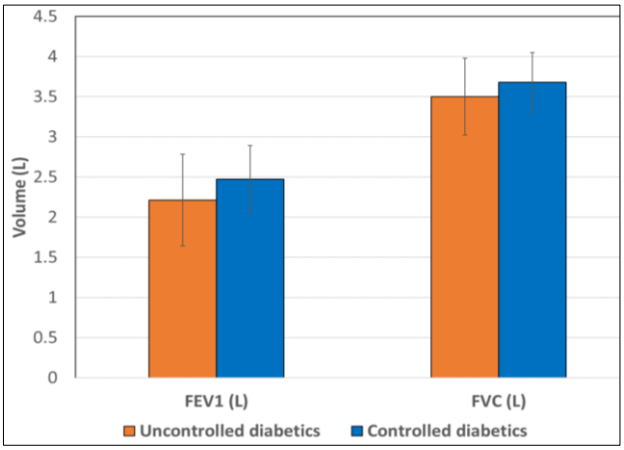

Figure 6: Comparison of pulmonary function parameters between study groups.

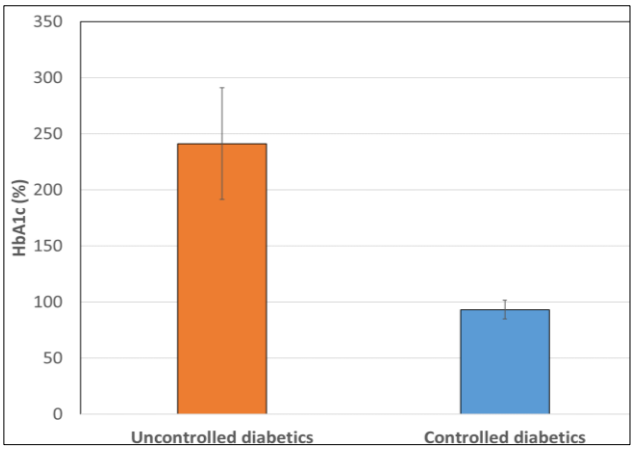

Figure 5: Comparison of HbA1C values between study groups.

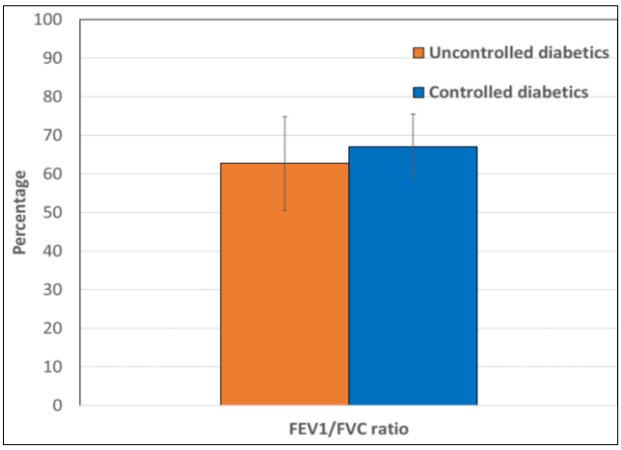

Figure 7: Comparison of FEV1/FVC ratio between study groups.

DISCUSSION

T2DM gradually affects human organ and systems with various systemic complications. Currently, T2DM has a high priority health agenda due to being a global pandemic and a deathtrap to human health.[12] Moreover, COVID-19 pandemic has an influence on human health, the diabetic population is at higher risk, as the infection also involves the respiratory system.[13]

Present study was conducted to assess pulmonary function parameters in T2DM patients. Results of our study indicates that statistically significant increase in T2DM patients was observed with the increasing age, and females were the most sufferers as compared to males. BMI data showed non-significant change in uncontrolled and controlled diabetics. Biochemical investigations revealed a highly significant increase in fasting blood glucose levels and HbA_1C value among uncontrolled diabetics as compared to controlled diabetics. Further we also observed significant decrease in pulmonary function parameters (FEV_1, FVC and FEV_1/FVC ratio) in uncontrolled diabetics as compared to controlled diabetics. Thus overall results indicate the impaired lung function in uncontrolled diabetics.

The data observed in our study shows immense similarity with previously conducted cross-sectional studies with T2DM patients. Ilavarasi and researchers studied 100 patients with type 2 diabetes and observed that pulmonary functions were decreased and inflammatory markers like hsCRP, fibrinogen, and ferritin significantly increased in uncontrolled diabetics.[14]

Rui-Heng et al conducted their study in Beijing population and explored the non-linear association between pulmonary function and blood glucose, insulin resistance, and CRP. They reported, diabetes mellitus is non-linearly associated with pulmonary function. Their finding of a negative association between HbA1c and FEV_1 in diabetes patients with good glucose control but not in patients with poor glucose control.[15]

South Korean research group analyzed hemoglobin A1c (HbA1c) levels and various lung function test results in healthy individuals after a 6-year follow-up period to explore the influence of lung function changes on glycemic control. They found individuals with FEV_1/FVC ratio values of 78% to 82% had lower risk of DM than those in the quartile with FEV_1/FVC ratio values of ≥86% after adjusting for age, sex, and body mass index ($p=0.04$).[16]

Study conducted by research team of Iran, demonstrated a significant direct relationship between interleukin-6, interleukin-1β with HbA1c, FBS, insulin, and insulin resistance. However, there was a significant inverse relationship between interleukin-6, interleukin-1β, and with vitamin D.[17]

Systematic and meta-analysis data indicates the pooled weighted mean difference (WMD) between diabetes patients and non-diabetic participants for FEV_1 and FVC were -5.65% and -5.91%, respectively, of predicted values. Diabetes-related microvascular complications and poor glycaemic control were also associated with poorer pulmonary function in those with diabetes.[18]

Praveena and researchers conducted a cross-sectional study with 140 patients with T2DM, and revealed the impact of T2DM on pulmonary function. Also the correlation analysis unveiled the association among glycemic status, pulmonary function of patients, and duration of diabetes with T2DM.[19]

Our study findings also provide insight into the relationship between the fasting blood glucose, HbA1c level, and impaired lung function parameters in T2DM patients. Our results also provide evidence that in T2DM patients, high HbA1c may be an essential clue to find the adverse effect on the lung function.

CONCLUSION

Our study findings conclude that high HbA1c or poor glycemic control impairs lung functions in T2DM patients. Uncontrolled diabetes with high HbA1c may further deteriorate lung functions with the duration of diabetes mellitus. Even though study participants did not report any respiratory symptoms, they may have underlying subclinical restrictive/obstructive airway pattern. Normal glycemic control may improve pulmonary functions and the overall health of diabetic patients. Further study with a large group of T2DM patients may help understand the mechanism in better way.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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