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Original Article

Study of the Effect of Diabetes Mellitus Type II on Spirometry Test among Adults

Afraa Moussa[1], Mohammed Al-khayer[2], Ruba Salman[3]

[1,3]Department of Endocrine Disease, Tishreen University, Faculty of Medicine, Lattakia, Syria.
[2]Department of Pulmonary Disease, Tishreen University, Faculty of Medicine, Lattakia, Syria.

[1]Corresponding Author : drafraamoussa@gmail.com

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Abstract *- Type 2 Diabetes Mellitus (T2DM) presents a significant concern in the realm of public health, contributing to heightened morbidity due to its widespread impact on multiple bodily systems, including adverse effects on lung function. The primary objective of this investigation was to delve into the intricacies of lung function among individuals afflicted by T2DM. Furthermore, we aimed to elucidate the connection between the severity of the disease and lung function. To accomplish this, an in-depth analytical case-control study spanned one year, from 2022 to 2023, at Tishreen University Hospital in Lattakia, Syria. Our research involved a cohort of T2DM patients aged 18 years and older, with a minimum disease duration of two years (referred to as cases), who were meticulously compared to a well-matched group of healthy individuals (referred to as controls) regarding their lung functions. Results: There were no significant differences between the two groups regarding age, sex, and body mass index BMI($p>0.05$). Duration of diabetes was longer than 10 years in 35.7% of the patients, with the presence of uncontrolled disease in 60.7% and 70.8% according to HbA1C and fasting blood glucose levels, respectively. A statistically significant decrease in FEV1 and FVC was seen in T2DM patients compared to healthy controls (p:0.0001) without a significant decrease in FEV1/FVC(p:0.6). There was a significant decrease in FEV1(p:0.01) and FVC(p:0.003) with increasing duration of disease without significant alterations in FEV1/FVC(p:0.08). In addition, there was a significant decrease in FEV1 and FVC ($p<0.05$) in uncontrolled patients according to HbA1C and fasting blood glucose.*

Keywords *- Glycemic control, Pulmonary functions, Restrictive, Type 2 diabetes mellitus, FEV1.*

1. Introduction

Diabetes mellitus (DM) is recognized as a group of metabolic disorders characterized by elevated blood sugar levels, stemming from either a deficiency in insulin secretion, whether partial or total or a varying degree of resistance to the effects of insulin[1,2]. It is classified into three types according to etiology and clinical presentation: type 1(T1DM), type 2(T2DM), and gestational(GDM) [3]. Type 2 diabetes mellitus (T2DM) is a diverse condition characterized by different prevalence rates. It is recognized as a global epidemic that continues to escalate due to the rising incidence of obesity and lifestyle changes. [4,5]. The pathophysiology of Type 2 diabetes mellitus (T2DM) encompasses peripheral insulin resistance, disrupted regulation of hepatic glucose production, and the progressive decline of β cells, ultimately culminating in β cell failure. [6,7]. Diabetes is associated with an increased risk of micro and macrovascular disease, which affects the kidneys, eyes, heart, blood vessels, nerves and lungs [8,9].

Pulmonary function tests offer precise and quantifiable assessments of lung function. Spirometry, in particular, evaluates lung volume and airflow by measuring the forced expiration following maximal inhalation, thereby determining the total lung capacity[10,11,12]. The respiratory system is one of the bodily systems influenced by diabetes mellitus, yet the precise pathophysiological mechanisms responsible for the alterations it may undergo due to diabetes remain unclear[13,14].

The lung is rich in microvascular circulation, explaining the association between lung injury and diabetes by angiopathic process and glycosylation of tissue proteins resulting from chronic hyperglycemia [15,16,17]. In addition, there is a decrease in ventilator drive and respiratory muscle myopathy in T2DM due to neuropathy that affects both the central and peripheral nervous systems [18,19]. Pulmonary functions of T2DM patients have been investigated in previous studies in adults with different results. The absence of local studies prompted us to carry out this study. Therefore, the study's objectives were to: 1- determine the effect of diabetes mellitus on pulmonary function tests.2- compare lung function between patients according to glycemic control and disease duration.

2. Patients and Methods

This study conducted at the Department of Endocrinology in Tishreen University Hospital, Lattakia, Syria, over a one-year period from 2022 to 2023, represents an analytical case-control investigation. The study group comprised patients diagnosed with Type 2 diabetes mellitus (T2DM), aged 18 years or older, of both sexes and with a disease duration exceeding two years. Exclusion criteria encompassed individuals with cardiac or pulmonary conditions contraindicating pulmonary function tests, smokers, pregnant individuals, and patients with a BMI of 35 or higher.

A comprehensive assessment was conducted, including a thorough medical history, a review of systems, and a physical examination. Height and weight measurements were obtained, and body mass index (BMI) was calculated using the formula weight(kg) divided by height(m) squared(kg/m²). BMI categories were defined as normal weight (18.5-24.9 kg/m²), overweight (25-29.9 kg/m²), and obesity (≥30 kg/m²). Good glycemic control was defined as having a glycated hemoglobin (HbA1c) level below 7% and fasting blood glucose within the range of 80-130 mg/dL.

The control group consisted of healthy individuals of matching age and sex without a diagnosis of T2DM. Pulmonary function tests were administered and compared between the two groups, with all patients undergoing chest X-rays to rule out the presence of obstructive lung diseases.

3. Statistical Analysis

Statistical analysis was performed by using the IBM SPSS version20. Basic Descriptive statistics included means, Standard Deviations (SD), median, Frequency and percentages. To examine the relationships and comparisons between the two groups, the chi-square test was used. Independent t student tests were used to compare 2 independent groups. All the tests were considered significant at a 5% type I error rate(p<0.05), β:20%, and power of the study:80%.

4. Results and Discussion

4.1. Results

The baseline characteristics of the participants are shown in (Table 1). The study included a group of 56 healthy adults (31 males, 25 females) and 56 patients with T2DM (35 males,21 females), p:0.5. No significant difference was found between the groups in terms of age (51.23±4.9 in cases group versus 48.62±6.6 in control group, p:0.9). According to BMI classification, overweight patients represented the most frequent group (53.5%), followed by normal weight (33.9%), obesity (8.9%) and underweight (3.5%) in cases group. In control group, overweight represented the most frequent group (48.2%), followed by normal weight (42.8%), obesity (3.5%), and normal weight (1.78%), p: 0.4. There were significant differences between two groups regarding FVC and FEV1(cases versus control); (72.91±8.8 versus 90.62±4.1, .p:0.0001) and(68.54±9.2 versus 85.49±3.9,p:0.0001) respectively. Fig 1

Table 1. Comparison of demographic characteristics and lung functions of the study population between two groups

Variable	Case group 56	Control group 56	P-value
Sex			
Male	35(62.5%)	31(55.4%)	0.5
Female	21(37.5%)	25(44.6%)	
Age (Year)	51.23±4.9	48.62±6.6	0.9
BMI			
<18.5	2(3.5%)	1(1.78%)	
18.5–24.9	19(33.9%)	24(42.8%)	
25–29.9	30(53.5%)	29(48.2%)	0.4
≥30	5(8.9%)	2(3.5%)	
LFTs			
FVC	72.91±8.8	90.62±4.1	
FEV1	68.54±9.2	85.49±3.9	0.6
FEV1/FVC	92.48±5.4	92.79±4.9	

Duration of diabetes was <10 years in 36 cases (64.3%) and longer than 10 years in 20 cases (35.7%). Based on direct measures of glycemia, good glycemic control was determined in 13 cases (23.2%) and 22 cases (39.3%) depending on fasting blood glucose and HbA1c levels, respectively.

Table 2. Lab-based blood glucose testing of the case group

Variable	Result
Duration of T2DM(year)	
<10	36(64.3%)
≥10	20(35.7%)
Fasting blood glucose	
Controlled	13(23.2%)
Uncontrolled	43(70.8%)
Glycosylated hemoglobin(HbA1c)	
Controlled	22(39.3%)
Uncontrolled	34(60.7%)

FVC was significantly lower with longer duration of disease (65.74±8.9 versus 75.92±5.6, p:0.003), uncontrolled disease depending on fasting blood glucose (68.92±5.8 versus 76.23±4.9, p:0.003) and HbA1C (68.22±7.9 versus 77.92±5.2, p:0.0001). FEV1 was significantly lower with longer duration of disease (63.35±9.2 versus 71.21±9.1, p:0.01), uncontrolled disease depending on fasting blood glucose (65.11±7.8 versus 73.92±6.5, p:0.001) and HbA1C (63.51±5.2 versus 74.92±6.9, p:0.002). FEV1/FVC did not differ significantly between patients according to duration of disease(p:0.08), glycemic status depending on fasting blood glucose(p:0.9) and HbA1C(p:0.07).

Table 3. Comparison of lung function according to glycemic control status and duration of disease

Glycemic status	Lung function		
	FVC	**FEV1**	**FEV1/FVC**
Duration of T2DM			
<10	75.92±5.6	71.21±9.1	93.07±4.9
≥10	65.74±8.9	63.35±9.2	91.75±5.2
p-value	0.003	0.01	0.08
Fasting blood Glucose			
Controlled	76.23±4.9	73.92±6.5	92.23±4.9
Uncontrolled	68.92±5.8	65.11±7.8	91.56±5.1
p-value	0.003	0.001	0.9
Glycosylated hemoglobin (HbA1c)			
Controlled	77.92±5.2	74.92±6.9	93.98±4.7
Uncontrolled	68.22±7.9	63.51±5.2	91.87±4.6
p-value	0.001	0.002	0.07

4.2. Discussion

This Analytical Case-Control study of 122 individuals (56 T2DM patients versus 56 healthy individuals) assessed the presence of abnormal lung functions and the association of disturbance with duration of T2DM and glycemic control.

This study showed the main findings: First, there were no significant differences between the two groups regarding age, sex and BMI($p>0.05$), in which approximately 60% of the patients were males in advanced age, and the overweight group represented the most frequent group. Second, disease duration was shorter than 10 years in approximately two-thirds of patients with uncontrolled disease, depending on fasting blood glucose and HbA1C. Third, there were significant differences between the two groups regarding FVC and FEV1, in which values were lower in T2DM patients. Values of FVC and FEV1 were significantly lower with a longer duration of disease and uncontrolled T2DM depending on HbA1C and fasting blood glucose($p<0.05$). Finally, there were no significant differences between the two groups regarding FEV1/FVC($p>0.05$). Decreased values of FVC and FEV1 with normal FEV1/FVC indicate the presence of restrictive lung disease in T2DM patients. Previous findings might be explained by increasing levels of systemic inflammatory mediators and inflammatory markers with microangiopathy that lead to changes in lung matrix proteins and disorders of pulmonary functions. These findings are comparable with the results of previous studies.

David et al. (2011) demonstrated in a study conducted in the USA, which included 76 T2DM patients and compared with 210 healthy individuals, that patients were older (63±1 versus 56±1) with higher BMI (34.2±1 versus 30.1±0.6). FVC and FEV1 were significantly lower in T2DM patients (75.3±0.7 versus 82.6±0.4) and (71.2±0.7 versus 83.8±0.5) without the presence of significant differences between the two groups regarding FEV1/FVC($p>0.05$) [20]. Compared to the current study, there was an agreement that diabetes leads to restrictive lung disease.

Hamdy et al. (2013) performed a study in Egypt that included 100 individuals (60 DM patients and 40 healthy individuals) with a mean age of 42.78±3.14 years, and females constituted 55% of the study population. FVC, FEV1 and FEV1/FVC were significantly lower in patients compared to controls: 1.7±0.47 versus 2.89±0.35, 2.02±0.41 versus 3.11±0.52 and 85.1±0.1 versus 92.91±0.61 respectively. Pulmonary functions were reduced with increasing duration of disease but without significant difference ($p>0.05$) [21]. In comparison with the current study, diabetes leads to obstructive lung disease in the Hamdy et al. study.

Shah et al. (2013) conducted a study in India that included 60 T2DM patients and 60 healthy individuals without the presence of significant differences between the two groups regarding age and BMI. There were significant differences between the two groups regarding FVC and FEV1(diabetes versus non-diabetes); (77.97±12.99 versus 89.36±9.71) and (78.98±14.09 versus 88.03±6.69) respectively, without any difference regarding FEV1/FVC (112.83±9.53 versus 111.36±10.62).

There was no correlation between disorders of lung functions and both the duration of disease and glycemic control [22]. By comparison with the current study, there was an agreement that diabetes leads to restrictive lung disease but without correlation with disease duration and glycemic control.

Huang et al. (2014) performed a study in India that included 584 individuals (292 T2DM patients and 292 healthy individuals) without significant differences between the two groups regarding age and sex. FVC, FEV1 and FEV1/FVC were significantly lower in patients compared to controls(p:0.0001). Fasting plasma glucose was associated negatively with FVC, FEV1 and FEV1/FVC [23]. In comparison with the current study, diabetes leads to obstructive lung disease in Huang et al. study.

Shergill et al. (2017) conducted a study in India that included 50 T2DM patients and 50 healthy individuals and found the presence of significant differences between the two groups regarding FVC, FEV1 and FEV1/FVC($p<0.05$) [24]. By comparison with the current study, diabetes leads to obstructive lung disease in Shergill et al. study in contrast to the current study without assessment of the correlation between glycemic control status and lung function.

Taspinar et al. (2020) conducted a study in Turkey that included 58 T2DM patients and 52 healthy individuals and found the presence of significant differences between the two groups regarding FVC and FEV1($p<0.05$) without the presence of difference regarding FEV1/FVC(p:0.3) [25]. By comparison with the current study, there was an agreement that diabetes leads to restrictive lung disease, but the association between lung functions and glycemic control status was not elucidated in this study.

5. Conclusion

The current study demonstrated that diabetes mellitus causes a number of pathological alterations in pulmonary function of the restrictive pattern, decreasing in pulmonary function was associated with the duration of disease and glycemic control, so early detection of these changes is important to prevent respiratory injury.

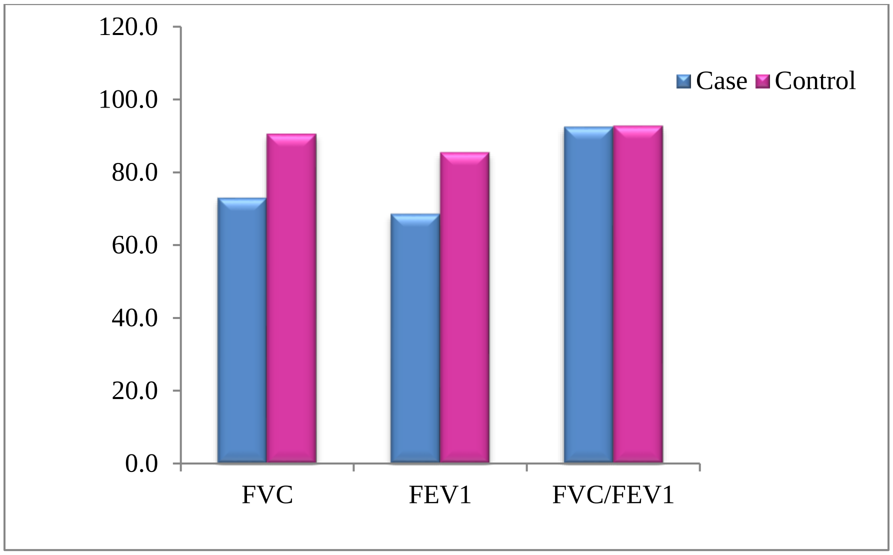

Fig. 1 Mean values of PFTs in the studied groups (Cases and controls)

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