

Research Article

# Pulmonary Function Test among Diabetic and Non-Diabetic: A Comparative Study

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## **ABSTRACT**

**Background and Objectives:** Type II diabetes mellitus (DM) is particularly common medical disorder and is leading cause of morbidity worldwide. The complication of DM is due to micro or macro vascular damage. The presence of an extensive microvascular circulation and abundant connective tissue in the lungs raises the possibility that lung tissue may be a target organ in diabetic patients and thus pulmonary function test can be affected by DM. This study was designed to compare pulmonary function test between Type II diabetic and non-diabetic individuals; and, with the duration of DM.

**Material and Methods:** This cross sectional comparative study was conducted at King Edward Medical University, Lahore Pakistan. Total sample consist of 91 diabetic and 91 non-diabetic grouped as group A and group B. FEV<sub>1</sub>, FVC, FEV<sub>1</sub>/FVC ratio, and PEFR were compared within two groups and with the duration of DM.

**Results:** Total 182 sample with mean age 53.1±5.90 years, with 91(50%) male and 91(50%) female. Group A and B had 91(50%) sample each. Mean value of FVC, FEV<sub>1</sub> and PEFR showed statistically significant difference among the both group. Mean of FVC decreases significantly with the increasing duration of DM; although, is not significant with FEV<sub>1</sub>, FEV<sub>1</sub>/FVC ratio, and PEFR.

**Conclusion:** Diabetic group showed significantly impaired pulmonary functions test as FEV<sub>1</sub>, FVC, and PEFR as compare to non-diabetic group.

**Key Words:** Diabetes mellitus, pulmonary diffusion capacity, PFT, FVC, FEV<sub>1</sub>, PEFR

## **INTRODUCTION**

Diabetes mellitus is a progressive disease affecting multiple organs over a period with an increasing occurrence across all age groups all over the world. It is an important metabolic disorder which is characterized by hyperglycemia with variable degree of insulin

resistance, impaired insulin secretion & increased glucose levels for Type-I (insulin-dependent) and Type-II (non-insulin-dependent) diabetes mellitus [1, 2].

Type II diabetes mellitus (DM) is a progressive disease which is associated with vast array of complications. These

complications are the result of both macro and micro-vascular damage [3]. Type II DM is the most prevalent form accounting for more than 90% of the total cases of diabetes [4]. The condition is asymptomatic in early phases and continues to remain undiagnosed for several years [5].

Diabetes mellitus occurs throughout the world but is more common in the developed European nations, US and the Middle-East [6]. According to the recent assessment by WHO more than one hundred and eighty million people worldwide are suffering from diabetes and this number is predicted to be increased two times by the year 2030 [3]. The occurrence and prevalence of diabetes mellitus is increasing and is becoming alarmingly high among Asian Indians [7]. According to the International Diabetes Federation (IDF), diabetes is one of the most common non-communicable diseases globally. IDF in 2013, reported 382 million people were suffering from diabetes and this number is estimated to incline almost 592 million by 2035 [8]. While it is the fourth leading cause of death in most high-income countries, 80% of current cases occur in low-and-middle income countries [8].

Diabetes mellitus is related to damage, dysfunction and failure of various organs which are mostly due to macro and micro-vascular damage; including cardiovascular disease, nephropathy, retinopathy, neuropathy, glomerular sclerosis and lung dysfunction [9]. The alveolar capillary network of the lung could be altered by microangiopathy[10,11]. Other complications are diabetic foot ulcer, numbness, poor sensation, recurrent infection which may cause tuberculosis, pneumonia, pyelonephritis, otitis and diabetic ulcer too [11]. Elevated blood glucose induces

oxidative stress and changes in the cellular redox state. NADPH oxidase has been responsible for the formation of high levels of reactive oxygen species (ROS) in response to high glucose [12].

In subject with diabetes mellitus, there is histopathologic evidence of the involvement of lungs showing thickened alveolar walls, capillary walls and the pulmonary arteriolar walls, all of which could result in pulmonary dysfunction [10]. The pulmonary and renal complications related to diabetes share a similar micro-angiopathic background [9, 10]. These micro-angiopathic complications have major impact on the quality of life of affected individuals and thus impose a heavy burden on health care providers worldwide [10]. Pulmonary function test impairment in DM has been described in numerous study with different result. However, significant harm of the micro-vascular bed could be bore without rising dyspnoea on the basis of its big reserve. And the consequences, micro-angiopathy of pulmonary diabetic could be under recognized clinically [13].

A reduced elastic recoil, reduced respiratory muscle performance, decreased lung volume, low degree chronic inflammation, reduction in pulmonary diffusion capacity for carbon-monoxide, autonomic changes occurring in respiratory muscles are few relevant alteration taking place in Diabetes Mellitus [14]. Despite such extensive histopathological micro-vascular involvement of the lungs, some authors have reported normal pulmonary function [10].

Although many researches on the influence of Diabetes Mellitus on lung functions are reported in literature internationally, the research pertaining to the same is minimal in Pakistan [15]. In view of the facts, the current

study has been intended to determine the effects of type II DM and its duration on pulmonary function tests. A timely recognition of pulmonary function impairment in diabetes mellitus can help in planning strategy for prevention of worse outcomes and better management of patients.

## MATERIAL AND METHODS

### Study design

This cross-sectional comparative study was conducted among patient attending outdoor clinics of Department of Medicine, Mayo Hospital, Lahore, Pakistan from August 2015 to end of October, 2015.

### Sample size

Sample size was determined as in other health studies, sample size of 182 patients (91 patients in each group) was estimated by using 90% confidence level, 10% margin of error with expected % age of diabetic group as 72% [12] and non-diabetic group as 84% [13].

$$n = \frac{Z^2_{1-\alpha/2} [P_1 (1-P_2) + P_2 (1-P_1)]}{d^2}$$

Where,

Z=confidence level of 90%=1.645

P1=population proportion I=72%

P2=population proportion II=84%

D=margin of error=10%

n=91 patient in each group

### Sampling technique

Non probability purposive sampling technique was used since it was a hospital based study with no sampling framework.

### Sample selection

All adults with type-2 DM diagnosed for at least 3 month on the day of interview and age and sex matched controls. Patients were diagnosed as DM using either of the following criteria [14]: Fasting blood sugar>126mg/dl; Post prandial blood sugar>200mg/dl; HbA1c>6.5%

### Exclusion criteria

All smokers, Patients already diagnosed to have either obstructive or restrictive lung disease, Patients unable to effectively perform spirometry, Patients with congestive cardiac failure on clinical ground and patients with respiratory infection/ allergy within previous three months are excluded from the study.

### Data collection procedure

After taking written Informed consent, patients were enrolled to participate in the study. The patients were divided into two groups: Group A: Type-2 diabetes mellitus and Group B: Non-diabetic healthy volunteers/attendants of the patients.

Pulmonary function tests [Forced vital capacity (FVC), Forced expiratory volume in one second (FEV<sub>1</sub>), FEV<sub>1</sub>/FVC ratio, Peak Expiratory Flow Rate (PEFR) were measured by using spirometer in both the groups.

Semi-structured, interviewer administered questionnaire was used for collecting information on two groups. The data was analyzed using SPSS version 20. Quantitative variables like age were presented as mean ± SD. Qualitative variables like gender were represented as frequency and percentages. Individual parameters of the spirometry, which is FEV<sub>1</sub>, FVC, FEV<sub>1</sub>/FVC ratio, and PEFR

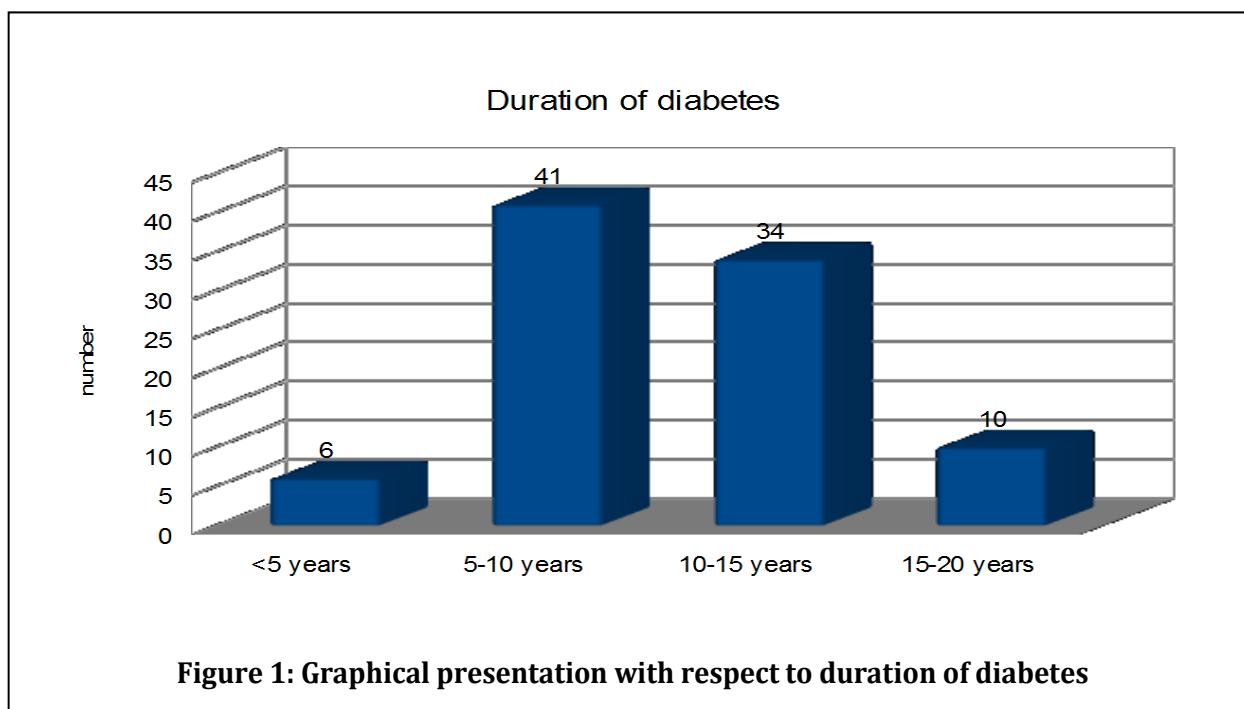
were compared among two groups using the t - test and p value  $\leq 0.05$  were taken as significant. One way ANOVA was used as a test to see the variation among the spirometry parameters with the duration of the DM among the individuals of the group A (DM)

**RESULTS**

Out of 182 samples half were males 91 (50%) and half were females 91 (50%). Mean age of patients was 52.2 years with standard deviation 9.1 years. Median age of the

In diabetic group 46(50.6%) were male and 45(49.4%) were female. The gender distribution in non-diabetic groups was male 45(49.4%) and female 46(50.6%). Having fairly same number of patient’s diabetic status versus gender distribution was not statistically significant (Table 1).

Table 1 shows that the mean age of patients in diabetic group was 53.1 years whereas in non-diabetic group was 51.3 years. However difference in age of the patients was not statistically significant. Mean FEV<sub>1</sub>/FVC ratio was 1.1 in both diabetic and non-diabetic



**Figure 1: Graphical presentation with respect to duration of diabetes**

respondents was 51.0 years and patients ranged from age 39 to 65 years.

Study group comprised of 91 (50%) diabetic patients as study cases and 91 (50%) as non-diabetic patients as controls. Majority of the patients had duration of 5-10 year of diabetes (n=41). 6 individuals had duration of 5 year, the early diabetic patients whereas 10 patients had diabetes for 15-20 years (fig- 1).

groups, so the ratio is not statistically significant (Table 1)

Mean value of pulmonary function test i.e. FVC, FEV<sub>1</sub> and PEF<sub>R</sub> showed statistically significant difference among the both diabetic and non-diabetic groups by independent sample t test (p<0.05) (Table 2).

Lung functions were particular restrictive or normal pattern and more in long duration of diabetes. Mean value of pulmonary functions

**Table 1: Descriptive and Inferential statistics of the Demographical and Risk factors of the patients with respect to the diabetic and non-diabetic status**

Variables		Diabetes Mellitus (n=91)	Non- diabetics (n=91)	Total	P value
Gender	Male	46(50.6%)	45(49.4%)	91(100%)	0.88
	Female	45(49.4%)	46(50.6%)	91(100%)	
	Total	91	91	182	
Age	years	53.1	51.3	52.2	0.19
FEV <sub>1</sub> /FVC	ratio	1.1	1.1	1.1	0.23

Test of significance: chi square (qualitative), t test (quantitative)

**Table 2: Comparison of Pulmonary Function Test in Diabetic and Non diabetic patients**

Parameters	Mean			
	Total	Diabetes	Non diabetes	P Value
<b>Forced vital capacity (FVC) (percent predicted)</b>	79.8	72.3	87.4	<b>&lt;0.001</b>
<b>Forced expired volume in 1<sup>st</sup> second (FEV<sub>1</sub>) (percent predicted)</b>	87.1	78	95	<b>&lt;0.001</b>
<b>FEV<sub>1</sub>/FVC ratio</b>	1.1	1.1	1.1	0.23
<b>PEFR (percentage predicted)</b>	76.9	63.8	90.0	<b>&lt;0.001</b>

Test of significance: t test

**Table 3: Pulmonary Function Test with respect to duration of diabetes mellitus**

Duration of diabetes in years	Mean			
	FEV <sub>1</sub> (percentage predicted)	FVC (percentage predicted)	FEV <sub>1</sub> /FVC	PEFR (percentage predicted)
<5	86.8	82.3	1.1	80.0
5-10	81.0	75.6	1.1	67.9
10-15	75.0	68.0	1.1	58.8
15-20	74.4	67.2	1.1	54.0
<b>Total</b>	87.1	79.8	1.1	76.9
<b>P value</b>	0.26	0.046*	0.17	0.13

Test of significance: one way ANOVA, ANOVAs between qualitative variable (age group) and quantitative variable (FEV<sub>1</sub>, FVC, FEV<sub>1</sub>/FVC ratio, PEFR)

**Table 4: Comparison of Pulmonary Function among duration of diabetic groups with respect to gender distribution**

Gender	Duration of DM (years)	FEV <sub>1</sub> (percentage predicted)	FVC (percentage predicted)	FEV <sub>1</sub> /FVC	PEFR (percentage predicted)
Male	<5	82.0	78.0	1.1	68.7
	5-10	81.0	73.9	1.1	71.1
	10-15	80.6	71.4	1.1	71.8
	15-20	74.4	67.0	1.1	54.8
Female	<5	91.7	86.7	1.1	91.3
	5-10	80.9	76.7	1.1	65.8
	10-15	69.4	64.6	1.1	45.9
	15-20	-	-	-	-
P Value		0.71	0.50	0.43	0.30

Test of significance: t test (quantitative), t-test between qualitative variables (duration of DM) with quantitative variables (FEV<sub>1</sub>, FVC, FEV<sub>1</sub>/FVC, PEFR) split by gender

test FVC showed statistically significant difference with duration of diabetes mellitus

in years (Table 3). Other PFT parameters were reduced as the duration of diabetes increased by were not significant statistically.

Although numerical there is difference in PFTs parameters like FEV<sub>1</sub>, FVC, FEV<sub>1</sub>/FVC, and PEFR in terms of gender and duration of diabetes none of the parameters were statistically significant (Table 4).

## DISCUSSION

In this study, the same number of male and female diabetic patients (50 % vs. 50%) was taken. In a similar study by Mishra GP et al "Study of pulmonary function test in diabetic with asthma or COPD" published on 2012 also had similar type of gender distribution i.e. 40 percent female with diabetes mellitus [16]. Another study by Irfan et al [17] published on 2011 has taken 42 percent of female with diabetes showing similar group division as in our study.

Present results showed that mean age of the patients in both diabetic and non-diabetic group was elder as (53.1±5.9 vs. 51.3±11.4). "Pulmonary function test in type 2 diabetes mellitus and their association with glycemic control and duration of diabetes mellitus" a study by Shah et al [18] also has taken a subject with mean age of 53.90± 8.45 Vs 54.88±8.28 among diabetic and non diabetics. Other study by Zeneldin et al [19] published in 2015 and Irfan et al also had higher mean age among the control subjects [17]. Anandhalakshmi S et al [20] and El-Habashy MM et al (2013) [21] scrutinized that in both diabetic and non-diabetic group mean age of the patients was younger (44.8± 8.9 vs. 39.4 ± 11.7), due to small sample size these studies showed dissimilar results.

Present study reported that diabetes mellitus was statistically significantly associated with reduced percent predicted value of FVC (72.3±15.7 vs. 87.4±14.7) , FEV<sub>1</sub> (78±17.5 vs. 95±15.3) and PEFR (63.8±26.5 vs. 90.0±18.0). Zineldin et al (2015) conducted the study titled "Respiratory function in type 2 diabetes mellitus" showed FVC of 75.04±3.81 and FEV<sub>1</sub> of 73.42±3.77 denoting that there is reduction in FEV<sub>1</sub> and FVC in patient with type II diabetes mellitus [19]. FEV<sub>1</sub> /FVC ratio was 97.84±1.74 in those subjects as compared to 97.99±3.57 in non diabetics. Furthermore, the result of the study done by Shah et al demonstrated FVC, FEV<sub>1</sub> and FEV<sub>1</sub>/FVC ratio in non diabetics and diabetics as 89.36±9.71 vs. 77.97±12.99, 88.03±6.69 vs. 78.98 ±14.09 and 111.36±10.62 Vs 112.83±9.35 respectively [18].

Anasuma et al and Lange et al have also reported that FEV<sub>1</sub> and FVC are reduced in patient with type 2 diabetes mellitus than the normal control subjects [22, 23]. Contradicting to our study along with other above mentioned study Benbassat et al in his study published in 2001 title "pulmonary function in patient with diabetic mellitus" showed no change in spirometric values in diabetic and non diabetic patient. But, his study had very few test subjects which was 27 and the mean age group was also less (48 years) [24].

Our study also compared PEFR between patient with diabetic mellitus and non diabetic controls which shows significant reduction in PEFR in diabetic subjects (63.8± 26.5 percent in diabetes VS 90±18 percent in healthy non diabetic subject)

Further study by Anuradha Yadav et al examined that mean PEFR was more reduced

in diabetic patients as compare to non-diabetic [25], another study by Anandhalakshmi S et al found that there was a marked reduction in PEFr in diabetic subjects [20], while present results demonstrated 1MAF showed dissimilar results reported similar mean rate of PEFr in both diabetic and non-diabetic groups. Due to poor mechanical properties of the lung, compliance and elastic recoil of lungs, the variation in collagen and elastin ratio is the primary pathological feature in the diabetic patients may contribute to significant decrease in PEFr among diabetic group.

In our study, decrease in PEFr appears to be early in onset and has a progressive course. As shown in Table 3. PEFr is 67.9 (percent predicted) in early stage of diabetes mellitus and further decline to 58.8 (percent predicted) in patient of DM with duration of 10-15 years and 54.0 (percent predicted) in patient of DM with duration of 15-20 years. It is observed that PEFr appears to decrease in earlier stages (5- 10 years of diabetes mellitus) than FEV<sub>1</sub> or FVC. Whereas, FEV<sub>1</sub> and FVC appears to decline after 10-15 years. Percentage predicted FEV<sub>1</sub> and FVC values after 10-15 yrs and 15-20 years are 75 and 68 respectively.

## CONCLUSION

Present study concludes that lung is a target organ for damage in diabetes and that the glycaemic exposure is a strong determinant of reduced pulmonary functions in type II diabetics. Present study concluded that the diabetes mellitus is independently associated with the impairment of the pulmonary function test and the duration of diabetes does not have significant impact on impairment of PFTs. FEV<sub>1</sub>, FVC and PEFr is significantly reduced in diabetes group as

compared with the non diabetes groups. However, FEV<sub>1</sub>/FVC ratio is not different than their non diabetic counterparts.

Lung functions need to be checked periodically to assess the severity of impairment and intensive glycaemic management can be suggested to diabetic patients. There is a need of large prospective study with long observational course to confirm these observations.

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## AUTHOR'S CONTRIBUTION

**AD-** Main researcher, involved in planning, direct data collection, analysis and drafting of manuscript; **TW-** Research supervisor involved in supervising the whole research; **KUD-** Involved in planning, literature search, intellectual content discussion, drafting and revision of final manuscript prepared.

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**CONFLICT OF INTEREST:** None declared

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