

## A Study of Peak Expiratory Flow Rate in Patients with Type 2 Diabetes Mellitus

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### Abstract:

**Background:** The peak expiratory flow rate (PEFR) is the maximal airflow during a forced expiratory vital capacity manoeuvre starting from a position of full inspiration. In healthy subjects this index reflects the calibre of the central airways and the force exerted by the expiratory muscles. Lungs are a potential target organ for diabetic microvascular complications. This is due to non-enzymatic glycosylation of proteins particularly collagen and elastin, as well as microangiopathy induced by chronic hyperglycemia. The thickening of the pulmonary capillary basal lamina and the alveolar epithelium and reduction in elastic recoil of the lung may result in decrease in the expiratory volume of air.

**Aims and Objectives:** The study was undertaken to analyze the PEFR in type II diabetic patients and compare them with age and gender matched healthy control. Correlation between PEFR in diabetic patients with glycaemic status and duration of the disease was also analyzed.

**Materials and Methods:** A cross-sectional study was conducted among 100 type 2 diabetic patients and 100 normal healthy controls aged between 30 - 60 years to record PEFR by spirometer and to find the correlation between mean PEFR in diabetics and non - diabetics. Glycaemic status – Fasting blood sugar (FBS) and Post-prandial blood sugar (PPBS) of subjects were determined by glucose oxidase and peroxidase methods. PEFR of diabetic patients and controls were compared by applying Student's unpaired t test. Associations between PEFR and duration of illness in diabetic patients were analyzed by applying Pearson's coefficient.

**Results:** The mean PEFR in the total diabetic group is  $265.35 \pm 114.46$  L/min which is lower than that of the total non-diabetic control group ( $359.71 \pm 123.68$  L/min) and the decreased value in the total diabetic control group is very highly significant ( $p < 0.001$ ). There is no significant correlation between PEFR with FBS among the total diabetic group ( $r = -0.1, p > 0.05$ ). There is no significant correlation of PEFR and PPBS among the diabetic cases ( $r = 0.04, p > 0.05$ ) in this study. No significant correlation is observed between PEFR with the duration of disease among the total diabetic group ( $r = 0.00, p > 0.05$ ).

**Conclusion:** Our study concluded that impairment of pulmonary function (PEFR) is associated with diabetes mellitus.

**Keywords:** Diabetes mellitus, Peak expiratory flow rate, Glycaemic status.

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### Introduction

Peak expiratory flow rate (PEFR) is the maximum air-flow achieved during an expiration delivered with maximal force starting from the level of maximal lung inflation.[1]

It is determined by the dimensions of the large intrathoracic and extrathoracic airways, the elastic properties of the lung, the power and co-ordination of expiratory muscles, speed with which maximal alveolar pressure is reached and how much the lung was stretched prior to the PEF manoeuvre. It is a reliable indicator of ventilation adequacy as well as airflow obstruction.

Diabetes mellitus (DM) is characterised by hyperglycaemia caused by absolute or relative insulin deficiency. Several studies have revealed that hyperglycemia could lead to interstitial fibrotic changes and alveolar microangiopathy. [2-5] Histopathological evidence has shown thickened alveolar epithelium and pulmonary capillary basal lamina in subjects with diabetes mellitus. Thickened alveolar epithelium is suggestive of existing pulmonary microangiopathy [6,7] This can result in decrease in peak expiratory flow. Spirometry is helpful in taking early preventive measures in dia-

betics and those subjects who are not diabetic but have impaired lung functions.

**Objectives**

1. To evaluate PEFR in patients with type 2 diabetes mellitus
2. To determine the correlation of PEFR with glycemic status of patients with diabetes mellitus.
3. To determine the correlation of PEFR with duration of diabetes mellitus

**Material and methods**

The study was carried out in Assam Medical College, Dibrugarh, Assam after obtaining written consent from the subjects and approval from the Institutional Ethical Committee.

Two hundred subjects were recruited in the study. One hundred diagnosed cases of type 2 diabetic mellitus aged 30 to 60 yrs with duration more than six months who were on treatment were randomly selected from the Medicine Outpatient Department. They were compared with one hundred healthy (age and gender matched) controls. Anthropometric measurements were recorded and BMI was calculated.

Measurement of PEFR - Spirometry was done to record PEFR (L/min) in all the cases and controls by using Medspiror.

Glycemic status (FBS & PPBS) of subjects was determined by glucose oxidase & peroxidase methods.

Inclusion criteria - Diabetics who has no history of lower respiratory tract illness and with symptoms related to respiratory illness (nasal itching and congestion, running nose, dry throat, hoarseness, epistaxis, sneezing, pain suggestive of sinusitis, cough, expectoration and dyspnea) at the time of examination were included for the study.

Exclusion criteria for both cases and controls included present or past history of respiratory diseases, history of occupational exposure to any substances that could affect lung function, individual with unacceptable spirometric techniques, individ-

ual with gross abnormalities of vertebral column or thoracic case and individual with history of major abdominal or thoracic surgery.

Study procedure - A questionnaire that contained a detailed personal and medical history was taken from the cases as well as controls. PEFR of all the cases and controls were done by trained personnel after five min of rest at sitting position at room temperature. Three readings were taken at the interval of 15 minutes and the best of the three was taken into account. Nearly two mL of venous blood was from all diabetic patients and healthy controls with aseptic precautions. Glycemic status was determined by recording fasting blood sugar (FBS) and postprandial blood sugar (PPBS) by glucose oxidase & peroxidase methods.

**Statistical analysis:**

The observations made were noted and after the completion of the study the data was organized using Microsoft Office Excel 2007.

Mean, standard deviation and Pearson’s correlation coefficient were calculated for relevant groups as needed. ‘p’ values for inter group comparison were calculated using ‘independent sample t - test’ (two tailed, unequal variance) in SPSS – 16. Regression analysis was done to assess the association of diabetes mellitus with blood sugar and duration of disease.

**Results**

The cross-sectional study conducted among 100 patients with type 2 diabetes mellitus and 100 age and gender matched healthy non-diabetic individuals with normal blood glucose level, including both males and females without any respiratory disease were selected by simple random sampling.

The data was organized using Microsoft Office Excel 2007. Mean, standard deviation and Pearson’s correlation coefficient were calculated.

‘P’ values for inter group comparison were calculated using ‘independent sample t - test’ (two tailed, unequal variance) in SPSS – 16. Regression analysis was done to assess the association of PEFR with blood sugar and duration of disease.

**Table 1: Demographic Parameters in the study population**

Parameters	Male				P value	Female				P value
	Diabetic		Non diabetic			Diabetic female		Non diabetic		
	Mean	±SD	Mean	±SD		Mean	±SD	Mean	±SD	
Age (yrs)	51.3	8.23	50.07	7.52	>.05	49.54	8.45	47.91	6.79	>.05
Ht(cm)	163.66	7.26	164.61	6.12	>.05	152.45	5.29	153.95	4.61	>.05
Wt (kg)	61.45	12.21	66.89	9.72	>.05	59.27	8.98	59.27	9.16	>.05
BMI kg/m <sup>2</sup>	22.79	3.57	24.62	2.87	<.01	25.48	3.54	24.98	3.53	>.05

**Table 2: Blood Glucose level in diabetic cases and non-diabetic controls**

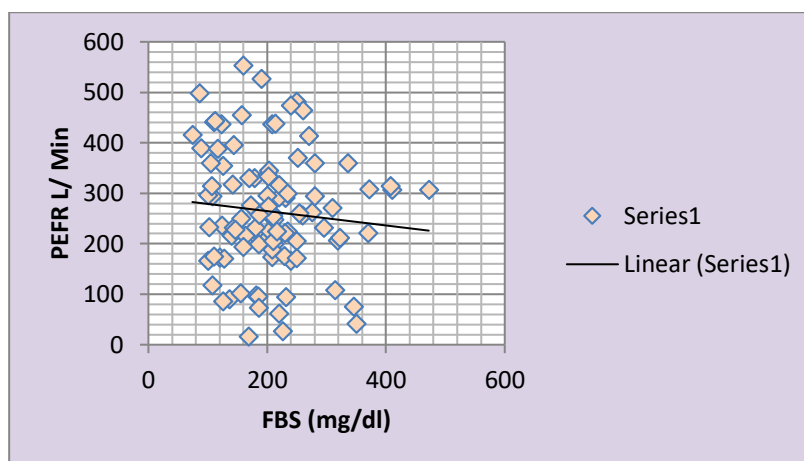
Parameters	Groups	Diabetic		Non Diabetic		P Value
		Mean	± SD	Mean	± SD	
FBS (mg/ dl)	Total	204.13	78.40	95.49	10.57	<0.001
	Male	208.11	87.39	94.09	11.97	<0.001
	Female	201	71.21	96.59	9.29	<0.001
PPBS (mg/ dl)	Total	281.58	96.48	128.07	5.59	<0.001
	Male	294.41	102.61	126.48	5.48	<0.001
	Female	271.50	91.04	129.32	5.40	<0.001

There is a very high significant difference in both fasting blood glucose and postprandial blood glucose level between all diabetics and non-diabetics. No significant difference in blood glucose level is seen between diabetic males and diabetic females

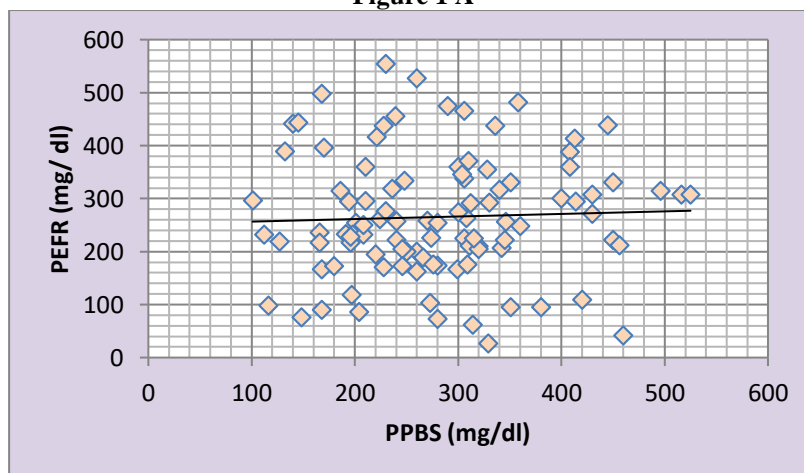
**Table 3: PEFR results in the study population**

Parameters	Diabetic case group (n=100)	Non-diabetic control group (n=100)		P value		
		Mean	± SD		Mean	± SD
Total	PEFR (L/min)	265.36	114.46	359.71	123.68	< 0.001
Male	PEFR (L/min)	334.70	112.1	436.16	124.72	< 0.001
Female	PEFR (L/min)	210.83	83	299.75	83.58	<0.001

The mean PEFR values is lower in the diabetic group than the non-diabetic group. The decreased value is very highly significant in both diabetic males and females compared to non-diabetic males and females.



**Figure 1 A**



**Figure 1 B**

**Figure 1**

Fig. 1 (A, B) shows regression analysis of PEFR against FBS and PPBS among the total diabetic group. There is no significant correlation of PEFR and FBS among the total diabetic group ( $r = -0.1, p > 0.05$ ). No significant correlation of PEFR and PPBS among the total diabetic cases ( $r = 0.04, p > 0.05$ ) was observed.

Table 4: Duration of diabetes in years

Groups	Number Of Cases	Disease Duration (Years)		Minimum (Years)	Maximum (Years)
		Mean	± SD		
TOTAL	100	6.66	4.67	0.5	20
MALE	44	6.11	4.09	0.5	18
FEMALE	56	7.09	5.07	0.5	20

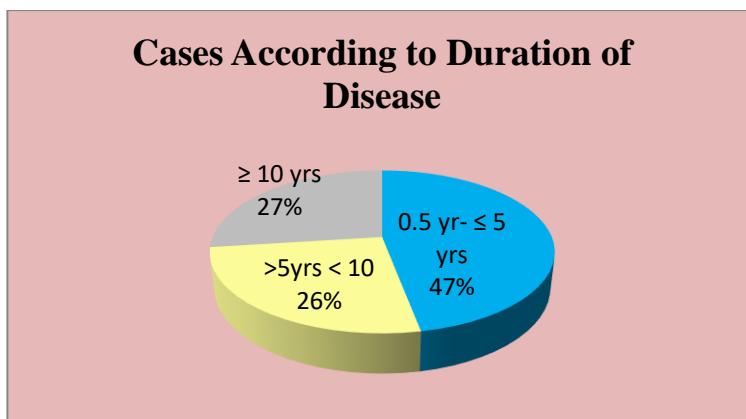


Figure 2: Distribution of diabetic cases according to duration of disease

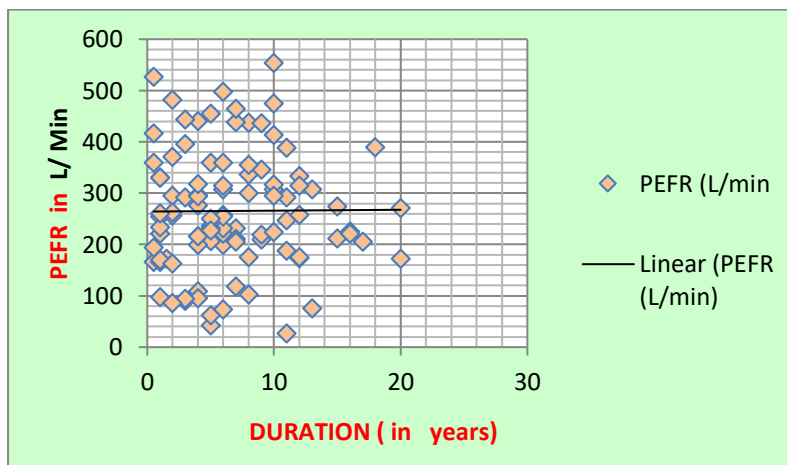


Figure 3

Figure 3: Regression analysis shows insignificant correlation between the PEFR and duration of disease among the total diabetic group ( $r = 0.00, p > 0.05$ ).

**Discussion**

In this study, we found a significant decrease in PEFR ( $p < 0.001$ ) in diabetics as compared to controls. The study by Aparna et al., showed a significant reduction in PEFR in type 2 diabetes as compared to controls.[8] A study conducted on Indian diabetics by Kanya Kumari et al., [9] showed that PEFR was reduced when compared with predicted values in cases with diabetes mellitus. The study demonstrated that Type 2 DM was associated with

restrictive pattern of respiratory abnormality. No significant correlation was seen between PEFR and duration of diabetes in the present study. But the study conducted by Kanya Kumari [9] showed that as the duration of diabetes increases, the restrictive profile becomes more prominent. A study by Shah et al. found that glycemic levels and duration of diabetes are probably not the major determinants of lung pathology.[10]

Lysyl oxidase is an enzyme essential for the normal development and function of the respiratory system. It facilitates the cross-linking of collagen and elastin fibers in the lung tissue. These fibers are critical for maintaining the structural integrity and function of the lung, enabling proper gas exchange

and lung expansion. Due to hyperglycemia, there is nonenzymatic glycosylation of collagen and elastin. Interstitial lung fibrosis occurs in diabetes due to increase in activity of lysyl oxidase.[11] The enzyme hyperactivity may be one of the reasons for alveolar thickening and loss of elastic recoil after inspiration in diabetes. Loss of elastic recoil may result in decreased PEFr values.

Respiratory muscle weakness due to diabetic neuropathy may also lead to decreased lung functions.[12,13] Autonomic and phrenic neuropathy causing alterations in bronchial reactivity and respiratory muscle function is suggested in one study.[14] Parasympathetic nerves are responsible for regulating the smooth muscle tone of the airways. Parasympathetic dysregulation in diabetics may also account to reduced pulmonary functions.[15] The calibre of the airways are affected with respiratory muscle weakness and reduction in PEFr. In the present study neither the duration of diabetes nor the glycemic index appears to influence the association with pulmonary dysfunction significantly. Those cases with longer duration of disease are also older and the effect of decline in pulmonary functions with age is a contributing factor.

Limitations of the study – A multicentric study with a large sample size would have yielded more precise conclusions. The cases were selected from the out-patient department, so they had comorbidities which may have had an impact on the results. The PEFr values were recorded at just one time and did not consider the effect of decline of PEFr values from the onset of diabetes mellitus. There is a need of prospective study with more sample size to confirm the observations.

PEFr is likely to occur in a person suffering from type 2 diabetes mellitus. But the relation of glycemic levels and duration of disease with pulmonary dysfunction requires further research. Lung functions need to be monitored periodically to assess the severity of impairment.

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