*Article*

# FVC, FEV$_1$ And FEV$_1$/FVC% In Type-1 Diabetic Male And Their Relationships With HbA$_{1c}$

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**Abstract**

**Background:** Diabetes mellitus is a chronic and debilitating disease. Its complications give rise to micro and macrovascular diseases which affect eyes, kidneys, heart, blood vessels, nerves and also lungs. There may be a relationship between type-1 diabetes and reduced lung function. **Objectives:** To observe FVC, FEV$_1$, FEV$_1$/FVC % and their relationship with HbA$_1$C in type-1 diabetic male in Bangladesh. **Methods:** This cross-sectional study was carried out in the Department of Physiology, Sir Salimullah Medical College, Dhaka from January to December 2009. A total number of 60 male subjects, from 18-30 years of age was taken and was divided into control and study groups. Among them study group was consisted of 30 type-1 diabetic male patients. Control group was consisted of 30 apparently healthy age, sex, BMI and socioeconomic status matched non-diabetic subjects. All the subjects belonged to lower socio-economic status. For assessment of lung function, FVC, FEV$_1$, FEV$_1$/FVC % of all the subjects were measured. All of theses tests were done by spirometric method by using a digital Spirometer. Again, to observe glycemic control of blood, glycosylated hemoglobin (HbA$_1$c) levels of diabetic patients were also measured by usual laboratory technique. Data were analyzed by Independent-Samples 't' test and Pearson's correlation coefficient test as applicable. **Results:** FVC (p <0.001), FEV$_1$ (p < 0.001), and FEV$_1$/FVC% (p < 0.05) were significantly lower in type-1 diabetic patients in comparison to those of apparently healthy non-diabetic male. Again FVC and FEV$_1$ had significant (p < 0.001) negative correlation but FEV$_1$/FVC% had non-significant positive correlation with HbA$_1$c. **Conclusion:** Impairment of some lung functions may be found in type-1 diabetic male which may be due to poor glycemic control.

**Key words:** Type-I diabetes mellitus, Lung function parameters, Glycosylated hemoglobin.

## Introduction

**D**iabetes mellitus is a chronic metabolic disease characterized by hyperglycemia due to absolute or relative deficiency of insulin[1]. Several distinct types of diabetes mellitus exist and are caused by a complex interaction of genetics and environmental factors [2].

Type-1 diabetes mellitus caused by autoimmune destruction of beta cells in pancreas, resulting in total lack of insulin secretion. It is always symptomatic and shows classical features of hyperglycemia[3]. Although it can occur at any age but usually found in young people specially who are thin[2]. However, it is a serious, progressive multifactorial disease associated with a number of chronic complications, which include

cardiovascular diseases, nephropathy, neuropathy, retinopathy and lung damage [4].

Several pathological conditions may affect the lungs of type-1 diabetic patients. Chronic hyperglycemia causes microvascular changes such as thickening of basal laminae in the smaller vessels of the lungs and ultimately causes reduction of vascular diffusing capacity[5]. It was also observed that hyperglycemia affects the lung by nonenzymatic glycosylation of chest wall and bronchial tree proteins which prevents lung expansion[6]. Similarly, because of structural changes, the volumes and elastic recoil of lung may also reduce in type-1 diabetic patients. However, like other systemic disorders impairment of lung function is considered as a potential risk factor for type-1 diabetic patients[7].

For assessment of lung function FVC, FEV$_1$, FEV$_1$ /FVC % are usually measured[8]. In addition, glycosylated haemoglobin (HbA$_{1c}$%) may also be estimated for the assessment of long term control of diabetes over the last 8 to 12 weeks and may increase in diabetic patients with pulmonary complications [8,9].

Low FVC may be associated with higher blood glucose and also with higher HbA$_{1c}$ % [9]. Other researchers also observed a significant reduction of FVC in type-1 diabetic patient[10]. Along with FVC, Forced expiratory volume in 1st second (FEV$_1$) also decreases with increasing blood glucose level[11]. Some researchers also found that, diabetic patients with HbA$_{1c}$>10% had significant reduction of FEV$_1$ [10].

Type-1 diabetes mellitus is likely to account for over 10% of the total diabetic cases[12] and the incidence is increasing globally[13]. It is an incurable life long disease, it involves multiple systems with wide ranging and devastating complications including lung damage[9].Diabetes mellitus is a leading cause of public healthcare problem with increasing incidence and long-term complications of various organs like eye, kidney, neuron and heart. Lungs also affected in diabetes mellitus. Many studies on pulmonary functions in type-2 diabetic patients had been done by different researchers of different countries and

also in our country[14]. However, little is known about lung function in type-1 diabetic patients in our country. Therefore, the present study was designed to observe some aspects of lung function status in diagnosed type-1 diabetic male patients. This study may help to create awareness among the physicians and the type-1 diabetic patients in Bangladesh regarding the damaging effect of diabetes on lung function. This may help earlier diagnosis and proper management of pulmonary complications in this group of patients.

**Methods**

This cross sectional study was done in the Department of Physiology, Sir Salimullah Medical College (SSMC) during the period of 1st January 2009 to 31st December 2009. A total number of 60 male subjects, from 18-30 years of age were included in this study and was divided into control and study groups. Control group consisted of 30 apparently healthy non-diabetic male subjects. Another thirty (30) were diagnosed type-1 diabetic male patients and was considered as study group. All the diabetic patients were selected from out patient department of BIRDEM hospital. Again, all the age and BMI matched control subjects were selected from slum area of Kallyanpur, Dhaka City. All the subjects were belonged to lower socio- economic status. Subjects having history of asthma, any acute or chronic lung infection, heart disease, renal insufficiency (serum creatinine>1.5 mg/dl)[15],or having any structural chest deformity were excluded from the study.

After selection of the subjects the objective, perspective, benefit and risk of this study were briefed in detail to the study subject. An informed written consent was taken from all the participants. Study protocol was approved by Institutional Ethics Committee (IEC) of SSMC. A detail medical and family history of all subjects was recorded in a preformed questionnaire. Thorough physical examination of the control and study subjects were done and documented. Height and weight of the subjects were measured for calculation of BMI. After 8 to 14 hours of over night fasting, 5 ml of venous blood was

collected at 8 am from every patient for estimation of fasting glucose, serum creatinine and HbA$_1$C level in the blood. A second blood sample was taken 2 hours after breakfast for estimation of blood glucose level. For the assessment of lung function FVC, FEV$_1$, and FEV$_1$ /FVC% of all the subjects were measured. All of theses tests were done by spirometric method by using a digital Spirometer (Spriobank G). Data were analyzed by Independent-Samples "t" test and Pearson's correlation coefficient test as applicable.

**Results**

The anthropometric data of the study subjects are presented in Table I. Both the groups were matched for age and BMI.Serum creatinine and blood glucose levels are presented in Table II. All the subjects were with normal renal function.

The mean percentage of predicted value of FVC and FEV$_1$ were significantly (p<0.001) lower and FEV$_1$/FVC % was also lower but not statistically significant in type-1 diabetic male patient than those of apparently healthy non-diabetic male. (Table III).

**Table I:** Age and BMI in both groups (n=60)

| Groups | Group A (n=30) | Group B (n=30) | P value |
|---|---|---|---|
| Age (years) | 23.43+3.41 | 23.63+3.38 | 0.820[ns] |
| BMI (kg/m$^2$) | 17.02+1.64 | 17.80+1.95 | 0.100 [ns] |

**Table II:** Serum creatinine, fasting blood glucose and blood glucose 2hr ABF in both groups (n=60)

| Groups | Group A (n=30) | Group B (n=30) | P value |
|---|---|---|---|
| Serum creatinine (mg/dl) | 0.86 ± 0.14 (0.7-1.4) | 1.19 ± 0.22 (0.8-1.5) | 0.000*** |
| Fasting blood glucose (mmol/L) | 4.84 ± 0.51 (4.0-5.9) | 11.11 ± 3.21 (5.7-18.7) | 0.000*** |
| 2hr ABF (mmol/L) | 7.14 ± 0.32 (6.2-7.7) | 16.38 ± 4.54 (8.4-26.5) | 0.000*** |

Data are expressed as Mean+SD. Statistical analysis was done by Independent-Samples " t" test. Figure in parentheses indicate maximum& minimum values.
Group A: Apparently healthy non-diabetic male  Group B: Type-I diabetic male   *** =  p<0.001.
 n = Total number of subjects.

**Table III:** Percentage of predicted values of FVC, FEV$_1$, FEV$_1$/FVC % in both groups (n=60):

| Groups | Group A (n=30) | Group B (n=30) | P value |
|---|---|---|---|
| FVC (%) | 100.63 ± 13.52 (74-135) | 55.73 ± 15.86 (24-84) | 0.000*** |
| FEV$_1$ (%) | 106.60+ 11.48 (87-128) | 56.40 ± 16.72 (26-87) | 0.000*** |
| FEV$_1$/FVC (%) | 111.63+7.45 (87-126) | 105.80+15.19 (78-124) | 0.066[ns] |

Data are expressed as Mean+SD. Statistical analysis was done by Independent-Samples " t" test. Figure in parentheses indicate maximum& minimum values.
Group A: Apparently healthy non-diabetic male          ns = Not significant
Group B: Type-I diabetic male                  *** = p<0.001    n=Total number of Subjects

Again, in this study FVC, and FEV$_1$ showed significant (p<0.001) negative correlations whereas FEV$_1$/FVC% showed non-significant positive correlation with HbA$_{1C}$ in type-1 diabetic male (Figure 1,2,3).
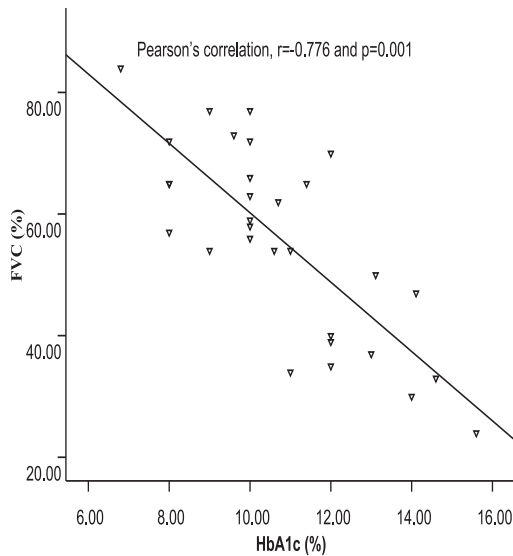


Pearson's correlation, r=-0.776 and p=0.001

**Figure 1:** Correlation of percentage of predicted value of FVC with HbA$_{1c}$ in type I diabetic male (n=30)



Pearson's correlation, r=-0.745 and p=0.001
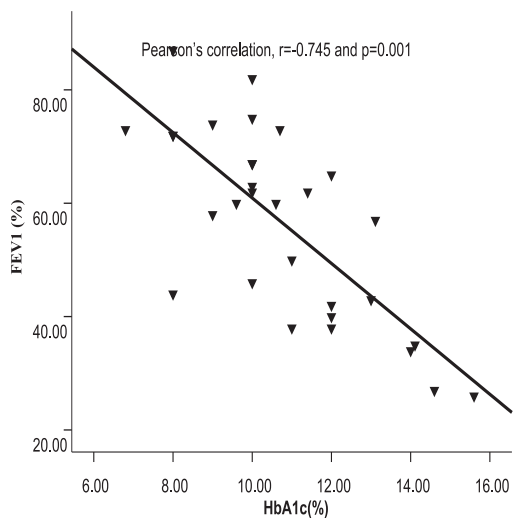
**Figure 2:** Correlation of percentage of predicted value of FEV$_1$ with HbA$_{1c}$ in type I diabetic male (n=30)

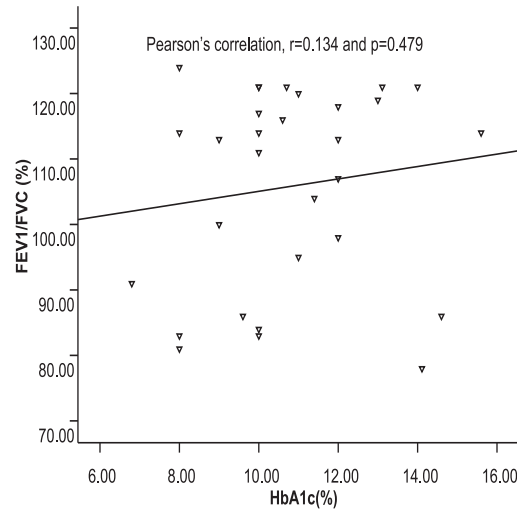

Pearson's correlation, r=0.134 and p=0.479

**Figure 3:** Correlation of percentage of predicted value of FEV$_1$/FVC% with HbA$_{1c}$ in type I diabetic male (n=30)

## Discussion

In the present study, the lung function parameters in healthy subjects were almost similar to the findings reported by the various investigators from different countries[6,10] as well as in our country[14]. No abnormal findings of pulmonary function tests were detected in them.

In this study, the mean percentage of predicted value of FVC and FEV$_1$ were significantly lower[4,8,10]. Whereas, FEV$_1$/FVC % were non significantly lower in type 1 diabetic male than those of non-diabetic subjects. This finding is consistent with that of some other researchers of different countries[6].

In the diabetic patients FVC and FEV$_1$ were negatively but FEV$_1$ /FVC% was positively correlated with HbA$_1$C. These observations are almost similar to those of some investigators[10]. They found type-1 diabetic patient with HbA$_1$C >10% showed significant reduction in FVC and FEV$_1$.

Various researchers of different countries suggested that chronic hyperglycemia may cause fibrosis of the lungs tissue by non-

enzymatic glycosylation and thus eventually causes reduction in lung compliance and subsequent chronic airflow obstruction[5,6].

Moreover, hyperglycemia causes thickening of alveolar epithelium and pulmonary capillary basal lamina and thereby may be result in reduced elastic recoil in the alveoli and also reduced lung volume [16].

Furthermore, long standing hyperglycemia may also cause autonomic as well as somatic neuropathy which causes impairment of bronchial activity and respiratory muscle function[17]. For this reason, respiratory muscle endurance also decreases in diabetes mellitus[18].

Again, hyperglycemia is also associated with poor skeletal muscle strength may be due to increased protein catabolism[19]. For this reason respiratory muscle endurance also decreases in diabetes mellitus[18].

In this cross sectional study, the decrement of lung function parameters such as FVC, FEV$_1$, and FEV$_1$/FVC% in type-1 diabetic subjects indicate decreased lung compliance and airflow obstruction. However, all these reduced lung function in the subjects of present study may be due to chronic hyperglycemia which may cause glycosylation of the chest wall and bronchial tissue protein and increased muscle protein catabolism. Again, negative correlations of most of the lung function parameters with HbA$_1$c in the study group are also in favor of this finding.

## Conclusion
Therefore, from this study, it may be concluded that lung function parameters like FVC, FEV$_1$, and FEV$_1$/FVC % decrease in type-1 diabetic male and the reduction is mainly due to poor glycemic control.

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