

## Association of Pulmonary Functions and HbA<sub>1c</sub> in Diabetics

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### ABSTRACT

**Aim:** To find the association of pulmonary functions and HbA<sub>1c</sub> in diabetes.

**Study design:** Prospective study

**Place of study:** Department of Physiology, Basic Medical Sciences Institute (BMSI), in collaboration with the Department of Chest Medicine and Department of Medicine, JPMC.

**Duration of study:** The study was conducted from September 2005-june 2006

**Patients and methods:** A total of 60 known subjects of diabetes of either sex age range between 40-60 years were selected for this study.

**Results:** The two main findings of the study were: (1) the pulmonary function test results in diabetics were significantly altered; (2) the pulmonary dysfunction was more pronounced in patients with long standing diabetes mellitus

**Keywords:** Pulmonary functions, Diabetic patients, Hemoglobin A<sub>1c</sub>

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### INTRODUCTION

Diabetes mellitus is a clinical syndrome characterized by hyperglycemia due to absolute or relative deficiency of insulin. Lack of insulin affects the metabolism of carbohydrate, protein and fat and causes a significant disturbance of water and electrolyte homeostasis<sup>1</sup>.

Hemoglobin A<sub>1c</sub> is a minor Hemoglobin component, which is known to be elevated in the diabetic state. The normal values range from 5-7%, but they are increased 2-3 fold in uncontrolled diabetes.<sup>2</sup> Glucose is attached to N terminal amino group of the  $\beta$ -chain by a ketoamine Linkage. HbA<sub>1c</sub> is formed slowly and continuously throughout the 120 days life span of the red cell. Measurement of HbA<sub>1c</sub> produces an index of average blood glucose level over the preceding 2-3 months i.e., 60-90 days. Thus HbA<sub>1c</sub> has proved to be useful in assessing diabetes mellitus and perhaps in screening people for diabetes<sup>3</sup>. Measurement of glycosylated hemoglobin is the standard method for assessing long term glycemic control. When plasma glucose is consistently elevated, there is an increase in the nonenzymatic glycation of hemoglobin. This alteration reflects the history of the previous 2-3 months, since erythrocytes have an average life span of 120 days<sup>4</sup>.

Patients with type 1 and type 2 diabetes mellitus have been found to have pulmonary function abnormalities in addition to other better known complications of diabetes such as retinopathy, sores and ulcers on the feet<sup>5</sup>.

### MATERIAL AND METHODS

This study was carried out in the Department of Physiology, Basic Medical Sciences Institute (BMSI), Jinnah Postgraduate Medical Centre (JPMC), Karachi, in collaboration with the Department of Chest Medicine and Department of Medicine, JPMC. A total of 60 known subjects of diabetes of either sex age range between 40-60 years were selected for this study. Subjects were subdivided into male and female subgroups and further divided into two groups according to their Hb A1c content. Subjects with known cardiac and respiratory diseases, Family history of asthma, Subjects with gross abnormality of vertebral column and thoracic cage, who have undergone abdominal or chest surgery, having history of respiratory infection within last one month, gross anemia and smokers were excluded from study. Expiratory spirometry was performed on auto spirometer (compact vitalograph). Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV<sub>1</sub>), Forced Expiratory Ratio (FEV<sub>1</sub>/FVC) and Peak Expiratory Flow (PEF) were carried out at the fixed time of the day (9am -1pm) to avoid the diurnal variation.

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## RESULTS

Table 1 show comparative analysis of the pulmonary function tests: Forced vital capacity (FVC), Forced expiratory volume in one second (FEV<sub>1</sub>), FEV<sub>1</sub>: FVC and Peak expiratory flow (PEF) between the diabetics with normal HbA<sub>1c</sub> (<6) and raised HbA<sub>1c</sub> (>6). Mean±S.E.M. for FVC were 3.41±0.15 in males with normal HbA<sub>1c</sub>, 2.14±0.11 in females with normal HbA<sub>1c</sub>, 2.32±0.15 in males with raised HbA<sub>1c</sub> and 1.71±0.08 in females with raised HbA<sub>1c</sub>. The differences were highly significant in males with raised HbA<sub>1c</sub> as compared to the males with normal HbA<sub>1c</sub>. In females the values were significantly greater (P<0.05) in those with raised HbA<sub>1c</sub> as compared to those with normal HbA<sub>1c</sub>. Mean±S.E.M. for FEV<sub>1</sub> were 3.01±0.10 in males with normal HbA<sub>1c</sub>,

1.93±0.07 in females with normal HbA<sub>1c</sub>, 2.04±0.17 in males with raised HbA<sub>1c</sub> and 1.50±0.07 in females with raised HbA<sub>1c</sub>. The differences were highly significant (P<0.001) in diabetics (males and females) with raised HbA<sub>1c</sub> as compared to the diabetics (male and female) with normal HbA<sub>1c</sub>. Mean±S.E.M. for PEF were 7.9±0.15 in males with normal HbA<sub>1c</sub>, 4.9±0.12 in females with normal HbA<sub>1c</sub>, 6.7±0.21 in males with raised HbA<sub>1c</sub> and 4.5±0.09 in females with raised HbA<sub>1c</sub>. In males and females the values were significantly greater (P<0.05) in those with normal HbA<sub>1c</sub> as compared to those with raised HbA<sub>1c</sub>. However no differences were observed in FEV<sub>1</sub>: FVC between diabetics (male and female) with raised HbA<sub>1c</sub> and the diabetics (male and female) with normal HbA<sub>1c</sub>.

Table 1: Comparison of pulmonary function tests: forced vital capacity (fvc), forced expiratory volume in one second (fev<sub>1</sub>), fev<sub>1</sub>/fvc and peak expiratory flow (pef) in diabetics with normal hba<sub>1c</sub> (≤6) and diabetics with raised hba<sub>1c</sub> (≥6)

Pulmonary Function		HbA <sub>1c</sub> ≤ 6		HbA <sub>1c</sub> ≥ 6	
		No.	Mean ± SEM	No.	Mean ± SEM
FVC (litres)	Male	15	3.41 ± 0.15	15	2.32 ± 0.15**
	Female	14	2.14 ± 0.11	16	1.71 ± 0.08*
FEV <sub>1</sub> (litres)	Male	15	3.01 ± 0.10	15	2.04 ± 0.17**
	Female	14	1.93 ± 0.07	16	1.50 ± 0.07**
FEV <sub>1</sub> /FVC (%)	Male	15	88.7 ± 2.37	15	86.8 ± 2.27
	Female	14	90.6 ± 1.89	16	88.7 ± 1.76
PEF (litres/sec)	Male	15	7.9 ± 0.15	15	6.7 ± 0.21*
	Female	14	4.9 ± 0.12	16	4.5 ± 0.09*

\*P < 0.05 when compared with the normal HbA<sub>1c</sub>

\*\* P < 0.001 when compared with the normal HbA<sub>1c</sub>

## DISCUSSION

The two main findings of the study were: (1) the pulmonary function test results in diabetics were significantly altered; (2) the pulmonary dysfunction was more pronounced in patients with long standing diabetes mellitus. The present study shows significantly reduced lung function parameters (FVC, FEV<sub>1</sub> and PEF) in diabetics. The ratio of FEV<sub>1</sub> to FVC was greater in diabetic patients. Hence a general reduction of lung volume and a possible restrictive defect was found, whereas no evidence of airway obstruction was found. The decline in the pulmonary function was also found to be associated with the increased duration of the disease. The pulmonary functions were more impaired in patients with long standing diabetes (>10 years). Primhak et al<sup>6</sup> report decreased lung function in diabetes. Our results correlate with these results. However Primhak et al<sup>6</sup> did not find associations of diminished functions with either duration of diabetes or glycosylated hemoglobin.

Several other studies show reduced pulmonary functions which are in accordance to our results; like Schnapf et al<sup>7</sup> conducted a study in type 1 diabetic

patients with limited joint mobility and showed significantly decreased FVC and FEV<sub>1</sub>. Who concluded that this decline in lung function could be due to decreased lung compliance or restriction of chest wall expansion.

Schuyler<sup>8</sup> and associates postulated that premature aging of collagen and elastin might possibly be responsible for the decreased lung elasticity and hence reduced lung volumes in diabetic patient. Schnack et al<sup>9</sup>, Ofulue et al<sup>10</sup> and Hsia<sup>11</sup> have also suggested a reduction of lung volumes in diabetic patients. Our study is also in agreement with the views of Goldman<sup>12</sup> who suggests that lung is a target organ of diabetes; and Philips and Baker<sup>13</sup> who suggest that hyperglycemia affects the lungs by damaging capillaries and by the non enzymatic glycosylation of collagen.

Davis et al<sup>14</sup> carried out a study and determined the association between diabetes mellitus and reduced lung function. They reported reduced FVC, FEV<sub>1</sub>, VC, and PEF when expressed as a percentage of those predicted for age, sex and height. They also established a significant association of the duration of the disease with FEV<sub>1</sub> and PEF. This study also

related the reduced pulmonary functions to the glycemic exposure, in the form of higher updated mean HbA<sub>1c</sub>. Our study is in agreement with the findings of Davis et al<sup>15</sup>.

The present study was undertaken in an attempt to clarify the relationship of the pulmonary functions and diabetes. We conclude that a decrease in FVC, FEV<sub>1</sub> and PEF impairs lung functions in diabetic patients. We also show that longer the duration of the disease, greater is the impairment of the lung functions. Furthermore we also conclude that the glycemic exposure is a determinant of reduced lung function.

Our data thus supports the suggestions that the lung is a target organ in diabetes. The findings are of importance in that they demonstrate the need for prevention of lung impairment. We advise therefore that diabetic patients undergo periodic spirometry test to assess the severity of lung function impairment. Spirometry will identify more susceptible diabetic patients so they can take additional preventive measures.

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