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Original Investigation

The Relationship of Plasma Glucose Level and HbA1c among Diabetic Patients attending Chitwan Medical College

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ARTICLE INFO	ABSTRACT

INTRODUCTION: Type 2 diabetes mellitus is a complex heterogeneous group of metabolic conditions characterized by an increased level of blood glucose, due to impairment in insulin action and/or insulin secretion. Normally the level of HbA1c is less than 6%. HbA1c level reveals the mean glucose level over the previous 10-12 weeks. HbA1c has become a very important part of the management of patients with diabetes mellitus. In addition, the HbA1c is a better indicator of chronic glycemic levels and has a better index to determine the risk for long-term complications as well. So for the screening or diagnosing DM by using glycated hemoglobin (HbA1c) level is very important. The aim of the study was to correlate the plasma glucose level and HbA1c in diabetic patients attending in Chitwan Medical College and Teaching Hospital. **MATERIALS AND METHODS:** The study was a cross sectional study carried out in Department of Biochemistry in collaboration with Department of Medicine, Chitwan Medical College, Nepal. The standard screening procedures such as fasting blood sugar (FBS), post prandial blood sugar (PPBS) and HbA1c were the parameters taken into account for the research work. **RESULTS:** It was found that both FBS and PPBG strongly correlated significantly with HbA1c values ($r = 0.79$, $p < 0.001$ and $r = 0.75$, $p < 0.001$). **CONCLUSIONS:** The results suggest that both fasting and postprandial blood glucose significantly correlated with HbA1c. However, our data suggest that HbA1c values may be a weak parameter to identify pre-diabetes cases. HbA1c threshold of $\geq 6.8\%$ can be considered a relatively sensitive marker for the diagnosis of diabetes in the study population.

Keywords: Diabetes mellitus, plasma glucose level, HbA1c

INTRODUCTION

Diabetes mellitus is a metabolic disorder that either arrives during the early year of growth or later in life [1]. It comprises a group of common metabolic disorders that share the phenotype of hyperglycaemia's. It is a chronic illness that requires continuing medical care and patient self-management education to prevent acute complications and to reduce the risk of long-term complications. Insulin deficiency in turn lead to chronic hyperglycemia with disturbance of carbohydrate, fat and protein metabolism [2]. Chronic hyperglycemia of diabetes is associated with damage, dysfunction and failure of different organs especially the eyes, kidney, nerves, and heart and blood vessels [3].Previously, National diabetes data group classified diabetes into major types according to descriptive of their clinical presentation: Non-insulin dependents diabetes mellitus and insulin dependents diabetes mellitus. [4] The new classification system identifies four types of diabetes mellitus: Type1 diabetes (IDDM) due to β-cell destruction, Type 2 diabetes (NIDDM) due to insulin secretory defects, other specific types and gestational diabetes [4]. High concentration of glucose can increase the glycation of common proteins such as hemoglobin, forming HbA1c it's important to note that HbA1c is neither considered dysfunctional nor harmful [5].

Glycated hemoglobin (HbA1c) is formed by non-enzymatic addition of glucose to amino terminal valine of the β-chain of hemoglobin progressively and irreversibly over a period of time and it is stable till the life of RBC [6]. Glycation of hemoglobin alters the surface charge and converts it to fast moving HbA1c on electrophoresis [7]. The best index of long-term control of blood glucose level is measurements of glycated hemoglobin or HbA1c. The rise in every 1% of HbA1c corresponds to an appropriate average increase of 2 mmol/l in blood glucose [8].HbA1c is not affected by day-to-day variation of carbohydrate intake and exercise and considerably more stable than plasma glucose (fasting glucose and postprandial plasma glucose).The Glycated hemoglobin are together called HbA1 fraction, out of this 80% molecules are HbA1c [9]. Measurement of HbA1c can be performed at any time of the day. The management of diabetes mellitus requires an accurate evaluation of blood glucose control to assess the efficiency of a particular therapy. Whole blood hemoglobin A1c (HbA1c) measurements have been widely used in diabetes patients for more than 25 years to monitor long-term glycemic control [10,11]. The measurement indicates a patients average blood glucose level during the previous 60-90 days. It is recommended that diabetes patients have

their HbA1c levels checked at least two times per year because quantitative and direct relationships have been identified between HbA1c concentration and the risk of diabetes micro vascular complications [12]. Therefore, clinicians use HbA1c test results to guide treatment decisions, and the test has become the cornerstone for assessing diabetes care [13]. The concentration of glycated hemoglobin remains relatively stable with time. This is due to the life span of red blood cells, which is usually 120 days. In individuals with a normal erythrocyte life span, glycated hemoglobin is directly proportional to the blood glucose concentration over the preceding 8 to 12 weeks [14]. In patients with diabetes mellitus, the glycated hemoglobin value is used to determine the degree of glycemic control and to make decisions regarding therapy [15].

MATERIALS AND METHODS

Study design and setting:

The study was a cross sectional study carried out in Department of Biochemistry in collaboration with Department of Medicine, Chitwan Medical College, Nepal. The CMC teaching hospital is one of the largest institution situated at the central part of the country. Data was collected from 15th July 2023 to 1st September 2023 from the hospital laboratory of Chitwan Medical College.

Participants, and study procedures:

Type 2 diabetic patients (n=110) of all age and sex groups attending Department of Medicine in Chitwan Medical College were included in this research work after their consent. 10 ml of blood sample was drawn from anticubital vein following overnight fasting. The blood sample was collected in plain, fluoride and EDTA vacutainers. The blood sample was centrifuged for 10 minutes at 3000 rpm at room temp. The serum was stored at 4oC for biochemical investigations. The standard screening procedures such as fasting blood sugar (FBS), post prandial blood sugar (PPBS) and HbA1c were the parameters taken into account for the research work. Patients with history of chronic alcoholism, thyroid disorders, chronic liver disease, severe hypertension, bone disease were excluded from this study. The criteria for diagnosing diabetes included: 1. HbA1c ≥ 6.5% (Perform in lab using NGSP- certified method and standardized to DCCT to assay, 2.FPG ≥ 126 mg/dl (7 mmol/L), post prandial plasma glucose ≥ 200 mg/dl (11.1 mmol/L) [16].

Statistical analysis and data management:

The Data was entered in Microsoft Excel Sheet and was analysed in Statistical Package of Social Sciences (SPSS) version 16.

Ethical consideration:

The ethical committee of CMC has approved this research work. (Reference no: CMC-IRC/078/079-232).

RESULTS

Male predominance was seen in this study. Among 110 type 2 diabetic patient, 49.1% (n=54) of the participants belonged to the age group 40-59 year (Table 1). The distribution of patients by fasting glucose level was high in 68.2% (n=75). Among 110 type 2 diabetic patients, 26.4% (n=29) had values of postprandial glucose normal and

73.3% (n=81) had values of postprandial glucose level high (Table 2) Among 110 patients, 9% (n=1) had values of

Table 1| Distribution of patients by age and sex	
Variables	**Frequency (%)**
Age (years)	
20-39	17 (15.5)
40-59	54(49.1)
60-79	30 (27.3)
≥80	9 (8.2)
Sex	
Male	60 (54.5)
Female	50 (45.4)

Table 2| Distribution of diabetic patients by fasting and PP glucose level	
Variables	Frequency (%)
FBS(mg/dl)	
Low (<70mg/dl)	1 (9)
Normal(70-110mg/dl)	34 (30.9)
High(>110mg/dl)	75 (68.2)
PP(mg/dl)	
Normal(70-140mg/dl)	29 (26.4)
High(>140mg/dl)	81 (73.6)
Low(<70 mg/dl)	

HbA1c level low, 23.6 %(n=26) had values of HbA1c level normal and 75.7% (n=83) had values of HbA1c level high (Table 3). Both postprandial and fasting blood glucose significantly correlated with HbA1c. Postprandial glucose and fasting blood glucose showed better correlation to HbA1c, (r= 0.79, p<0.001 and r=0.75, p<0.001) as shown in table 4.

Table 4| Correlation between fasting blood glucose, postprandial Blood glucose level and HbA1c		
	Coefficient of correlation (r)	p value
HbA1b and FBS	0.75	<0.001
HbA1c and PP	0.79	<0.001

In this quantitative study, we tried to estimate the overall correlation of HBA1c and plasma glucose level in diabetes patient. In this study, the main results of the present study are that both FBG and PPBG strongly correlated significantly with HbA1c values (r= 0.79, p<0.001and r=0.75, p<0.001) and which is similar to the results observed by Shrestha L et al. [17], where they reported both postprandial and fasting blood glucose significantly correlated with HbA1c. Postprandial glucose showed better correlation to HbA1c than fasting blood glucose (r= 0.630, p=0.05 vs.= 0.452, p<0.001). In study observed by Swetha N K. also found significant correlation between HbA1c & FBS, PPBS & RBS (p<0.010) with PPBS showed better correlation than FBS & RBS (r=0.764 vs. 0.739 & 0.601) [18]. In our study the correlation of HbA1c and plasma glucose (FBS, PP) level in type 2 diabetic subjects were in consistent with the results of customers of Health Examination Service done by Chi – Chau Liang et al. [19] and Waqar Azim et al. [20]. In this study the HbA1c and plasma glucose (FBS, PP) level were performed and reported the distribution of patients by fasting glucose level. Among 110 patients, 9 %

had values of fasting glucose level low, 30.9 % had values of fasting glucose level normal and 68.2 % had values of fasting glucose level high. Which is similar to the results of the study on the relationship between fasting glucose and HbA1c among customers of Health Examination Service done by Chi – Chau Liang et al., where fasting glucose was 103.1 ± 28.6 mg/dl [21]. Our study also reported distribution of diabetic patients by postprandial glucose level. Among 110 patients, 26.4 % had values of postprandial glucose normal and 73.3 % had values of postprandial glucose level high. Similarly, present study highlighted the distribution of diabetes patients by HbA1c level. Among 110 patients, 9% had values of HbA1c level low, 23.6 % had values of HbA1c level normal and 75.7 % had values of HbA1c level high. In the findings, Mean (±SD) HbA1c of the patient is 8.73±2.46 which is similar to the results done on correlation between Glycated Haemoglobin and Random Plasma Glucose levels for the screening of DM by Waqar Azim et al., where mean ±(SD) HbA1c was 6.34±1.5% [20].

CONCLUSIONS

The results suggest that both fasting and postprandial blood glucose significantly correlated with HbA1c. However, our data suggest that HbA1c values may be a weak parameter to identify pre-diabetes cases. In conclusion, an HbA1c threshold of ≥6.8% can be considered a relatively sensitive marker for the diagnosis of diabetes in this population. More studies are required, particularly long-term prospective studies, including all possible factors of influence, such as ethnicity, food habits, and lifestyle, in order to confirm our findings in such a multi-ethnic and multi-cultural society like Nepal. The study was conducted only in one instituion with very small sample, so, it may not be generalized to whole nation.

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