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Correlation of Glycated Hemoglobin with Plasma Glucose in Type 2 Diabetic Patients

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ABSTRACT

Background: Diabetes is a common disease in both developed and developing countries. Increasing prevalence of the disease sets the goal to aim for control of the disease process which is aimed mainly as therapy. Monitoring tool for the complications of this common disease is Glycated Hemoglobin (HbA1C). **Objective:** In the present retrospective study HbA1C level is correlated with both fasting and post meal plasma glucose level in type-2 diabetes mellitus patients. **Methods:** The retrospective study was done in Department of Biochemistry & Molecular Biology, Gonoshasthaya Samaj Vittik Medical College & Hospital, Savar, Bangladesh from January to June-2021. Data were collected from Computerized Hospital Information Processing System (CHIPS) biochemistry department on the basis of HbA1c tests. Data collected from the Computerized Hospital Information Processing System (CHIPS) data base consisted of patient's hospital number, name, age, sex, and test results for HbA1C, fasting and postprandial plasma glucose levels and the final diagnosis of the patient. Correlation study was done to find correlation between HbA1C and plasma glucose levels (fasting and post prandial plasma glucose).**Results:** Both fasting and postprandial plasma glucose showed significant correlation with HbA1C (r=0.631; p=0.000 vs r=0.590; p=0.000). Therapeutic target to lower both fasting and two-hour plasma glucose during oral glucose tolerance test while treating patients with type 2 diabetes mellitus, so as to reduce long term risks associated with the disease process. **Conclusion:** The results suggested that HbA1C significantly correlated with both fasting plasma glucose and postprandial plasma glucose. Therapeutic target to lower both fasting and two-hour plasma glucose during oral glucose tolerance test while treating patients with type 2 diabetes mellitus, so as to reduce long term risks associated with the disease process.

Keywords: *HbA1C, Fasting Plasma Glucose, Post Prandial Plasma Glucose.*

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INTRODUCTION

Diabetes mellitus is a group of metabolic disorders characterized by hyperglycemia resulting from either defect in insulin secretion, insulin at its sites of action, or both[1]. Diabetes is a common disease but the exact prevalence is unknown. Acute and chronic complications make diabetes the fourth most common cause of death in the developed world[2]. In the United States, the prevalence from 1999 to 2002 was 9.3%, 30% of whom were undiagnosed. Analysis of the 2005–2006 National Health and Nutritional Examination Survey (NHANES) using both fasting glucose and oral glucose tolerance testing (OGTT) shows a prevalence of diabetes in the United States in persons 20 years of age and older of 12.9% (equivalent to 40 million people)[2]. Glycated hemoglobin (HbA1c) is formed non-enzymatically by condensation of glucose or other reducing sugars with beta-globin chains of hemoglobin. HbA1c is used to diagnose diabetes, monitor glycemic control, evaluate the need to change therapy, and predict the development of micro vascular complications[3].Mixing different methods to diagnose diabetes should be avoided[3].The number of people with diabetes has increased dramatically worldwide. In the absence of unequivocal hyperglycemia, these criteria should be confirmed by repeating the same test on a different day[4]. It was estimated by the year 2035, this number is predicted to reach 592 million and 80% of this population will live in low- and middle-income countries[4].Similarly, the prevalence of diabetes in Asian populations has increased rapidly in recent decades, with China and India ranked first and second, respectively, among countries with the largest diabetic populations[5]. Recent analysis in Chinese adults suggests that in 2010 the estimated prevalence of diabetes and prediabetes was 11.6% and 50.1%, respectively. Blood levels of HbA1c have been used for monitoring the degree of control of glucose levels in diabetic patients since 1976. A total of 30-35% of reduction in micro vascular complications occurs per 1% absolute reduction in glycated hemoglobin (Hb). It is found that a 14 to 16% decrease in macro vascular complication occurs for every 1% absolute reductions in glycated Hb[5]. Fasting or

postprandial plasma glucose level alone or in combination will be necessary in adjusting the therapy to achieve optimal HbA1C levels in type-2 diabetes mellitus. In the present retrospective study HbA1C level is correlated with both fasting and post meal plasma glucose level in type-2 diabetes mellitus patients. It can be an alternative economical test, compared to HbA1C for glycemic control for uncomplicated diabetic patients.

Diabetes mellitus was diagnosed based on the guidelines (American Diabetic Association) asfollows.[6]	
Any one of the following is diagnostic for diabetes mellitus:	1. Hemoglobin A1c (HbA1c) 6.5% or greater, OR 2. Fasting plasma glucose (FPG) 126 mg/dL or greater, OR 3. Symptoms of hyperglycemia and casual plasma glucose 200 mg/dL or greater, OR 4. Two-hour plasma glucose 200 mg/dL or greater during an oral glucose tolerance test (OGTT).

MATERIALS ANDMETHODS

The retrospective study was done in Department of Biochemistry & Molecular Biology, GonoshasthayaSamajVittik Medical College & Hospital, Savar, Bangladesh from January to June-2021. Data were collected from Computerized Hospital Information Processing System (CHIPS) biochemistry department on the basis of HbA1c tests.

Data collected from the Computerized Hospital Information Processing System (CHIPS) data base consisted of patients name, age, sex, and test results for HbA1c, fasting and postprandial plasma glucose levels and the final diagnosis of the patient. It was ascertained whether this occasion was a patient's first visit to Gonoshasthaya Samaj Vittik Medical College & Hospital, Savar as earlier. This was done by checking to see whether the patients had previous records of laboratory tests done. For patients on their first visit, their values for HbA1c were used to designate them into those who had normal levels (≤ 5.6%), those who were pre-diabetic (5.7-6.4%) and those who were diabetic (≥ 6.5%). For these new patients, it was assumed that the HbA1c test was done as a diagnostic test for diabetes mellitus and diabetic patients were included in the study. Other patients were selected based on the diagnosis given by the Computerized Hospital Information Processing System (CHIPS).

Statistical Analysis: Data was analyzed using SPSS (Statistical Package for Social Sciences) version 21.0, using appropriate tests. A p value of less than 0.05 was taken to indicate statistical significance.

RESULTS

Data collected from Computerized Hospital Information Processing System (CHIPS) Biochemistry department on the basis of HbA1c tests ordered during January to June 2021. It was found that for 4331 patients HbA1c was ordered. The test was ordered for 1875 female patients (43.3% of the total patients) and 2456 male patients (56.7% of the total patients). 986 (22.78%) tests were ordered from broad specialty departments (Emergency Medicine, Community Medicine, Child Health, Dermatology, Dental, ENT, Family Medicine, General Medicine, Geriatric Medicine, Obstetrics and Gynecology, Orthopedics, Reproductive Medicine, Respiratory Medicine and Staff ,Student Health Service) 3345 (77.22%) tests were ordered from super specialty (Cardiology, Endocrinology, Paediatric Endocrinology, Endocrine Surgery, Gastroenterology, Hepato-biliary Surgery, Haematology, Medical Genetics, Medical Oncology, Nephrology, Neurology, Paediatric Orthopaedics, Rheumatology, Thoracic Surgery, Urology and Vascular Surgery) (Table-1).

Table 1: Percentage distribution of patient data.

	Number	Percentage
HbA1c ordered during January to June 2021	4331	100%
Number of female patients	1875	43.3%
Number of male patients	2456	56.7%
Tests ordered from broad specialty departments	986	22.78%
Tests ordered from super specialty departments	3345	77.22%
Patients with diabetes mellitus (Newly diagnosed and known diabetes mellitus patients)	324	7.5%

Out of 4331 patients for whom HbA1c was ordered, 324 patients were diabetic patients who were newly diagnosed as mentioned in materials and methods also known diabetic patients on treatment (Fig-1).

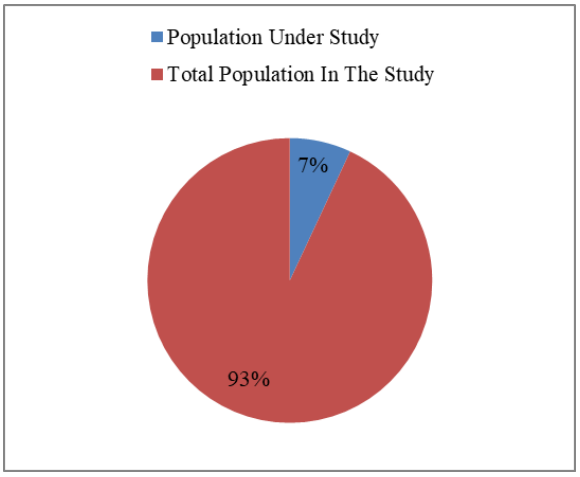

Fig-1: distribution of study population.

Table 2: Percentage distribution of study population.

Distribution Of Study Population	Number	Percentage
HbA1c ordered during January to June 2021in diabetic patients	324	100%
Number of female patients	121	37.3%
Number of male patients	203	62.6%
Number of Fasting plasma glucose test ordered	109	33.6%
Number of post prandial plasma glucose test ordered	108	33.3%

Among 324 patients include both the patients from out-patient (208 patients) and in-patient department (116 patients) (Fig 2). Fasting plasma glucose test was available for 109 patients and postprandial plasma glucose was available for 108 patients (Table-2).

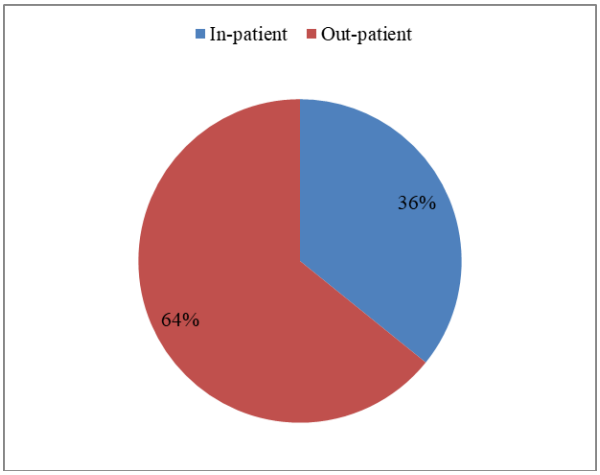

Fig-2 Distribution in-patient and out-patient.

Table 3: Descriptive statistics of the study population.

	Range	Minimum	Maximum	Median	Skewness
Age	90	0	90	55	-0.699
HbA1c	15.3	4.3	19.6	7.50	1.294
Fasting plasma glucose	372	69	441	138.50	1.383
Post prandial plasma glucose	420	83	503	222.50	0.683

Table 4: Correlation of HbA1c with fasting and post prandial plasma glucose.

Correlation of HbA1c	Spearman's Rho correlation coefficient	p-value
HbA1c (N=324) vs Fasting plasma glucose (N=109)	0.631**	0.000
HbA1c (N=324) vs postprandial plasma glucose (N=108)	0.590**	0.000
**- *Correlation is significant at the 0.01 level (2-tailed).*		

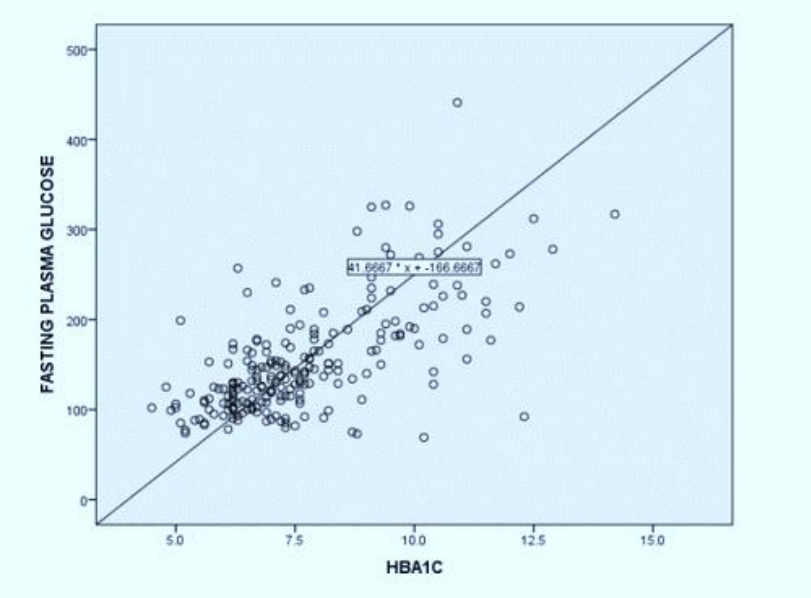

Fig-4: HbA1c Fasting plasma glucose level.

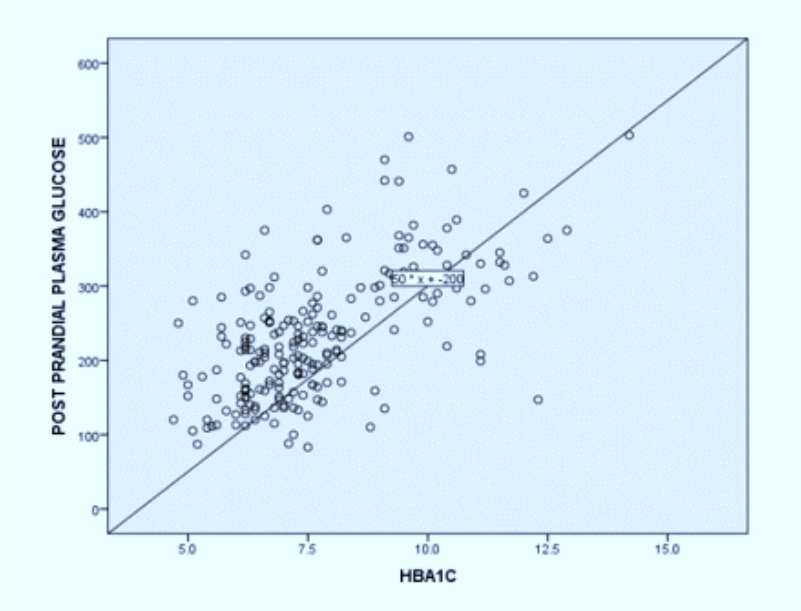

Fig-5: HbA1c postprandial plasma glucose level.

Correlation test showed both fasting and postprandial plasma glucose showed significant correlation with glycated hemoglobin (r=0.631; p=0.000 vs r=0.590; p=0.000) (Table 4, Figure 4, 5).

DISCUSSION

HbA1C being a diagnostic as well as monitoring tool in diabetes mellitus. The availability and cost of the test makes it difficult for catering the primary health care services. 1% absolute reduction in glycated hemoglobin (Hb) gives 30-35% of reduction in micro vascular complications and 14 to 16% decrease in macro vascular complication[7, 8]. The present study aimed to find the correlation between HbA1C and plasma glucose levels (both fasting and post prandial plasma glucose). It was found both fasting and post prandial plasma glucose showed significant correlation with glycated hemoglobin (r=0.631; p=0.000 vs r=0.590; p=0.000). Bonoraet al.[9] showed HbA1c correlated more closely to pre-prandial than postprandial blood sugar. Similar conclusions have been reached by Peter et al.[10] and Goudswaard et al.[11]. These findings have strong potential implication in treatment of DM-2. As it is well known fact that reducing HbA1c values can lower risks associated with DM-2, e.g. retinopathy, neuropathy, cardiovascular risks etc, knowing whether FBG or PPBG is independent predictor of HbA1c, aids in choosing effective medication in lowering HbA1c value, i.e., targeting PPBG or FBG to lower HbA1c[12]. Feinglos et al., in a study of patients with type 2 diabetes with secondary failure of sulfonylurea therapy, showed that improvement of postprandial hyperglycemia, using insulin lispro (Humalog) at mealtime in combination with a sulfonylurea, not only reduced two hours postprandial glucose excursions, but also

reduced both fasting glucose and HbA1c levels from 9.0% to 7.1% (P<0.001)[13]. Improvements in HbA1C levels were also reported in a study by Bastyr et al, 2000, which showed that therapy focused on lowering postprandial glucose versus fasting glucose may be better for loweringglycated hemoglobin levels[14]. Further, De Veciana et al., in his study of patients with gestational diabetes demonstrated that targeting treatment to one-hour postprandial glucose levels rather than fasting glucose reduces glycated hemoglobin levels improves neonatal outcomes[15].Bonora et al., also found that there is lack of strong correlation between HbA1c and glucose levels in a single day[16]. This is indirect proof that the blood glucose profile varies day by day, although more informative than a sporadic fasting or random glucose determination, cannot adequately describe daily glucose profiles occurring within several weeks period. Indeed Brewer et al., has concluded that several glucose determinations over a period of several weeks are better correlated to HbA1c than a single or a few glucose determinations on a single day[17].Though definitive correlation can be made out with the data studied, the main limitation of the study is analysis done based on the data, which did not have HbA1C along fasting and postprandial plasma glucose values for same patient. Now as per recent guidelines (American Diabetic Association) two-hour plasma glucose during an oral glucose tolerance test (OGTT) despite of postprandial plasma glucose is considered for diagnosis which was not studied in the present study.

CONCLUSION

The results suggested that HbA1C significantly correlated with both fasting plasma glucose and postprandial plasma glucose. Therapeutic target to lower both fasting and two-hour plasma glucose during oral glucose tolerance test glucose while treating patients with type 2 diabetes mellitus, so as to reduce long term risks associated with the disease process.

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Conflict of Interest: There is no conflict of interest.
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REFERENCES:

1. Nader Rifai; Andrea R. Horvath, Carl T. Wittwer(2018). Tietz textbook of Clinical Chemistry and Molecular Diagnostics. 6th ed. Elsevier.
2. Jameson JL, Fauci AS, Kasper DL, Hauser SL, Longo DL, Loscalzo J(2018). Harrison's principles of internal medicine. 20th ed. McGraw Hill.
3. International Diabetes Federation. IDF DiabetesAtlas,6theditionhttp://www.idf.org/diabetesatlas/5e/
4. Chan JC, Malik V, Jia W, et al(2009). Diabetes in Asia: epidemiology, risk factors, and pathophysiology. JAMA; 301: 2129–40.
5. Stratton, I. M., Adler, A. I., Neil, H. A. W., Matthews, D. R., Manley, S. E., Cull, C. A., ... & Holman, R. R. (2000). Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. Bmj, 321(7258), 405-412.
6. American Diabetes Association(1997). Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. Diabetes Care; 20:1183–97.
7. Ogurtsova, K., da Rocha Fernandes, J. D., Huang, Y., Linnenkamp, U., Guariguata, L., Cho, N. H., ... & Makaroff, L. E. (2017). IDF Diabetes Atlas: Global estimates for the prevalence of diabetes for 2015 and 2040. Diabetes research and clinical practice, 128, 40-50.
8. Shrestha L, Jha B, Yadav B, Sharma S(2012). Correlation between fasting blood glucose, Postprandial blood glucose and glycated Hemoglobin in non-insulin treated type 2 diabeticSubjects Sun sari Technical College Journal, Volume 1, Issue 1, October; 2091-2102.
9. Bonora E, Calcaterra F, Lombardi S, Bonfante N, Formentini G, Bonadonna R, Muggeo M. Plasma glucose levels throughout the day and HbA1c interrelationships in type 2 diabetes: implications for treatment and monitoring of metabolic control. Diabetes Care 2001; 24:2023.029.
10. R. Peter, S. D. Luzio, G. Dunseath, V. Pauvaday, N. Mustafa, D. R. Owen(2006). Relationship between HbA1c and indices of glucose tolerance derived from a standardized meal test in newly diagnosed. Diabetic Med; 23(9):990-95.
11. Goudswaard AN, Stolk RP, Zuithoff P, Rutten GE(2004). Patient characteristics do not predict poor glycaemic control in type 2 diabetes patients treated in primary care. Eur J Epidemiol; 19(6):541-5.
12. Use of Glycated Haemoglobin (HbA1c) in the Diagnosis of Diabetes Mellitus: Abbreviated Report of a WHO Consultation [Internet]. Geneva: World Health Organization; 2011 [cited 2017 Nov 10]. (WHO Guidelines Approved by the Guidelines Review Committee). Available from:http://www.ncbi.nlm.nih.gov/books/NBK304267
13. Feinglos, M. N., Thacker, C. H., English, J., Bethel, M. A., & Lane, J. D. (1997). Modification of postprandial hyperglycemia with insulin lispro improves glucose control in patients with type 2 diabetes. Diabetes Care, 20(10), 1539-1542.
14. Bastyr EJ, Stuart CA, Brodows RG, Schwartz S, Graf CJ, Zagar A, Robertson KE(2000). Therapy focused on lowering postprandial glucose, not fasting glucose, may be superior for lowering HbA1c. Diabetes Care; 23:1236–

41.
15. De Veciana M, Major CA, Morgan MA, Asrat T, Toohey JS, Lien JM, Evans AT(1995). Postprandial versus preprandial blood glucose monitoring in women with gestational diabetes mellitus requiring insulin therapy. N Engl J Med; 333:1239–41.
16. Bonora E, Calcaterra F, Lombardi S, Bonfante N, Formentini G, Bonadonna R, Muggeo M(2000). Plasma glucose levels throughout the day and HbA1c interrelationships in type 2 diabetes: implications for treatment and monitoring of metabolic control. Diabetes Care 200; 24:2023–029.
17. Brewer KW, Chase HP, Owen S, Garg SK(1998). Slicing the pie: correlating HbA1c values with average blood glucose values in a pie chart form. Diabetes Care; 21:209–12.