

Original Article

Prediction of HbA1c from Fasting Plasma Glucose: Comparison between Uncontrolled and Controlled Diabetes Mellitus among Adults in a Tertiary Care Hospital of Bangladesh

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Abstract:

Background and Objective: Diabetes Mellitus has emerged as a major public health problem globally and uncontrolled diabetes mellitus plays important role to develop micro and macro vascular complications. So the present study is done to determine the prevalence of uncontrolled diabetes and to predict the HbA1c from the fasting plasma glucose (FPG) level for Type 2 diabetes mellitus (T2DM) patients.

Method: Cross-sectional study was conducted in adult out-patients department of BIRDEM Hospital, Dhaka from January 2019 to June 2019. Data were collected from diabetes guide book of patients who had tested FPG and HbA1c from the same blood sample. For determining the relationship between FPG and HbA1c, linear regression equation was used.

Result: A total of 554 T2DM patients were taken for this study. Of the total participants, male and female were 52.1% and 47.9% respectively. Mean±SD of age, FBG and HbA1c were 51.6±10.51 years, 10.89±4.14 mmol/L and 8.83±1.82% respectively. According to this study prevalence of controlled HbA1c (≤7.0%) and FPG (≤7.2mmol/L) were 16.6% and 18.6% respectively by ADA criteria. The prediction model between HbA1c and FPG, expressed as $HbA1c = 5.369 + 0.32 FPG$ ($R^2 = 0.529$, $p < 0.001$) in the study subjects. The study found that the HbA1c level increased by approximately 0.32% per increment of 1.0 mmol/L in FPG.

Conclusions: The authors observed that the prevalence of uncontrolled HbA1c (>7.0%) and FPG (>7.2mmol/L) were 84.7% and 81.9% respectively based on ADA criteria. The study also concluded that HbA1c level could be predicted from FPG by using regression equation.

Keywords: Diabetes Mellitus, Glycated Hemoglobin, Prediction, ADA.

Introduction:

Among the non-communicable diseases type 2 Diabetes Mellitus is one of the most alarming across the world as well as in Bangladesh. The slow onset of the disease, delayed detection, unhealthy dietary habits and lack of physical activities make the disease far more common in developing countries. Globally 463 million adults are living with diabetes¹. Multiple chronic complications in patients with

long term uncontrolled diabetes creates a large number of economic and social burdens in the society^{2,3}. In 2019, the American Diabetes Association (ADA) has recommended that HbA1c ≤7% can reduce the development and progression of vascular complications⁴. Previous studies such as Diabetes Control and Complications (DCCT), United Kingdom Prospective Diabetes Study (UKPDS) and Action in Diabetes and Vascular Disease (ADVANCE) in type 2 diabetes-confirmed that improved glycemetic control significantly reduced the risk of microvascular complications, but it had no significant effect on cardiovascular (CV) outcomes⁵⁻⁷. Though, the secondary end point of all-cause death, stroke and Myocardial Infarction was significantly decreased by 16%. Therefore, glycemetic control is fundamental rule to manage diabetes as well as to prevent vascular complications.

Thus, this study was taken to measure the prevalence of uncontrolled diabetes and to establish if HbA1c levels can be predicted from FPG level.

Methods:

The study was cross-sectional and conducted in out-patients department of BIRDEM General Hospital during the period from January, 2019 to June, 2019. Patients who visited out-patients departments of BIRDEM General Hospital with Type 2 diabetes mellitus & aged ≥ 20 years were included in

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the study. Patients with newly diagnosed type 2 diabetes mellitus, with type 1 diabetes mellitus & Gestational diabetes mellitus were excluded.

All patients' history and clinical parameters were taken from their personalized diabetic guide book. Study data included age, gender and lab parameters like FPG and HbA_{1c}.

Statistical Analysis:

The statistical analysis was performed using SPSS version 20. Data were described as simple percentage. Mean with standard deviation (SD) were used for continuous variables. The association between FPG and HbA_{1c} was examined using linear regression models and P value ≤ 0.05 was considered statistically significant.

Results:

A total 554 T2DM patients who met the inclusion criteria were studied. Of the total subjects, mean age was 51.62 ± 10.90 years and was ranges 22 to 80 years. The mean FPG and HbA_{1c} were 10.9±4.29 mmol/L and 8.86±1.89 mmol/L respectively. Majority of the patients was in the age group of 40-50 and 50-60 years which were 30.5% and 31.9% respectively. About 18.0% participants were below or equal to 40 years of the age group and 19.6% of patients had age of older than 60 years (Table 1). Of the total participants, the male and female were 53.2% and 46.8% respectively. Approximately 18.1% patients had controlled (FPG ≤ 7.2mmol/L) diabetes and most of the patients had uncontrolled FPG (81.9%) by ADA criteria. Only 15.3% patients had controlled HbA_{1c} (≤7.0%) and rest of patients had uncontrolled HbA_{1c} (84.7%) i.e; below recommended level (Table 2)

Table 1:

Variables	N	Min	Max	Mean	SD
Age Yrs.	551	22	80	51.62	10.903
FPG mmol	554	4.3	35.1	10.901	4.2970
HbA _{1c} %	554	5.5	16.2	8.858	1.8904

Table 2:

Variables	Number (%)	
Gender	Male	295 (53.2%)
	Female	259 (46.8%)
Age:	≤ 40y	99(18.0%)
	40-50y	168(30.5%)
	50-60y	176(31.9%)
	>60	108(19.6%)
FPG:	≤ 7.2	100(18.1%)
	>7.2	454(81.9%)
HbA_{1c}:	≤ 7.0	85 (15.3%)
	> 7.0	469 (84.7%)

By using linear regression model, prediction between HbA_{1c} and FPG in the study population, expressed as $HbA_{1c} = 5.369 + 0.32 \times FPG$ ($R^2 = 0.529$; $p < 0.001$), is shown in Fig.1. The HbA_{1c} level increased by approximately 0.32% per increment of 1.0 mmol/L in FPG. Based on these calculations, the correspondence of HbA_{1c} to specific FPG was shown in Table 3. In this table, we found that FPG of 5.6 and 7.0mmol/L and the predicted HbA_{1c} were 7.39% and 7.61% respectively. However, the FPG of 8.0 and 10.0mmol/L and predicted HbA_{1c} were 7.93% and 8.57% respectively. These results showed that when FPG ranges from 5.6 to 7.5 mmol/L, their corresponding regression estimated HbA_{1c} was increasing gradually (HbA_{1c}:7.39% to 7.77%) in study population. When FPG range from 8.0 to 15.1 mmol/L indicating uncontrolled DM than their corresponding actual HbA_{1c} and regression estimated HbA_{1c} did not increase in the same pace. There is a downward trend of gradual increase in both actual and regression estimated HbA_{1c} in uncontrolled FPG in contrast with controlled FPG.

Table 3

Study Population		Regression Estimated HbA _{1c} (%)
FPG	HbA _{1c}	
5.6	6.6	7.39
6.0	7.7	7.29
6.5	6.3	7.45
7.0	7.2	7.61
7.5	7.4	7.77
8.0	8.8	7.93
8.5	8.8	8.09
9.0	9.3	8.25
9.5	9.2	8.41
10.0	9.5	8.57
10.5	9.4	8.73
11.0	8.6	8.89
11.5	10.4	9.05
12.0	8.3	9.21
13.0	9.7	9.53
14.0	9.4	9.85
15.1	10.0	10.20

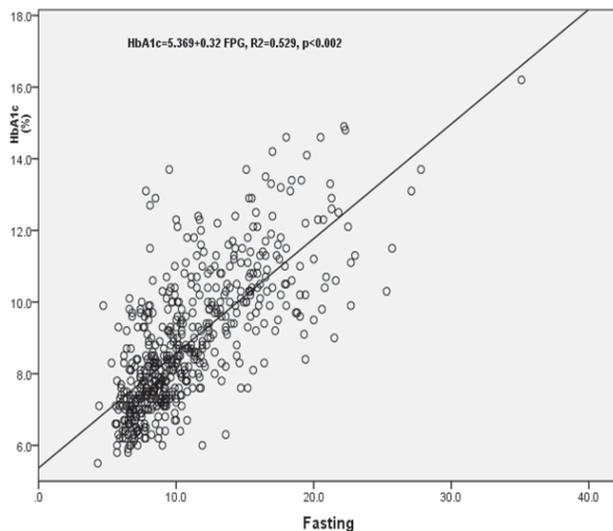


Fig. 1

Discussion:

Diabetes is a complex and chronic illness all over the world. It is well known fact that poor glycemic control increases the risk of micro and macro vascular complications. Continuous medical support can help the patients with multifactorial risk-reduction strategies beyond glycemic control. Glycemic control is to prevent acute complications and reducing the risk of long-term complications. The American Diabetes Association (ADA) has been actively involved in the development and dissemination of diabetes care standards and guidelines related documents for 25 years⁴. ADA's current clinical practice recommendations are viewed as important resources for health care professionals who care for people with diabetes. Therefore, we studied glycemic status in our diabetic patients by ADA criteria and to predict the HbA1c from the FPG level using regression equation for T2DM subjects.

The key focus of diabetes management should be adequate control of blood glucose level and to reduce the progression of different types of vascular complications. This study found that most of the patients (84.7%) had uncontrolled glycated hemoglobin (HbA1c) >7% and only 15.3% patients had controlled diabetes based on ADA criteria. In a study done by Borgharkar SS *et al*, the prevalence of uncontrolled HbA1c >7.0% was 76.6%, which was lesser when compared with our study⁸. Another study done by Anusuya GS *et al*. reported the prevalence of uncontrolled blood sugar levels among known diabetics was 65.4% in south Chennai⁹ which was also lesser than in our study. The United Kingdom Prospective Diabetes Study in type 2 diabetes and the DCCT in type 1 diabetes confirmed that glycemic control significantly reduced both microvascular and cardiovascular (CV) complications¹¹⁻¹³. Therefore we also suggest that it is necessary to control the blood glucose level in diabetic patients to reduce the vascular complications.

This study also found a close association between HbA1c and FPG levels for T2DM which is in concordance with the other recent study¹⁰. The HbA1c level corresponding to FPG of 6.0

mmol/L was 7.7% in the study subjects and predicted HbA1c was 7.29%. Similarly, FPG of 7.0 mmol/L and corresponding HbA1c was 7.2% in the study population and predicted HbA1c was 7.77%. However, in the subjects with uncontrolled diabetes by the HbA1c criteria, 8.0 and 9.0 mmol/L of FPG and their corresponding HbA1c were 8.8% and 9.3% and predicted HbA1c were 7.93% and 8.25% respectively for the study subjects. These results suggested that controlled diabetic subjects had slightly increasing estimated HbA1c level but uncontrolled diabetic subjects had slightly decreasing estimated HbA1c level with corresponding FPG. So the study noted that if the FPG level is known, it will be possible to calculate its predicted HbA1c. But prediction will differ between controlled and uncontrolled group. To our knowledge, it was the first epidemiological study showing the correlation between FPG concentrations and HbA1c levels in our population. These findings will likely benefit the patients and their treating physicians to ensure optimal glycemic control. This has the potential to reduce the overall healthcare expenditures in our country by reducing complication of DM.

Conclusion:

The study showed the prevalence of uncontrolled HbA1c (>7.0%) and FPG (>7.2mmol/L) to be 84.7% and 81.9% respectively based on ADA criteria. The study also concluded that HbA1c level could be predicted from FPG by using regression equation. Large-scale longitudinal study is needed to determine more precisely the relation between HbA1c and FPG.

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