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Original Research Article

A cross sectional study to determine the correlation of blood glucose and HbA1C in type 2 diabetes mellitus patients

Reeta Baishya[1]*, Madhurima Bora[2], Arijit Mazumdar[3]

[1]Department of Physiology, [2]Department of Biochemistry, Kokrajhar Medical College, Assam, India
[3]Physiology Royal School of Medical and Allied Sciences, Guwahati, Assam, India

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***Correspondence:**
Dr. Reeta Baishya,
E-mail: sahariareeta@gmail.com

ABSTRACT

Background: Measurement of glycosylated hemoglobin (HbA1c) is considered the gold standard for monitoring chronic glycemic level of diabetes patients. HbA1c is a form of hemoglobin that is measured primarily to identify the average plasma glucose concentration over prolonged periods of time. Levels of HbA1C represent the average blood glucose levels of diabetic patients over the previous 120 days. The objective of this study was to see the correlation between HbA1c levels and glucose levels.
Methods: This cross-sectional study included 60 randomly selected subjects with known diabetes. Both fasting and post prandial blood glucose levels were measured by using venous blood samples. HbA1c levels were measured in venous blood by immunoturbidimetric method. Data were recorded on a proforma in MS-excel sheet. Pearson's coefficient of correlation was applied to find out any significant correlation between the HbA1c levels and the both fasting and postprandial blood glucose levels.
Results: Results were obtained by statistical calculation and plotted with respect to scatter and bar diagram was done and a $p<0.05$ was considered significant (With 95% CI).
Conclusions: A significant linear positive correlation exists between levels of HbA1C and fasting and post prandial blood glucose.

Keywords: Type 2DM, FBG, PPBG, Glycosylated hemoglobin

INTRODUCTION

Globally, an estimated 422 million adults are living with diabetes mellitus according to latest 2016 data from the world health organization (WHO).[1] The WHO estimated that diabetes resulted 1 million deaths in 2012, making the 8th leading cause of death.[1] The incidence of type 2 diabetes is increasing rapidly; previous 2013 estimates from the international diabetes federation (IDF) put the number at 381 million people having diabetes.[2] The number is projected to almost double by 2030.[3]

Type 2 diabetes makes up about 85-90% of all cases.[4,5] Without timely diagnosis and treatment complications and morbidity from diabetes rises exponentially.[6] However, another 2.2 million deaths worldwide were attributable to high blood glucose and the increased risks of associated complications (e.g., heart disease, stroke, kidney failure), which often result in premature death and are often listed as the underlying cause on death certificates rather than diabetes.[1,7]

In type 1 diabetes, the β-cells of pancreas are destroyed by the autoimmune mechanism. In type 2 diabetes, a resistance to insulin is developed.[8]

Criteria for the diagnosis of diabetes mellitus include one of the following: [9] Levels to label a patient as diabetic:

fasting plasma glucose (FPG) ≥ 126 mg/dL (7.0 mmol/L). Fasting is defined as no caloric intake for at least 8 h, 2 h plasma glucose ≥200 mg/dl (11.1 mmol/L) during an OGTT and HbA1C ≥ 6.5% (48 mmol/mol).

In a patient with classic symptoms of hyperglycemia or hyperglycemic, crisis, a random plasma glucose ≥200 mg/dl (11.1 mmol/L).

Control of plasma glucose in patients with diabetes can be assessed by measurement of glycated hemoglobin (HbA1C), FPG, and postprandial plasma glucose (PPG). However, still measurement of HbA1C level remains the gold standard for assessment of glycemic control at follow up.[10]

Diabetes is caused by an absolute or functional lack of insulin, which leads to increased glucose levels outside the cell. High concentrations of glucose can increase the glycation of common proteins such as hemoglobin, forming Hemoglobin A1C (HbA1C).

However, it is important to note that HbA1C is neither considered dysfunctional nor harmful.[11] Nevertheless, the concentration of HbA1C predicts diabetes complications because it reflects more harmful glycation sequelae of diabetes, such as retinopathy and nephropathy, which are understood to be due to harmful advanced glycation end (AGE's) products.

Hemoglobin A1C is known to correlate with blood glucose levels over the lifetime of the red blood cell, which is approximately 120 days.[12,13] Although red cell survival may show subtle differences between diabetes patients and non-diabetic patients which could be considered, the fundamental understanding is that blood glucose-levels determine HbA1C levels and this underpins the value of HbA1C as the current gold standard for clinical monitoring of diabetes.[14,15]

The ultimate goal of treating a person with diabetes is to prevent the development of complications and thereby improving the quality of life and also increasing their longevity. These complications can be prevented by achieving strict glycemic control. There is considerable evidence from the studies done in the past that achieving glycemic control by reducing the blood glucose levels is instrumental in decreasing the microvascular complications of diabetes namely neuropathy, nephropathy and retinopathy. Every 1% reduction in HbA1c is said to result in more than 35% decrease in risk of microvascular complications and around 20% decrease in the risk of death related to diabetes.[16,17] Early diagnosis of diabetes is essential to prevent its devastating complications.

Aim and objectives

Aim and objective were to estimate the blood glucose level in type 2 diabetic patients, to estimate the HbA1C level in type 2 diabetic patients and to determine the correlation between blood glucose and HbA1C.

METHODS

Study type

The study type was of cross sectional

Study place

Study condicted at Gauhati medical college and hospital, Guwahati.

Period of study

Study carried out from Oct 2021 to Nov 2021.

Criteria for selection of cases and exclusion of cases

Persons with age more than 35 years and less than 70 years were included. Both genders were inclusive in the study cases. The cases were all patients of type-2 diabetes mellitus. The cases excluded were type1 diabetes mellitus patients. Also, those with severe diabetic complications and other systemic diseases were not taken in the ambit of the study. Those patients taking medications other than antidiabetics were not considered. Smokers, alcoholics, pregnant ladies were left out of the study. Patients with xerostomia were not taken in the study and those persons less than 35 years and more than 70 years were not considered.

Procedure

Age and sex matched population of 60 diabetics (Type 2 DM) of 35-70 years of age were included in the study. After taking the consent, both fasting and post prandial blood glucose were estimated. For fasting blood glucose, patient was asked to remain in fasting state for at least 8 hrs (overnight fasting) and 2 ml venous blood was collected. For post prandial blood glucose estimation, 2 ml of venous blood was collected after two hours of taking food.

For estimating HbA1C, 2 ml of venous blood which was collected for analysis of FBG. Five ml of venous blood was collected by venipuncture from medial cubital vein and centrifuged at 3000 rpm. After processing of serum, the blood glucose both FBG and PPBG was estimated using oxidase-peroxidase method.

HbA1C was estimated in the study group by particle enhanced immunoturbidimetric test.

Institutional ethical approval to conduct the study was given by the institutional ethical committee Gauhati medical college and hospital, Guwahati.

Statistical analysis was done using ANOVA in MS-excel.

RESULTS

A total of 60 diabetic patients were included in the study. Minimum age was 35 year and maximum was 70 years with mean age being 59 years. The lowest level of HbA1C was 5.9% and the highest was 11.7% with a mean of 7.6%. The lowest value of fasting blood sugar was 66 mg/dl and highest was 99 mg/dl with a mean of 83.82 mg/dl. The lowest value for post prandial blood sugar was 123 mg/dl and highest value of post prandial blood sugar was 491mg/dl with a mean of 250 mg/dl.

Out of 60 patients 30 were male and 30 were female. The p value for relation between PPBG and HbA1C was $3.73x10^{-18}$ which is less than 0.05 showing a value of statistical significance whereas p values of those between FBG and HbA1C and between FBG and PPBG did not yield statistically significant p values.

The Pearson's coefficient of correlation between the different modalities of measurement of blood sugar as determined showed a positive correlation between all the parameters:

Table 1: The correlation between FBG, PPBG and glycosylated hemoglobin.

Parameters	Values
Correlation between FBG and PPBG	0.10758
Correlation between PPBG and HbA1C	0.859449
Correlation between FBG and HbA1C	0.067623

This shows that rise of one parameter is associated with the increase of the other variable and vice versa as shown in Figures 1-3. Figure 4 and 5 confirms the already established hypothesis as regards T2 DM that the blood glucose rises with increasing age. However, as per modern evidence-based diagnosis and treatment of diabetes individualized approach is the key as evidenced by Figures from 6 and 7 which shows trends towards blood glucose increase in a person-to-person basis and rise of blood glucose values amongst diabetics is not linear and variable pointing towards other factors like social environ and stress being the major factors implicated. In figures 8-10, it depicts that patients who follow the treatment and dietary regulation regime properly have a somewhat proper control of the blood glucose levels. The number of male and female cases were 50% each with persons in private jobs suffering more due to diabetes with age preponderance showing slightly that is age increases the incidence of diabetes increases by almost 60%, but the cases with family history of diabetes were 41% compared to first time diabetics. The dietary habit seems to influence the diabetic cases as non-vegetarians have almost 60% incidence. Interestingly, married persons seems to be affected more compared to unmarried and almost 98% of the cases were married.

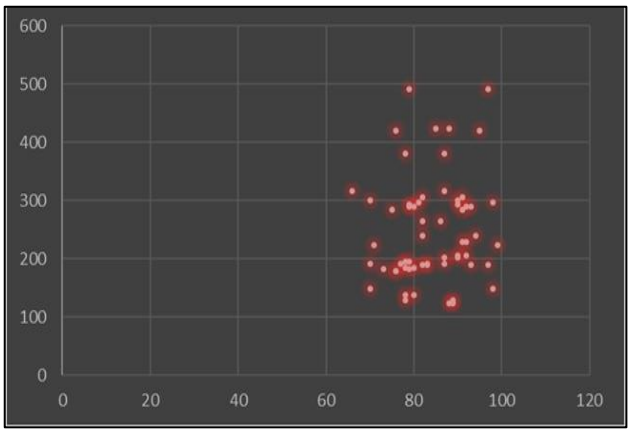

Figure 1: Correlation between FBG and PPBG.

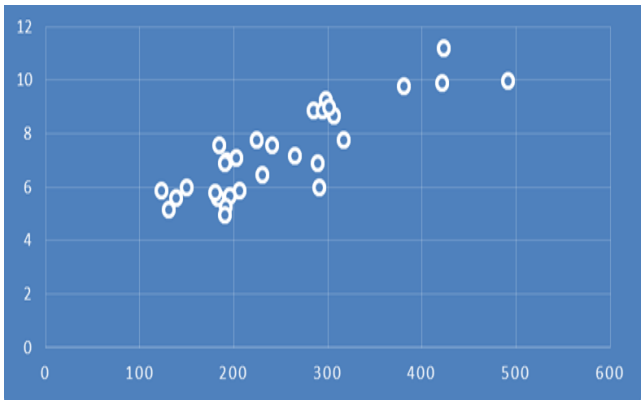

Figure 2: Coefficient of correlation between PPBG and HbA1C.

Figure depicting a positive correlation which is evidenced by rise of PPBG with rise of HbA1C.

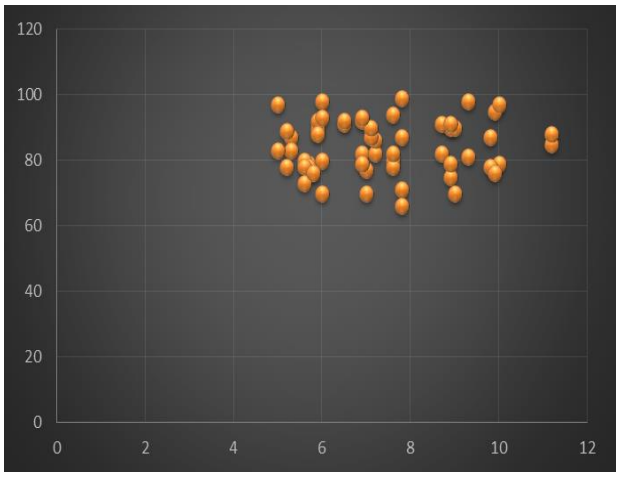

Figure 3: Correlation between FBG and HbA1C.

Figure depicts values of HbA1C and FBG cluttered together showing a positive correlation, that is- rise of one of the values is associated with rise of the other.

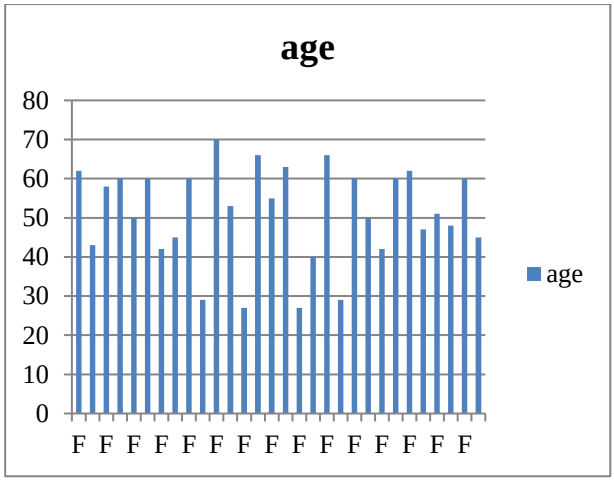

Figure 4: Distribution of age in females.

Trends depict towards rise prevalence of T2DM amongst elderly.

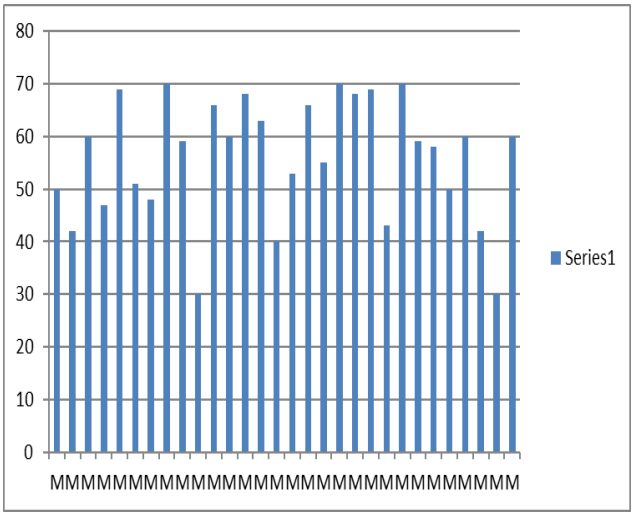

Figure 5: Distribution of age pattern in males.

Trends depicts towards rise prevalence of T2DM amongst elderly.

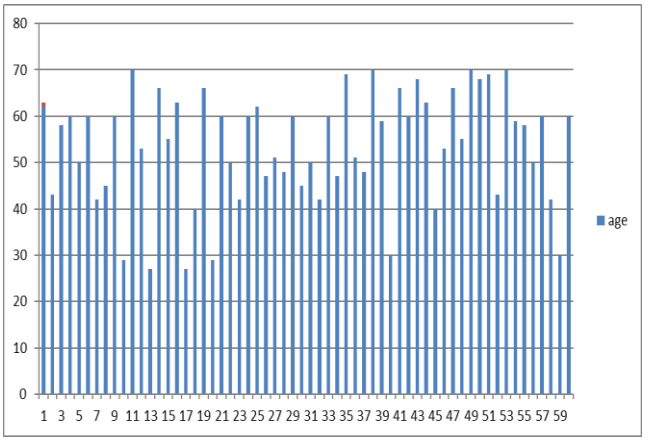

Figure 6: The age distribution of the sample.

it shows trends that age and blood glucose rise is variable and not related linearly.

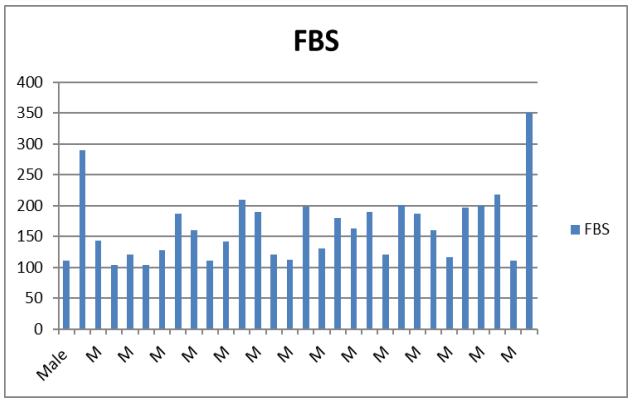

Figure 7: Variability of distribution of fasting blood glucose.

It shows trends that fasting blood glucose rise is variable and not related linearly with increase of age.

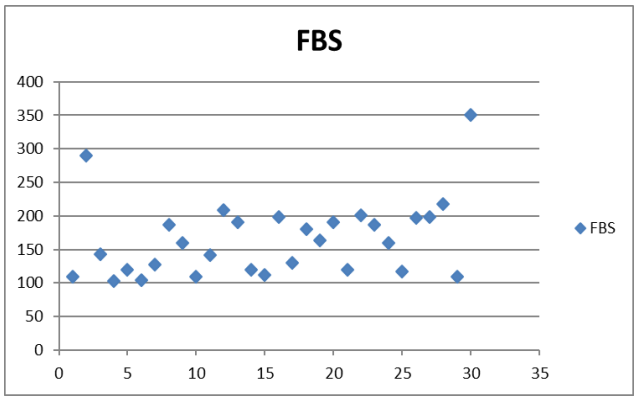

Figure 8: Values of FBG.

Values of FBG somewhat scattered around 130-200 mg/dl in the patients.

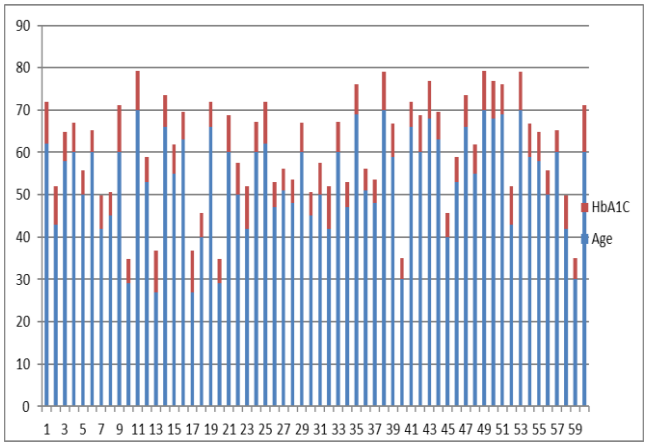

Figure 9: Scatter diagram of HbA1C with age.

This values of HbA1c scattered around 7.5-8%.

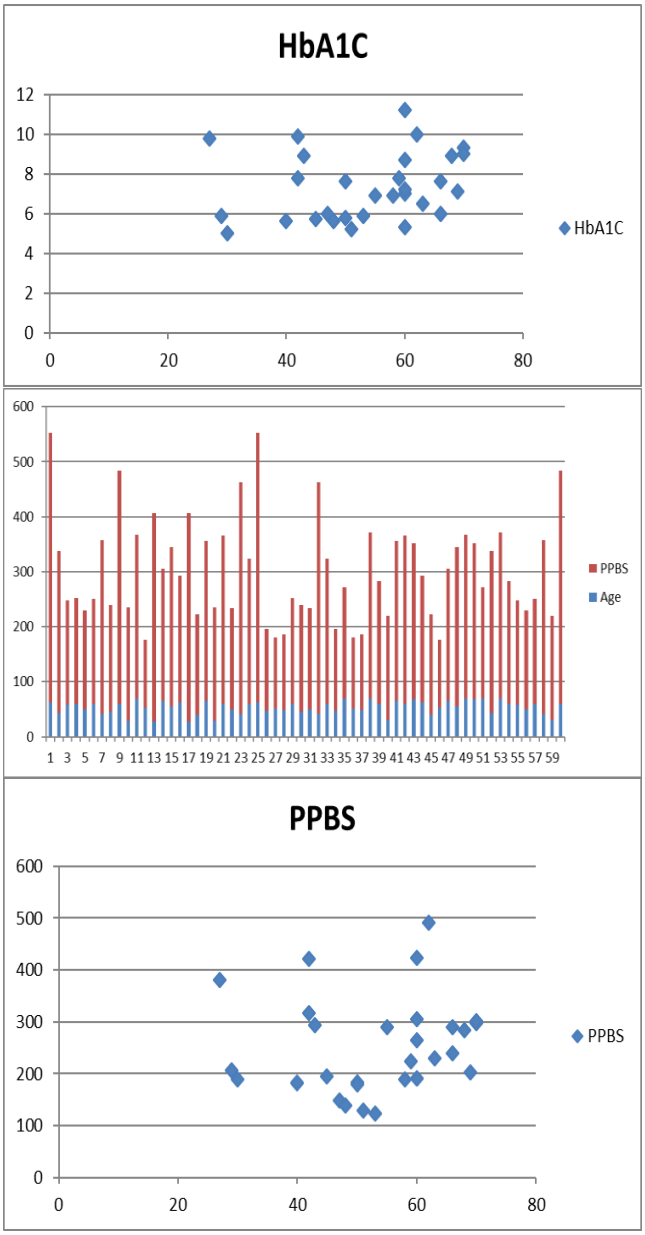

Figure 10: Comparison of PPBG with age.

This shows values of PPBG around 200-300 mg/dl range among the patients of type 2 diabetes.

DISCUSSION

The value of HbA1C as the current gold standard for clinical monitoring of diabetes. The superiority of HbA1C over discrete blood glucose measurements should be acknowledged and may also be extended to diabetes screening and diagnosis.[18] It provides far more revealing information on glycemic behavior than a fasting blood sugar value. However, fasting blood sugar tests are crucial in making treatment decisions. The results of our study showed a significant positive correlation between levels of both fasting and post prandial blood glucose and levels of HbA1C.

Studies done in the past have proved that the FBS levels correlate well with HbA1C. It was even considered that HbA1C was an indicator of FBS levels. According to the American diabetes association, FPG is the diagnostic test for diabetes as the PPBS values are subject to lots of variation like physical activity, the gastric emptying and even the composition of the meals and FBS is a predictor of hepatic gluconeogenesis.[19-21]

There is evidence to suggest that PPBS is a better indicator of development of macrovascular complications, especially the cardiovascular complications.[22]

In few studies it has been found that postprandial glucose levels correlate with HbA1c better than fasting levels.[23,24] In studies when comparing blood glucose levels at specific times of the day with HbA1c levels, showed that postprandial blood glucose values were more closely associated with HbA1c levels.[25-31] However, the strongest correlation was observed between HbA1c and mean plasma glucose levels.

Limitations

Maintenance of good glycaemic control plays a very important role in preventing the development of complications related to diabetes, thus improving the quality of life of diabetic patients. The glycaemic control of a person can be assessed with reasonable accuracy using HbA1C. However, this method has got its own limitations in that it is more expensive than the conventional FBS and PPBS estimations and that the method requires proper standardization to be reliable. It also has its own advantages in that the sample collection for this test doesn't cause much inconvenience to the patient as it only requires a random sample that can be collected any time, unlike FBS and PPBS samples that have to be collected at specified periods of time. If HbA1C cannot be estimated due to limited resources, FBS and PPBS estimations can be done.

CONCLUSION

Both the fasting and post prandial blood sugar levels and HbA1C have a significant positive correlation and can give a clear idea about glycemic control in the past three months and hence can be used as a preferred method to assess glycemic control in diabetics.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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