Original Research Paper Biochemistry CORRELATION BETWEEN HBA1C AND BLOOD SUGAR LEVELS: CAN FBS OR PPBS REPLACE HBA1C FOR MONITORING GLYCEMIC CONTROL IN ITS ABSENCE

Akanksha Dubey	Bhopal MP	
Dr P. J. Hisalkar*	Professor and HOD, Dept of Biochemistry, Government Medical College and Hospital Dungarpur, Rajasthan *Corresponding Author	
Dr Neerja Mallick	Professor & Registrar, People's University Bhopal	

**ABSTRACT Background:** India leads the world with the largest number of Diabetic subjects, hence can be called as Diabetic Capital of World. Diabetes is a serious, chronic disease that occurs due to defects in insulin secretion or insulin action or may be both. Optimal glycemic control is fundamental and still is the main therapeutic objective for the managing and prevention micro and macrovascular complications arising from diabetes that can impact on quality of life. The main objective of the study is to identify correlation between above three parameters and Glycemic Control.

Methods: Total 500 subjects were studied which were divided into two groups of 250 each as cases and controls after defining proper inclusion and exclusion criteria.

**Results:** The result shown that cases have significantly elevated FBS PPBS and HbA1C when compared to age and sex matched healthy controls with p<0.0001. We also identified Pearson correlation among parameters, FBS and HbA1C found to be strongly correlated as compared to PPBS and HbA1C.

**Conclusion:** We can conclude that in developing countries like India where estimation of Glycated Hemoglobin is not financially possible FBS can be used as better parameter for Glycemic Control. Although both FBS and PPBS can show Glycemic control.

**KEYWORDS** : Type 2 Diabetes Mellitus, HbA1C, Glycemic Control

# Introduction:

India leads the world with largest number of Diabetics subjects hence can be called as Diabetic capital if World. Diabetes Mellitus was described as honey urine disease in Ancient Indian literature which is associated with gross emaciation and wasting. Glycemic control is the most important aspect in management of Diabetes. Many research studies have demonstrated importance of monitoring glycemia because there is positive direct relationship between blood sugar level and progression of diabetic control.<sup>1,2</sup> It is most important factor in reducing morbidity and mortality of the disease. The chronic hyperglycemia involved damage, dysfunction and multiorgan failure mainly eyes, kidneys, nerves, heart and blood vessels.<sup>3</sup>

Earlier articles and research studies have shown that achieving hypoglycemia or glycemic control can decrease chances of macrovascular and microvascular complications of Diabetes.<sup>4-6</sup> Glycemic control can be assessed by FBS, PPBS and Glycated Hemoglobin(HbA1C). However measuring HbA1C is still a Gold Standard for glycemic control at follow up.Hemoglobin A1c is a term used to describe a series of stable minor hemoglobin components formed slowly and non-enzymatically from hemoglobin and glucose. The clinical utility of HbA1c as a tool to assess the risk of diabetes complications was confirmed by the publication of the results of the Diabetes Control and Complications Trial (DCCT) and also the United Kingdom Prospective Diabetes Study<sup>10</sup> The concentration of HbA1C can be correlated with complications of Diabetes because it reflects formation of advances glycation end products.

Epidemiological and large randomized clinical trial studies such as Diabetes Control and Complication Trial (DCCT) and the United Kingdom Prospective Diabetes Study (UKPDS) indicated that HbA1c >7.0 % is associated with a significantly increased risk of both microvascular and macrovascular complications, regardless of underlying treatment.<sup>457</sup> HbA1C reflects overall glucose exposure for last 2-3 months even when FBS and PPBS levels are undefined.<sup>89</sup> But HbA1C test is not available everywhere due to its cost then especially in developing countries FBS and PPBS are used a parameter to define glycemic control.<sup>6</sup>Several research studies have shown positive correlation b/w FBS and PPBS with HbA1C.The main objective of this study is to find correlation of blood sugar level with HbA1C if any. So that, this will help to identify marker for glycemic control status in a better way.

Need for the study: Over the decades, the diabetics have become doubled globally, making it most important public health challenge for all the nations. The severity of disease and associated complications demands for following study. Important objectives of study:

- To compare efficiency of FBS, PPBS and HbA1C in diagnosis of diabetes.
- b) To derive correlation b/w FBS, PPBS and HbA1C
- c) To ensure parameter can be used in absence of HbA1C as a marker of glycemic control.

## Material and methods:

This study was conducted in Peoples College of Medical Sciences and Research Center Bhopal and associated People's Hospital Bhopal. Total 500 subjects included in this study were divided into 2 groups:

- Group I: included 249 normal healthy individuals, who were in the age group 25-70 years, of either sex and without any family history of diabetes mellitus.
- Group II: included 250 diagnosed patients of type 2 DM in the same age group i.e., 25-70 years.

**Inclusion criteria:** Type-2 DM diagnosed on the basis of the ADA 2015 guidelines were included in the study.

Criteria for diabetes diagnosis: 4 options

**A1C** ≥**6.5%**\* Perform in lab using NGSP-certified method and standardized to DCCT assay

**FPG**  $\ge$  **126 mg/dL (7.0 mmol/L)**\* Fasting defined as no caloric intake for  $\ge$ 8 hours

2-hour PG ≥200 mg/dL (11.1 mmol/L) during OGTT (75-g)\* Performed as described by the WHO, using glucose load containing the equivalent of 75g anhydrous glucose dissolved in water

Random PG ≥200 mg/dL (11.1 mmol/L) In persons with symptoms of hyperglycemia or hyperglycemic crisis

Exclusion criteria: Type 1 DM, congestive heart failure, tuberculosis, gout, rheumatoid arthritis, renal failure and those who were on hypoglycemic drugs and on insulin therapy were excluded from the study.

Fasting blood samples (FBS), 2 hour Post prandial (PP), Random blood sugar (RBS), HbA1C, were analysed on Roche Cobas C311

Test	Bulb	Method
Fasting plasma glucose (FBS)	Fluoride	GOD-POD method
Post-meal plasma glucose (PPBS)	Fluoride	GOD-POD method
Glycosylated hemoglobin (HbA1C)	EDTA	Immunoturbidemetric method

Statistical analysis of data: All data were expressed as Mean  $\pm$  SD. Statistical analysis was done using unpaired students t test. A level of p value <0.05 was used to indicate statistical significance in all analyses. The correlation between the parameters was carried out using Pearson's correlation.

# **Result:**

The comparison of 250 controls with 250 cases has been shown in following tables:

#### Table 1 comparison of various parameters of controls and cases.

S.No	Parameters	Controls	Cases	P value
1.	No of subjects	249	249	-
2.	Age	51.93±16.96	56.96±12.99	-
3.	FBS	99.37±14.59	194.9±51.6	<0.0001
4.	PPBS	151±15.17	298.3±56.36	<0.0001
5.	HbA1c	5.5±0.47	8.76±2.09	<0.0001

#### Table 2 comparison of various parameters of Male controls and Male cases.

S.No	Parameters	Controls Male	Cases Male	P value
1.	No of subjects	150	150	-
2.	Age	53.94±17.19	58.25±13.30	-
3.	FBS	94.4±14.2	187.5±47.3	<0.0001
4.	PPBS	149.5±17.4	295.5±40.4	< 0.0001
5.	HbA1c	5.64±0.47	8.64±2.15	<0.0001

Table 2 comparison of various parameters of Female controls and Female cases.

S.No	Parameters	<b>Controls FeMale</b>	Cases FeMale	P value
1.	No of subjects	99	99	-
2.	Age	48.8±16.2	55.0±12.32	-
3.	FBS	106.7±11.8	206.1±55.7	<0.0001
4.	PPBS	153.3±10.4	302.7±74.6	<0.0001
5.	HbA1c	5.34±0.41	8.94±1.98	<0.0001

The Pearson correlation b/w FBS and HbA1C was 0.956 ( $r^2 = 0.914$ ) which was higher than PPBS and HbA1C but both were significantly correlated.

### **Discussion:**

People with diabetes have greater risk of developing number of major health problems. Proper glycemic control is the best strategy to prevent and delay the progression of diabetes complications and improve quality of life. Many studies have demonstrated positive correlation b/w HbA1C and duration of diabetes mellitus, and it is a good predictor of diabetic complications. HbA1C plays important role in determining random hyperglycemia, fasting sample is not required and it is not affected by recent food intake and blood sugar levels. Many research studies have demonstrated that it has pre-analytical stability and less effect of stress or illness.

In our study mean HbA1C was significantly higher in cases as compared to controls. FBS and PPBS values in cases were also elevated significantly when compared to controls. We have also compared FBS and PPBS on gender basis and results were significant in terms of stats.

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A community based study demonstrated that HbA1C more than 5.7 may have risk of developing diabetes and its complications. Hence individuals with HbA1C 5.7-6.4 % can be considered for risk of developing diabetes in near future and they can be called as prediabetic. Hba1c is very much familiar marker of hyperglycemia to clinicians. Moreover it has several advantages over FBS/PPBS.

We have also derived Pearson correlation b/w HbA1C and FBS, HBA1C and PPBS amongst cases and controls. Both showed positive correlation however FBS and HbA1C have strong positive correlation than PPBS and HbA1C. Similar findings were reported by:

Prof K Goswami conducted a study to correlate HbA1c with eAG on 204 subjects and found strong positive correlation b/w FBS and eAG ie FBS and HbA1c. The study conclude that HbA1c and FBS have  $r^2$  0.379<sup>11</sup>.

The study of Mirza Asif Baig demonstrated that HbA1c can be used effectively for diagnosis of type 2 DM and can be be used to predict complications of Diabetes. It is better parameter than FBS and PPBS.<sup>12</sup>.

Wei-Yen Lim studies test performance of HbA1c compared to FBS on 3540. Residents of Singapore and draws conclusion that HbA1c is an appropriate alternative to FBG as a first step screening test.<sup>13</sup>

Study conducted by Shubham Gupta has also shown that FBG appreciably contributes as compared to PPBS. The study involved 50 cases of type 2 diabetes without any complications.  $^{\rm 14}$ 

Study carried out by Mohammad Haghithpanah, including 633 cases profiles shown that there is significant correlation b/w PPBS and HbA1c. However they later concluded that their study demonstrated that FBS and PPBS have positive correlation with HbA1c<sup>15</sup>

Our study was not in concordance with Ezra Belay Ketema et al conducted meta-analysis of 11 articles in 2015 and evaluated correlation b/w fasting and post prandial blood glucose and HbA1C. Out of which 7 articles mean 63.5% have stronger or better correlation b/w PPBG and HbA1C rather than with FBS. Pooled correlation coefficient b/w PPBS and HbA1C was 0.68 which is higher than FBS i.e. 0.61. This study draws conclusion that PPBS is better in predicting overall glycemic control in absence if HbA1C.<sup>16</sup>

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