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The association between estimated average glucose levels and fasting plasma glucose levels in a rural tertiary care centre

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ABSTRACT

The level of hemoglobin A1c (HbA1c), also known as glycated hemoglobin, determines how well a patient's blood glucose level has been controlled over the previous 8-12 weeks. HbA1c levels help patients and doctors understand whether a particular diabetes treatment is working and whether adjustments need to be made to the treatment. Because the HbA1c level is a marker of blood glucose for the previous 60- 90 days, average blood glucose levels can be estimated using HbA1c levels. Aim in the present study was to investigate the relationship between estimated average glucose levels, as calculated by HbA1c levels, and fasting plasma glucose levels. Methods: Type 2 diabetes patients attending medicine outpatient department of RL Jalappa hospital, Kolar between March 2010 and July 2012 were taken. The estimated glucose levels (mg/dl) were calculated using the following formula: 28.7 x HbA1c-46.7. Glucose levels were determined using the hexokinase method. HbA1c levels were determined using an HPLC method. Correlation and independent t- test was the test of significance for quantitative data. Results: A strong positive correlation between fasting plasma glucose level and estimated average blood glucose levels (r=0.54, p=0.0001) was observed. The difference was statistically significant. Conclusion: Reporting the estimated average glucose level together with the HbA1c level is believed to assist patients and doctors determine the effectiveness of blood glucose control measures.

Keywords: HbA1c, Glycated hemoglobin, Diabetes mellitus, glucose control

INTRODUCTION

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.[1-2] 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.[3] Therefore, clinicians use HbA1c test results to guide treatment decisions, and the test has become the cornerstone for assessing diabetes care.[4]

Various analytical methods based on different assay techniques, such as ion-exchange chromatography, affinity chromatography, immunoassays and electrophoresis, have been used to measure glycated hemoglobin levels.[5] Results can vary considerably when measured by different laboratories or methods. Several years ago, the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) developed a new reference method that specifically measures the concentration of a single molecular species of glycated A1c[4]. However, the new method

results in values that are 1.5%-2.0% lower than current values, and the results are expressed in different units (mill moles per mole of unglycated hemoglobin), which may cause for patients and health care providers.[6]

The relationship between the mean blood glucose level and the level of HbA1c has been investigated in different studies, and various equations have been obtained.[2,7& 8] Using Nathan's regression equation, which has been recommended by the American Diabetes Association (ADA) , the estimated average glucose (eAG) level calculation and its relationship to the fasting plasma glucose (FPG) level were investigated in the present study.

MATERIALS AND METHODS

This cross sectional study was done in R L Jalappa hospital attached to Sri Devraj Urs Medical College, Kolar. Type 2 diabetes patients attending medicine outpatient department of RL Jalappa hospital, Kolar between March2010 to July 2012 were included in the study. Institutional ethical committee clearance was taken and informed consent was obtained from patients. All the patients were interviewed with pre-designed and pre-tested Proforma.

The study group was selected from patient samples that had hemoglobin levels between 12 and 16 g/dl , because HbA1c results can be influenced by several factors, including anemia. In addition, samples from patients with hemoglobin abnormalities or uremia or who were pregnant were excluded. The estimated glucose levels (mg/dl) were calculated using the following formula: 28.7 x HbA1c-46.7 [6.] According to the patients levels of blood glucose control, we divided the samples into three groups: Group A: FPG<126mg/dl; group B: FPG =126-200mg/dl and group C: FPG >200mg/dl. Glucose levels were determined using the hexokinase method. HbA1c levels were determined using an HPLC method. Hemoglobin (Hb) levels were determined using a Beckman Coulter Gen S System (Beckman Coulter Inc., Fullerton, CA, USA).

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS, version 11.0). Data were expressed as the mean ± standards error of the mean (SEM). A p-value <0.05 was accepted as significant. The Pearson correlation coefficient was used to test the correlation between the FPG and eAG levels, and independent t-test was used to find the difference between male and female.

RESULTS

The study group consisted of 1075 individuals with a mean age 53.83±.7 ranging from 33 to 73 years old **(Table 1)**. The mean FPG, eAG, HbA1c and Hb levels are presented in **Table 1**. A strong positive correlation was found between FPG and eAG levels (r= 0.54, P= 0.0001).

Table 1 The levels of the glycemic parameters and the correlation coefficients for all groups (Mean ±SEM)

Parameters	Entire Group	Group A FPG <126 mg/dl	Group B FPG 126-200 mg/dl	Group C >200 mg/dl
N	1075	652	237	186
Age (yr)	53.83±.716	54.58±.916	53.34±1.398	51.84±1.82
FPG (mg/dl)	135.009±4.4	88.20±1.4	159.3±2.86	268±7.7
eAG (mg/dl)	196.10±6.42	152.10±4.02	241.58±19.68	292.39±12.4
Hb (g/dl)	13.74±1.66	13.58±.206	13.88±.272	14.13±.518
HbA1c (%)	8.46±.224	6.92±.14	10.04±.68	11.81±.432
FPG Vs eAG	r = 0.54	r= 0.382	r= 0.113	r= 0.011

There was positive significant correlation between FPG and eAG levels for entire study group (p= 0.0001).

When the data was split based on FPG it was observed that Group A and Group C showed positive correlation with eAG. Group B showed no significant correlation. Higher eAG levels were found in group C i.e. when FPG was >200mg/dl.

Table 2 A comparison of the glycemic parameter levels in males and females (mean±SEM)

	Male	Female	p-value
N	667	408	-
Age (yr)	54.63	52.53	.005
Hb (g/dl)	14.44	12.60	.0001
FPG (mg/dl)	136.65	132.31	.344
eAG (mg/dl)	196.56	195.35	.856
HbA1c (%)	8.47	8.43	.856

The mean levels of FPG, eAG, HbA1c and Hb were higher in males than in females **(Table 2)**. There was no significant difference between males and females with respect to eAG, FPG and HbA1c using independent t-test, i.e. No gender difference for the following variables.

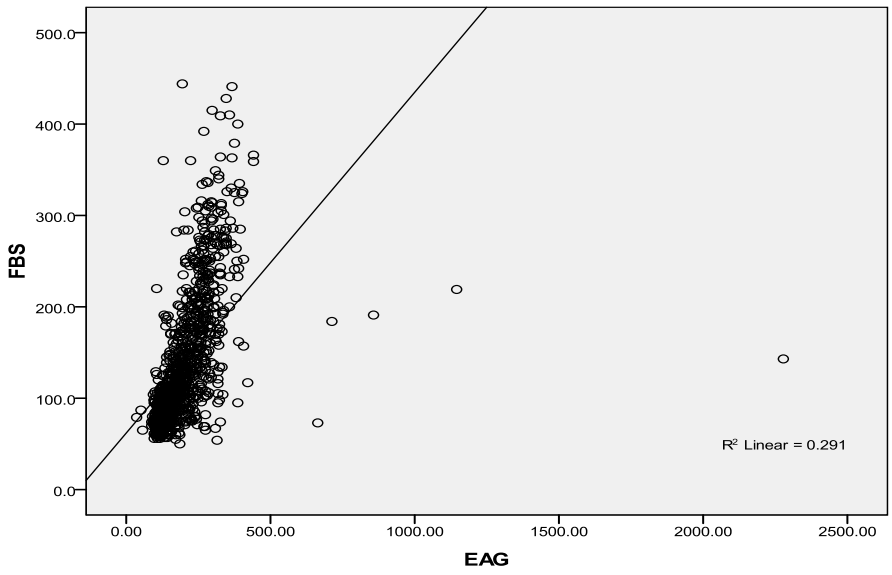

Figure 1 Scatter-plot of FPG Vs eAG in the whole group

DISCUSSION

The HbA1c measurement is used to determine the average level of glycemic control over the previous 8-12 weeks; this measurement is accepted as a gold-standard measurement of chronic glycemia.[9]The ADA, and the European Association for the Study of Diabetes (EASD) and the International Diabetes Federation (IDF) sponsored an International study to define a mathematical relationship between HbA1c and the eAG level.[6] The following formula describes this relationship: 28.7xHbA1c-46.7= eAG. This formula

will assist health care providers and their patients see regularly self-monitoring.[6]

The HbA1c test is subject to certain limitations. Conditions that affect erythrocyte turnover (hemolysis, blood loss) and hemoglobin variants must be considered, particularly when the A1c results does not correlate with the patients clinical situation.[10]

The American Diabetes Association and American Association of Clinical Chemists have determined that the correlation (r=0.92) is strong enough to justify reporting both an HbA1c result and an estimated average glucose (eGA) result when the clinician order the HbA1c test.[11] In the ADAG trail, there were no significant differences among racial and ethnic groups in the regression lines between A1c and eAG[12]

Using this formula, we calculated the eAG levels of our study group and investigated their relationship with the FPG levels. The eAG levels were positively correlated with the FPG levels. On the other hand, most patients who come to the clinic for plasma glucose determination pay more attention to fasting and diet rules. The eAG levels in the study group were higher than the FPG levels not only because patients come to the lab in a fasting state but also because the eAG level is reflective of all plasma glucose levels over the previous three months, including the postprandial glucose levels.

Among the study group, females had lower eAG and FPG levels than males (Table 2). The of eAG, FPG and HbA1c in women were not significant from males. It is observed that diabetic patients require better strategies to improve self-management[13]. One of these strategies is the use of eAG levels together with HbA1c values. Although the clinical usefulness of eAG is not clear by Lesile RD et.al. and Rodriguez-Segade S et al.[14,15,] This study suggest that every patient's eAG level should be calculated and reported along with his or her HbA1c level. This strategy will help patients better understand the importance of keeping their blood glucose levels within acceptable limits and may rescue them from invasive approaches for glucose homeostasis.[16]

CONCLUSION

The study concludes that, there is a positive correlation between eAG and FPG, hence reporting the estimated average glucose level together with the HbA1c level is believed to assist patients and doctors determine the effectiveness of blood glucose control measures.

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