Section: General Medicine

Original Research Article

ASSOCIATION OF Hba1c WITH RAISED POST-PRANDIAL PLASMA GLUCOSE LEVEL AMONG DIABETES PATIENTS IN A TERTIARY CARE HOSPITAL

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Abstract

Background: Diabetes mellitus is a metabolic disorder that results in elevated blood glucose levels. India has the highest diabetes prevalence in the world, with type 2 diabetes accounting for 90%-95% of all cases. The study aims to investigate the association between HbA1c (glycated hemoglobin) levels and raised post-prandial plasma glucose levels in diabetes patients. **Materials and Methods:** The study included 218 permanent resident T2DM patients aged 30 years and above, excluding those with Type 1 DM, comorbidities, or unwillingness to participate. Electronic data capture software was used to collect data on demographic and behavioral factors. Various measurements were taken, including anthropometric measurements, blood pressure readings, and several blood and urine tests. **Result:** This study included 218 patients, mostly male, with a normal body mass index and diagnosed with diabetes for 6-10 years. The Pearson correlation coefficients revealed that blood sugar levels were positively correlated with HbA1c levels with fasting blood glucose (FBS). Post-prandial Blood Sugar (PPBS) showed a strong positive correlation, and Random Blood Sugar (RBS) showed a moderately strong positive correlation. Regression analysis overall model was statistically significant, with an R-squared value of 0.538. **Conclusion:** Blood sugar levels are important predictors of HbA1c levels in individuals with diabetes, and FBS and PPBS may be better predictors than RBS. The findings suggest that monitoring blood sugar levels, particularly FBS and PPBS, is crucial in managing diabetes and reducing the risk of complications. Additionally, the age and duration of diabetes should also be considered when predicting HbA1c levels.

INTRODUCTION

Diabetes mellitus (DM) is a metabolic disorder with elevated blood glucose levels. There are various types of diabetes, including type 1, type 2, maturity-onset diabetes of the young (MODY), gestational diabetes, neonatal diabetes, and secondary causes linked to endocrine disorders, steroid use, and other factors. Between 1980 and 2014, the proportion of adults aged 18 and above with diabetes increased from 4.7% to 8.5% globally.[1,2] In India, diabetes is 8.8%, making it the country with the highest diabetes prevalence globally, earning it the title of the "diabetes capital." Type 2 diabetes accounts for 90-95% of all diabetes cases and is primarily diagnosed in adults. Unfortunately, it is believed that as many as one-third of individuals with type 2 diabetes are undiagnosed, leading to a higher risk of developing complications. As a result, early identification and treatment are critical for preventing complications.[3]

In the 21st century, the American Diabetes Association recommended using glycated hemoglobin (HbA1c) as an alternative to glucose tolerance testing for diagnosing and monitoring diabetes and prediabetes. HbA1c is a type of hemoglobin that indicates the average plasma glucose concentration over the preceding three

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months. HbA1c levels are crucial in routine diabetes management because they measure long-term glycemic control and predict the risk of complications. With the improvement in the test's accuracy, HbA1c levels are increasingly used in diabetes diagnosis.[4]

To diagnose type 2 diabetes, medical professionals rely on laboratory tests such as FBS, PPBS, RBS, and HbA1C. The FBS test requires a period of no food intake for at least 8 hours, and a reading of FBS ≥126 mg/dl (7.0 mmol/l) indicates diabetes. An Oral Glucose Tolerance Test (OGTT) is used to measure PPBS, with a plasma glucose reading of PPBG ≥200 mg/dl (11.1 mmol/l) at the two-hour mark indicating diabetes. HbA1C levels are also used to diagnose diabetes, with a reading of 6.5% or higher indicating the presence of the disease. These tests are important in detecting and managing type 2 diabetes.[5]

The existing literature has produced mixed findings regarding the correlation between HbA1C levels and fasting blood glucose (FBS). Some studies suggest a stronger correlation with post-prandial blood glucose (PPBS). As a result, there is uncertainty about the reliability of HbA1C, FBS, and PPBS to monitor glycemic control. This current study investigates the correlation between HbA1C, FBS, and PPBS and determines their usefulness in evaluating glycemic control.

MATERIALS AND METHODS

The study was conducted at a tertiary care hospital on 218 T2DM patients.

Before the study, we obtained institutional ethical approval, and all individuals who met the eligibility criteria and provided informed consent were selected.

Inclusion criteria

All T2DM patients above 30 years of age and permanent residents were included in the study.

Exclusion criteria

Patients with Type 1 DM, unwilling to participate, and other comorbidities such as alcoholism, hypertriglyceridemia, hemoglobinopathy, and vitamin B-12 deficiency were excluded.

Data on demographic and behavioural factors were collected using electronic data capture software. Anthropometric measurements, blood pressure readings, CBC, FBS, PPBS, RBS, HbA1C, urine routine, C peptide assay, serum calcium, serum phosphorous, serum lipid profile, RFT, serum electrolytes, urinary albumin-creatinine ratio, eGFR, ECG, and USG abdomen were also recorded. We collected data using Microsoft Excel and analyzed it using SPSS 22. Percentage analysis was used for categorical variables, and Pearson's correlation was used to assess the relationship between the variables.

RESULTS

The study participants are mostly middle-aged and older, with the largest group (60 participants) falling between 41-60. The majority of participants were male (127) and had a normal body mass index (191), while only a small percentage were overweight (14) or obese (8). Most participants had been diagnosed with diabetes for 6-10 years (113) and received treatment through lifestyle modifications. Oral hypoglycemic agents (OHA), either as monotherapy (42), dual therapy (101), or triple therapy (61). A few participants also received insulin therapy combined with OHA (6).

Table 1: shows the count and percentage of participants in each age group, gender, BMI category, diabetes duration, and treatment type.

		Count	Row N %
Age group	<30	3	100.00%
	31-40	46	100.00%
	41-50	60	100.00%
	51-60	79	100.00%
	61-70	18	100.00%
	>71	12	100.00%
Gender	Female	91	100.00%
	Male	127	100.00%
BMI	Underweight	5	2.3%
	Normal weight	191	87.6%
	Overweight	14	6.4%
	Obese	8	3.7%
Diabetes Duration	Newly diagnosed	23	100.00%
	<5	59	100.00%
	6-10	113	100.00%
	>11	23	100.00%
Treatment	Lifestyle modifications	8	100.00%
	Lifestyle modifications + Monotherapy	42	100.00%
	Lifestyle modifications + Dual therapy	101	100.00%
	Lifestyle modifications + Triple therapy	61	100.00%
	Lifestyle modifications + Insulin Therapy +OHA	6	100.00%

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Table 2 shows the Pearson correlation coefficients and p-values for the association between HbA1C and FBS, PPBS, and RBS.

		HbA1C %
FBS mg/dl	Pearson Correlation	.675**
	p-value	<0.0001
PPBS mg/dl	Pearson Correlation	.692**
	p-value	<0.0001
RBS mg/dl	Pearson Correlation	0.591
	p-value	<0.0001

The Pearson correlation coefficients indicate a positive relationship between blood sugar levels (FBS, PPBS, and RBS) and HbA1C levels in individuals with diabetes. Specifically, there is a strong positive correlation between FBS and HbA1C ($r = 0.675$, $p < 0.0001$), a strong positive correlation between PPBS and HbA1C ($r = 0.692$, $p < 0.0001$), and a moderately strong positive correlation between RBS and HbA1C ($r = 0.591$, $p < 0.0001$). However, the relationship between RBS and HbA1C is not as strong as between FBS/PPBS and HbA1C.

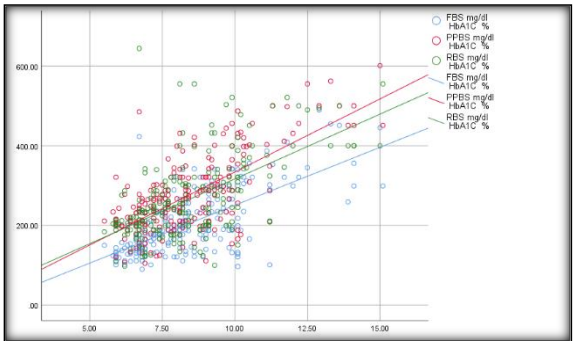

Figure 1: Regression analysis for testing association between HbA1C and FBS, PPBS, and RBS.

The multiple regression analysis aimed to predict HbA1c levels from FBS, PPBS, RBS, age, and duration of diabetes. The overall model was statistically significant ($F=49.444$, $p<0.0001$), with an R-squared value of 0.538. FBS, PPBS, age, and duration of diabetes were found to be significant predictors of HbA1c levels ($p<0.05$). However, RBS was not a significant predictor.

DISCUSSION

The study revealed that the majority of people with diabetes were in the middle-aged and older adult age groups, with around 60 participants in the 41-50 years age group and 79 participants in the 51-60 years age group. These results support the previous research conducted by Mohammadi et al,[6] which reported a mean age of 44, and Farrukh et al,[7] which found a mean age of 50.11 ± 11.18 years. According to a study conducted by Nordstrom et al,[8] in the past, the prevalence of type 2 diabetes was found to be 14.6% among males and 9.1% among females, with a statistically significant difference ($P < .001$). Our study aligns with these findings, with 127 (58.25%) males and 91 (41.75%) females included in the sample.

The present study found that most participants had a normal body mass index, suggesting they managed their diabetes through lifestyle changes or medication or that the study involved a relatively healthy population. Additionally, a network meta-analysis of randomized controlled trials indicated that lifestyle modifications were effective in reducing the onset of type 2 diabetes, at least as much as other treatments, and more effective than standard and placebo interventions for diabetes.[9,10] It is also noteworthy that most participants received treatment through lifestyle modifications and oral hypoglycemic agents, which aligns with current guidelines for managing type 2 diabetes. The small number of participants receiving insulin therapy in combination with OHA may reflect the fact that this treatment is generally reserved for more advanced cases of diabetes or those who have failed to achieve glycemic control with other treatments.[11]

Diabetes Mellitus is associated with various complications such as cardiovascular diseases, neuropathy, retinopathy, and nephropathy, primarily caused by persistent hyperglycemia. Therefore, monitoring glucose levels is essential in treating type 2 DM. Studies conducted in clinical trials have demonstrated that reducing elevated levels of HbA1c can effectively decrease the incidence of complications related to microvessels. Common pathological tests for diagnosing hyperglycemia include random blood glucose, fasting blood glucose, HbA1c levels and post-meal blood glucose.[12,13]

HbA1c is a dependable indicator of chronic hyperglycemia in diabetes management due to its many benefits. Unlike plasma glucose levels, it does not necessitate fasting, provides information on glycemia over an extended period, and employs consistent and trustworthy laboratory diagnostic techniques. Additionally, measurement errors are infrequent. Chronic hyperglycemia results in glycation of various proteins, including HbA1c. Non-enzymatic binding of glucose moieties to haemoglobin causes this process. This represents the average mean glucose level over the previous 8-12 weeks, which is the lifespan of a red blood cell.

Our study found a significant positive correlation between HbA1c and PPBS $r = 0.692$, $p < 0.0001$), which is consistent with the findings of Swetha et al.[14] Interestingly, the correlation between HbA1c and PPBS was slightly stronger than that of FBS and HbA1C ($r = 0.675$, $p < 0.0001$), as observed in both our study and that of Swetha et al.[14] Additionally, studies by Ketema et al,[3] and Rosendiani et al,[15]

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reported a stronger correlation between PPBS and HbA1c compared to FBS and HbA1c. A moderately strong positive correlation between RBS and HbA1C ($r = 0.591$, $p < 0.0001$). Our finding is similar to the finding of Vittal et al., who showed a significant correlation between RBS and HbA1c with Pearson's Correlation coefficients (r) 0.7005.[16] The results of the multiple regression analysis indicate that FBS, PPBS, age, and duration of diabetes are significant predictors of HbA1c levels, while RBS is not a significant predictor. These findings are consistent with previous studies that have shown FBS, PPBS, and age to be important predictors of HbA1c levels in individuals with diabetes.[17,18]

The importance of monitoring and managing FBS and PPBS levels in diabetes management has been well-established in the literature. High FBS and PPBS are associated with poor glycemic control and may increase the risk of complications such as retinopathy, nephropathy, and cardiovascular disease. Similarly, age and duration of diabetes are important predictors of HbA1c levels, with older age and longer duration of diabetes being associated with poorer glycemic control.[19,20]

Limitation

The limitations of the current study are small and not diverse sample size. The lack of information about dietary habits and exercise routines may confound the relationship between blood sugar and HbA1c levels. Additionally, the correlation design of the study cannot establish causality.

CONCLUSION

In individuals with diabetes, blood sugar levels are vital indicators of HbA1c levels, and both FBS and PPBS may be better predictors than RBS. Effective management of diabetes and reducing the risk of complications requires close monitoring of blood sugar levels, particularly FBS and PPBS. It is also important to consider the age and duration of diabetes when predicting HbA1c levels.

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