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ASSOCIATION BETWEEN GLYCATED HEMOGLOBIN (HBA1C) AND FASTING BLOOD GLUCOSE LEVELS IN PATIENTS WITH TYPE 2 DIABETES MELLITUS IN PESHAWAR: A CROSS-SECTIONAL STUDY

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Abstract

Type 2 Diabetes Mellitus (T2DM) is a major metabolic disorder requiring effective assessment of glycemic control. Fasting blood glucose (FBS) reflects blood glucose levels at a specific point in time, whereas glycated hemoglobin (HbA1c) provides an indication of longer-term glycemic exposure. Understanding the relationship between FBS and HbA1c is particularly important in settings where HbA1c testing may be less accessible or more costly. This study aimed to determine the association between fasting blood glucose and HbA1c levels among patients with Type 2 Diabetes Mellitus attending Sugar General Hospital, Hayatabad, Peshawar. It also aimed to determine whether FBS significantly predicts HbA1c and to assess whether age and gender influence or moderate this relationship. A hospital-based, cross-sectional observational study was conducted among 385 adult patients with Type 2 Diabetes Mellitus aged 30 years and above at Sugar General Hospital, Hayatabad Phase V, Peshawar. Participants were identified prospectively during the study period through the routine hospital clinical workflow when their physicians advised both fasting blood glucose (FBS) and HbA1c testing. Eligible patients provided written informed consent, and their Medical Record (MR) numbers were collected. Demographic information and corresponding FBS and HbA1c results were retrieved from the hospital Laboratory Information System. The laboratory\ tests were performed as part of routine clinical care and were not specifically conducted for this research. Participants were selected using a non-probability convenience sampling technique. Data was analyzed using SPSS. Pearson correlation, simple linear regression, and hierarchical multiple regression were performed, with statistical significance set at $p < 0.05$. The mean age of participants was 51.19 ± 11.95 years, while the mean HbA1c and FBS levels were 8.90 ± 2.57% and 181.42 ± 87.29 mg/dL, respectively. A statistically significant, moderately strong positive correlation was observed between FBS and HbA1c ($r = 0.570$, $p < 0.001$). Simple linear regression demonstrated that FBS significantly predicted HbA1c ($F(1,383) = 183.88$, $p < 0.001$) and

explained 32.4% of the variance in HbA1c (R^2 = 0.324). In hierarchical regression, age and gender did not significantly moderate the FBS–HbA1c relationship. The FBS × Age interaction was not significant (p = 0.638), and the FBS × Gender interaction did not reach statistical significance (p = 0.059). The study demonstrated a significant positive association between fasting blood glucose and HbA1c among patients with Type 2 Diabetes Mellitus in Peshawar. FBS was a significant predictor of HbA1c; however, the observed association does not support treating FBS as a substitute for HbA1c. Age and gender did not significantly alter the relationship between FBS and HbA1c in this sample. FBS and HbA1c therefore provide related but distinct information about glycemic status.

Material and Methods:

The study was a hospital-based, cross-sectional observational study conducted over six months at Sugar General Hospital (SGH), Hayatabad Phase V, Peshawar. A total of 385 adult patients diagnosed with Type 2 Diabetes Mellitus (T2DM), aged 30 years and above, including both males and females, were recruited using a non-probability convenience sampling technique. The sample size was calculated using the Qualtrics Sample Size Calculator, with a 95% confidence level, 5% margin of error, and an estimated Peshawar population of 2,617,160. Patients advised by their physicians to undergo both fasting blood glucose (FBS) and glycated hemoglobin (HbA1c) testing were included after providing written informed consent. Patients with Type 1 Diabetes Mellitus, pregnant women, individuals with severe anemia or hemoglobinopathies, and those unwilling to provide consent were excluded. HbA1c was measured using the Bio-Rad D-10 Hemoglobin Testing System based on High-Performance Liquid Chromatography (HPLC), while FBS was measured using the Roche Cobas c 501 Clinical Chemistry Analyzer through the Glucose Oxidase–Peroxidase (GOD–POD) method. Routine laboratory reagents and consumables were used according to the manufacturers' instructions. The researchers did not independently collect or process blood samples; instead, demographic information and laboratory results were retrieved from the hospital's Laboratory Information System (LIS) using patients' Medical Record (MR) numbers. Eligible patients were identified during regular hospital visits, informed about the study, and enrolled after obtaining written consent. Their age, gender, HbA1c, and FBS results were recorded in a Microsoft Excel spreadsheet. Data were subsequently analyzed using the Statistical Package for the Social Sciences (SPSS). Official permission for data collection was obtained through CECOS University, while ethical approval was granted by the Ethical Committee of Diabetes General Hospital, Hayatabad, Peshawar (Reference No. DGH/EC/2026/08, dated 19 May 2026). Participants' confidentiality and privacy were maintained throughout the study.

Results:

A total of 385 adult patients with Type 2 Diabetes Mellitus attending Sugar General Hospital, Hayatabad, Peshawar were included in this cross-sectional study. Descriptive, correlational, and regression analyses were performed to address the three study objectives: (i) whether Fasting Blood Glucose (FBS) significantly predicts HbA1c, (ii) the strength of the correlation between FBS and HbA1c, and (iii) whether age and gender influence this relationship.

3.1 Demographic and Clinical Characteristics of Study Participants

The mean age of the participants was 51.19 ± 11.95 years, with ages ranging from 30 to 92 years. The mean HbA1c level was 8.90% ± 2.57%, ranging from 4.7% to 16.0%, while the mean Fasting Blood Glucose (FBS) level was 181.42 ± 87.29 mg/dL, ranging from 70 to 495 mg/dL (Table 1). Of the 385 participants, 217 (56.4%)

were female and 168 (43.6%) were male (Table 2, Figure 1).

Table 1
Descriptive Statistics of Age, HbA1c, and FBS (N = 385)

Variable	N	Minimum	Maximum	Mean	SD
Age (years)	385	30	92	51.19	11.951
HbA1c (%)	385	4.7	16.0	8.900	2.5711
FBS (mg/dL)	385	70.0	495.0	181.423	87.2894

Frequency Distribution of Gender (N = 385)
Table 2

Gender	Frequency	Percent (%)
Female	217	56.4
Male	168	43.6
Total	385	100.0

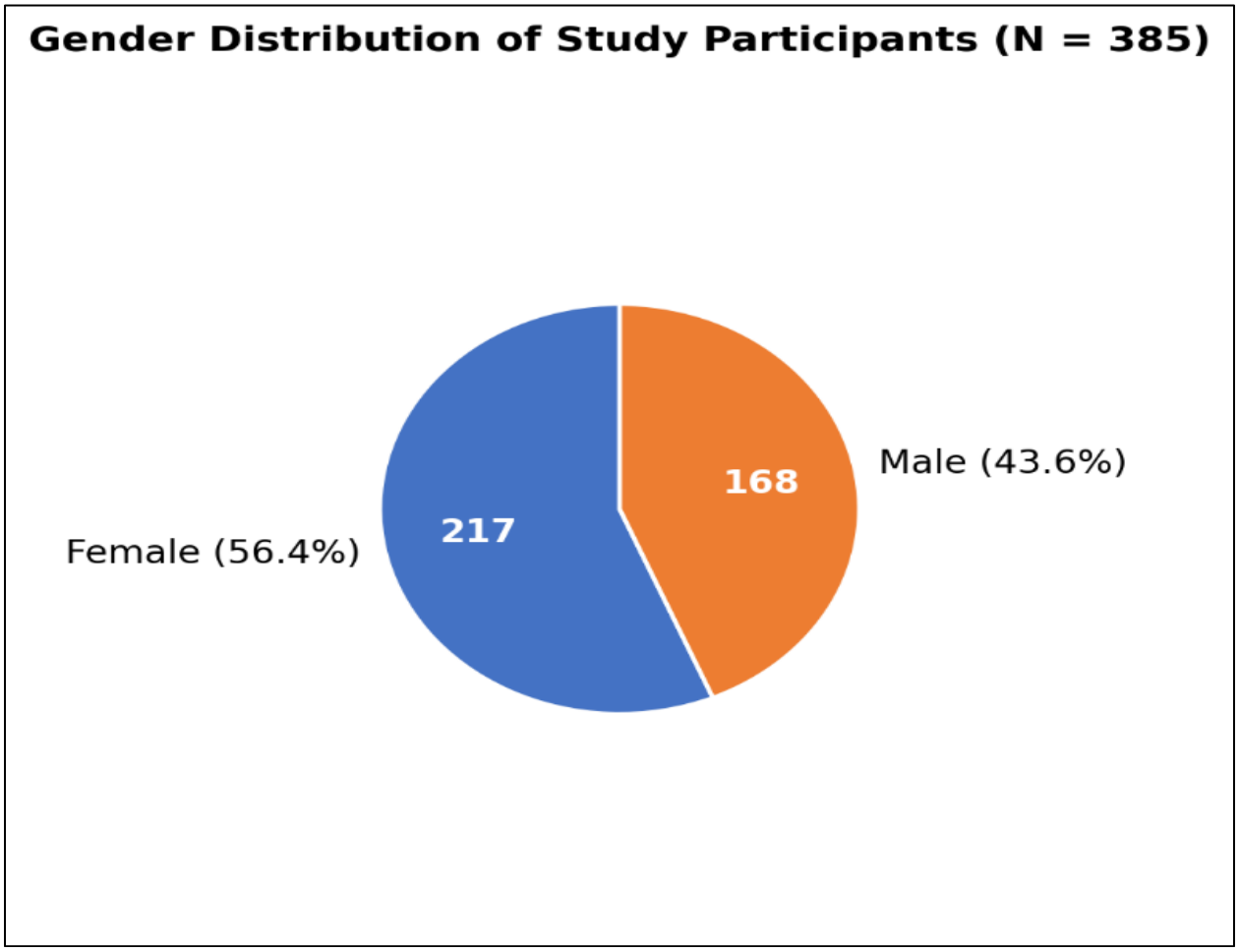


Figure 1

Gender Distribution of Study Participants (N = 385)

3.2 FBS as a Predictor of HbA1c (Objective 1)

A simple linear regression was conducted to determine whether Fasting Blood Glucose (FBS) significantly predicts HbA1c levels. The overall model was statistically significant, $F(1, 383) = 183.88$, $p < .001$, indicating that FBS is a significant predictor of HbA1c. FBS accounted for 32.4% of the variance in HbA1c levels ($R = .570$, $R^2 = .324$, Adjusted $R^2 = .323$, SEE = 2.1161).

The unstandardized regression coefficient for FBS was $B = .017$ (SE = .001, 95% CI [.014, .019], $\beta = .570$), $t(383) = 13.56$, $p < .001$, indicating that for every 1 mg/dL increase in FBS, HbA1c is predicted to increase by 0.017 percentage points, holding all else constant. The regression equation obtained was: HbA1c = 5.857 + .017(FBS)

Simple Linear Regression of HbA1c on FBS

Table 3

Predictor	B	SE	β	t	p	95% CI
(Constant)	5.857	.249	—	23.52	< .001	[5.367, 6.346]
FBS	.017	.001	.570	13.56	< .001	[.014, .019]

3.3 Association Between FBS and HbA1c (Objective 2)

A Pearson correlation analysis assessed the strength of the association between FBS and HbA1c. A statistically significant, moderately strong positive correlation was found between the two variables, $r(383) = .570$, $p < .001$, indicating that higher Fasting Blood Glucose levels are associated with higher HbA1c levels among patients with Type 2 Diabetes Mellitus (Table 4). This finding is consistent with the regression results reported in Section 3.2 and supports rejection of the null hypothesis of no association between HbA1c and FBS.

Pearson Correlation Between HbA1c and FBS

Table 4

	HbA1c	FBS
HbA1c — Pearson r (p)	1	.570 (p < .001)
FBS — Pearson r (p)	.570 (p < .001)	1

Note. N = 385 for each correlation.

3.4 Influence of Age and Gender on the FBS–HbA1c Relationship

To determine whether age and gender influenced the relationship between FBS and HbA1c, interaction terms between FBS and age (FBS × Age) and between FBS and gender (FBS × Gender) were examined. FBS and age were mean centered before calculating the interaction terms. The FBS × Age interaction was not statistically significant ($B = -0.00005$, $\beta = -.020$, $t = -0.47$, $p = .638$), indicating that age did not significantly moderate the relationship between FBS and HbA1c. Similarly, the FBS × Gender interaction was not statistically significant ($B = .005$, $\beta = .111$, $t = 1.89$, $p = .059$). Although the gender interaction was close to the conventional significance level of .05, it did not reach statistical significance. Therefore, neither age nor gender significantly moderate the relationship between FBS and HbA1c in the study population. (Table 5).

Hierarchical Regression Testing the Moderating Effects of Age and Gender on the FBS–HbA1c Relationship

Table 5

Predictor / Interaction	B	β	t	p	Interpretation
FBS × Age	−0.00005	−0.020	−0.47	.638	Not significant
FBS × Gender	0.005	0.111	1.89	.059	Not significant / borderline

Summary of Findings

Fasting Blood Glucose was a statistically significant, positive predictor of HbA1c, accounting for approximately 32% of the variance in HbA1c levels. A moderately strong positive Pearson correlation ($r = .570$, $p < .001$) was observed between FBS and HbA1c. Age and gender did not independently or interactively (via FBS × Age and FBS × Gender terms) significantly alter the FBS–HbA1c relationship, although the FBS × Gender interaction approached significance ($p = .059$). Overall, the findings support rejection of the null hypothesis and confirm a significant association between HbA1c and Fasting Blood Glucose levels among adult patients with Type 2 Diabetes Mellitus in Peshawar.