



ASSESSMENT OF BLOOD GLUCOSE LEVELS, SERUM INSULIN, INFLAMMATORY MARKERS, AND METABOLIC PARAMETERS IN PREDICTING GLYCEMIC CONTROL IN TYPE 2 DIABETES MELLITUS.

Dr. Jalari Ramu^{1*}

^{1*} Assistant Professor, Department of Biochemistry, Manipal College of Medical Sciences.
Email: ramujalari@gmail.com

***Corresponding Author:** Dr. Jalari Ramu

*Assistant Professor, Department of Biochemistry, Manipal College of Medical Sciences.
Email: ramujalari@gmail.com

Abstract

Background: Type 2 Diabetes Mellitus (T2DM) is a growing global health concern characterized by chronic hyperglycemia due to insulin resistance and/or impaired insulin secretion. Inflammatory markers and metabolic parameters are increasingly recognized as important contributors to disease progression and glycemic control.

Objective: To assess the relationship between blood glucose levels, serum insulin, inflammatory markers (CRP, IL-6), and metabolic parameters (BMI, lipid profile) in predicting glycemic control among patients with T2DM.

Methods: This observational analytical study was conducted at the Department of Biochemistry and Department of General Medicine, Manipal College of Medical Sciences, Nepal. A total of 129 T2DM patients aged 30–65 years were included based on specific inclusion and exclusion criteria. Participants were categorized into good (HbA1c < 7%) and poor (HbA1c ≥ 7%) glycemic control groups. Biochemical and metabolic markers were measured and statistically compared between groups.

Results: Patients with poor glycemic control had significantly higher levels of fasting blood glucose, postprandial glucose, serum insulin, HOMA-IR, CRP, IL-6, BMI, and triglycerides ($p < 0.05$). Conversely, HDL-C levels were significantly lower in this group. These findings indicate strong associations between poor glycemic control and increased insulin resistance, systemic inflammation, obesity, and dyslipidemia.

Conclusion: Inflammatory and metabolic markers are significantly associated with poor glycemic control in T2DM patients. Monitoring these parameters may help in early detection of poor metabolic status and in guiding personalized treatment strategies to improve long-term diabetes outcomes.

Keywords: Type 2 Diabetes Mellitus, Glycemic Control, Inflammatory Markers, CRP, IL-6, HOMA-IR, Serum Insulin, BMI, Triglycerides, HDL-C

Introduction:

Type 2 Diabetes Mellitus (T2DM) is a long-term metabolic condition marked by consistently elevated blood glucose levels due to insulin resistance, inadequate insulin secretion, or a combination of both.

The global burden of T2DM has risen sharply, increasing from 108 million cases in 1980 to 422 million by 2014. Projections estimate that this number will exceed 552 million by the year 2030, highlighting the growing public health challenge it presents worldwide.¹ In India, more than 72 million people are currently living with diabetes, and this figure is expected to almost double by the year 2045, indicating a rapidly growing health concern.²

Type 2 Diabetes Mellitus (T2DM), marked by insulin resistance and relative insulin deficiency, impairs glucose metabolism and is also associated with elevated inflammatory markers, which may contribute to the progression and severity of the disease.³

Chronic, systemic subclinical inflammation has also been identified as a driving force for insulin resistance, metabolic syndrome, and type 2 DM. C-reactive protein (CRP) is a sensitive physiological biomarker of sub-clinical inflammation associated with hyperglycemia, insulin resistance and type 2 diabetic patients. Small increases in CRP predict the likelihood of developing cardiovascular events both in diabetic and nondiabetic populations.⁴

Diabetes is commonly diagnosed using fasting plasma glucose (FPG) levels, with values below 100 mg/dL considered normal, 100-125 mg/dL indicating prediabetes, and levels above 126 mg/dL on two separate tests confirming diabetes. Additionally, Hemoglobin A1C (HbA1c) reflects average blood glucose levels over the previous two to three months, helping healthcare professionals monitor long-term glycemic control.⁵

Material and Methods:

Study was conducted in the of Department of Biochemistry, Manipal college of Medical Sciences and Department of General Medicine, Manipal college of medical sciences, Nepal

Study design: Observational analytical study.

Sample size: 129 sample size

Inclusion criteria:

- Patients diagnosed with Type 2 Diabetes Mellitus.
- Age between 30 and 65 years.
- Patients who provide informed consent and agree to participate in the study.

Exclusion criteria:

- Patients with obesity.
- Individuals who consume alcohol regularly.
- Current smokers or tobacco users.
- Patients with chronic liver disease.
- Individuals diagnosed with hypertension.
- Patients with coronary artery disease or other significant cardiovascular conditions.
- Those with bone disorders or metabolic bone diseases.
- Patients with malignancies or undergoing cancer treatment.
- Pregnant or lactating women.
- Patients who have undergone recent surgical procedure

Result:

Table 1: Gender distribution of the patients.

Gender	Number of Patients (n)	Percentage (%)	p value
Male	70	54	0.423
Female	59	46	
Total	129	100 %	

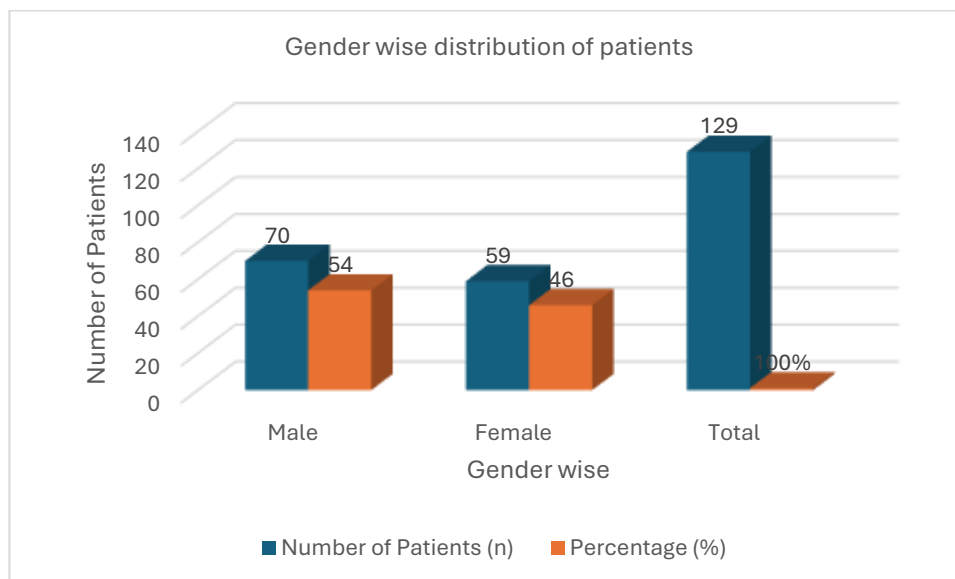


Figure 1: graphical represents gender distribution of the patients.

Among the 129 patients included in the study, 70 (54.3%) were male and 59 (45.7%) were female. The p-value of 0.423 indicates that there is no statistically significant difference in the gender distribution of the study population. This suggests that both males and females were fairly equally represented in the sample, and gender is unlikely to be a confounding factor in this study.

Table 2: Age-wise Distribution of Study Participants

Age Group (years)	Number of Participants (n)	Percentage (%)
30–39	22	17
40–49	39	30
50–59	44	34
60–65	24	19
Total	129	100%

The majority of participants were aged 50–59 years (34%), followed by 40–49 years (30%), and 60–65 years (19%). The 30–39 years group had the lowest representation at 17%. This indicates a higher prevalence of Type 2 Diabetes Mellitus among middle-aged adults in the study population.

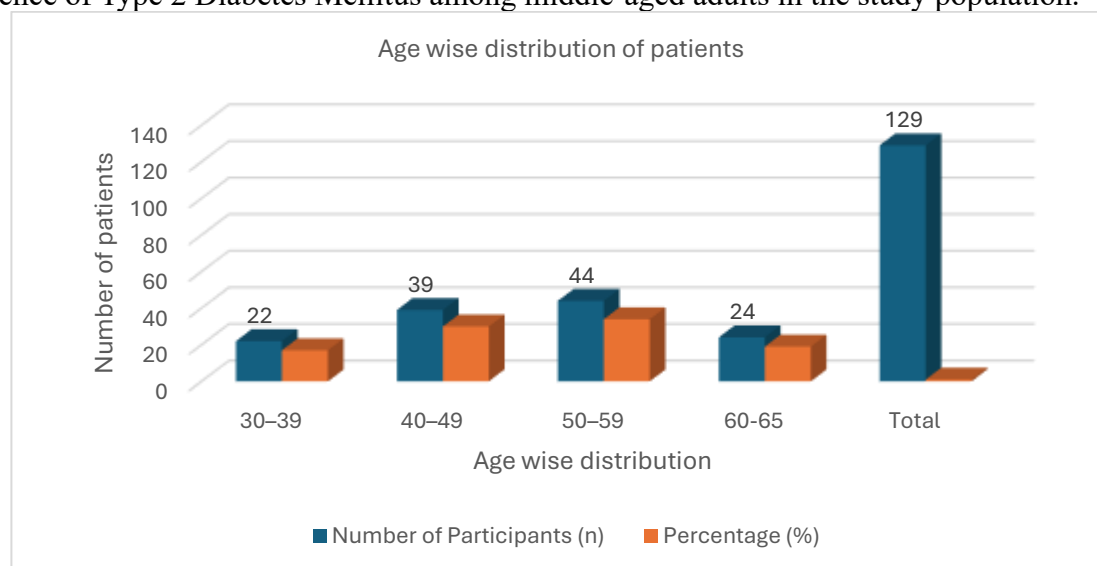


Figure 2: graphical represents age-wise distribution of Study Participants

Parameter	Good Control (HbA1c <7%) (Mean ± SD)	Poor Control (HbA1c ≥7%) (Mean ± SD)	p-value
Fasting Blood Glucose (mg/dL)	105.3 ± 12.6	158.7 ± 25.1	0.001 **
Postprandial Glucose (mg/dL)	145.2 ± 18.4	210.5 ± 35.9	0.001 **
HbA1c (%)	6.5 ± 0.3	8.9 ± 1.1	0.001 **
Serum Insulin (μIU/mL)	12.4 ± 4.1	18.9 ± 5.3	0.002 *
HOMA-IR (Insulin Resistance)	2.1 ± 0.6	3.8 ± 1.1	0.001 **
CRP (mg/L)	2.9 ± 0.8	6.2 ± 1.5	0.001 **
IL-6 (pg/mL)	3.7 ± 1.2	7.9 ± 2.4	0.001 **
BMI (kg/m ²)	25.6 ± 2.3	29.1 ± 3.5	0.001 *
Triglycerides (mg/dL)	145.1 ± 28.6	202.3 ± 40.4	0.001 **
HDL-C (mg/dL)	48.7 ± 6.5	39.4 ± 5.9	0.001 **

The comparison between patients with good glycemic control (HbA1c < 7%) and those with poor glycemic control (HbA1c ≥ 7%) revealed significant differences in several biochemical and metabolic parameters. Individuals with poor glycemic control exhibited notably higher levels of fasting blood glucose, postprandial glucose, HbA1c, serum insulin, HOMA-IR (a marker of insulin resistance), C-reactive protein (CRP), interleukin-6 (IL-6), body mass index (BMI), and triglycerides. These findings suggest a close association between poor glycemic control and increased insulin resistance, systemic inflammation, obesity, and dyslipidemia. In contrast, HDL-C levels were significantly lower in the poor control group, indicating a less favorable lipid profile. All these differences were statistically significant, with p-values less than 0.05, underscoring the importance of these parameters in predicting and monitoring glycemic control in patients with Type 2 Diabetes Mellitus.

Discussion: This study found that patients with poor glycemic control (HbA1c ≥ 7%) had significantly higher levels of blood glucose, serum insulin, HOMA-IR, CRP, IL-6, BMI, and triglycerides, along with lower HDL-C levels, compared to those with good control. These results highlight the strong association between poor glycemic control and increased insulin resistance, inflammation, and dyslipidemia.⁶ Elevated CRP and IL-6 support the role of chronic inflammation in worsening diabetes outcomes, while higher BMI underscores obesity as a key modifiable risk factor. These parameters may serve as useful predictors and targets in managing Type 2 Diabetes Mellitus.⁷

Conclusion: This study confirms that poor glycemic control in T2DM is significantly associated with elevated insulin resistance, inflammatory markers, adverse lipid profiles, and increased BMI. Monitoring these parameters can enhance early detection of poor metabolic control and guide more personalized treatment strategies. Integrating inflammation and metabolic markers into routine diabetes management may improve long-term outcomes and reduce complications in patients with Type 2 Diabetes Mellitus.

Conflict of Interest: The authors declare no conflict of interest related to this study.

References:

1. Hosseinzadeh M, Saber N, Bidar SS, et al. Association of dietary and lifestyle inflammatory indices with type 2 diabetes risk in Iranian adults. *BMC Endocr Disord.* 2024; 24:131
2. Meriga RK et al. Correlation between glycemic control, lipid profile and C-reactive protein in adults with type 2 diabetes mellitus (Nellore, India). *Int J Adv Med.* 2020;7(9):1312–1317.
3. Gupta AK, Saxena R, Mahajan A, Bamniya S. Comparative analysis of serum insulin, insulin resistance, and inflammatory markers in type 2 diabetes mellitus patients and healthy controls. *Int J Pharm Clin Res.* 2025;17(1):323-7.

4. Pfützner A, Schöndorf T, Hanefeld M, Forst T. High-sensitivity C-reactive protein predicts cardiovascular risk in diabetic and nondiabetic patients: effects of insulin-sensitizing treatment with pioglitazone. *J Diabetes Sci Technol*. 2010 May 1;4(3):706-16.
5. American Diabetes Association. Classification and diagnosis of diabetes: Standards of medical care in diabetes—2024. *Diabetes Care*. 2024;47(Suppl 1):S20–S26.
6. Gupta AK, Saxena R, Mahajan A, Bamniya S. Comparative analysis of serum insulin, insulin resistance, and inflammatory markers in type 2 diabetes mellitus patients and healthy controls. *Int J Pharm Clin Res*. 2025;17(1):323-7.
7. Meriga RK, Shaik AP, Velaga MK. Correlation between glycemic control, lipid profile and C-reactive protein in adults with type 2 diabetes mellitus (Nellore, India). *Int J Adv Med*. 2020;7(9):1312–1317.