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Correlation of HbA1c with Mean Corpuscular Volume in Type 2 Diabetes Mellitus.

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Abstract

Background: Glycated haemoglobin (HbA1c) is widely used to assess long-term glycaemic control in type 2 diabetes mellitus (T2DM), but its value may be influenced by erythrocyte characteristics. Mean corpuscular volume (MCV), a routinely reported red-cell index, may therefore be associated with HbA1c. ***Objectives:*** To evaluate the correlation between HbA1c and MCV in adults with T2DM and explore the potential role of MCV as an adjunct marker of glycaemic status. ***Methods:*** This single-centre, cross-sectional observational study enrolled 100 adults with T2DM attending inpatient or outpatient services over 18 months. HbA1c was measured by high-performance liquid chromatography and MCV by an automated haematology analyser. Demographic and clinical data were summarised descriptively, and the association between HbA1c and MCV was assessed using Pearson's correlation coefficient; $p<0.05$ was considered statistically significant. ***Results:*** Of the 100 participants, 55% were male and 45% were female; 41% were aged 49–58 years. HbA1c was <7.0% in 20%, 7.0–9.0% in 48%, and >9.0% in 32%. MCV was normocytic (80–100 fL) in 88%, microcytic in 6%, and macrocytic in 6%. Mean MCV decreased across increasing HbA1c categories, from 89.1 fL at HbA1c <7% to 87.6 fL at 7–9% and 85.4 fL at >9%. HbA1c showed a statistically significant inverse correlation with MCV ($r=-0.312$, $p=0.001$). ***Conclusion:*** Higher HbA1c was modestly associated with lower MCV in adults with T2DM. MCV may provide supportive information when assessing glycaemic status, particularly where resources are limited; however, it should not replace HbA1c, and the association requires confirmation in larger longitudinal studies that account for anaemia and other determinants of MCV.

Keywords: Diabetes Mellitus, Type 2; Glycated Hemoglobin; Erythrocyte Indices; Mean Corpuscular Volume; Cross-Sectional Studies.

INTRODUCTION

Type 2 Diabetes Mellitus is a chronic condition where HbA1c is used to assess long-term glycemic control.
HbA1c levels may be influenced by red blood cell parameters, particularly mean corpuscular volume (MCV).
Studies, including a large Indonesian cohort (n = 1,688), have shown a moderate negative correlation between HbA1c and MCV.
This study aims to assess the relationship between HbA1c and MCV in T2 Diabetes mellitus patients to explore MCV as a supportive marker.

OBJECTIVES OF THE STUDY

To measure HbA1c levels and MCV values in patients diagnosed with Type 2 Diabetes Mellitus.
To Analyze the correlation between HbA1c and MCV among T2DM patients.
To Determine whether changes in MCV are significantly associated with variations in glycemic control.
To explore potential clinical implications of MCV as an adjunct parameter in evaluating long-term glycemic status.

MATERIALS AND METHODS

Study Design:
Cross-sectional Observational Study

Study Duration:
18 months

Sample Size:
100 patients

Study Population :
A total of 100 adult patients diagnosed with type 2 Diabetes Mellitus
(T2DM), attending the outpatient or inpatient services of the department during the study period, were enrolled after obtaining informed consent.

INCLUSION CRITERIA
Patients aged 18 years or older with a confirmed diagnosis of Type 2 Diabetes Mellitus as per the American Diabetes Association (ADA) criteria.
Both HbA1c and Complete blood count (CBC) including MCV at the time of evaluation.
Patients who provided informed written consent.

EXCLUSION CRITERIA
Known cases of Hematological disorders (e.g., thalassemia, sickle cell disease, megaloblastic anemia)
Patients with chronic kidney disease (stage 3 or higher) or chronic liver disease
Recent history (within 3 months) of blood transfusion or hematinic therapy (iron, folic acid, vitamin B12)
Pregnant women

METHODOLOGY
Demographic data including age, gender, and duration of diabetes were recorded for all patients.
Blood samples were collected using standard phlebotomy procedures.
HbA1c levels were measured using high-performance liquid chromatography (HPLC).
Mean corpuscular volume (MCV) was obtained from complete blood counts using an automated hematology analyzer.
All laboratory investigations were performed in the institutional central laboratory under strict quality control protocols.
Data were entered into Microsoft Excel and analyzed using SPSS version 25.0.
Descriptive statistics were used to summarize the study variables.
Continuous variables were expressed as mean ± standard deviation (SD).
Categorical variables were presented as frequencies and percentages.
Pearson correlation coefficient was used to assess the relationship between HbA1c and MCV.
A p-value of <0.05 was considered statistically significant.

RESULTS

Table 1. Age Distribution of the Study Population

Age Group (years)	Number of Patients	Percentage (%)
30–38	8	8.0%
39–48	21	21.0%
49–58	41	41.0%
59–68	18	18.0%
69–78	12	12.0%
Total	**100**	**100.0%**
Mean ± SD	54.2 ± 10.6	

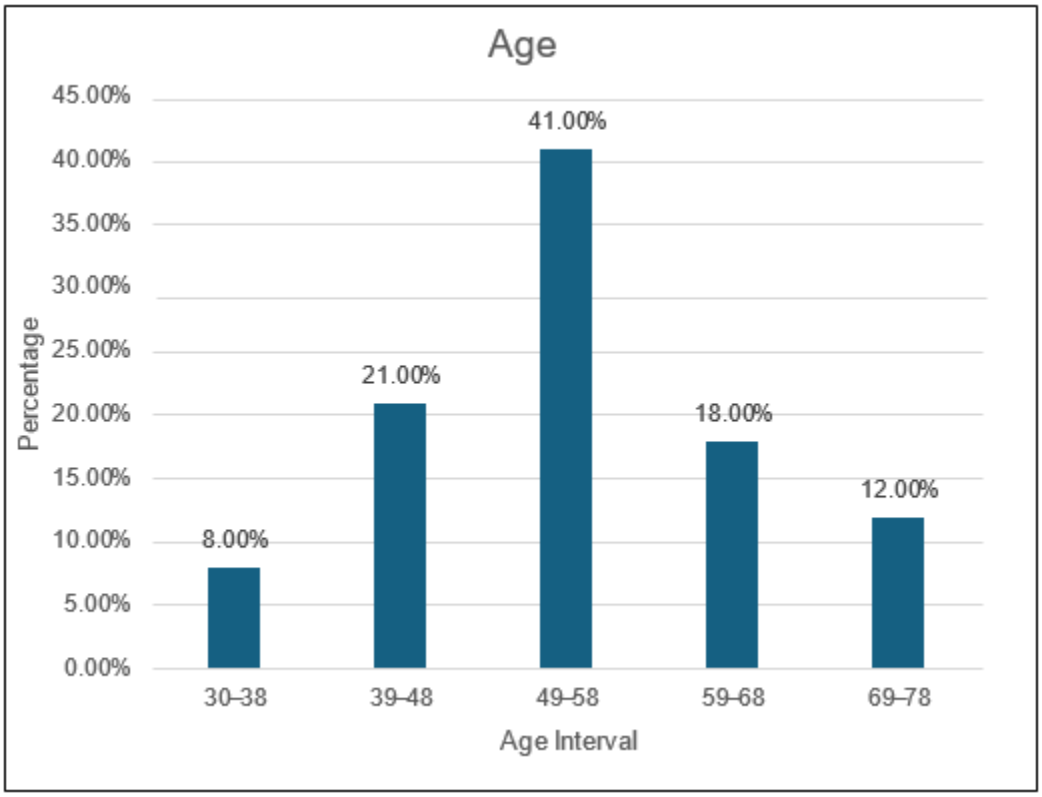


Table 2. Sex Distribution of the Study Population

Sex	Number of Patients	Percentage (%)
Male	55	55.0%
Female	45	45.0%
Total	100	100.0%

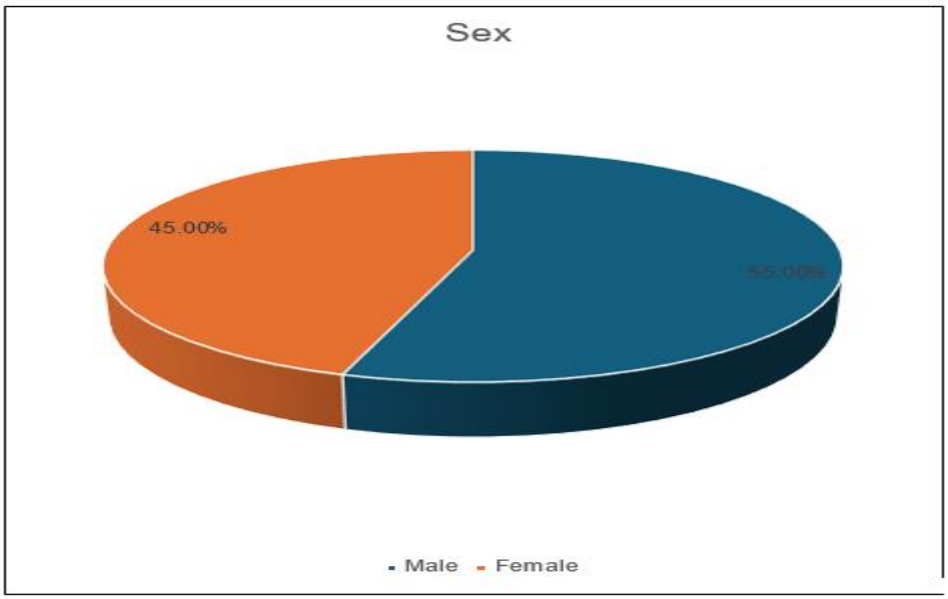


Table 3. Duration of Diabetes in Study Population

Duration of Diabetes (years)	Number of Patients	Percentage (%)
< 5	26	26.0%
5–9	42	42.0%
≥ 10	32	32.0%
Total	100	100.0%
Mean ± SD	7.8 ± 4.5	

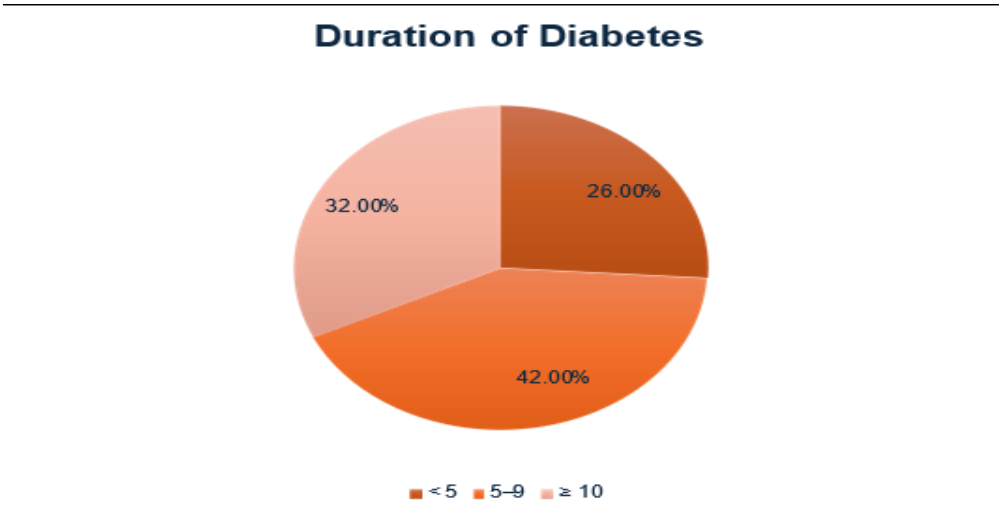


Table 4. HbA1c (%) Distribution in Study Population

HbA1c Range (%)	Number of Patients	Percentage (%)
< 7.0	20	20.0%
7.0–9.0	48	48.0%
> 9.0	32	32.0%
Total	**100**	**100.0%**
Mean ± SD	**8.4 ± 1.6**	

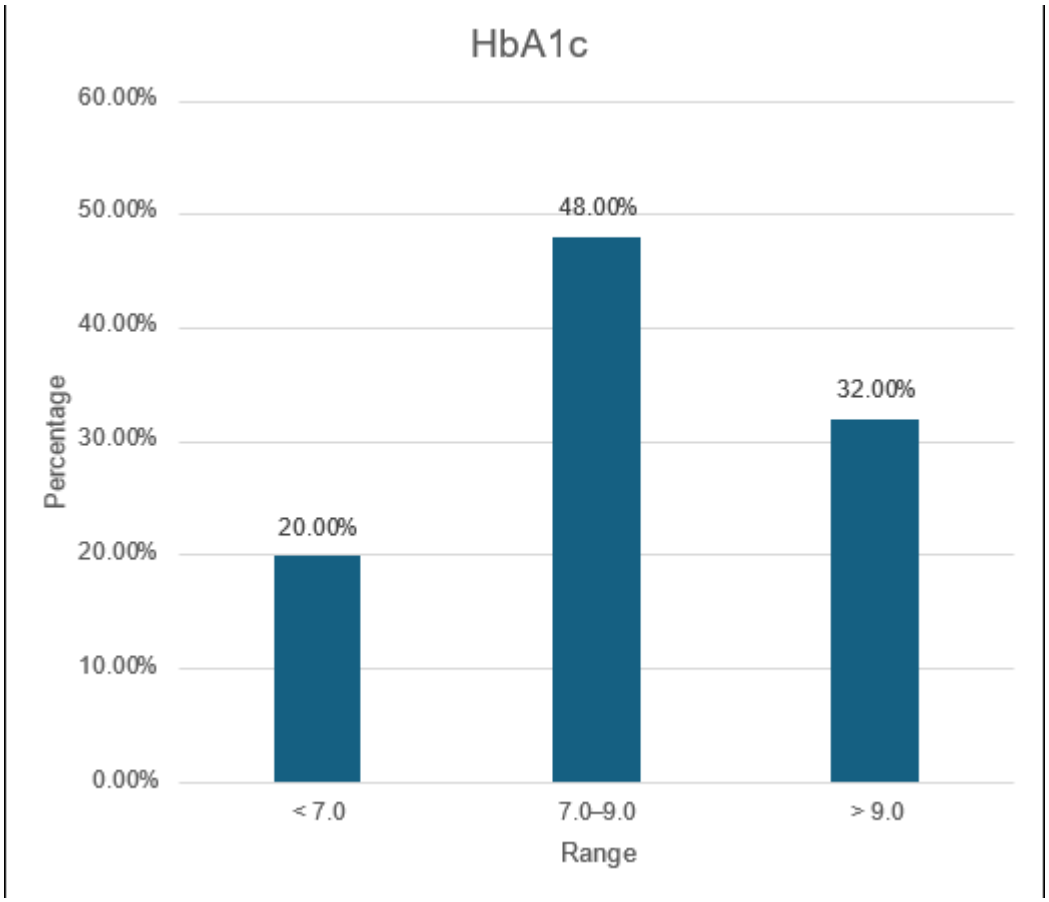


Table 5. Mean Corpuscular Volume (MCV) Distribution

MCV Range (fL)	Number of Patients	Percentage (%)
< 80 (Microcytic)	6	6.0%
80–100 (Normocytic)	88	88.0%
> 100 (Macrocytic)	6	6.0%
Total	**100**	**100.0%**
Mean ± SD	**87.5 ± 6.2**	

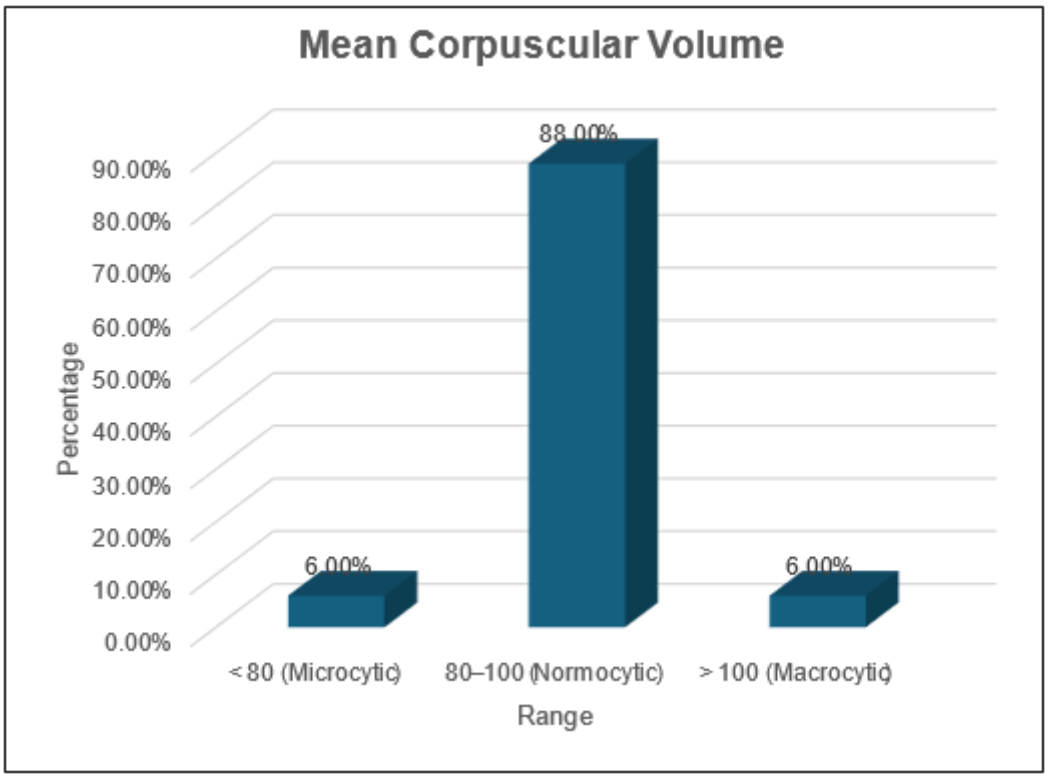


Table 6. Subgroup Analysis Based on HbA1c Levels

HbA1c Group	Number of Patients (n)	Mean MCV (fL)
Group A (<7%)	20	89.1 ± 5.8
Group B (7–9%)	48	87.6 ± 6.3
Group C (>9%)	32	85.4 ± 6.1

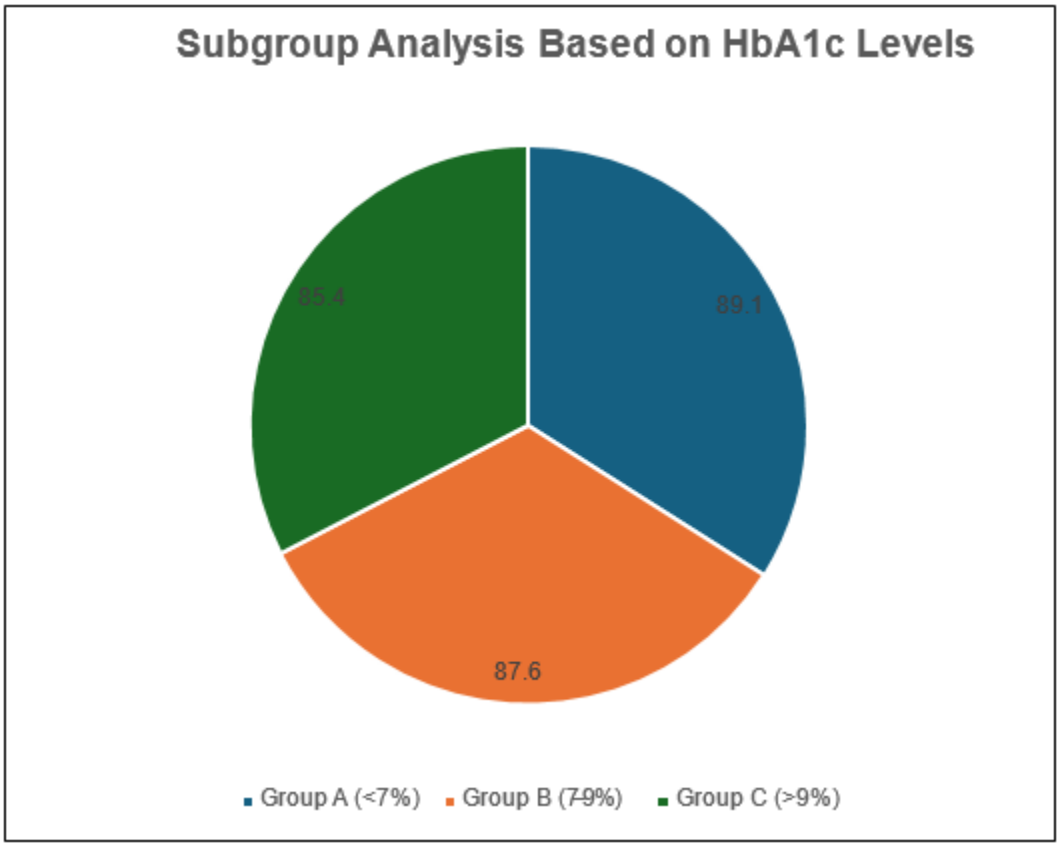
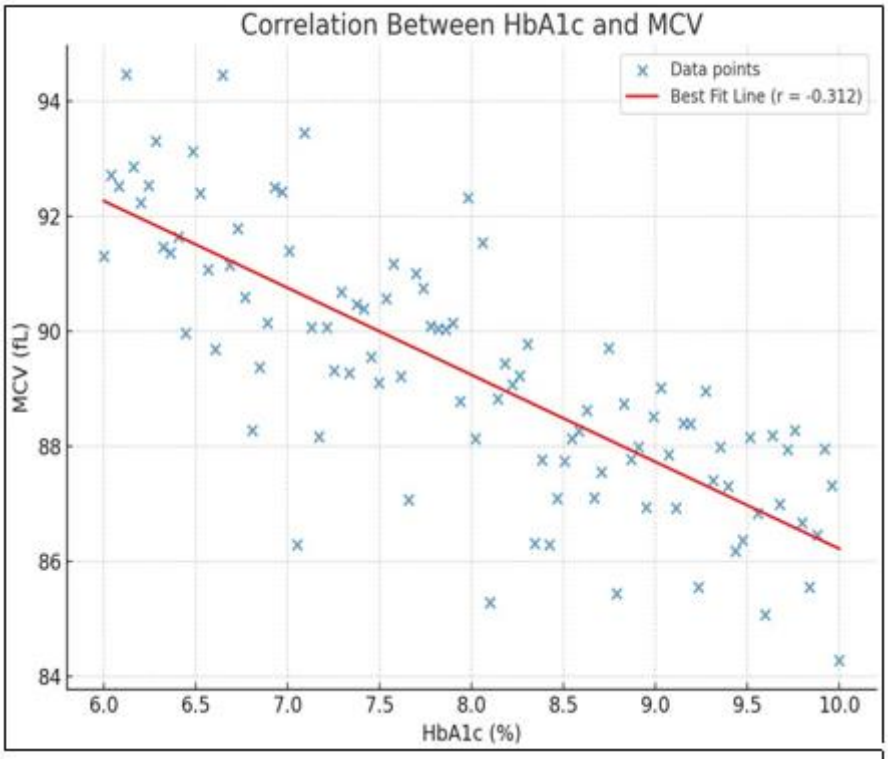


Table 7. Correlation Between HbA1c and MCV

Statistical Test	Result
Pearson Correlation Coefficient (r)	–0.312
p-value	0.001 (Significant)



CONCLUSION

A significant inverse correlation was found between HbA1c and MCV (r = –0.312, p = 0.001), indicating that higher glycemic levels are associated with lower red blood cell size, possibly due to oxidative stress and shortened RBC lifespan. These findings suggest that MCV, a routinely available hematological parameter, may serve as a supportive marker for glycemic control in type 2 diabetes, though further longitudinal studies are needed to validate this association.

This study suggests true physiological reduction in MCV due to chronic glycemic burden, not just analytical error.
MCV may be a useful adjunct marker of glycemic control, especially in low-resource settings.

Interpretation of MCV should be cautious in cases of severe hyperglycemia to avoid misleading conclusions

LIMITATIONS

The cross-sectional, single-center design limits causal inference and generalizability to broader populations.
The study focused only on HbA1c and MCV, excluding other relevant RBC indices like MCH, MCHC, and RDW.
Potential confounders affecting MCV (e.g., iron, folate, B12 deficiency, liver disease, alcohol use, thyroid disorders) were not controlled for.
Lack of anemia stratification and longitudinal follow-up prevented assessment of how MCV changes with glycemic control over time.

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