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Original article

Comparative Analysis of Mean Platelet Volume and Platelet Distribution Width in Type 2 Diabetic Patients and Healthy Controls

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ABSTRACT

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by persistent hyperglycemia and an increased risk of vascular complications. Platelet activation plays a central role in the pathogenesis of these complications. Simple hematological indices, such as mean platelet volume (MPV) and platelet distribution width (PDW), may serve as accessible markers of platelet function and vascular risk. This study aimed to evaluate alterations in platelet indices (MPV and PDW) in patients with T2DM compared with healthy controls and to investigate their relationship with glycemic control, as assessed by HbA1c levels. This comparative cross-sectional study was conducted in August 2025 at Ghout Al-Shaal Medical Center, Tripoli, Libya. The study included 60 adults aged 30–60 years, comprising 40 patients with T2DM and 20 healthy controls. Venous blood samples were collected in EDTA tubes for complete blood count (CBC) analysis and HbA1c measurement using standardized laboratory analyzers. Independent t-tests were used for group comparisons, and Pearson correlation analysis was applied to assess the relationship between HbA1c and platelet indices. MPV was significantly increased in diabetic patients compared with controls (10.33 ± 1.04 vs. 9.41 ± 1.00, P = 0.0013), whereas platelet count and PDW showed no statistically significant differences between groups. HbA1c levels were significantly higher in the diabetic group compared with controls (9.00 ± 1.85 vs. 5.40 ± 0.33, P < 0.001). A positive correlation was observed between HbA1c and MPV in the overall sample (r = 0.2499, P = 0.0269), with a stronger association noted among females (r = 0.2586, P = 0.0470). Conclusion: Patients with T2DM exhibit increased MPV compared with healthy individuals, suggesting enhanced platelet activation in association with poor glycemic control. MPV may serve as a useful and cost-effective hematological marker for assessing platelet activity and potential vascular risk in diabetic patients.

Introduction

Type 2 diabetes mellitus (T2DM), the most common form of diabetes, is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from impaired insulin secretion, insulin resistance, or both. Prolonged hyperglycemia contributes to progressive damage affecting multiple organs and tissues, particularly the kidneys, retina, peripheral nerves, and vascular system (1-4). The global burden of T2DM continues to increase at an alarming rate, posing major public health and economic challenges worldwide (5). According to the International Diabetes Federation, approximately 589 million adults aged 20–79 years were living with diabetes in 2024, representing a global prevalence of 11.1%. This number is expected to rise to nearly 853 million by 2050 if effective preventive and therapeutic interventions are not implemented (6). Platelets play a central role in the pathogenesis of diabetic vascular complications. In addition to their established contribution to thrombus formation following atherosclerotic plaque rupture, platelets are actively involved in endothelial dysfunction, inflammation, and the initiation and progression of atherosclerosis, which are major contributors to the macrovascular complications associated with T2DM, including coronary artery disease, cerebrovascular disease, and peripheral arterial disease(7-10).

Platelet indices, particularly mean platelet volume (MPV) and platelet distribution width (PDW), are simple, inexpensive, and readily available hematological parameters obtained from routine complete blood count analysis. MPV reflects average platelet size and is considered an indicator of platelet activation, whereas PDW reflects the variability in platelet size and provides information regarding platelet heterogeneity. Elevated values of these indices have been associated with enhanced platelet reactivity, inflammation, thrombosis, and increased vascular risk (11-13). Consequently, platelet indices have gained increasing attention as potential biomarkers for evaluating the pathophysiological alterations associated with T2DM and for identifying patients at greater risk of diabetic complications (14-16).

Previous studies have demonstrated significant alterations in platelet indices among patients with T2DM compared with healthy individuals. Increased MPV levels have been consistently reported, particularly in patients with poor glycemic control, suggesting enhanced platelet activation in diabetic states(17, 18). Some studies have also documented elevated

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PDW and platelet large cell ratio (P-LCR) levels, while platelet count often remains within normal ranges (19, 20). Furthermore, higher MPV and PDW values have shown positive correlations with glycated hemoglobin (HbA1c), indicating a possible relationship between platelet activation and chronic hyperglycemia.(21). Certain investigations have additionally proposed specific cut-off values for MPV and PDW as potential predictors of diabetic vascular complications, highlighting their possible utility in risk assessment and disease monitoring (22 ,23).

Despite the increasing prevalence of diabetes mellitus in Libya, there is a notable lack of published data evaluating platelet indices among Libyan patients with T2DM. Most local studies have primarily focused on glycemic status and general diabetic complications, with limited attention given to hematological markers associated with platelet activation. Therefore, the present study was conducted to address this gap in the Libyan literature and to further explore the clinical significance of platelet indices in T2DM. This study aimed to evaluate alterations in platelet indices, particularly mean platelet volume (MPV) and platelet distribution width (PDW), among patients with type 2 diabetes mellitus compared with healthy controls, in order to assess their potential role as indicators of platelet activity. In addition, the study sought to investigate the relationship between these platelet indices and glycemic control as assessed by glycated hemoglobin (HbA1c) levels.

Methods

Study Design and Setting

This comparative cross-sectional study was conducted at the laboratory facilities of Ghout Al-Shaal Medical Center in Tripoli, Libya. Data collection was carried out during August 2025. The study population included adults aged between 30 and 60 years who were categorized into two groups: patients diagnosed with type 2 diabetes mellitus and apparently healthy controls. Participants with a history of hematological disorders, inflammatory diseases, cardiovascular diseases, malignancies, or any condition known to affect platelet parameters were excluded from the study. Individuals receiving antiplatelet therapy or other medications that could influence platelet function were also excluded. All participants underwent complete blood count (CBC) analysis, including platelet indices such as mean platelet volume (MPV), platelet distribution width (PDW), and platelet count, in addition to glycated hemoglobin (HbA1c) measurement.

Sample Collection and Laboratory Methods

Venous blood samples were collected from all participants under aseptic conditions. Approximately 5 mL of venous blood was drawn and transferred into tubes containing ethylenediaminetetraacetic acid (EDTA) anticoagulant. Complete blood count analysis, including platelet indices was performed using the Mission HA-360 Hematology Analyzer. Glycated hemoglobin (HbA1c) levels were measured using the G20 HbA1c Analyzer according to the manufacturer's instructions.

Data Analysis

Statistical analysis was performed using IBM SPSS Statistics. Descriptive statistics, including means, standard deviations, frequencies, and percentages, were used to summarize demographic characteristics and laboratory findings. Differences between study groups were assessed using the independent-samples t-test. A p-value of less than 0.05 was considered statistically significant. Pearson's correlation coefficient was applied to evaluate the relationships between HbA1c levels and platelet-related parameters, including platelet count, MPV, and PDW.

Ethical considerations

The study was approved by the Department of Medical Laboratories Sciences at University of Tripoli. All participants provided consent before participating in the study.

Results

A total of 60 participants were included in the study, comprising 40 individuals (66.7%) in the diabetic group and 20 individuals (33.3%) in the control group. In the diabetic group, females accounted for 27 participants (67.5%), whereas males represented 13 participants (32.5%). In the control group, females constituted 16 participants (80.0%), while males accounted for 4 participants (20.0%).

The mean age of male participants was 46.69 ± 8.15 years in the diabetic group and 50.25 ± 14.25 years in the control group. Among female participants, the mean age was 50.18 ± 9.44 years in the diabetic group and 45.37 ± 11.30 years in the control group (Table 1).

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Table 1. Demographic Characteristics of the Study Population

Variables		Control Group (n=20) (33.3%)	Diabetic Group (n=40) (66.7%)
Gender	Male (n - %)	4 (20%)	13 (32.5%)
	Female (n - %)	16 (80%)	27 (67.5%)
Age Group	Males (Mean ± SD)	50.25 ± 14.25	46.69 ± 8.15
	Females (Mean± SD)	45.37 ± 11.30	50.18 ± 9.44

Comparison of Platelet Parameters and HbA1c Between Diabetic Patients and Healthy Controls

Table 2 summarizes the descriptive statistics and comparative analysis of Platelet Parameters and HbA1c between the diabetic patients and control groups. HbA1c levels were significantly higher in the diabetic group (9.00 ± 1.85) compared with the control group (5.40 ± 0.33) ($t = -11.76$, $P < 0.001$). Platelet count was lower in diabetic patients (253.72 ± 66.51 $\times 10^3/\mu L$) than in controls (267.40 ± 62.96 $\times 10^3/\mu L$), although the difference was not statistically significant ($P = 0.2269$). Mean platelet volume was significantly higher in the diabetic group (10.33 ± 1.04 fL) compared with the control group (9.41 ± 1.00 fL) ($t = 3.22$, $P = 0.0013$). Platelet distribution width was also higher among diabetic patients (13.60 ± 2.20%) than controls (12.82 ± 2.09%), with no statistically significant difference observed ($P = 0.1001$). Significant differences between the two groups were observed for HbA1c and MPV, whereas PLT and PDW showed no statistically significant differences (Table 2).

Table 2. Comparison of Platelet Parameters and HbA1c Between Diabetic Patients and Healthy Controls

Variables	Diabetic Group (n=40)	Control Group (n=20)	T-test	P-value
HbA1c	9.00 ± 1.85	5.40 ± 0.33	-11.7620	0.001*
PLT ($\times 10^3/\mu L$)	253.72 ± 66.51	267.40 ± 62.96	0.7619	0.2269
MPV (fL)	10.33 ± 1.04	9.41 ± 1.00	3.2242	0.0013*
PDW (%)	13.60 ± 2.20	12.82 ± 2.09	-1.3122	0.1001

Relationship Between HbA1c and Platelet Activity Among All Participants

Table 3 and Figures 1-3 present the Pearson correlation analysis between HbA1c levels and platelet activity parameters, including platelet count, mean platelet volume, and platelet distribution width, among all study participants. No statistically significant correlation was observed between HbA1c and PLT in the total sample ($r = 0.0181$, $P = 0.4456$), males ($r = -0.0716$, $P = 0.3940$), or females ($r = 0.0787$, $P = 0.3087$). In contrast, MPV demonstrated a statistically significant positive correlation with HbA1c in the overall study population ($r = 0.2499$, $P = 0.0269$). A significant positive correlation was also observed among females ($r = 0.2590$, $P = 0.047$), whereas the positive association identified in males ($r = 0.2432$, $P = 0.1765$) did not reach statistical significance. Regarding PDW, weak positive correlations with HbA1c were observed in the total sample ($r = 0.1276$, $P = 0.1662$), males ($r = 0.0823$, $P = 0.3787$), and females ($r = 0.1490$, $P = 0.1711$); however, none of these correlations were statistically significant.

Table 3. Pearson Correlation Coefficients Between HbA1c and Platelet Activity Parameters Among All Participants

Variables	R-value	P-value
PLT ($\times 10^3/\mu L$)	0.0181	0.4456
MPV (fL)	0.2499	0.0269*
PDW (%)	0.1276	0.1662

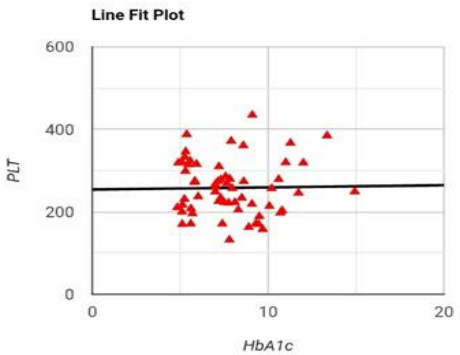

Figure (1): HbA1c & PLT

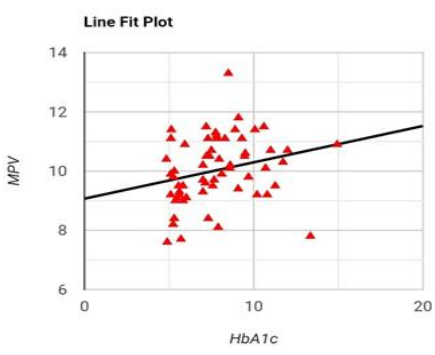

Figure (2): HbA1c & MPV

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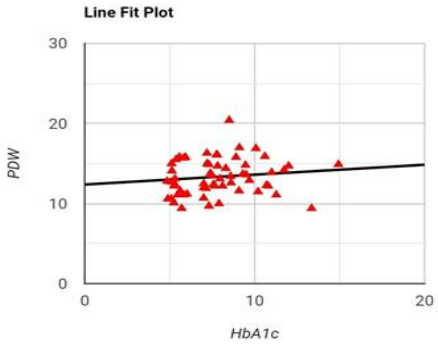

Figure (3): HbA1c & PDW

Discussion

The present study demonstrated significant differences in platelet indices between patients with type 2 diabetes mellitus (T2DM) and healthy controls, with particular emphasis on the relationship between platelet activity and glycemic control. HbA1c levels were significantly higher in diabetic patients than in controls (9.00 ± 1.85 vs. 5.40 ± 0.33, P < 0.001), reflecting poor long-term glycemic control among the diabetic group. Similar findings have been reported in previous studies, including that of Suresh *et al*., confirming the value of HbA1c as a reliable indicator of chronic hyperglycemia in patients with T2DM (24).

Among the platelet parameters evaluated, mean platelet volume was significantly increased in diabetic patients compared with healthy individuals (10.33 ± 1.04 vs. 9.41 ± 1.00, P = 0.0013). Elevated MPV is considered an indicator of increased platelet activation and larger platelet size, both of which are associated with enhanced thrombotic potential. This finding is in agreement with Yenigün *et al*., who also reported increased MPV values in patients with diabetes and suggested a relationship between platelet hyperactivity and vascular complications (25).

In contrast, platelet count and platelet distribution width showed no statistically significant differences between diabetic patients and controls. The absence of significant changes in platelet count has been documented previously by Chen *et al.,* indicating that platelet function may be altered in diabetes without a corresponding change in platelet number (26). Although some studies, such as that of Buch *et al.,* have described variations in PDW among diabetic patients, these discrepancies may be related to differences in study populations, inflammatory status, sample size, or laboratory methods (27).

Correlation analysis further demonstrated a significant positive relationship between MPV and HbA1c levels in the overall study population, with a stronger association observed among female participants. However, no significant correlations were detected between HbA1c and either PLT or PDW. These results are consistent with findings reported by Dindar *et al.,* who identified MPV as a marker associated with poor glycemic control and increased platelet reactivity in diabetes (28). Likewise, Rossi *et al*. found no significant association between HbA1c and PDW, suggesting that PDW may have limited value in assessing glycemic-related platelet changes (29) .

Taken together, these findings suggest that MPV is more sensitive to changes in glycemic status than other platelet indices and may serve as a useful hematological marker of platelet activation in patients with T2DM. The stronger association observed among female patients may indicate possible gender-related differences in platelet response and warrants further investigation in larger studies.

Conclusion

This study demonstrated increased platelet activation in patients with type 2 diabetes mellitus, as reflected by significantly elevated HbA1c and MPV levels compared with healthy controls. In contrast, platelet count and platelet distribution width did not differ significantly between the two groups. MPV showed a significant positive association with HbA1c, particularly among female participants, suggesting that poor glycemic control may contribute to enhanced platelet reactivity. The findings support the potential clinical value of MPV as a simple and readily available hematological marker for assessing platelet activation and thrombotic risk in patients with T2DM. Incorporating platelet indices, especially MPV, into routine diabetic evaluation may provide additional information regarding vascular risk and disease monitoring. Further large-scale studies are recommended to clarify the clinical significance of platelet indices in diabetes and their relationship with diabetic complications.

Conflicts of Interest

The authors declare no conflicts of interest.

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Data Availability Statement
The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Declarations
AI declaration during the preparation of this work, the authors used AI to improve the grammar and structure without any use in methodology or results. After using this tool/service, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

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