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# MEAN PLATELET VOLUME AND DISTRIBUTION WIDTH IN TYPE II DIABETES

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## Abstract

**Background:** Type 2 diabetes mellitus (T2DM) is a chronic metabolic illness characterized by persistent hyperglycemia, which raises the chance of macrovascular and microvascular complications. These issues are linked to increased platelet activation, aggregation, and thromboxane production.

**Objective:** This study sought to assess the use of Mean Platelet Volume (MPV) and Platelet Distribution Width (PDW) as possible hematologic indicators for detecting vascular complications in people with T2DM.

**Methods:** A retrospective cross-sectional research was conducted using the medical records of 141 T2DM patients treated at Sanjiwani Gianyar Hospital in 2023. Patients were split into two groups based on the presence or absence of vascular complications such as coronary artery disease, cerebrovascular disease, peripheral arterial disease, diabetic nephropathy, and diabetic retinopathy. MPV and PDW values were derived from routine Complete Blood Count (CBC) testing. The data were tested for normality, and any changes between groups were calculated using an independent samples t-test.

**Results:** Patients with vascular complications had significantly higher MPV values (9.53 ± 1.30 fL) than those without complications (8.99 ± 0.96 fL), with a statistically significant p-value of 0. 018. However, the two groups' PDW values did not differ significantly (15.95 ± 0.44 vs. 15.91 ± 0.36; p = 0.582).

**Conclusions:** MPV may be a useful and cost-effective hematological parameter associated with vascular complications in T2DM patients, but the clinical relevance of PDW is unclear and requires more research.

## Cite this Article

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## INTRODUCTION

Diabetes mellitus is a chronic metabolic disease defined by persistent hyperglycemia caused by impaired insulin production, insulin resistance, or both (1). The incidence of type 2 diabetes mellitus (T2DM) has risen dramatically throughout the world in recent decades. Globally, an estimated 422 million people suffer from diabetes, and around 1.5 million deaths occur each year as a direct result of the condition (2). In Indonesia, the incidence of T2DM increased from 6.2% in 2019 to 10.8% in 2021, making the country one of the world's top T2DM sufferers (3).

Persistent hyperglycemia contributes to chronic vascular complications by causing oxidative stress, endothelial dysfunction, and systemic inflammation (4). These circumstances promote platelet activation, resulting in increased aggregation and thromboxane production (4,5). Platelet activation also causes structural alterations, such as increased platelet size, which contribute to the release of prothrombotic mediators such as thromboxane A2 (6,7,8). Mean Platelet Volume (MPV) is a measurement of average platelet size and is thought to be a predictor of platelet activity (9). Platelet Distribution Width (PDW) is a measure of platelet size variation that is also linked to platelet activation (10).

MPV and PDW are inexpensive and often evaluated using hematology analyzers, making them possible biomarkers for early diagnosis of vascular complications in T2DM (11). However, prior findings remain contradictory, and population-specific statistics, notably from Indonesia, are scarce.

According to Riskesdas data in 2018, Bali has a rather high rate of diabetes mellitus, at 1.7% (12). Despite this, there is little research comparing MPV and PDW in T2DM individuals with and without vascular complications in this population. As a result, this research aims to examine MPV and PDW levels in T2DM patients at Sanjiwani Gianyar Hospital in order to determine their usefulness as simple, cost-effective indicators for vascular complications.

## MATERIALS AND METHODS

This research used a retrospective cross-sectional approach, gathering data from medical records created during a single year (2023) and evaluating it retrospectively based on previously recorded patient information. The study population was made up of all individuals diagnosed with type 2 diabetes mellitus (T2DM) who were treated at Sanjiwani Gianyar Hospital in 2023. A total of 141 patients satisfied the inclusion criteria, which included a verified T2DM diagnosis, treatment during the 2023 period, and full medical records. Exclusion criteria included patients who were diagnosed with type 1 DM, gestational DM, or other particular forms of DM; patients with incomplete medical records; those who had blood transfusions within the previous three months; and patients who were now receiving or had received antiplatelet treatment (13,14). After applying elimination criteria, the final sample size was 141 patients.

Patient features such as age and sex, history of vascular complications, Mean Platelet Volume (MPV), and Platelet Distribution Width (PDW) were among the data collected. Vascular complications were defined as documented diagnoses of coronary artery disease, cerebrovascular disease, peripheral arterial disease, diabetic nephropathy, or diabetic retinopathy (6,15). Using an automated hematology analyzer (Mindray BC-6000), MPV and PDW values were derived from routine Complete Blood Count (CBC)

tests conducted in accordance with standard laboratory operating procedures, with MPV measured in femtoliters (fL) and PDW expressed as a percentage (%).

Data analysis was conducted in two steps: descriptive and inferential analysis. Descriptive analysis was used to summarize patient features. Comparative analysis of MPV and PDW between patients with and without vascular complications was performed using the independent sample t-test when normality and homogeneity assumptions were satisfied; otherwise, the Mann-Whitney U test was used. All statistical analysis was performed using SPSS version 26.0 (IBM Corp., Chicago, IL, USA). A significance threshold of $\alpha = 0.05$ was used, and findings were deemed statistically significant if $p < 0.05$.

The Health Research Ethics Committee of Sanjiwani Hospital reviewed and approved this study with the approval number [111/PEPK/XI/2024]. Because the research was conducted retrospectively, the need for informed consent was waived.

## RESULTS AND DISCUSSION

Table 1 presents the distribution of detected patient features by age, gender, and history of vascular complications. Vascular complications in this study were defined as documented diagnoses of coronary artery disease, cerebrovascular disease, peripheral arterial disease, diabetic nephropathy, or diabetic retinopathy, in accordance with established classifications of diabetic vascular complications (6,15). Based on age characteristics, the majority of individuals are between the ages of 65 and 74, with 47 patients (33.3%). Based on the data, the majority of patients (99 individuals, 70.2%) had a history of vascular complications, whereas the remaining 42 patients (29.8%) did not.

**Table 1.** Distribution of Study Patient Characteristics by Age, Sex, and History of Vascular Complications

| Characteristic | n | Frequency (%) |
|---|---|---|
| **Age** | | |
| 25-34 | 1 | 0.7 |
| 35-44 | 11 | 7.8 |
| 45-54 | 26 | 18.4 |
| 55-64 | 41 | 29.1 |
| 65-74 | 47 | 33.3 |
| 75-84 | 13 | 9.2 |
| 85-94 | 2 | 1.4 |
| **Gender** | | |
| Female | 72 | 51.1 |
| Male | 69 | 48.9 |
| **History of Vascular Complications** | | |
| Yes | 99 | 70.2 |
| No | 42 | 29.8 |

**Table 2.** MPV and PDW levels in patients with a history of vascular complications vs non a history of vascular complications

| Variabel | Mean±SD | Range |
|---|---|---|

| | | |
|---|---|---|
| **MPV** | | |
| With Vascular Complications | 9.53±1.3 | 6.60−13.50 |
| Without Vascular Complications | 8.99±0.96 | 7.0−10.7 |
| **PDW** | | |
| With Vascular Complications | 15.95±0.44 | 14.7−17.1 |
| Without Vascular Complications | 15.91±0.36 | 15.2−16.7 |

Table 2 shows the MPV and PDW values for individuals with and without vascular complications. The PDW values were nearly identical between the two groups, with overlapping means and standard deviations, indicating very little variation even before statistical analysis. In contrast, patients with vascular complications had greater MPV levels.

Normality testing using the Kolmogorov-Smirnov approach revealed that the residuals were normally distributed (p=0.200), and Levene's test showed variance homogeneity for PDW (p=0. 269), allowing the use of an independent sample t-test. Despite the fact that the Levene's test revealed unequal variance (p=0.041), the strong Welch correction confirmed the significance of the findings.

**Table 3.** Independent sample t-test *results*

| **Variabel** | **Mean±SD** | ***p-value*** | ***Confidence Interval*** |
|---|---|---|---|
| **MPV** | | | |
| With Vascular Complications | 9.53±1.3 | 0.018 (<0.05) | 0.091 - 0.979 |
| Without Vascular Complications | 8.99±0.96 | (Significant) | |
| **PDW** | | | |
| With Vascular Complications | 15.95±0.44 | 0.582 (>0.05) | –0.109 - 0.194 |
| Without Vascular Complications | 15.91±0.36 | (Insignificant) | |

Based on the independent sample t-test results presented in Table 3, the mean platelet volume (MPV) was considerably greater in type 2 diabetes mellitus (T2DM) individuals who had vascular complications than in those who did not (p=0.018). The mean MPV value in the vascular complication group was 9.53 ± 1.3 fL, whereas patients without vascular complications had a mean MPV of 8.99 ± 0.96 fL. The 95% confidence interval (CI) for the mean difference ranged from 0.091 to 0.979, indicating that the observed difference was statistically significant and unlikely to be caused by chance variation. Clinically, this data indicates that increased MPV may indicate enhanced platelet activity in T2DM patients who already have vascular complications (16, 17).

In contrast, there were no significant differences in Platelet Distribution Width (PDW) between groups (p=0.582), and its 95%CI (–0.109 to 0.194) crossed zero, indicating considerable overlap between individuals with and without vascular complications. This implies that PDW has little discriminatory value in detecting vascular complications in this study group.

The independent sample t-test revealed a statistically significant difference in Mean Platelet Volume (MPV) between type 2 diabetes mellitus (T2DM) patients with and without vascular complications (p=0.018). Patients with vascular complications had

greater MPV values, indicating increased platelet activity. This finding is consistent with Aktas and Aktuglu's (2021) research, which found that MPV is a measure of platelet activity and is linked to both microvascular and macrovascular complications in T2DM. Larger platelets are more metabolically and enzymatically active and have denser granules, which promote the release of prothrombotic substances, increasing thrombotic risk (18).

The observed elevation in MPV may be attributed to chronic hyperglycemia, which is common in T2DM. Chronic hyperglycemia causes oxidative stress and systemic inflammation, resulting in endothelial dysfunction and platelet membrane damage (19). These pathological processes increase platelet turnover and stimulate the development of larger, more reactive platelets, resulting in an increase in MPV values (19,20). Furthermore, insulin resistance—frequently observed in patients with long-standing T2DM—contributes to endothelial dysfunction and disrupts the balance between procoagulant and anticoagulant factors, facilitating platelet aggregation and thrombus development (21). Although the length of diabetes was not expressly assessed in this investigation, patients with vascular complications are more likely to have a longer disease duration, which may partly explain the increased MPV levels seen (22).

In contrast, Platelet Distribution Width (PDW) did not differ statistically significantly between individuals with and without vascular complications (p=0.582). This finding is consistent with the research by Shilpi et al. (2018), which found that while MPV, PDW, and platelet-large cell ratio (P-LCR) were typically higher in patients with type 2 diabetes mellitus who had microvascular difficulties such as diabetic retinopathy and nephropathy, these differences were not statistically significant (23). The absence of a link between PDW and vascular complications may be explained by inter-individual variation, discrepancies in glycemic control, medication use, and methodological variances among studies.

In contrast to the research by Joshi et al (2019), which showed that larger, younger, and hyperactive platelets clot more readily than smaller platelets due to increased serotonin and beta-thromboglobulin secretion, denser granules, and greater thromboxane A2 production, which causes a procoagulant effect leading to thrombotic vascular complications (16,24). This indicates a link between platelet size and vascular complications of diabetes, implying that changes in MPV reflect thrombogenesis. Although not significant in this research, the evaluation of PDW as a marker of vascular complications in people with type 2 diabetes warrants further investigation, since numerous studies support its use in forecasting some vascular complications in T2DM patients (25).

## CLINICAL IMPLICATION

The findings of this investigation suggest that Mean Platelet Volume (MPV) may have clinical utility as an easy and inexpensive indicator for the early screening of vascular risk in people with type 2 diabetes mellitus (T2DM). Because MPV is frequently acquired as part of a complete blood count (CBC), it may provide additional informational value without incurring additional testing or healthcare expenses, which may be useful, especially in regional or resource-constrained situations. Although MPV levels were significantly higher in people with vascular complications, this numerical discrepancy alone does not qualify MPV as a definitive clinical biomarker or indicator of vascular outcomes. Rather, it proposes a probable relationship that deserves further investigation

via prospective or longitudinal research to see if it has predictive value and clinical relevance.

In contrast, platelet distribution width (PDW) did not vary substantially between the groups. While the clinical importance of PDW in this trial is unknown, previous research indicates that it may be beneficial in some diabetic populations, warranting additional, more focused research. Overall, the integration of MPV into future risk-stratification algorithms should be done with care and backed by additional research to properly assess its prognostic value.

## LIMITATIONS

This research has certain limitations. The retrospective cross-sectional approach precludes causal interpretation between MPV or PDW and vascular complications. The use of secondary medical record data may result in inconsistencies due to inadequate documentation. Key confounding factors, including glycemic control, diabetes duration, drug use, and lifestyle, were not investigated. The single-center setting and small sample size may compromise the generalizability of findings. To validate MPV's usefulness and further explore PDW in T2DM vascular risk evaluation, more prospective, multi-center research including wider clinical data are required.

## CONCLUSIONS

According to this research, MPV had a strong link with vascular complications in T2DM patients and may serve as a simple and cost-effective biomarker for early detection of vascular risk, but PDW requires additional evaluation. The incorporation of routine MPV testing as part of a full hematology test (Complete Blood Count) can offer clinical advantages in the early screening of vascular problems, particularly in health care institutions with limited resources. As a result, doctors should begin to explore the use of MPV as a supplementary indication in the treatment of T2DM patients and encourage future research with a longitudinal design and a larger population to investigate the causal link between platelet index and vascular complications, as well as assess the clinical accuracy of PDW as a supporting biomarker in medical practice.

## CONFLICT OF INTEREST

The authors state that the research was carried out without any commercial or financial ties that might be interpreted as a conflict of interest.

## AUTHOR CONTRIBUTIONS

AP planned and designed the study, collected and processed the data, and wrote the report. SRD aided in data interpretation, extensively edited the document, and offered substantial intellectual input. SD contributed to data collecting, statistical analysis, and manuscript preparation.

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**DECLARATION OF ARTIFICIAL INTELLIGENCE USE**

The authors used ChatGPT (OpenAI, version GPT-5) to help with idea generation and literature search on the topic of Mean Platelet Volume and Platelet Distribution Width in Type II Diabetes. To assure accuracy, validity, and academic integrity, the authors thoroughly evaluated, verified, and improved all AI-assisted content.

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