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Comparison of Platelet Index in Type 2 Diabetes Mellitus Patients with and Without Diabetic Ulcers

Putri Rahma Yuliana*, Suhariyadi, Evy Diah Woelansari
Politeknik Kesehatan Kemenkes Surabaya, Indonesia
Email: putrirahmayuliana0@gmail.com*, suharkemenkes@gmail.com, evydiahws@gmail.com

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ABSTRACT

Hyperglycaemia is caused by poor insulin production and insulin resistance, which is the beginning of type 2 diabetes mellitus. The blockage of blood vessels caused by this disease is due to the increase in blood sugar levels, which is the cause of diabetic ulcers. As a result, patients are often unaware of their injuries. This research aims to identify differences in platelet indices (MPV, PDW, and PCT) in people with type 2 diabetes mellitus who have diabetic ulcers and those who do not. This research uses observational analysis methods and a cross-sectional analysis approach. The independent variable in this study was type 2 diabetes mellitus patients with and without diabetic ulcers, while the dependent variable was the platelet value, consisting of MPV in type 2 diabetes mellitus patients with and without diabetic ulcers of 7.716 fL and 7.837 fL, respectively. The mean PCT in type 2 diabetes mellitus patients with and without diabetic ulcers was 0.225% and 0.245%, respectively. The mean PDW in type 2 diabetes mellitus patients with and without diabetic ulcers was 18.825% and 14.237%, respectively. The results of data analysis using the unpaired t-test showed a p-value of 0.00 for PDW and 0.002 for MPV, so it was concluded that there were differences in MPV and PDW in type 2 diabetes mellitus patients who had diabetic ulcers and those who did not.

INTRODUCTION

Globally, diabetes mellitus (DM) represents a significant and escalating public health challenge. According to the World Health Organization (WHO), approximately 422 million people worldwide suffer from diabetes mellitus, with the disease contributing to 1.5 million deaths annually. The global prevalence of diabetes has shown a marked increase from 2015 to 2023, with projections indicating continued growth in the coming decades. Beyond mortality, diabetes mellitus imposes substantial economic and social burdens through increased healthcare costs, disability, and reduced productivity. In Southeast Asia, Indonesia ranks among the countries with the highest diabetes burden, highlighting the critical need for improved diagnostic and prognostic tools in this region (Nugrahani et al., 2025; Takkar et al., 2022).

Diabetes mellitus is the primary cause of several severe health complications, including cardiovascular disease, blindness, and kidney failure. The economic impact of diabetes treatment, coupled with the loss of productivity due to disability, creates a significant strain on healthcare systems and societies. In Indonesia, the prevalence of type 2 diabetes mellitus continues to rise, particularly among urban populations, making it an urgent public health priority that requires comprehensive management strategies and early detection of complications (Dany et al., 2020; Hidayat et al., 2022; Hossain, Al-Mamun, & Islam, 2024; Suastika, 2020).

Four types of tests can be used to diagnose diabetes mellitus, as the number of cases increases. Among others: "(1) plasma glucose test after administration of 75g of oral glucose

for two hours or glucose tolerance test; (2) plasma glucose check during fasting; (3) HbA1C examination; and (4) random blood glucose tests". Because the HbA1c test provides more accurate information about the actual health of diabetic patients, it is a very important tool for monitoring diabetes mellitus (Sartika & Hestiani, 2019). There are two types of diabetes mellitus: type one diabetes mellitus, which is caused by an autoimmune protein called pancreatic islet cells, and type two diabetes mellitus, which is caused by environmental factors such as aging, stress, obesity, poor diet and lack of mobility with genetic factors related to insulin resistance and impaired insulin secretion (Lestari & Zulkarnain, 2021).

Several previous studies have investigated platelet indices in diabetes mellitus patients. Mardia et al. (2018) demonstrated significant differences in platelet indices between diabetic patients with and without foot ulcers, showing that complications were associated with elevated MPV and PDW values. Zamzam et al. (2021) found that hemostatic system changes, including alterations in platelet parameters, were significantly associated with diabetic foot ulcer development. Korniluk et al. (2019) established that Mean Platelet Volume (MPV) serves as a valuable marker in the course and prognosis of inflammatory conditions, including diabetes mellitus. Additionally, Purnama and Safitri (2022) investigated blood cell parameters in type 2 diabetes mellitus patients with and without diabetic ulcers, highlighting the importance of hematological markers in assessing diabetic complications.

Hyperglycemia is the main cause of type 2 diabetes mellitus, which arises due to impaired conditions of insulin production and insulin resistance. Hyperglycemia, one of the characteristics of diabetes mellitus (DM) that can also be caused by other medical disorders, is defined as an increase in sugar levels (Purnama & Safitri, 2022). People with diabetics are often unaware of their high blood sugar levels, which can lead to peripheral neuropathy and blockage of blood vessels in the legs, which can lead to skin ulcers.

Hyperglycemia, which causes blood vessels to become stiff and narrow, is the leading cause of diabetic ulcers. The endothelium becomes damaged after injury, which causes platelets to attach to the endothelium (a process known as the adhesion process). To close the wound, the platelets then become proactive and disperse the contents of the granules "granules", which will combine the platelets with each other to combine and create platelet clumps (Durachim & Astuti, 2018). Thrombocytosis is caused by excessive production of platelets to close the incision. This results in reduced platelet formation and impaired function (Novitasari et al., 2019). Therefore, hematology tests in the form of platelet index are important to evaluate the function of hemostasis and have diagnostic uses for blood clotting disorders (Budiman et al., 2022).

Patients with diabetes mellitus can use platelet index as a prognostic biomarker for vascular problems. At Ibnu Sina Gresik Hospital, clinical observations indicate an increasing trend of diabetic ulcer cases among type 2 diabetes mellitus patients, with many cases presenting at advanced stages. This local phenomenon reflects the broader national pattern in Indonesia, where complications from diabetes mellitus often go undetected until significant tissue damage has occurred, underscoring the need for accessible and cost-effective biomarkers for early detection of vascular complications.

The urgency of this research lies in the critical need for early detection biomarkers for diabetic complications, particularly vascular disorders that lead to ulcer formation. Current diagnostic approaches for vascular complications in diabetes mellitus often rely on complex and expensive imaging techniques or invasive procedures. Platelet indices, which are readily available through routine complete blood count examinations, offer a potentially cost-effective and accessible alternative for identifying patients at high risk of developing diabetic ulcers. Early identification of these high-risk patients could enable timely intervention, potentially preventing or delaying the onset of diabetic ulcers and reducing the associated morbidity and healthcare costs. Given Indonesia's growing diabetes burden and limited

healthcare resources in many regions, establishing simple, affordable prognostic markers is particularly crucial.

The novelty of this research lies in its specific investigation of platelet indices (MPV, PDW, and PCT) as combined biomarkers for diabetic ulcer presence in the Indonesian population, specifically at Ibnu Sina Gresik Hospital. While previous international studies have examined individual platelet parameters in diabetes mellitus, limited research has comprehensively evaluated the combined utility of these three indices in the Indonesian context. Furthermore, this study contributes to the growing body of evidence supporting the use of routine hematological parameters as accessible prognostic tools in resource-limited settings, which is particularly relevant for developing countries like Indonesia where advanced diagnostic facilities may not be readily available in all healthcare centers.

Therefore, this research aims to identify differences in platelet indices (MPV, PDW, and PCT) between type 2 diabetes mellitus patients with and without diabetic ulcers at Ibnu Sina Gresik Hospital. The benefits of this research include providing evidence-based data to support the use of platelet indices as simple, cost-effective screening tools for identifying type 2 diabetes mellitus patients at high risk of developing vascular complications. The findings are expected to have practical implications for clinical practice, particularly in primary healthcare settings where early detection of diabetic complications can significantly improve patient outcomes and reduce the burden of advanced diabetic ulcer management. Additionally, this research may contribute to developing screening protocols that can be implemented in resource-limited healthcare facilities across Indonesia.

METHOD

This research employed an observational analytic method with a cross-sectional study design. The study was conducted at Ibnu Sina Gresik Hospital during February-March 2024. The research aimed to investigate the differences in platelet indices between groups of type 2 diabetes mellitus patients with and without diabetic ulcers.

The study population consisted of type 2 diabetes mellitus patients who met the following inclusion criteria: (1) diagnosed with type 2 diabetes mellitus with HbA1c levels ≥6.5% (above normal threshold), and (2) aged above 20 years. The total population meeting these criteria was 32 patients. Using total sampling technique, all 32 eligible patients were included in the study and divided into two groups: 16 respondents with diabetic ulcers and 16 respondents without diabetic ulcers. The independent variable in this study was type 2 diabetes mellitus patients with and without diabetic ulcers. The dependent variable consisted of platelet indices, specifically Plateletcrit (PCT), Platelet Distribution Width (PDW), and Mean Platelet Volume (MPV), obtained from hematology test results.

Data collection was performed through the following procedures: First, respondents were selected according to predetermined criteria by examining patient medical records to identify those meeting the inclusion criteria. After obtaining eligible samples, 3 ml of venous blood was collected by laboratory officers using standard phlebotomy procedures. The blood samples were placed in vacutainer tubes containing EDTA anticoagulant to prevent clotting. The tubes were then gently inverted 8 to 10 times to ensure proper mixing of blood with the anticoagulant. Each sample tube was labeled with patient identification and examination details.

Sample quality was assessed before analysis. Only samples in good condition without evidence of hemolysis were processed for examination. For type 2 diabetes mellitus patients, HbA1c levels were either tested or verified through medical record data to confirm the actual glycemic control status. Patients with HbA1c test results above the normal threshold (≥6.5%) proceeded to the next examination phase. Platelet indices (PDW, MPV, and PCT) were

analyzed using a hematology analyzer following standard operating procedures. All examination results were systematically recorded for subsequent analysis.

Data analysis was conducted in two stages. First, univariate analysis was performed to determine descriptive statistics including mean, minimum, maximum, and standard deviation for each platelet index parameter in both groups. Second, the normality of data distribution was assessed. Following confirmation of normal distribution, parametric statistical analysis using the unpaired t-test was conducted to evaluate the differences in platelet indices (MPV, PDW, and PCT) between type 2 diabetes mellitus patients with and without diabetic ulcers. Statistical significance was set at p-value <0.05. All statistical analyses were performed using SPSS version 25.0.

RESULTS AND DISCUSSION

Table 1. Identification of Type 2 DM Sufferers Who Have and Do Not Have Ulcers at Ibnu Sina Gresik Hospital.

Gender			Age		
Category	**(nF) Data**	**Percentage (%)**	**Category**	**(nF) Data**	**Percentage (%)**
Man	10	31,30%	10-19 years old (Teenager)	0	0
Woman	22	68,80%	20-44 years old (Adult)	3	9,4
			45-59 Years (Pre-elderly)	18	56,3
			>60 years old (Elderly)	11	34,4
Total	**32**	**100%**		**32**	**100%**

Table 1 outlines a total of 32 samples, 10 males and 22 females were determined. The results illustrate that there are more female patients than male patients. In addition, it can be seen that the majority of patients with type two diabetes mellitus at Ibnu Sina Gresik Hospital, both with and without diabetic ulcers, are in the age range of 45-59 years.

Table 2. Description of Statistical Data of Type 2 DM Platelet Samples That Have and Do Not Have Ulcers at Ibnu Sina Gresik Hospital.

		With ulcers				No Ulcers			
Varible	**(nF) data**	**Mean**	**Min**	**Max**	**Std. Dev**	**Mean**	**Min**	**Max**	**Std. Dev**
MPV	16	7,716	5,71	9,8	1,26814	7,837	6,9	8,8	0,55602
PCT	16	0,225	0,135	0,325	0,05324	0,245	0,137	0,37	0,06366
PDW	16	18,825	14,6	24,7	2,37585	14,237	12,5	15,3	0,86631

Table 2 explains the average MPV value in patients with type two diabetes mellitus who have and do not have diabetic ulcers of 7.716 fL and 7.837 fL. The average PCT value in people with type two diabetes mellitus who have and do not have diabetic ulcers is 0.225% and 0.245%. The average PDW value of people with type two diabetes mellitus who have and do not have diabetic ulcers is 18.825% and 14.237%.

Table 3. Frequency Distribution of Type 2 DM Platelet Index That Has and Does Not Have Ulcers at Ibnu Sina Gresik Hospital.

			With ulcers		No Ulcers	
	Normal value	**Information**	**(nF) data**	**Percentage (%)**	**(nF) data**	**Percentage (%)**
MPV	7.2-11.7 fL	Usual	10	62,5%	14	87,5%
	<7.2 fL	Low	6	37,5%	2	12,5%
	>11.7 fL	Tall	0	0	0	0
PCT	0,22-0,24%	Usual	0	0	0	0
	<0.22%	Low	9	56,3%	5	31,3%
	>0.24%	Tall	7	43,8%	11	68,8%
PDW	9-13 %	Usual	0	0	1	6,3%
	<9%	Low	0	0	0	0
	>13%	Tall	16	100%	15	93,8%

The MPV (Mean Platelet Volume) value is basically normal in people with type two diabetes mellitus who have and do not have diabetic ulcers, as shown in Table 5.3. In people with diabetes mellitus who do not have diabetic ulcers, PCT (Plateletcrit) values are more dominant in the high value range, while in people with diabetes mellitus who have diabetic ulcers the PCT value in the low value range, type two diabetes mellitus people who have and do not have diabetic ulcers all have high PDW (Platelet Distribution Width) values, and the group that does not dominate ulcers also has high values.

Table 4. T-Test results of MPV, PCT and PDW data of Type 2 DM Platelets Who Have and Do Not Have Ulcers at Ibnu Sina Gresik Hospital.

Variable	**Sig.**	**Decision**	**Information**
MPV with and without diabetic ulcers	0,002	Hi accepted	There is a difference
PCT with and without diabetic ulcers	0,343	H0Accepted	No difference
PDW with and without diabetic ulcers	0,000	Hi accepted	There is a difference

Based on table 4 MPV values "Mean Platelet Volume" and PDW "Platelet Distribution Wide" of people with type two diabetes mellitus who have diabetic ulcers are higher than those with diabetes mellitus without diabetic ulcers, according to the results of statistical analysis using SPSS 25.0 with Unpaired T-Test. However, the results of the PCT (Plateletcrit) test showed no difference between people with type two diabetes mellitus who had and did not have a diabetic ulcer.

Discussion

The results of this study in the form of platelet index values that have been examined are known to have an average MPV in people with type 2 diabetes mellitus along with diabetic ulcers of 7.716 fL and without diabetic ulcers showing a result of 7.837 fL. The average results of the MPV examination had normal values of eight patients with low PMV scores, but in statistical analysis it was found that there were differences in MPV values in patients with diabetes mellitus who had and did not have diabetic ulcers. MPV screening is used for prosnostics and risk markers for thrombolytic, cardiovascular and inflammatory diseases and sepsis (Bommenahalli et al., 2021). According to Mardia et al. (2018) who stated that there are differences in MPV in people with diabetes mellitus who have and do not have diabetic ulcers. According to Korniluk et al. (2019) low MPV can be caused by the use of statin drugs to lower cholesterol, high MPV levels in people with cardiovascular problems, such as diabetes mellitus, can be a sign of a possible increase in disease severity.

The average PDW of people with type 2 diabetes mellitus with diabetic ulcers was 18.825% if they did not have a diabetic ulcer of 14.237%. The data shows that the average PDW value is above normal and there is a difference in PDW values in people with type 2 diabetes mellitus who have or do not have diabetic ulcers, there is one patient without diabetic ulcers with normal PDW values. According to research by Mardia et al. (2018) which states that the PDW value of diabetics with vascular disorders is higher. The PDW checker is used to measure platelet size variability and is a marker of platelet activation. High PDW values are associated with an increased risk of cardiovascular thrombosis and low PDW values can be caused by bone marrow failure in producing platelets (Ulucan et al., 2016).

Average PCT results of patients with type two diabetes mellitus who had a diabetic ulcer of 0.225% of normal value and without having a diabetic ulcer of 0.245% of high value, it was found that eighteen patients had a high PCT value. Statistical analysis found no difference between people with diabetes mellitus who have or do not have diabetic ulcers. According to the statement of Purnama and Safitri (2022) that there is no difference in PCT values between people with type 2 diabetes mellitus who have or do not have diabetic ulcers. A decrease in PCT and platelet values and together illustrates that platelets have been used by the body excessively (thrombocytopenia), if the number of platelets and PCT increases simultaneously indicates thrombocytosis that occurs because the body fights infection or bleeding (Zhang et al., 2015).

The presence of diabetic ulcers in people with type 2 diabetes mellitus who have or do not have diabetic ulcers causes differences in platelet index values. This is shown in figure 5.1 and table 5.5 which shows that there is a difference in MPV and PDW values in people with type 2 diabetes mellitus who have and do not have diabetic ulcers. This is reinforced by the statement of Mardia et al. (2018) that people with diabetes with complications have high levels of MPV, PDW and PCT compared to people with diabetes mellitus without complications. In addition, MPV, PDW, and PCT values were significantly higher in diabetic ulcer diabetic mellitus patients compared to diabetic mellitus patients who did not have diabetic ulcers (Zamzam et al., 2021).

According to Trijuanita (2020) this difference in platelet index is due to an increase in platelet production in patients with diabetes mellitus until there is an increase in the release of immature platelets or from bone marrow megacaryocytes into the blood circulation. Platelet function is disrupted and production increases, thus reducing the lifespan of platelets in circulation. This is in accordance with the statement of Nurdin (2019) in patients with diabetes mellitus with complications of decreased insulin secretion can increase 2-4 times compared to healthy people, because in patients with diabetes mellitus there is hyperglycemia which stimulates protein C kinase which lowers the platelet stimulation threshold.

CONCLUSION

Results of Analysis of Platelet Index values for people with type two diabetes mellitus who have and who do not have diabetic ulcers at Gresik Hospital "Ibnu Sina" in March-April 2023. Platelet index in patients with type two diabetes mellitus was found to be above normal HbA1c test results showed that namely, the average MPV, PDW and PCT values in people with type two diabetes mellitus with diabetic ulcers were 7.716 fL, 18.825% and 0.225% while in patients with diabetes mellitus without diabetic ulcers showed results of 7.837 fL, 14.237% and 0.245%. Platelet index examination can be used as an alternative to examination to find out vascular complications experienced by people with type two diabetes mellitus. These findings suggest that platelet index examination, particularly MPV and PDW, can serve as accessible and cost-effective alternative biomarkers for identifying vascular complications in type 2 diabetes mellitus patients. Future research should investigate the

longitudinal predictive value of these platelet indices in diabetic ulcer development, explore the optimal cut-off values for clinical screening purposes, and examine the correlation between platelet indices and ulcer severity grades to enhance risk stratification and early intervention strategies in diabetes mellitus management.

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