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## Platelet to HDL Cholesterol Ratio (PHR) is Associated with Diabetes and Comorbidity Risk

Ani Umar<sup>1\*</sup>, Firdayanti<sup>1</sup>, Heni Umar<sup>2</sup>, Angriani Fusvita<sup>1</sup>, Susanti<sup>1</sup>, Sri Aprilianti Idris<sup>1</sup>

<sup>1</sup> Department of Medical Laboratory Technology, Bina Husada Kendari Polytechnic, Kendari, Indonesia

<sup>2</sup> Clinical Pathology Laboratory, Bahteramas Hospital, Kendari, Indonesia

\*Correspondence: [aniumar016@gmail.com](mailto:aniumar016@gmail.com)

Diabetes mellitus is a chronic metabolic disease characterized by hyperglycemia and closely associated with inflammation and lipid metabolism disorders, which increase the risk of comorbidities. This study aims to analyze the relationship between the platelet-to-HDL cholesterol ratio (PHR) and diabetes and the risk of comorbidities. This study used an observational analytic design involving 224 research subjects, consisting of 112 diabetes patients and 112 healthy individuals as controls. The examination included platelet counts and HDL cholesterol levels, and then the PHR value was calculated. Data analysis was carried out using descriptive, bivariate, and multivariate logistic regression to assess the relationship of PHR with the incidence of diabetes and comorbidities after controlling for confounding factors. The results showed that PHR values in diabetes patients were higher ( $5.49 \pm 2.10$ ) than in healthy individuals ( $4.25 \pm 2.39$ ;  $p < 0.001$ ) and were significantly associated with an increased risk of comorbidities. Holistic regression analysis showed that PHR was an independent factor contributing to the incidence of diabetes and its complications. The ROC curve showed that the AUC of PHR in predicting the risk of comorbidities was 0.70. The platelet to HDL cholesterol ratio (PHR) is significantly associated with diabetes and comorbidity risk and has the potential to be a simple, inexpensive, and easily accessible biomarker for screening complication risk in patients with diabetes and comorbidity risk.

**Keywords:** Platelet to HDL Ratio, Type 2 Diabetes Mellitus, Cardiometabolic Risk, Inflammatory Biomarker

### INTRODUCTION

Diabetes mellitus is a chronic metabolic disease characterized by hyperglycemia due to impaired insulin secretion, insulin action, or both (Reddy et al., 2023). This disease has become a global health problem with a prevalence that continues to increase from 9.3% (463 million individuals) in 2019, estimated to increase to 10.9% (700 million) in 2045 (J. Chen et al., 2024). Diabetes in Indonesia is a serious public health burden and contributes to high morbidity and mortality rates due to chronic complications such as cardiovascular disease, nephropathy, neuropathy, and retinopathy (Zhao et al., 2025). Kind 2 diabetes mellitus is closely related to chronic low-grade inflammatory tactics, insulin resistance, and endothelial disorder pathophysiologically. Platelet activation increases the risk of cardiovascular complications through inflammatory processes and atherothrombosis in diabetic patients (Hu et al., 2025). High-density lipoprotein (HDL) cholesterol levels have a protective effect on the cardiovascular system through anti-inflammatory, antioxidant, and endothelial function-

improving mechanisms (Zheng et al., 2023). Individuals with metabolic syndrome and diabetes often show decreased HDL levels (Li et al., 2020).

Platelet to HDL Ratio (PHR) is a new parameter that can be easily obtained from routine laboratory tests (J. Chen et al., 2024). This ratio reflects the balance between prothrombotic activity and protective lipid status in the body. High platelet values reflect inflammatory activation and risk of thrombosis, while low HDL levels are associated with an increased risk of atherosclerosis (Wang et al., 2024). As a composite index combining platelet count and HDL cholesterol levels, the Platelet to HDL Ratio (PHR) reflects systemic inflammation and the tendency for thrombosis (Delibaş Katı & Uçan Tokuç, 2025; Ding J et al., 2023). Several latest research have said a big association between PHR and various persistent diseases, such as high blood pressure, heart failure, and diabetes, suggesting its potential as a predictor of cardiometabolic disorders (Ye et al., 2024).

Chronic low-grade inflammation associated with obesity is a major risk factor in the pathogenesis and

progression of metabolic disorders (Tudurachi et al., 2023). Research Marra et al. (2024) established that several inflammatory indices derived from complete blood counts, including PHR, have good validity in predicting metabolic syndrome (MetS) in individuals with severe obesity, as a result potentially serving as a clinical tool for assessing obesity-related metabolic risk. A retrospective study reported that PHR can be used as a reliable indicator for predicting the incidence of type 2 diabetes mellitus in obese people (P. Chen et al., 2024). PHR is idea to be a simple biomarker for assessing the risk of diabetes and the possibility of comorbidities, especially cardiovascular disease. several international studies have shown a relationship between hematological parameters and lipid profiles with the incidence of diabetes and its complications. (Ye et al., 2024)(Ye et al., 2024).

However, studies that specifically evaluate the ratio of platelets to HDL cholesterol as an indicator of the risk of diabetes and its comorbidities are still limited, especially in the Indonesian population. research that integrates hematology and lipid parameters into a single ratio indicator that is practical and applicable to primary health care is still limited. This research is important to analyze the relationship between the platelet to HDL cholesterol ratio (PHR) with the incidence of diabetes and the risk of comorbidities.

## METHODS

### Research Type

This study used an analytical observational design with a cross-sectional method to analyze the relationship between Platelet to HDL Ratio (PHR) and the incidence of diabetes and the risk of comorbidities at a single observation time without intervention in the research subjects.

### Population and Study Subjects

The populace of this study included outpatients at the Bahteramas regional trendy hospital Laboratory, with the study period running from July 2025 to December 2025. The sample of this study consisted of patients selected based on predetermined inclusion and exclusion criteria. The inclusion criteria for this study were patients aged  $\geq 18$  years, undergoing platelet count and HDL cholesterol level examinations, having a diabetes diagnosis status based on a doctor's diagnosis or glucose test results, having comorbidity data in the form of metabolic syndrome (MetS), and being willing to participate by signing an informed consent form. Exclusion criteria for this study included patients with acute infections, such as sepsis or acute pneumonia, which can significantly affect platelet counts, patients with severe liver disease or cease-stage renal failure, patients taking medications that affect platelet counts or lipid levels, and patients with incomplete laboratory data. The number of samples in this study was 224 participants selected using purposive sampling technique, consisting of 112 diabetes patients with comorbidities and 112 participants as healthy individuals.

### Research Variables

The independent variable in this study was the platelet to HDL cholesterol ratio (PHR). PHR was the primary variable analyzed as a factor associated with diabetes incidence and comorbidity risk. PHR values were calculated using the formula  $PHR = \text{platelet count (} 10^3/\mu\text{L)} \text{ divided by HDL cholesterol level (mg/dL)}$ . Platelet counts were obtained from routine hematology tests, while HDL cholesterol levels were obtained from lipid profiles. furthermore, PHR values were categorized based on cut-off values determined through ROC curve analysis. The dependent variable in this study was diabetes mellitus with comorbidities, namely patients who had been diagnosed with diabetes mellitus and had one or more comorbidities. The control group consisted of individuals without a history of diabetes and without metabolic comorbidities (MetS). Confounding variables are factors that can influence the relationship between PHR and diabetes. Confounding variables in this study included age, gender, body mass index (BMI), blood pressure, glucose levels, and lipid profile parameters, namely total cholesterol, HDL cholesterol, triglycerides, and LDL cholesterol.

### Statistical Analysis

The data acquired were analyzed using the Statistical package for the Social Sciences (SPSS) version 23.00. Descriptive analysis was performed to describe the characteristics of the study subjects, both in the group of diabetes patients with comorbidities and in the group of healthy individuals. furthermore, binary logistic regression analysis was used to assess the independent association between PHR and the incidence of diabetes with comorbidities. Receiver operating characteristic (ROC) curve analysis was used to assess the PHR's ability to differentiate between diabetic patients with comorbidities and healthy individuals. determining the significance of the relationship between variables was based on the probability cost (p-value), where a p-value  $< 0.05$  indicates a statistically significant relationship, while a p-value  $> 0.05$  indicates a statistically insignificant relationship.

### Ethics

This take a look at has obtained approval from the research Ethics Committee of Bahteramas regional general hospital underneath number: 44/KEP/RSUD/VII/2025. After the research objectives and procedures had been explained, each participant provided written consent through an informed consent form. Confidentiality of participant data was guaranteed, and participants were assured that the research report was prepared based on the aggregated data without disclosing individual identities.

## RESULT AND DISCUSSION

### Characteristics of Study Subjects

Table 1 presents the general characteristics of the study participants, providing an overview of the baseline profile of each group. The analysis revealed no statistically

significant difference in age between healthy individuals and patients with diabetes mellitus and comorbidities, indicating a comparable age distribution across groups. (55.92 ± 10.09 vs. 56.82 ± 12.16 years; p = 0.551). In contrast, gender distribution was significantly different between the two groups (p = 0.007). Platelet counts were significantly higher in diabetes mellitus sufferers with comorbidities compared to healthy individuals (281.26 ± 89.48 vs. 229.98 ± 74.44 ×10<sup>3</sup>/μL; p < 0.001). Conversely, high-density

lipoprotein cholesterol levels were significantly lower in the diabetes mellitus group with comorbidities compared to healthy individuals (53.75 ± 12.72 vs. 60.82 ± 20.07 mg/dL; p < 0.001). In line with these differences, the platelet to high-density lipoprotein ldl cholesterol ratio turned into significantly higher in diabetes mellitus patients with comorbidities as compared to wholesome individuals (5.49 ± 2.10 vs. 4.25 ± 2.39; p < 0.001).

**Table 1.**  
Characteristics of Study Subjects

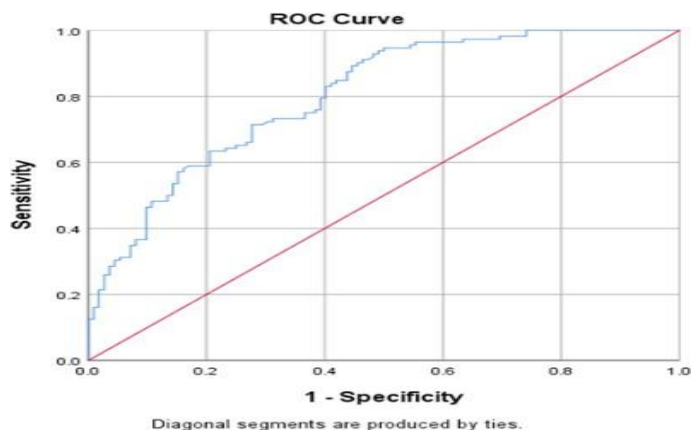
Variable	Healthy individuals N= 112	DM Patients+ Mets N= 112	P-Value
Age (years), mean ± SD	55.92±10.09	56.82±12.16	0.551
Jenis kelamin (M/F), n (%)	61 (54.5%) / 51 (45.5%)	50 (44.6%) / 62 (55.4%)	0.007
Platelet (10 <sup>3</sup> /μL), mean ± SD	229.98 ± 74.44	281.26 ± 89.48	0.000
HDL (mg/dL), mean ± SD	60.82 ± 20.07	53.75 ± 12.72	0.000
PHR, mean ± SD	4.25 ± 2.39	5.49 ± 2.10	0.000

**The relationship between PHR and the incidence of diabetes accompanied by comorbidities**

**Table 2.**  
Logstic Regression Analysis of the Relationship between PHR and Diabetes and Comorbidities

Variable	OR	95% CI	p-value
PHR	2.112	1.681–2.654	<0.001

As shown in table 2, PHR was significantly associated with diabetes with comorbidities, with an odds ratio (OR) of 2.11 and a 95% confidence interval (CI) of 1.681–2.654 (p < 0.001). This finding indicates that individuals with higher PHR values had a 2.11-fold greater risk of developing diabetes with comorbidities compared to individuals with lower PHR values.



**Figure 1.** ROC Curve

As shown in figure 1, the Receiver operating characteristic (ROC) curve analysis results showed an area under the curve (AUC) of 0.802 (95% CI: 0.746–0.858; p < 0.001). The optimal PHR cut-off value was 38.333, with a sensitivity of 93.8% and a specificity of 50.9%. High sensitivity indicates that the PHR has excellent ability to identify diabetic patients with comorbidities, while moderate specificity indicates limitations in accurately classifying healthy individuals. Overall, these results indicate that the PHR has good screening ability in differentiating diabetic patients with comorbidities from healthy individuals.

**Discussion**

The main findings of this study indicate that the platelet to high-density lipoprotein cholesterol ratio is significantly higher in patients with diabetes mellitus with comorbidities compared to healthy individuals. In addition, logistic regression analysis showed that the platelet to high-density lipoprotein cholesterol ratio was

significantly associated with the incidence of diabetes mellitus with comorbidities, with an odds ratio of 2.112 (95% CI: 1.681–2.654;  $p < 0.001$ ). Receiver operating characteristic (ROC) curve analysis also showed that the platelet to high-density lipoprotein cholesterol ratio has good diagnostic ability, with an area under the curve (AUC) of 0.802. these findings indicate that an increased platelet to high-density lipoprotein cholesterol ratio is associated with an extended danger of diabetes mellitus with comorbidities and shows potential as a clinically relevant biomarker.

The findings of this study align with several preceding studies that reported a significant association between the platelet to high-density lipoprotein cholesterol ratio and metabolic disorders. A study by P. Chen et al. (2024) showed that the platelet to high-density lipoprotein cholesterol ratio was significantly associated with the incidence of diabetes and prediabetes and has the potential to be used as an indicator of metabolic risk. Another study also reported that this ratio was associated with metabolic syndrome and metabolic obesity (Wu et al., 2025). The consistency of these findings strengthens the evidence that the platelet to high-density lipoprotein cholesterol ratio is an indicator reflecting hematological and metabolic changes that play a role inside the pathogenesis of diabetes. Biologically, the relationship between the platelet-to-high-density lipoprotein (HDL) cholesterol ratio and diabetes mellitus can be understood through their roles in inflammation and impaired vascular function. Chronic hyperglycemia in diabetes contributes to platelet activation and increased release of anti mediators, ultimately leading to endothelial damage and increasing the risk of vascular complications. An elevated platelet count reflects the proanti and prothrombotic conditions common in individuals with diabetes mellitus (Lao et al., 2023). Conversely, HDL has a protective effect through its anti-inflammatory and antioxidant properties, as well as its ability to maintain and repair endothelial function. Decreased HDL levels in diabetic patients can weaken these protective effects, thereby increasing the risk of metabolic disorders and cardiovascular complications (Cicek et al., 2024; Hou et al., 2024). Thus, an elevated platelet-to-HDL ratio reflects an imbalance between proanti and protective factors, which plays a role in the pathogenesis and progression of diabetes mellitus and its associated comorbidities (Du et al., 2025).

The area under the curve (AUC) value of 0.802 in this study indicates that the platelet to high-density lipoprotein (HDL) cholesterol ratio has good discriminatory ability in differentiating patients with diabetes mellitus with comorbidities from healthy individuals. This finding is consistent with previous studies that reported that the ratio has adequate diagnostic value in identifying metabolic disorders and the risk of cardiovascular complications (Liao et al., 2023). The high sensitivity value indicates that the platelet to HDL ratio has the capacity to be used as a screening tool to detect high-risk individuals. However,

the moderate specificity value indicates that this parameter should not be used as the sole diagnostic indicator, but rather as part of a comprehensive clinical evaluation and combined with other clinical and laboratory parameters to improve diagnostic accuracy (Tong & Lou, 2025).

Although this study yielded significant findings, several barriers should be considered in interpreting the results. First, the cross-sectional design did not allow for a causal relationship between the platelet-to-high-density lipoprotein (HDL) cholesterol ratio and the incidence of diabetes mellitus with comorbidities, thus the association found was only associative (Feng et al., 2025). Second, this study was conducted at a single healthcare center with a relatively limited sample size, potentially limiting the external validity and generalizability of the findings to a broader population. Third, other factors known to influence platelet count and HDL levels, such as systemic inflammation status, lifestyle, use of certain cures, and genetic factors, were not comprehensively analyzed. Therefore, further studies with a longitudinal design, large sample size, and consideration of these confounding factors are had to confirm the association and strengthen the validity of this study's findings. Despite these limitations, this look at offers important practical and theoretical implications. The platelet-to-high-density lipoprotein cholesterol ratio is readily available through routine laboratory testing, making it a potential simple, cost-effective, and accessible biomarker to help identify individuals at risk for diabetes mellitus and comorbidities. Furthermore, these findings reinforce the concept that inflammation and lipid metabolism dysfunction play a key role in the pathogenesis of diabetes mellitus and the development of its complications. However, given the limitations of the study design and the incompletely controlled confounding factors, further studies with longitudinal designs, large sample sizes, and more heterogeneous populations are needed to confirm the predictive value of this ratio and more comprehensively evaluate its utility in clinical practice.

## CONCLUSIONS

This study aimed to evaluate the relationship between the platelet to high-density lipoprotein cholesterol ratio and the incidence of diabetes mellitus with comorbidities. The results showed that the ratio was significantly associated with diabetes mellitus and comorbidities and demonstrated good capability to identify individuals with the condition. These findings indicate that the platelet to high-density lipoprotein cholesterol ratio has the capability to be used as a simple and easily received biomarker through routine laboratory checking out to assist in assessing the risk of diabetes mellitus and its comorbidities. This study also contributes to the development of biomarkers based on hematological and lipid parameters, which can be utilized to support early detection and clinical risk evaluation.

## SUGGESTION

This study shows that the platelet to HDL cholesterol ratio (PHR) is a simple, inexpensive, and non-invasive biomarker because it could be calculated from routine blood tests, namely complete blood count (CBC) and lipid profile, and has good discriminatory ability (AUC 0.80) in identifying the risk of diabetes mellitus. However, this study has limitations because it used a cross-sectional design and involved a relatively limited sample size from a single service center, namely Bahteramas regional general hospital. Therefore, further research is recommended to use a prospective longitudinal design with a larger sample size and a longer follow-up period to more accurately evaluate the role of PHR as a predictor of diabetes incidence and cardiovascular complications. Furthermore, further research should also contain a more diverse population and consider other confounding factors, such as inflammatory status, ongoing therapy, and lifestyle factors, to increase outside validity and strengthen the evidence for the clinical utility of PHR.

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