



RESEARCH ARTICLE

Diagnostic Accuracy of Neutrophil-to-Lymphocyte Ratio and Platelet-to-Lymphocyte Ratio for Detection of Microalbuminuria in Patients with Diabetes Mellitus: A Hospital-Based Cross-Sectional Observational Study

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ABSTRACT

Background: Diabetes mellitus (DM) is one of the leading causes of chronic kidney disease worldwide. Diabetic nephropathy develops gradually, with microalbuminuria representing the earliest clinically detectable manifestation of renal involvement. Early identification of patients at increased risk is essential because timely intervention can delay or prevent progression to overt nephropathy and end-stage renal disease. Although urinary albumin estimation remains the gold standard for detecting microalbuminuria, it may not always be readily available in resource-limited settings. Chronic low-grade inflammation plays a pivotal role in the development of diabetic vascular complications. Neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR), derived from routine complete blood counts, have emerged as inexpensive inflammatory biomarkers reflecting systemic inflammation. Their potential diagnostic value in identifying microalbuminuria among patients with diabetes has generated increasing research interest.

Methodology: A hospital-based cross-sectional observational study was conducted in the Department of Medicine, Pt. Jawaharlal Nehru Memorial Medical College and Dr. B.R.A.M. Hospital, Raipur, Chhattisgarh, over one year. One hundred twenty adult patients with diabetes mellitus fulfilling the eligibility criteria were enrolled consecutively. Clinical characteristics, duration of diabetes, anthropometric measurements, laboratory investigations, complete blood count parameters, NLR, PLR, HbA1c, and urinary albumin excretion were recorded. Diagnostic performance of NLR and PLR for detecting microalbuminuria was evaluated using receiver operating characteristic (ROC) curve analysis. Statistical analysis was performed using IBM SPSS Statistics version 26.0.

Results: Among 120 patients, 48 (40.0%) had microalbuminuria. Patients with microalbuminuria demonstrated significantly higher mean NLR (3.91 ± 1.24 vs. 2.18 ± 0.76 ; $p < 0.001$) and PLR (164.7 ± 39.8 vs. 118.5 ± 28.9 ; $p < 0.001$) compared with normoalbuminuric patients. ROC analysis showed that NLR had an area under the curve (AUC) of 0.86 (95% CI: 0.79–0.92), whereas PLR demonstrated an AUC of 0.81 (95% CI: 0.73–0.89). At an optimal cut-off value of 2.95, NLR showed 83.3% sensitivity and 80.6% specificity for detecting microalbuminuria.

Conclusion: Both NLR and PLR were significantly associated with microalbuminuria among patients with diabetes mellitus. NLR demonstrated superior diagnostic accuracy compared with PLR and may serve as a practical, inexpensive, and readily available screening biomarker for early diabetic nephropathy.

Keywords: Diabetes mellitus; Microalbuminuria; Neutrophil-to-lymphocyte ratio; Platelet-to-lymphocyte ratio; Diabetic nephropathy; Diagnostic accuracy.

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INTRODUCTION

Diabetes mellitus (DM) is among the most prevalent chronic metabolic disorders worldwide and represents one of the greatest public health challenges of the twenty-first century. The International Diabetes Federation estimated that approximately 537 million adults were living with diabetes in 2021, and this number is projected to exceed 780 million by 2045 if current trends continue. India has emerged as one of the countries with the highest burden of diabetes, accounting for nearly one-sixth of the global diabetic population. The rapid increase in diabetes prevalence has been attributed to urbanization, sedentary

lifestyles, obesity, unhealthy dietary habits, population ageing, and genetic susceptibility. The growing burden of diabetes has consequently led to a marked increase in chronic vascular complications, particularly diabetic kidney disease, cardiovascular disease, retinopathy, and neuropathy, which significantly contribute to morbidity, mortality, and healthcare expenditure worldwide.[1,2]

Diabetic nephropathy remains one of the most common and devastating microvascular complications of diabetes mellitus. It is the leading cause of chronic kidney disease and end-stage renal disease in many countries and substantially increases cardiovascular

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mortality. Approximately 30–40% of patients with diabetes eventually develop diabetic kidney disease during the course of their illness. The pathological changes include glomerular basement membrane thickening, mesangial expansion, podocyte injury, glomerulosclerosis, tubular inflammation, and progressive decline in renal function. Early detection of nephropathy is therefore critical because therapeutic interventions initiated during the early stages can considerably delay disease progression and reduce long-term renal complications.[3,4]

Microalbuminuria represents the earliest clinically detectable stage of diabetic nephropathy and is defined as urinary albumin excretion between 30 and 300 mg/day or an albumin-to-creatinine ratio of 30–300 mg/g. Beyond its significance as an indicator of renal injury, microalbuminuria is also recognized as an independent predictor of cardiovascular disease, stroke, and all-cause mortality in patients with diabetes. Numerous longitudinal studies have demonstrated that individuals with persistent microalbuminuria have a substantially greater risk of progression to overt proteinuria, declining glomerular filtration rate, and end-stage renal disease than those with normoalbuminuria.[5,6]

The pathogenesis of diabetic nephropathy is complex and multifactorial. Chronic hyperglycaemia induces oxidative stress, formation of advanced glycation end products, activation of the renin-angiotensin-aldosterone system, endothelial dysfunction, chronic inflammation, and altered renal haemodynamics. These

mechanisms collectively contribute to increased glomerular permeability, mesangial matrix expansion, podocyte dysfunction, and progressive renal fibrosis. Among these pathogenic mechanisms, persistent low-grade inflammation has emerged as a central contributor to both the initiation and progression of diabetic kidney disease. Inflammatory cytokines such as interleukin-6, tumour necrosis factor- α , transforming growth factor- β , and C-reactive protein have been implicated in accelerating glomerular injury and renal fibrosis.[7,8]

Growing evidence indicates that systemic inflammatory biomarkers derived from routine hematological investigations may provide valuable information regarding diabetic vascular complications. Complete blood count is one of the most commonly performed laboratory investigations in clinical practice and provides several inflammatory indices without additional cost. Among these indices, the neutrophil-to-lymphocyte ratio (NLR) has received increasing attention because it reflects the balance between innate inflammatory responses and adaptive immune regulation. Neutrophilia indicates activation of inflammatory pathways, whereas lymphopenia reflects physiological stress and impaired immune regulation. Consequently, elevated NLR has been associated with several inflammatory, cardiovascular, autoimmune, malignant, and metabolic disorders.[9]

Similarly, the platelet-to-lymphocyte ratio (PLR) has emerged as another promising inflammatory biomarker. Platelets actively participate in inflammatory responses through release of chemokines, cytokines, growth factors, and prothrombotic mediators. Increased platelet activation contributes to endothelial dysfunction, vascular inflammation, and accelerated atherosclerosis. Elevated PLR has therefore been associated with chronic inflammatory diseases, cardiovascular events, diabetic complications, malignancies, and adverse clinical outcomes. Because both NLR and PLR are inexpensive, reproducible, and universally available, they have considerable potential for routine clinical application, particularly in resource-limited healthcare settings.[10]

Several investigators have explored the association between inflammatory biomarkers and diabetic nephropathy. Previous studies have demonstrated significantly higher NLR and PLR values among diabetic patients with microalbuminuria compared with those without renal involvement. Elevated NLR has also shown significant correlations with urinary albumin excretion, estimated glomerular filtration rate, glycaemic control, and severity

of diabetic nephropathy. Nevertheless, reported cut-off values and diagnostic performance vary considerably across different populations owing to variations in ethnicity, duration of diabetes, treatment strategies, glycaemic control, and prevalence of comorbid conditions.[11]

Receiver operating characteristic (ROC) curve analysis has become the standard statistical approach for evaluating diagnostic biomarkers. Parameters such as area under the curve (AUC), sensitivity, specificity, positive predictive value, negative predictive value, and optimal cut-off values enable objective assessment of diagnostic performance. Although urinary albumin estimation remains the reference investigation for diagnosing microalbuminuria, inflammatory indices such as NLR and PLR may serve as valuable adjunctive screening tools, particularly where specialized laboratory facilities are unavailable.[12]

India continues to experience a rapidly increasing burden of diabetes and diabetic kidney disease. Despite this growing public health concern, relatively few studies have comprehensively evaluated the diagnostic accuracy of NLR and PLR for detecting microalbuminuria among Indian patients with diabetes mellitus. Furthermore, most available studies have involved relatively small sample sizes or have evaluated only one inflammatory biomarker. Comparative assessment of both NLR and PLR within the same patient population may provide more clinically meaningful information regarding their diagnostic utility.[13]

Early identification of patients at increased risk of diabetic nephropathy enables timely institution of intensive glycaemic control, blood pressure optimization, renin-angiotensin system blockade, sodium-glucose cotransporter-2 inhibitors, lifestyle modification, and regular renal surveillance. Therefore, identifying simple, inexpensive, and universally available biomarkers capable of predicting early renal involvement has important clinical implications, especially in developing countries where healthcare resources remain limited.[14]

Recent advances in understanding the inflammatory basis of diabetic complications have reinforced the concept that inflammatory biomarkers should complement traditional metabolic indicators during risk assessment. Incorporating hematological inflammatory indices into routine diabetic evaluation may improve early identification of patients at high risk of nephropathy without substantially increasing healthcare costs. Because complete blood count is routinely performed in almost every hospitalized

patient, calculation of NLR and PLR requires no additional laboratory expenditure or sophisticated equipment, making these indices particularly attractive for widespread clinical use.[15]

Several meta-analyses have further confirmed that elevated NLR is consistently associated with diabetic nephropathy and may predict progression of renal impairment. Similarly, PLR has demonstrated moderate diagnostic utility in several observational studies. Nevertheless, direct comparisons between both biomarkers remain limited, and consensus regarding the superior predictor has not yet been established. Additional studies from different geographical regions are therefore required to validate these findings and determine clinically useful cut-off values.[16]

The present study was therefore undertaken to evaluate the diagnostic accuracy of neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio for detecting microalbuminuria among patients with diabetes mellitus attending a tertiary care teaching hospital. The study also aimed to compare the diagnostic performance of these inflammatory biomarkers using ROC curve analysis and identify their potential role as inexpensive screening tools for early diabetic nephropathy.[17]

MATERIALS AND METHODS

Study Design

A hospital-based cross-sectional observational study was conducted to evaluate the diagnostic accuracy of inflammatory biomarkers, namely neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR), for detecting microalbuminuria among patients with diabetes mellitus.

Study Setting

The study was conducted in the Department of Medicine, Pt. Jawaharlal Nehru Memorial (Pt. JNM) Medical College and Dr. B.R.A.M. Hospital, Raipur, Chhattisgarh, India.

Study Duration

The study was carried out over a period of one year, from January 2025 to December 2025.

Study Population

Adult patients with Type 2 Diabetes Mellitus attending the outpatient and inpatient services of the Department of Medicine during the study period were screened for eligibility.

Sample Size

A total of 120 patients fulfilling the eligibility criteria were

Table 1: Baseline Demographic Characteristics of the Study Population (n = 120)

Variable	Frequency (n)	Percentage (%)
<i>Age (years)</i>		
<40	16	13.3
40–49	22	18.3
50–59	38	31.7
≥60	44	36.7
<i>Gender</i>		
Male	68	56.7
Female	52	43.3

Mean age = 56.8 ± 10.4 years

enrolled consecutively during the study period.

Inclusion Criteria

- Patients fulfilling all of the following criteria were included:
- Age ≥18 years.
- Diagnosed Type 2 Diabetes Mellitus according to American Diabetes Association (ADA) 2025 criteria.
- Duration of diabetes ≥1 year.
- Willing to provide written informed consent.
- Availability of complete laboratory investigations including urine albumin estimation and complete blood count.

Exclusion Criteria

- Patients with the following conditions were excluded:
- Type 1 Diabetes Mellitus.
- Macroalbuminuria (>300 mg/day).
- Acute urinary tract infection.
- Chronic inflammatory disorders.

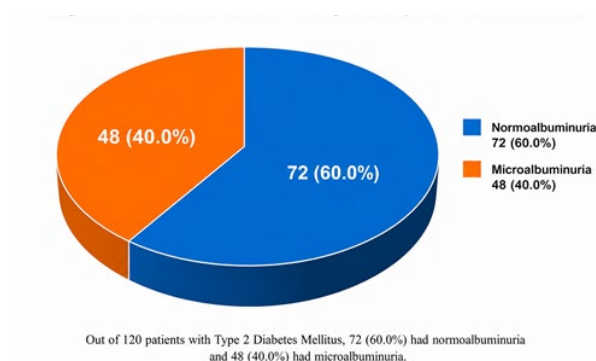


Figure 1: Distribution of Patients According to Urinary Albumin Status

Table 2: Baseline Clinical Characteristics

Variable	Mean ± SD / n (%)
Duration of Diabetes (years)	9.4 ± 4.8
HbA1c (%)	8.1 ± 1.5
BMI (kg/m ²)	26.3 ± 3.4
Hypertension	74 (61.7%)
Dyslipidaemia	52 (43.3%)
Smoking	30 (25.0%)
Alcohol Consumption	24 (20.0%)

- Autoimmune diseases.
- Active malignancy.
- Acute infections.
- Hematological disorders affecting leukocyte or platelet counts.
- Chronic liver disease.
- End-stage renal disease.
- Pregnancy.
- Current corticosteroid or immunosuppressive therapy.
- Recent major surgery or trauma.

Study Procedure

After obtaining written informed consent, each participant underwent detailed clinical evaluation.

Demographic details including age, sex, occupation, residence, duration of diabetes, smoking status, alcohol consumption, hypertension, dyslipidaemia, medication history, and family history of diabetes were recorded using a structured case record form.

Anthropometric measurements including height, weight, body mass index (BMI), and waist circumference were obtained according to standard techniques.

Blood pressure was measured after five minutes of rest using a calibrated sphygmomanometer.

Laboratory Investigations

Following an overnight fast of at least eight hours, venous blood samples were collected under aseptic precautions.

The following investigations were performed

- Complete blood count (CBC)
- Fasting Blood Sugar (FBS)

Table 3: Distribution According to Urinary Albumin Status

Albumin Status	Frequency	Percentage
Normoalbuminuria	72	60.0
Microalbuminuria	48	40.0

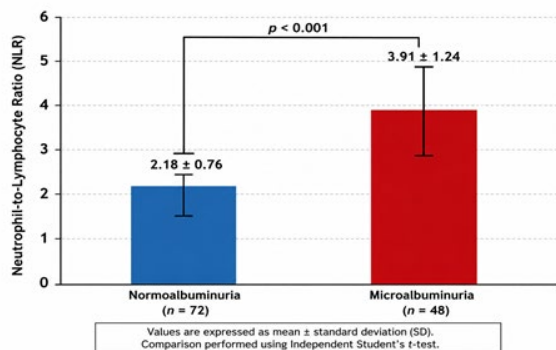


Figure 2: Comparison of Neutrophil-to-Lymphocyte Ratio (NLR) Between Study Groups

- Postprandial Blood Sugar (PPBS)
- HbA1c
- Serum creatinine
- Blood urea
- Estimated Glomerular Filtration Rate (eGFR)
- Lipid profile
- Urine routine examination
- Urinary Albumin-Creatinine Ratio (UACR)

Estimation of Complete Blood Count

Complete blood counts were analyzed using an automated five-part hematology analyzer.

Absolute neutrophil count, lymphocyte count, and platelet count were recorded.

Calculation of Neutrophil-to-Lymphocyte Ratio

The NLR was calculated using the formula:

$$\text{NLR} = \frac{\text{Absolute Neutrophil Count}}{\text{Absolute Lymphocyte Count}}$$

Calculation of Platelet-to-Lymphocyte Ratio

The PLR was calculated using the formula:

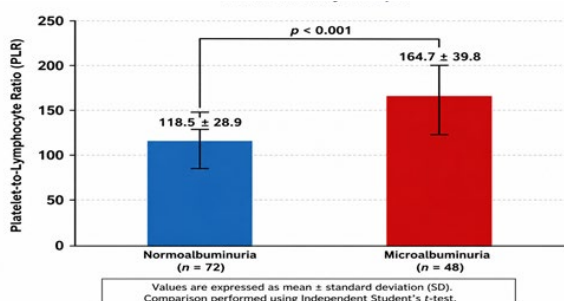


Figure 3: Comparison of Platelet-to-Lymphocyte Ratio (PLR) Between Study Groups

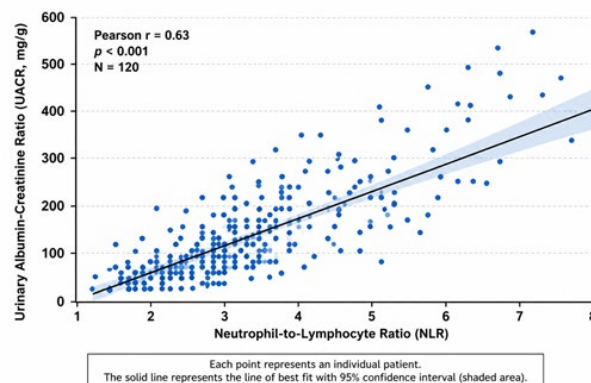


Figure 4: Correlation Between Neutrophil-to-Lymphocyte Ratio and Urinary Albumin-Creatinine Ratio

$$\text{PLR} = \frac{\text{Platelet Count}}{\text{Absolute Lymphocyte Count}}$$

Measurement of HbA1c

HbA1c estimation was performed using High Performance Liquid Chromatography (HPLC), standardized according to National Glycohemoglobin Standardization Program (NGSP) recommendations.

Assessment of Microalbuminuria

- Morning spot urine samples were collected.
- Urinary albumin excretion was estimated by immunoturbidimetric assay.

Microalbuminuria was defined as

- Urinary Albumin-Creatinine Ratio (UACR): **30–300 mg/g**
- Normoalbuminuria
- UACR <30 mg/g
- Patients with UACR >300 mg/g were excluded.

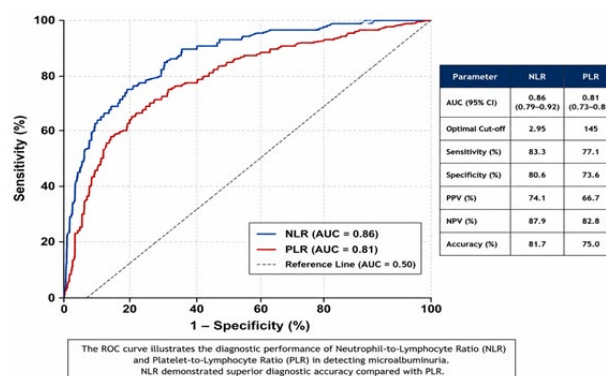


Figure 5: Receiver Operating Characteristic (ROC) Curves for NLR and PLR

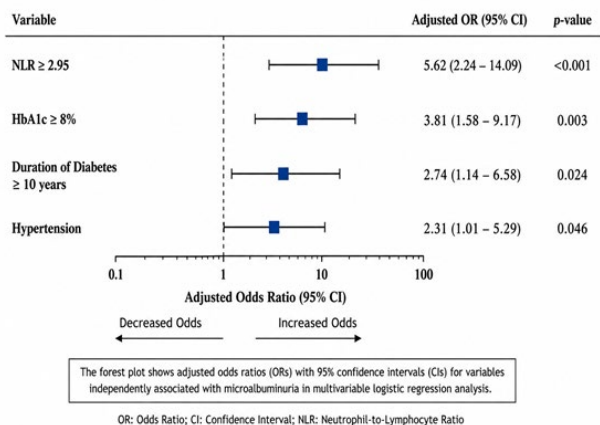


Figure 6: Forest Plot of Independent Predictors of Microalbuminuria

Study Variables

Primary Outcome Variable

Presence of microalbuminuria.

Primary Exposure Variables

Neutrophil-to-Lymphocyte Ratio (NLR)

Platelet-to-Lymphocyte Ratio (PLR)

Secondary Variables

- Age
- Gender
- Duration of diabetes
- Body Mass Index
- Hypertension
- Dyslipidaemia
- Smoking
- Alcohol consumption
- HbA1c
- Serum Creatinine
- eGFR

Table 4: Comparison of Laboratory Parameters

Variable	Normoalbuminuria (n=72)	Microalbuminuria (n=48)	p-value
HbA1c (%)	7.4 ± 1.1	9.2 ± 1.4	<0.001
Serum Creatinine (mg/dL)	0.92 ± 0.18	1.14 ± 0.29	<0.001
eGFR (mL/min/1.73m ²)	88.5 ± 14.2	74.8 ± 16.6	<0.001

Table 5: Comparison of Neutrophil-to-Lymphocyte Ratio

Variable	Normoalbuminuria	Microalbuminuria	p-value
NLR	2.18 ± 0.76	3.91 ± 1.24	<0.001

Table 6: Comparison of Platelet-to-Lymphocyte Ratio

Variable	Normoalbuminuria	Microalbuminuria	p-value
PLR	118.5 ± 28.9	164.7 ± 39.8	<0.001

- Fasting Blood Sugar
- Postprandial Blood Sugar

Outcome Measures

- Primary Outcome
- Diagnostic accuracy of
- Neutrophil-to-Lymphocyte Ratio
- Platelet-to-Lymphocyte Ratio
- for detecting microalbuminuria.

Secondary Outcomes

- Sensitivity
- Specificity
- Positive Predictive Value (PPV)
- Negative Predictive Value (NPV)
- Area Under ROC Curve (AUC)
- Diagnostic Odds Ratio
- Likelihood Ratio
- Independent predictors of microalbuminuria

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 26.0. Continuous variables were tested for normality using the Shapiro–Wilk test and expressed as mean ± standard deviation (SD) or median (interquartile range [IQR]), as appropriate, while categorical variables were presented as frequencies and percentages. Comparisons between patients with and without microalbuminuria were performed using the Independent Student's *t*-test, Mann–Whitney U test, Chi-square test, or Fisher's exact test, as appropriate. The

Table 7: Association Between Elevated NLR and Microalbuminuria

NLR	Normoalbuminuria	Microalbuminuria
<2.95	58	8
≥2.95	14	40

Chi-square = 36.82
p < 0.001

Table 8: Association Between Elevated PLR and Microalbuminuria

PLR	Normoalbuminuria	Microalbuminuria
<145	60	14
≥145	12	34

Chi-square = 28.16

p <0.001

diagnostic performance of the neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) was evaluated using Receiver Operating Characteristic (ROC) curve analysis, and the area under the curve (AUC), sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and optimal cut-off values were determined using the Youden Index. Pearson correlation analysis was performed to assess the relationship between inflammatory biomarkers and urinary albumin excretion. Variables significant on univariate analysis were entered into a multivariable binary logistic regression model to identify independent predictors of microalbuminuria, with results reported as adjusted odds ratios (ORs) and 95% confidence intervals (CIs). A two-tailed p-value <0.05 was considered statistically significant.

Ethical Considerations

- The study protocol was reviewed and approved by the Institutional Ethics Committee of Pt. Jawaharlal Nehru Memorial Medical College and Dr. B.R.A.M. Hospital, Raipur, prior to commencement of the study.
- Written informed consent was obtained from all participants before enrollment.
- Confidentiality of patient information was maintained throughout the study by anonymizing all collected data.
- The study was conducted in accordance with the ethical principles of the Declaration of Helsinki (2013 revision) and Good Clinical Practice guidelines.

RESULTS

A total of 120 patients with Type 2 Diabetes Mellitus were enrolled during the study period. Based on urinary albumin-creatinine ratio (UACR), 48 patients (40.0%) had microalbuminuria, whereas 72 patients (60.0%) had

Table 9: Correlation Between Inflammatory Biomarkers and Urinary Albumin Excretion

Variable	Pearson <i>r</i>	<i>p</i> -value
NLR vs UACR	0.63	<0.001
PLR vs UACR	0.54	<0.001
HbA1c vs UACR	0.58	<0.001

Table 10: Diagnostic Accuracy of NLR and PLR

Parameter	NLR	PLR
AUC (95% CI)	0.86 (0.79–0.92)	0.81 (0.73–0.89)
Optimal Cut-off	2.95	145
Sensitivity (%)	83.3	77.1
Specificity (%)	80.6	73.6
PPV (%)	74.1	66.7
NPV (%)	87.9	82.8
Diagnostic Accuracy (%)	81.7	75.0

normoalbuminuria.

Baseline Characteristics

- The baseline demographic characteristics of the study population are summarized in Table 1.
- The baseline clinical characteristics of study participants are presented in Table 2.
- The distribution of patients according to urinary albumin status is illustrated in Figure 1.

Comparison Between Groups

Patients with microalbuminuria had significantly higher HbA1c and serum creatinine levels, while eGFR was significantly lower than patients without microalbuminuria (Table 4).

- Patients with microalbuminuria had significantly higher NLR values compared with normoalbuminuric patients (Table 5).
- The comparison is illustrated in Figure 2.
- PLR was significantly elevated among patients with microalbuminuria (Table 6).
- The comparison is shown in Figure 3.

Association Analysis

- Elevated NLR was significantly associated with the presence of microalbuminuria (Table 7).
- Patients with elevated PLR had significantly higher prevalence of microalbuminuria (Table 8).

Table 11: Independent Predictors of Microalbuminuria

Variable	Adjusted OR	95% CI	<i>p</i> -value
NLR ≥2.95	5.62	2.24–14.09	<0.001
HbA1c ≥8%	3.81	1.58–9.17	0.003
Duration of Diabetes ≥10 years	2.74	1.14–6.58	0.024
Hypertension	2.31	1.01–5.29	0.046

Correlation Analysis

NLR demonstrated the strongest positive correlation with urinary albumin excretion (Table 9).

The scatter plot demonstrating the relationship between NLR and UACR is shown in Figure 4.

ROC Curve Analysis

Receiver operating characteristic analysis demonstrated that NLR had superior diagnostic performance compared with PLR for identifying microalbuminuria.

The ROC curves are presented in Figure 5.

Multivariable Logistic Regression

Multivariable logistic regression identified elevated NLR as the strongest independent predictor of microalbuminuria (Table 11).

The adjusted odds ratios are illustrated in Figure 6 (Forest Plot).

DISCUSSION

The present study evaluated the diagnostic accuracy of the neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) for detecting microalbuminuria among patients with Type 2 diabetes mellitus. The principal findings demonstrated that patients with microalbuminuria had significantly higher NLR and PLR values than those with normoalbuminuria. Receiver operating characteristic (ROC) analysis further showed that NLR had better diagnostic performance than PLR, with an area under the curve (AUC) of 0.86 compared with 0.81. Moreover, multivariable logistic regression identified elevated NLR as the strongest independent predictor of microalbuminuria after adjustment for major clinical confounders. These findings support the growing evidence that systemic inflammation plays a central role in the early development of diabetic nephropathy and that inflammatory hematological indices may provide useful adjunctive tools for identifying high-risk patients.[13]

In the present study, 40% of patients had microalbuminuria, which is comparable to the prevalence reported in previous studies of patients with Type 2 diabetes mellitus. The occurrence of microalbuminuria reflects early glomerular injury resulting from prolonged hyperglycaemia, endothelial dysfunction, oxidative stress, and chronic low-grade inflammation. Early identification of these patients is clinically important because prompt intervention through improved glycaemic control, blood pressure management, and renoprotective therapy can delay progression to overt diabetic nephropathy. A review by Sagoo et al. similarly emphasized that microalbuminuria remains one of the

earliest and most reliable predictors of diabetic kidney disease and future cardiovascular events.[13]

One of the major findings of the present study was the significantly higher NLR among patients with microalbuminuria. The mean NLR was 3.91 ± 1.24 in patients with microalbuminuria compared with 2.18 ± 0.76 among normoalbuminuric patients ($p < 0.001$). Neutrophils contribute to vascular inflammation through the release of reactive oxygen species, inflammatory cytokines, and proteolytic enzymes, whereas lymphocyte depletion reflects chronic physiological stress and impaired immune regulation. Consequently, an elevated NLR represents an imbalance favoring systemic inflammation. Similar observations have been reported by Huang et al., whose meta-analysis demonstrated that diabetic patients with nephropathy consistently exhibit significantly higher NLR than those without renal involvement, supporting its role as an inflammatory marker of diabetic kidney disease.[14]

The present study also demonstrated that PLR was significantly elevated among patients with microalbuminuria. Activated platelets release numerous inflammatory mediators, including platelet-derived growth factor, transforming growth factor- β , and thromboxane A₂, which promote endothelial injury and renal fibrosis. Although PLR showed a statistically significant association with microalbuminuria, its diagnostic performance was inferior to NLR. Similar findings have been reported by Ciray et al., who observed that both NLR and PLR were elevated in diabetic nephropathy, although NLR consistently demonstrated stronger correlations with urinary albumin excretion and renal dysfunction.[15]

Receiver operating characteristic analysis showed that NLR achieved an AUC of 0.86, indicating good diagnostic accuracy for detecting microalbuminuria. At an optimal cut-off value of 2.95, NLR demonstrated 83.3% sensitivity and 80.6% specificity, outperforming PLR across all diagnostic indices. These findings suggest that NLR may be a useful screening biomarker for identifying diabetic patients at increased risk of nephropathy during routine clinical evaluation. Similar diagnostic performance has been described by Akbas et al., who reported that elevated NLR independently predicted microvascular complications and showed favorable sensitivity and specificity for diabetic nephropathy.[17]

Another important observation in the present study was the significant positive correlation between NLR and urinary albumin excretion ($r = 0.63$, $p < 0.001$). This finding indicates that increasing systemic inflammation parallels worsening renal injury in diabetes mellitus.

Chronic inflammatory activation contributes to glomerular endothelial dysfunction, mesangial expansion, podocyte injury, and extracellular matrix accumulation, ultimately resulting in increased urinary albumin excretion. Similar correlations between NLR and albuminuria have been reported in several observational studies, supporting the biological plausibility of using inflammatory hematological indices as surrogate markers of early renal damage.[18]

Multivariable logistic regression analysis identified $\text{NLR} \geq 2.95$, $\text{HbA1c} \geq 8\%$, duration of diabetes ≥ 10 years, and hypertension as independent predictors of microalbuminuria. These findings are consistent with current understanding of diabetic nephropathy, in which prolonged exposure to hyperglycaemia, hypertension, and chronic inflammation interact to accelerate glomerular injury. Previous longitudinal studies have likewise demonstrated that poor glycaemic control and longer disease duration substantially increase the risk of albuminuria and progressive decline in renal function.[19,20]

The present findings have important clinical implications. Complete blood count is routinely performed in almost every patient with diabetes and does not require additional laboratory infrastructure or cost. Calculation of NLR and PLR requires only simple mathematical ratios derived from routinely available hematological parameters. In resource-limited healthcare settings where urinary albumin estimation may not always be immediately available, NLR could serve as a practical screening marker to identify patients who require more comprehensive nephropathy evaluation. Nevertheless, these biomarkers should be considered complementary rather than substitutes for standard urinary albumin assessment.[21]

The findings of this study should be interpreted in light of certain limitations. The cross-sectional study design precludes establishing a causal relationship between inflammatory biomarkers and diabetic nephropathy. The study was conducted at a single tertiary care center with a relatively modest sample size, which may limit the generalizability of the findings. In addition, inflammatory biomarkers such as C-reactive protein, interleukin-6, and tumor necrosis factor- α were not measured for comparison. Future multicenter prospective studies with larger sample sizes and serial biomarker measurements are warranted to further validate the diagnostic performance of NLR and PLR across different patient populations.[22]

Despite these limitations, the present study has several strengths. Both inflammatory indices were evaluated simultaneously within the same cohort using standardized laboratory methods. Diagnostic accuracy

was comprehensively assessed using ROC curve analysis, sensitivity, specificity, predictive values, and multivariable logistic regression. The findings provide clinically relevant evidence supporting the incorporation of inexpensive inflammatory biomarkers into routine diabetic risk assessment, particularly in settings where advanced laboratory investigations are not readily accessible.[23]

Overall, the present study reinforces the concept that chronic inflammation contributes significantly to the development of diabetic nephropathy. Among the evaluated biomarkers, NLR demonstrated superior diagnostic performance compared with PLR, making it a promising adjunctive screening tool for early detection of microalbuminuria in patients with diabetes mellitus. Routine assessment of NLR alongside conventional clinical evaluation may facilitate earlier recognition of renal involvement, enabling timely implementation of renoprotective interventions and potentially improving long-term renal outcomes. These observations are in agreement with contemporary evidence emphasizing inflammation-based risk stratification in diabetic kidney disease and support further large-scale prospective validation before widespread clinical implementation.[24,25]

CONCLUSION

The present study demonstrated that both the neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) were significantly elevated among patients with Type 2 diabetes mellitus and microalbuminuria. Patients with microalbuminuria exhibited significantly higher mean NLR and PLR values compared with those without renal involvement, indicating that systemic inflammation is closely associated with the early stages of diabetic nephropathy.

Among the two inflammatory biomarkers evaluated, NLR showed superior diagnostic performance, with higher sensitivity, specificity, and area under the receiver operating characteristic (ROC) curve than PLR. Furthermore, elevated NLR remained an independent predictor of microalbuminuria after adjustment for established clinical risk factors, including poor glycaemic control, hypertension, and longer duration of diabetes. These findings suggest that NLR is a reliable and inexpensive inflammatory biomarker that may complement conventional screening methods for early diabetic kidney disease.

Since complete blood count is routinely performed in clinical practice, calculation of NLR and PLR requires no additional laboratory investigations or financial burden. Incorporating these biomarkers into routine diabetic evaluation may facilitate earlier identification of patients at

increased risk for nephropathy, allowing timely intervention and potentially slowing progression to chronic kidney disease. Nevertheless, larger multicentre prospective studies are required to validate these findings before routine implementation in clinical guidelines.

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