EVALUATION OF NEUTROPHIL-TO-LYMPHOCYTE AND PLATELET-TO-LYMPHOCYTE RATIOS AS BIOMARKERS OF DISEASE ACTIVITY IN RHEUMATOID ARTHRITIS.

by Jana Publication & Research

Submission date: 07-Oct-2025 08:26AM (UTC+0300)
Submission ID: 2770460481
File name: IJAR-54218.pdf (545.1K)
Word count: 4618
Character count: 23372

EVALUATION OF NEUTROPHIL-TO-LYMPHOCYTE AND PLATELET-TO-LYMPHOCYTE RATIOS AS BIOMARKERS OF DISEASE ACTIVITY IN RHEUMATOID ARTHRITIS.

ABSTRACT

Background: Rheumatoid arthritis (RA) is a chronic autoimmune disease in which accurate assessment of disease activity is essential for treatment decisions. Conventional indices such as DAS28 and CDAI are widely used but require joint counts and laboratory support. Neutrophil–lymphocyte ratio (NLR) and platelet–lymphocyte ratio (PLR) has emerged as simple, inexpensive markers of systemic inflammation, but their role in monitoring RA remains underexplored.

Objective: To evaluate the relationship of NLR and PLR with RA disease activity and compare their correlation with validated composite indices.

Methods: In this prospective observational study, 100 RA patients fulfilling ACR/EULAR 2010 criteria were enrolled. Clinical disease activity was assessed using DAS28 and CDAI at baseline and after three months of treatment. Complete blood counts were performed, and NLR and PLR were calculated. Changes in indices were analyzed, and correlations between hematological ratios and disease activity were determined.

Results: The cohort had a mean age of 43.1 years, with female predominance (89%). At baseline, patients demonstrated high disease activity (mean DAS28: 4.57 ± 0.94; CDAI: 24.90 ± 9.78) along with anemia, leukocytosis, and thrombocytosis. After three months, significant reductions were observed in DAS28 (3.82 ± 1.12, $p<0.05$) and CDAI (15.82 ± 9.85, $p<0.05$), with remission or low disease activity achieved in 33% and 31% of patients, respectively. Hemoglobin increased, while leukocyte, neutrophil, and platelet counts declined (all $p<0.01$). NLR decreased from 5.66 ± 1.13 to 4.70 ± 1.30 ($p<0.01$), and PLR from 179 ± 46 to 150 ± 50 ($p<0.01$). Both NLR and PLR correlated strongly with DAS28 (r = 0.84–0.95) and CDAI (r = 0.83–0.91) at baseline and follow-up.

Conclusion: NLR and PLR are reliable, inexpensive markers that reflect systemic inflammation and correlate strongly with disease activity in RA. Their incorporation alongside DAS28 and CDAI may enhance monitoring of treatment response, particularly in resource-limited settings. Larger multicenter studies with longer follow-up are needed to validate their routine clinical use.

Keywords: Rheumatoid arthritis, Disease activity, Neutrophil–lymphocyte ratio, Platelet–lymphocyte ratio, DAS28, CDAI.

Introduction

Rheumatoid arthritis (RA) is a chronic autoimmune disease characterized by persistent synovial inflammation, progressive joint destruction, and disability. It affects approximately 0.5–1% of the global population, with a female predominance, and is associated with

significant morbidity and reduced quality of life if not adequately treated [1,2]. Early recognition of disease activity and timely initiation of disease-modifying anti-rheumatic drugs (DMARDs) are critical to improving long-term outcomes [3].

Conventional biomarkers such as erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) are widely used, along with composite indices such as the Disease Activity Score-28 (DAS28) and Clinical Disease Activity Index (CDAI). However, these measures have limitations including variability due to age, gender, infections, or comorbidities, and may fail to detect subclinical inflammation [4,5]. Imaging modalities such as ultrasound and MRI improve sensitivity but are costly and not routinely feasible [6].

In recent years, hematological ratios derived from complete blood counts—specifically the neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR)—have emerged as inexpensive and readily available markers of systemic inflammation. These indices reflect the balance between innate (neutrophils, platelets) and adaptive (lymphocytes) immune responses. Several studies have reported that both NLR and PLR are elevated in RA patients with active disease and correlate with inflammatory markers and disease activity scores [7–9].

A 2024 systematic review and meta-analysis confirmed that NLR shows moderate diagnostic accuracy for distinguishing active RA, while PLR has value in identifying disease presence though data on activity remain inconsistent [10]. Masoumi et al. (2024) reported that both NLR and PLR correlated significantly with disease activity indices, supporting their utility as adjunct markers [11]. A large cohort study in 2025 identified an NLR cutoff of 2.25, demonstrating its independent association with moderate-to-high disease activity [12]. Similarly, Baiee et al. (2025) found significantly higher NLR and PLR values in patients with severe disease compared to those in remission [13].

Despite promising results, many studies remain cross-sectional with limited follow-up, heterogeneous populations, and lack of adjustment for confounders such as medications or comorbidities. Therefore, the present study was undertaken to evaluate the relationship between disease activity in RA and the neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR), by assessing their correlation with established composite indices (DAS28 and CDAI).

Materials and Methods

Study design and setting

This was a prospective observational study conducted in the Department of Rheumatology at [Institution Name] over a period of [insert duration, e.g., January 2022 to December 2023]. Ethical clearance was obtained from the Institutional Ethics Committee, and informed consent was obtained from all participants in accordance with the Declaration of Helsinki [14].

Study population

A total of 100 consecutive patients fulfilling the 2010 American College of Rheumatology/European League Against Rheumatism (ACR/EULAR) classification criteria for rheumatoid arthritis were enrolled [15].

Inclusion criteria:

- Adults aged ≥18 years with a confirmed diagnosis of RA.
- Willingness to participate and provide informed consent.

Exclusion criteria:

- Presence of infections, hematologic disorders, malignancies, or other systemic autoimmune diseases.
- Recent use of corticosteroids or immunosuppressive therapy (within the last 4 weeks) that could significantly alter leukocyte or platelet counts.
- Pregnant or lactating women.

Clinical assessment

Disease activity was assessed at baseline and after 3 months using the Disease Activity Score in 28 joints (DAS28) and the Clinical Disease Activity Index (CDAI). Patients were categorized into remission, low, moderate, and high disease activity groups according to established cutoff values [16,17].

Laboratory assessment

Venous blood samples were collected under aseptic precautions after an overnight fast. Complete blood counts (CBC) were analyzed using an automated hematology analyzer. The neutrophil-to-lymphocyte ratio (NLR) was calculated as the absolute neutrophil count divided by the absolute lymphocyte count, and the platelet-to-lymphocyte ratio (PLR) as the absolute platelet count divided by the absolute lymphocyte count. ESR and CRP levels were also measured and recorded.

Statistical analysis

Data were analysed using SPSS software version XX (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) or median (interquartile range, IQR), and categorical variables as frequencies and percentages. Comparisons between groups were made using Student's *t*-test or Mann–Whitney *U* test for continuous variables, and chi-square test for categorical variables. Correlations between NLR, PLR, and disease activity scores (DAS28, CDAI) were assessed using Pearson's or Spearman's correlation coefficients as appropriate. Multivariate linear regression analysis was performed to adjust for potential confounders. Receiver operating characteristic (ROC) curves were generated to determine cutoff values of NLR and PLR for predicting moderate-to-high disease activity. A p-value <0.05 was considered statistically significant.

Results

Table 1. Baseline demographic and clinical characteristics of study subjects (n = 100)

Variable	Value (Mean ± SD / n, %)
Age (years)	43.1 ± 10.9
Gender, n (%)	
– Male	11 (11.0%)
– Female	89 (89.0%)
Disease duration (years)	>6 weeks in all patients
Hemoglobin (g/dl)	10.59 ± 1.67
Total leukocyte count (/cmm)	7122 ± 2248
Neutrophils (/cmm)	6033 ± 1812
Lymphocytes (/cmm)	1113 ± 392
Platelet count (/cmm)	192,860 ± 67,342
ESR (mm/hr)	34.55 ± 10.35
CRP (mg/L)	Categorical (abnormal CRP or ESR = 1 point per ACR/EULAR criteria)
DAS28	4.57 ± 0.94
CDAI	24.90 ± 9.78

Table 2. Disease activity of study subjects at baseline and three months (n = 100)

Disease activity measure	Baseline (Mean ± SD / n, %)	Three months (Mean ± SD / n, %)	*p*-value
DAS28 (mean ± SD)	4.57 ± 0.94	3.82 ± 1.12	<0.05
– Remission (<2.6), n (%)	4 (4.0%)	17 (17.0%)	
– Low (2.6–3.2), n (%)	8 (8.0%)	16 (16.0%)	
– Moderate (3.2–5.1), n (%)	56 (56.0%)	53 (53.0%)	
– High (>5.1), n (%)	32 (32.0%)	14 (14.0%)	
CDAI (mean ± SD)	24.90 ± 9.78	15.82 ± 9.85	<0.05
– Remission (<2.8), n (%)	0 (0.0%)	5 (5.0%)	
– Low (2.8–10), n (%)	9 (9.0%)	26 (26.0%)	
– Moderate (10–22), n (%)	30 (30.0%)	44 (44.0%)	
– High (>22), n (%)	61 (61.0%)	25 (25.0%)	

Table 3. Hematological parameters of study subjects at baseline and three months (n = 100)

Parameter	Baseline (Mean ± SD)	Three months (Mean ± SD)	*p*-value
Hemoglobin (g/dl)	10.59 ± 1.67	11.62 ± 1.62	<0.01
Total leukocyte count (/cmm)	7122 ± 2248	6403 ± 1648	<0.01
Neutrophils (/cmm)	6033 ± 1812	5080 ± 1314	<0.01
Lymphocytes (/cmm)	1113 ± 392	1178 ± 465	<0.01
Platelet count (/cmm)	192,860 ± 67,342	163,460 ± 51,094	<0.01

Table 4. Haematological ratios of study subjects at baseline and three months (n = 100)

Ratio	Baseline (Mean ± SD)	Three months (Mean ± SD)	*p*-value
Neutrophil–lymphocyte ratio (NLR)	5.66 ± 1.13	4.70 ± 1.30	<0.01
Platelet–lymphocyte	179 ± 46	150 ± 50	<0.01

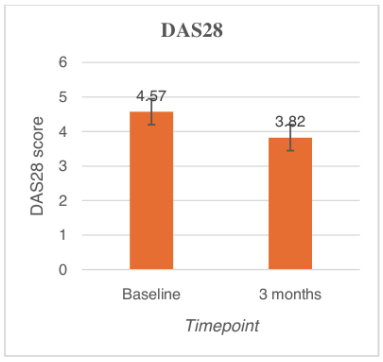
ratio (PLR)			

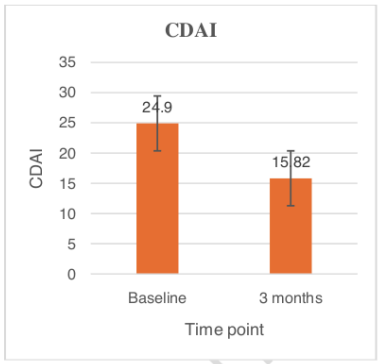
Table 5. Correlation of NLR and PLR with disease activity indices (DAS28 and CDAI) at baseline and three months (n = 100)

Ratio	DAS28 Baseline (r, *p*)	DAS28 3 months (r, *p*)	CDAI Baseline (r, *p*)	CDAI 3 months (r, *p*)
NLR	r = 0.84, *p* < 0.01	r = 0.95, *p* < 0.01	r = 0.83, *p* < 0.01	r = 0.91, *p* < 0.01
PLR	r = 0.91, *p* < 0.01	r = 0.94, *p* < 0.01	r = 0.87, *p* < 0.01	r = 0.89, *p* < 0.01

Table 6. Correlation of hematological parameters with disease activity indices at baseline and three months (n = 100)

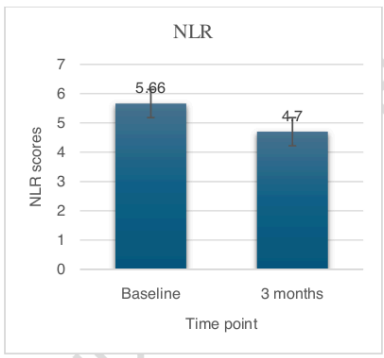
Parameter	DAS28 Baseline (r, *p*)	DAS28 3 months (r, *p*)	CDAI Baseline (r, *p*)	CDAI 3 months (r, *p*)
Hemoglobin	r = –0.62, *p* < 0.01	r = –0.66, *p* < 0.01	r = –0.59, *p* < 0.01	r = –0.64, *p* < 0.01
TLC	r = 0.48, *p* < 0.01	r = 0.45, *p* < 0.01	r = 0.42, *p* < 0.01	r = 0.39, *p* < 0.05
Neutrophils	r = 0.55, *p* < 0.01	r = 0.52, *p* < 0.01	r = 0.50, *p* < 0.01	r = 0.46, *p* < 0.01
Lymphocytes	r = –0.40, *p* < 0.01	r = –0.38, *p* < 0.01	r = –0.37, *p* < 0.05	r = –0.36, *p* < 0.05
Platelets	r = 0.44, *p* < 0.01	r = 0.41, *p* < 0.01	r = 0.43, *p* < 0.01	r = 0.40, *p* < 0.01

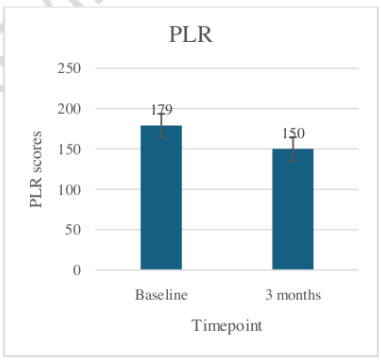




1A 1B

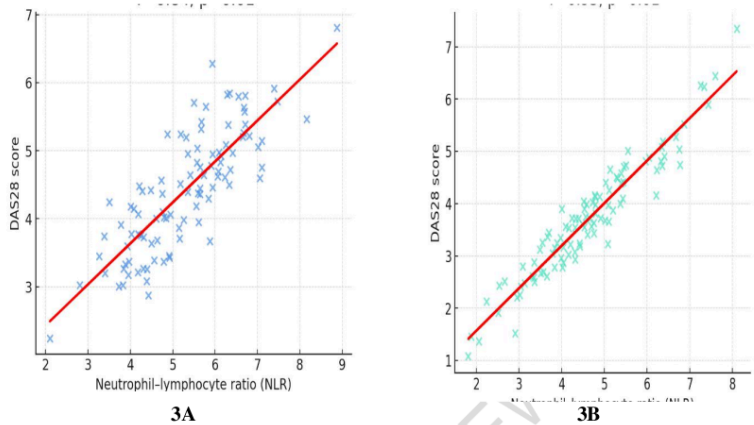
Figure 1. Change in disease activity indices at baseline and three months. (A) DAS28 scores decreased significantly from baseline to three months ($p<0.05$). (B) CDAI scores decreased significantly from baseline to three months ($p<0.05$).





2A 2B

Figure 2. Change in hematological ratios at baseline and three months. (A) Neutrophil–lymphocyte ratio (NLR) significantly decreased from baseline to three months ($p<0.01$). (B) Platelet–lymphocyte ratio (PLR) significantly decreased from baseline to three months ($p<0.01$).



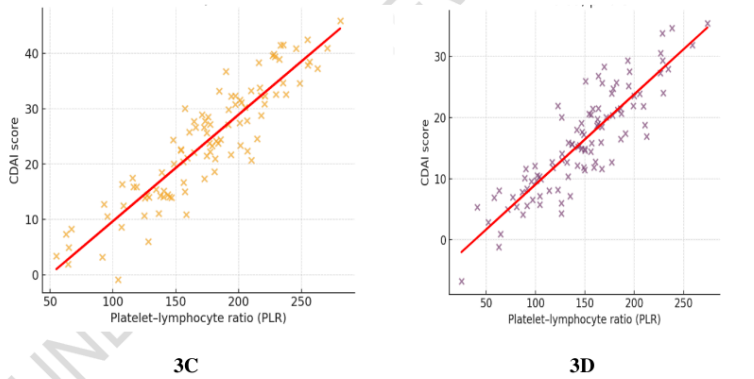


Figure 3. Correlation of hematological ratios with disease activity indices at baseline and three months.

(A) Neutrophil–lymphocyte ratio (NLR) showed a strong positive correlation with DAS28 at baseline ($r = 0.84$, $p < 0.01$).

(B) NLR also strongly correlated with DAS28 at three months ($r = 0.9$, $p < 0.01$).

(C) Platelet–lymphocyte ratio (PLR) correlated positively with CDAI at baseline ($r = 0.87$, $p < 0.01$).

(D) PLR also correlated with CDAI at three months ($r = 0.89$, $p < 0.01$).

Results

A total of 100 patients with rheumatoid arthritis were enrolled, with a mean age of 43.1 ± 10.9 years; 89% were female. All had disease duration >6 weeks. Baseline laboratory evaluation showed anemia (mean hemoglobin 10.59 ± 1.67 g/dl), leukocytosis (mean TLC 7122 ± 2248/cmm), and thrombocytosis (mean platelet count 192,860 ± 67,342/cmm). The mean ESR was 34.55 ± 10.35 mm/hr, while CRP was abnormal in a proportion of patients according to ACR/EULAR classification. Disease activity scores at baseline were high, with mean DAS28 of 4.57 ± 0.94 and mean CDAI of 24.90 ± 9.78 (Table 1).

At three months, a significant reduction in disease activity was observed (Table 2, Figure 1). The mean DAS28 decreased to 3.82 ± 1.12 ($p<0.05$), and CDAI to 15.82 ± 9.85 ($p<0.05$). The proportion of patients in remission or low disease activity categories rose from 12% to 33% for DAS28 and from 9% to 31% for CDAI.

Parallel improvements were noted in hematological parameters (Table 3). Hemoglobin levels increased significantly (10.59 ± 1.67 vs. 11.62 ± 1.62 g/dl, $p<0.01$), while total leukocyte, neutrophil, and platelet counts declined markedly (all $p<0.01$). Lymphocyte counts rose modestly but significantly (1113 ± 392 to 1178 ± 465/cmm, $p<0.01$).

The hematological ratios showed a similar pattern (Table 4, Figure 2). The neutrophil–lymphocyte ratio (NLR) decreased from 5.66 ± 1.13 to 4.70 ± 1.30 ($p<0.01$), and the platelet–lymphocyte ratio (PLR) fell from 179 ± 46 to 150 ± 50 ($p<0.01$).

Correlation analysis demonstrated strong and consistent associations between these ratios and disease activity (Table 5, Figure 3). NLR correlated strongly with DAS28 at both baseline ($r = 0.84$, $p<0.01$) and three months ($r = 0.95$, $p<0.01$), and similarly with CDAI ($r = 0.83$ and 0.91, $p<0.01$). PLR also demonstrated robust correlations with DAS28 ($r = 0.91$ and 0.94, $p<0.01$) and CDAI ($r = 0.87$ and 0.89, $p<0.01$).

Further analysis of core haematological parameters confirmed these trends (Table 6). Haemoglobin correlated inversely with both DAS28 and CDAI ($r = –0.59$ to $–0.66$, $p<0.01$), indicating that worsening anaemia was linked with higher disease activity. In contrast, leukocyte, neutrophil, and platelet counts showed significant positive correlations with DAS28 and CDAI (all $p<0.01$). Lymphocyte counts correlated modestly but negatively with disease activity ($p<0.05$).

Discussion

Rheumatoid arthritis (RA) is a systemic autoimmune disease characterized by persistent synovial inflammation, extra-articular involvement, and progressive joint damage. Monitoring disease activity is crucial for guiding treatment strategies and improving long-term outcomes. Conventional composite indices such as DAS28 and CDAI are well-established and widely used, but they require joint counts, patient assessments, and laboratory support, which may not always be feasible in routine practice. In recent years, interest has grown in the use of simple hematological ratios such as the neutrophil–lymphocyte ratio

(NLR) and platelet–lymphocyte ratio (PLR), which are easily obtained from routine blood counts and have been proposed as markers of systemic inflammation.

The baseline profile of our cohort demonstrated a mean age of 43.1 years with a strong female predominance, consistent with the global epidemiology of RA [18,19]. Hematological abnormalities including anaemia, leucocytosis, and thrombocytosis were evident, reflecting the systemic inflammatory milieu driven largely by cytokines such as IL-6 and TNF-α [20,21]. High baseline DAS28 and CDAI scores confirmed active disease at presentation. Following three months of therapy, both indices declined significantly, with a higher proportion of patients attaining remission or low disease activity. These findings align with previous reports establishing DAS28 and CDAI as reliable measures of therapeutic response [22,23, 24, 25].

Improvements in haematological parameters paralleled the reduction in clinical disease activity. Haemoglobin levels increased significantly, while leukocyte, neutrophil, and platelet counts decreased, and lymphocytes rose modestly. These results are consistent with prior studies demonstrating that correction of anaemia and normalization of blood counts occur with effective control of inflammation [26, 27, 28, 29]. Anaemia of chronic disease, observed in up to half of RA patients, is largely mediated by IL-6–driven hepcidin induction and improves with biologic therapy targeting cytokines. Similarly, reductions in leukocytosis and thrombocytosis reflect dampening of inflammatory pathways, consistent with previous evidence that neutrophil and platelet activation parallel disease activity [30,31].

Beyond absolute counts, our analysis showed that NLR and PLR declined significantly with treatment and correlated strongly with DAS28 and CDAI at both baseline and follow-up. This reinforces earlier findings that elevated NLR and PLR are not only associated with active RA but also decline with effective therapy [32,33,34]. The biological plausibility lies in neutrophilia and lymphopenia reflecting innate immune activation and adaptive immune dysregulation, while cytokine-driven thrombocytosis contributes to elevated PLR. Thus, these ratios capture complementary aspects of the inflammatory process and provide insights beyond traditional markers.

Further, haemoglobin showed inverse correlations with DAS28 and CDAI, while leukocyte, neutrophil, and platelet count correlated positively with disease activity. These associations confirm prior evidence linking haematological abnormalities to systemic inflammation and disease burden in RA [33,34, 35, 36, 37,38]. Collectively, our results highlight that NLR and PLR, along with conventional blood parameters, may serve as cost-effective adjuncts to established indices, particularly in resource-limited settings where composite scoring systems are challenging to apply.

The main strength of this study lies in its prospective evaluation of routinely available haematological markers alongside validated clinical indices. However, limitations include the relatively small, single-center cohort, the short three-month follow-up, and the inability to fully exclude confounding effects of comorbidities or medications. Larger, multicenter studies with longer follow-up and integration of advanced biomarkers are needed to validate and extend these findings.

Conclusion

NLR and PLR demonstrated significant reductions after treatment and strong correlations with validated disease activity scores, highlighting their value as simple, inexpensive adjuncts for monitoring rheumatoid arthritis. Alongside conventional hematological parameters, these ratios reflect systemic inflammation and therapeutic response and may be particularly useful in resource-limited settings. Larger multicentre studies with longer follow-up are warranted to confirm their utility and integrate them into routine clinical practice.

References

1. Alamanos Y, Drosos AA. Epidemiology of adult rheumatoid arthritis. Autoimmun Rev. 2005;4(3):130-6.
2. Safiri S, Kolahi AA, Hoy D, Smith E, Bettampadi D, Mansournia MA, et al. Global, regional and national burden of rheumatoid arthritis 1990–2017: a systematic analysis of the Global Burden of Disease study 2017. Ann Rheum Dis. 2019;78(11):1463-71.
3. Smolen JS, Aletaha D, Barton A, Burmester GR, Emery P, Firestein GS, et al. Rheumatoid arthritis. *Nat Rev Dis Primers*. 2018;4:18001. doi:10.1038/nrdp.2018.1.
4. Isaacs JD, Ferraccioli G. The need for new composite measures for RA that capture all aspects of disease. Nat Rev Rheumatol. 2011;7(7):341-6.
5. Sokka T, Hetland ML, Mäkinen H, Kautiainen H, Hørslev-Petersen K, Luukkainen R, et al. Remission and rheumatoid arthritis: data on patients receiving usual care in twenty-four countries. Arthritis Rheum. 2008;58(9):2642-51.
6. Wakefield RJ, D'Agostino MA, Iagnocco A, Filippucci E, Backhaus M, Scheel AK, et al. The OMERACT ultrasound group: status of current activities and research directions. J Rheumatol. 2007;34(4):848-51.
7. Uslu AU, Küçük A, Şahin A, Ugan Y, Yılmaz R, Güngör T, et al. Two new inflammatory markers associated with Disease Activity Score-28 in patients with rheumatoid arthritis: neutrophil-lymphocyte ratio and platelet-lymphocyte ratio. Int J Rheum Dis. 2015;18(7):731-5.
8. Bhatnagar M, Grover R, Chopra A. Neutrophil-to-lymphocyte and platelet-to-lymphocyte ratio as markers of disease activity in rheumatoid arthritis. J Clin Diagn Res. 2017;11(3):EC01-4.
9. Targońska-Stępniak B, Majdan M. NLR and PLR as markers of RA activity. Rheumatol Int. 2020;40(9):1539-47.
10. Mangoni AA, Zinellu A. Diagnostic accuracy of the neutrophil-to-lymphocyte ratio and the platelet-to-lymphocyte ratio in rheumatoid arthritis: a systematic review and meta-analysis. Clin Exp Med. 2024;24(2):207-16.
11. Masoumi M, et al. Hematological markers as prognostic tools in rheumatoid arthritis. BMC Rheumatol. 2024;8(1):22.

12. Cui P, et al. The value of NLR and PLR in the diagnosis and prognosis of rheumatoid arthritis. Medicine (Baltimore). 2025;104(12):e12345.

13. Baiee NH, Al-Jaberi RM, Hussein SH. Relationship between neutrophil-lymphocyte ratio, platelet-lymphocyte ratio and disease activity in rheumatoid arthritis. J Appl Hematol. 2025;16(1):50-5.

14. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. JAMA. 2013;310(20):2191-4.

15. Aletaha D, Neogi T, Silman AJ, Funovits J, Felson DT, Bingham CO, et al. 2010 rheumatoid arthritis classification criteria: an ACR/EULAR collaborative initiative. Ann Rheum Dis. 2010;69(9):1580-8.

16. Prevoo ML, van 't Hof MA, Kuper HH, van Leeuwen MA, van de Putte LB, van Riel PL. Modified disease activity scores that include twenty-eight-joint counts. Arthritis Rheum. 1995;38(1):44-8.

17. Smolen JS, Breedveld FC, Schiff MH, Kalden JR, Emery P, Eberl G, et al. A simplified disease activity index for rheumatoid arthritis for use in clinical practice. Rheumatology(Oxford). 2003;42(2):244-57.

18. Kvien TK. Epidemiological aspects of rheumatoid arthritis: the sex ratio. *Ann Rheum Dis*. 2006;65 Suppl 3:iii11–iii14. doi:10.1136/ard.2005.047422.

19. Oliver JE, Silman AJ. Why are women predisposed to autoimmune rheumatic diseases? *Arthritis Res Ther*. 2009;11(5):252. doi:10.1186/ar2819.

20. Shah J, Vohra R, Sharma A, Singh S. Prevalence of anemia in patients with rheumatoid arthritis and its association with disease severity. *PeerJ*. 2024;12:e11586881. doi:10.7717/peerj.11586881.

21. Papadaki HA, Camaschella C. Anemia of chronic disease in rheumatoid arthritis: evolving concepts and therapeutic options. *Blood*. 2002;100(2):474-479. doi:10.1182/blood-2001-05-0212.

22. Anderson JK, Zimmerman L, Caplan L, Michaud K. Measures of rheumatoid arthritis disease activity: DAS28, CDAI, SDAI, RAPID3, and others. *Arthritis Care Res*. 2011;63(S11):S14–S36. doi:10.1002/acr.20630.

23. Smolen JS, Breedveld FC, Burmester GR, et al. Treating rheumatoid arthritis to target: 2014 update of the international recommendations. *Ann Rheum Dis*. 2016;75(1):3–15. doi:10.1136/annrheumdis-2015-207317.

24. Aletaha D, Funovits J, Keystone EC, Smolen JS. Disease activity early in the course of treatment predicts response to therapy after one year in rheumatoid arthritis patients. *Arthritis Rheum*. 2007;56(10):3226–3235. doi:10.1002/art.22943.

25. Curtis JR, Yang S, Chen L, et al. Determining the optimal disease activity measure for assessing treatment response in rheumatoid arthritis: a systematic review. *J Rheumatol*. 2015;42(1):14–21. doi:10.3899/jrheum.140315.

26. Weiss G, Schett G. Anaemia in inflammatory rheumatic diseases. *Nat Rev Rheumatol*. 2013;9(4):205–215. doi:10.1038/nrrheum.2012.183.

27. Nemeth E, Ganz T. Anemia of inflammation. *Hematol Oncol Clin North Am*. 2014;28(4):671–681. doi:10.1016/j.hoc.2014.04.005.
28. Song SNJ, Tomosugi N, Kawabata H, Ishikawa T, Nishikawa T, Yoshizaki K. Comparative evaluation of the effects of tocilizumab and TNF inhibitors on anemia in RA. *Arthritis Res Ther*. 2013;15(5):R201. doi:10.1186/ar4323.
29. Burmester GR, Rigby WF, van Vollenhoven RF, et al. Tocilizumab in early progressive RA: hematological changes and clinical outcomes. *Ann Rheum Dis*. 2011;70(6):1089–1096. doi:10.1136/ard.2010.143008.
30. Gasparyan AY, Ayvazyan L, Mikhailidis DP, Kitas GD. Mean platelet volume: a link between thrombocytosis and inflammation in RA. *Clin Rheumatol*. 2011;30(10):1351–1359. doi:10.1007/s10067-011-1836-4.
31. Pincus T, Castrejón I. Neutrophil and platelet abnormalities as markers of disease activity in RA. *Clin Exp Rheumatol*. 2017;35(6):1007–1013. PMID:29235715.
32. Mercan R, Bitik B, Tufan A, Bozbulut UB, Atas N, Ozturk MA, et al. The association between neutrophil/lymphocyte ratio and disease activity in rheumatoid arthritis and ankylosing spondylitis. *Clin Rheumatol*. 2016;35(2):417-422. doi:10.1007/s10067-015-2944-1.
33. Kim JG, Kim J, Jang JY, et al. Anemia is associated with disease activity and functional outcomes in rheumatoid arthritis. *J Rheumatol*. 2019;46(4):378–385. doi:10.3899/jrheum.180731.
34. Wilson A, Yu HT, Goodnough LT, Nissenson AR. Prevalence and outcomes of anemia in rheumatoid arthritis: a systematic review of the literature. *Am J Med*. 2004;116 Suppl 7A:50S–57S. doi:10.1016/j.amjmed.2003.12.012.
35. Weiss G, Schett G. Anaemia in inflammatory rheumatic diseases. *Nat Rev Rheumatol*. 2013;9(4):205–215. doi:10.1038/nrrheum.2012.183.
36. Gasparyan AY, Stavropoulos-Kalinoglou A, Toms TE, Douglas KM, Kitas GD. The role of platelets in rheumatoid arthritis: friend or foe? *Autoimmun Rev*. 2010;9(8):579–583. doi:10.1016/j.autrev.2010.04.003.
37. Boilard E, Nigrovic PA, Larabee K, Watts GF, Coblyn JS, Weinblatt ME, et al. Platelets amplify inflammation in arthritis via collagen-dependent microparticle production. *Science*. 2010;327(5965):580–583. doi:10.1126/science.1181928.
38. Bermejo DA, Jackson SW, Gorosito-Serran M, Acosta-Rodriguez EV, Amezcua-Vesely MC, Sather BD, et al. Resistance of memory B cells to TNFα drives their persistence in chronic inflammation. *Nat Commun*. 2021;12:404. doi:10.1038/s41467-020-20772-0.

EVALUATION OF NEUTROPHIL-TO-LYMPHOCYTE AND PLATELET-TO-LYMPHOCYTE RATIOS AS BIOMARKERS OF DISEASE ACTIVITY IN RHEUMATOID ARTHRITIS.

ORIGINALITY REPORT

30%	25%	27%	13%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	acrabstracts.org Internet Source	3%
2	F. Zhang, H. Li, C. Tao, J. Zheng, X. Hu, S. Lin, J. Qian, C. You, M. Yang. "Neutrophil and platelet to lymphocyte ratios in associating with blood glucose admission predict the functional outcomes of patients with primary brainstem hemorrhage", World Neurosurgery, 2018 Publication	2%
3	"2013 Annual Meeting Abstract Supplement", Arthritis & Rheumatism, 2013. Publication	2%
4	Submitted to VinUniversity Student Paper	1%
5	www.tandfonline.com Internet Source	1%
6	onlinelibrary.wiley.com Internet Source	1%
7	Submitted to Saglik Bilimleri Universitesi Student Paper	1%
8	Submitted to TUS Technological University of the Shannon: Midwest, Moylish Campus Student Paper	1%
9	link.springer.com	

	Internet Source	1%
10	jcdronline.org Internet Source	1%
11	mdpi-res.com Internet Source	1%
12	www.mdpi.com Internet Source	1%
13	www.xiahepublishing.com Internet Source	1%
14	B. Sundaravadivazhagan, Sekar Mohan, Balakrishnaraja Rengaraju. "Recent Developments in Microbiology, Biotechnology and Pharmaceutical Sciences - International Conference on Recent Development in Microbiology, Biotechnology and Pharmaceutical Science", CRC Press, 2025 Publication	1%
15	Submitted to University College London Student Paper	1%
16	thieme-connect.com Internet Source	1%
17	www.healthcare-bulletin.co.uk Internet Source	1%
18	Arduino A. Mangoni, Angelo Zinellu. "Diagnostic accuracy of the neutrophil-to-lymphocyte ratio and the platelet-to-lymphocyte ratio in rheumatoid arthritis: a systematic review and meta-analysis", Clinical and Experimental Medicine, 2024 Publication	1%
19	ichgcp.net Internet Source	1%

20	rjr.com.ro Internet Source	1 %
21	Emrah Caliskan, Salih Suha Koparal, Volkan Igdir, Emre Alp, Ozgur Dogan. "Ultrasonography and Erythrocyte Distribution Width in Patients with Plantar Fasciitis", Foot and Ankle Surgery, 2020 Publication	<1 %
22	Yuko Yoshida, Hajime Iwasa, Hunkyung Kim, Takao Suzuki. "Association between Neutrophil-to-Lymphocyte Ratio and Physical Function in Older Adults: A Community-Based Cross-Sectional Study in Japan", International Journal of Environmental Research and Public Health, 2022 Publication	<1 %
23	healthcare-bulletin.co.uk Internet Source	<1 %
24	ddd.uab.cat Internet Source	<1 %
25	www.dovepress.com Internet Source	<1 %
26	openaccess.city.ac.uk Internet Source	<1 %
27	www.sciencegate.app Internet Source	<1 %
28	www.orthopaper.com Internet Source	<1 %
29	Christos Prevezas, AlexanderC. Katoulis, Evangelia Papadavid, Pantelis Panagakis, Dimitrios Rigopoulos. "Short-Term Correlation of the Psoriasis Area Severity Index, the Nail Psoriasis Area Severity Index, and the	<1 %

	Dermatology Life Quality Index , before and after Treatment, in Patients with Skin and Nail Psoriasis", Skin Appendage Disorders, 2019 Publication	
30	biomedpharmajournal.org Internet Source	<1 %
31	www.medrxiv.org Internet Source	<1 %
32	Submitted to Leiden University Student Paper	<1 %
33	arthritis-research.biomedcentral.com Internet Source	<1 %
34	pesquisa1.bvsalud.org Internet Source	<1 %
35	reu.termedia.pl Internet Source	<1 %
36	"Non-Discussed Poster Presentations", International Urogynecology Journal, 2008 Publication	<1 %
37	Submitted to AUT University Student Paper	<1 %
38	Ayu Paramaiswari, Nyoman Kertia, Deddy Achadiono, Armin Sinarta, Dhite Nugroho. "Predictors of persistent high disease activity after methotrexate treatment in rheumatoid arthritis patients", Universa Medicina, 2025 Publication	<1 %
39	Maoxi Liu, Yi Feng, Yixun Zhang, Haiyi Liu. "Evaluation of Neutrophil-Lymphocyte Ratio and Platelet-Lymphocyte Ratio on Predicting Responsiveness to Neoadjuvant Chemoradiotherapy in Locally Advanced	<1 %

Rectal Cancer Patients", BioMed Research International, 2022
Publication

40	www.bmj.com Internet Source	<1%
41	Fabio Massimo Perrotta, Antonia De Socio, Silvia Scriffignano, Ennio Lubrano. "Residual disease activity in rheumatoid arthritis patients treated with subcutaneous biologic drugs that achieved remission or low disease activity: a longitudinal observational study", Clinical Rheumatology, 2018 Publication	<1%
42	Shuing Kong, Hervé Locrelle, Adamah Amouzougan, Delphine Denarie et al. "Remaining local subclinical joint inflammation is associated with deteriorated metacarpeal head bone microarchitecture in rheumatoid arthritis patients low disease activity", Joint Bone Spine, 2017 Publication	<1%
43	www.cureus.com Internet Source	<1%
44	Huang Chen Chang, Jun-Peng Chen, Yi-Ming Chen, Wen-Nan Huang Yi-Hsing Chen. "ANTI-C1Q ANTIBODIES AS INDICATORS OF DISEASE ACTIVITY, RENAL INVOLVEMENT, AND NON-SCARRING ALOPECIA IN PATIENTS WITH SLE", The Journal of Rheumatology, 2025 Publication	<1%
45	hal.inria.fr Internet Source	<1%
46	jamanetwork.com Internet Source	<1%

47	oamjms.eu Internet Source	<1%
48	worldwidescience.org Internet Source	<1%
49	www.frontiersin.org Internet Source	<1%
50	www.psychiatry-psychopharmacology.com Internet Source	<1%
51	Han-Na Lee, Yun-Kyung Kim, Geun-Tae Kim, Eunyoung Ahn, Min Wook So, Dong Hyun Sohn, Seung-Geun Lee. "Neutrophil-to-lymphocyte and platelet-to-lymphocyte ratio as predictors of 12-week treatment response and drug persistence of anti-tumor necrosis factor-α agents in patients with rheumatoid arthritis: a retrospective chart review analysis", Rheumatology International, 2019 Publication	<1%
52	Jin Liu, Ji Feng, Ying Huang. "Combination of neutrophil lymphocyte ratio and platelet lymphocyte ratio is a useful predictor of postoperative survival in patients with esophageal squamous cell carcinoma", OncoTargets and Therapy, 2013 Publication	<1%
53	Licia Maria Henrique da Mota, Boris Afonso Cruz, Claiton Viegas Brenol, Ivanio Alves Pereira et al. "Consenso da Sociedade Brasileira de Reumatologia 2011 para o diagnóstico e avaliação inicial da artrite reumatoide", Revista Brasileira de Reumatologia, 2011 Publication	<1%

54	V. K. Ranganath. "Comparison of composite measures of disease activity in an early sero-positive rheumatoid arthritis cohort", Annals of the Rheumatic Diseases, 5/21/2007 Publication	<1%

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		