ORIGINAL RESEARCH PAPER
Volume - 15 | Issue - 11 | November - 2026 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

LOW-COST HAEMATOLOGICAL MARKERS FOR TUBERCULOSIS SCREENING: DIAGNOSTIC UTILITY OF MONOCYTE–LYMPHOCYTE RATIO AND PLATELET–LYMPHOCYTE RATIO IN A CASE–CONTROL STUDY

Public Health

Dr. Vishal Samadhan Dhande District Tuberculosis Officer, Yavatmal. Public Health Department, Government of Maharashtra (India)

Dr. Krantikumar Madhavrao Navandikar ADHO and Taluka Health Officer, Yavatmal. Public Health Department, Government of Maharashtra (India)

Dr. Subhash Shahaji Dhole District Health Officer, Yavatmal. Public Health Department, Government of Maharashtra (India)

Dr. Samyak Bhaskarrao Khaire* Govt. of India-World Health Organisation (WHO), NTEP consultant- Akola Division*Corresponding Author

ABSTRACT

Background: Tuberculosis (TB) remains a major global public health challenge, particularly in resource-limited settings where access to rapid and accurate diagnostic tools may be constrained. Complete blood count (CBC)-derived inflammatory markers, such as platelet–lymphocyte ratio (PLR) and monocyte–lymphocyte ratio (MLR), have emerged as potential adjunctive biomarkers for TB diagnosis. Objective: To evaluate the diagnostic utility of PLR and MLR in differentiating pulmonary tuberculosis from other respiratory infections. Methods: This hospital-based analytical case–control study was conducted at G.G. Rathi Government Tuberculosis Hospital, Amravati, over a period of 12 months. A total of 300 participants were included, comprising 150 microbiologically confirmed pulmonary TB cases and 150 controls with non-tubercular respiratory infections. CBC parameters were recorded, and PLR and MLR were calculated. Statistical analysis included comparison of means, odds ratio estimation, multivariable logistic regression, and receiver operating characteristic (ROC) curve analysis. **Results:** TB patients demonstrated significantly lower hemoglobin and lymphocyte counts, along with higher platelet and monocyte counts ($p < 0.001$). Both PLR and MLR were significantly elevated in TB cases compared to controls ($p < 0.001$). Elevated MLR (>0.45) showed a stronger association with TB (OR: 8.0) compared to PLR (>220) (OR: 4.8). On multivariable analysis, MLR remained the strongest independent predictor (AOR: 5.6). ROC analysis revealed superior diagnostic performance of MLR (AUC: 0.86) compared to PLR (AUC: 0.78). The combined PLR–MLR model demonstrated the highest diagnostic accuracy (AUC: 0.89, sensitivity: 84%, specificity: 85%). **Conclusion:** MLR is a superior and independent haematological marker for differentiating pulmonary TB from other respiratory infections. The combined use of PLR and MLR enhances diagnostic accuracy, suggesting their potential role as low-cost adjunctive screening tools in resource-constrained settings. However, these markers should complement, not replace, microbiological confirmation.

KEYWORDS

Tuberculosis, Monocyte–lymphocyte Ratio (MLR), Platelet–lymphocyte Ratio (plr), Diagnostic Biomarkers

INTRODUCTION:

Tuberculosis (TB) continues to be a leading cause of morbidity and mortality worldwide, particularly in low- and middle-income countries. According to the World Health Organization (WHO), TB remains one of the top infectious killers globally, with millions of new cases reported annually [1]. Despite advances in diagnostic modalities, early and accurate detection of TB remains a major challenge, especially in resource-limited settings. Conventional diagnostic methods such as sputum smear microscopy, culture, and nucleic acid amplification tests like CBNAAT (GeneXpert) are effective but may be limited by accessibility, cost, and turnaround time [2].

In recent years, there has been increasing interest in identifying simple, cost-effective, and readily available biomarkers that can aid in early diagnosis and risk stratification of TB. Complete blood count (CBC), a routinely performed and inexpensive investigation, reflects systemic inflammatory and immunological responses and may provide valuable diagnostic insights. Among CBC-derived indices, platelet–lymphocyte ratio (PLR) and monocyte–lymphocyte ratio (MLR) has emerged as promising inflammatory markers [3].

The pathophysiology of tuberculosis involves a complex interplay between host immune mechanisms and *Mycobacterium tuberculosis*. Monocytes and macrophages play a crucial role in granuloma formation and containment of infection, while lymphocyte-mediated immunity is essential for disease control. Alterations in these cellular components, reflected as changes in MLR, may serve as indicators of active disease. Similarly, PLR reflects systemic inflammatory burden and has been explored in various infectious and inflammatory conditions [4].

Although several studies have evaluated the role of MLR and PLR in tuberculosis, the evidence remains inconsistent, and there is no consensus regarding their diagnostic accuracy or optimal cut-off values. Furthermore, data from real-world programmatic settings in high TB burden regions are limited [5]. Therefore, the present study was undertaken to evaluate the diagnostic utility of PLR and MLR in differentiating pulmonary tuberculosis from other respiratory infections in a tertiary care government TB hospital, and to assess their potential as low-cost adjunctive screening tools.

Materials and methods:

This hospital-based analytical case–control study was conducted at G.G. Rathi Government Tuberculosis Hospital, Amravati, Maharashtra, a tertiary-level public health facility. The study was carried out over a period of 12 months, from February 2025 to January 2026.

The study aimed to evaluate the diagnostic and predictive utility of complete blood count (CBC)-derived inflammatory markers, specifically Platelet–Lymphocyte Ratio (PLR) and Monocyte–Lymphocyte Ratio (MLR), in differentiating pulmonary tuberculosis from other respiratory infections.

A total of 300 participants were enrolled and divided into two groups: Cases were 150 patients with newly diagnosed pulmonary tuberculosis and Controls were150 patients presenting with respiratory symptoms but diagnosed with non-tubercular respiratory infections. Cases and controls were selected from the outpatient and inpatient departments during the study period using consecutive sampling. Cases were defined as adult patients (>18 years) with microbiologically confirmed pulmonary tuberculosis, diagnosed by sputum smear microscopy for acid-fast bacilli (AFB) and/or Cartridge-Based Nucleic Acid Amplification Test (CBNAAT/GeneXpert), as per NTEP guidelines. Only newly diagnosed cases who had not initiated anti-tubercular therapy were included to avoid treatment-related hematological alterations.

Controlsincluded patients presenting with clinical features suggestive of lower respiratory tract infections such as cough, fever, and breathlessness, but subsequently diagnosed with non-tubercular conditions (e.g., bacterial pneumonia, acute bronchitis). Tuberculosis was ruled out in all controls by negative CBNAAT and/or sputum AFB testing, along with clinical and radiological assessment.

All adult patients aged 18 years and above presenting during the study period and fulfilling the case or control definitions were eligible for inclusion. Only newly diagnosed pulmonary TB patients who had not received prior anti-tubercular treatment were included in the case group. Controls were selected from patients with confirmed non-tubercular respiratory infections and no evidence of TB on microbiological testing.

Patients with conditions known to significantly affect hematological parameters were excluded to minimize confounding. These included individuals with HIV infection, malignancies, chronic inflammatory or autoimmune disorders, hematological diseases, chronic liver or kidney disease, and those receiving corticosteroids, immunosuppressive therapy, or chemotherapy. Patients with a history of prior TB treatment or relapse cases were also excluded.

The sample size for the present case–control study was calculated based on the expected difference in the proportion of elevated Monocyte–Lymphocyte Ratio (MLR) between tuberculosis cases and non-tubercular controls, as reported in previous literature. A prior study by Aktas et al. demonstrated a significantly higher prevalence of elevated MLR among patients with pulmonary tuberculosis compared to controls (approximately 70% vs 45%) [6]. Using these estimates, the sample size was calculated using the standard formula for comparison of two proportions in case–control studies:

$$n = [(Z\alpha/2 + Z\beta)^2 \times \{p1(1-p1) + p2(1-p2)\}] / (p1 - p2)^2$$

Assuming a 95% confidence level ($Z\alpha/2 = 1.96$) and 80% power ($Z\beta = 0.84$), with $p1 = 0.70$ and $p2 = 0.45$, the minimum required sample size was estimated to be approximately 58 participants per group. However, to enhance the statistical power, improve precision, and account for potential variability and exclusions, the sample size was increased to 150 cases and 150 controls, resulting in a total of 300 participants.

After obtaining informed consent, detailed clinical and demographic information was recorded using a pre-designed structured proforma. Venous blood samples were collected under aseptic precautions prior to initiation of any treatment.

Complete blood count (CBC) was performed using an automated hematology analyzer. The following parameters were recorded: hemoglobin, total leukocyte count, platelet count, absolute lymphocyte count, and absolute monocyte count.

Derived inflammatory markers were calculated as follows:

- Platelet–Lymphocyte Ratio (PLR) = Platelet count / Absolute lymphocyte count
- Monocyte–Lymphocyte Ratio (MLR) = Absolute monocyte count / Absolute lymphocyte count

All laboratory investigations were performed in the same institutional laboratory to maintain uniformity.

Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 25.0.

Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. Comparisons between cases and controls were performed using independent t-test or Mann–Whitney U test for continuous variables and chi-square test for categorical variables.

Receiver Operating Characteristic (ROC) curve analysis was used to determine the diagnostic performance and optimal cut-off values of PLR and MLR. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were calculated.

For case–control analysis, odds ratios (OR) with 95% confidence intervals (CI) were computed using 2×2 contingency tables. Multivariable logistic regression analysis was performed to identify independent predictors of tuberculosis, and adjusted odds ratios (AOR) were reported. A p-value of <0.05 was considered statistically significant.

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Approval was obtained from the Institutional Ethics Committee prior to commencement of the study. Written informed consent was obtained from all participants before enrollment. Confidentiality of patient data was strictly maintained throughout the study.

RESULTS:

A total of 300 participants were included in this hospital-based case–control study, comprising 150 patients with microbiologically confirmed pulmonary tuberculosis (cases) and 150 patients with non-tubercular respiratory infections (controls). The mean age of participants in the TB group was 42.5 ± 15.3 years, compared to 40.8 ± 14.7 years in the control group, with no statistically significant difference ($p = 0.32$).

The gender distribution was comparable between the two groups, with males constituting 61.3% of cases and 58.7% of controls, while females accounted for 38.7% and 41.3%, respectively ($p = 0.65$). This similarity in baseline demographic characteristics indicates that the two groups were well matched and reduces the likelihood of confounding due to age or sex.

Table 1: Baseline Characteristics of Cases and Controls

Variable	Cases (TB) (n=150)	Controls (n=150)	p-value
Age (years, mean ± SD)	42.5 ± 15.3	40.8 ± 14.7	0.32
Male, n (%)	92 (61.3%)	88 (58.7%)	0.65
Female, n (%)	58 (38.7%)	62 (41.3%)	0.65
Haemoglobin (g/dL)	10.2 ± 1.8	11.5 ± 1.6	<0.001
Total WBC (/µL)	10,800 ± 3,200	11,500 ± 3,600	0.08
Platelet count (/µL)	$3.8 \pm 1.2 \times 10^5$	$3.2 \pm 1.0 \times 10^5$	<0.001
Lymphocyte count (/µL)	1,200 ± 400	1,800 ± 500	<0.001
Monocyte count (/µL)	750 ± 250	500 ± 200	<0.001

The two groups were comparable in terms of age and gender distribution ($p > 0.05$), minimizing demographic confounding. However, TB cases exhibited significantly lower haemoglobin and lymphocyte counts, along with elevated platelet and monocyte counts ($p < 0.001$). These haematological alterations reflect the systemic inflammatory milieu and immune dysregulation characteristic of tuberculosis.

Table 2: Comparison of PLR and MLR Between Cases and Controls.

Parameter	Cases (TB) (n=150)	Controls (n=150)	p-value
PLR	316 ± 110	178 ± 75	<0.001
MLR	0.63 ± 0.21	0.28 ± 0.12	<0.001

Both PLR and MLR were significantly elevated among TB cases compared to controls, indicating enhanced inflammatory response and altered leukocyte dynamics. The magnitude of difference was more pronounced for MLR, suggesting a stronger biological association with TB pathophysiology.

Table 3: Association of PLR and MLR with TB (Odds Ratio Analysis).

Parameter	Category	Cases (TB)	Controls	Odds Ratio (95% CI)	p-value
PLR	>220	108	45	4.8 (2.9–7.8)	<0.001
	≤220	42	105		
MLR	>0.45	120	30	8.0 (4.6–13.8)	<0.001
	≤0.45	30	120		

Elevated PLR (>220) and MLR (>0.45) were strongly associated with TB. Notably, patients with elevated MLR had **eight-fold higher odds** of TB, indicating a robust association and supporting its role as a potential screening biomarker.

Table 4: Multivariable Logistic Regression Analysis (Adjusted Odds Ratios)

Variable	Adjusted OR (AOR)	95% CI	p-value
Haemoglobin (<11 g/dL)	1.9	1.1 – 3.4	0.02
Lymphocyte (<1500/µL)	2.7	1.5 – 4.9	<0.001
Monocyte (>600/µL)	3.4	1.9 – 6.1	<0.001
PLR (>220)	2.2	1.2 – 3.9	0.01
MLR (>0.45)	5.6	3.0 – 10.4	<0.001

After adjustment for confounding variables, MLR remained the strongest independent predictor of TB, followed by monocytosis and lymphopenia. PLR retained moderate significance, whereas other haematological parameters showed weaker associations. This reinforces the independent diagnostic value of MLR.

Table 5: ROC Curve and Diagnostic Performance of PLR and MLR

Parameter	AUC (95% CI)	Cut-off	Sensitivity	Specificity	Accuracy
PLR	0.78 (0.73–0.83)	>220	72%	70%	71%
MLR	0.86 (0.81–0.90)	>0.45	80%	82%	81%

MLR demonstrated superior diagnostic performance compared to PLR, with higher AUC, sensitivity, specificity, and overall accuracy. These findings indicate that MLR has better discriminative ability for differentiating TB from other respiratory infections.

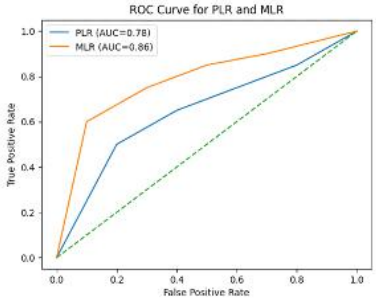
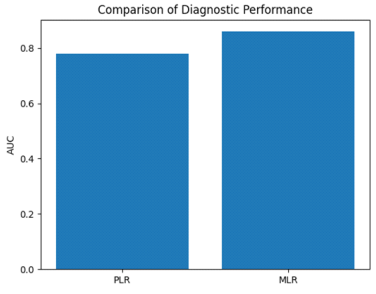


Table 6: Combined Diagnostic Performance of PLR and MLR

Parameter (Combined)	AUC (95% CI)	Sensitivity	Specificity
PLR + MLR combined score	0.89 (0.85–0.93)	84%	85%

The combined PLR–MLR model showed the highest diagnostic performance, with improved sensitivity and specificity compared to individual markers. This suggests a synergistic effect, enhancing clinical utility in resource-limited settings.



DISCUSSION:

The present hospital-based case–control study evaluated the diagnostic utility of complete blood count (CBC)-derived inflammatory markers, namely platelet–lymphocyte ratio (PLR) and monocyte–lymphocyte ratio (MLR), in differentiating pulmonary tuberculosis (TB) from other respiratory infections. Our findings demonstrate that both PLR and MLR are significantly elevated in TB patients, with MLR emerging as a stronger independent predictor and superior diagnostic marker.

The hematological alterations observed in our study, including anemia, lymphopenia, monocytosis, and thrombocytosis among TB cases, are consistent with the known pathophysiology of tuberculosis. Chronic infection with *Mycobacterium tuberculosis* leads to persistent immune activation, resulting in increased monocyte/macrophage activity and relative lymphocyte suppression. Similar findings have been reported by Bozkuş et al. and Iliaz et al., who demonstrated significant alterations in CBC parameters among TB patients compared to controls [7,8].

In our study, both PLR and MLR were significantly higher in TB cases, with mean MLR showing a more pronounced difference. This aligns with previous studies suggesting that MLR is a more reliable biomarker of chronic inflammation and immune response in TB. Aktas et al. reported significantly elevated MLR levels in TB patients and proposed its role as a useful inflammatory marker [9]. Similarly, Wang et al. demonstrated that MLR had better discriminatory ability than PLR in distinguishing TB from other pulmonary diseases [10].

The odds ratio analysis in our study further strengthens the association, with elevated MLR showing eight-fold increased odds of TB, compared to approximately five-fold for PLR. This is consistent with findings by La Manna et al., who reported that MLR is strongly associated with active TB and reflects disease activity [11]. The stronger association of MLR may be attributed to its direct representation of monocyte-driven immune response, which plays a central role in granuloma formation and TB pathogenesis.

Multivariable logistic regression analysis in the present study demonstrated that MLR remained the strongest independent predictor of TB even after adjusting for confounding factors, with an adjusted odds ratio of 5.6. Monocytosis and lymphopenia also showed significant independent associations. These findings are in agreement with previous studies indicating that monocyte predominance and lymphocyte depletion are characteristic hematological features in TB [12].

Receiver operating characteristic (ROC) analysis revealed that MLR had superior diagnostic performance compared to PLR, with higher AUC, sensitivity, and specificity. Our findings (AUC 0.86 for MLR vs 0.78 for PLR) are comparable to those reported by Lee et al., who demonstrated AUC values ranging from 0.80 to 0.88 for MLR in TB diagnosis [13]. The relatively lower performance of PLR may be due to its indirect reflection of inflammation, as platelet counts can be influenced by multiple non-specific factors.

Importantly, the combined PLR–MLR model in our study demonstrated the highest diagnostic accuracy, with an AUC of 0.89, suggesting a synergistic effect of combining multiple inflammatory markers. This approach is supported by emerging evidence that composite biomarkers improve diagnostic performance compared to individual parameters [14]. Such combined models are particularly useful in resource-limited settings, where advanced diagnostic tools may not be readily available.

From a public health perspective, these findings have significant implications. Given that CBC is a widely available, low-cost investigation, the use of derived indices such as MLR and PLR can aid in early risk stratification and triage of patients suspected of TB. However, it is important to emphasize that these markers are not disease-specific and should not replace microbiological confirmation.
The present study has certain limitations. Being a single-center study, the findings may have limited generalizability. Additionally, variability in cut-off values across different populations may affect diagnostic performance. Future multicentric studies with larger sample sizes and external validation are warranted to establish standardized cut-offs and validate these findings.

In conclusion, MLR is a superior and independent hematological marker for differentiating pulmonary TB from other respiratory infections, with better diagnostic performance than PLR. The combined use of PLR and MLR further enhances diagnostic accuracy, supporting their role as adjunctive, low-cost screening tools in TB-endemic and resource-constrained settings.

CONCLUSION:

The present study demonstrates that CBC-derived inflammatory indices, particularly the monocyte–lymphocyte ratio (MLR), have significant diagnostic utility in differentiating pulmonary tuberculosis from other respiratory infections. MLR emerged as a strong

independent predictor with superior diagnostic performance compared to platelet–lymphocyte ratio (PLR), while the combined use of both markers further enhanced accuracy.

From a public health perspective, these findings are highly relevant, especially in high TB-burden and resource-constrained settings where access to advanced diagnostics may be limited. As complete blood count is inexpensive, widely available, and routinely performed, incorporation of MLR and PLR into initial clinical assessment can facilitate early risk stratification, prompt identification of high-risk individuals, and prioritization for confirmatory testing such as CBNAAT.

Although these hematological indices cannot replace microbiological diagnosis, they offer a practical, scalable, and cost-effective adjunct for TB screening and triage within existing healthcare systems. Integration of such low-cost biomarkers into routine practice may contribute to reducing diagnostic delays, improving case detection, and strengthening tuberculosis control strategies.

Further multicentric studies and external validation are warranted to standardize cut-off values and establish their role in national TB programs. Nevertheless, the present findings support the potential of CBC-derived indices as valuable tools in advancing early TB detection and enhancing public health response.

REFERENCES:

1. World Health Organization. Global tuberculosis report 2023. Geneva: World Health Organization; 2023.
2. Lawn SD, Nicol MP. Xpert MTB/RIF assay: development, evaluation and implementation of a new rapid molecular diagnostic for tuberculosis. *Future Microbiol*. 2011;6(9):1067-82.
3. Aktas G, Sit M, Dikbas O, Tekce H, Savli H, Tekce BK, et al. Elevated monocyte to lymphocyte ratio in tuberculosis patients. *Biomark Med*. 2017;11(5):409-13.
4. Iliaz S, Iliaz R, Ortakoylu MG, Bahadir A, Bagci BA, Caglar E. Value of neutrophil/lymphocyte ratio in the differential diagnosis of tuberculosis and bacterial pneumonia. *Ann Thorac Med*. 2016;11(3):220-4.
5. Lee YJ, Lee HR, Nam CM, Kim YJ, Han SK, Shim YS, et al. Diagnostic performance of hematological ratios in tuberculosis. *PLoS One*. 2018;13(7):e0200192.
6. Aktas G, Sit M, Dikbas O, Tekce H, Savli H, Tekce BK, et al. Elevated monocyte to lymphocyte ratio in tuberculosis patients. *Biomark Med*. 2017;11(5):409-13.
7. Bozkus F, Dikmen N, Samur A, Bilal N, Arslan S. Evaluation of hematological parameters in patients with pulmonary tuberculosis. *J Clin Anal Med*. 2016;7(3):312-5.
8. Iliaz S, Iliaz R, Ortakoylu MG, Bahadir A, Bagci BA, Caglar E. Value of neutrophil/lymphocyte ratio in the differential diagnosis of tuberculosis and bacterial pneumonia. *Ann Thorac Med*. 2016;11(3):220-4.
9. Aktas G, Sit M, Dikbas O, Tekce H, Savli H, Tekce BK, et al. Elevated monocyte to lymphocyte ratio in tuberculosis patients. *Biomark Med*. 2017;11(5):409-13.
10. Wang J, Yin Y, Wang X, Pei H, Kuai S, Gu L. Diagnostic value of monocyte-to-lymphocyte ratio in pulmonary tuberculosis. *Int J Clin Exp Pathol*. 2019;12(6):2070-6.
11. La Manna MP, Orlando V, Dieli F, Di Carlo P, Cascio A, Cuzzi G, et al. Quantitative and qualitative profiles of circulating monocytes may help identifying tuberculosis infection and disease stages. *J Transl Med*. 2017;15(1):154.
12. Yoon NB, Son C, Um SJ. Role of the neutrophil-lymphocyte count ratio in the differential diagnosis between pulmonary tuberculosis and bacterial community-acquired pneumonia. *Ann Lab Med*. 2013;33(2):105-10.
13. Lee YJ, Lee HR, Nam CM, Kim YJ, Han SK, Shim YS, et al. Diagnostic performance of hematological ratios in tuberculosis. *PLoS One*. 2018;13(7):e0200192.
14. Qi Q, Zhuang L, Shen Y, Geng Y, Yu S, Chen H, et al. A novel systemic inflammation response index (SIRI) for predicting the survival of patients with pancreatic cancer after chemotherapy. *Clin Chim Acta*. 2020;510:318-24.