

# Evaluation Of Neutrophil To Lymphocyte Ratio And Platelet To Lymphocyte Ratio Among Hypertensive And Normotensive in adult population – A Cross-Sectional Study.

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## ABSTRACT

**Background:** Hypertension is a major universal health problem and a leading contributor to cardiovascular morbidity and mortality. Recent evidence suggests that systemic inflammation plays an important role in the pathogenesis of hypertension. Simple haematological markers, such as the Neutrophil-to-Lymphocyte Ratio (NLR) and Platelet-to-Lymphocyte Ratio (PLR), have gained attention as cost-effective and easily accessible indicators of inflammatory status. **Objectives:** This study aimed to compare NLR and PLR between hypertensive and normotensive individuals and to evaluate their association with blood pressure parameters. **Methods:** A cross-sectional study was conducted among 128 adults attending Sharda Hospital, Greater Noida. Participants were categorized into hypertensive and normotensive groups. Complete blood counts were used to calculate NLR and PLR, and their relationship with systolic and diastolic blood pressure was analysed. **Results:** The mean NLR and PLR were significantly higher in hypertensive individuals compared to normotensive controls (NLR:  $5.65 \pm 2.91$  vs.  $2.26 \pm 0.93$ ; PLR:  $16.85 \pm 12.10$  vs.  $8.83 \pm 5.16$ ;  $p < 0.001$ ). Both NLR and PLR demonstrated a significant positive association with systolic and diastolic blood pressure. **Conclusion:** Elevated NLR and PLR in hypertensive individuals highlight the role of systemic inflammation in hypertension. These inexpensive, readily available markers may aid in early detection, risk stratification, and hypertension monitoring in routine clinical practice

**Keywords:** Hypertension, Neutrophil, Lymphocyte, Platelet, Inflammation

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**Conflict of interest:** None

## INTRODUCTION

Hypertension (HT) is a modern-day epidemic.<sup>1</sup> About 1.28 billion adults between the ages of 30 and 79 worldwide suffer from hypertension, and an estimated 46% of those individuals are not aware that they have the illness.<sup>2</sup> Compared to wealthy countries, low-income countries had more difficulty regulating hypertension, according to a cross-sectional study covering 89 countries.<sup>3</sup> A review of global information HT is a global load that affected 20.6% of males and 20.9% of females in India in 2005.<sup>4</sup> Furthermore, a substantial hazard influence for the manifestation of atherothrombosis, which accounts for roughly 25% of fatalities globally. Crucially, inflammation is a major factor in the pathophysiology of hypertension, which has a complicated etiology.<sup>5</sup> Importantly, hypertension has a complex origin, and inflammation plays a major part in the pathophysiology of this condition. It is

crucial to discover a prognostic indicator that is both easily measurable and reasonably accurate to upgrade the screening of hypertension.<sup>6</sup>

Hypertension is a chronic inflammatory condition, and the overall count of white blood cells (WBC) and their subcategories can serve as markers of systemic inflammation.<sup>2</sup> As a result of endothelial cell erosion, it encourages platelet activation, which in turn drives the manufacture of thrombus, therefore causing atherothrombotic conditions and cardiovascular incidents. PLR is investigated as an inflammatory biological marker in both primary hypertension and pro-inflammatory illnesses.<sup>6</sup>

Along with Platelets, neutrophils play an important role in cardiovascular function, which contributes to the development of atherosclerotic disease.<sup>7</sup> A full blood count is used to calculate the NLR, and it serves as an important haematological measure of immunological reaction and

## Evaluation Of Neutrophil To Lymphocyte Ratio And Platelet To Lymphocyte Ratio Among Hypertensive And Normotensive in adult population – A Cross-Sectional Study.

complete inflammation.<sup>8</sup> By calculating the ratio of absolute neutrophil counts to absolute lymphocyte counts, the NLR is determined.<sup>9</sup>

Acute coronary syndrome, heart failure, stroke, cardiac events, and both fatal and nonfatal events have all been strongly linked to elevated NLR, according to recent data.<sup>10</sup> It has been suggested that NLR is a valuable predictor of the incidence of hypertension since it can significantly raise the risk of numerous illnesses, including heart failure, acute coronary syndromes, and stable coronary artery disease.<sup>11</sup> NLR reflects inflammation and physiologic stress. PLR indicates endothelial dysfunction, local vascular wall inflammation, and platelet and clotting system activation.<sup>12</sup> Compared with individual blood parameters, the NLR-to-PLR ratio is more stable, as it is less affected by various factors.<sup>13</sup> This study is therefore carried out to evaluate NLR and PLR among Hypertensive and Normal patients at Sharda Hospital, Greater Noida. The American Heart

### AIM AND OBJECTIVES

#### RESEARCH QUESTION:

What is the association between Neutrophil-Lymphocyte Ratio and the Platelet-Lymphocyte Ratio in hypertensive individuals compared to those with normal blood pressure?

#### AIM

Investigate and compare the Neutrophil-Lymphocyte Ratio (NLR) and Platelet-Lymphocyte Ratio (PLR) in hypertensive individuals and those with normal blood pressure.

#### OBJECTIVES

**PRIMARY OBJECTIVE:** To evaluate Neutrophil-Lymphocyte Ratio and Platelet-Lymphocyte Ratio among Hypertensives and Normotensives.

**SECONDARY OBJECTIVE:** Determining the clinical significance of these ratios in identifying systemic inflammation associated with hypertension.

### MATERIAL AND METHODS

**ETHICAL CLEARANCE:** A research protocol was reviewed and approved by the Ethical Board of the Medical College. After obtaining approval and ethical clearance, the research protocol was conducted on scheduled dates.

**SOURCE OF THE DATA:** This research was conducted among the adult Hypertensive and normotensive population to evaluate the association between NLR and PLR in Sharda Hospital, Greater Noida.

**STUDY DESIGN:** A qualified examiner from the Physiology Department, Sharda University, School of Medical Sciences & Research, Greater Noida, carried out the descriptive, cross-sectional study.

**STUDY SETTING:** This study was conducted in the physiology department of Sharda University's School of Medical Sciences and Research, in cooperation with the medicine department and the central library.

**STUDY POPULATION:** This study consists of the adult population attending Sharda Hospital, Greater Noida, aged 25-55 years. Based on the demographic information saved, Table 1

Gender of both Hypertensive and Normotensive patients

participants were segregated by gender, age, and occupation.

**INFORMED CONSENT:** Following the study explanation, participants voluntarily provided written informed consent. The preformat was presented in both English and Hindi and explained by the researcher in the vernacular for the convenience of the study participants.

**INCLUSION CRITERIA:** Individuals willing to give written informed consent and a drug history

Individuals of both genders aged between 25 and 55 years. Essential hypertensive patients with primary hypertension with blood pressure SBP slightly lower than 140 mm Hg, DBP slightly lower than 90 mm Hg.

Essential hypertension patients with lifestyle and diet modification.

**EXCLUSION CRITERIA:** Intake of medication within two weeks before the study

Patients with haematological diseases or other medical conditions that impact WBC count

Any illness other than hypertension, such as systemic lupus erythematosus, rheumatoid arthritis, osteoarthritis, or tuberculosis,

Acute coronary syndrome, typhoid, malaria, pharyngitis, and other acute infections during the last six months, as well as any current illnesses.

Use of glucocorticoids throughout the previous three months

People who already have heart failure, chronic kidney disease, liver illness, or cerebrovascular disease.

People who are cognitively or physically challenged, or who are terminally ill.

**METHOD IN COLLECTION OF DATA:** A questionnaire, clinical examination using anthropometric measurements which include height, weight, and Body mass index, measuring of blood pressure, and collecting of blood.

**Statistical Method:** All data were analyzed using SPSS version 26. The data's mean, median, and standard deviation were calculated using descriptive statistics. Tables are prepared on Microsoft Excel. The correlation between NIR and PIR was carried out using Pearson's coefficient 'r'. The Shapiro-Wilk test is used to determine whether continuous data are normally distributed. An independent t-test was conducted to compare both intragroup and intergroup comparisons. For regularly distributed data, the paired t-test was employed. The mean parameter values obtained were statistically analysed, and the parameters were compared between groups. The 95% C.I. and 5% level of significance were used for the analysis of data.

Highly significant if p is less than 0.01, significant if p is less than 0.05, extremely important if p is less than 0.001, and it is not Significant if P is greater than 0.05.

### Results

Evaluation Of Neutrophil To Lymphocyte Ratio And Platelet To Lymphocyte Ratio Among Hypertensive And Normotensive in adult population – A Cross-Sectional Study.

Group		Frequency	Percent
Hypertensive	Female	25	39.1
	Male	39	60.9
	Total	64	100.0
Normotensive	Female	31	48.4
	Male	33	51.6
	Total	64	100.0

Table 1 shows that 60.9 percent of patients were males, compared to 39.1 percent females, who were hypertensives & 51.6 percent of patients were males, compared to 48.4 percent females, who were normotensives.

Group	Frequency	Percent	
Hypertensive	Mixed Diet	44	68.8
	Veg	20	31.2
	Total	100	100
Normotensive	Mixed Diet	47	73.4
	Veg	17	26.6
	Total	100	100

Table 2 shows that 68.8 percent of patients were on a mixed diet, compared to 31.2 percent who were vegetarian, in the hypertensive group & 73.4 percent were on a mixed diet, compared to 26.6 percent who were vegetarian, in the normotensive group.

Table 3: Habit of both Hypertensive and Normotensive patients

Habit	Hypertensive	Normotensive
Alcohol	3.10%	0.00%
Smoke	28.10%	15.60%
No	68.80%	84.40%

Table 3 shows that 3.10 percent of patients take in Alcohol, 28.10 percent Smoke, and 68.80 percent do not take in Alcohol or Smoke in the hypertensives group & 0.00 percent of patients take

Evaluation Of Neutrophil To Lymphocyte Ratio And Platelet To Lymphocyte Ratio Among Hypertensive And Normotensive in adult population – A Cross-Sectional Study.

**Table 4: Descriptive Statistics of both group 1 and group 2**

Group		Age	Weight (Kg)	Height (Cm)	Neutrophil	Lymphocyte	Platelet	Neutrophil Lymphocyte Ratio	Platelet Lymphocyte Ratio	SBP (mmHg)	DBP (mmHg)
Hypertensive	N	64	64	64	64	64	64	64	64	64	64
	Valid Missing	0	0	0	0	0	0	0	0	0	0
	Mean	50.516	60.297	153.313	76.131	16.4313	232.344	5.6498	16.85445	164.531	90.000
	Median	51.000	61.000	156.000	76.450	15.0000	214.000	5.2600	13.39000	165.000	90.000
	Mode	57.0	60.0 <sup>a</sup>	156.0	80.0	12.00	167.0	5.26 <sup>a</sup>	8.350 <sup>a</sup>	160.0	90.0
	Std. Deviation	9.6527	7.3803	9.4950	7.4192	6.41199	105.4921	2.91213	12.101021	12.4887	0.0000
	Range	43.0	34.0	45.0	35.1	27.50	664.0	13.02	70.670	54.0	0.0
	Minimum	22.0	40.0	128.0	55.0	6.00	70.0	1.64	3.330	136.0	90.0
	Maximum	65.0	74.0	173.0	90.1	33.50	734.0	14.66	74.000	190.0	90.0
Normotensive	N	64	64	64	64	64	64	64	64	64	64
	Valid Missing	0	0	0	0	0	0	0	0	0	0
	Mean	51.391	57.663	149.875	60.070	29.2661	239.953	2.2636	8.83289	114.156	77.109
	Median	52.000	57.000	149.500	60.000	30.0000	217.000	2.0300	7.24000	119.000	80.000
	Mode	65.0	60.0	143.0	60.0	30.00	153.0 <sup>a</sup>	2.00	3.500 <sup>a</sup>	120.0	80.0
	Std. Deviation	11.0175	6.1242	9.0457	7.3000	7.34107	122.1605	.93020	5.159976	7.5765	4.0674
	Range	43.0	30.0	42.0	28.1	40.27	644.0	5.23	21.970	30.0	10.0
	Minimum	25.0	40.0	125.0	41.9	10.13	90.0	.83	2.490	100.0	70.0
	Maximum	68.0	70.0	167.0	70.0	50.40	734.0	6.06	24.460	130.0	80.0

a. Multiple modes exist. The smallest value is shown in the Hypertensive group: mean age = 50.52 years (SD ≈ 9.65); mean NLR ≈ 5.65 (SD ≈ 2.91); mean PLR ≈ 16.85 (SD ≈ 12.10); mean SBP ≈ 164.53 mmHg (SD ≈ 12.49); mean DBP = 90.00 mmHg.

Normotensive group: mean age = 51.39 years (SD ≈ 11.02); mean NLR ≈ 2.26 (SD ≈ 0.93); mean PLR ≈ 8.83 (SD ≈ 5.16); mean SBP ≈ 114.16 mmHg (SD ≈ 7.58); mean DBP ≈ 77.11 mmHg.

in Alcohol, 15.60 percent smoke, and 84.40 percent do not take in Alcohol or Smoke in the normotensive group

Evaluation Of Neutrophil To Lymphocyte Ratio And Platelet To Lymphocyte Ratio Among Hypertensive And Normotensive in adult population – A Cross-Sectional Study.

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Age	1.676	.198	-.478	126	.634	-.8750	1.8310	-4.4985	2.7485
Weight (Kg)	.314	.576	2.198	126	<b>.030</b>	2.6344	1.1988	.2620	5.0067
Height (Cm)	.001	.975	2.097	126	<b>.038</b>	3.4375	1.6393	.1934	6.6816
Neutrophil	.001	.977	12.345	126	<b>.000</b>	16.0609	1.3010	13.4862	18.6357
Lymphocyte	.346	.557	-10.534	126	<b>.000</b>	-12.83484	1.21838	-15.24598	-10.42370
Platelet	.020	.888	-.377	126	.707	-7.6094	20.1757	-47.5365	32.3177
Neutrophil Lymphocyte Ratio	35.665	.000	8.861	126	<b>.000</b>	3.38625	.38214	2.63001	4.14249
Platelet Lymphocyte Ratio	13.579	.000	4.878	126	<b>.000</b>	8.021563	1.644404	4.767336	11.275789
SBP (mmhg)	11.214	.001	27.589	126	<b>.000</b>	50.3750	1.8259	46.7616	53.9884
DBP (mmhg)	183.359	.000	25.354	126	<b>.000</b>	12.8906	.5084	11.8845	13.8968

In this age, the p-value is greater than 0.05 (0.634), indicating it is not statistically significant.

In terms of weight, the p-value is greater than 0.05 (0.030), indicating it is extremely statistically significant.

In height, the p-value is greater than 0.05 (0.038), indicating it is extremely statistically significant.

In the Neutrophil count, the p-value is less than 0.05 (0.000), indicating it is highly statistically significant.

In the Lymphocyte count, the p-value is less than 0.05 (0.000), indicating it is highly statistically significant.

In the platelet count, the p-value is greater than 0.05 (0.707), indicating it is not statistically significant.

In the Neutrophil-to-Lymphocyte Ratio (NLR), the p-value is less than 0.05 (0.000), indicating it is highly statistically significant.

In the Platelet-to-Lymphocyte Ratio (PLR), the p-value is less than 0.05 (0.000), indicating it is highly statistically significant.

In Systolic Blood Pressure (SBP), the p-value is less than 0.05 (0.000), indicating it is highly statistically significant.

Systolic Blood Pressure (DBP): p-value is less than 0.05; it is 0.000, indicating it is highly statistically significant.

Evaluation Of Neutrophil To Lymphocyte Ratio And Platelet To Lymphocyte Ratio Among Hypertensive And Normotensive in adult population – A Cross-Sectional Study.

Table 6 Pearson correlation

Hypertensive Variables	Age	Weight (Kg)	Height (Cm)	Neutrophil	Lymphocyte	Platelet	Neutrophil Lymphocyte Ratio	Platelet Lymphocyte Ratio	SBP (mmhg)
Age	1	-.104	-.086	.052	-.024	-.012	.088	.009	-.100
Weight (Kg)		1	.232	.112	-.050	.191	.029	.162	.249*
Height (Cm)			1	.153	-.171	-.095	.099	.054	.069
Neutrophil				1	-.954**	-.014	.840**	.557**	-.171
Lymphocyte					1	.017	-.869**	-.582**	.193
Platelet						1	.072	.628**	.077
Neutrophil Lymphocyte Ratio							1	.731**	-.175
Platelet Lymphocyte Ratio								1	-.034
SBP (mmhg)									1

Normotensive Variables	Age	Weight (Kg)	Height (Cm)	Neutrophil	Lymphocyte	Platelet	Neutrophil Lymphocyte Ratio	Platelet Lymphocyte Ratio	SBP (mmhg)	DBP (mmhg)
Age	1	.110	.172	-.005	-.105	-.076	.077	-.007	-.037	.019
Weight (Kg)		1	.054	.053	.072	-.071	-.098	-.149	.203	.162
Height (Cm)			1	-.169	.235	-.100	-.261*	-.240	.008	.080
Neutrophil				1	-.816**	.030	.729**	.341**	.050	.153
Lymphocyte					1	-.043	-.936**	-.539**	.073	-.079
Platelet						1	.011	.822**	.089	.002
Neutrophil Lymphocyte Ratio							1	.553**	-.078	.039
Platelet Lymphocyte Ratio								1	.005	.018
SBP (mmhg)									1	.412**
DBP (mmhg)										1

\*. Correlation is significant at the 0.05 level (2-tailed)

\*\* . Correlation is significant at the 0.01 level (2-tailed), and a. Cannot be computed because at least one of the variables is constant.

## DISCUSSION

This study aimed to evaluate and compare the neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) in hypertensive and normotensive individuals. These hematological indices have recently emerged as cost-effective, readily available, and reliable biomarkers for assessing complete inflammation and cardiovascular threat. The discoveries of this research provide important insights into the inflammatory mechanisms underlying hypertension and their potential clinical utility in diagnosis and prognosis.

In this cross-sectional study involving 128 participants (64 hypertensives and 64 normotensives), the mean NLR and PLR were significantly higher in hypertensive participants. Specifically, the mean NLR in hypertensive participants was  $5.65 \pm 2.91$ , compared to  $2.26 \pm 0.93$  in normotensive participants, while the mean PLR was  $16.85 \pm 12.10$  and  $8.83 \pm 5.16$ , respectively. The independent-samples t-test revealed a statistically significant difference between the groups ( $p < 0.001$ ). These findings strongly support the hypothesis that hypertension is associated with elevated inflammatory markers and immune dysregulation.

The elevated NLR reflects increased neutrophil activity and decreased lymphocyte counts, suggesting a heightened inflammatory response and diminished immune regulation. Similarly, a high PLR indicates platelet activation and endothelial dysfunction, both of which are key contributors to vascular inflammation and atherothrombosis. Together, these results highlight the key role of NLR and PLR as surrogate markers of vascular inflammation in hypertensive patients.

The present findings are consistent with previous reports in the literature. Mistry and Parmar (2019) and Akkoyun et al. (2018) demonstrated that hypertensive patients have significantly higher NLR and PLR values, indicating an elevated risk of atherosclerotic and atherothrombotic events. Liu et al. (2015) also observed a strong correlation between NLR and increased risk of developing hypertension, emphasizing its prognostic relevance. Moreover, Zhang et al. (2024) and Xu et al. (2025) discovered that high NLR and PLR values were positively linked with cardiovascular and all-cause mortality among hypertensive individuals.

Gang and Yanyan (2016) reported increased NLR among hypertensive subjects with hyperhomocysteinemia, further supporting the inflammatory basis of hypertension. Similarly, Bayrakci et al. (2015) found that non-dipper hypertensive patients exhibited higher PLR compared to dipper counterparts, linking PLR to circadian variations in blood pressure and endothelial function. The agreement between this study and earlier research reinforces the clinical value of NLR and PLR as inflammatory indices in hypertensive pathology.

Pearson's correlation analysis revealed significant positive relationships among NLR, PLR, and systolic blood pressure (SBP), whereas lymphocyte count showed an inverse correlation with neutrophil count and SBP. This suggests that inflammatory activity, as reflected in NLR and PLR, increases with rising blood pressure. These results align with the conclusion of Susam et al. (2015), who reported significant associations among NLR levels and blood pressure variability in hypertensive subjects.

## CONCLUSION

This study aimed to evaluate the Neutrophil-to-Lymphocyte Ratio (NLR) and Platelet-to-Lymphocyte Ratio (PLR) in hypertensive and normotensive individuals and to examine their association with systemic inflammation and cardiovascular risk. The findings clearly demonstrate that both NLR and PLR were significantly higher in hypertensive participants compared to normotensive controls. This confirms that inflammation plays a key role in the growth and advancement of hypertension. Elevated NLR reflects increased neutrophil activity and decreased lymphocyte response, indicating an enhanced inflammatory state and compromised immune regulation. Similarly, an elevated PLR indicates platelet activation and endothelial dysfunction, both of which contribute to vascular injury and atherothrombosis.

The statistical analyses strongly support these associations, showing significant correlations between blood pressure

levels, NLR, and PLR. These outcomes not only align with previous national and international research but also underscore that these hematological parameters, readily obtained through routine blood tests, can serve as reliable, cost-effective biomarkers in clinical practice.

From a public health perspective, the results highlight the potential of incorporating NLR and PLR evaluations into routine hypertension screenings, especially in resource-limited settings. Early detection of elevated inflammatory markers may allow healthcare professionals to identify high-risk individuals, initiate timely interventions, and prevent cardiovascular complications.

In summary, this study concludes that NLR and PLR are valuable indicators of systemic inflammation and can provide additional insight into the pathophysiology of hypertension. Their integration into regular medical assessments could enhance early diagnosis, risk stratification, and effective management of hypertensive patients. An upcoming study involving larger, more diverse populations is recommended to strengthen these findings and further explore their prognostic value in cardiovascular disease.

Future scope and Social relevance

Use of Reliable and Cost-Effective Biomarkers: One of the major strengths of this study is its reliance on routinely obtainable and inexpensive blood test parameters. NLR and PLR are derived from standard complete blood count (CBC) tests, making the findings both accessible and applicable to healthcare settings, with resource-limited environments. This increases translational value in real medical practice.

Strong Statistical Analysis: Advanced statistical tools, including the Independent-Samples T-test and Pearson's Correlation Coefficient, were employed in SPSS. These tests not only provided evidence of significant differences between groups but also revealed strong correlations between inflammatory markers and blood pressure. The use of confidence intervals and p-values reinforced the validity of the findings.

Alignment with Existing Scientific Evidence: The study's results are consistent with several national and international studies, lending it strong external validity. This alignment with global research trends confirms the data's reliability and demonstrates the researcher's ability to contextualize findings within the broader scientific literature.

Limitations: Although this Research offers crucial insight into the association between inflammation and hypertension by evaluating NLR and PLR, it is not without limitations. First, the language barrier was a key factor in this study because the researcher was unable to speak the local language of most patients attending the hospital.

Second, the sample size was small and limited to individuals attending Sharda Hospital, potentially failing to accurately reflect the general population.

Recommendation: This study's results and limitations led to several suggestions for further research and clinical practice.

**Lifestyle and demographic variables**, including diet, physical activity, body composition, and stress, should be

carefully documented and adjusted for in future analyses to minimize confounding bias.

Health institutions should consider **including NLR and PLR assessments as part of routine blood investigations** for hypertensive patients, as they are inexpensive and easily obtainable indicators of systemic inflammation.

Clinicians should **monitor changes in NLR and PLR values** alongside blood pressure to identify high-risk patients early and initiate timely interventions such as lifestyle modifications and anti-inflammatory therapies.

Finally, **community-based screening programs** emphasizing inflammation control, dietary regulation, and hypertension awareness should be encouraged to reduce the burden of cardiovascular complications

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