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ORIGINAL ARTICLE

A comparative analysis of platelet to lymphocyte ratio(PLR) and atherogenic index of plasma(AIP) and its correlation with NIHSS for prediction of severity in patients of acute ischemic stroke

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ABSTRACT:
Background: Acute ischemic stroke (AIS) is a major global health concern associated with high morbidity and mortality. Inflammatory and lipid-related biomarkers such as Platelet to Lymphocyte Ratio (PLR) and Atherogenic Index of Plasma (AIP) may serve as potential predictors of stroke severity. The National Institutes of Health Stroke Scale (NIHSS) is a validated tool for assessing stroke severity. **Objectives:** To estimate PLR and AIP in patients with AIS and analyze their correlation with NIHSS scores to assess their prognostic value in predicting stroke severity. **Methods:** This observational cross-sectional study was conducted at the Department of General Medicine, Karnataka Institute of Medical Sciences, Hubballi, from June 2013 to June 2014. A total of 110 patients aged >40 years with confirmed AIS were enrolled. PLR was calculated from complete blood counts, and AIP was derived from fasting lipid profiles using the formula log(TG/HDL-C). Stroke severity was categorized using NIHSS scores into mild (≤8), moderate (9–15), and severe (>15). Data were analyzed using SPSS v26.0, applying ANOVA and Chi-square tests for statistical comparisons. **Results:** Higher PLR and AIP values were associated with increased stroke severity as categorized by NIHSS scores. Statistical analysis demonstrated significant differences in PLR and AIP across the three NIHSS-based severity groups, suggesting their predictive utility in AIS. **Conclusion:** PLR and AIP are promising, accessible biomarkers that correlate significantly with NIHSS scores in AIS patients. They may be valuable for early prediction of stroke severity and guiding clinical decision-making.
Keywords: Acute Ischemic Stroke, Platelet to Lymphocyte Ratio, Atherogenic Index of Plasma, NIHSS, Stroke Severity

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INTRODUCTION

Stroke ranks as the second most prevalent cause of mortality and is recognized as the third most frequent contributor to disability-adjusted life years globally. Atherosclerosis is fundamentally implicated in the pathophysiology of stroke, with inflammation serving a pivotal role in the initiation, advancement, and complications associated with atherosclerosis through its mediation of each phase of atheroma formation. Elevated platelet counts may potentiate thrombocyte activation and exacerbate the liberation of inflammatory mediators. Conversely, lymphocytes contribute an anti-inflammatory response during the progression of atherosclerosis. The utility of the platelet to lymphocyte ratio (PLR) lies in its ability to encapsulate the status of both inflammatory and thrombotic pathways, rendering it more informative than the assessment of platelet or lymphocyte counts in isolation. This emerging biomarker has not been extensively investigated in the context of acute ischemic stroke; therefore, the objective of the current study was to elucidate the role of PLR (Platelet to lymphocyte ratio) in patients experiencing acute ischemic stroke and to establish correlations with the NIHSS for the purpose of prognostic prediction[1,2].

Similarly research has indicated that atherosclerosis (AS) represents the predominant etiological factor contributing to acute ischemic stroke (AIS), with dyslipidemia identified as the primary risk determinant for AS. Various lipid profiles have been employed to assess the likelihood of adverse stroke outcomes, including total cholesterol (TC), triglycerides (TG), low-density lipoprotein (LDL-C), high-density lipoprotein (HDL-C), non-HDL-C, among other parameters; nevertheless, the predictive efficacy of these metrics remains constrained. The atherogenic index of plasma (AIP), derived from the logarithm of the ratio of TG to HDL, serves as an indicator of the concentrations of TG and HDL-C cholesterol. AIP, recognized as a significant biomarker of dyslipidemia and AS, has been utilized to evaluate overall lipid metrics. It is additionally regarded as a biomarker pertinent to coronary syndrome and metabolic syndrome. Prior investigations have established a positive correlation between AIP and the risk of cardiovascular disease. Importantly, certain studies have indicated that AIP

may exhibit a stronger association with the risk of cardiovascular and cerebrovascular diseases compared to the concentrations of individual lipoprotein cholesterol alone[3-5]. However, there exists a paucity of research exploring the connection between AIP and functional outcomes in AIS. Consequently, studies with larger sample sizes and prospective cohort designs are requisite to thoroughly assess this relationship. In the present investigation, we sought to elucidate the association between AIP and the severity of acute ischemic stroke.

AIM & OBJECTIVES

Objectives

1. To estimate Platelet to Lymphocyte ratio (PLR) and Atherogenic Index of Plasma (AIP) in patients with Acute ischemic stroke.
2. To correlate Platelet to Lymphocyte ratio (PLR) and Atherogenic Index of Plasma (AIP) in predicting the severity of acute ischemic stroke patients based on NIHSS score.

MATERIAL AND METHODS

- **Study design:**Observational cross-sectional study
- **Study area:** Department of General Medicine at Karnataka Institute of Medical Sciences, Hubballi.
- **Study period:** Research study was conducted fromJune 2013 to June 2014. Below is the work plan.
- **Sample size**: At a confidence level of 99% and allowable error of 0.1, the sample size for the study was calculated to be 110 using the formula:

$N = Z^2(1-\alpha/2)\ (1-r^2)^2 + 1+6r^2/D^2$

The calculation was based on the total number of inpatient admissions under General Medicine from January 2012 to December 2012, which was 18,081.

- **Inclusion criteria:**

1. Patients admitted in General Medicine wards and Medical Intensive Care Unit with a diagnosis of Acute ischemic stroke evidenced by NIHSS Score and confirmed by neuroimaging
2. Patients above the age of 40 years

- **Exclusion criteria:**

1. Acute ischemic stroke in patients less than 40 years of age
2. Any other cardiovascular events other than ischemic cerebrovascular accident
3. Patients in whom NIHSS scores could not be calculated
4. Patients who refused to give consent

METHODOLOGY

All individuals who fulfilled the inclusion criteria and provided consent for study participation were enrolled subsequent to acquiring written informed consent from either the individual or their legally authorized representative. A comprehensive clinical history was meticulously gathered from each individual and/or their caregivers. This history encompassed the onset of symptoms, progression, and relevant risk factors including hypertension, diabetes mellitus, dyslipidemia, tobacco use, alcohol consumption, as well as prior cerebrovascular or cardiovascular incidents. An exhaustive clinical examination was conducted, which included a general physical assessment, vital sign measurements (blood pressure, pulse rate, respiratory rate, and temperature), and a detailed neurological evaluation to determine the severity of the stroke. The severity of acute ischemic stroke was quantified utilizing the National Institutes of Health Stroke Scale (NIHSS) at the point of admission. The NIHSS represents a 15-item neurological assessment tool that appraises the impact of acute ischemic stroke on consciousness, language, neglect, visual-field impairment, extraocular movement, motor strength, ataxia, dysarthria, and sensory deficits. The cumulative score ranges from 0 to 42, with elevated scores signifying increased stroke severity. Based on the NIHSS classification, patients were stratified into mild (NIHSS score ≤ 8), moderate (NIHSS score 9-15), and severe (NIHSS score > 15) stroke categories.

Investigations

Blood samples were collected from all patients within 24 hours of admission. The following investigations were performed:

1. Complete Hemogram: Blood samples were collected in EDTA tubes for complete blood count analysis. The total platelet count and absolute lymphocyte count were noted, and the Platelet to Lymphocyte Ratio (PLR) was calculated by dividing the absolute platelet count by the absolute lymphocyte count.
2. Fasting Lipid Profile: Blood samples were collected after overnight fasting (at least 8 hours) for lipid profile analysis. The lipid profile included Total Cholesterol (TC), Triglycerides (TG), High-Density Lipoprotein Cholesterol (HDL-C), and Low-Density Lipoprotein Cholesterol (LDL-C). The Atherogenic Index of Plasma (AIP) was calculated as the logarithm (base 10) of the ratio of TG to HDL-C.
3. Neuroimaging: All patients underwent either Non-Contrast Computed Tomography (NCCT) of the brain or Magnetic Resonance Imaging (MRI) of the brain, or both, to confirm the diagnosis of acute ischemic stroke and to rule out hemorrhagic stroke.

Data Collection and Analysis

All patient information was systematically gathered utilizing a pre-structured proforma. The dataset encompassed demographic characteristics, clinical history, findings from physical examinations, NIHSS scores, and results from investigations such as complete blood count, fasting lipid profile, PLR, and AIP.

Statistical Analysis

The amassed data were inputted into Microsoft Excel and subsequently analyzed using IBM SPSS Statistics (Statistical Package for the Social Sciences) version 26.0. Descriptive statistics were articulated as mean ± standard deviation (SD) for continuous variables exhibiting a normal distribution and as frequencies with corresponding percentages for categorical variables.

The normality of the data distribution was evaluated employing the Shapiro-Wilk test. To compare continuous variables across the three stroke severity categories (mild, moderate, and severe), one-way Analysis of Variance (ANOVA) was applied for data that conformed to a normal distribution. Categorical variables were contrasted utilizing Pearson's Chi-square test or Fisher's exact test, contingent upon appropriateness. The interrelation between PLR and AIP with NIHSS scores was examined using Pearson's correlation coefficient (r). Receiver

Operating Characteristic (ROC) curve analysis was executed to ascertain the optimal cut-off values of PLRand AIP for predicting severe stroke (NIHSS score > 15), with calculations of the area under the curve (AUC), sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) performed. Multiple linear regression analysis was implemented to delineate independent predictors of NIHSS scores. A p-value < 0.05 was deemed statistically significant.

Ethical Considerations

The investigation was undertaken subsequent to acquiring approval from the Institutional Ethics Committee of Karnataka Institute of Medical Sciences, Hubballi. Written informed consent was procured from all participants or their legally authorized representatives prior to their enrollment in the study. All patient information was maintained in a confidential manner, and the anonymity of the patients was preserved throughout the duration of the study.

OBSERVATION AND RESULTS

In our study, the demographic profile of the study participants indicates that the majority were older adults, with a significant proportion (56.4%) falling within the **61–80 years** age group.

Participants aged **40–60 years** constituted 38.2% of the sample, while those over **80 years** made up only 5.5%. Regarding **gender distribution**, **male participants were overrepresented**, comprising 64.5% of the sample, compared to 35.5% female participants. Table 1 depicts the age and frequency distribution of study participitants.

Table 1: Demographic Characteristics of Study Participants (n=110)

Characteristics	Frequency (n)	Percentage (%)
Age Category		
40-60 years	42	38.2
61-80 years	62	56.4
>80 years	6	5.5
Gender		
Male	71	64.5
Female	39	35.5

Table 2 presents the distribution of various risk factors among the 110 study participants. Hypertension was the most prevalent risk factor, observed in 70.0% of the participants, followed closely by tobacco chewing (67.3%) and smoking (54.5%). Diabetes mellitus was present in 46.4% of the individuals, while alcohol consumption was reported by 31.8%. A history of previous stroke was the least common, identified in only 13.6% of participants

Table 2: Risk Factors Distribution Among Study Participants (n=110)

Risk Factors	Present		Absent	
	n	%	N	%
Diabetes Mellitus	51	46.4	59	53.6
Hypertension	77	70.0	33	30.0
Previous Stroke	15	13.6	95	86.4
Smoker	60	54.5	50	45.5
Alcohol Consumption	35	31.8	75	68.2
Tobacco Chewer	74	67.3	36	32.7

In our study, the most common severity category was minor stroke, affecting 32.7% of participants, followed closely by severe strokes at 30.9%. Moderate strokes accounted for 27.3%, while 9.1% experienced moderate to severe strokes. Overall, the data indicate a nearly even distribution between milder and more severe stroke presentations, with a substantial proportion (40%) falling into the moderate

to severe or severe categories, reflecting a significant clinical burden.Table 3 summarizes the distribution of stroke severity among the 110 participants based on NIHSS scores.

Table 3: Stroke Severity Distribution Based on NIHSS Scores (n=110)

Severity	Frequency (n)	Percentage (%)
Minor	36	32.7
Moderate	30	27.3
Moderate to Severe	10	9.1
Severe	34	30.9
Total	**110**	**100.0**

Table 4 displays the distribution of stroke territory based on neuroimaging findings among the 110 participants. The majority of strokes (68.2%) involved the middle cerebral artery (MCA) territory, making it the most commonly affected region. Posterior cerebral artery (PCA) strokes accounted for 27.3% of cases, while anterior cerebral artery (ACA) involvement was the least frequent, observed in only 4.5% of participants. These results suggest a strong predominance of MCA territory involvement in the study population.

Table 4: Distribution of Stroke Territory Based on Neuroimaging (n=110)

Territory	Frequency (n)	Percentage (%)
ACA	5	4.5
MCA	75	68.2
PCA	30	27.3
Total	**110**	**100.0**

Table 5 presents the descriptive statistics of vital signs recorded among the 110 study participants. The mean systolic blood pressure (SBP) was 148.36 mmHg with a standard deviation of 28.25, indicating elevated average SBP levels and notable variability. The mean diastolic blood pressure (DBP) was 87.33 mmHg (SD ±13.16), also reflecting slightly elevated values. The average pulse rate was 87.54 beats per minute (bpm) with a standard deviation of 12.79, suggesting a relatively normal but mildly elevated heart rate across the cohort. These findings highlight a trend of elevated cardiovascular parameters among the participants

Table 5: Descriptive Statistics of Vital Signs (n=110)

Parameter	Mean	Standard Deviation
SBP (mmHg)	148.36	28.246
DBP (mmHg)	87.33	13.159
Pulse Rate (bpm)	87.54	12.791

Table 6 outlines the distribution of platelet-to-lymphocyte ratio (PLR) categories among the 110 study participants. A majority of participants (60.9%) fell into the high PLR category (>210), while 39.1% had a low PLR (90–210). The overall mean PLR was 244.05 with a standard deviation of 73.9, indicating that, on average, participants exhibited elevated PLR levels. This suggests a potential association between high PLR and the clinical characteristics observed in the study population.

Table 6: PLR Category Distribution (n=110)

PLR Category	Frequency (n)	Percentage (%)
Low (90-210)	43	39.1
High (>210)	67	60.9
Total	**110**	**100.0**
Mean±SD	244.05±73.9	

Table 7 presents the distribution of Atherogenic Index of Plasma (AIP) categories among the 110 participants. The majority (60.0%) had a low AIP (<0.1), suggesting a lower atherogenic risk in this group. However, a considerable proportion (30.9%) fell into the high-risk category (AIP >0.24), while 9.1% were classified as having intermediate risk (AIP 0.11–0.24). The mean AIP was 0.074 with a standard deviation of 0.16, indicating that while the average value remained within the low-risk range, there was substantial variability and a noteworthy subset of participants with elevated atherogenic risk.

Table 7: AIP Category Distribution (n=110)

AIP Category	Frequency (n)	Percentage (%)
Low (<0.1)	66	60.0
Intermediate (0.11-0.24)	10	9.1
High (>0.24)	34	30.9
Total	**110**	**100.0**
Mean±SD	0.074±0.16	

Table 8 presents the hematological and biochemical laboratory parameters for the 110 study participants. The mean hemoglobin level was 12.52 g/dL, and the total leukocyte count averaged 10,941.09 cells/µL, with considerable variability (SD ±11,257.23). Lymphocyte and platelet counts were 1,197.10 cells/µL and 276,309.09 cells/µL, respectively, both within normal ranges. Biochemical markers showed a mean blood urea level of 34.91 mg/dL and serum creatinine of 1.22 mg/dL, indicating generally preserved renal function. The mean total protein was 6.63 g/dL, and albumin averaged 3.65 g/dL, reflecting adequate nutritional and hepatic status in the majority of participants

Table 8: Laboratory Parameters (n=110)

Parameter	Mean	Standard Deviation
Hematological Parameters		
Hemoglobin (g/dL)	12.521	1.6144
Total Leukocyte Count (cells/µL)	10941.09	11257.229
Lymphocyte Count (cells/µL)	1197.10	243.046
Platelet Count (cells/µL)	276309.09	43483.150
Biochemical Parameters		
Blood Urea (mg/dL)	34.907	21.528
S. Creatinine (mg/dL)	1.218	0.389
Total Protein (g/dL)	6.628	0.746
Albumin (g/dL)	3.649	0.497

Table 9 The laboratory findings related to lipid profile among the 110 participants reveal a mean total cholesterol level of 163.12 mg/dL and triglycerides averaging 117.12 mg/dL, both within generally acceptable ranges. The mean HDL-C (good cholesterol) was 42.02 mg/dL, which is on the lower side of the desirable range, while LDL-C (bad cholesterol) averaged 100.54 mg/dL, falling within optimal limits. The mean TC/HDL-C ratio was 3.99 and the LDL-C/HDL-C ratio was 2.47, both of which are considered within moderate cardiovascular risk thresholds. Overall, the lipid profile suggests relatively controlled cholesterol levels with a slight tendency toward lower protective HDL-C values.

Table 9: Laboratory Parameters (n=110)

Lipid Profile	Mean	Standard Deviation
Total Cholesterol (mg/dL)	163.120	14.903
Triglycerides (mg/dL)	117.124	30.025
HDL-C (mg/dL)	42.017	5.371
LDL-C (mg/dL)	100.542	14.251
TC/HDL-C ratio	3.988	0.861
LDL-C/HDL-C ratio	2.472	0.650

Table 10 presents a cross-tabulation of Platelet-to-Lymphocyte Ratio (PLR) categories with stroke severity based on NIHSS scores, revealing a statistically significant association ($p < 0.001$). Among participants with minor stroke, the vast majority (97.2%) had a low PLR, while those with severe strokes were exclusively in the high PLR group (100%). Similarly, all participants with moderate to severe strokes also had high PLR values. The trend continues with 73.3% of moderate cases falling into the high PLR category. The mean PLR increased progressively with stroke severity: 164.3 for minor, 231.8 for moderate, 292.8 for moderate to severe, and 324.8 for severe strokes. These findings suggest that higher PLR is strongly associated with increased stroke severity.

Table 10: Cross-tabulation of PLR Categories by NIHSS Severity

PLR Category	NIHSS Severity				p-value
	Minor	Moderate	Moderate to Severe	Severe	
Low (90-210)	35 (97.2%)	8 (26.7%)	0 (0.0%)	0 (0.0%)	**<0.001**

High (>210)	1 (2.8%)	22 (73.3%)	10 (100.0%)	34 (100.0%)	
Total	**36 (100.0%)**	**30 (100.0%)**	**10 (100.0%)**	**34 (100.0%)**	
Mean±SD	164.3±24.17	231.8±48.1	292.8±27.5	324.8±26.4	**<0.001**

Table 11 shows a significant association between Atherogenic Index of Plasma (AIP) categories and stroke severity as measured by NIHSS scores ($p < 0.001$). All participants with minor and moderate strokes had low AIP values (<0.1), while those with moderate to severe strokes exclusively fell into the intermediate AIP category (0.11–0.24). Similarly, all participants with severe strokes had high AIP values (>0.24). The mean AIP values increased progressively with stroke severity: –0.112 for minor, 0.033 for moderate, 0.161 for moderate to severe, and 0.28 for severe strokes. These results indicate a strong, positive correlation between increasing AIP and greater stroke severity.

Table 11: Cross-tabulation of AIP Categories by NIHSS Severity

AIP Category	NIHSS Severity				p-value
	Minor	Moderate	Moderate to Severe	Severe	
Low (<0.1)	36 (100.0%)	30 (100.0%)	0 (0.0%)	0 (0.0%)	**<0.001**
Intermediate (0.11-0.24)	0 (0.0%)	0 (0.0%)	10 (100.0%)	0 (0.0%)	
High (>0.24)	0 (0.0%)	0 (0.0%)	0 (0.0%)	34 (100.0%)	
Total	**36 (100.0%)**	**30 (100.0%)**	**10 (100.0%)**	**34 (100.0%)**	
Mean±SD	**-0.112±0.009**	**0.033±0.02**	**0.161±0.03**	**0.28±0.01**	**<0.001**

Table 12 presents the correlation matrix between biomarkers and NIHSS scores, revealing strong positive correlations. PLR showed a Pearson's correlation coefficient of 0.817 ($p < 0.001$), while AIP demonstrated an even stronger correlation at 0.925 ($p < 0.001$), both indicating statistically significant associations. These results suggest that as PLR and AIP values increase, stroke severity—as measured by NIHSS scores—also increases, highlighting the potential of these biomarkers as predictive indicators of stroke severity

Table 12: Correlation Matrix Between Biomarkers and NIHSS Scores

NIHSS	PLR	AIP
Pearson's correlation	0.817	0.925
p-value	**<0.001**	**<0.001**

DISCUSSION

This study investigated the prognostic significance of two accessible and cost-effective biomarkers—the Platelet-to-Lymphocyte Ratio (PLR) and the Atherogenic Index of Plasma (AIP) in predicting stroke severity among 110 patients with acute ischemic stroke (AIS). The study found a strong, statistically significant correlation between elevated PLR and AIP values and higher NIHSS (National Institutes of Health Stroke Scale) scores, suggesting their potential use as early predictors of stroke severity.

The clinical and demographic data revealed a predominance of modifiable risk factors, with hypertension (70.0%), tobacco chewing (67.3%), and smoking (54.5%) being the most prevalent.

The involvement of the middle cerebral artery (MCA) territory was most common in our study (68.2%), consistent with other studies who also identified MCA territory as the most frequently affected vascular region due to its size and blood supply[6].

Stroke severity distribution in our cohort showed that 32.7% had minor, 27.3% moderate, 9.1% moderate to severe, and 30.9% had severe strokes. Laboratory data reflected elevated cardiovascular and inflammatory markers, with a mean systolic BP of 148.36 mmHg, diastolic BP of 87.33 mmHg, and pulse rate of 87.54 bpm. Lipid profiles were within borderline ranges, but AIP and PLR values showed strong prognostic relevance.

In our study, PLR was significantly associated with NIHSS severity ($p < 0.001$), with a mean PLR of 244.05 ± 73.9. All patients with moderate to severe and severe strokes had high PLR (>210), while 97.2% of minor stroke cases fell into the low PLR category. The correlation coefficient between PLR and NIHSS was 0.817, indicating a strong positive relationship. This trend shows progressive increase in PLR from mild strokes to severe strokes, and highlighted its predictive potential. Likewise, few other studies found high PLR to be a significant risk factor for poor functional outcomes in AIS patients[7].

Further supporting these results, showed a significant increase in PLR values across increasing stroke severities ($p < 0.001$), with a correlation coefficient of 0.776. The consistency of these findings with our data reinforces the value of PLR as a dual indicator of thrombosis and systemic inflammation in acute stroke.

Similarly, AIP showed a robust correlation with stroke severity. In our study, the AIP mean was 0.074 ± 0.16, with 60.0% of patients falling into the low-risk category, while 30.9% had high AIP values (>0.24).

Importantly, all patients with moderate to severe and severe strokes had intermediate or high AIP, while those with minor and moderate strokes exclusively had low AIP values. The correlation coefficient between AIP and NIHSS was 0.925 ($p < 0.001$), signifying a very strong association.

This observation demonstrated that elevated AIP values were independently predictive of poor clinical outcomes in AIS patients[8].

The integration of PLR and AIP with NIHSS scoring offers an enhanced stratification method that captures both inflammatory and lipid-mediated contributions to stroke pathophysiology.

These markers are advantageous due to their derivation from routine blood tests, making them highly practical in both advanced and resource-limited healthcare settings[9,10].

Overall, this study provides compelling evidence that elevated PLR and AIP are strongly associated with greater stroke severity. These findings, supported by multiple external studies, highlight the potential of these markers as adjunctive tools for early risk assessment, guiding clinical decision-making, and prioritizing resource allocation in acute stroke management.

CONCLUSION

This study demonstrated that both Platelet-to-Lymphocyte Ratio (PLR) and Atherogenic Index of Plasma (AIP) are significantly associated with stroke severity in patients with acute ischemic stroke, as measured by NIHSS scores. Elevated PLR and AIP values correlated strongly with increasing stroke severity, highlighting their utility as accessible and cost-effective biomarkers for early risk stratification. Given their derivation from routine laboratory tests, PLR and AIP can serve as valuable tools in clinical settings—particularly in resource-limited environments—helping to prioritize early intervention and management strategies. These findings align with existing literature and support the growing body of evidence advocating for the use of inflammation and lipid-related indices in stroke prognosis.

LIMITATION OF STUDY

- **Single-Center Study**: The research was conducted at a single tertiary care center, which may limit the generalizability of the findings to broader populations, especially community-based or primary care settings.
- **Relatively Small Sample Size**: Although the sample size (n=110) was adequate for statistical analysis, a larger multicenter study would offer more robust and generalizable results.
- **Cross-Sectional Design**: The study was cross-sectional in nature, limiting the ability to establish causality or assess changes in PLR and AIP over time or during recovery.
- **Lack of Long-Term Outcome Data**: Functional outcomes and mortality beyond the initial presentation were not evaluated, which could have strengthened the prognostic value of the biomarkers.
- **Potential Confounders**: Although major comorbidities were considered, other inflammatory or metabolic conditions that may influence PLR or AIP were not fully accounted for.
- **No Comparison with Other Inflammatory Markers**: The study did not compare PLR and AIP with other established markers such as C-reactive protein (CRP) or neutrophil-to-lymphocyte ratio (NLR), which may have added depth to the analysis

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