Section: General Medicine

Original Research Article

ASSOCIATION OF MEAN PLATELET VOLUME WITH NIHSS-ASSESSED SEVERITY OF ACUTE ISCHEMIC STROKE: A CROSS-SECTIONAL STUDY

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Received *: 12/09/2026*
Received in revised form *: 10/10/2026*
Accepted *: 24/10/2026*

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DOI: 10.70034/ijmedph.2026.4.244

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (4); 1591-1597

ABSTRACT

Background: Mean platelet volume (MPV) is a routinely available platelet index that has been investigated as a marker of acute ischemic stroke severity. However, evidence regarding its association with neurological impairment remains inconsistent. The objective is to assess the association between MPV and severity of acute ischemic stroke evaluated using the National Institutes of Health Stroke Scale (NIHSS).

Materials and Methods: A hospital-based cross-sectional study was conducted in the Department of General Medicine at Shridevi Institute of Medical Sciences and Research Hospital, Tumkur, Karnataka, from July 2023 to December 2024. The study included 95 patients with acute ischemic stroke presenting within 48 hours of symptom onset. MPV was obtained from laboratory records, and recorded NIHSS categories were classified as minor stroke (1-4) or moderate stroke (5-15). The association between MPV and severity category was assessed using point-biserial correlation, while mean MPV was compared between groups using Welch's independent-samples t-test. Statistical significance was defined as $p<0.05$.

Results: The mean MPV was 12.96 (SD 1.03) fL (95% CI 12.75-13.17). Minor stroke was recorded in 46 patients (48.4%), and moderate stroke in 49 patients (51.6%). MPV showed a weak positive association with severity category, which was not statistically significant ($r=0.127$; 95% CI −0.077 to 0.320; $p=0.220$). Mean MPV was 13.08 (SD 1.13) fL in moderate stroke and 12.82 (SD 0.89) fL in minor stroke. The mean difference was 0.26 fL (95% CI −0.16 to 0.68; Welch's $t=1.244$; $p=0.217$).

Conclusion: MPV was not significantly associated with NIHSS-defined minor versus moderate stroke severity in this sample. These findings did not support its use as a standalone severity indicator.

Keywords: Acute ischemic stroke; Mean platelet volume; National Institutes of Health Stroke Scale.

INTRODUCTION

Acute ischemic stroke is an important cause of mortality and persistent neurological disability, creating a substantial burden for patients, families and healthcare systems. Feigin et al. (2022).[1] highlighted the increasing global burden of stroke and its disproportionate impact on countries with limited healthcare resources. These findings emphasise the importance of accessible methods for evaluating patients with acute stroke. Platelets contribute to arterial thrombosis and participate in inflammatory processes associated with atherosclerosis. Mean platelet volume (MPV), a routinely reported platelet index, represents average platelet size and provides an indirect measure of platelet activity. Larger platelets generally exhibit greater prothrombotic activity, providing a biological

basis for investigating MPV in ischemic stroke. Sreejith et al. (2021).[2] demonstrated an association between higher MPV and greater disability assessed using the modified Rankin Scale, although they emphasised the need for further validation. Similarly, Kamat et al. (2021).[3] reported elevated MPV above 12.5 fL in 64% of patients with acute ischemic stroke and observed an association with greater disability at presentation. However, their assessment used the modified Rankin Scale, which measures disability rather than the neurological deficits quantified by the National Institutes of Health Stroke Scale (NIHSS). Evidence regarding the clinical significance of MPV has remained inconsistent. Ciancarelli et al. (2016).[4] described MPV as a potential inflammatory biomarker during acute stroke and rehabilitation without a direct relationship with clinical outcome, suggesting that increased platelet size does not invariably indicate greater neurological impairment or poorer recovery. The NIHSS provides a structured assessment of stroke-related neurological deficits, including disturbances of consciousness, motor function, sensation, language and attention. Lyden (2017).[5] emphasised its clinical usefulness while drawing attention to limitations in its interpretation. Evaluating MPV against NIHSS-assessed severity could therefore help clarify whether this readily available laboratory parameter is associated with the extent of neurological impairment at presentation. The present study examined this association among patients with acute ischemic stroke at a tertiary care hospital. Its cross-sectional design addressed contemporaneous association and did not establish causality or long-term prognostic performance.

AIM: To assess the association between mean platelet volume and NIHSS-assessed severity of acute ischemic stroke.

Objectives

1. To describe mean platelet volume among patients with acute ischemic stroke.
2. To assess the severity of acute ischemic stroke using the National Institutes of Health Stroke Scale.
3. To compare mean platelet volume across NIHSS-defined stroke severity categories.

MATERIALS AND METHODS

Source of Data: Data were obtained from patients with acute ischemic stroke admitted to the Department of General Medicine, Shridevi Institute of Medical Sciences and Research Hospital, Tumkur, Karnataka. Clinical information was obtained through patient assessment and the study proforma, while laboratory findings were obtained from the investigations recorded during hospitalisation. The study population comprised patients of either sex presenting within 48 hours of symptom onset.

Study Design: The study was a hospital-based analytical cross-sectional study. Mean platelet volume and stroke severity were evaluated during the acute presentation, and their association was examined. No longitudinal outcome assessment formed part of the present MPV-NIHSS research objective.

Study Location: The study was conducted in the Department of General Medicine at Shridevi Institute of Medical Sciences and Research Hospital, Tumkur, Karnataka.

Study Duration: The study was conducted over 18 months, from July 2023 to December 2024.

Sample Size: The actual sample comprised 95 patients, as reported in the source document.

The original calculation used the proportion of patients with elevated MPV reported by Kamat et al. (2021),[3] namely 64%, with a 95% confidence level and 5% absolute precision. The single-proportion formula was:

Therefore, the required sample size under the stated assumptions was 355 patients after rounding upward, rather than 95.

Reporting clarification: The study should retain 95 as the actual enrolment and acknowledge the discrepancy in the original calculation. The 9.65% figure is a retrospective calculation, not evidence that this precision was chosen during planning. Moreover, a proportion-based calculation does not establish adequate statistical power for the primary MPV-NIHSS association.

Sampling Technique: A non-probability purposive sampling technique was used, as specified in the source methodology. Patients were selected according to the stated eligibility criteria during the study period.

Inclusion Criteria

The documented inclusion criteria were:

1. Patients aged 45-70 years.
2. Patients of either sex.
3. Patients with a clinically and/or radiologically confirmed diagnosis of acute ischemic stroke presenting within 48 hours of symptom onset.

Exclusion Criteria

The documented exclusion criteria were:

1. Cerebral ischemic events associated with trauma or neoplasm.
2. Active infection, including chronic fungal meningitis, HIV-related stroke or sepsis.
3. Use of antiplatelet medication or immunosuppressive agents.
4. Haematological diseases, including leukaemia, lymphoma and myeloma.

The timing of antiplatelet exposure relative to enrolment was not specified in the source document and requires confirmation before this criterion is finalised.

Procedure and Methodology: The source methodology specified institutional ethical clearance and informed consent before inclusion. Eligible patients underwent clinical assessment, and information was recorded using a predesigned proforma described as internally validated. The assessment included demographic characteristics, presenting neurological complaints, affected limbs and relevant medical history. Hypertension, diabetes

mellitus, smoking, alcohol consumption, previous transient ischemic attack and ischemic heart disease were among the variables recorded.

The diagnosis of acute ischemic stroke was based on the documented clinical and/or radiological assessment. Neurological severity was evaluated using the NIHSS, and laboratory investigations included haemoglobin, red blood cell count, white blood cell count, platelet count and MPV. For the present study title, MPV was the principal laboratory variable, while NIHSS-defined severity was the principal clinical variable.

The NIHSS assessed neurological deficits across several domains, including consciousness, gaze, visual fields, facial movement, limb strength, coordination, sensation, language, dysarthria and inattention. Its total score ranged from 0 to 42, with higher scores indicating greater neurological impairment.

The attached master chart recorded two severity categories:

Recorded NIHSS category	Appropriate description
1-4	Minor stroke
5-15	Moderate stroke

The source description of NIHSS 5-15 as "moderate to severe" was corrected to "moderate." Exact individual NIHSS scores were not available in the attached master chart; consequently, the documented data supported comparisons between severity categories.

Sample Processing: Blood investigations were performed as part of the laboratory assessment, and MPV values were recorded in femtolitres alongside other complete blood count parameters. The recorded MPV results were linked with each participant's clinical and NIHSS-category information.

However, the source document did not specify the blood volume collected, anticoagulant used, analyser manufacturer or model, interval between collection and analysis, storage conditions, or procedures for identifying platelet clumping and rejecting unsuitable samples. These details could not be reliably reconstructed from the available material. A definitive account of sample processing therefore requires the laboratory records or standard operating procedure used during the study. An EDTA collection method or a specific processing interval should not be described as having been used without confirmation.

Statistical Methods: The source document reported that data were entered into Microsoft Excel and analysed using IBM SPSS Statistics. Categorical variables were summarised using frequencies and percentages, while continuous variables were summarised using means and standard deviations. A significance threshold of \(p<0.05\) was specified.

The source reported t-tests, analysis of variance and Pearson correlation. However, the attached master chart contained NIHSS categories rather than exact scores. Therefore, its reported Pearson correlation with numerical NIHSS scores could not be verified from the supplied data. For the present article, the principal analysis should compare MPV between the two recorded severity groups, with the mean difference, 95% confidence interval, test statistic and p value reported after verification.

Analysis clarification: The comparison should use an independent-samples t-test or Welch's t-test when its assumptions are suitable; a non-parametric comparison may be appropriate if the distribution requires it. These are recommendations for verified reanalysis and should only be converted into statements of completed analysis after execution. The SPSS version also requires confirmation because both versions 22 and 25 appeared in the source.

Data Collection: Data were collected using the predesigned study proforma and compiled in a master chart. Recorded variables included age, sex, limb weakness, distribution of affected limbs, history of transient ischemic attack, ischemic heart disease, hypertension, diabetes mellitus, smoking and alcohol consumption. Laboratory variables included haemoglobin, red blood cell count, white blood cell count, platelet count and MPV. Stroke severity was recorded in NIHSS categories of 1-4 and 5-15.

The available records provided the demographic, clinical and laboratory information required for a category-based assessment of MPV and stroke severity. They did not provide exact NIHSS scores or detailed preanalytical laboratory information.

Source discrepancies requiring correction before final use: The master chart included one patient aged 74 despite the stated upper age limit of 70. Some severity tables totalled 100 patients despite the reported sample of 95. The methods also mentioned transient ischemic attacks, although the inclusion criteria and present title specified acute ischemic stroke. These points require reconciliation with the original records; eligibility criteria or participant counts should not be changed retrospectively merely to remove inconsistencies.

RESULTS

Table 1: Association between mean platelet volume and NIHSS-assessed severity of acute ischemic stroke (N=95)

Variable	Summary	Association coefficient	95% CI for coefficient	Test statistic	p value
Mean platelet volume, fL	12.96 (1.03)	-	-	-	-
Minor stroke, NIHSS 1-4, n (%)	46 (48.4)	-	-	-	-
Moderate stroke, NIHSS 5-15, n (%)	49 (51.6)	-	-	-	-
MPV versus NIHSS severity category	Minor=0; moderate=1	(r=0.127)	−0.077 to 0.320	t=1.234; df=93	0.220

Among the 95 patients with acute ischemic stroke, the mean platelet volume (MPV) was 12.96 (SD 1.03) fL. Minor stroke was observed in 46 patients (48.4%), while 49 patients (51.6%) had moderate stroke. MPV showed a weak positive association with NIHSS-defined severity category; however, this association was not statistically significant (point-biserial r=0.127; 95% CI −0.077 to 0.320; t=1.234; df=93; p=0.220).

Table 2: Distribution of mean platelet volume among patients with acute ischemic stroke (N=95)

MPV parameter	Observed value	95% CI	Test statistic	p value
Mean (SD), fL	12.96 (1.03)	12.75-13.17*	Not applicable	Not applicable
Median (Q1-Q3), fL	13.10 (12.10-13.70)	-	Not applicable	Not applicable
Minimum-maximum, fL	10.70-15.10	-	Not applicable	Not applicable

The mean MPV among the 95 patients was 12.96 (SD 1.03) fL, with a 95% confidence interval of 12.75-13.17 fL. The median MPV was 13.10 fL, with an interquartile range of 12.10-13.70 fL. MPV values ranged from 10.70 to 15.10 fL.

Table 3: Distribution of acute ischemic stroke severity according to recorded NIHSS categories (N=95)

Stroke severity	NIHSS category	n (%)	95% CI for percentage	Test statistic	p value
Minor stroke	1-4	46 (48.4)	38.6-58.3	Not applicable	Not applicable
Moderate stroke	5-15	49 (51.6)	41.7-61.4	Not applicable	Not applicable
Total	Recorded categories	95 (100.0)	-	-	-

Moderate stroke, corresponding to NIHSS scores of 5-15, was recorded in 49 patients (51.6%; 95% CI 41.7-61.4%). Minor stroke, corresponding to NIHSS scores of 1-4, was recorded in 46 patients (48.4%; 95% CI 38.6-58.3%).

Table 4: Comparison of mean platelet volume across NIHSS-defined stroke severity categories (N=95)

Parameter	Minor stroke: NIHSS 1-4 (n=46)	Moderate stroke: NIHSS 5-15 (n=49)	Mean difference (95% CI)†	Test statistic	p value
MPV, fL, mean (SD)	12.82 (0.89)	13.08 (1.13)	0.26 (−0.16 to 0.68)	Welch's t=1.244; df=90.34	0.217
95% CI for mean MPV, fL	12.56-13.09	12.76-13.41	-	-	-

†Mean difference was calculated as moderate minus minor stroke. The test was two-sided, with α=0.05.

Patients with moderate stroke had a higher mean MPV of 13.08 (SD 1.13) fL compared with 12.82 (SD 0.89) fL among patients with minor stroke. The respective 95% confidence intervals for mean MPV were 12.76-13.41 fL and 12.56-13.09 fL. The mean difference between the groups was 0.26 fL (95% CI −0.16 to 0.68), which was not statistically significant (Welch's t=1.244; df=90.34; p=0.217).

DISCUSSION

The present cross-sectional study evaluated the association between mean platelet volume (MPV) and NIHSS-defined severity of acute ischemic stroke among 95 patients. The mean MPV was 12.96 (SD 1.03) fL, and patients were almost equally distributed between minor and moderate stroke categories. Although MPV was numerically higher in moderate stroke, neither the point-biserial correlation nor the comparison of group means demonstrated statistical significance. These findings did not establish MPV as a marker capable of distinguishing the two recorded severity categories.

Feigin et al. (2022).[1] highlighted the substantial global burden of stroke, supporting continued investigation of accessible laboratory markers. However, accessibility alone does not establish clinical usefulness. Sreejith et al. (2021).[2] and Kamat et al. (2021).[3] reported associations between higher MPV and greater disability assessed using the modified Rankin Scale (mRS). Conversely, Ciancarelli et al. (2016).[4] found that MPV was not directly linked to clinical outcome. These differing observations also reflect differences in the outcomes measured. As discussed by Lyden (2017).[5] NIHSS measures neurological deficits and requires careful interpretation; it should not be treated as interchangeable with a disability scale such as mRS.

[Table 1] Association between MPV and NIHSS-assessed severity

In the present study, MPV demonstrated a weak positive association with NIHSS severity category, with a point-biserial correlation coefficient of 0.127 (95% CI −0.077 to 0.320; p=0.220). The confidence interval included zero, indicating that the data did not demonstrate a statistically significant association. Nevertheless, the interval remained compatible with a modest positive association; therefore, the finding should not be interpreted as definitive evidence that no relationship exists.

Neki et al. (2016).[6] reported findings broadly consistent with the present study. Although their stroke patients had higher MPV than controls, the association between MPV and mRS-defined severity was not statistically significant (p=0.191). Patel et al. (2018).[7] similarly observed higher MPV in stroke

patients than controls but found no significant relationship with clinical severity assessed using mRS (p=0.550). These studies illustrate that a difference between stroke patients and healthy controls does not necessarily imply that MPV distinguishes severity among patients who already have stroke. Their agreement with the present findings was therefore conceptual, although the severity measures differed.

Lok et al. (2017).[8] also reported that MPV was not a reliable marker of prognosis or functional outcome in first-ever acute ischemic stroke and found no correlation with NIHSS or mRS scores. This provides more direct support for the present nonsignificant association. In contrast, Miller et al. (2020).[9] in a study of 577 patients, found that the highest MPV quartile remained independently associated with greater admission NIHSS after adjustment for relevant covariates (p=0.025). Their larger sample, use of numerical NIHSS scores and adjusted analysis differed from the present analysis of two grouped severity categories. These methodological differences could contribute to the contrasting results, although their individual effects cannot be determined from the present data.

Xue et al. (2022).[10] reported higher MPV in patients classified as having severe stroke than in those with mild stroke in a retrospective study of 188 patients. Dębiec et al. (2021).[11] similarly found higher baseline NIHSS scores in the highest MPV quartile than in the lowest quartile among patients receiving reperfusion therapy. However, the present study contained only minor and moderate stroke categories. The absence of patients with recorded NIHSS scores above 15 restricted the severity spectrum and may have reduced the ability to identify an association across the full range of neurological impairment. This is a possible explanation for the difference, rather than a demonstrated mechanism.

[Table 2] Distribution of MPV

The mean MPV in the present study was 12.96 (SD 1.03) fL, with a 95% CI of 12.75-13.17 fL. The median was 13.10 fL, the interquartile range was 12.10-13.70 fL, and values ranged from 10.70 to 15.10 fL. These values were numerically higher than those reported by Neki et al. (2016).[6] who observed a mean MPV of 8.92 (SD 1.03) fL among stroke cases, and Patel et al. (2018).[7] who reported 9.78 (SD 1.25) fL. However, these cross-study differences cannot be interpreted as evidence of greater platelet activation or more severe stroke without comparable laboratory methods and patient characteristics.

Noris et al. (2016).[12] emphasised that biological variability and poor standardisation of MPV measurement limit the interpretation of individual values and comparisons between studies. Buttarello et al. (2018).[13] investigated the effects of preanalytical and analytical variables, including time, temperature and anticoagulant, on MPV measurement. Harrison et al. (2022).[14] in an international inter-laboratory study, demonstrated differences in MPV between instruments and measurement approaches. These findings are particularly relevant because the present study did not document the analyser model, anticoagulant or collection-to-analysis interval. Consequently, its relatively high mean MPV should be described as an observed laboratory finding rather than labelled abnormal using a reference interval taken from another laboratory.

Patient characteristics and treatment exposure may also influence MPV. Patil et al. (2018).[15] reported higher MPV among diabetic than nondiabetic stroke patients, with mean values of 10.16 (SD 0.89) and 8.25 (SD 0.91) fL, respectively. Haungsaithong et al. (2015).[16] in a small randomised study of 21 patients with non-cardioembolic stroke, observed reductions in MPV during four weeks of antiplatelet treatment alongside improvement in clinical scores. These observations support documenting diabetes, medication exposure and sampling time when interpreting MPV. They do not establish that these factors explained the present results, because the supplied tables did not evaluate their effects.

[Table 3] Distribution of NIHSS-defined severity

Minor stroke was recorded in 46 patients (48.4%; 95% CI 38.6-58.3%), while moderate stroke was recorded in 49 patients (51.6%; 95% CI 41.7-61.4%). This distribution provided reasonably balanced comparison groups but represented a limited range of stroke severity. Moreover, grouping NIHSS scores into 1-4 and 5-15 removed information about differences within each category. Patients with NIHSS scores of 5 and 15 were therefore analysed within the same group despite potentially substantial differences in neurological impairment.

Lyden (2017).[5] described the clinical usefulness and limitations of NIHSS, while Powers et al. (2019).[17] incorporated structured stroke-severity assessment into recommendations for acute ischemic stroke care. These publications support retaining the clinical scale itself as the central assessment of neurological impairment. In the present study, the absence of exact NIHSS scores prevented examination of a graded relationship between MPV and neurological deficit. Recording individual scores would improve the precision and interpretability of future analyses.

Dourado Sotero et al. (2021).[18] studied patients treated with intravenous thrombolysis and reported a median admission NIHSS of 14, with an interquartile range of 8-19. Their population therefore included a broader and generally more severe neurological spectrum than the present cohort. Similarly, the reperfusion-treated population studied by Dębiec et al. (2021).[11] included patients with large-vessel occlusion and substantial neurological deficits. Differences in treatment eligibility, vascular occlusion and severity distribution limit direct comparison with the present hospital-based sample. Associations identified in these selected populations cannot automatically be generalised to patients with predominantly minor or moderate stroke.

[Table 4] Comparison of MPV between severity categories

Mean MPV was 13.08 (SD 1.13) fL in moderate stroke and 12.82 (SD 0.89) fL in minor stroke. The mean difference was 0.26 fL (95% CI −0.16 to 0.68), and the comparison was not statistically significant (Welch's t=1.244; p=0.217). Thus, the observed numerical difference was insufficient to demonstrate a difference in population means. The confidence interval included both a small negative difference and a larger positive difference, indicating uncertainty about the magnitude and direction of the underlying effect. This finding was consistent with the weak association shown in Table 1; the two tables represented complementary analyses of the same patients.

Staszewski et al. (2019).[19] found that higher admission MPV was associated with poorer short-term outcomes after intravenous thrombolysis. However, discrimination for poor outcome was limited, with an area under the curve of 0.586. This illustrates that even a statistically significant association may offer limited clinical prediction. Dourado Sotero et al. (2021).[18] also reported higher MPV among patients with unfavourable disability outcomes. These studies evaluated outcomes after treatment, whereas the present study examined contemporaneous differences between severity categories. Their positive prognostic findings therefore do not directly contradict the present nonsignificant cross-sectional comparison.

Demir (2019).[20] reported higher admission MPV among patients who died than among those discharged, with mean values of 11.29 (SD 1.12) and 10.59 (SD 1.01) fL, respectively (p=0.029). However, mortality was the outcome of interest, and the cohort differed markedly from the present sample. Elsayed and Mohamed (2017).[21] found higher MPV and MPV-to-platelet-count ratios in stroke patients than controls, addressing disease-associated differences that could not be examined here because no control group was included. Ludhiadch et al. (2024).[22] reported an association between higher MPV and greater mRS-defined disability, as well as an association with large-artery atherosclerosis. Together, these studies suggest that the relationship of MPV with stroke may vary according to the endpoint and patient population rather than represent a uniform association with NIHSS severity.

CONCLUSION

The mean platelet volume among 95 patients with acute ischemic stroke was 12.96 (SD 1.03) fL. Although patients with moderate stroke had numerically higher MPV than those with minor stroke, the difference was not statistically significant. MPV also showed a weak, nonsignificant association with NIHSS-defined severity category. Thus, the study did not establish MPV as a useful standalone indicator for distinguishing minor from moderate acute ischemic stroke. Larger studies incorporating exact NIHSS scores, a broader severity spectrum and standardised laboratory measurements are needed to clarify this relationship.

Limitations of the Study: The study was conducted at a single tertiary care hospital using non-probability purposive sampling, which limited the generalisability of its findings. The sample of 95 patients provided limited precision, and the original sample-size calculation contained an arithmetic discrepancy. The cross-sectional design prevented assessment of causality, changes in MPV over time and long-term outcomes. NIHSS was available only as grouped categories, resulting in loss of information and preventing correlation with exact scores. Furthermore, all recorded categories represented minor or moderate stroke, limiting assessment across the full severity spectrum. The analyses were unadjusted for potential confounders such as age, diabetes mellitus, hypertension, platelet count and stroke subtype. Incomplete documentation of the analyser, anticoagulant and sample-processing interval limited assessment of laboratory variability. The absence of a control group prevented comparison with individuals without stroke. The previously identified age-eligibility discrepancy also requires reconciliation with the original records before final reporting.

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