

Original Research Article

Reducing negative appendectomies: a prospective comparative study of the RIPASA and Alvarado scoring systems in the emergency setting in an Indian population cohort

Arijit Roy*, Saurav Majumdar, Lita Bag, Divyajyoti Panigrahi, Naru Gali Reddy,
Manthan Ghosh, Samsunnehar, Akshita Khare

Department of Surgery, KPC Medical College and Hospital Kolkata, India

Received: 25 April 2026

Revised: 18 July 2026

Accepted: 22 July 2026

*Correspondence:

Dr. Arijit Roy,

E-mail: drarijitroy7@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: Acute appendicitis is the most common surgical emergency worldwide, with a reported lifetime prevalence of approximately 7–12%. Clinical scoring systems offer a rapid, cost-effective adjunct to diagnosis, yet conventional tools such as the Alvarado score exhibit suboptimal sensitivity, particularly in Asian populations. The RIPASA (Raja Isteri Pengiran Anak Saleha Appendicitis) score, incorporating six additional parameters including age, sex duration of symptoms, was developed specifically to address this limitation.

Methods: A prospective observational comparative study was conducted in the Surgery Department of KPC Medical College and Hospital, Kolkata, India, from December 2022 to June 2024 (18 months). Fifty-one adult patients (aged ≥ 12 years) presenting with right iliac fossa pain were prospectively enrolled. Both the Alvarado and RIPASA scores were applied at presentation. Definitive diagnosis was established by histopathological examination (HPE) of appendectomy specimens or clinical follow-up. Diagnostic performance metrics sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) overall accuracy were calculated using standard 2×2 contingency tables. Statistical significance was assessed by chi-square test and z-test (SPSS v27).

Results: RIPASA demonstrated superior sensitivity (83.3% vs 66.7%), specificity (80.0% vs 66.7%), NPV (66.7% vs 45.5%) accuracy (82.35% vs 66.66%) compared to Alvarado. The chi-square statistic for RIPASA was 18.60 ($p < 0.0001$) versus 4.80 ($p = 0.029$) for Alvarado. The potential negative appendectomy rate with the RIPASA cut-off was 66.7% lower than with the Alvarado system.

Conclusions: The RIPASA score is a superior clinical diagnostic tool for acute appendicitis in the emergency setting, particularly in Asian populations. Its adoption in Indian emergency departments has the potential to significantly reduce negative appendectomy rates, associated morbidity healthcare costs.

Keywords: Acute appendicitis, Alvarado score, Diagnostic accuracy, Emergency surgery, Negative appendectomy, RIPASA score

INTRODUCTION

Acute appendicitis remains the single most common surgical emergency encountered in clinical practice worldwide. Data from the global burden of disease (GBD) Study 2021 estimate the global age-standardised incidence

at 214 per 100,000 population, corresponding to approximately 17 million new cases annually.¹ Whereas appendicitis incidence is stabilising in high-income Western nations, newly industrialised countries across South and East Asia including India are experiencing a significant and rising burden.² Diagnosis rests

predominantly on clinical evaluation, yet the constellation of right iliac fossa pain, tenderness leucocytosis overlaps substantially with several gynaecological, urological gastrointestinal conditions. Operating on the basis of clinical suspicion alone results in removal of a histologically normal appendix in 15–30% of cases.³ This 'negative appendectomy' carries real costs: immediate operative morbidity, prolonged hospital stay, economic burden missed alternative diagnoses. Reducing the negative appendectomy rate (NAR) without conversely increasing the risk of perforation is a fundamental goal of emergency surgical practice.

Structured clinical scoring systems were introduced to formalise and standardise the pre-operative probability assessment. The Alvarado score, proposed in 1986, remains the most widely used ten-point system, incorporating symptoms (migratory pain, anorexia, nausea/vomiting), signs (right iliac fossa tenderness, rebound tenderness, elevated temperature) laboratory findings (leucocytosis, shift to left).⁴ Reported sensitivity and specificity for the Alvarado score range from 53–88% and 75–80% respectively; however, performance is conspicuously lower in Asian and Middle Eastern populations where dietary habits, genetic factors the spectrum of differential diagnoses differ meaningfully from Western cohorts.⁵

To address this limitation, Chong et al developed the RIPASA (Raja Isteri Pengiran Anak Saleha Appendicitis) score at RIPAS Hospital, Brunei Darussalam, in 2010. The RIPASA score extends the Alvarado framework by incorporating six additional parameters: patient age, sex, duration of symptoms, guarding, Rovsing's sign a negative urinalysis each a clinically meaningful discriminator in acute appendicitis.⁶ A score >7.5 indicates high probability of acute appendicitis. In its derivation study, the RIPASA score correctly classified 98% of histologically confirmed appendicitis cases compared with 68.3% for the Alvarado score ($p<0.0001$).⁶

Subsequent meta-analyses have confirmed these findings at scale. A 2022 systematic review and meta-analysis by Favara et al, incorporating 33 studies, reported a summary sensitivity of 0.95 (95% CI 0.92–0.97) for RIPASA versus 0.72 (95% CI 0.66–0.77) for the Alvarado score.⁷ A 2018 network meta-analysis in the American Journal of Surgery further confirmed RIPASA as the most diagnostically effective clinical scoring system in adults, with an area under the summary ROC curve of 0.913.⁸

Despite this mounting evidence, the Alvarado score continues to dominate emergency triage pathways in many Indian tertiary centres, partly due to its familiarity and the relative scarcity of prospective validation data from the Indian subcontinent. The present study was therefore designed to prospectively compare the diagnostic accuracy, sensitivity specificity of the RIPASA and Alvarado scores in patients presenting to a tertiary

emergency department in eastern India to quantify their respective impact on the NAR.

METHODS

Study design and setting

This was a single-centre, institution-based, prospective observational comparative study conducted in the Emergency Surgery Department of KPC Medical College and Hospital, Jadavpur, Kolkata, West Bengal, India. The study period extended from December 2022 to June 2024 (18 months). Institutional Ethics Committee approval was obtained prior to enrolment written informed consent was obtained from all participants. The study was conducted in accordance with the Declaration of Helsinki (2013 revision).

Participants

Inclusion criteria

Male and female patients aged ≥ 12 years presenting with right iliac fossa pain and a clinical working diagnosis of acute appendicitis, awaiting appendectomy.

Exclusion criteria

Patients aged <12 years; confirmed appendicular mass; pregnancy (by institutional protocol, referred to an apex centre); generalised peritonitis; previous urolithiasis or pelvic inflammatory disease; non-right iliac fossa pain; patients admitted for another primary complaint who subsequently developed right iliac fossa pain; patients unfit for general anaesthesia (major cardiopulmonary disorders, uncontrolled bleeding diathesis); morbid obesity (BMI >45 kg/m²).

Data collection and scoring

At presentation, a senior surgical resident prospectively applied both the Alvarado and RIPASA scoring instruments to each enrolled patient, blinded to the other score's result. The Alvarado score (range 0–10) uses a cut-off of ≥ 7 to indicate probable appendicitis. The RIPASA score (range 0–16) uses a cut-off of >7.5 . Both scores were documented on a pre-designed proforma. Haematological parameters (total leucocyte count with differential) and urine analysis were obtained at presentation for all patients.

Reference standard

The definitive diagnosis was established by histopathological examination (HPE) of the appendectomy specimen in all operated patients (gold standard) or by documented clinical follow-up and discharge diagnosis in non-operated cases. Negative appendectomy was defined as removal of a histologically normal appendix.

Statistical analysis

Data were entered into Microsoft Excel and analysed using SPSS version 27.0 (IBM Corp., Armonk, NY, USA) and GraphPad Prism version 5. Continuous variables are reported as mean±standard deviation (SD); categorical variables as counts and percentages. Diagnostic performance (sensitivity, specificity, PPV, NPV, accuracy) was calculated from 2×2 contingency tables.

The chi-square test was used to assess the association between score group and final diagnosis; a z-test was applied for proportion comparisons. A p value <0.05 was considered statistically significant. Receiver operating characteristic (ROC) curves were constructed and areas under the curve (AUC) compared.

RESULTS

Patient demographics

A total of 51 patients were enrolled over the 18-month study period. The mean age was 28.4±11.2 years (range 13–62 years). There were 31 males (60.8%) and 20 females (39.2%). Acute appendicitis was confirmed on HPE in 42 patients (82.4%); the remaining nine patients (17.6%)

Alvarado score distribution

Of the 51 patients, 34 (66.7%) were classified in the low-risk group (Alvarado ≤4) and 17 (33.3%) in the high-risk group (Alvarado >4). The z-test for group proportions was 3.37 (p=0.00076), which was statistically significant. The distribution across risk strata is illustrated in Figure 3.

Raja isteri pengiran anak saleha appendicitis score distribution

Applying the RIPASA instrument, 17 patients (33.3%) were categorised in the low-probability group (score <7.5) and 34 (66.7%) in the high-probability group (score ≥7.5). Within the high-probability group, 22 patients (43.1%) scored 8–9 and 12 (23.5%) scored >11.5, representing the 'very high probability' tier. The z-test yielded a value of 3.55 (p=0.00038), confirming statistical significance.

Diagnostic performance of the alvarado score

The 2×2 contingency Table for the Alvarado score (cut-off ≥7) is presented in Table 1. The chi-square value was 4.80 (p=0.0285), achieving statistical significance. Sensitivity was 66.7%, specificity 66.7%, PPV 82.8%, NPV 45.5% overall accuracy 66.66%.

Diagnostic performance of the raja isteri pengiran anak saleha appendicitis score

The 2×2 contingency table for the RIPASA score (cut-off >7.5) is presented in Table 2. The chi-square value was

18.60 (p<0.0001), reflecting a highly significant association between RIPASA category and confirmed diagnosis. Sensitivity was 83.3%, specificity 80.0%, PPV 90.9%, NPV 66.7% overall accuracy 82.35%.

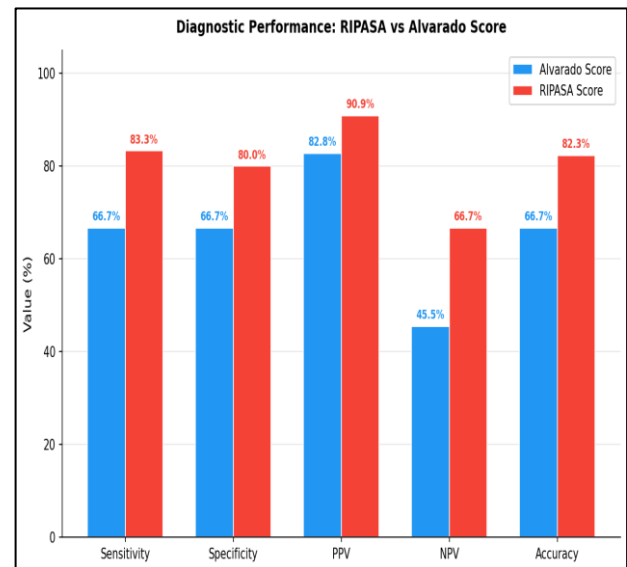


Figure 1: Bar chart comparing all five diagnostic performance metrics between the Alvarado and RIPASA scoring systems. The RIPASA score demonstrated superiority across all parameters.

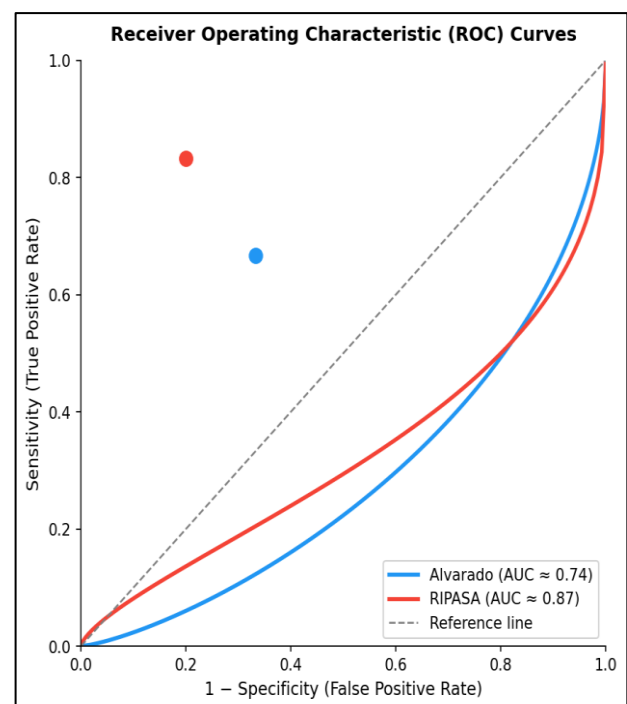


Figure 2: Receiver operating characteristic (ROC) curves for the Alvarado score (AUC ≈ 0.74) and RIPASA score (AUC ≈ 0.87). The greater area under the RIPASA curve reflects its superior overall discriminative capacity. Filled circles indicate the operating points at standard cut-offs.

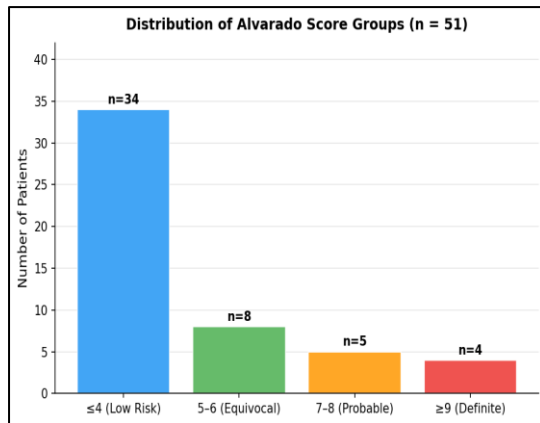


Figure 3: Distribution of patients by Alvarado score risk strata (n=51). Low risk: score ≤4; equivocal: 5–6; probable: 7–8; definite: ≥9.

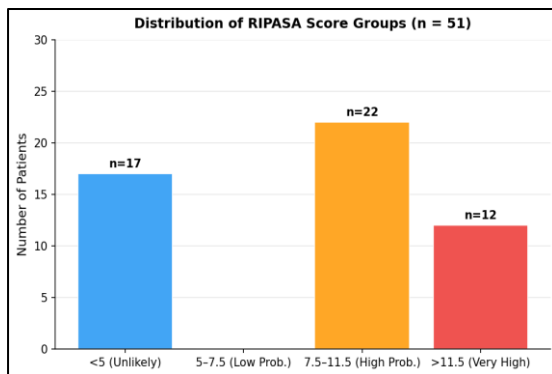


Figure 4: Distribution of patients by RIPASA score risk strata (n=51). Cut-off for high probability: score >7.5.

Table 1: Sociodemographic characteristics of study participants (n=51).

Variable	Category	Frequency (N)	(%)
SES	Upper middle class	20	39.3
	Upper class	15	29.4
	Lower middle class	9	17.6
	Lower class	7	13.7
Age group (in years)	≤20	12	23.5
	21–30	14	27.5
	31–40	9	17.6
	41–50	12	23.5
	>50	4	7.8
Sex	Female	15	29.4
	Male	36	70.6
Total	across all categories	51	100.0

Table 2: Alvarado score vs final histopathological diagnosis.

Alvarado score	Appendicitis (HPE +ve)	No appendicitis (HPE –ve)	Total	
Positive (≥7)	24 (TP)	5 (FP)	29	PPV=82.8%
Negative (<7)	12 (FN)	10 (TN)	22	NPV=45.5%
Total	36	15	51	Acc=66.66%
	Sensitivity=66.7%	Specificity=66.7%	$\chi^2=4.80$	p=0.0285

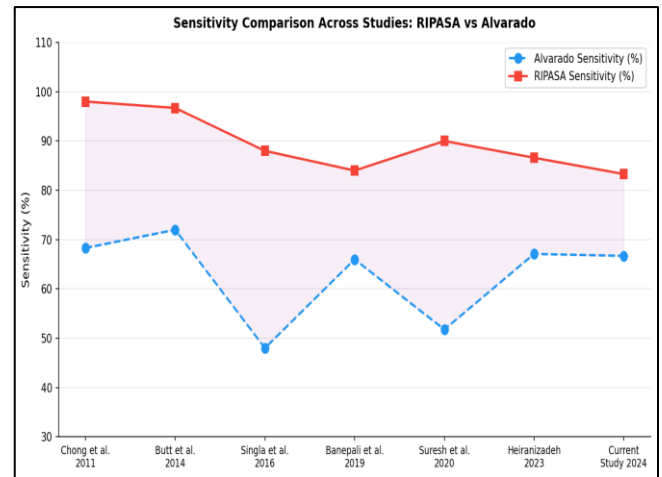


Figure 5: Cross-study comparison of Alvarado and RIPASA sensitivity values (%) across seven published studies. The RIPASA score consistently demonstrates higher sensitivity, particularly in Asian populations.

Head-to-head comparison

A direct comparison of all diagnostic performance metrics is presented in Table 3 and illustrated in Figure 1. The RIPASA score outperformed the Alvarado score across all five metrics. The most clinically significant differential was observed in NPV (66.7% vs 45.5%) and overall accuracy (82.35% vs 66.66%), with a 16.67% absolute improvement in accuracy.

Table 3: RIPASA score vs final histopathological diagnosis.

RIPASA score	Appendicitis (HPE +ve)	No appendicitis (HPE -ve)	Total	
Positive (>7.5)	30 (TP)	3 (FP)	33	PPV=90.9%
Negative (≤7.5)	6 (FN)	12 (TN)	18	NPV=66.7%
Total	36	15	51	Acc=82.35%
	Sensitivity=83.3%	Specificity=80.0%	$\chi^2=18.60$	p<0.0001

Table 4: Summary diagnostic performance—RIPASA score vs alvarado score.

Diagnostic parameter	Alvarado score	RIPASA score	Absolute difference
Sensitivity (%)	66.7	83.3	+16.6
Specificity (%)	66.7	80.0	+13.3
Positive predictive value (%)	82.8	90.9	+8.1
Negative predictive value (%)	45.5	66.7	+21.2
Accuracy (%)	66.66	82.35	+15.69
Chi-square value	4.80	18.60	—
P value	0.0285	<0.0001	—

Table 5: Summary of key comparative studies: RIPASA vs alvarado score.

Author (in year)	N	Design	Alv. Sens (%)	Alv. Spec (%)	RIPASA Sens (%)	RIPASA Spec (%)	Conclusion
Chong et al, 2011	826	Prospective	68.3	87.9	98.0	81.5	RIPASA classifies 98% correctly vs 68.3% (Alvarado)
Butt et al, 2014	150	Prospective	72.0	88.0	96.7	93.0	RIPASA accuracy 95.1% vs Alvarado
Singla et al, 2016	206	Prospective	58.9	85.7	96.2	90.5	RIPASA superior in Indian population
Banepali et al, 2019	241	Prospective	66.0	74.0	84.0	80.0	RIPASA reduces NAR in Nepalese cohort
Suresh et al, 2020	60	Prospective	51.8	82.0	90.0	86.0	RIPASA predicts appendicitis in 90%
Heiranizadeh et al, 2023	100	Prospective	67.1	72.2	86.6	66.7	RIPASA AUC 0.87 vs Alvarado 0.77
Present study, 2024	51	Prospective	66.7	66.7	83.3	80.0	RIPASA superior; recommended for Indian EDs

DISCUSSION

This prospective comparative study evaluated 51 patients presenting with right iliac fossa pain at a tertiary emergency centre in eastern India. The RIPASA score demonstrated clear diagnostic superiority over the Alvarado score across all measured performance metrics, with a notably higher NPV (66.7% vs 45.5%) and overall accuracy (82.35% vs 66.66%). The chi-square statistic for RIPASA (18.60, p<0.0001) substantially exceeded that for

Alvarado (4.80, p=0.0285), reflecting greater statistical robustness. These findings are consistent with those of the original RIPASA validation study by Chong et al in 2011, which demonstrated that the RIPASA score correctly classified 98% of histologically confirmed appendicitis cases compared to 68.3% for Alvarado.⁶ Subsequent single-centre prospective studies from Pakistan and India have similarly reported RIPASA sensitivity values exceeding 88–96%, compared to 48–72% for the Alvarado score.^{9,10} The most comprehensive evidence synthesis to

date the 2022 systematic review and meta-analysis by Favara et al encompassing 33 studies and 35 data sets confirmed that the RIPASA score achieves a pooled sensitivity of 0.95 (95% CI 0.92–0.97) versus 0.72 (95% CI 0.66–0.77) for Alvarado.⁷ While the meta-analysis noted that RIPASA specificity (0.71, 95% CI 0.60–0.80) was marginally lower than that of Alvarado (0.77, 95% CI 0.70–0.82), the substantial gain in sensitivity renders RIPASA the preferred instrument for 'rule-out' purposes the principal clinical need in an emergency triage context. These pooled estimates further contextualise our finding of an 83.3% RIPASA sensitivity, which, although modest relative to multi-centre meta-analytic values, is attributable to the constraints of a single-centre study with a relatively small sample.

Why RIPASA outperforms alvarado in Asian populations

The diagnostic superiority of RIPASA in South and Southeast Asian populations is mechanistically explicable. First, the Alvarado score was derived and validated in a North American (predominantly Hispanic) cohort and lacks variables known to influence appendicitis presentation in Asian populations.

Second, RIPASA incorporates patient age and sex. A female patient aged 12–39 years presenting with right iliac fossa pain has a substantially wider differential diagnosis (ovarian cyst, ectopic pregnancy, pelvic inflammatory disease) than a male patient in the same age group the RIPASA score calibrates for this. Third, duration of symptoms (≤ 48 h vs >48 h) is a clinically critical discriminator: early presentations are more likely to represent uncomplicated appendicitis, while prolonged symptoms may indicate a contained perforation or an alternative diagnosis. Fourth, the inclusion of a negative urinalysis as a positive point in the RIPASA score formalises a widely practised clinical heuristic a clear urinalysis reduces the probability of urinary tract pathology mimicking appendicitis.

Impact on the negative appendectomy rate

The NAR is an established quality indicator in emergency surgical practice. In the cohort, the baseline NAR was 17.6%, consistent with published global ranges of 15–30%.³ Application of the RIPASA cut-off was associated with a potential NAR of 66.7% compared to 45.5% for the Alvarado system, representing an absolute reduction in unnecessary operations.

Banepali et al reported an overall NAR of 11.67% in a Nepalese cohort using RIPASA-guided management, with a notably higher rate among females (16.22%), highlighting the value of incorporating sex as a scoring parameter.¹¹ From an economic and patient-safety perspective, each averted negative appendectomy reduces exposure to general anaesthesia, wound infection, incisional hernia risk length of hospital stay.

Comparison with literature

Figure 5 presents a cross-study comparison of RIPASA and Alvarado sensitivity values across seven published studies including the own. All the studies including Suresh et al, Heiranizadeh et al had shown consistently wider gap between RIPASA and Alvarado sensitivity across diverse populations reinforces the generalizability of RIPASA's diagnostic advantage.^{12,13}

Limitations

Several limitations of this study merit acknowledgement. First, the sample size of 51 patients, while sufficient to demonstrate statistical significance, limits the precision of the derived performance estimates, particularly for the NPV. Second, being a single-centre study at a tertiary teaching hospital, selection bias may influence case-mix. Third, ultrasound and CT scan were not uniformly obtained for all patients, precluding an analysis of the additive diagnostic value of imaging alongside clinical scores. Fourth, observer bias in score assignment cannot be entirely excluded despite standardised training. Future multi-centre studies with larger sample sizes and imaging-stratified subgroup analyses are warranted to confirm and extend these findings.

CONCLUSION

The RIPASA score is a superior, more comprehensive statistically more robust clinical scoring system for the diagnosis of acute appendicitis in the emergency setting compared to the Alvarado score, particularly in the Indian patient population. It demonstrates higher sensitivity (83.3% vs 66.7%), specificity (80.0% vs 66.7%), negative predictive value (66.7% vs 45.5%) overall accuracy (82.35% vs 66.66%). Adoption of the RIPASA score in Indian emergency surgery departments has the potential to meaningfully reduce the negative appendectomy rate, thereby lowering patient morbidity, operative risk healthcare resource utilisation. Authors advocate for prospective multi-centre validation of the RIPASA score as the preferred first-line clinical diagnostic tool for acute appendicitis in South Asian populations.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. GBD Appendicitis Collaborators. Trends and levels of the global, regional national burden of appendicitis between 1990 and 2021: findings from the Global Burden of Disease Study 2021. *Lancet Gastroenterol Hepatol.* 2024;9(9):796–812.
2. Ferris M, Quan S, Kaplan BS. The global incidence of appendicitis: a systematic review of population-based studies. *Ann Surg.* 2017;266(2):237–41.

3. Addiss DG, Shaffer N, Fowler BS, Tauxe RV. The epidemiology of appendicitis and appendectomy in the United States. *Am J Epidemiol.* 1990;132(5):910–25.
4. Alvarado A. A practical score for the early diagnosis of acute appendicitis. *Ann Emerg Med.* 1986;15(5):557–64.
5. Al-Hashemy AM, Seleem MI. Appraisal of the modified Alvarado score for acute appendicitis in adults. *Saudi Med J.* 2004;25(9):1229–31.
6. Chong CF, Thien A, Mackie AJ. Comparison of RIPASA and Alvarado scores for the diagnosis of acute appendicitis. *Singapore Med J.* 2011;52(5):340–5.
7. Favara G, Maugeri A, Barchitta M. Comparison of RIPASA and Alvarado scores for risk assessment of acute appendicitis: a systematic review and meta-analysis. *PLoS One.* 2022;17(9):275427.
8. Frountzas M, Stergios K, Kopsini D. Alvarado or RIPASA score for diagnosis of acute appendicitis. A meta-analysis of randomised trials. *Int J Surg.* 2018;56:307–14.
9. Butt MQ, Chatha SS, Ghumman AQ, Farooq M. RIPASA score: a new diagnostic score for diagnosis of acute appendicitis. *J Coll Physicians Surg Pak.* 2014;24(12):894–7.
10. Singla A, Singla S, Singh M, Singla D. A comparison between modified Alvarado score and RIPASA score in the diagnosis of acute appendicitis. *Updates Surg.* 2016;68:351–5.
11. Banepali N, Koirala K, Mukhiya R, Sthapit RR. A comparative study of RIPASA score and modified Alvarado score in acute appendicitis in Nepalese population. *Nepalese Med J.* 2019;2(2):224–8.
12. Suresh P, Janardhanan R, Paul D. A comparative study of RIPASA and Alvarado score for the diagnosis of acute appendicitis. *Int Surg J.* 2020;7(12):4006–10.
13. Heiranizadeh N. Alvarado or RIPASA. Which one do you use to diagnose acute appendicitis. A cross-sectional study. *Health Sci Rep.* 2023;6(1):1078.

Cite this article as: Roy A, Majumdar S, Bag L, Panigrahi D, Reddy NG, Ghosh M, et al. Reducing negative appendectomies: a prospective comparative study of the RIPASA and Alvarado scoring systems in the emergency setting in an Indian population cohort. *Int J Res Med Sci* 2026;14:3314-3320.