

Diagnostic Accuracy of Modified Alvarado and RIPASA Scores for Acute Appendicitis in Zakho Emergency Hospital: A Cross-Sectional Study

Farhad MR Ahmed^{1,2}, Mahmoud Ali Abdi^{1*}, Iman Ramadhan Yousifi¹, Hajar Hassan Abdulqadir¹, Yamama Judaan Ali¹

¹Department of Surgery, College of Medicine, University of Zakho, Zakho, Kurdistan Region, Iraq.

²Department of Surgery, Zakho Emergency Teaching Hospital, Zakho, Kurdistan Region, Iraq.

*Corresponding to: Mahmoud Ali Abdi (E-mail: mahmoud.abdi@uoz.edu.krd)

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Abstract

Objective: To compare the diagnostic performance of the Modified Alvarado and RIPASA scoring systems in patients presenting with RIF pain.

Methods: A cross-sectional study was conducted at Zakho Emergency Hospital between October 2022 and May 2023. A total of 195 consecutively admitted patients with RIF pain were evaluated using both scoring systems. Histopathology (when available) served as the reference standard. Statistical analysis included descriptive statistics, two-tailed independent *t*-tests, ANOVA, chi-square tests, logistic regression, and receiver operating characteristic (ROC) curve analysis. Sensitivity, specificity, predictive values, accuracy, and area under the curve (AUC) were calculated with 95% confidence intervals (CI).

Results: Histopathology confirmed appendicitis in 141 patients (72.3%). Using a cutoff ≥ 7 , the MA score showed sensitivity 67.4%, specificity 61.1%, PPV 83.3%, NPV 41.8%, and accuracy 65.6%. The RIPASA score (cutoff ≥ 10) demonstrated sensitivity 75.9%, PPV 86.3%, NPV 45.8% and accuracy 72.3%, with identical specificity (61.1%). Logistic regression confirmed both scores as significant predictors ($P < 0.001$). ROC analysis demonstrated acceptable discrimination for both systems.

Conclusion: Both scoring systems demonstrated moderate diagnostic performance. RIPASA showed higher sensitivity and overall discrimination; however, the difference was not statistically significant. These findings suggest that RIPASA may provide incremental diagnostic benefit, but neither score should replace imaging in equivocal cases.

Keywords: Abdominal pain, appendicitis, severity of illness index, clinical decision rules, sensitivity and specificity, predictive value of tests, reproducibility of results

Introduction

Acute appendicitis is one of the most common surgical emergencies worldwide, with a lifetime risk of 8.6% in males and 6.7% in females.^{1–3} Its incidence varies according to sex, age, ethnicity, and seasonal factors.^{4,5}

Clinically, appendicitis often begins with periumbilical pain that later localizes to the right iliac fossa due to parietal peritoneal irritation.^{6,7} Differential diagnoses include ileitis, colitis, diverticulitis, mesenteric adenitis, ureteric stones, and gynecological conditions such as ovarian torsion or ectopic pregnancy.⁸

Despite advances in imaging and laboratory investigations, misdiagnosis rates may reach up to 30%.^{9–12} Diagnostic approaches typically combine clinical evaluation, laboratory testing, ultrasound, computed tomography, and occasionally diagnostic laparoscopy.^{13–15}

To reduce negative appendectomy rates, several clinical scoring systems have been developed.^{16–18} The Modified Alvarado (MA) score, consisting of seven parameters, is widely used due to its simplicity.¹⁷ The RIPASA score, developed in 2010, includes 14 parameters and has been reported to demonstrate improved sensitivity in Asian populations.^{11,14,19}

Evidence from the Kurdistan Region regarding the comparative performance of these scores remains limited. Therefore, this study aimed to evaluate and compare the diagnostic accuracy of MA and RIPASA scores in a local emergency hospital setting.

Patients and Methods

Study Design and Data Collection

This cross-sectional study was conducted at Zakho Emergency Hospital to evaluate patients presenting with right iliac fossa (RIF) pain. Data were collected from October 1, 2022, to May 19, 2023, participants were enrolled consecutively and 195 patients from the general population were enrolled. Each participant completed a self-administered questionnaire and underwent a clinical examination.

In addition, all patients received ultrasound evaluations, and specimens from operative cases were subsequently sent for histopathological analysis. In order to determine the prevalence of acute appendicitis among patients presenting with RIF pain and to evaluate the accuracy of two diagnostic tools.

Study Tools

This study questionnaire was based on previously validated questionnaires Appendix A. Scoring weights were applied exactly as originally described without modification.^{14,20}

The study instrument comprised a structured questionnaire divided into two parts. The first section gathered key demographic information, including age and gender. The second section was designed to assess clinical presentation using two scoring systems: the Modified Alvarado score and the RIPASA score. The Modified Alvarado score,

which includes seven parameters—migratory pain, anorexia, nausea/vomiting, tenderness, rebound tenderness, fever, and white blood cell count—served as an initial diagnostic tool. The RIPASA score, incorporating additional factors such as age, gender, duration of symptoms, and urinalysis findings (totaling 14 parameters), provided further diagnostic insight. Threshold scores of ≥ 7.0 for the Modified Alvarado and ≥ 10 for the RIPASA were used to indicate a likely diagnosis of appendicitis.^{14,20}

Following the clinical evaluation, all patients underwent ultrasound examinations, and those requiring surgical intervention had operative specimens sent for histopathological analysis, with the results systematically recorded and reported.

Inclusion and Exclusion Criteria

Inclusion criteria encompassed all patients presenting with RIF pain and admitted to Zakho Emergency Hospital, regardless of age, gender, or ethnicity, were eligible for inclusion. Patients were excluded if they were not admitted to the hospital or if their data were incomplete or missing.

Ethical Approval

The study received approval from the Institutional Ethics Committee of the College of Medicine, University of Zakho (Approval No: FEB2023/E02; approved on 10 February 2023). Verbal informed consent was obtained from all participants or guardians.

Statistical Analysis

Statistical analysis was conducted using SPSS version 26. Descriptive statistics were presented as frequencies and percentages. Associations were analyzed using two-tailed independent t-tests and one-way ANOVA. Chi-square tests evaluated ultrasound–histopathology associations. Logistic regression assessed independent predictors.

Diagnostic accuracy measures (sensitivity, specificity, PPV, NPV, accuracy) were calculated. Confidence intervals were estimated. Receiver Operating Characteristic (ROC) curves and Area Under the Curve (AUC) values were computed to assess discriminative performance. A P -value < 0.05 was considered statistically significant.

This study was conducted and reported in accordance with the STARD 2015 guidelines for diagnostic accuracy studies.²¹

Results

A total of 195 patients presenting with right iliac fossa (RIF) pain at Zakho Emergency Hospital were included in the study. The mean age was 17.9 years (SD = 13.1), with a median of 14 years and a range of 4–76 years, reflecting a predominantly young population. The age distribution was right-skewed, indicating a higher concentration of children and adolescents (Figure 1). Females comprised 57.4% ($n = 112$) of the cohort, while males accounted for 42.6% ($n = 83$) (Figure 2).

Histogram showing right-skewed age distribution with peak incidence in adolescents.

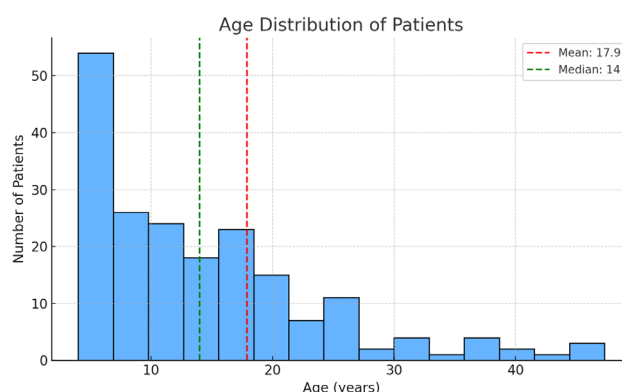


Fig. 1 Age distribution of study population.

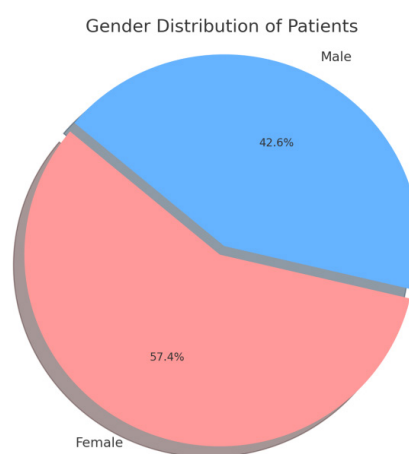


Fig. 2 Gender distribution of study population.

Bar chart demonstrating proportion of male and female participants.

The mean Modified Alvarado (MA) score was 6.7 (SD = 1.6; range 2.0–9.0), with a median of 7.0. The mean RIPASA score was 10.4 (SD = 2.4; range 4.5–15.0), with a median of 10.5. Both scores demonstrated approximately normal distributions, with slight left skew for MA and slight right skew for RIPASA (Table 1).

Appendicitis was confirmed in 141 patients (72.3%), making it the most frequent diagnosis. Other diagnoses included urinary tract infection (11.8%), mesenteric lymphadenopathy (8.2%), gastroenteritis (2.6%), ovarian cyst (2.6%), irritable bowel syndrome (2.1%), and one case of appendicular carcinoid (0.5%) (Table 2).

Using a cutoff value of ≥ 7 for the MA score, sensitivity was 67.4% (95% CI: 59.0–75.1), specificity 61.1% (95% CI: 46.9–74.1), positive predictive value (PPV) 83.3% (95% CI: 75.6–89.4), negative predictive value (NPV) 41.8% (95% CI: 30.5–53.8), and overall accuracy 65.6%. For the RIPASA score using a cutoff ≥ 10 , sensitivity was 75.9% (95% CI: 68.0–82.6), specificity 61.1% (95% CI: 46.9–74.1), PPV 86.3% (95% CI: 78.9–91.8), NPV 45.8% (95% CI: 34.3–57.7), and accuracy 72.3%. The identical specificity observed for both scoring systems reflects overlapping false-positive classifications among non-appendicitis cases (Table 3).

Table 1. Descriptive statistics of MA and RIPASA scores

Statistic	MA score	RIPASA score
Mean	6.7	10.4
Median	7.0	10.5
Standard deviation	1.6	2.4
Range	2.0–9.0	4.5–15.0
Distribution	Slight left skew	Slight right skew

Table 2. Differential diagnosis of RIF pain

Diagnosis	Number	Percentage
Appendicitis	141	72.3%
UTI	23	11.8%
Mesenteric lymphadenopathy	16	8.2%
Gastroenteritis	5	2.6%
Ovarian cyst	5	2.6%
IBS	4	2.1%
Appendicular carcinoid	1	0.5%
Total	195	100%

Table 3. Diagnostic performance of MA and RIPASA scores

Metric	MA ≥ 7	RIPASA ≥ 10
Sensitivity	67.4% (95% CI: 59.0–75.1)	75.9% (95% CI: 68.0–82.6)
Specificity	61.1% (95% CI: 46.9–74.1)	61.1% (95% CI: 46.9–74.1)
Positive predictive value	83.3% (95% CI: 75.6–89.4)	86.3% (95% CI: 78.9–91.8)
Negative predictive value	41.8% (95% CI: 30.5–53.8)	45.8% (95% CI: 34.3–57.7)
Accuracy	65.6%	72.3%

Receiver Operating Characteristic (ROC) curve analysis demonstrated acceptable discriminative performance for both scoring systems. The Area Under the Curve (AUC) for the MA score was 0.707 (95% CI: 0.632–0.776), while the RIPASA score showed a higher AUC of 0.744 (95% CI: 0.679–0.808). The difference between the two AUCs was not statistically significant ($P = 0.089$) (Table 4).

Logistic regression analysis identified both MA and RIPASA scores as significant independent predictors of appendicitis. The odds ratio for MA was 1.5 (95% CI: 1.2–1.9; $P < 0.001$), and for RIPASA it was 1.4 (95% CI: 1.2–1.7; $P < 0.001$). Age and gender were not statistically significant predictors.

Ultrasound findings showed a significant association with histopathological confirmation. Among patients with a dilated appendix on ultrasound, 81.8% had confirmed acute infection. When the appendix was not visualized, 41.3% had confirmed infection. The presence of fluid in the right lower quadrant correlated with histopathology in 66.7% of cases. This association was statistically significant ($\chi^2 = 14.2$, $P < 0.01$).

Table 4. ROC curve analysis

Score	AUC	95% Confidence interval	P-value (AUC comparison)
MA score	0.707	0.632–0.776	—
RIPASA score	0.744	0.679–0.808	0.089

Discussion

Right iliac fossa (RIF) pain remains one of the most frequent presentations in emergency and surgical practice. Acute appendicitis is the leading surgical cause of RIF pain and, although generally manageable when diagnosed early, delayed recognition may result in perforation, abscess formation, peritonitis, and occasionally mortality. Therefore, improving diagnostic accuracy remains a clinical priority.

In the present study, appendicitis accounted for 72.3% of cases, confirming its predominance among patients presenting with RIF pain. This proportion is comparable to findings reported in Turkey (77.8%)²² and is within the range described in Spain (50.35%),²³ supporting the external validity of our population profile. The predominance of a young cohort, with a mean age of 17.9 years, aligns with epidemiological evidence indicating peak incidence during adolescence and early adulthood.²⁴

Although females constituted a slightly larger proportion of the cohort (57.4%), gender was not a significant predictor of appendicitis. Similar observations have been reported in studies from Alexandria and India.^{25,26} This finding is clinically relevant because gynecological conditions frequently mimic appendicitis, particularly in reproductive-age women.²⁷ The absence of gender as an independent predictor reinforces the importance of structured clinical scoring rather than reliance on demographic assumptions.

Both MA and RIPASA scores were significantly higher in patients with confirmed appendicitis compared with other diagnoses. These differences are consistent with previously published data from Iran and Jordan,^{28,29} confirming the reproducibility of both scoring systems across diverse settings. However, the clinical relevance lies not merely in statistical significance but in discriminative performance.

In our cohort, RIPASA demonstrated higher sensitivity (75.9%) compared with MA (67.4%), while specificity was identical (61.1%) for both scores. The identical specificity reflects overlapping false-positive classifications rather than methodological duplication. The higher sensitivity of RIPASA suggests improved detection of true appendicitis cases, which may be advantageous in emergency settings where minimizing missed diagnoses is critical. Nevertheless, the relatively low negative predictive values (45.8% for RIPASA and 41.8% for MA) indicate that neither score alone is sufficient to safely exclude appendicitis without adjunctive imaging.

ROC analysis further demonstrated acceptable discrimination for both systems. Although RIPASA showed a higher AUC, the difference was not statistically significant. This finding suggests incremental rather than definitive superiority. These results are consistent with previous literature indicating improved sensitivity of RIPASA in Asian and Middle Eastern populations,²⁹ yet they also highlight that diagnostic scoring

systems remain supportive tools rather than standalone diagnostic tests.

An additional noteworthy finding was that RIPASA, but not MA, significantly differentiated appendicitis from urinary tract infections. This suggests superior discriminative capacity in conditions with overlapping symptoms, which is clinically important in regions where UTI is a frequent alternative diagnosis.³⁰

Logistic regression analysis confirmed that both scores independently predicted appendicitis, with each incremental point significantly increasing diagnostic odds. The absence of age and gender as significant predictors further supports the robustness of structured scoring systems in reducing subjective bias.

The strengths of this study include prospective data collection, application in a real-world emergency setting, and use of histopathology as a reference standard where available. The comparative evaluation of two scoring systems within the same patient cohort provides direct and clinically relevant insight.

However, several limitations must be acknowledged. The study was conducted at a single center with a relatively modest sample size and a predominantly young population. The high prevalence of appendicitis may also have influenced predictive values. Therefore, caution is warranted in generalizing these findings beyond similar clinical contexts.

Future research should focus on multi-center validation with larger and more diverse populations. Integration of inflammatory biomarkers such as C-reactive protein and advanced imaging modalities may further enhance diagnostic pathways. Additionally, cost-effectiveness analyses could clarify the practical utility of these scoring systems in emergency triage protocols.

Conclusion

Both Modified Alvarado and RIPASA scores demonstrated statistically significant associations with confirmed appendicitis. RIPASA showed higher sensitivity and overall accuracy; however, findings suggest incremental benefit rather than definitive superiority. These scoring systems may support clinical decision-making, particularly in resource-limited settings, but should complement rather than replace imaging.

AI-Assisted Writing Disclosure

Language editing assistance tools were used for grammatical refinement. All scientific content and analyses were independently verified by the authors.

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Financial Disclosure

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Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of Interest

None.

List of Abbreviations

RIF — Right Iliac Fossa
 RIPASA — Raja Isteri Pengiran Anak Saleha Appendicitis (Score)
 MA — Modified Alvarado (Score)
 UTI — Urinary Tract Infection
 IBS — Irritable Bowel Syndrome
 PPV — Positive Predictive Value
 NPV — Negative Predictive Value
 OR — Odds Ratio
 CI — Confidence Interval
 SD — Standard Deviation
 ANOVA — Analysis of Variance
 CT — Computed Tomography
 CRP — C-Reactive Protein
 SPSS — Statistical Package for the Social Sciences ■

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Appendix A

Questionnaire No:

Patient's full name:

Age:

Gender: M F

RIPASA Score	RIPASA/MA score	MA score
0.5	Pain Migration to RIF	1
1	Anorexia	1
1	Nausea & vomiting	1
1	Tenderness RIF	2
1	Rebound tenderness	1
1	Fever >37 °C < 39 °C	1
1	Raised WBC	2
0.5	RIF pain	Total
2	Rovsing Sign	
2	Guarding	
0.5	Duration of Symptoms >48 h	
1	Duration of Symptoms <48 h	
1	Negative urine analysis	
1	Male	
0.5	Female	
1	Age < 39.9	
0.5	Age > 40	
Total		

Ultrasound findings

1. Appendix can't be visualized 2. Noncompressible appendix 3. Pain with compression 4. Appendicolith 5. Fluid in RLQ/pelvis
Other

Diagnosis

Histopathological results

Normal appendix Acute infection Chronic infection Appendicular Carcinoid Appendicular Carcinoma Appendicular Mucocele
Other

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