J Surg Med. 2026;10(8):e8648.
https://doi.org/10.28982/josam.8648

JOSAM

Research Article
https://jsurgmed.com/

Journal of Surgery and Medicine
e-ISSN: 2602-2079

Diagnostic value of dry lips in patients with suspected acute appendicitis: A prospective cohort study

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Ethical Approval
This prospective observational cohort study was approved by the Institutional Review Board of Security Forces Hospital Program, Riyadh, Saudi Arabia (Research No. 24-722-19; KACST IRB Registration No. H-01-R-069) on September 12, 2024. All procedures involving human participants were conducted in accordance with the ethical standards of the institutional research committee and the 1964 Declaration of Helsinki and its later amendments.

Informed Consent
Written informed consent was obtained from all participants before enrollment.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Published
2026 August 8

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Abstract

Background/Aim: Acute appendicitis is a common surgical emergency, but accurate diagnosis remains challenging. Simple bedside findings may complement established diagnostic strategies. This study aimed to evaluate the diagnostic accuracy of dry lips as a bedside clinical sign in adults presenting with suspected acute appendicitis.

Methods: This prospective observational cohort study was conducted in the emergency department of a tertiary care hospital from June 2024 to May 2025. Consecutive adults presenting with suspected acute appendicitis were enrolled. Dry lips were assessed during the initial examination before intravenous fluid administration, laboratory testing, or imaging. Histopathological examination confirmed appendicitis in operated patients, whereas non-operated patients were classified as not having appendicitis based on negative computed tomography findings and/or an uneventful 30-day clinical follow-up. Sensitivity, specificity, predictive values, likelihood ratios, and 95% confidence intervals (CIs) were calculated.

Results: Of 115 patients screened, 96 met the eligibility criteria and were included. Acute appendicitis was confirmed in 44 patients (45.8%), and dry lips were present in 36 (37.5%). Dry lips had a sensitivity of 54.6% (95% CI, 38.8-69.6%) and a specificity of 76.9% (95% CI, 63.2-87.5%). The positive likelihood ratio was 2.36 (95% CI, 1.34-4.16), and the negative likelihood ratio was 0.59 (95% CI, 0.41-0.84). Combining dry lips with a C-reactive protein level of at least 10 mg/L increased specificity to 93.9% (95% CI, 84.4-98.0%) and the positive likelihood ratio to 6.61 (95% CI, 2.24-22.49).

Conclusion: Dry lips showed moderate specificity but limited sensitivity for diagnosing acute appendicitis. This finding is not sufficiently accurate for use as a standalone test but may provide a rapid, cost-free adjunct to bedside assessment when interpreted with inflammatory markers and other clinical findings. Larger multicenter studies are needed to validate these results.

Keywords: acute appendicitis, dry lips, physical examination, diagnostic accuracy, dehydration

How to cite: Akeely YY, Alfaifi A, Patel SB, Bokhari NN, Alblowi NS, Alshaheen R, Alanazi WA. Diagnostic value of dry lips in patients with suspected acute appendicitis: A prospective cohort study. J Surg Med. 2026;10(8):e8648.

Introduction

Acute appendicitis is among the most common abdominal surgical emergencies, with an annual incidence of approximately 100 cases per 100,000 adults worldwide [1]. Despite advances in laboratory testing and diagnostic imaging, accurate diagnosis remains challenging because clinical presentations range from nonspecific abdominal pain to generalized peritonitis [1, 2]. Delayed diagnosis increases the risk of perforation and postoperative morbidity, whereas overdiagnosis may lead to unnecessary appendectomy. Timely and accurate diagnosis therefore remains a major objective in emergency and surgical practice.

The diagnosis of acute appendicitis relies on a combination of clinical assessment, laboratory investigations, and imaging. Clinical prediction tools, including the Alvarado score and the Appendicitis Inflammatory Response score, can support risk stratification but cannot consistently confirm or exclude appendicitis when used alone [3-5]. Similarly, inflammatory biomarkers such as the white blood cell count and C-reactive protein (CRP) level should be interpreted within the broader clinical context because normal values do not reliably exclude the disease [6].

Computed tomography (CT) provides excellent diagnostic accuracy, with reported sensitivity and specificity above 95%. However, routine CT use is associated with radiation exposure, cost, and limited availability in some settings [7]. Additional studies of clinical scoring systems have likewise shown that bedside scores are most useful for risk stratification rather than as independent definitive tests [8-11]. CRP has also been investigated as a diagnostic adjunct, but it should not be interpreted in isolation [12, 13].

These limitations sustain interest in simple bedside findings that may improve early assessment. Patients with acute appendicitis commonly experience anorexia, nausea, vomiting, and reduced oral intake, which may contribute to dehydration. Dry lips are readily observable and may reflect this physiological state. Unlike laboratory tests or imaging, their assessment requires no equipment, incurs no additional cost, and can be performed immediately during the initial clinical evaluation.

Evidence regarding the diagnostic value of dry lips is limited. A previous adult study reported an association between dry lips and acute appendicitis, and an earlier pediatric study evaluated the same finding [14, 15]. Prospective validation in an independent adult cohort remains limited. This study therefore aimed to evaluate the diagnostic accuracy of dry lips as a bedside clinical sign in adults presenting with suspected acute appendicitis, using histopathological confirmation for operated patients and negative CT findings and/or 30-day clinical follow-up for non-operated patients.

Materials and methods

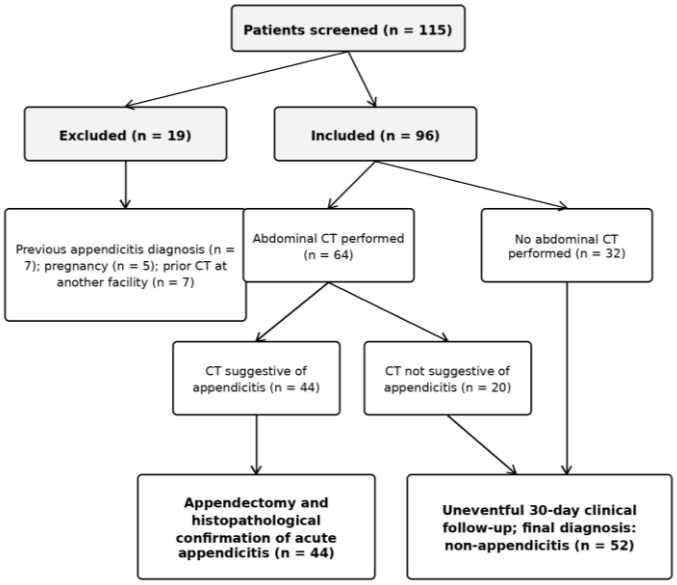
Study design and setting

This prospective observational cohort study was conducted in the emergency department of Security Forces Hospital Program, Riyadh, Saudi Arabia, from June 2024 to May 2025. The study evaluated the diagnostic accuracy of dry lips as a bedside clinical sign in adults presenting with suspected acute appendicitis. Reporting followed the Standards for Reporting Diagnostic Accuracy Studies recommendations where applicable.

Study population

All consecutive adults aged 18 years or older who presented to the emergency department with suspected acute appendicitis during the study period were screened. Of 115 patients screened, 19 were excluded: seven had a previous diagnosis of appendicitis, five were pregnant, and seven had undergone abdominal CT at another healthcare facility before presentation. The final cohort comprised 96 prospectively enrolled patients (Figure 1).

Figure 1. STARD flow diagram of participant enrollment and diagnostic classification



Abbreviations: CT: computed tomography, STARD: Standards for Reporting Diagnostic Accuracy Studies.

Index test

The index test was the presence of dry lips during the initial clinical assessment. Dry lips were defined a priori as visible dryness, fissuring, or cracking on direct inspection. Emergency physicians assessed the finding before intravenous fluid administration, laboratory testing, or imaging and recorded it as present or absent. The physicians were blinded to laboratory and imaging findings at the time of examination. Outcome assessment and data analysis were performed independently by investigators who were not involved in the initial clinical evaluation.

Reference standard and follow-up

A composite reference standard was used because not all participants underwent surgery. For patients who underwent appendectomy, acute appendicitis was confirmed by histopathological examination. Patients who did not undergo surgery were classified as not having appendicitis based on negative CT findings and/or an uneventful 30-day clinical follow-up. Follow-up included review of electronic medical records and telephone contact. All participants completed follow-up, and none were lost to follow-up. Patients without recurrent symptoms or subsequent appendectomy were considered not to have appendicitis.

Clinical management was independent of the study protocol. Treating physicians determined the need for laboratory testing, imaging, surgical consultation, hospital admission, or appendectomy according to routine practice. The dry-lips assessment was not used to guide clinical decisions.

Laboratory investigations included the white blood cell count and CRP level. A CRP threshold of at least 10 mg/L was selected a priori based on previous literature.

Outcomes

The primary outcome was the diagnostic accuracy of dry lips for acute appendicitis. Secondary outcomes were the diagnostic performance of dry lips when combined with a CRP level of at least 10 mg/L and with symptom duration.

Statistical analysis

Data were analyzed using IBM SPSS Statistics for Windows, version 23.0 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean (standard deviation), and categorical variables as frequency and percentage. Diagnostic accuracy was evaluated by calculating sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio, and negative likelihood ratio with 95% CIs. A 2 × 2 contingency table was constructed for dry lips and the final diagnosis. Combined analyses used an AND rule; a positive result required both dry lips and the specified criterion. Where inferential analyses were applicable, a two-sided $P < 0.05$ was considered statistically significant. No inferential hypothesis tests were prespecified for the primary diagnostic-accuracy analysis.

Results

Participant characteristics

During the study period, 115 consecutive adults with suspected acute appendicitis were screened. Nineteen were excluded according to the predefined criteria, and 96 were included in the final analysis (Figure 1). The mean age was 27.9 (9.8) years, and 50 participants (52.1%) were female. Dry lips were present in 36 participants (37.5%), and 87 (90.6%) presented at least 12 hours after symptom onset. Baseline characteristics are presented in Table 1, and the final clinical classification and laboratory findings are presented in Table 2.

Table 1. Baseline characteristics of the study population (n = 96)

Variable	Value
Age, years, mean (SD)	27.9 (9.8)
Female sex, n (%)	50 (52.1)
Male sex, n (%)	46 (47.9)
Symptom duration ≥12 h, n (%)	87 (90.6)
Dry lips present, n (%)	36 (37.5)

Abbreviation: SD: standard deviation.

Table 2. Final clinical classification and laboratory findings (n = 96)

Variable	Value
Acute appendicitis, n (%)	44 (45.8)
Non-appendicitis, n (%)	52 (54.2)
Operated patients, n (%)	44 (45.8)
WBC, ×10^9/L, mean (SD)	8.17 (6.24)
CRP, mg/L, mean (SD)	31.39 (61.68)

Abbreviations: CRP: C-reactive protein, SD: standard deviation, WBC: white blood cell count.

Acute appendicitis was confirmed in 44 participants (45.8%), all of whom underwent appendectomy with histopathological confirmation. The remaining 52 participants (54.2%) were classified as not having appendicitis based on negative CT findings and/or an uneventful 30-day clinical follow-up. No participant was lost to follow-up.

Diagnostic performance of dry lips

The 2 × 2 contingency table is shown in Table 3. Dry lips had a sensitivity of 54.6% and a specificity of 76.9% for acute appendicitis. When dry lips were combined with a CRP level of at least 10 mg/L, specificity increased to 93.9% and the positive likelihood ratio to 6.61, whereas sensitivity remained limited. Detailed diagnostic-accuracy estimates and 95% CIs are shown in Table 4. Estimates for participants presenting within 12 hours of symptom onset should be interpreted cautiously because this subgroup was small.

Table 3. Two-by-two contingency table for dry lips and the final diagnosis of acute appendicitis

Dry-lips assessment	Appendicitis	Non-appendicitis	Total
Dry lips present	24	12	36
Dry lips absent	20	40	60
Total	44	52	96

Table 4. Diagnostic accuracy of dry lips alone and in combination with C-reactive protein level and symptom duration for acute appendicitis

Index test	Sensitivity, % (95% CI)	Specificity, % (95% CI)	PPV, % (95% CI)	NPV, % (95% CI)	LR+ (95% CI)	LR- (95% CI)
Dry lips	54.6 (38.8-69.6)	76.9 (63.2-87.5)	66.7 (49.0-81.4)	66.7 (53.3-78.3)	2.36 (1.34-4.16)	0.59 (0.41-0.84)
Dry lips + CRP ≥10 mg/L	40.5 (27.7-55.6)	93.9 (84.4-98.0)	85.0 (65.4-95.0)	64.8 (54.1-75.1)	6.61 (2.24-22.49)	0.63 (0.49-0.81)
Dry lips + symptom duration <12 h	4.5 (1.3-15.2)	92.3 (82.1-97.1)	33.3 (9.7-70.0)	53.3 (43.4-63.0)	0.59 (0.13-2.63)	1.03 (0.95-1.10)

Abbreviations: CI: confidence interval, CRP: C-reactive protein, LR+: positive likelihood ratio, LR-: negative likelihood ratio, NPV: negative predictive value, PPV: positive predictive value. Combined tests used an AND rule.

Discussion

In this prospective diagnostic-accuracy study, dry lips showed moderate specificity but limited sensitivity in adults presenting with suspected acute appendicitis. The finding alone was insufficient to diagnose or exclude the disease. When dry lips were interpreted with an elevated CRP level, specificity and the positive likelihood ratio increased substantially. These results suggest that dry lips may contribute incremental information within a broader clinical assessment rather than function as an independent diagnostic test.

Acute appendicitis remains a clinical diagnosis supported by laboratory and imaging findings. CT provides excellent diagnostic accuracy but may be constrained by radiation exposure, cost, availability, and emergency department workflow [7]. Clinical prediction tools improve risk stratification but cannot reliably confirm or exclude appendicitis in isolation [3-5, 8-11]. Careful bedside examination therefore remains important during the initial evaluation.

The rationale for assessing dry lips is biologically plausible. Anorexia, nausea, vomiting, fever, and reduced oral intake may cause dehydration in patients with acute appendicitis. Dry lips may reflect this state but are nonspecific and may occur in many medical and surgical conditions. The finding should therefore be interpreted with the history, physical examination, laboratory findings, and imaging results.

Our findings differ from those of Mohammadi Tofigh et al. [14], who reported substantially higher sensitivity for dry lips. Their study included a much higher proportion of patients with confirmed appendicitis, which may have affected diagnostic estimates. Differences in patient selection, disease severity, healthcare setting, and assessment methods may also explain the discrepancy. Nevertheless, both studies indicate that dry lips may have a supportive role in patients with suspected appendicitis.

The improved diagnostic performance observed when dry lips were combined with elevated CRP was clinically relevant. The coexistence of these findings increased the probability of

appendicitis, but sensitivity remained modest. The absence of dry lips, even when interpreted with CRP, should therefore not be used to exclude the diagnosis. These findings support the use of simple bedside observations as complements to established diagnostic strategies.

The strengths of this study include its prospective design, consecutive enrollment, assessment of the index test before laboratory and imaging results were available, blinding of assessors to subsequent diagnostic information, complete 30-day follow-up, and independent outcome assessment. Histopathological confirmation in all operated patients further strengthened the final diagnosis.

Limitations

This study has several limitations. First, it was conducted at a single tertiary care center and included a relatively modest sample, which may limit generalizability. Second, a composite reference standard was required because histopathological confirmation was available only for patients who underwent appendectomy. Classification of non-operated patients by negative CT findings and/or 30-day follow-up may have introduced verification bias.

Third, dry lips were assessed by visual judgment using a predefined definition, but formal observer training and interobserver agreement were not evaluated. Observer variability therefore cannot be excluded. Fourth, dry lips are a nonspecific manifestation of dehydration and may be influenced by vomiting, reduced oral intake, fever, mouth breathing, environmental conditions, medications, or chronic lip disorders. These potential confounders were not systematically recorded. Finally, subgroup analyses, particularly among participants presenting within 12 hours, included small numbers and should be interpreted cautiously.

Conclusion

Dry lips showed moderate specificity but limited sensitivity for acute appendicitis. Although this bedside finding cannot diagnose or exclude appendicitis when used alone, it may provide useful adjunctive information when interpreted with clinical assessment and inflammatory markers, particularly CRP. As a rapid, noninvasive, and cost-free observation, dry lips may support early bedside risk stratification, especially where immediate imaging is unavailable. Larger multicenter diagnostic-accuracy studies are needed to validate these findings and clarify the role of dry lips in contemporary diagnostic pathways.

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