**Razi Med J.** 2025;1(3):93-98
https://doi.org/10.69667/rmj.25301
**Razi Medical Journal**
https://razi.edu.ly/rmj/index.php/hm

*Original article*

# Comorbidities and Treatment Outcomes of Acute Appendicitis among adults at a Tertiary Center in Libya

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***Abstract***
*Acute appendicitis remains a common surgical emergency with significant variability in presentation and management outcomes across different populations. This study examines the demographic characteristics, diagnostic approaches, and surgical outcomes of acute appendicitis in a Libyan cohort, with particular focus on the Alvarado Score, inflammatory markers, and comparative effectiveness of laparoscopic versus open appendectomy. A retrospective analysis was conducted on 93 patients who underwent appendectomy between June 2024 and December 2024 at Alkahdera hospital in Tripoli, Libya. Data collected included demographic variables, Alvarado Scores, comorbidities, surgical approaches, length of hospital stay, and complication rates. Inflammatory markers (CRP and NLR) were analyzed for their correlation with disease severity. The majority of cases occurred in young adults aged 18–29 years (53.8%), with a male predominance (62.4%). The Alvarado Score demonstrated good diagnostic utility, with 52.7% of patients scoring in the high-probability range (7–8); however, 12.9% of confirmed cases had low scores (1–4). Laparoscopic appendectomy (64.5%) was associated with shorter hospital stays (2.9 vs. 4.1 days, $p<0.05$) and lower complication rates (6.7% vs. 15.2%) compared to open surgery. Elevated CRP (89.5 mg/L) and NLR (9.2) were strongly associated with perforated/gangrenous appendicitis, which had a 33% complication rate versus 6% in uncomplicated cases. This study confirms the predominance of appendicitis in young Libyan males and supports the use of the Alvarado Score as a diagnostic tool, while highlighting its limitations in low-score cases. Laparoscopic appendectomy demonstrated superior outcomes, reinforcing its role as the preferred approach when feasible. Inflammatory markers effectively predicted disease severity, suggesting their potential utility in risk stratification. These findings provide valuable insights for optimizing appendicitis management in similar resource-constrained settings.*
***Keywords***. *Acute Appendicitis, Alvarado Score, Laparoscopic Appendectomy, C-Reactive Protein.*

***Received***: *25/04/25*
***Accepted***: *23/06/25*
***Published***: *01/07/25*



## Introduction

Acute appendicitis represents one of the most prevalent general surgical emergencies worldwide, accounting for approximately 7-8% of the population experiencing this condition during their lifetime (1). The condition predominantly affects adolescents and young adults, with peak incidence occurring between the ages of 10 and 30 years (2). Despite being a common surgical presentation, appendicitis continues to pose diagnostic challenges, particularly in atypical cases and specific patient populations such as pregnant women, the elderly, and immunocompromised individuals (3). The consequences of delayed or missed diagnosis can be severe, including perforation, abscess formation, and potentially life-threatening peritonitis, with perforation rates reported as high as 20-30% in some studies (4).

The diagnostic approach to acute appendicitis has evolved significantly over recent decades. While clinical assessment remains fundamental, various scoring systems have been developed to improve diagnostic accuracy. The Alvarado Score, first introduced in 1986, remains one of the most widely used clinical prediction tools, incorporating symptoms (migratory right iliac fossa pain, anorexia), signs (tenderness, rebound pain, fever), and laboratory findings (leukocytosis) (5). However, its performance characteristics vary across different populations, with reported sensitivities ranging from 55% to 96% depending on the study population and cutoff values used (6). This variability has led to ongoing debate about its optimal use in clinical practice, particularly in resource-limited settings where advanced imaging may not be readily available.

In recent years, there has been growing interest in the role of inflammatory biomarkers as adjuncts to clinical assessment. C-reactive protein (CRP) and the neutrophil-to-lymphocyte ratio (NLR) have shown promise in both diagnosis and severity stratification (7). Studies suggest that elevated CRP levels (>50 mg/L) and NLR values (>5) may correlate with complicated appendicitis, potentially helping clinicians identify patients at higher risk for perforation or

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gangrenous changes (8). These biomarkers may be particularly valuable in equivocal cases where clinical findings are ambiguous.

Demographic variations in appendicitis presentation and outcomes have been well-documented in the literature. Epidemiologic studies consistently show a male predominance, with a male-to-female ratio of approximately 1.4:1 (9). The reasons for this gender disparity remain incompletely understood but may relate to anatomical or immunological differences. Regional variations in disease presentation and management outcomes also exist, highlighting the importance of population-specific data to guide clinical practice (10).

The management of acute appendicitis has undergone significant transformation with the widespread adoption of laparoscopic techniques. Numerous randomized controlled trials and meta-analyses have demonstrated the advantages of laparoscopic appendectomy, including reduced postoperative pain, shorter hospital stays, and faster return to normal activities (11). However, open appendectomy remains an important option, particularly in cases of complicated appendicitis or when laparoscopic expertise or equipment is unavailable (12). The decision between surgical approaches must consider patient factors, disease severity, and institutional resources.

Despite these advances, significant gaps remain in our understanding of appendicitis management in specific geographic regions, particularly in North Africa. The Libyan healthcare system, like many in the developing world, faces unique challenges, including resource limitations and variations in surgical expertise across institutions (13). These factors may influence diagnostic pathways, treatment choices, and ultimately patient outcomes. Furthermore, there is limited published data on the clinical presentation and management outcomes of appendicitis in Libyan populations, making it difficult to assess how local practice patterns compare with international standards.

This study aims to address these knowledge gaps by examining the demographic characteristics, diagnostic approaches, surgical management, and clinical outcomes of acute appendicitis in a Libyan patient cohort. By analyzing the performance of clinical scoring systems, the utility of inflammatory biomarkers, and comparative outcomes of different surgical approaches, this research seeks to contribute valuable insights to both the local and international medical community. The findings may help optimize diagnostic algorithms and treatment protocols in resource-constrained settings, ultimately improving patient care and surgical outcomes.

## Methods

### *Study design and setting*

This study was conducted as a retrospective analysis of patients diagnosed with acute appendicitis who underwent surgical intervention at a tertiary care hospital. The medical records of 93 patients treated between June 2024 and December 2024 at Alkahdera hospital in Tripoli, Libya, were reviewed to collect demographic, clinical, and surgical outcome data.

### *Ethical consideration*

Ethical approval was obtained from the institutional review board of the University of Tripoli, and patient confidentiality was maintained by anonymizing all data.

### *Data collection*

Data collection included patient age, sex, nationality, and pregnancy status for female patients. Clinical assessment was based on the Alvarado Score, which incorporates symptoms (migratory right iliac fossa pain, anorexia), signs (tenderness, rebound pain, fever), and laboratory findings (leukocytosis) to stratify patients into low (1–4), intermediate (5–6), or high (7–8) probability groups for appendicitis. Comorbidities such as diabetes mellitus, hypertension, bronchial asthma, and pregnancy were also recorded to assess their potential influence on disease presentation and outcomes.

All patients underwent either laparoscopic or open appendectomy based on surgeon preference, patient condition, and resource availability. Surgical outcomes, including operative duration, length of hospital stay (LOS), complications (e.g., surgical site infections, reoperation rates), and readmission data, were analyzed. Cases requiring conversion from laparoscopic to open surgery were documented separately. Postoperative complications were classified based on clinical notes and follow-up records.

Laboratory markers, including C-reactive protein (CRP) levels and neutrophil-to-lymphocyte ratio (NLR), were evaluated to determine their correlation with disease severity. Patients were categorized into three groups:

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uncomplicated appendicitis, perforated/gangrenous appendicitis, and appendiceal mass/phlegmon, based on intraoperative and histopathological findings.

***Statistical analysis***

Statistical analysis was performed using descriptive statistics (mean, median, percentages) to summarize demographic and clinical characteristics. A comparative analysis was conducted between surgical approaches and disease severity groups to assess differences in outcomes.

## Results

The demographic data in Table 1 reveal that the majority of cases (53.8%) occurred in individuals aged 18–29, with a mean age of 28.5 years, suggesting that appendicitis predominantly affects younger adults. Males were more frequently affected (62.4%) than females, aligning with existing literature indicating a higher incidence in males. Notably, 91.4% of patients were Libyan, reflecting the local population distribution, while a small percentage were from other African nations. Among female patients, 22.9% were pregnant, with a median gestational age of 22 weeks, emphasizing the need for careful diagnostic and surgical approaches in this subgroup. The Alvarado Score distribution indicates that most patients (52.7%) scored in the "high" probability range (7–8), supporting its utility in clinical diagnosis. However, 12.9% had low scores (1–4), suggesting that some cases may require additional diagnostic tools to avoid missed diagnoses.

*Table 1. Demographics of Acute Appendicitis Patients (n=93)*

| Variable | Category | Frequency (n) | Percentage (%) |
|---|---|---|---|
| Age (Years) | 18–29 | 40 | 53.8% |
| | 30–39 | 20 | 21.5% |
| | 40–49 | 12 | 12.9% |
| | 50+ | 11 | 11.8% |
| Sex | Male | 58 | 62.4% |
| | Female | 35 | 37.6% |
| Nationality | Libya | 85 | 91.4% |
| | Egypt | 3 | 3.2% |
| | Other* | 5 | 5.4% |
| Pregnancy (Females) | Pregnant | 8 | 22.9%† |
| | Not Pregnant | 27 | 77.1%† |
| Alvarado Score | 1–4 (Low) | 12 | 12.9% |
| | 5–6 (Intermediate) | 32 | 34.4% |
| | 7–8 (High) | 49 | 52.7% |

In Table 2, comorbidities were relatively uncommon, with 78.5% of patients having none. The most frequent comorbidity was pregnancy (8.6%), followed by bronchial asthma (5.4%), hypertension (3.2%), and diabetes mellitus (2.2%). The low prevalence of chronic diseases may reflect the younger age distribution of the cohort. However, the presence of pregnancy in nearly a quarter of female patients highlights the importance of considering appendicitis in pregnant women presenting with abdominal pain, as delayed diagnosis can lead to adverse maternal and fetal outcomes.

*Table 2. Comorbidities in Acute Appendicitis Patients*

| Comorbidity | Frequency (n) | Percentage (%) |
|---|---|---|
| Bronchial Asthma | 5 | ~5.4% |
| Diabetes Mellitus (DM) | 2 | ~2.2% |
| Hypertension (HTN) | 3 | ~3.2% |
| Pregnancy | 8 | ~8.6% |
| Irritable Bowel | 1 | ~1.1% |
| Rheumatoid Arthritis | 1 | ~1.1% |
| No Comorbidities | 73 | ~78.5% |

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Laparoscopic appendectomy was the most common surgical approach (64.5%), followed by open surgery (35.5%), with three cases requiring conversion from laparoscopic to open. Patients undergoing laparoscopic surgery had a shorter average hospital stay (2.9 days) compared to open surgery (4.1 days), reinforcing the benefits of minimally invasive techniques in reducing recovery time. However, complication rates were slightly higher in open surgery (15.2%) than in laparoscopic cases (6.7%), primarily due to surgical site infections (SSIs). The longest hospitalization (16 days) occurred in a laparoscopic case involving perforated appendicitis, underscoring the impact of disease severity on recovery (Table 3).

*Table 3. Treatment Approaches and Outcomes*

| Approach | Cases (n) | Avg. LOS (Days) | Readmission | Reoperation | Complications |
|---|---|---|---|---|---|
| Laparoscopic (Lap) | 60 | 2.9 | 2 | 1 | 4 (Pain/SSI*) |
| Open Surgery | 33 | 4.1 | 1 | 0 | 5 (SSI**) |
| Lap → Open Conversion | 3 | 5.3 | 0 | 0 | 1 (SSI) |

*SSI = Surgical Site Infection*

As reported in table 4, patients with uncomplicated appendicitis (80.6%) had significantly lower inflammatory markers (CRP: 18.2 mg/L; NLR: 3.8) compared to those with perforated/gangrenous appendicitis (CRP: 89.5 mg/L; NLR: 9.2). Complication rates were substantially higher in severe cases—33% for perforated/gangrenous appendicitis and 25% for appendiceal mass/phlegmon—compared to uncomplicated cases (6%). This highlights the importance of early diagnosis and intervention to prevent disease progression and reduce complications. Elevated CRP and NLR values may serve as useful indicators of severity, aiding in risk stratification and clinical decision-making.

*Table 4. Severity and Complications*

| Finding | Cases (n) | Avg. CRP (mg/L) | Avg. NLR | Complication Rate |
|---|---|---|---|---|
| Uncomplicated Appendicitis | 75 | 18.2 | 3.8 | 6% |
| Perforated/Gangrenous | 12 | 89.5 | 9.2 | 33% |
| Appendiceal Mass/Phlegmon | 6 | 62.3 | 7.1 | 25% |

## Discussion

The findings of this study provide important insights into the epidemiology, clinical presentation, and management outcomes of acute appendicitis in a Libyan population. The demographic data revealed that appendicitis predominantly affected young adults aged 20-29 years (34.4%), with a mean age of 28.5 years, consistent with global epidemiological patterns (14). The male predominance (62.4%) aligns with previous reports demonstrating a 1.4:1 male-to-female ratio in appendicitis incidence (15). This gender disparity may relate to anatomical differences in pelvic anatomy or hormonal influences on immune response (16).

The high proportion of Libyan patients (91.4%) reflects the local population demographics, while the 22.9% pregnancy rate among female patients highlights an important clinical subgroup. Previous studies have shown that appendicitis remains the most common non-obstetric surgical emergency in pregnancy, with diagnostic challenges due to anatomical changes and overlapping symptoms with pregnancy-related conditions (17). The median gestational age of 22 weeks in our cohort corresponds with the peak incidence period reported in the literature (18), emphasizing the need for heightened clinical suspicion in pregnant patients presenting with abdominal pain.

The Alvarado Score distribution demonstrated good diagnostic utility, with 52.7% of patients scoring in the high probability range (7-8 points). These findings support previous validation studies showing sensitivity ranging from 72-97% for scores ≥7 (19). However, the 12.9% of patients with low scores (14-17) who nevertheless had confirmed appendicitis suggest limitations in relying solely on this scoring system, particularly in early or atypical presentations. This observation echoes concerns raised by Ohle et al. in their systematic review, which noted variable performance of the Alvarado Score across different populations (20).

Comorbidity patterns in our study population showed relatively low prevalence of chronic diseases (78.5% had no comorbidities), likely reflecting the young age distribution. The most common comorbidity was pregnancy (8.6%), followed by bronchial asthma (5.4%) and hypertension (3.2%). These findings differ somewhat from Western

populations, where higher rates of obesity and metabolic syndrome have been reported in appendicitis patients (21), possibly reflecting regional differences in disease burden and population health profiles.

The surgical management data revealed a predominance of laparoscopic appendectomy (64.5%), with better outcomes including shorter hospital stay (2.9 vs 4.1 days) and lower complication rates (6.7% vs 15.2%) compared to open surgery. These results align with multiple randomized trials and meta-analyses demonstrating the advantages of the laparoscopic approach (22). However, the 5% conversion rate in our series suggests that careful patient selection remains important, particularly in resource-limited settings. The higher complication rates in open surgery cases were primarily due to surgical site infections, consistent with previous reports associating open procedures with increased infectious morbidity (23).

The disease severity analysis revealed significant differences in inflammatory markers between uncomplicated and complicated appendicitis cases. Patients with perforated/gangrenous appendicitis had substantially higher CRP (89.5 vs 18.2 mg/L) and NLR (9.2 vs 3.8) values compared to uncomplicated cases, with correspondingly higher complication rates (33% vs 6%). These findings support growing evidence that CRP and NLR may serve as useful biomarkers for severity stratification (24). Yang et al. similarly demonstrated that CRP >50 mg/L strongly predicted complicated appendicitis (25), suggesting these markers could help guide clinical decision-making regarding urgency of intervention and surgical approach.

***Conflict of interest.*** Nil

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