



## Original Research



### Investing the Relation between Different Types of Acute Appendicitis and the Number of White Blood Cells and C-reactive Protein Level

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#### ABSTRACT

Acute appendicitis is one of the surgical emergencies that has many differential diagnoses. The accuracy of clinical diagnosis in acute appendicitis is between 76% and 92%, and the error rate in acute appendicitis diagnosis is 9.3% in men and 23.2% in women. Therefore, it is important to use paraclinical help to diagnose and cure this disease, and prevent its complications. Considering the importance of diagnosis, we decided to determine the relationship between acute appendicitis and WBC count and CRP level in patients admitted to Payambar Azam Hospital in Kerman in 2022. All patients without age limitation visited Payambar Azam Hospital in Kerman in 2022 with abdominal pain suspected to be appendicitis were included in the study. All patient information, including age, gender, neutrophils, white blood cell count, C-reactive protein level, were extracted from the files and recorded in the data collection form. After data collection, SPSS version 20 software was used for analysis. In this study, 169 patients were examined, of which 82 (48.5%) were women and 87 (51.5%) were men. The average age of the patients was  $24.28 \pm 14.62$ . According to the type of appendicitis, 86 people (50.9%) were acute, 51 people (30.2%) had purulent appendicitis, and 32 people (18.9%) had gangrene. The frequency of positive C-reactive protein, White Blood Cells above 10000, and neutrophils was statistically significant according to the type of appendicitis. Due to the fact that there is a possibility that many diseases that cause symptoms like acute appendicitis will mistakenly lead to appendectomy, the results of our study showed that by measuring CRP and counting White Blood Cells along with clinical examination, appendectomy can be performed.

**Keywords:** Acute appendicitis, C-reactive Protein, White Blood Cell.

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## INTRODUCTION

Acute appendicitis is one of the most common causes of abdominal pain, often leading patients to seek emergency care. It is predominantly diagnosed in young hospitalized patients presenting with acute abdominal complaints [1] [2].

Clinical manifestations such as right lower quadrant abdominal pain, abdominal tenderness, and pain radiating to the right lower quadrant are crucial for diagnosing acute appendicitis in adults. Conversely, the absence or reduction of bowel sounds, positive rebound tenderness, and Rovsing's sign are highly reliable indicators for diagnosing acute appendicitis in children [3]. The incidence of appendicitis ranges from 1.1 to 0.9 per 1000 individuals annually, with a lifetime risk of 6.6% in men and 7.6% in women, most commonly occurring between the ages of 25 and 35 [4]. The perforation rate varies from 16% to 40%, with higher rates observed in younger age groups (40-57) and patients over 50 years old (55-70) [5]. While the mortality rate from non-gangrenous acute appendicitis is less than 0.1%, it increases to 0.6% in cases of gangrenous appendicitis. Perforated appendicitis carries a higher mortality rate of around 5% [6]. Overall, approximately 8% of individuals experience appendicitis during their lifetime, with the highest incidence occurring between the ages of 10 and 30, and slightly more common in men than in women [1].

Early surgical intervention in acute appendicitis significantly improves outcomes. Diagnosis in patients presenting with abdominal pain relies on clinical signs and symptoms, supplemented by laboratory and radiological examinations, while ruling out other causes [1].

The presence of numerous diseases with symptoms resembling acute appendicitis has made its diagnosis challenging, often leading to

delayed or misdiagnosis and consequently increased complications or mortality [2]. Various inflammatory conditions of the urinary tract can mimic the clinical signs and symptoms of acute appendicitis [7]. Effective pain management with analgesics, non-steroidal anti-inflammatory drugs, and acetaminophen should take precedence to avoid delayed or unnecessary interventions. Appendiceal rupture may lead to sepsis, occurring in 17% to 32% of patients with acute appendicitis, with prolonged symptom duration increasing this risk. In moderate to high-risk patients, surgical consultation should be promptly sought to reduce mortality resulting from perforation [8].

Accurate diagnosis of appendicitis is essential to avoid unnecessary surgical procedures and dissatisfaction among patients with the medical staff [9] [10]. Pediatric appendicitis scores and inflammatory response markers such as white blood cell count and CRP levels are commonly used to classify patients into low, moderate, or high-risk categories, aiding timely diagnosis [4] [3]. Concerns about overtreatment, such as natural appendectomy (removal of a histologically normal appendix), which may increase postoperative complications, hospital stays, and healthcare costs compared to laparoscopic diagnostic surgery, also exist [8]. Sonographic imaging is the initial diagnostic step, followed by either open or laparoscopic appendectomy, the standard treatment for acute appendicitis. However, intravenous antibiotics may be considered as the first-line treatment in selected patients [3]. Some laboratory measures, such as WBC and CRP levels, can be used to diagnose cases with doubtful clinical and physical examination findings, potentially preventing negative appendectomies [11]. Nonetheless, these tests may also be abnormal in other



inflammatory conditions mimicking appendicitis, challenging their diagnostic accuracy. Studies assessing the value of inflammatory markers in acute appendicitis diagnosis have reported inconsistent results, with sensitivity of leukocytosis ranging from 52% to 96%, left shift sensitivity from 39% to 96%, and CRP sensitivity from 60% to 86.8% [11] [12]. In our country, several studies have been conducted on the role of CRP and WBC in diagnosing appendicitis, yielding different results, some of which emphasize the effective role of these factors in diagnosing acute appendicitis, while others suggest that measuring these factors does not have a significant role in diagnosing appendicitis [13] [14] [15]. Given the importance of this issue and the need for further studies in this regard, we conducted this study to determine the association between acute appendicitis and WBC count and CRP level in hospitalized patients at Payambar Azam Hospital in Kerman in 2021, aiming to take an effective step towards improving the diagnostic process of this disease.

## MATERIAL AND METHODS

### *Research Setting, Population, and Sample Size*

This descriptive cross-sectional study was conducted on patients visiting the Payambar Azam Hospital with abdominal pain and suspected appendicitis in Kerman in 2022. Out of the 406 patient records reviewed, 169 met the inclusion criteria and were selected for the study.

### *Inclusion and Exclusion Criteria*

Inclusion criteria encompassed all pediatric and adult patients who visited Payambar Azam Hospital with abdominal pain suspected to be appendicitis and subsequently underwent appendectomy. Patients were included if they did not have chronic diseases (renal, infectious, respiratory), were not on immunosuppressive

medications, had not been hospitalized in the past two weeks, and were not infected with COVID-19. Patients with incomplete records were excluded from the study.

### *Method and Tools for Data Collection*

Data collection involved the use of demographic information forms and clinical characteristics forms. The demographic form captured patient age and gender, while the clinical form recorded WBC count, neutrophil count, and CRP levels. The information was extracted from patient medical records by the researcher and entered into the respective forms.

### *Data Analysis Tools and Methods*

Descriptive statistics, including frequency distribution and descriptive measures, were utilized to analyze the data. Data analysis was performed using SPSS software, version 20, with a significance level set at 0.05.

## RESULTS

In this study, 169 patients were examined, of whom 82 (48.5%) were female and 87 (51.5%) were male. The mean age of the patients was  $24.28 \pm 14.62$  years. Regarding the type of appendicitis, 86 patients (50.9%) had acute appendicitis, 51 (30.2%) had purulent appendicitis, and 32 (18.9%) had gangrenous appendicitis. In terms of WBC count, 51 patients (30.2%) had a count less than 10,000, and 118 patients (69.8%) had a count greater than 10,000. 44 patients (26%) had a neutrophil percentage of less than 70%, and 125 patients (74%) had more than 70% neutrophil. Additionally, 103 patients (60.9%) tested positive for CRP, while 66 (39.1%) tested negative.

The frequency of acute appendicitis was higher in females (58.1%) compared to males (41.9%), while purulent appendicitis was more



common in males (51%) compared to females (49%). Gangrenous appendicitis was also more prevalent in males (62.5%) compared to females (37.5%). However, these differences were not statistically significant (Table 1).

Although the age of patients in the purulent appendicitis group was higher than that in the acute and gangrenous groups, this difference was not statistically significant (Table 1).

**Table 1**

*Comparison of types of appendicitis based on gender and age*

Acute appendicitis		Purulent appendicitis	Gangrenous appendicitis	P.V.
Sex	male	36 (41.9%)	26 (51%)	0.12
	female	50 (58.1%)	12 (37.5%)	
Age		23.48±13.93	26.7 ±14.21	0.12

The frequency of positive CRP, WBC count higher than 10000, and neutrophil count higher

than 70% between different types of appendicitis was statistically significant (Table 2).

**Table 2**

*Frequency of laboratory tests in different kinds of appendicitis*

Acute appendicitis		Purulent appendicitis	Gangrenous appendicitis	P.V.
CRP count	positive	41 (47.7%)	37 (72.5%)	0.001
	negative	45 (52.3%)	14 (27.5%)	
WBC count	<10000	39 (45.3%)	9 (17.6%)	0.001
	>10000	47 (54.7%)	29 (90.6%)	
Neutrophil	<70%	32 (37.2%)	10 (19.6%)	0.001
	>70%	54 (62.8%)	41 (80.4%)	

## DISCUSSION

Acute appendicitis remains one of the most common causes of emergency surgery, with approximately 7% of the population requiring appendectomy during their lifetime due to this condition [9] [16] [17]. The incidence is highest in the second and third decades of life, with a slightly higher prevalence in men compared to women, and an overall mortality rate of about 3%. In cases of perforation, acute appendicitis can lead to life-threatening complications such as bacterial peritonitis, sepsis, and abdominal abscesses, with mortality rates reaching up to 80% if left untreated. Therefore, timely

diagnosis and surgical intervention are crucial to reducing mortality. Clinical diagnostic accuracy for acute appendicitis ranges from 76% to 92%, with misdiagnosis rates of 9.3% in men and 23.2% in women [9] [16].

Our study comprised 169 patients, with a slight male predominance (51.5% male and 48.5% female), and an average age of  $24.28 \pm 14.62$  years. This demographic distribution aligns with previous studies by Pakzad et al. in 2019 [7], Khorrami et al. in 2011 [15], and Rezaei et al. in 2004 [13], which also reported a higher incidence of appendicitis in males. The pathological examination revealed that 50.9%



had acute appendicitis, 30.2% had suppurative appendicitis, and 18.9% had gangrenous appendicitis. These findings are consistent with previous research, indicating a significant proportion of patients present with more advanced stages of the disease at the time of surgery [7] [14].

Inflammatory markers such as WBC count and CRP levels are valuable in diagnosing acute appendicitis. Our study demonstrated that mean WBC count and CRP levels were significantly higher in patients with acute and perforated appendicitis compared to those with normal appendices. This observation is supported by other studies, which also found elevated WBC and CRP levels in patients with appendicitis [7] [18] [19].

The CRP, synthesized by the liver in response to tissue injury, peaks 24-48 hours after the onset of inflammation and remains elevated as long as the tissue injury or infection persists. Previous studies have indicated that elevated CRP levels, in combination with WBC counts, can enhance diagnostic accuracy and reduce the rates of negative appendectomies and perforations [20] [19] [21]. In our study, 92.6% of patients with acute appendicitis had a positive CRP, which aligns with findings from other studies [20] [13]. The diagnostic accuracy of acute appendicitis based on clinical symptoms ranges from 76% to 92%, with inflammatory markers playing a crucial role in ambiguous cases. Although elevated CRP and WBC counts are associated with acute appendicitis, their diagnostic utility is most pronounced when combined with clinical evaluation. As indicated by Shakhathreh in 2000 [22], while laboratory findings are valuable, they should complement rather than replace clinical judgment. Overall, our findings support the continued use of CRP and WBC counts as part of the diagnostic process for acute appendicitis. However, the skillful integration of clinical

assessment with these markers remains essential for accurate diagnosis and optimal patient outcomes.

## CONCLUSION

Given that many diseases can present with symptoms similar to acute appendicitis, potentially leading to unnecessary appendectomies, our study highlights the importance of combining CRP measurement and WBC count with clinical examination. This integrated approach enhances the timely diagnosis of acute appendicitis, allowing for prompt surgical intervention. Consequently, this strategy helps prevent complications, therefore reducing both mortality and morbidity associated with delayed or incorrect diagnosis.

## Ethical Considerations

Participant information was kept strictly confidential, and only credible and reliable sources were utilized. The latest research methodologies were employed, ensuring that ethical considerations in the use of resources and research articles were strictly adhered to. This study was reviewed and approved by the Ethics Committee of the Kerman Azad University of Medicine, Iran, under the registration number IR.IAU.KERMAN.REC.1401.012.

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## Transparency declaration

There is no conflict of interests.

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