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ORIGINAL ARTICLE

Complicated appendicitis in pediatric age group: The challenge of timely identification.

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ABSTRACT… Objective: To determine the frequency of factors associated with delayed presentation of complicated appendicitis in pediatric patients. **Study Design:** Prospective Cross-sectional study. **Setting:** Department of Pediatric Surgery, Allied Hospital Faisalabad, A Tertiary Care Hospital. **Period:** 23-08-2024 to 22-02-2025. **Methods:** Included 60 pediatric patients aged 3–12 years diagnosed with complicated appendicitis. Consecutive sampling was used based on predefined criteria. Data were collected through parental interviews and medical records. Factors analyzed included demographics, clinical presentation, misdiagnosis, mistreatment, socioeconomic barriers, parental refusal, and healthcare access. **Results:** Most patients (58.3%) were aged 8–12 years, and 63.3% were male. Low socioeconomic status (40.0%), misdiagnosis by physicians (60.0%) and pediatricians (23.3%), mistreatment by quacks (26.7%), and self-medication (35.0%) contributed to delays. Financial constraints (51.7%), parental refusal of surgery (33.3%), lack of awareness (36.7%), and unavailability of pediatric surgeons (36.7%) further delayed diagnosis. Complications included peritonitis (31.7%), perforation (25.0%), abscess/mass (23.3%), and gangrene (20.0%). Postoperative complications and prolonged hospital stays occurred in 28.3%, while 43.3% fully recovered. **Conclusion:** Delayed presentation of complicated appendicitis in pediatric patients is influenced by misdiagnosis, mistreatment, financial barriers, and healthcare access issues. Early recognition, improved care access, and parental education can reduce morbidity and financial burdens.

Key words: Complicated Appendicitis, Diagnostic Delay, Pediatric Population, Pediatric Surgery.

INTRODUCTION

Acute appendicitis (AA) is a common abdominal surgical emergency in children[1], classified into uncomplicated appendicitis (UA) and complicated appendicitis (CA). CA is associated with a poorer prognosis and may lead to severe complications such as appendiceal gangrene, perforation, or periappendiceal abscess.[2] However, the reported incidence in young children is comparatively low.[3]

Efforts to improve the early diagnosis of complicated appendicitis (CA) in young children have faced persistent challenges.[4] While laboratory markers such as white blood cell count (WCC), C-reactive protein (CRP), calprotectin (Cal) and total bilirubin (TBil) have been valuable in adult cases, their diagnostic accuracy in pediatric patients is limited.[5] Imaging techniques provide some assistance, but ultrasound lacks specificity, and computed tomography (CT) raises concerns due to radiation exposure in young children.[6-7] Similarly, the Pediatric Appendicitis Score (PAS), though commonly used, is not always reliable, especially in cases with atypical symptoms.[8] These challenges highlight the urgent need for improved diagnostic tools and strategies to enhance early identification of CA in pediatric patients.

Healthcare provider-related factors, including the experience level, specialty, utilization of diagnostic modalities, and adherence to guidelines also contribute to diagnostic timeliness.[9-10] Variations in clinical practice, availability of resources, and access to specialized care may influence the efficiency of diagnostic evaluation and management. Furthermore, parental/caregiver-related factors, such as health-seeking behavior,

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awareness, perceived severity of symptoms, and healthcare access barriers, play a significant role in the diagnostic process.[11-12] Parental recognition of symptoms, prompt seeking of medical attention, and adherence to healthcare recommendations are essential for timely diagnosis and optimal outcomes.

To summarize, acute appendicitis if not timely diagnosed and timely managed accordingly will result in delayed presentation to hospital with complications like perforation, gangrene, abscess formation, peritonitis which in turn will result in difficult surgery, prolong recovery, longer hospital stay and increase financial burden on patients and hospitals. The aim of our study is to determine the frequency of factors that are associated with delayed presentation of appendicitis in pediatric population.The result will help in reducing morbidity and mortality of the patients to reduce the hospital stay thereby reducing the financial burden of patients and hospitals.

METHODS

This study employed a cross-sectional descriptive prospective design to determine the frequency of factors associated with the delayed presentation of complicated appendicitis in pediatric patients. The study was conducted at the Department of Pediatric Surgery, Allied Hospital Faisalabad, a tertiary care hospital. The total duration of the study was six months, commencing after approval from the Ethical Review Committee (ERC). (48ERC/FMU/2023-24/510)

Based on the inclusion/exclusion criteria, we enrolled 60 pediatric patients, aged 3 to 12 years, diagnosed with complicated appendicitis. The sampling technique used was consecutive sampling, enrolling all eligible pediatric patients who met the inclusion criteria during the study period.The inclusion criteria for the study consisted of all confirmed cases of complicated appendicitis presenting to the pediatric surgical floor. Both male and female patients within the defined age range were included. The exclusion criteria involved patients who had undergone any previous abdominal surgery due to intestinal obstruction or perforation. Additionally, patients who were immunocompromised or had comorbid conditions such as diabetes mellitus or those receiving steroids were excluded from the study.

Data collection commenced following ethical approval and informed consent from the parents or legal guardians of all participants. Each eligible patient was consecutively enrolled to minimize selection bias. The study's purpose, procedures, potential risks, and benefits were thoroughly explained to the guardians before participation. Data were gathered using a standardized data collection form designed to capture demographic information (age, gender, socioeconomic status), clinical presentation (symptoms and duration), diagnostic modalities used, previous treatment facilities visited, and patient outcomes. Patients with delayed presentations of appendicitis were assessed regarding factors contributing to the delay, and the information was systematically recorded.

The primary mode of data collection involved direct interviews with parents or guardians and a review of medical records. All collected data was analyzed using SPSS Version 22, with findings compared to available local and international literature on the subject.

RESULTS

The study included 60 pediatric patients diagnosed with complicated appendicitis. The age distribution showed that 41.7% (n=25) of patients were between 3-7 years, while the remaining 58.3% (n=35) were aged 8-12 years. Males comprised 63.3% (n=38) of the study population, whereas females accounted for 36.7% (n=22). The socioeconomic status of the patients varied, with 40.0% (n=24) belonging to the low socioeconomic class, 36.7% (n=22) from the middle class, and 23.3% (n=14) from the high socioeconomic class. This distribution suggests that complicated appendicitis is more common in children from lower socioeconomic backgrounds.

Several factors contributed to the delayed presentation of patients with complicated appendicitis. Among these, misdiagnosis by healthcare professionals played a significant

role, with 60.0% (n=36) of cases initially diagnosed by a physician, while 23.3% (n=14) were misdiagnosed by a pediatrician, and 16.7% (n=10) by a general surgeon. Regarding mistreatment, 38.3% (n=23) of patients did not receive any proper treatment, but 26.7% (n=16) consulted quacks, and 35.0% (n=21) practiced self-medication before seeking proper medical care.Economic constraints also influenced patient care, with 51.7% (n=31) of families citing non-affordability as a major barrier, while 48.3% (n=29) did not face financial constraints. Additionally, 33.3% (n=20) of patients or their attendants initially refused surgery, whereas 66.7% (n=40) agreed to undergo surgery without hesitation. Lack of awareness about specialized healthcare facilities contributed to delays, as 36.7% (n=22) of families were unaware of the appropriate facility for treatment, while 63.3% (n=38) had adequate knowledge. Furthermore, the non-availability of pediatric surgeons at primary and secondary healthcare facilities was reported in 36.7% (n=22) of cases, contributing to treatment delays, while 63.3% (n=38) had access to a pediatric surgeon at the time of presentation.

The study also assessed the types of complications observed in patients with delayed appendicitis presentations. The most common complication was peritonitis, occurring in 31.7% (n=19) of cases, followed by perforation in 25.0% (n=15) of cases. Peri-appendicular abscess/ mass was identified in 23.3% (n=14) of patients, while gangrene of the appendix was noted in 20.0% (n=12) of cases. These findings indicate that delayed diagnosis often leads to severe intra-abdominal infections requiring extensive surgical intervention. Regarding patient outcomes, 28.3% (n=17) of cases experienced post-operative complications, while another 28.3% (n=17) required a prolonged hospital stay due to their severe condition. However, 43.3% (n=26) of patients fully recovered without significant complications. These findings highlight the importance of early detection and timely intervention in preventing severe complications and reducing morbidity associated with complicated appendicitis in pediatric patients.

Variable		Frequency	Percent
Age	3-7 years	25	41.7%
	8-12 years	35	58.3%
Gender	Male	38	63.3%
	Female	22	36.7%
Socioeconomic Status	High	14	23.3%
	Middle	22	36.7%
	Low	24	40.0%

Table-I. Demographics of the patients(n=60)

Variable		Frequency	Percent
Misdiagnosed By	General Surgeon	10	16.7%
	Physician	36	60.0%
	Pediatrician	14	23.3%
Mistreatment By	None	23	38.3%
	Quack	16	26.7%
	Self-Medication	21	35.0%
Non Affordability	Yes	31	51.7%
	No	29	48.3%
Refusal of Surgery	Yes	20	33.3%
	No	40	66.7%
Lack of Knowledge of Facility/ Specialty	Yes	22	36.7%
	No	38	63.3%
Non-availability of Pediatric Surgeon	Yes	22	36.7%
	No	38	63.3%

Table-II. Factors associated with delayed presentation or complicated appendicitis

Variable		Frequency	Percent
Type of Complication	Gangrene	12	20.0%
	Perforation	15	25.0%
	Peri-appendicular Abscess/ Mass	14	23.3%
	Peritonitis	19	31.7%
Final Outcome	Post-op Complications	17	28.3%
	Prolonged Hospital Stay	17	28.3%
	Recovery	26	43.3%

Table-III. Type of complications and outcome of the patients

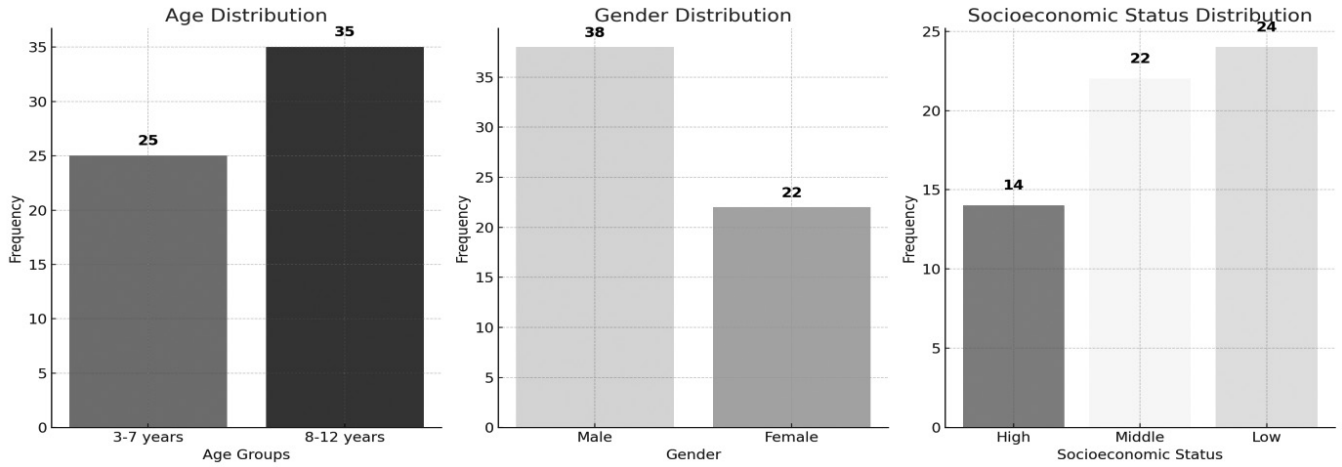

Figure-1: Demographic Information

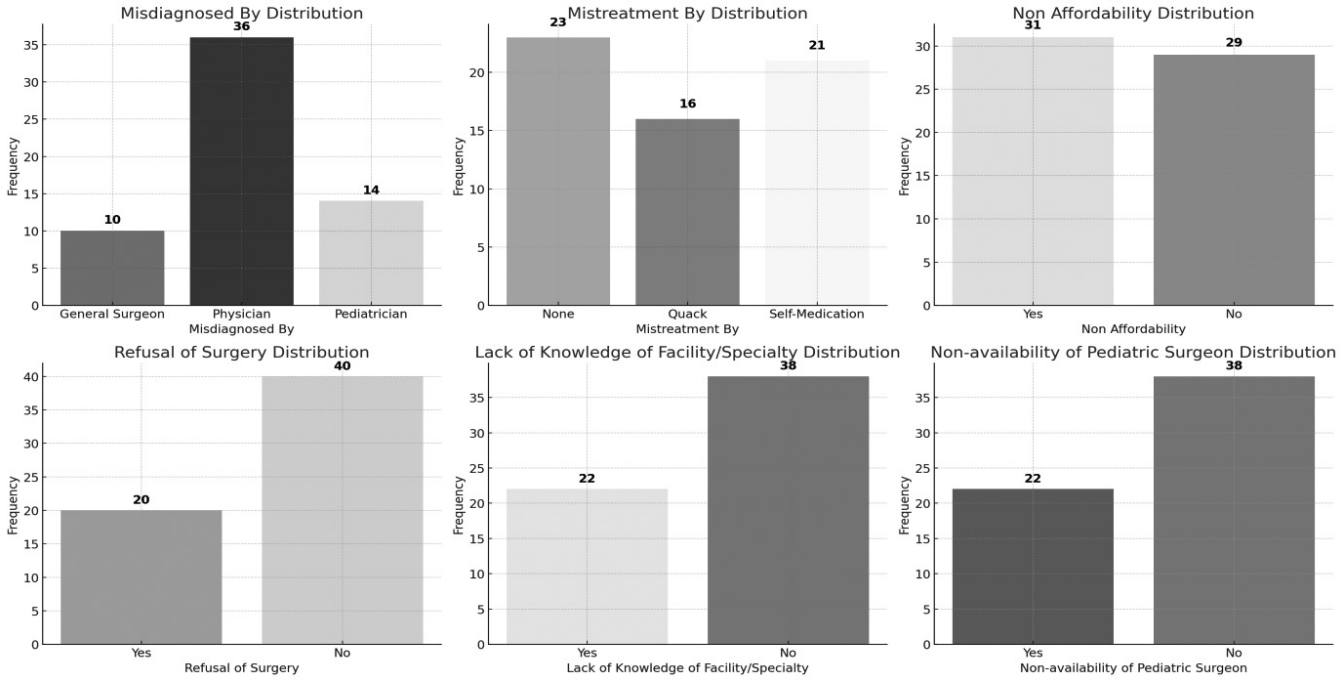

Figure-2: Factors associated with delayed presentation or complicated appendicitis

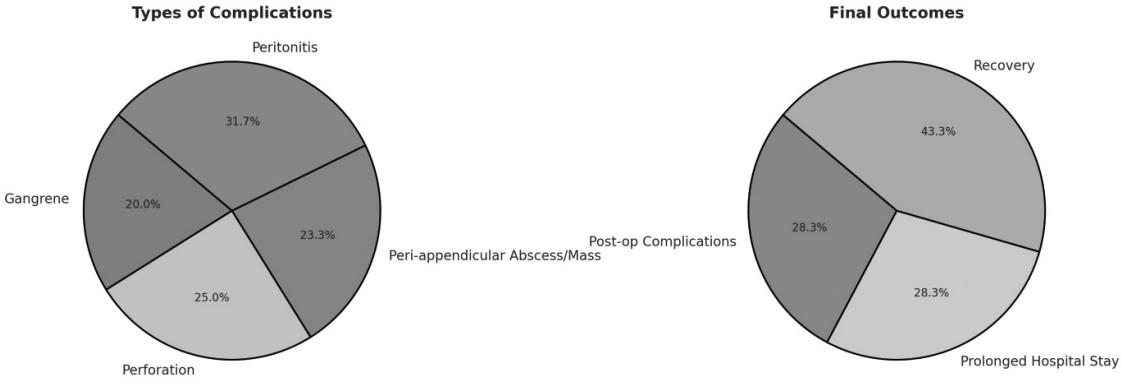

Figure-3: Type of complications and outcome of the patients

DISCUSSION

The present study aimed to determine the frequency and contributing factors associated with the delayed presentation appendicitis leading to complicated appendicitis in pediatric patients. Our findings highlight that delayed diagnosis is common in younger children, particularly those from lower socioeconomic backgrounds. Various factors, including misdiagnosis, financial constraints, lack of awareness, and limited access to specialized healthcare facilities, played significant roles in delaying appropriate treatment. While our findings align with several previous studies, notable differences were also observed, reflecting variations in study populations, healthcare systems, and diagnostic approaches.

Our study found that delayed diagnosis of complicated appendicitis was more prevalent in younger children, with 41.7% of cases occurring in the 3-7 years age group and 58.3% in the 8-12 years age group. This finding is consistent with studies by Michelson et al[13] and Paran et al[14] which also reported that younger children often experience diagnostic delays due to atypical clinical presentations. Similar to Michelson et al[13] our study found that misdiagnosis by healthcare professionals was a major factor contributing to delays. We observed that 60.0% of cases were initially diagnosed by a physician, 23.3% by a pediatrician, and 16.7% by a general surgeon, highlighting the challenge of early recognition. This supports Michelson et al.'s conclusion that children with delayed diagnosis often present with milder symptoms, leading to underestimation of appendicitis severity.

Financial constraints also played a significant role in delayed presentation, with 51.7% of families citing economic difficulties in accessing timely medical care. This finding aligns with the studies of Roy et al[15] and Naseem Khan et al[16] both of whom reported that children from low-income backgrounds were more likely to present with advanced stages of appendicitis due to financial barriers. Furthermore, our study found that a significant number of patients (35.0%) practiced self-medication, while 26.7% consulted unqualified practitioners (quacks) before seeking proper care. Roy et al. also noted that misinformation and healthcare literacy influenced treatment delays, further supporting our findings.

Similar to previous studies[13-15], our results demonstrated that delays in presentation lead to more severe complications. We found that peritonitis occurred in 31.7% of cases, perforation in 25.0%, peri-appendicular abscess/mass in 23.3%, and gangrene in 20.0%. This is in agreement with Roy et al[15] who also reported high rates of appendicular perforation and abscess formation in delayed cases. Michelson et al[13] found that children with delayed diagnosis had significantly higher odds of perforation (OR: 7.8) and prolonged hospital stays (mean difference: 2.8 days), which is consistent with our observation that 28.3% of patients experienced post-operative complications, and another 28.3% required prolonged hospitalization.

Despite these agreements, some differences were observed between our findings and previous studies. While Michelson et al[13] reported that pain localization, particularly right lower quadrant pain, was a key distinguishing factor in delayed cases, our study did not find a strong correlation between specific symptoms and delayed diagnosis. Instead, we observed that misdiagnosis occurred even when symptoms were suggestive of appendicitis, indicating potential gaps in diagnostic accuracy among healthcare providers in our setting.

Another notable difference was in the role of healthcare accessibility. While Michelson et al[13] found that many delayed cases involved patients who did not undergo indicated imaging at the first emergency department visit, our study found that the primary issue was the availability of specialized pediatric surgeons. We observed that 36.7% of cases experienced delays due to the unavailability of pediatric surgeons at primary and secondary healthcare facilities. Paran et al[14] also reported similar findings, emphasizing that younger children with atypical appendicitis presentations were often misdiagnosed and managed conservatively before being referred to specialized centers. However, our proportion of

delayed referrals was somewhat lower than that reported in Michelson et al[13] suggesting that while specialist availability remains a challenge, delays in imaging and diagnostic testing may be a more significant issue in other healthcare settings.

A significant reason for the disagreement with previous studies could be differences in healthcare infrastructure and physician expertise between study settings. Studies conducted in high-resource healthcare settings, such as Michelson et al[13] often have better access to diagnostic tools and imaging modalities, allowing for earlier detection of appendicitis in unclear cases. In contrast, our study was conducted in a resource-limited setting, where reliance on clinical diagnosis is higher due to the restricted availability of imaging and laboratory investigations. This difference highlights the need for context-specific approaches to addressing delayed diagnosis, as solutions effective in high-resource settings may not be directly applicable to low-resource environments.

Additionally, our study found that 43.3% of patients fully recovered without significant complications despite delayed diagnosis, which contrasts with Michelson et al., who reported significantly higher odds of multiple surgical procedures in delayed cases (OR: 8.0). This suggests that while delays contribute to complications, differences in surgical management protocols and post-operative care may influence patient outcomes across different institutions. The variation in findings underscores the importance of developing tailored interventions that consider local healthcare realities.

Our study provides valuable insights into the specific factors influencing delayed presentation of complicated appendicitis in a resource-limited setting. Unlike many previous studies that focused on tertiary care settings, we included patients from a public-sector hospital, capturing a broader range of socioeconomic and healthcare accessibility issues. The use of consecutive sampling helped reduce selection bias, ensuring that our findings reflect real-world challenges faced by pediatric patients and their caregivers.

Another strength of our study is the detailed assessment of multiple contributing factors, including financial constraints, healthcare literacy, and access to specialized surgical care. By identifying both patient-related and system-related barriers, our study highlights key areas for intervention to reduce delays in appendicitis diagnosis and management.

Additionally, our study provides a comparative analysis of delayed and timely cases, enabling us to assess the impact of delayed diagnosis on clinical outcomes. The inclusion of post-operative complications and hospital stay duration as outcome measures strengthens our ability to evaluate the long-term consequences of diagnostic delays.

Despite its strengths, our study has certain limitations. The sample size of 60 pediatric patients is relatively small compared to previous studies. This limited sample size may affect the generalizability of our findings.

Our study was also conducted at a single institution, which may not fully represent the variability in healthcare access and diagnostic practices across different regions. A multicenter study would provide a more comprehensive understanding of the factors influencing delayed presentation in different healthcare settings.

Furthermore, while we identified financial constraints as a major factor, we did not conduct an in-depth economic analysis to quantify the cost burden of delayed diagnosis and treatment. Future studies incorporating cost-effectiveness analysis would be beneficial in designing healthcare policies aimed at reducing delays.

CONCLUSION

This study highlights the significant impact of delayed diagnosis on complicated appendicitis in pediatric patients, emphasizing that multiple factors contribute to treatment delays. Our findings align with previous research in recognizing misdiagnosis, financial constraints, and healthcare accessibility as major contributors to late presentation. However, key differences

were noted, particularly in the role of pain localization, healthcare infrastructure, and the influence of limited diagnostic resources in our setting compared to studies conducted in high-resource environments.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Muhammad Mughees Anjum:** Data collection, manuscript writing.
2	**Samreen Jamil:** Core concept, manuscript writing, proof reading.
3	**Ikramullah Khan:** Data analysis, manuscript writing.
4	**Sadaqat Ali:** Data analysis, proof reading.