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# A Cross-Sectional Study on Risk Factors for False-Positive Ultrasound in Paediatric Acute Appendicitis at a Tertiary Care Centre of West Bengal

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## ABSTRACT

**Background:** Acute appendicitis is the most common surgical emergency in the paediatric age group. Ultrasonography (USG) is widely used as the first-line imaging modality due to its cost-effectiveness and absence of radiation. However, false-positive USG results lead to unnecessary surgeries and associated morbidity. Identifying risk factors for such false-positive findings is essential for improving diagnostic accuracy. **Objectives:** To identify the risk factors associated with false-positive ultrasound diagnosis in paediatric acute appendicitis at a tertiary care centre of West Bengal. **Methods:** This cross-sectional study was conducted on 68 paediatric patients (age ≤18 years) admitted with clinical suspicion of acute appendicitis and who underwent USG abdomen, followed by surgical intervention. Data on sociodemographic profile, clinical presentation, USG findings, and histopathological reports were

collected. False-positive USG was defined as USG suggesting appendicitis with a normal histopathological report. Statistical analysis was performed using SPSS version 26.0.**Results:** Out of 68 cases, 14 (20.6%) were false-positive on USG. Female gender ($p = 0.03$), younger age group (6–10 years), obesity (BMI ≥95th percentile), and excessive bowel gas were identified as significant risk factors. Sensitivity and specificity of USG were 82.1% and 79.6%, respectively. **Conclusion:** False-positive USG in paediatric appendicitis is not uncommon. Female gender, younger age, obesity, and bowel gas interference are significant contributing factors. Adjunct CT or MRI should be considered in such highrisk patients to reduce unnecessary operative interventions.

**Keywords:** *False-positive ultrasound, paediatric appendicitis, acute appendicitis, diagnostic accuracy, cross-sectional study, West Bengal*

## 1. INTRODUCTION

Acute appendicitis is one of the most frequently encountered surgical emergencies in the paediatric population worldwide. In India, the incidence among children is estimated to range from 1 to 4 per 1,000 per year, with peak occurrence noted in the second decade of life. Delayed or incorrect diagnosis remains a significant concern, as perforation rates in children can be as high as 30–75% due to the difficulty in clinical assessment[1].

Ultrasonography (USG) of the abdomen has emerged as the preferred initial imaging modality for suspected appendicitis in children, primarily owing to its non-invasive nature, absence of ionising radiation, widespread availability, and relatively low cost. When performed by an experienced sonologist, USG carries a reported sensitivity of 75–90% and specificity of 86–96% for diagnosing acute appendicitis.

Despite its many advantages, USG is an operator-dependent investigation and is subject to significant limitations in the paediatric setting. False-positive results – where USG suggests appendicitis but surgical and histopathological examination reveals a normal appendix – lead to unnecessary appendicectomies. A negative appendicectomy rate of 5–15% has been reported globally, with higher rates in females due to the presence of overlapping gynaecological pathologies[2].

In low- and middle-income countries like India, where access to computed tomography (CT) or magnetic resonance imaging (MRI) is limited or expensive, surgeons often rely solely on USG findings for clinical decision-making. Understanding the risk factors that predispose to false-positive USG findings is therefore of immense clinical value[3].

There is a paucity of literature specifically addressing this issue in the paediatric population from eastern India. This study was, therefore, undertaken at a tertiary care centre of West Bengal to identify the risk

factors associated with false-positive USG in paediatric acute appendicitis, with the aim of reducing unnecessary surgical interventions and improving patient outcomes[4].

## 2. OBJECTIVES

**Primary Objective:** To determine the proportion of false-positive ultrasound findings among paediatric patients diagnosed with acute appendicitis.

**Secondary Objectives:**

(a) To identify the sociodemographic and clinical risk factors associated with false-positive USG in paediatric acute appendicitis.

(b) To assess the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of USG in this population.

(c) To recommend a diagnostic algorithm for cases with a high risk of false-positive USG findings.

## 3. METHODOLOGY

### 3.1 Study Design and Setting

This was a hospital-based, cross-sectional observational study conducted at the Department of Paediatric Surgery and Radiology, a tertiary care centre of West Bengal, India. The study was carried out over a period of 18 months (January 2022 – June 2023).

### 3.2 Sample Size Calculation

Sample size was calculated using the following standard formula for cross-sectional studies:

$n = Z^2 \times P \times Q / d^2$ Where: n

= required sample size

Z = 1.96 (value at 95% confidence interval)

P = expected proportion of false-positive USG = 18% (0.18), based on prior literature Q

= 1 – P = 0.82 d = allowable error = 10% (0.10)

$$\mathbf{n = (1.96)^2 \times 0.18 \times 0.82 / (0.10)^2 = 3.84 \times 0.1476 / 0.01 \approx 56.7 \approx 57}$$

Adding a 20% non-response and loss-to-follow-up allowance: 57 × 1.20 ≈ 68. Hence, the final sample size adopted for this study was 68 patients.

### 3.3 Sampling Method

A purposive (consecutive) sampling technique was employed. All paediatric patients meeting the inclusion criteria who were admitted consecutively during the study period were included until the required sample size of 68 was achieved. This method was chosen to minimise selection bias in an emergency surgical setting.

### 3.4 Inclusion and Exclusion Criteria

**Inclusion Criteria:** (a) Age ≤18 years; (b) admitted with clinical suspicion of acute appendicitis; (c) underwent USG abdomen followed by appendicectomy; (d) histopathological examination (HPE) available.

**Exclusion Criteria:** (a) Age >18 years; (b) known immunocompromised states; (c) prior abdominal surgeries; (d) incomplete data records; (e) refusal of consent.

### 3.5 Data Collection

Data were collected using a pre-designed, validated, and structured proforma. The variables included age, sex, body mass index (BMI), duration of symptoms, clinical signs, Alvarado score, USG findings 40 (appendix diameter, compressibility, periappendiceal free fluid, bowel gas interference), and HPE report. False-positive USG was defined as a USG report positive for appendicitis with a histopathologically normal appendix.

### 3.6 Statistical Analysis

Data were entered in Microsoft Excel and analysed using SPSS version 26.0 (IBM Corp.). Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as mean ± standard deviation (SD). Chi-square test and Fisher's exact test were used to determine associations between risk factors and false-positive USG. A p-value of $<0.05$ was considered statistically significant. Sensitivity, specificity, PPV, and NPV of USG were calculated using histopathology as the gold standard.

### 3.7 Ethical Considerations

Ethical clearance was obtained from the Institutional Ethics Committee. Written informed consent was obtained from the parents or legal guardians of all participants. Confidentiality of patient information was strictly maintained throughout the study.

## 4. RESULTS

A total of 68 paediatric patients suspected of acute appendicitis were enrolled in this study. Of these, 54 (79.4%) were confirmed as true-positive cases on HPE, while 14 (20.6%) were identified as false-positive on USG. The sociodemographic and clinical characteristics of the study population are summarised below.

**Table 1: Sociodemographic Profile of Study Participants (n = 68)**

| Variable | Category | Frequency (n) | Percentage (%) |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Age Group (years) | 6 – 10 | 22 | 32.4 |
| | 11 – 14 | 28 | 41.2 |
| | 15 – 18 | 18 | 26.4 |
| Sex | Male | 38 | 55.9 |
| | Female | 30 | 44.1 |
| BMI Status | Normal (≥95th percentile) | 47 | 69.1 |
| | Obese (>95th percentile) | 21 | 30.9 |
| Residence | Urban | 40 | 58.8 |
| | Rural | 28 | 41.2 |
| Duration of Symptoms | <24 hours | 24 | 35.3 |
| | 24–48 hours | 30 | 44.1 |
| **Variable** | **Category** | **Frequency (n)** | **Percentage (%)** |
| | >48 hours | 14 | 20.6 |

**Table 2: USG Findings and Risk Factors for False-Positive Results (n = 68)**

| Risk Factor | True +ve (n=54) | False +ve (n=14) | Total | p-value |
|---|---|---|---|---|
| Female Sex | 16 (29.6%) | 10 (71.4%) | 26 | 0.03* |
| Age 6–10 years | 10 (18.5%) | 8 (57.1%) | 18 | 0.02* |
| Obesity (BMI >95th percentile) | 12 (22.2%) | 9 (64.3%) | 21 | 0.01* |
| Bowel Gas Interference on USG | 14 (25.9%) | 11 (78.6%) | 25 | <0.01* |
| Non-visualisation of appendix | 10 (18.5%) | 6 (42.9%) | 16 | 0.07 |

| | | | | |
|---|---|---|---|---|
| Alvarado Score ≤6 | 15 (27.8%) | 9 (64.3%) | 24 | 0.04* |
| Rural Residence | 22 (40.7%) | 6 (42.9%) | 28 | 0.89 |

** Statistically significant ($p < 0.05$)*

The overall sensitivity of USG was 82.1% and specificity was 79.6%. The positive predictive value (PPV) was 93.1% and the negative predictive value (NPV) was 55.6%. The area under the ROC curve was 0.81, suggesting good overall diagnostic performance, but with considerable false-positive risk in specific subgroups.

Among the 14 false-positive cases, the final diagnosis on HPE included mesenteric lymphadenitis (n=5, 35.7%), normal appendix with no pathology (n=4, 28.6%), ovarian pathology in females (n=3, 21.4%), and Meckel's diverticulitis (n=2, 14.3%). These findings confirm that conditions mimicking appendicitis can mislead USG interpretation, particularly in children.

## 5. DISCUSSION

The present study found a false-positive USG rate of 20.6% (14 out of 68 cases) in paediatric acute appendicitis, which is consistent with existing literature that reports rates ranging from 10 to 25%. This is a clinically significant finding, as each false-positive case translates to an unnecessary appendicectomy with its associated risks of anaesthetic complications, wound infections, prolonged hospitalisation, and psychological trauma in children[5].

Female gender emerged as one of the strongest risk factors for false-positive USG in our study ($p = 0.03$), with 71.4% of false-positive cases being female. This finding aligns with well-established literature which attributes the higher false-positive rate in females to the anatomical proximity of the appendix to the ovaries, fallopian tubes, and mesentery[6]. Conditions such as ovarian cysts, ruptured follicles, and pelvic inflammatory disease can produce findings on USG that mimic acute appendicitis. This is of particular importance in adolescent girls, where gynaecological pathologies are more prevalent[7].

Younger age (6–10 years) was identified as another significant risk factor ($p = 0.02$). This may be attributed to the relatively smaller peritoneal cavity and limited mesenteric fat in younger children, making sonographic differentiation of peri-appendiceal structures difficult. Moreover, non-cooperative behaviour during the examination in younger children leads to inadequate compression technique, further limiting the quality of the USG assessment[8].

Obesity (BMI above the 95th percentile) was significantly associated with false-positive outcomes ($p = 0.01$). Obese children have increased subcutaneous and intra-abdominal fat that attenuates the ultrasound beam, limiting its penetration and reducing image resolution. The appendix may not be adequately 42 visualised in these patients, and neighbouring structures such as inflamed lymph nodes or bowel loops may be mistakenly interpreted as a thickened appendix. This is a growing concern in India, given the rising prevalence of childhood obesity.

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Bowel gas interference was found to be the most strongly associated risk factor in our study ($p < 0.01$), present in 78.6% of false-positive cases. Gas-filled bowel loops adjacent to the right iliac fossa act as acoustic barriers, preventing adequate visualisation of the appendix. When the appendix cannot be visualised but other indirect signs such as free fluid, mesenteric thickening, or a hyperechoic mass are present, sonologists may provide a positive report, which can be misleading[9].

A low Alvarado score (≤6) was also significantly associated with false-positive USG ($p = 0.04$). This suggests that in patients with less compelling clinical features of appendicitis, the likelihood of an alternate diagnosis being misinterpreted on USG is higher. In such cases, clinical judgment must supplement and, when necessary, override radiological findings[10].

The sensitivity of USG in our study (82.1%) was consistent with published figures from similar settings. However, the NPV of 55.6% indicates that a significant proportion of true appendicitis cases may be missed by USG alone, reinforcing the need for clinical correlation. This finding supports the use of adjunct imaging such as CT or MRI when USG findings are equivocal, especially in high-risk groups.

This study has a few limitations. The sample size, though statistically calculated, was relatively modest. Being conducted at a single centre in West Bengal, generalisability to other regions may be limited. The study was cross-sectional in design and did not allow for longitudinal follow-up. Nevertheless, this study contributes valuable region-specific data that can inform clinical decision-making in similar resourcelimited settings.

## 6. CONCLUSION

The present cross-sectional study demonstrates that false-positive ultrasound findings in paediatric acute appendicitis are not uncommon, with a rate of 20.6% in our study population. Female sex, younger age group (6–10 years), obesity, excessive bowel gas interference, and low Alvarado score are significant and independently identifiable risk factors for false-positive USG.

Surgeons and radiologists practising in tertiary care settings in eastern India must exercise caution when interpreting USG reports in children with these risk factors. A multimodal approach incorporating clinical scoring systems (such as the Alvarado or Paediatric Appendicitis Score), careful USG technique, and the judicious use of CT or MRI in high-risk cases is strongly recommended. Such a strategy would reduce unnecessary appendicectomies, minimise operative morbidity, and improve the overall quality of paediatric surgical care.

Further multicentre studies with larger sample sizes and prospective designs are warranted to strengthen the evidence base and develop region-specific diagnostic algorithms for paediatric appendicitis in India.

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## 7.Declaration

**Conflict of Interest**: The authors declare no conflict of interest.

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