Clinical Manifestations, Laboratory Markers, and Renal Ultrasonographic Examinationsin 1-month to12-year-old Iranian Children with Pyelonephritis: A Six-year Cross-sectional Retrospectivestudy

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Abstract

Background: Upper urinary tract infection (UTI) or pyelonephritismay increase the pathogenesis rate and risk of severe complications in children due to the atrophy of the kidneys.

Objective: A set of clinical symptoms, laboratory markers, and ultrasound findings were assessed to reach early diagnosis and prognosis of pyelonephritis in hospitalized pediatrics.

Methods: A cross-sectional study was conducted on 104 Iranian children (95 girls and 9 boys) aged 1 month to 12 years with acute pyelonephritis during 2012-2018. The ultrasound examination of kidneys and urinary tract during the hospitalization period, the incidence of clinical symptoms, and the monitoring of laboratory markersin blood and urine were studied to identify the best predictive factors of early diagnosis of this bacterial infection.

Results: Three-fourth of the patients had one of the four clinical symptoms of abdominal pain, constipation, dysuria, andvomiting, whileotherswere asymptomatic. A considerable frequency of pyuria(88.4%), *Escherichia coli* in urine (92%), leukocytosis (81.7%), and high ESR (> mm/h, 80%) and CRP (> 10mg/L, 82.8%) was observed. The kidney and urinary tract ultrasonography onlyin 32.7% of children showed in favor of pyelonephritis (cystitis, ureteral stones, and hydronephrosis).

Conclusion: In the majority of patients, there was a high prevalence of clinical signs and laboratory markers associated with pyelonephritis. Since most patients have normal sonography, ultrasound alonecould notbe an efficient tool fortracingfebrile UTI.

Background

Febrile urinary tract infections (UTIs) or acute pyelonephritis(AP) is one of the most common bacterial infections of the renal pelvis and kidney among children and young adult women [1]. It has beenreported that the annual cost to treat this disease in France and the US respectively was about €58 million and $2.47 billion [2,3]. In childhood, this disease commonly occurs in boy infants due to congenital anomalies of the kidneys and urinary tract, while AP is observed in girls at older ages [4-6]. *Escherichia coli* is the main responsible pathogen for AP, which is often associated with severe inflammation and short-term (such as fever, dysuria, and flank pain) and long-term (irreversible renal scarring (RS)) morbidities [7,8]. The RS significantly accelerates the risk development of hypertension, proteinuria,vesicoureteral reflux (VUR), chronic kidney disease, and end-stage renal disease [9,10]. Since about 37% of children with AP after two years from the infection onset showed renal scarring, the rapid diagnosis and the implementation of effective therapeutic measures are necessary to manage this disease among children [4,11-13].

Although the existence of some complications such as dysuria, urgency, hesitancy, small-volume voids, or lower abdominal pain in children with UTI at older ages was recognized, infants involved with this disease usually appear non-specific symptoms like fever, failure to thrive, jaundice, irritability, and

vomiting [14,15]. On the other hand, it was mentioned that the definitive analysis among infants with UTI involves bladder catheterization due to the nonspecific signs and symptoms for UTI in pediatric populations. Besides, in recent years, clinical strategies driven by antibiotic prophylaxis or imaging tools have been implemented for hospitalized children with UTIs. Accordingly, several imaging techniques (e.g., ultrasound, micturition cystourethrogram, and Tc-99m dimercaptosuccinic acid) along with a broad spectrum of intravenous prophylactic antibiotics were recommended to monitor and treat febrile UTIs (e.g., VUR and renal scarring) in children [8,21].

While there are many studies on the association between demographic and laboratory factors and the AP severity in children, little evidence on the combination of findings obtained from clinical manifestations, laboratory markers, and renal sonography among Iranian children within a wide age rangehas been published. As a result, the objective of this six-year cross-sectional study was to scrutinize the febrile UTIin 1-month to 12-year-old Iranian children based onclinical outcomes and signs, as well as renal ultrasound findings to adopt clinical practices and diagnostic tools/markers to make a notablecontribution to the early disease prognosis, monitoring, and treatment in the future.

Methods

Study design and participants

A cross-sectional study was designed to evaluate the results of clinical laboratory signs and symptoms and ultrasonography examinations obtained from 104 children with AP who were hospitalized in Bahrami Hospital (Tehran, Iran) in 2012-2018. The sampling method was census so that all the admitted children with APwere assessed to find early prognosis and diagnosis markers.The collected sample numberwas adequate since several previous studies with the same count of participants were successfully implemented [17-19].After conducting phone contacts and face to face interviews, both the verbal and written informed consents from all the parents were obtained after mentioning objectives and used methodologies for the present study. This research was performed following the Declaration of Helsinkiand approved by the Human Ethics Committee of the Tehran University of Medical Sciences (TUMS).

Inclusion and exclusion criteria

Only pediatric patients with AP aged from 1month to 12years old were included in this study. The AP was diagnosedafter the specialist approval according toan axillary temperature of higher than 38.5°C, bad general conditions, and positive urine culture (PUC).The significant microbial growth assessed by standard microbiological criteria was considered to define PUCs. Accordingly, the colony count inthe midstream urine sample was more than or equal to 10^5CFU/mL of a single pathogen, or $\geq 10^4$CFU/mLmicroorganism counted with the reference catheter method, and/or $\geq 10^3$ Gram-positive bacteria or any number of gram-negative onesin urine culture taken by the suprapubic method

[20].Besides, children with negative urine culture (NUC) and those who had a NUC after the antibiotic administration were excluded from the study.

Data collection

The medical information of all patients with AP was completed from archivedelectronic files available from March 2012 to March 2018.After ensuring the accuracy of pyelonephritis diagnosis, the necessary information was extracted by referring to the history, disease course, and summary of patients' files.Patients were included in the pre-prepared questionnaire form if they met the inclusion criteria. This questionnaire consisted of patient' name, gender, age, height, weight, body mass index (BMI, kg/m^2), hospitalization stay, fever degree, fever duration before and after the antimicrobial therapy, treatment drug(intravenous antibiotic type), and the history of having constipation, dysuria, vomiting, and abdominal pain during the hospitalization. Children were classified into four classes of underweight, normal, overweight, and obese based on the BMI reported by the Centers for Disease Control and Prevention (CDC) growth charts [21]. Also, the results of laboratory markers such as urine culture (negative/positive),microorganisms typein PUC, urine analyses (e.g., pyuria (white blood cells (WBCs)per mm^3), hematuria (red blood cells (RBCs) per high-power field (HPF)), and positive nitrite), and levels of hematological factors (e.g., hemoglobin (Hb, ng/mL), erythrocyte sedimentation rate (ESR, mm/h), and C-reactive protein (CRP, mg/L), WBCs(count per mm^3), blood urea nitrogen (BUN, mg/dL), serum creatinine (SCr, mg/dL), potassium (K, mEq/L), and sodium (Na, mEq/L) were recorded. Then, findings related to the ultrasound examination of kidneys and urinary tract in terms of renal anomalies,cystitis, ureteral stones, and hydronephrosis during hospitalization stay were collected.Lastly, the kidney function levelwas assessed according to the estimated glomerular filtration rate (eGFR, mL/min/1.73 m^2) using the following equation [22]:

$$eGFR = \frac{0.413 \times \text{Height (cm)}}{\text{SCr (mg/dL)}} \quad (1)$$

Statistical analysis

The one-sample Kolmogorov-Smirnov test was used to evaluate the normality of variables' distribution. Data were examined at a significance level of $p < 0.05$. The descriptive data were expressed as frequency, percentage, and mean ± standard deviation.The statistical differences were determined using the independent *t*-tests for continuous variables and Pearson's Chi-square (χ^2) test for categorical variables. The one-sample Kolmogorov-Smirnov test was used to evaluate the normality of variables' distribution. Thenon-parametric, Mann–Whitney test was used for the analysis of the data with the abnormal distribution. Pearson’s coefficient was considered to find any significant correlation between tested variables.

Results

The average age of 104 patients with AP was 47.08 years. 91.34% (n = 95) of the studied patients were girls. The minimum, mean, and maximum height and weight of patients were 52 cm and 3.3 kg, 94.26 cm and 15.77 kg, and 147 cm and 69.9 kg, respectively. Accordingly, the highest and lowest BMI were respectively calculated to be 10 and 28 kg/m^2, while the mean BMI of the total pediatric patients with AP was 16.29kg/m^2(Table 1). Table 2 exhibits the frequency of BMI classes as a function of gender difference and age groups (< 1, 1-5, and > 5 years old). Most children (62.1% girls and 44.44% boys) had a BMI in the normal range. Also, almost equal numbers of children were in different age ranges (31.73-34.61%, Table 2). Based on the age group classification, most overweight children had an age less than one year old (n = 23) and over five years old (n = 23) (Table 2).

Table 1
The demographic and laboratory parameters of children with AP

Parameter [a]	Frequency (n [%])	Values		
		Mean (±SD)	Minimum	Maximum
Gender-boy	9 [8.66]	-	-	-
Gender-girl	95 [91.34]	-	-	-
Age (month)	-	47.08±41.49	1	144
Height (cm)	-	94.26±26.36	52	147
Weight (kg)	-	15.77±9.87	3.3	69.9
BMI (kg/m^2)	-	16.29±2.78	10	28
Fever (°C)	-	39.41±2.51	38.5	40.9
Fever duration (BT, day)	-	4.23±1.54	1	7
Fever duration (AT, day)	-	3.54±0.47	0	5
HS (day)	-	5.41±4.14	2	16
WBC (count per mm^3)	-	14.90±5.73	3.6	34.0
Hb (ng/mL)	-	11.02±1.32	7.6	14.7
ESR (mm/h)	-	46.52±26.42	3	108
CRP (mg/L)	-	58.73±36.81	1	118
BUN (mg/dL)	-	11.31±7.43	5	62
SCr (mg/dL)	-	0.57±0.23	0.05	2.40
Na (mEq/L)		140.70±3.41	131	152
K (mEq/L)		4.36±0.35	3.5	5.8
eGFR (mL/min/1.73 m$^{2)}$	-	68.94±18.11	17.2	134.0

[a]BMI: Body mass index, HS: Hospitalization stay, BT/AT: Before/After treatment, WBC: White blood cell, Hb: Hemoglobin, ESR: Erythrocyte sedimentation rate, CRP: C-reactive protein, BUN: Blood urea nitrogen, SCr: Serum creatinine, eGFR: Estimated glomerular filtration rate

Table 2

The frequency of BMI classesof children with AP within different gender and age groups[a]

BMI group	Gender		Total	Age group			Total
	Girl	Boy		< 1 yr old	1-5 yrs old	> 5 yrs old	
Underweight	13 (12.50)	2 (1.92)	15 (14.42)	2 (1.92)	5 (4.81)	8 (7.70)	15 (14.42)
Normal	59 (56.72)	4 (3.86)	63 (60.58)	23 (22.11)	17 (16.34)	23 (22.12)	63 (60.57)
Overweight	16 (15.38)	1 (0.96)	17 (16.34)	6 (5.77)	9 (8.66)	2 (1.92)	17 (16.35)
Obese	7 (6.74)	2 (1.92)	9 (8.66)	5 (4.81)	2 (1.92)	2 (1.92)	9 (8.66)
Total	95 (91.34)	9 (8.66)	104 (100)	36 (34.61)	33 (31.73)	35 (33.66)	104 (100)

[a] Frequency was represented as: count (percentage)

The minimum and maximum hospitalization stay were 2 days (n = 9) and 16 days (n = 1), respectively (Table 1). In general, 75% of the patients with AP were symptomatic. A high number of girls (78.9%) in this study were symptomatic, while most boys (66.7%) were asymptomatic (Fig. 1a). This finding indicates that UTIs may occur in boys with fewer clinical symptoms, thus, this population group needs further laboratory investigations. Also, the percentage of asymptomatic children in three age groups of < 1, 1-5, and > 5 years old were 47.2, 12.1, and 14.3%, respectively (Fig. 1b). Hence, asymptomatic is more common at younger ages.The symptomatology rate was increasedwith increasing age, although there was no significant difference in this index between age groups of 1-5 and > 5 years old. As 20.19% (n = 21) of the patients with AP complained of constipation, this symptom can be considered as a risk factor for UTIs. Fever as the main inclusion criteria for all the patients averagely was at 39.4°C at the admission time, while the minimum and maximum fever degrees were 38.5 and 41.0°C, respectively.The shortest and longest fever durations before the treatment were 1 day (n = 10) and 7 days (n = 6), respectively (Table 1). Although the duration of the child's fever before starting the antimicrobial therapy does not play a role in confirming or rejecting a UTI, a delay in beginning the treatment can significantly have consequences likeRS. Three cases did not show any fever after the treatment, while fever in the two other cases continued for up to five days after treatment, showing a necessity to change the used antibiotic type. Dysuria was observed among 30 patients with AP (28.84%), which shows the absence of dysuria does not rule out a UTI. Abdominal pain and vomiting were detected in 33.6% (n = 35) and 40.3%(n = 42) of the subjects, respectively(Table 4).Based on the Pearson's Chi-square analysis, there were significant

associations between patients' age and symptoms of dysuria ($p = 0.003$) and abdominal pain ($p = 0.0001$).

Pyuria and hematuriaare usually defined as the presence of ≥10 WBCs/$mm^3$and ≥5RBCs/HPFin a urine specimen,respectively. Pyuria,hematuria,and positive nitrite were respectively diagnosedin 88.46% (n = 92), 38.46% (n = 40) and 45.19% (n = 47) of urine tests of patients with AP (Table 4). As a result, not only pyuria can be one of the most important symptoms of a UTI, but also not having hematuria and urine nitrite do not rule out this disease. Fig. 1c shows that theseabnormal urinary changeswere increased by increasing the age from less than one year old to over five years old. In addition, there was a negative correlation between and eGFR and patients' age ($r = 0.754$, $p = 0.001$). Results proved that this increase in the urine nitrite (50.0%) was more evident than hematuria (36.36%) and pyuria (10.12%) (Fig. 1c). *E. coli* was the most frequent pathogen in urine samples (n = 96). so that this bacterium was present in samples of 59 patients (88.05%). Other bacteria such asGram-negative *Bacillus*(2 cases), Group-B *Streptococcus* (2 cases), *Klebsiellapneumoniae*(1 case), *Acinetobacter* (1 case), *Enterococcus* (1 case), and*Staphylococcusaureus*(1 case) were observed in urine samples taken from patients less than one-year-old (Table 4).Ceftizoxime was the most common intravenous antibiotic to treat patients with AP (n = 78, 75.0%). Other used antibiotics were ceftriaxone(n = 12, 11.53%), amikacin (n = 7, 6.73%), cefotaxime (n = 2, 1.92%), cefepime (n = 2, 1.92%), vancomycin (n = 1, 0.96%), meropenem (n = 1, 0.96%), and gentamicin (n = 1, 0.96%) (Table 4). Patients receiving two antibiotics of vancomycin and meropenemhad abnormal ultrasound results. But, the administration of other antibiotics led to more normal sonographic findings. The Pearson's Chi-square analysis also showed that there were significant correlations betweengender andantibiotic type ($p = 0.0001$) and hospitalization stay ($p = 0.001$). Thus, a proper choice of used antibiotic can significantly reduce fever degree and duration, and subsequently, hospitalization stay in children with AP.

Overall, the ESR and CRP values had recorded for 91 and 99 patients with AP, respectively. The minimum, mean, and maximum levels of ESR and CRP were 3 mm/h and 1 mg/L, 46.5 mm/h and 58.7 mg/L, and 108 mm/h and 118 mg/L, respectively (Table 1). The elevated ESR (>10 mm/h) and CRP (> 10 mg/L) levels [23] were observed among 84 (92.30%) and 82 (82.82%) patients, respectively. Therefore, only 7 and 17 patients had an ESR and CRP within a normal range. Accordingly, high amounts of these hematological factors may be effective in the diagnosis of patients with AP. The minimum, mean, and maximum amounts of BUN and SCr were 5 and 0.05 mg/dL, 11.31 and 0.057 mg/dL, and 62 and 2.4 mg/dL, respectively. Also, the minimum and maximum eGFR amounts respectively were 17.2 and 134 mL/min/1.73 m^2, while the average value of this index was calculated to be 68.9 mL/min/1.73 m^2 (Table 1). Also, the lowest, average, and highest values of WBCs and Hb were 3.6/$mm^3$and 7.6 ng/mL, 14.9/$mm^3$and 11.02 ng/mL, and 34/$mm^3$and 14.7 ng/mL, respectively (Table 1). The leukocytosisand anemia frequency in the studied population was 81.7% (n = 85) and 36.5% (n = 38), respectively. The mean Na and K amounts in blood samples were 140.7 and 4.36 mEq/L, respectively. The lowest and highest values of Na and K were 131 and 3.5 mEq/L, and 152 and 5.8mEq/L, respectively (Table 1).

In general, 67.3% of patients had normal sonographic examinations.Sonographic findings showed that the presence of hydronephrosis, cystitis, and renal anomalies in 22 (21.15%), 9 (8.65%), and 2 (1.92%) patients with AP, respectively (Table 4). However, none of the patients showed ureteral stones on their ultrasound images. Consequently, hydronephrosis was the most common abnormality in the kidney and urinary tract ultrasonography. Since sonography results of 70 patients (67.30%) were not in favor of pyelonephritis, this diagnosis alone cannot be a valid diagnosis technique for this disease.

Table 3
A summary of urine markers, clinical complications, and ultrasound findings of children with AP

Findings	**Observed**		**Non-observed**	
	Frequency (n)	**Percentage (%)**	**Frequency (n)**	**Percentage (%)**
Urine marker				
Pyuria	92	88.46	12	11.54
Hematuria	40	38.46	64	61.54
Positive nitrite	47	45.19	57	54.81
Clinical complication				
Abdominal pain	35	33.65	69	66.35
Constipation	21	20.19	83	79.81
Dysuria	30	28.84	74	71.16
Vomiting	42	40.38	62	59.62
Ultrasound				
Hydronephrosis	22	21.15	82	78.85
Cystitis	9	8.65	95	91.35
Stone	0	0.00	104	100
Anomaly	2	1.92	102	98.08

Table 4
The type of identified pathogens and used antibiotics to treat 104 children with AP

Pathogen type	Frequency (n [%])	Antibiotic therapy type	Frequency (n [%])
Escherichia coli	96 [92.30]	Ceftizoxime	78 [75.0]
Gram-negative *Bacillus*	2 [1.92]	Ceftriaxone	12 [11.53]
GroupB *Streptococcus*	2 [1.92]	Amikacin	7 [6.73]
Acinetobacter	1 [0.96]	Cefotaxime	2 [1.92]
Enterococcus	1 [0.96]	Cefepime	2 [1.92]
Klebsiella	1 [0.96]	Vancomycin	1 [0.96]
Staphylococcus aureus	1 [0.96]	Meropenem	1 [0.96]
		Gentamicin	1 [0.96]

Discussion

A particular interest in the field of pediatric studies is early diagnosis and discrimination of AP from other UTIs such as cystitis because of long-term morbidities and serious complications. Generally speaking, girls due to their shorter urethras are more susceptible to get AP compared to boys. However, boy populations with UTIs typically possess underlying anatomical or functional abnormalities of the genitourinary tract with a higher primary scarring rate [24]. The most common pathogen causing AP in children patients was *E. coli*. Mahmoudi et al. [25] and Sarvari et al. [26] earlier reported this microorganism as the most frequent pathogen present in urine samples collected from Iranian pediatric populations with AP. Since *E. coli* is the main pathogen responsible for AP, the antimicrobial sensitivity profile of this member of the family Enterobacteriaceae should be a principle in determining the empirical therapeutic choice [17]. A higher number of symptomatic patients with AP in this study than that in Mahmoudi et al. 's survey (12.8%) was recorded [25]. Although Muhammad et al. [27] explained that constipation is a frequent and overlooked problem in children patients with UTI symptoms, most patients in this study (79.81%) did not show constipation complications. Pelvic floor dynamics are significantly worsened with this complication. The existence of large stool masses accompanied by volitional holding because of pain with defecation delays/prevents whole bladder emptying. This mechanism leads to the high accumulation of post-void residuals facilitating bacterial colonization (such as *E. coli*) in the bladder [28,29]. The guideline available in the American Academy of Pediatrics recommends pyuria as a clinical factor to diagnose UTIs [30]. Pyuria was the common factor in most children with AP (88.46%). The pyuria percentage in this study was in agreement with the findings of Nickavar and Sadeghi-Bojd [31] and Shaikh et al. [32] who reported 81% and 87% pyuria among Iranian and American children with AP, respectively. As a laboratory factor in diagnosing AP in children patients, we found that the presence of

nitrite in urine samples was more pronounced than hematuria. The positive nitrite reaction is a specific test so that it only detects Gram-negative coliforms, whereas atypical pathogens (such as pseudomonas and Gram-positive organisms) cannot be identified [33]. Since the presence of atypical pathogens in urine samples was insignificant, this factor in our study was relatively appropriate to detect children with AP. The prevalence rate of leukocytosis as a common feature of inflammatory reaction in the current study (81.7%) was much more than that of (56%) in Ayazi et al. [23]. The levels of CRP and ESR also were much more than the measured amounts in studies conducted by Ayazi et al. [23] and Naseri [34]. This fact showed that the high amount of these hematological factors are risk factors to develop renal scars in the long term follow up. In contrast, Lin et al. [35] reported that the ESR and CRP have a relatively low sensitivity to diagnose UTI in febrile infants.

We realized that only 34 patients in the sonography examination showed in favor of AP with a more appearance of hydronephrosis. The size of kidneys in AP may be enlarged so that they have hypoechoicparenchyma with loss of the normal corticomedullary junction [36]. Our ultrasonographic findings demonstrated that this imaging tool did not have sufficient adequacy to diagnose APas it may miss parenchymal and perinephric abnormalities [37]. Thus, other diagnostic methods in addition to ultrasound should be used to monitor AP in pediatric patients.

Limitations

Although the number of patients in this study was following other studies with a normal range of samples, more count of subjects in this six-year cross-sectional study could present the data with better reliability and generalizability. Accordingly, the AP evaluation in larger population sizes from several hospitals in different geographical areas is recommended because this work was performed in a single academic hospital, limiting its generalizability to other centers and settings. Another limitation is no record of the dose of each used antibiotic to make decisions about the potential of antibiotic therapies and its effects on the fever duration and hospitalization stay. Hence, the present study cannot a criterion to choose appropriate antibiotic treatment for AP in children populations. The other limitation was the failure to record of inflammatory markers in medical files. The assessment of molecular mechanisms regulating the inflammatory profiles could contribute to more comprehension of the overall pathogenesis and clinical outcomes of pediatric UTIs to define the best type and dose of antibiotics with the lowest acquired resistance.

Conclusions

The present study showed that the AP in most Iranian childrenwas symptomatic and mainly caused by *E. coli*. This bacterial infection was highly associated with some urine (pyuria and urine nitrite) and hematological (high levels of CRP and ESR, and leukocytosis) factors. Furthermore, the most common antibiotics used to treat AP were ceftriaxone and amikacin. Apart from the management of AP in pediatric populations is a challenging and controversial process, the detection, treatment, and follow-up of children with AP should be conducted according to the efficient medical guidelines by pediatricians

and renal specialists. Findings obtained from the accurate markers for early prognosis, diagnosis, and treatment of AP based on urine and hematological analyses, antibiotic therapies, and imaging tools would be helpful to overcome this common health problem in childhood. As ultrasonographic findings were not efficient to differentiate pediatrics with and without AP, the use of other imaging diagnostic tools alone or in combination with ultrasound can provide better diagnostic performance.

Abbreviations

AP:acute pyelonephritis, BMI: body mass index, BUN: blood urea nitrogen, CRP: C-reactive protein,ESR:erythrocyte sedimentation rate,Hb: hemoglobin, HPF: high-power field, PUC/NUC: positive/negative urine culture, RBCs: red blood cells, RS: renal scarring, SCr: serum creatinine, UTI: urinary tract infection, VUR: vesicoureteral reflux,WBCs: white blood cells

Declarations

Ethics approval and consent to participate:

The performed study's protocol was following the principles of the declaration of Helsinki and the Nuremberg Code and approved by the Ethics Committee of Tehran University of Medical Sciences. The project approval number is IR.TUMS.MEDICINE.REC.1397.761. The verbal and written informed consent from all the children and their parents was obtained before performing this research.

Consent for publication

Written informed consent was obtained from the participants for publication of this research.

Availability of data and materials

All the data of this case series are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Competing interests

The authors have declared no conflict of interests.

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Author's contribution

MJ performed research and analyzed data; SYM and DF designed researchand critically reviewed the manuscript; LK wrote the manuscript and contributed to scientific discussions; MV and EHBsupervised the study and edited the manuscript. All authors approved the final version of the manuscript to be published.

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Figures

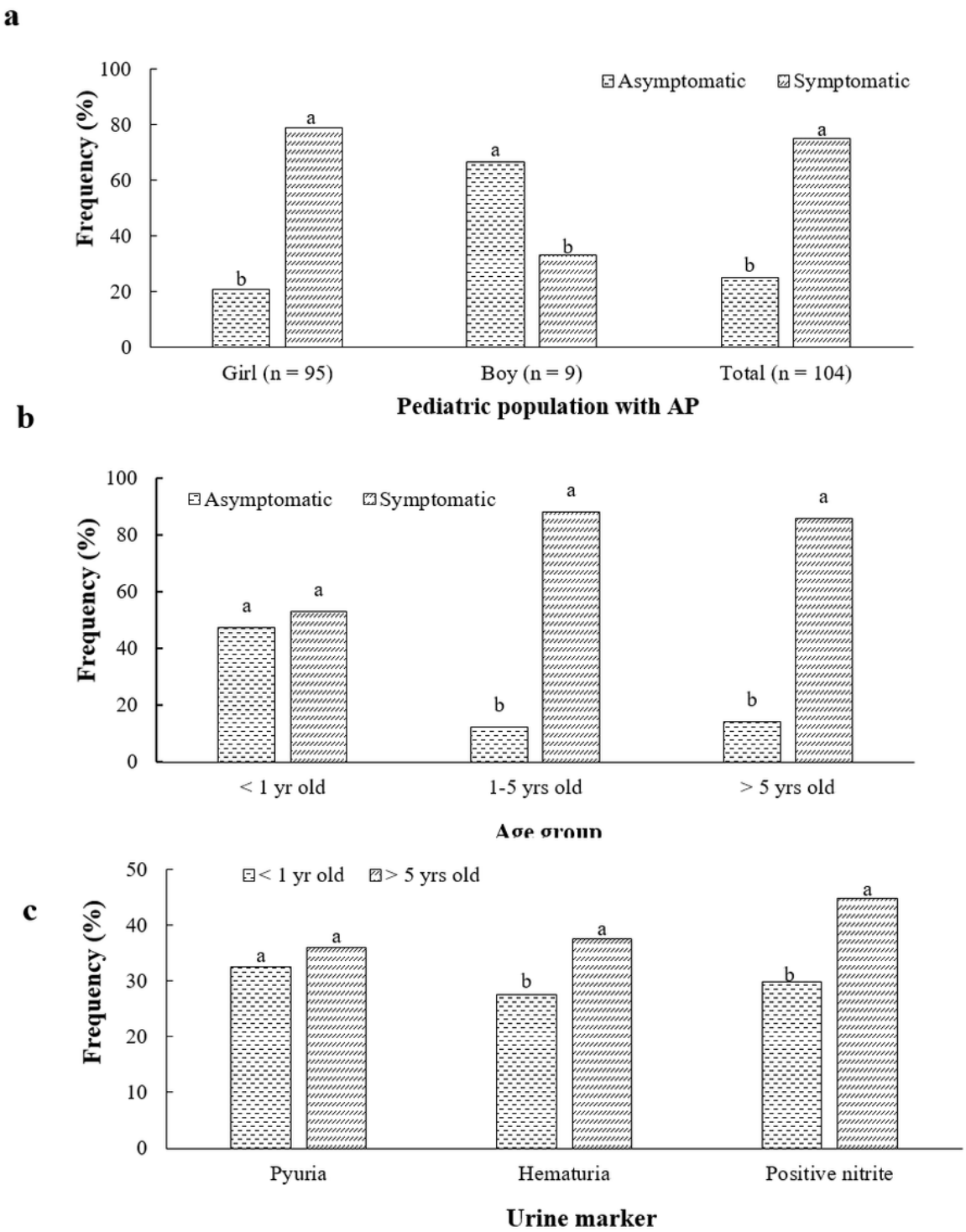
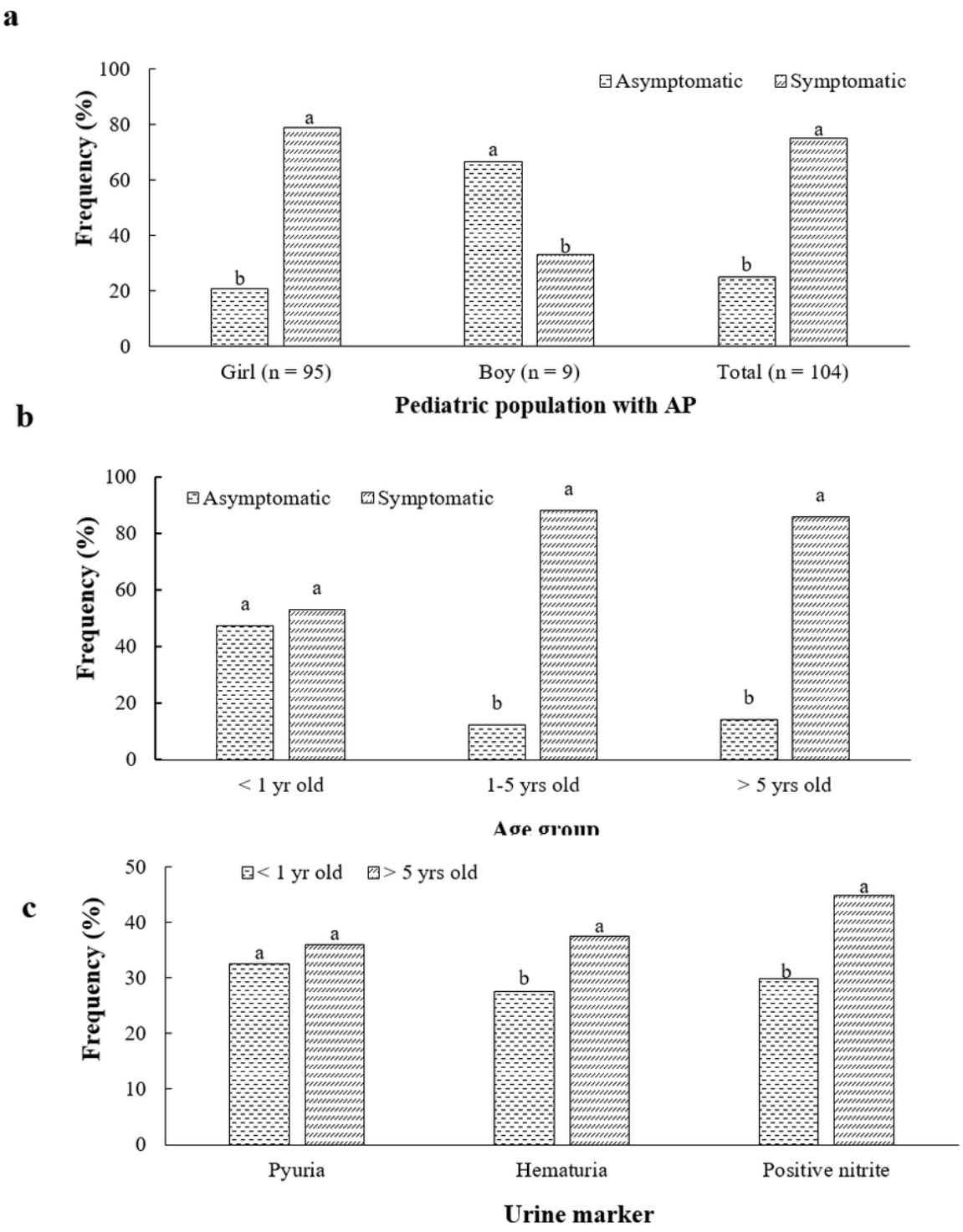


Figure 1

The frequency ofsymptomatology of the children population with AP based on gender (a) and age range (b), and the percentage of positive urine markers in age groups (c)



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