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Pediatric High Body Mass Index and Urinary Tract Infections: The Clinical and Microbiological Association

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Abstract

Background: Both increased body mass index (BMI) and urinary tract infections (UTI) are common pediatric problems. Being overweight or obese is a risk factor for pediatric UTI, but it has not been extensively studied. This study aimed to investigate the clinical and microbiological associations between overweight and obesity and UTI among hospitalized children.
Methods and Results: This cross-sectional analytical study involved hospitalized children at Al-Khansaa Pediatric Hospital in Mosul, northern Iraq. A total of 74 patients aged ≤15 years of both sexes were included in the study from October 2023 to September 2024. Upper UTI was documented by urine culture and ultrasonography. The mean age of patients was 6.88±4.49 years. Males accounted for 37.8%, females for 62.2%, and 77% of patients were from urban areas. Patients were divided into three groups based on BMI: normal weight, overweight, and obese. Most patients (43.2%) had a normal weight, 18.9% were overweight, and 37.8% were obese. Overweight and obesity were more prevalent among UTI children than among normal children, according to the current data (P=0.03 and P=0.000, respectively). *E. coli* was the main causative organism among the normal weight group (31%), while *Candida* species dominated among the overweight and obese groups (38% and 35%). There was increasing resistance to antibiotics with the increase in BMI among the obese group, with a significant Spearman correlation (R^2 =0.14, P=0.045).
Conclusion: According to this study, overweight and obesity are possible risk factors for pediatric UTI. Increases in BMI beyond the normal range shift the causative microorganisms of UTI from *E. coli* to *Candida* species and increase antibiotic resistance. (**International Journal of Biomedicine. 2026;16(1):90-94.**)

Keywords: children • obesity • overweight • urinary tract infection

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Introduction

Febrile UTI is a leading cause of doctor visits and hospitalizations in pediatric patients. Reports from meta-analyses of 36 studies published between 200 and 2021 documented a global prevalence of UTI of 16% among girls and 10% among boys aged <18 years, with *Escherichia coli* identified as the leading causative microorganism in up to 58% of cases.[1,2] On the other hand, it is also estimated that the global prevalence of pediatric overweight and obesity is considerably high in both sexes, with a pooled rate of 14.8% and 22.2%, respectively.[3] A much higher rate of childhood obesity (49.4%) was reported in the Middle East and North African countries.[4] In Iraq, higher than the global rates of pediatric UTI were observed in different regions, ranging from 14.7% in Baghdad school-aged children to as high as 43.3% in Erbil hospitalized children.[5,6] It has been reported that the prevalence of overweight and obesity in Iraq ranges from 11.14% and 11.74%, respectively, in Mosul to as high as 25.3% and 28.7% in Kirkuk.[7-9] Increased BMI is now considered a risk factor for UTI in the pediatric population, and such risk increases by 45% in some studies; furthermore, the odds ratio of overweight and obesity is approximately double among UTI children. Excess abdominal fat can put pressure on the bladder and urethra, impairing complete bladder emptying and causing urinary stasis, which creates an ideal environment for bacterial growth and increases the risk of UTI.[10,11] The habit of infrequent voiding and reduced

urinary tract flushing due to bacterial colonization among such children further contributes to the higher risk of UTI.[12] In addition to these, obesity contributes to chronic low-grade inflammation and alters the body's immune response.[13] Some studies also suggest that overweight and obesity may increase the incidence of vesicoureteral reflux, which acts as another risk factor for UTI among children.[14]

Methods

This cross-sectional analytical study involved hospitalized children at Al-Khansaa Pediatric Hospital in Mosul, northern Iraq. A total of 74 patients (28 males and 46 females) aged ≤15 years of both sexes were included in the study from October 2023 to September 2024. Upper UTI was documented by urine culture and ultrasonography.

In this study, the sample size was calculated based on the global average UTI prevalence (7%) at a 90% confidence level and a 5% margin of error. All patients were admitted to pediatric wards for management of fever, with or without urinary symptoms. Written parental consent was obtained for each participant. Patient demographic and clinical data were recorded using a specific questionnaire. The BMI for each patient was calculated and plotted on the appropriate Centers for Disease Control and Prevention (CDC) growth charts to determine the corresponding percentile. Participants with a BMI <5% were classified as underweight and excluded from the study; those with a BMI> 5% and <85% were classified as having normal BMI, ≥85% as overweight, and ≥95% as obese. A clean-catch midstream urine collection method was used for toilet-trained children, and a catheterized urine sample collection method was used for non-toilet-trained children. Urine cultures were performed and evaluated by a different person who was blinded to the patients' identities. Cystine-Lactose-Electrolyte Deficient (CLED) and Sabouraud Dextrose (SAD) agars were used to culture the urine samples and identify the causative microorganism. Every other patient diagnosed with UTI was selected in an alternate manner to ensure randomization.

Statistical analysis was performed using the statistical software package SPSS version 27.0 (SPSS Inc, Armonk, NY: IBM Corp). Chi-square and two proportions Z test, and Spearman correlation tests were used for statistical analysis. A significant *P*-value was set at ≤0.05.

Results

The mean age of patients was 6.88±4.49 years. Males accounted for 37.8%, females for 62.2%, and 77% of patients were from urban areas. Patients were divided into three groups based on BMI: normal weight (43.2%), overweight (18.9%), and obese (37.8%) (Table 1).

Regarding the clinical manifestations of UTI, a significantly higher number of normal weight children, 23(71.8%), were complaining of dysuria, while decreased food intake was more common among obese children, 21(75%), than among the other groups (Table 2). The three groups did not show a significant difference with the other clinical manifestations of UTI, like abdominal pain, fever, and vomiting, as well as being an uncircumcised male. On the other hand, the three groups did not show significant differences in the microscopic examination of urine with respect to the number of WBC or viable bacteria per high-power field (HPF).

Table 1.

Baseline characteristics of the study patients.

Variable		Patients (n=74)
Mean age (years)		6.88 ±4.49
Gender	Male	28 (37.8%)
	Female	46 (62.2%)
Residence	Urban	57 (77.0%)
	Rural	17 (33.0%)
BMI	Normal weight	32 (43.2%)
	Overweight	14 (18.9%)
	Obese	28 (37.8%)

Table 2.

Clinical and laboratory features among the three groups [n(%)]

Variable		Normal weight (n= 32)	Over-weight (n=14)	Obese (n=28)	*P*-value
Clinical features	Abdominal pain	22 (68.7)	13 (93)	25 (89.2)	0.59
	Dysuria	23 (71.8)	9 (64.3)	8 (28.5)	0.002
	Fever	26 (31.25)	12 (85.7)	25 (89.2)	0.86
	Nausea	7 (21.8)	7 (50)	9 (32.1)	0.16
	Vomiting	17 (53.1)	7 (50)	7 (25)	0.07
	Low appetite	9 (28.1)	2 (14.3)	21 (75)	0.000
	Uncircum-cised male	11 (34.4)	3 (21.4)	13 (46.4)	0.27
≥ 5 Pus cells per HPF on GUE	Positive	24 (75)	10 (71.4)	24 (85.7)	0.47
	Negative	8 (25)	4 (28.5)	4 (14.3)	
Bacteria on GUE	Positive	27 (84.4)	11 (78.6)	18 (64.3)	0.18
	Negative	5 (15.6)	3 (21.4)	10 (35.7)	

Figure 1 shows the results of urine culture among the three groups. It is clear that *E.coli* followed by *Staphylococcus* species were the most frequent among normal weight patients in a frequency of 31% and 25% respectively, while among overweight children, *Candida* species followed by *Staphylococcus* species were the most frequent (38% and 31%, respectively), however *Candida* species followed *E.coli* were most frequent among obese group (35% and 31%). *Candida* species become the dominant causative microorganisms when BMI exceeds the normal range.

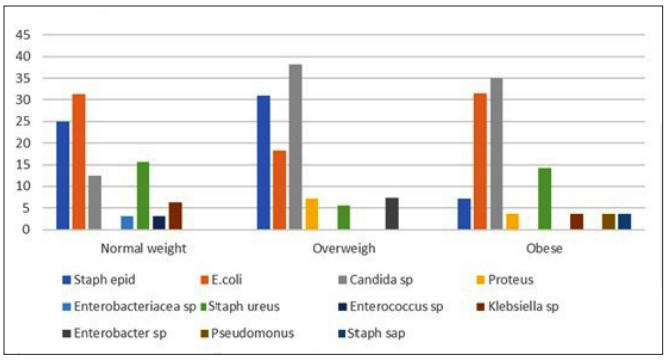

Fig. 1. *Results of urine culture.*

The sensitivity results (Figure 2) showed that amikacin, followed by nitrofurantoin and nalidixic acid, had the highest sensitivity rates among normal-weight children as antibacterial agents, and nystatin, followed by itraconazole and fluconazole, as antifungal agents (62%, 59%,35%, 59%, 47% and 31%, respectively). The same order of antibiotic sensitivity, with lower frequencies, is observed in the overweight group. This pattern differs in the obese children group, with the order shifting to meropenem, followed by amikacin and ciprofloxacin (50%, 47%, and 25%, respectively) as antibacterial agents, whereas the antifungal agents shift to miconazole, followed by nystatin and ketoconazole (52%, 49% and 48%, respectively). When we examined the correlation between increased BMI percentile and the number of antibiotics to which resistance was detected on urine culture, only the obese group showed a significant Spearman correlation (R^2 =0.14, *P*=0.045) (Figure 3). A higher BMI in this group is associated with a greater number of such antibiotics.

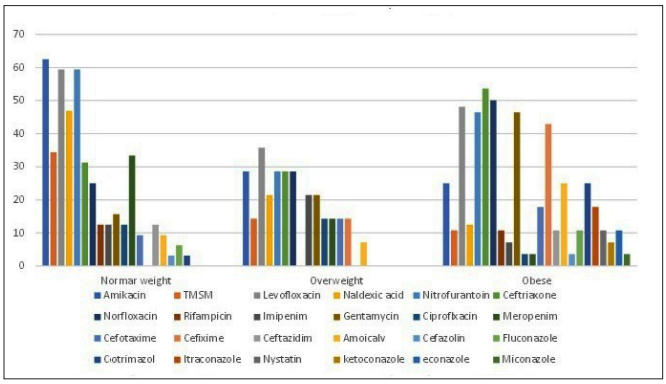

Fig. 2. *Antibiotic sensitivity on urine culture.*

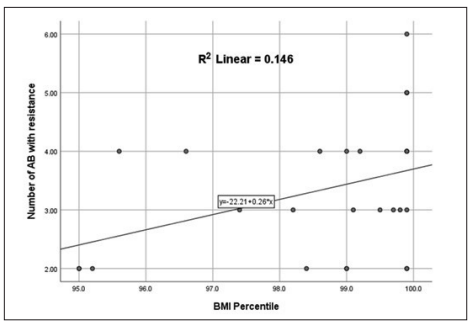

Fig. 3. *Correlation of BMI with the number of AB with resistant action among obese children.*

Discussion

Pediatric overweight, obesity, and UTI are relatively common and challenging problems for the health institutes and medical care providers everywhere in the world. According to the current literature reports, about one-fifth of the pediatric population suffers from either overweight or obesity.[3,15] Recently, Alqishawi et al. reported a prevalence of overweight and obesity in children aged 2-18 years in Mosul city as 11.14 and 11.74, respectively.[8] Using two proportion Z tests, we found that there was a significantly higher prevalence of overweight and obesity among our sample children with UTI (*P*=0.034 and *P*=0.000, respectively), supporting our hypothesis that there is an association between these two types of pediatric morbidities. We believe that the pelvic muscle dysfunction due to the increased intra-abdominal pressure in overweight and obese children will predispose them to urination problems and consequently increase the risk of UTI. In addition to that, there are many studies about the association of obesity with the malfunction of the body's immune system to explain the increased risk of infections, including UTI, among obese and overweight children. Elevated TNF-α and leptin levels, and a disrupted infection-related immune response in macrophages, monocytes, and lymphocytes, are likely responsible for the increased risk.[16] As in this study, Yang et al.[17] reported a high odds ratio for obesity in their sample of children with UTI.It has been reported that obese patients experience UTI symptoms more frequently than normal-weight individuals.[18] The current study did not show a significant difference in symptoms, except for a lower appetite level among obese patients than among the normal weight group (*P*=0.000), who experienced a higher frequency of dysuria than the other groups (*P*=0.002). It is well established that obesity is characterized by a chronic inflammatory state, with elevated baseline levels of the cytokines TNF-α and IL-6, as well as the cytokine-like substance leptin, and by a marked surge during infections. These cytokines have appetite-suppressing effects.[19,20] It is also reported that obese adult patients may have more severe UTIs than normal subjects, which might be an additional reason for such a lower appetite level. The chronicity of bladder inflammation and higher frequency of overactive bladder, and possible resultant reduction in pain sensation, may explain the lower frequency of dysuria among overweight and obese patients with UTIs.[21]

A variety of studies across pediatric age groups have established that *E. coli* is the leading cause of UTI, accounting for one-half to three-quarters of such infections.[22,23] Studies of Iraqi children also reported similar findings.[24,25] The current study results are the same for the normal weight group. The reason is that *E. coli* is the most common gut flora and possesses characteristics that enable it to colonize the urinary tract and exhibit specialized virulence traits.[26] Although not statistically significant (*P*=0.07), *Candida* species were the dominant organisms among overweight and obese children (38% and 35%, respectively) compared with the normal-weight group (12.5%) in this study. It has been reported that being overweight and obese are both risk factors for fungal infections due to an altered body immunity and associated

hyperglycemia, but we couldn't find such a study to support that for UTI in children.[27,28]

Generally, the antibiotic resistance and sensitivity patterns also showed special characteristics in association with an increase in the BMI, specifically among the obese group. Correlations showed that there is a significant increase in the number of ineffective antibiotics as the BMI increases in the obese group (P=0.045). The pharmacokinetics of antibiotics, particularly hydrophilic agents such as aminoglycosides and β-lactams, are significantly altered by high BMI and increased blood volume, resulting in more diluted and less effective concentrations in the circulation. It has also been noted that obesity alters the body's immune function in response to infections.[29,30] Although many adult studies report results consistent with ours, studies in pediatric age groups are scarce.[31-34] However, pediatric studies linking antibiotic resistance with abnormally high BMI support our findings.[35]

In conclusion, the frequency of being overweight and obese is significantly higher among children with UTI than among those who do not have UTI. Interestingly, this study reports that high BMI is associated with an increased risk for fungal UTI and increased resistance to antibiotics.

Competing Interests

The authors declare that they have no conflicts of interest.

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