Patient Safety & Quality Improvement Journal
http://psj.mums.ac.ir
PSQI

Relationship Between Body Mass Index (BMI) and Kidney Stones in Children

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ARTICLEINFO

Article type:
Original Article

***Article History*:**
Received: 13 Oct 2024
Accepted: 03 Des 2024

Keywords:
Body Mass Index; Obesity; Kidney Stone; Children; Ardabil

ABSTRACT

Introduction:
A widespread and significant problem in pediatric medicine, kidney and urinary tract stones are becoming more common as a result of sedentary lifestyles, poor diets, wrong fluid intake patterns, and improper medication use.

Materials and Methods:
Children referred to Ardabil City's Kowsar Clinic received sonography and a clinical assessment. In this investigation, 91 children with normal sonography were chosen as the control group, and 91 children with kidney stones identified by sonography were chosen as the case group. The association between kidney stones and BMI was examined analytically using logistic single and multiple-variable regression models, and the odds ratio was shown.

Results:
182 people were analyzed in this study, 50% in the case group and 50% in the control group. Children had one stone at the highest rate (57.1%). According to the multiple variable logistic model, the body mass index has an odds ratio of 0.99. Additionally, a statistically significant gender study revealed that women are 2.29 times more likely than men to have kidney stones. Furthermore, compared to children over ten, children under five have a 4.14-fold increased risk of kidney stones, according to age analysis.

Conclusion:
These findings indicate that kidney stones and body mass index do not significantly correlate. Kidney stones are more likely to occur in girls than in boys, and in children younger than five.

► ***Please cite this paper as:***
Katebi L, Ekhlasi N, Parhizghar A, Amani F. Relationship Between Body Mass Index (BMI) and Kidney Stones in Children Journal of Patient Safety and Quality Improvement. 2024; 11(4):157-162. Doi: 10.22038/psj.2024.83291.1444

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Introduction

One of the prevalent and significant issues in children's medicine is kidney stones and urinary tracts, which are becoming more widespread as a result of driving, poor nutrition, incorrect fluid drinking habits, and inappropriate medication use. Kidney stones affect 1 in 1000 to 1 in 7600 hospitalized children in the United States, with a prevalence of 1.7–4.1% in girls and 4-9% in boys. Kidney stones are generally less common in children than adults, with adults being 50–75 times more likely to develop kidney stones than children.

This discrepancy results from the fact that children's urine contains higher levels of citrate and magnesium than adults' and more chemicals that inhibit crystals from adhering to the kidney epithelium (1).

Men are four times more likely than women to experience urinary tract stones because they are more common in men than in women. Naturally, in youngsters, this ratio is slightly different, with boys experiencing 1.5–2 times as many urinary stones as girls. According to a recent American study, the prevalence of urinary stones has grown fivefold over the previous ten years. Numerous factors, including structural abnormalities of the urinary tract, genetic metabolic diseases, nutritional deficiencies, and medications, can result in kidney stones. In 75% of pediatric kidney stone cases, the underlying causes can be found (2,3).

Over 20% of people are obese (body mass index [BMI] > 30 kg/m2), which is generally regarded as an epidemic. Numerous studies have demonstrated a link between obesity and both men's and women's risk of developing stones. Wealth and nutritional variables have long been linked to kidney stones. Regarding childhood obesity, BMI equal to or greater than 95% and the 85-95th percentile were considered overweight (4). One of the risk factors for kidney stones is being overweight or obese. Researchers believe that the development of kidney stones is closely related to the existence of adipose tissue, body insulin resistance, urine chemicals, and a growing waist circumference and high BMI. Overweight individuals are more likely to develop stones because their bodies release more calcium and uric acid. Research indicates that 13% of obese men and 6.9% of obese women may get kidney stones at some point in their lives. It is precisely twice as many patients as those with a balanced weight, meaning that 8.7% of men and 8% of women experience kidney stones, or 4.4% of the total population (5).

Obesity can raise the risk of kidney stones by causing insulin resistance and elevated calcium levels in the urine. According to a study, a person's risk of kidney stones was raised by their body mass index (BMI), large waist circumference, and obesity from the start of adolescence. Kidney stones can also be an issue for people who do not participate in sports or physical activities (6).

Very specific dietary components have recently been shown to enhance the incidence of kidney stones. These include consuming more protein, less potassium, less hydration, and, to some extent, more sugar. It is assumed that all these dietary factors act by changing urinary composition. In support of this idea, it has been reported that the risk of stones is lower among people whose food intake is close to that of a diet with dietary approaches to stop high blood pressure. Fatty dairy products and low protein indicate it. Given these observations, it is tempting to conclude that common dietary habits explain both obesity and kidney stones, as obese individuals are more likely to eat more and more unhealthy food (7). This study aimed to investigate the relationship between body mass index (BMI) and kidney stones in children referred to the Kausar Clinic in Ardabil.

Materials and Methods

The present study was a case-control study conducted on 182 children aged 2 to 15 who were referred to the Nephrology Clinic of Kausar Center in Ardabil. The case group consisted of 91 children with kidney stones, and the control group consisted of 91 children with normal ultrasound.

The two groups were matched in terms of age and sex. The study included children without any underlying conditions that affected their BMI (Cushing's syndrome, hypothyroidism) or kidney stones (hyperparathyroidism, multiple myeloma, vitamin D overdose, DRTA, and Barter). The parents of the youngsters gave their consent

to take part in the study. The study does not include children under two or those above fifteen. A nephrologist performed a clinical examination on the kids before requesting a urine test to check for kidney stones. Ultrasound was the gold standard for diagnosing stones. A checklist with questions based on the study's goals was used to gather information. For childhood obesity, a BMI equal to or greater than 95% and the 85-95th percentile was considered overweight. Data were analyzed using SPSS version 26 software. Qualitative variables were described as number (percentage), and quantitative variables were described as mean (standard deviation).

The analysis used the univariate logistic model to investigate the relationship between BMI and kidney stones, and the odds ratio was reported. A significance level of less than 0.05 was considered.

Results

Among the children, 38.5% of the case group and 54.9% of the control group were boys. Most people were in the age group of 5 to 10 years (48.9%).

The average body mass index was 17.5, with a standard deviation 3.7. 68.7% of the participants used tap water for drinking water (Table 1).

Table 1. Characteristics of the study population by case and control groups

Variable	class	Case group, n (%)	control group, n (%)	Total, n (%)
sex	Male	35 (38.5)	50 (54.9)	85 (46.7)
	Female	56 (61.5)	41 (45.1)	97 (53.3)
age	Under 5 years	37 (40.6)	16 (17.6)	53 (29.1)
	5-10 years	40 (44.0)	49 (53.8)	89 (48.9)
	Above 10 years	14 (15.4)	26 (28.6)	40 (22)
Body mass index (mean ± standard deviation)		17.1±3.5	17.8±3.8	17.5±3.7
Type of water used	plumbing	64 (70.4)	61 (67)	125 (68.7)
	refined	11 (12.1)	14 (15.4)	25 (13.7)
	mineral	10 (11)	15 (16.5)	25 (13.7)
	fountain	6 (6.5)	1 (1.1)	7 (3.9)
The number of glasses of water consumed	3	11 (12.5)	6 (6.6)	17 (9.5)
	4	27 (30.7)	18 (19.8)	45 (25.1)
	5	18 (20.5)	17 (18.7)	35 (19.5)
	6	22 (25)	24 (26.3)	46 (25.7)
	7	9 (10.2)	20 (22)	29 (16.2)
	8	1 (1.1)	6 (6.6)	7 (3.9)

One stone was present in the largest proportion of children (57.6%). In addition, 22.0 of the stones were larger than 5 mm, while 33% were smaller than 2 mm. These findings demonstrate that children with kidney stones varied in both the quantity and size of stones (Table 2).

Kidney stones were 1.89 times more common in girls than in boys. With a significant odds ratio of 6.27 (95%CI:1.23-53.47), those who drink fountain water are more likely to develop kidney stones than those who drink other types of water (Table 3).

Table 2. Determining the number and size of stones in children with kidney stones (case group)

Variable	class	n	%
Number of stones	1	52	57.1
	2	21	23.1
	3 and more	16	17.6
	Unknown	2	2.2
Size of stones	< 2 mm	30	3.3
	2-3	20	22
	3-4	8	8.8
	4-5	13	14.2
	>5 mm	20	22

Table 3. The relationship between body mass index and kidney stones in children according to the investigated variables based on the univariate model

Variable	class	OR	CI	p-value
sex	Boys	Ref	-	-
	Girls	1.89	1.03-3.3	0.030
age	Under 5 years	3.70	1.93-8.50	0.002
	5-10 years	1.51	0.73-3.26	0.28
	Above 10 years	Ref	-	-
Body mass index (mean ± standard deviation)		0.95	0.86-0.104	0.245
Type of water used	plumbing	Ref	–	–
	refined	0.76	0.32-1.70	0.54
	mineral	0.58	0.24-1.35	0.20
	fountain	6.27	1.23-53.47	0.04
Amount of consumed water		0.73	0.58-0.91	0.006

Discussion

Kidney stones are one of the problems among children that can have serious effects on their health. This research investigated the relationship between body mass index (BMI) and kidney stones in children referred to the Kausar Clinic in Ardabil. Also, the relationship between factors such as gender, age, and the type of water consumed with kidney stones was investigated. The results of the present study showed that the highest frequency of the investigated people was in the age group of 5 to 10 years. Also, the average body mass index of the studied subjects was 17.5, with a standard deviation of 3.7. The results showed that most children had one stone, one-third had stones below 2 mm, and 22% had stones larger than 5 mm. The univariate regression model showed no relationship between body mass index and kidney stones in children. However, girls, children under 5 years of age, and mineral and spring water users have a higher chance of suffering from kidney stones, which was statistically significant.

In connection with this issue, obesity in children has also become a more serious problem; 13.9% of children aged 2-5 years, 18.8% of children aged 6-11 years, and 17.4% of adolescents aged 12-19 years in the United States are obese (8). In Iran, the prevalence of overweight and obesity in children under the age of 18 is estimated at 20 and 13.5%, respectively (9). The results of this investigation demonstrated that there was no link between childhood obesity and kidney stone development. Conversely, Taylor et al. examined the connection between kidney stones and rising body mass index. This study found that kidney stones and greater body mass were significantly associated with an elevated risk (5). According to Siner et al., a higher body mass index (BMI) disrupts the equilibrium of the urine and raises parameters such as the pH of the urine dropping, the calcium level rising, and the excretion of uric acid in the urine increases, all of which lead to the production of stones (10).

Taylor and Korhan also found that while there was no discernible difference in urinary calcium oxalate saturation in favor of an increased risk of stone formation, high BMI was linked to a drop in urine pH and increased excretion of calcium oxalate and uric acid. However, they found that uric acid saturation was elevated and concluded that uric acid saturation is the main cause of stone formation associated with obesity (11). According to preliminary research, children and adults may experience various metabolic alterations that result in the development of stones. Children were expected to have urinary concentrations of calcium, oxalate, citrate, uric acid, and urine pH within the normal range, according to Difor et al.'s characterization of the urinary metabolic profile of normal children, which revealed notable variations from normal adults. Furthermore, saturation levels of uric acid were much lower, those of calcium phosphate were significantly higher, and those of calcium oxalate were not different (12). Higher BMI was linked to higher urine pH, higher calcium phosphate saturation, and lower urinary calcium oxalate, according to a recent study by Isner et al. that examined the relationship between BMI and urinary metabolic profile in children with kidney stones (13).

In the study of Kieran et al., there was no correlation between BMI and kidney stones in children (14). Kim et al.'s study indicated that the pathophysiology of kidney stone formation in children may be distinct from the adult population and provided further evidence to support the role of BMI in kidney stones (15).

The studies mentioned above have reported different results, some of which agreed with the results of the present study and some of which conflicted with the present study. This issue could be due to the differences in the studied populations. Racial, ethnic, and climatic differences are known risks for kidney stone disease. Also, access to medical care and diagnostic tools plays an important role. Among other influential factors, metabolic abnormalities, urinary tract infections, and anatomical abnormalities can also be responsible for the occurrence of this disease.

Contrary to the results of our investigation, Siner et al.'s study revealed that obese men are more susceptible to kidney stone formation than obese women (10). The results of this study were consistent with the current investigation (16), which found that girls were more susceptible to the issue of obesity with higher risk factors for urinary stone formation than boys. On the other hand, there was no discernible link between kidney stones and gender in the study by Novak et al. (17). The findings of the current study are at odds with the findings of Kim et al.'s investigation, which found no significant association between kidney stones and gender (15). Although some studies indicate that the risk is highest for women in their late 20s and 30s (18–20), the risk of kidney stones increases with age in adults, peaking in the 50s and 60s- findings from pediatric research point to a lower risk at earlier ages. According to a 12-year study, the prevalence peaked in children ages 0–3 (0.6 per 100,000) and rose until puberty (2). This outcome aligns with the current study's findings. Having a suitable control group that matches the case group in terms of gender and age is one of the research's strengths. The lack of clarity and access to data on crucial factors like dietary intake and genetic traits, medical care, advanced imaging techniques, and potential abnormalities that may be significant contributors to kidney stones in children are among the study's significant limitations. Berkson bias may result from the use of hospital controls. One bias associated with medical research that might arise in case-control and clinical investigations is the Berkson bias. The choice of the hospital control group could be the source of this bias. This bias may impact the validity and accuracy of the findings. The findings of this study might not apply to all kids.

Conclusion

The current study demonstrated that kidney stones and body mass index did not significantly correlate. However, compared to boys and children under five, kidney stones were more common in girls. It is recommended that additional clinical research be done to determine the precise contribution of being overweight to kidney stone development. In the context of additional variables, a more comprehensive picture of the association between kidney stones and body mass index can be obtained by performing cohort studies and tracking individuals for several years. Additional factors influencing this association should be investigated through multi-center research with a sizable sample size.

Conflict of Interest:

None

Declarations

Ethics approval and consent to participate

The present research was submitted to the ethics committee of Ardabil University of Medical Sciences and was approved with the code IR.ARUMS.MEDICINE.REC.1402.137. All participants filled out the consent form.

Consent for publication

All authors have consented to publishing this paper.

Funding

None

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