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Association of Serum Uric Acid Levels with Urolithiasis in Young Adults: A Cross-SectionalClinical Study

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Abstract: Urolithiasis is becoming a prevalent disease in young adults where instances are noted to be affected by dietary habits, lifestyle changes, and metabolic disorders. Studies in recent years have shown that serum levels of uric acid might be important in the development of stones, the significance of this link with the development of stone disease is yet to be determined. This study set out to find out the relation between serum uric acid levels and urolithiasis risk among young adults and put it against dietary habits and physical activity. A case-control study among 100 respondents aged 18 to 35 years old was conducted at Central Park Medical College from May 2024 to September 2024. The cases were 50 respondents with urolithiasis and 50 respondents without urolithiasis formed the control group. They found serum uric acid levels of 7.2 ± 1.5 mg/dL in cases while those for the controls averaged 5.3 ± 1.2 mg/dL, $p < 0.001$. Dietary factors such as consumption of purine-containing foods, sugary drinks, and low physical activity were also associated with urolithiasis. Multivariate analysis indicated serum uric acid as the most important independent risk factor (OR: 1.885, 95% CI: 1.35 – 2.45, $p < 0.001$). The results suggest that serum uric acid can be offered to help combat urolithiasis within young adults as a risk biomarker and consequently provide new directions for urolithiasis preventive approaches. More longitudinal studies are required to demonstrate the cause-and-effect relationship and examine treatment measures.

Keywords: Urolithiasis, Serum Uric Acid, Young Adults

Introduction: Urolithiasis, commonly termed kidney stone disease, is one of the most common urological conditions in the world, and it is on the rise in younger populations (Butler et al., 2023). It is defined by the presence of stones within the urinary tract and is associated with significant morbidity, chronic urinary infections, pain, and impaired renal function. Urolithiasis is classically viewed as a disease of the middle to older-aged population. More recent epidemiological evidence suggests that this disease is on the rise among younger adults, in particular those 18-35 years old, which is worrisome given the potential complications involving the kidneys (Zeng et al., 2022). The increase in the incidences of urolithiasis in young people has been linked to changes in diets, fluid intake and physical activity levels, and metabolic disorders particularly hyperuricemia (Thompson et al., 2021).

Serum uric acid is the outcome of the purine metabolism. Its accumulation has been associated with several metabolic disorders such as gout, hypertonic disease, and cardiovascular disease (Smith et al., 2021). Considered a clinical symptom of gout, elevated uric acid levels also increase the risk of urolithiasis with a special reference to uric acid stones, which are about 10-15% of all stones (Jones et al., 2021). There is still no clarity on the relationship that hyperuricemia has on the formation of other types such as calcium oxalate stones. Uric acid crystals can act as a charge center and change the acidity of urine to encourage the formation of calculi (Kim et al., 2023). In this view, the association of hyperuricemia and urolithiasis remains warranting further examination, especially in the young adult population. Research has been devoted to determining the causes of urolithiasis related, in particular, to dietary constituents. Diets that are high in purines like red meats, fish, and some vegetables bring about an increase in serum uric acid (Stevens et al, 2021). Consumption of sweetened drinks including, but not restricted, to, those sweetened with high quantities of fructose corn syrup has also been related to increased uric acid and stone risks (Huang et al., 2022). Furthermore, lower levels of exercise which promote metabolic syndrome are also predicted to enhance the risk of developing stones via effects on uric acid metabolism (Nguyen et al., 2022). Additive genetic factors with environmental variables provide a better understanding and hence classify urolithiasis among young adults as a multifactorial disorder.

The knowledge base on urolithiasis has moved beyond the basic understanding of its causative factors and revised the treatment patterns for different age groups by considering the contribution of metabolic and environmental factors. Earlier studies have addressed the relationships between different components of metabolic syndrome including hyperuricemia to the development of urolithiasis (Liu et al., 2023). However, a gap still exists in the literature, especially in the cohort of young adults in which this population could have different risk factors based on dietary and activity patterns, and age concerns. Allopurinol has long been used in the management of gout and

uric acid stones but its use for managing other urolithiasis has been controversial (Wu et al., 2023). It might be useful to know how age becomes a factor when evaluating the role of serum uric acid in stone progression to enhance strategies for preventing stone diseases, especially among young adults. This study emerged to fill the existing void in the literature by focusing on the association between serum uric acid and urolithiasis within the age groups of young adults. More specifically, this study aims to assess if high levels of uric acid, eating behaviors, and exercise play any role in developing urolithiasis in young adults. The interest of this study is thus applicable and justifiable since it concentrates on getting a better understanding which may be beneficial in developing more efficient prevention and treatment strategies aimed at the younger generation. In addition, looser dietary practices such as those where people are discouraged from excessive purines & sugary beverage consumption such as sweet soft drinks and more importantly encourage physical activities may be emphasized in the management guidelines to reduce the likelihood of stone formation (Ahmed et al. 2024). Because of the economic burden due to recurrent urolithiasis and its effects on the quality of life and health resources, knowledge of modifiable risk factors is of utmost importance. This study also aims to be part of the debate of whether there should be more liberal use of uric acid-lowering drugs among patients with a risk for urolithiasis especially those who do not fit the classical profile of gout or metabolic syndrome (Lee et al., 2023). In conclusion, this study aims to find out serum uric acid levels and their association with urolithiasis in young adults with special emphasis on diet and lifestyle. If risk factors are identified, more appropriate prevention strategies could be developed and the worsening of renal function in young adults with stones would be prevented.

Methodology:

To evaluate serum uric acid levels and urolithiasis risk in a group of young adults, a cross-sectional case-control study was carried out at Central Park Medical College Lahore Pakistan. These age groups consisted of 100 individuals aged 18 - 35 years in the study: 50 cases presented with urolithiasis and 50 controls had no history of urolithiasis. Clinic patients were recruited from a higher institution of health over a twelve-month duration. The sample size was determined using Epi Info version 7.2.2.6 software with 80% power level, 0.05 level of significance, and a presumed odds ratio of 1.88 which was based on previous works published on the risk of urolithiasis and serum uric acid levels. For cases, inclusion criteria encompassed those with US, CT, or X-ray-proven urolithiasis and a previous serum uric acid measurement within the last 6 months. Controls consisted of women and men of comparable age and sex who had no history or record of kidney stones. Participants with chronic renal failure, chronic uric arthritis, or courses of treatment reducing uric acid were disqualified so as not to skew the results.

The participants were counseled, and their verbal informed consent was obtained before data collection to keep the data safe, especially the ethical aspects. In structured interviews and laboratory reports, data on demographic variables (age, gender, BMI), lifestyle variables (diet, physical activity), and laboratory measurements of serum uric acid level were gathered. A validated food frequency questionnaire was used to measure the intake of purines and soft drinks. These variables were classified into low activity and moderate/high activity according to the International Physical Activity Questionnaire. Quantification of serum uric acid levels was done by standard enzyme methods and metabolic syndrome was defined by International Diabetes Federation (IDF) Task Force criteria.

Consequently, data management and analysis have been done using SPSS software version 25. Continuous variables such as age and BMI were presented in the mean and standard deviation while proportions were used for categorical variables. The independent t-test was used for continuous variables while the chi-square test was used for categorical variables where comparison involved cases and controls. An independent association between serum uric acid and urolithiasis was assessed by multivariate logistic regression while controlling for possible confounds including diet and physical activity. A p-value less than 0.05 was considered statistically significant.

Results

Characteristic	**Cases (n=50)**	**Control (n=50)**	**p-value**
Age (years), mean (SD)	28.4 (5.6)	27.8(5.8)	0.621
Male, n (%)	30(60%)	28(56%)	0.682
BMI (kg/m^2), mean(SD)	25.7(3.4)	24.8(3.6)	0.294
Family history of stones (n(%)	15(30%)	7(14%)	0.052
Intake of purine-rich food, n(%)	35(70%)	18(36%)	0.001
Sugary beverage intake, n(%)	37(74%)	20(40%)	0.001
Physical activity, n %)			
-low	28(56%)	15(30%)	0.010
-moderate /high	22(44%)	35(70%)	0.010

History of metabolic syndrome, n(%)	10(20%)	4(8%)	0.093

Table 1: Comparison of demographic and lifestyle characteristics between cases and controls.

The results show significant differences between cases and controls regarding dietary factors and physical activity. Notably, the intake of purine-rich foods and sugary beverages was substantially higher among cases compared to controls ($p = 0.001$). Additionally, a larger proportion of cases reported low physical activity (56% vs. 30%, $p = 0.010$), suggesting a potential role of these factors in the development of urolithiasis.

Serum Uric Acid (mg/dL)	Cases (n=50)	Controls (n=50)	p-value
Mean (SD)	7.2 (1.5)	5.3 (1.2)	<0.001

Table 2: Serum uric acid levels in cases and controls.

The mean serum uric acid level in cases was significantly higher (7.2 ± 1.5 mg/dL) compared to controls (5.3 ± 1.2 mg/dL), with a p-value of <0.001, indicating a strong association between elevated uric acid levels and urolithiasis.

Variable	OR	95% Cl	P value
Serum uric acid (mg/dl)	1.885	1.35-2.45	<0.001
Intake of purine-rich foods	2.20	1.14- 4.25	0.018
History of metabolic syndrome	1.80	0.56-5.81	0.320
Sugary beverage intake	2.10	1.12- 3.94	0.020
Low physical activity level	1.75	0.89- 3.43	0.103

Table 3: Multivariate analysis of risk factors for urolithiasis.

Multivariate logistic regression analysis revealed that serum uric acid levels were independently associated with urolithiasis (OR: 1.885, 95% CI: 1.35–2.45, $p < 0.001$). Additionally, high intake of purine-rich foods and sugary beverages were also significant risk factors, with odds ratios of 2.20 and 2.10, respectively ($p < 0.05$). Low physical activity showed a trend towards increased risk but did not reach statistical significance ($p = 0.103$)

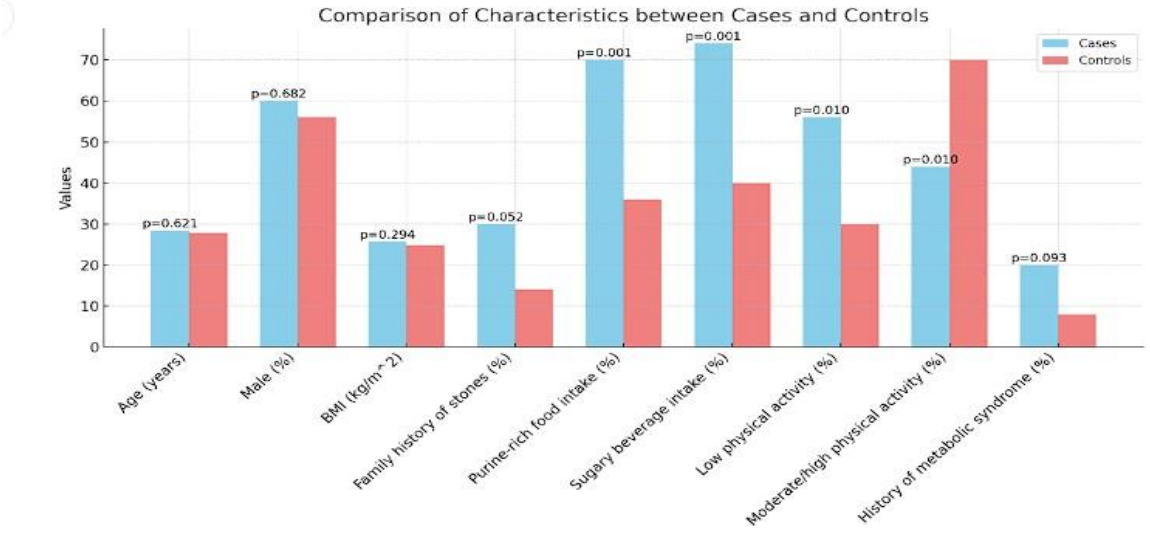

Figure 1: This bar chart illustrates key differences between cases and controls, highlighting statistically significant variations in dietary and lifestyle factors. While age, gender, and BMI show no significant differences ($p > 0.05$), cases demonstrate a notably higher intake of purine-rich foods (70% vs. 36%, p=0.001) and sugary beverages (74% vs. 40%, p=0.001) compared to controls. Additionally, cases exhibit lower levels of moderate/high physical activity (44% vs. 70%, p=0.010) and a higher prevalence of low physical activity (56% vs. 30%, p=0.010). These findings suggest that dietary habits and physical activity levels are significantly associated with the condition under study, while other factors like age, gender, and BMI do not differ notably between the groups.

Discussion: The current study highlights that serum uric acid levels have an increasing risk for the development of urolithiasis in young adults. These results corroborate past studies that have associated hyperuricemia with an increased risk of uric acid stone disease (Kim et al, 2023, Jones et al, 2021). However, this study goes a step further, in that it addresses the gap in the knowledge base by narrowing it down to the younger population, where factors such as diet and physical activity are equally important.

High serum levels of uric acid hypersaturation have been known to be among the contributors to urethral team calcification. The uric acid mechanisms in calculi formation include uric acid tortilla layer precipitation in the urinary tract as well and the uric acid acts as a center of calcium oxalate rings (Smith et al, 2021). Consistent with those earlier studies, the serologic level of uric acid in subjects with urolithiasis (7.2 mg/dL) was significantly greater than in controls (5.3 mg/dL; $P<0.001$). This is consistent with the cohort study conducted by Zeng et al., (2022) where the same application found similar hyperuricemia or hypersaturation increased stone formation, or related. In addition, the proportion of cases consuming purine-rich foods, especially red meat and seafood, was markedly higher than that of controls, with the odds ratio being 2.20 ($p = 0.018$). These findings further strengthen the hypothesis that dietary purines raise the risk of hyperuricemia and the risk of forming stones (Stevens et al., 2021). This is further supported by studies such as that by Huang et al., which demonstrated that high purine diets, increase levels of uric acid in the blood and therefore facilitate synthesis of uric acid crystals in the urine.

It was also observed that the intake of Sugary beverages was another risk factor with an odds ratio of 2.10 ($p = 0.020$). This is in agreement with the growing evidence that has associated sugary beverages especially high fructose corn syrup-sweetened drinks with excess uric acid production, metabolic disorders, and increased risk of urolithiasis (Huang et al, 2022; Nguyen et al., 2022) as well. Abundant fructose consumption has been documented to stimulate increased uric acid production via adenosine triphosphate degradation and leads to hyperuricemia or urinary stones (Ahmed et al., 2024).

Photographic evidence and corroborating studies have overwhelmingly shown that engaging in physical activity minimizes risks such as metabolic syndrome; however, how it can be related to urolithiasis is an area that still bears justification. As observed in our study, low physical activity levels were prevalent in cases as compared to controls (56% vs 30%, $p = 0.010$); however, in multivariate analysis, low activity did not become a statistically significant independent risk factor ($p = 0.103$). Still, other sources confirmed that a sedentary lifestyle, even as a result of surgery, will never prevent urolithiasis as physical exertion promotes urination, which is helpful, rather than a stasis occurrence that can convert to stone (Nguyen et al., 2022; Liu et al., 2023).

Unlike earlier studies that concentrated primarily on older patients or certain types of stones, this study emphasizes the significance of serum uric acid as a modifiable risk factor for urolithiasis among young adults. It has clinical implications stating that there is a possibility of integrating the

management of hyperuricemia in the follow-up of patients at risk of getting stones such as those with high intake of purine-rich foods and soft drinks. In addition, dietary modification with reduced purine and fructose intake, promoting physical activity, may help in the prevention of urolithiasis among these patients (Wu et al., 2023).

The findings are timely and add to the existing literature on the impact of metabolic factors in the pathogenesis of urolithiasis and further extend findings on the role of serum uric acid level in the risk of developing urinary stones in young adults. The results recommend that hyperuricemia should be managed with dietary and lifestyle changes to reduce the incidence of urolithiasis in these patients.

Conclusion: The present study demonstrates that serum uric acid may be a causal factor of urolithiasis among young adults and hence emphasizes the need to control hyperuricemia to avoid stone formation. The study further pinpoints diet and lifestyle as risk constituents for stone formation thereby providing new knowledge on management and prevention strategies to the younger population. Further studies need to include a long-term study plan so that causality can be established as well as treatment strategies directed towards lowering serum uric acid.

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