



Nutritional risk factors and recurrence of urinary lithiasis

Factores de riesgo nutricionales para la recurrencia de las litiasis urinarias

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ABSTRACT

Introduction: the recurrence of kidney stones has been increasing in recent years; inadequate diet is one of the risk factors that can favor its appearance and recurrence. **Objectives:** we carried out an updated bibliographic review about the nutritional risk factors that favor the recurrence of urinary stones. **Methods:** a systematic review of updated literature was carried out in national and international databases. **Analysis and integration of information:** when evaluating the information obtained, the influence that nutritional risk factors can have on the development and recurrence of urinary stones and the way it can be prevented with dietary compliance was observed. **Conclusions:** nutritional risk factors constitute an essential component in the appearance and recurrence of urinary stones.

Keywords: urolithiasis; risk factors; recurrence; diet, nutrition.

RESUMEN

Introducción: La recurrencia de la urolitiasis ha venido en aumento en los últimos años, la dieta inadecuada es uno de los factores de riesgo que pueden favorecer su aparición y recidiva. **Objetivo:** Realizar una revisión bibliográfica acerca de los factores de riesgo nutricionales que favorecen la recurrencia de las litiasis urinarias. **Método:** Revisión bibliográfica de literatura actualizada en bases de datos nacionales e internacionales. **Análisis e integración de la información:** al evaluar la información obtenida se observó la influencia que pueden tener los factores de riesgo nutricionales en el desarrollo y recidiva de las urolitiasis y la manera que se puede prevenir con el cumplimiento dietético. **Conclusiones:** los factores de riesgo nutricionales constituyen un componente esencial en la aparición y recurrencia de las urolitiasis.

Palabras clave: urolitiasis; factores de riesgo; recurrencia; dieta, nutrición.

INTRODUCTION

Urolithiasis is a common condition, affecting 5–12% of the population. Lifetime prevalence ranges from 1 to 15%, with variations according to age, sex, ethnicity, geographic location, hydration status, climate, genetic predisposition, and other factors, including dietary factors.¹

The population of developed countries experiences a symptomatic episode before the age of 70 years, with a somewhat lower incidence in Asia (1–5%).¹ Among these countries, the United States has shown a progressive increase in prevalence over the last four decades, secondary to the increased incidence of metabolic syndrome, which has raised the risk by 30%.²

Likewise, in countries such as Colombia, Mexico, Spain, and Ecuador, the disease is common and represents a current health problem.³ In Cuba, the prevalence of urolithiasis is considered to be no less than 8% in the adult population, and to date there are no large epidemiological studies that have examined disease recurrence or its risk factors; therefore, national data remain limited.^{4,5}

Once a patient develops a kidney stone, the probability of recurrence is 11% at 2 years, 20% at 5 years, 31% at 10 years, and 39% at 15 years. It is considered an important cause of morbidity because of symptoms such as pain, infection, and obstruction, and it represents a risk factor for chronic kidney disease.^{6,7} Recurrence is one of the most important epidemiological problems because it increases disease morbidity, affects the function of the involved renal unit, and raises healthcare costs.

Numerous factors inherent to human biology and several sociodemographic variables have been identified as favoring the development of kidney stones. Likewise, unhealthy lifestyles and concomitant diseases such as arterial hypertension and diabetes mellitus may increase the risk of their occurrence and recurrence.⁷

Because nutritional habits play an important role in the genesis and recurrence of urolithiasis, dietary interventions are a fundamental tool in its management. Diet is an important consideration among risk factors; foods rich in oxalic acid, sodium, protein, purines, and fructose, together with low fluid and calcium intake, have been associated with an increased frequency of the disease.⁸

Several studies have demonstrated a relationship between nutritional habits and recurrence of urolithiasis. An example is the study by Lorduy Gómez et al.,⁹ in which overweight showed a statistically significant value compared with other independent variables, implying a greater risk of recurrence. Likewise, Romero et al. in 2020,¹⁰ found that 51% of patients with obesity had some metabolic abnormality in their stone profile.

Regarding food consumption, studies show that the risk of recurrence has been associated with the intake of citrus fruits, coffee, and dairy products, as reported by Méndez, Martínez, and others.^{11,12} They also concluded that stone composition varies according to the dietary behaviors of the population.

Although published studies on coffee are conflicting, a low association between its consumption and the development of urolithiasis was found in the United States. However, another study published in the *European Journal of Nutrition* reported that caffeine consumption was independently and linearly associated with a higher risk of recurrent kidney stones in adults, particularly in women and non-White individuals.^{13,14}

At present, few studies address how nutritional factors influence recurrence. The objective of this literature review is to assess the most up-to-date information on nutritional risk factors that may favor recurrence of urolithiasis.

METHODS

A literature review was conducted between January and March 2026. The descriptors “urolithiasis” OR “ICT” AND “nutritional risk factors” were defined. The review was performed in the Cuban Virtual Health Library, LILACS, Google Scholar, SciELO, Springer, Semantic Scholar, and Science Research. The search considered the presence of the descriptors in the “keywords” field.

The search retrieved 4,000 articles, to which a series of filters was applied to refine the results. After applying the recency filter (last five years), 2,500 articles remained. A language filter was then applied to obtain only articles written in Spanish, refining the search to 2,100.

The process continued by excluding citations, yielding 2,000 articles. Finally, a filter was applied to retrieve books, review articles, and publications closely related to the study topic, resulting in a total of 250 articles. To refine this final set further, after no additional filtering options were available in the bibliographic databases, a selection process was carried out. The following criteria were considered:

1. Selection of articles based on title and abstract to eliminate literature that was irrelevant or not aligned with the study topic.

2. Full-text reading to ensure that the selected studies included the relevant information and data to be extracted for subsequent analysis, and to eliminate those that were not relevant.

3. A secondary search based on reviewing the references and citations of the selected studies for subsequent inclusion.

Sources meeting the following characteristics were considered for inclusion in the study:

- Articles related to the topic under study
- Articles providing access to the full text
- Peer-reviewed articles
- Publication period (2026)
- Articles written in Spanish
- Articles considered by the authors even when they did not meet all the preceding inclusion criteria.

DEVELOPMENT

Uroliths are concretions of different mineral salts incorporated into an organic matrix that originate in the kidney or urinary tract. Their chemical composition may vary according to geographic, climatic, and socioeconomic conditions. In terms of composition, 60–70% consist of calcium oxalate (alone or with apatite), followed by uric acid stones in 10–15%, ammonium magnesium phosphate (struvite) in 10% of cases, calcium phosphate/apatite in 7%, brushite in 1%, and cystine in 1%; the studies reviewed confirm these proportions.¹⁵

In the current year, Leslie¹⁶ devoted a chapter of his book to stone composition in patients with urolithiasis. Calcium stones (76.6%), struvite (13.5%), uric acid (7.8%), and cystine (2.1%) were identified. These findings were similar to those reported in several countries but differed from those of other regions because of specific sociocultural and nutritional factors.¹⁷

In the study by Bacallao Méndez et al.,⁴ the study population consisted of Cuban patients aged 19 years and older. Urolith composition studies were performed at the “Dr. Abelardo Buch” Institute of Nephrology in Havana; calcium stones were the most common, particularly calcium oxalate stones (50.9%), consistent with previous research.

Mechanisms of urinary stone formation

The pathogenesis of urolithiasis involves physicochemical changes, including urine saturation with urinary solutes, a lack of inhibitory substances, and urinary stasis. For a stone to develop, dissolved salts must saturate the urine and condense into a solid phase.¹⁷

Many factors influence stone formation, including low urine volume, high urinary excretion of calcium, oxalate, and urate, and changes in urinary pH (a low urinary pH below 5.5 favors uric acid stone formation, whereas an alkaline pH promotes calcium phosphate stone formation, generally when the pH is 6.5 or higher).¹⁷

The sequence of stone formation begins with urine saturation, followed by supersaturation, nucleation, crystal growth, aggregation, crystal retention, and subsequent urinary stone formation. Most urinary stones (70–80%) contain calcium and consist of oxalate, phosphate, or a combination of both.¹⁸

Approximately 10–15% of urinary stones are composed of struvite. These stones are often associated with infection by urea-degrading bacteria, including *Proteus*, *Klebsiella*, *Corynebacterium* species, and *Staphylococcus*, which are also common causes of staghorn calculi and increase urinary pH.¹⁸

On the other hand, 10% of urinary stones contain uric acid, and the literature indicates that 25% of patients with gout are predisposed to this type of urolithiasis. In addition, 1% of patients with urolithiasis have cystine stones, which occur in patients with cystinuria, a genetic disorder that alters amino acid transport.¹⁹

Prevention of recurrent kidney stones is based on several medical and dietary approaches aimed at increasing urine volume, reducing the excretion of pro-lithogenic solutes such as calcium, oxalate, and uric acid, and increasing the excretion of substances that protect against kidney stone formation, such as magnesium, potassium, and citrate. The result is a reduction in urinary supersaturation with lithogenic salts.

Nutritional risk factors for urinary stone formation

Nutritional exposure is one of the most important factors involved in the increasing frequency of nephrolithiasis in the general population. Dietary counseling and nutritional modifications are now understood to be crucial for preventing recurrence, while also helping to prevent associated systemic disorders and cardiovascular risk. 20

The aim of the diet is to confer anti-lithogenic characteristics on the urine by controlling the dietary factors involved, such as calcium, oxalate, protein, sodium, citrate, fluids, among others.

Overweight and obesity are among these factors and form part of a metabolic disorder that leads to cardiovascular and musculoskeletal problems that consequently affect renal function. Rodríguez Pastoriza et al. 21 demonstrated this in a publication in which they observed a direct correlation between overweight patients (44.6%) or patients with obesity (22.9%) and the development of this condition, as did Bacallao Mendez et al. 4

Likewise, in the study by Zeng et al., 22 patients with an obesity phenotype had a high risk of urolithiasis, reflecting the strong predisposition of these patients to develop the disease.

Kidney stones and diabetes mellitus are related because diabetes increases kidney stone formation, while its prevalence is also higher among patients with nephrolithiasis. These patients have insulin resistance and altered renal acid-base metabolism, resulting in lower urinary pH and increased uric acid stone formation. In addition, this condition is associated with dietary disorders in which patients consume large amounts of nutrients that favor stone formation. 23

This was demonstrated in studies by Shusheng Zhu and Sandy Olivares, 24, 25 both of which showed that uric acid stone formation was more frequent in patients with diabetes.

Among all dietary interventions aimed at reducing the risk of kidney stones, insufficient fluid intake is one of the most important factors because it is associated with the incidence of nephrolithiasis; for every 200 mL of fluid consumed per day, the risk of kidney stones is reduced by 13%. Therefore, patients with this condition should maintain sufficient fluid intake to consistently produce at least 2 liters of urine per day.

To achieve this goal, the best approach is to recommend the additional amount of fluid the patient should drink based on 24-hour urine volume. 19 For example, if total urine volume is 1.5 liters, two additional 8-ounce (240 mL) glasses of fluid per day are recommended to achieve the goal of at least 2 liters of urine output per day. 26

However, many beverages do not provide this benefit. Carbonated and sugar-sweetened beverages may increase the excretion of calcium, oxalate, and uric acid and are associated with a higher risk of kidney stone formation; therefore, nephrolithiasis risk is greater in people who consume larger amounts of these beverages. 27

A study including 194,095 participants showed a higher risk of kidney stones with consumption of one or more servings of cola. In contrast, when compared with coffee (>500 mg/day of caffeine), the risk of recurrence was significantly lower; caffeine therefore appears to have a protective effect because it was associated with higher urinary potassium excretion, lower urinary calcium and oxalate excretion, and greater urine volume. 26,28

The relationship between caffeine and recurrence of urolithiasis is contradictory because, as outlined above, some studies support a protective association whereas others indicate a predisposition to stone development. We therefore believe that further research on this topic is needed.

Fruit juices have not been shown to represent a risk for kidney stone development. In people with high orange juice consumption, a 12% reduction in stone risk has been observed; similarly, frequent lemonade consumption reduced the stone formation rate from 1.00 to 0.13 stones/patient/year. This is attributed to the low fructose and high citrate content, which provide an alkali load, increase urinary citrate excretion and net gastrointestinal alkali absorption, and raise urinary pH. 26, 29

Sodium intake increases urinary calcium excretion and decreases citrate excretion, favoring crystallization of calcium oxalate crystals. This occurs because calcium is passively reabsorbed in the proximal tubule along the favorable concentration gradient created by sodium and water reabsorption. 30 Therefore, a low-sodium diet (80–100 mEq/day) may improve proximal sodium and calcium reabsorption and reduce calcium excretion.

This is supported by Tang's study 30 on sodium intake and the presence of urolithiasis, in which patients with high sodium intake and lower potassium intake were associated with a greater risk of urolithiasis. In light of the above, when urinary calcium excretion is high and estimated dietary sodium is also high (urinary sodium excretion >200 mmol/day), introducing a low-sodium diet is always recommended.

However, this can be very difficult to achieve given current dietary culture worldwide, in

which processed foods with a high sodium content are widely consumed. These foods include: 30

Proteins are essential for proper nutrition, and their properties also influence kidney stone disease. A high dietary content of non-dairy animal protein (poultry, meat, fish, eggs), together with low-alkali foods, is believed to be harmful to kidney stone formers because it may cause negative calcium balance, low urinary pH, and decreased urinary excretion of citrate, potassium, and magnesium. 19

Animal protein increases purine metabolism and contributes to hyperuricosuria in both uric acid and calcium nephrolithiasis. In addition, high intake also appears to affect urinary oxalate excretion in idiopathic calcium nephrolithiasis with or without mild metabolic hyperoxaluria.

Table 1. Dietary sodium and potassium intake and prevalence of kidney stones: National Health and Nutrition Examination Survey 2011–2018

Foods with the highest sodium content
Smoked, cured, or canned meat (bacon, ham, sausages)
Smoked or canned fish (sardines, caviar, anchovies)
Prepackaged or canned main dishes (ravioli, chili)
Parmesan cheese, soy sauce, mustard, tomato sauce.

<https://pmc.ncbi.nlm.nih.gov/articles/PMC11279477/>
Source: (30). Tang J, Sammartino C, Chonchol M. Dietary Sodium and Potassium Intakes and Kidney Stone Prevalence: The National Health and Nutrition Examination Survey 2011-2018. *Nutrients*. 2024. [Accessed January 20, 2026];16(14):2198. Available from: <https://pmc.ncbi.nlm.nih.gov/articles/PMC11279477/>

Epidemiological evidence has supported the association between protein intake and kidney stone risk and has shown that a DASH-style diet (Dietary Approaches to Stop Hypertension), rich in vegetables and low in animal protein, is associated with the lowest incidence risk. Three large cohorts similarly found that plant proteins were not associated with kidney stone risk. 31

In another study conducted in Shanghai, 32 diets rich in vegetables, shellfish, and low-sugar beverages showed protective dietary patterns, whereas diets favoring meat and sugar-sweetened beverages were risk patterns for the disease.

Multiple factors are involved in uric acid stone formation, the most important of which include urinary acidity, low solubility, increased production and excretion, and meals with a high content of animal meat (purine load), which increase the filtered uric acid load. For this reason, reducing the intake of beef, pork, shellfish, fish, and chicken is recommended. 27

The above is consistent with the series by Minga García et al., 33 in which uric acid stones were the most prevalent stone type (62.2%).

Because calcium is the element most frequently found in stones and its intake affects calciuria, limiting normal dietary calcium intake was for many years a common practice in the treatment of patients with stones. Although this restriction appeared reasonable, research indicates the opposite.

Reducing calciuria is a treatment goal; however, it should not be achieved at the expense of dietary calcium restriction, because adequate calcium intake is associated with lower stone formation. Normal intake through daily dairy products is recommended, because a deficient diet affects bone density and also increases oxaluria. 34,35,36

Patients with calcium stones are advised to consume 1,000–1,200 mg/day of dietary calcium. Conversely, a high dietary calcium level reduces gastrointestinal oxalate absorption; this is explained by the fact that intestinal calcium acts as a chelator of several substances, including oxalate. 37

Oxalate is derived from plants and may be present in vegetables, nuts, fruits, and grains. Half of urinary oxalate is derived from the diet and endogenous synthesis; in urine, it binds to calcium and increases calcium oxalate supersaturation.

Increased urinary oxalate excretion may occur as a consequence of excessive intake, endogenous overproduction, or increased intestinal absorption. Intestinal absorption depends not only on oxalate intake but also on calcium intake. Therefore, a diet rich in calcium leads to reduced oxalate absorption and consequently lower urinary oxalate excretion. 38

A diet with normal calcium intake and restriction of oxalate intake is recommended. Foods with high oxalate content include spinach, collard greens, potatoes, beans, almonds, tea, quinoa, amaranth, wheat bran, corn flour, walnuts, and chocolate, among others. Dietary restriction is indicated when these foods are consumed excessively. At present, the only way to reduce intestinal absorption is to use calcium supplements or dietary sources of calcium. 29

High-dose vitamin C therapy may result in greater oxalate generation as ascorbic acid is metabolized. A study in stone-forming patients estimated that urinary oxalate excretion increases

by 6 to 13 mg/day for every 1,000 mg of vitamin C consumed above 500 mg/day. 26

Metabolic studies have shown that intake of 2,000 mg/day of vitamin C can increase urinary oxalate excretion in a large proportion of calcium oxalate stone formers as well as in normal controls. Therefore, most researchers recommend limiting vitamin C intake to the recommended daily allowance (90 mg/day) in patients with a history of calcium oxalate stones. 38

Citrate plays an important role in urinary alkalization and anti-lithogenic activity. It has a high affinity for calcium, inhibits crystal formation, prevents aggregation of already formed calcium oxalate crystals, and prevents the formation of larger concretions and stones. 18

Because of their high potassium citrate concentrations, drinking 1.2 liters of orange juice or 2 liters of lemon juice per day has been shown to increase urinary citrate excretion and reduce the recurrence rate of kidney stones in both healthy subjects and hypocitraturic stone formers. 20,28

An observational study analyzed the effect of dietary alkali load on urinary composition in both healthy individuals and stone formers. It showed that a diet rich in fruits and vegetables in hypocitraturic stone formers increased urinary pH (from 5.84 to 6.19) and the excretion of potassium, citrate, and magnesium. These urinary changes reduced uric acid and calcium oxalate supersaturation. 26

Magnesium has long been thought to play a protective role in kidney stone formation. In vitro studies have shown that it can inhibit each of the steps involved in stone formation. Its anti-lithogenic effect has been tested in studies, showing that it can inhibit the formation of calcium oxalate crystals in urine; it also acts as an oxalate chelator in the intestine and reduces intestinal oxalate absorption. 38,39

Increasing dietary magnesium is therefore advised because of its association with a lower risk of stone formation. Its main sources are fruits and vegetables; however, despite the strong rationale for considering magnesium an inhibitor of kidney stones, the currently available literature remains controversial. 26

Higher dietary potassium intake has been associated with a lower risk of stone formation. One possible explanation is that it decreases urinary calcium excretion. Another mechanism is that it may increase urinary citrate excretion because potassium-rich foods tend to have a high alkali content. The evidence supports intake of fruits and vegetables as sources of this electrolyte. 30

Fiber consumption has been shown to reduce urinary calcium concentrations because phytic acid binds intestinal calcium and prevents its absorption; however, depending on the type of fiber, urinary oxalate may or may not increase. Wheat bran has the highest oxalate content and may produce hyperoxaluria, whereas soybean or corn bran has a lower oxalate content, as do fruits and vegetables. 40

Regarding the impact of different types of diets on stone formation, the EPIC study 26 established five dietary patterns according to meat consumption and their relationship with kidney stone risk: high meat consumption (>100 g/day), moderate consumption (50–99 g/day), low meat consumption (<50 g/day), fish consumers, and vegetarian diets. The study concluded that vegetarian and low-meat diets were associated with fewer cases of kidney stones than high meat consumption. Red meat and poultry were associated with a higher risk of kidney stones than processed meat. 27

A vegetarian diet, in which calcium intake is higher than in a vegan diet, has a low incidence of kidney stone formation provided that there is a balance between high dairy consumption, restriction of meat intake, and foods low in oxalate. 26 A vegan diet, because it is rich in plant-derived oxalate (spinach, beet greens, and chard) and low in calcium, carries a high risk of developing oxalate stones.

The DASH diet, designed for the management and prevention of arterial hypertension, is based on a high intake of vegetables, nuts and legumes, low-fat dairy products, and whole grains, together with reduced intake of sodium (to 1,500 or 2,300 mg per day according to the WHO [World Health Organization]), sugar-sweetened beverages, and red meat. 41

A prospective study involving approximately 241,000 U.S. healthcare workers developed a score for this type of diet and showed that a higher score corresponded to a lower risk of developing kidney stones in both men and women. The authors concluded that it reduces kidney stone risk by avoiding the simultaneous combination of foods rich in oxalate and calcium. 42

At the same time, the Mediterranean diet has a protective effect similar to that of the DASH diet in preventing kidney stones because of its high predominance of plant-based foods over animal-derived foods. Research has shown that strong adherence to this diet provides substantial benefits in preventing urinary lithogenesis. 43

Table 2. Dietary recommendations to reduce the risk of urolithiasis

Component	Recommendation
Fluids	Fluid intake to maintain urine volume ≥ 2.5 L/day
	Limit consumption of sugar-sweetened beverages
	Intake of juices and citrus fruits
Calcium	Avoid severe dietary calcium restriction
	Recommended intake: 1000–1200 mg/day
Oxalate	Avoid foods rich in oxalate (nuts, chocolate, spinach, tea, beans)
Protein	Restrict animal protein to less than 200 grams/day
Carbohydrates	Restrict refined carbohydrates to <20 g/day
Salt	Limit sodium intake to 100 mEq/day (2300 mg/day)
Vitamin C	Limit vitamin C intake
DASH diet	Protective against recurrence of urolithiasis
Mediterranean diet	Protective against recurrence of urolithiasis

<https://doi.org/10.1007/s00394-025-03623>

Source: (43). Bai S, Shu Liu Y, Yang H, Zhang Y. Ultra-processed food, genetic predisposition, and the risk of kidney stone: a population-based prospective cohort study. *European Journal of Nutrition*. 2025; 64(2). Available from: <https://doi.org/10.1007/s00394-025-03623>

At present, the country is experiencing difficult economic conditions, and food availability is not exempt from these problems. Even so, based on the foods available, patients can choose a dietary pattern and consume less harmful foods to prevent the risks of urolithiasis. This can be supported by providing the necessary information through dietary education and intervention aimed at changing lifestyle habits.

CONCLUSIONS

Diet is an essential factor in the risk of recurrent urinary stones among patients with urolithiasis. Current recommendations include maintaining a high intake of fluids and fruits, controlling protein and carbohydrate intake, and reducing salt intake.

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