



Association of kidney stone disease with dietary factors: a review

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ABSTRACT: Kidney stone disease is one of the most common urologic disorders worldwide. The incidence of kidney stones disease is increasing all over the world. It is a multifactorial disease accompanied by various factors. The dietary factor is one of the most important risk factors for the formation and recurrence of kidney stone disease. Formation and recurrence of kidney stone disease can be prevented by modifying our day to day dietary habits. Fewer intakes of animal protein, higher intake of fluid, higher intake of fruits, and higher intake of green leafy vegetables, which contain a low amount of oxalate, can prevent the formation of kidney stones and recurrence of kidney stones. From this review, it may be presumed that the higher prevalence rate of kidney stone disease in northeast India may be the dietary factors accompanied by environmental and climatic conditions of the region.

KEY WORDS: kidney, urologic, animal protein, water, fruits, vegetables, oxalate, dietary, multifactorial, recurrence.

Introduction

Kidney stone disease is one of the most common diseases nowadays. It is the third most common urological disorder affecting both males and females but more common among males. The prevalence rate of kidney stone disease all over the world is approximately 10–15% (Moe 2006). The prevalence rate of kidney stone disease has been increasing in both sexes. It is also reported that Europe has a prevalence rate of 5–9%, 13–15% in the United States of America, 12% in Canada, but the highest prevalence

rate of kidney stone is reported from the Asian country i.e. 20.1% from Saudi Arabia (Bibl and Mayers 2001; Reynolds 2005). 12% of the American Men will develop a kidney stone at some point of their lifetime (Bose et al. 2016). There is a chance of reoccurrence of kidney stone, if a person is once encountered with a kidney stone, the recurrence rates of kidney stone after 10 year is 50% and 75% after 20 years (Lopez and Hoppe 2010). Most of the kidney stone is a calcium-containing stone, 75% of the kidney stones are calcium oxalate stones, (out of which 50% are of calci-

um hydroxyl phosphate in very small or greater amounts), 10–20% is composed of magnesium ammonium phosphate, 5% are of urate, and 1–2% is of cystine (Bibl and Mayers 2001). The stone is usually formed when the urine become supersaturated with a specific substance such as calcium, oxalate, uric acid, or cystine. Due to this supersaturation of urine, the crystal particle grows and forms a solid particle known as stone, which can form in any part of the urinary tract except urethra, but most commonly formed inside the kidneys (Sutherland et al. 1985; Trinchieri et al. 1999). The incidence of kidney stones is increasing globally, with variation in gender, racial and geographical location. It is a multifactorial disease accompanied by various factors. Genetic factors are also responsible for the formation of kidney stones, but the genes associated with kidney stones are still unclear. The dietary factor is one of the most important factors which are responsible for the formation of urinary stone; diet can alter the composition of urine and affect the process of stone formation. The European Association of Urology's guidelines suggested that the daily intake of water should attained at least 2.5L of urine volume in order to avoid from the formation of kidney stones and recurrence of kidney stone (Turk et al. 2018). Beside this, Mitra et al. (2018) also suggested that water intake of >3L per day will lower the risk of kidney stones formation.

Importance of balance diet: Nutrition is the intake of food as per the dietary requirement of the body to maintain growth and health. Adequate and balanced nutrition is important for being healthy along with the regular physical activity. Poor or imbalanced nutrition can affect health status such as reduced

immunity, increased susceptibility to disease, impaired physical and mental development, and reduced productivity, etc. A balanced diet is a kind of diet that gives our body the nutrients that we need; it is important because our body needs proper nutrition to work effectively. A balanced diet includes fruits, vegetables, grains, proteins, dairy, etc. but we need to consume all these diets in the right proportion. Higher intake of fluids, mainly water, is also needed to keep our body fit and healthy because it will clean our body and excrete mainly in the form of urine with the help of the kidney. Kidneys perform many crucial functions in our body: maintaining overall fluid balance, regulating and filtering minerals from the blood, filtering waste materials from food, medications, and toxic substance. The objective of the present systematic review is to understand the effect of dietary factors, such as fluid intake and protein or meat intake, as risk factors for kidney stone formation.

Materials and Methods

Original research articles published in English language, related to kidney stone disease and food habits were searched using search engine (Pubmed, Medline, and Google Scholar). The search word included “kidney stone”, “kidney stone and food habits”, “nephrolithiasis and dietary factors”, “urolithiasis”, “fluid intake and urolithiasis” etc. The study covers the published articles on or before October, 2019, and which are available on the public domain. A total number of 38 articles related to search words were found. Five articles were excluded as they were not related to the objectives of the study, thereby, 33 research articles are included for the review.

Results and Discussion

Increased fluids intake is one of the most important dietary measures to prevent the formation of kidney stones and to avert the recurrence of kidney stones. Regular fluid intake of 2.5–3 liters per day, especially water, is recommended for the prevention of kidney stones (Borghi et al. 1996 and Turk et al. 2018). Whereas increased intake of fluids, such as grapes juice, may increase the risk for developing kidney stones due to the presence of high oxalate (Curhan et al. 1998) but Trinchieri et al. (2002) reported that the drinks containing grapefruits are not the risk factors for the formation of kidney stones. And prevalence rate of kidney stones among those who drink water with high fluorine content is 4.6 times higher than those of the fluorine-free water (Singh et al. 2001). Other fluids such as coffee are also evident to be protective in the VET (Vietnam Era Twin) twin study, those who drank 1200 ml or more of coffee daily were 60% less likely to develop stones than non-coffee drinkers (Goldfarb et al. 2005).

Moreover, people who have drink beers regularly have 53% reduction rate in the formation of urinary stones. But there was no trend in the grade of safety with increased drinking of beer (Krieger et al. 1996 and Ferraro et al. 2013). Furthermore, a cross-sectional study conducted in Pakistan also reported that the lack of drinking water and increasing body weight are the major risk factors for the formation of urinary stones (Jabbar et al. 2015). In a large 5-year study of case-control, it is also reported that large ingestion of water was the best preliminary therapy to avoid stone recurrence. It is evident that among the urinary stone formers, urine volume was significantly

lower than the controls and thereby increasing the urinary super-saturations of calcium oxalate and uric acid than those of the controls. Therefore, water consumption was directly proportional to urine volume and subsequently to the formation of kidney stones, but the investigators did not quantify the optimal amount of water intake required to avoid the formation or recurrence of kidney stone (Borghi et al. 1996). Another study also reported that drinking more quantity of water is additionally beneficial for stone formers whose stones are not calcium-based (Pak et al. 1980). Further, the Academy of Nutrition and Dietetics (AND) also recommends that stone formers should drink enough fluids to produce at least 2500 ml of urine daily.

High consumption of protein, predominantly animal protein, is responsible for the comparatively high prevalence rate of kidney stone formation. There is a high correlation between the formation of kidney stones, and non-vegetarian food habits, a diet rich in animal protein may increase the risk of kidney stones, and however, vegetarian diet has a lower risk for the formation of kidney stones (Sandilya and Sandilya 2019). Consuming the high amount of animal meat will lead to the acidification of urine which may lead to the formation of calcium oxalate stone in the urinary tract (Chandrajith et al. 2006), it could also alter the renal function or increasing the intestinal absorption of calcium which will lead to the formation of calcium-based kidney stone (Licata et al. 1979). And also, the consumption of meat with the combination of protein-rich food had a significant association with the prevalence of urinary tract stones (Basiri et al. 2009).

Moreover, some studies also associated the intake of carbohydrates with

Table 1. Studies showing the association of dietary factors with the formation of kidney stone disease

Source	Study design	Country	Sample	Associated factors	Outcome
Licata et al., 1979	Case control study	USA	4 controls 4 cases	High protein intake	Increased risk of kidney stone
Borghesi et al., 1996	Case control study	Italy	101 controls 199 cases	Low urine volume, low water intake	Increased risk of kidney stones
Krieger et al., 1996	Case control study	USA	392 controls 240 cases	Beer drinking	Lower risk of kidney stone formation
Curhan et al., 1998	Prospective cohort study	USA	8 years of follow up	Lower intake of fluid	Increased risk of kidney stone
Singh et al., 2001		India		Water containing high amount of fluoride	Risk of kidney stone
Meschi et al., 2004	Case control study	Italy	12 controls 26 case with hypocitraturia	Limiting fruits and vegetables intake	Increased risk of calcium stone formation
Goldfarb et al., 2005	Twin study	USA	7500	High intake of coffee, tea, fruits, and vegetables	Lower risk of kidney stone formation
Nouvenne et al., 2010	Case study	Italy	210 with idiopathic calcium oxalate stone disease	Higher intake of salt rich food	Higher risk of idiopathic calcium oxalate stone formation
Meschi et al., 2012	Case control study	Italy	143 cases 170 controls	High intake of protein and salt, low intake of fruits and vegetables	Increased risk of kidney stone
Salmeh et al., 2012	Case study	Iran	190 patients with kidney stone	Lower intake of fluids	Increased risk of kidney stone

Source	Study design	Country	Sample	Associated factors	Outcome
Dai et al., 2013	Case control study	China	1019 cases 987 controls	High consumption of grains and oxalate rich vegetables, low water intake	Increased risk of kidney stone disease
Shamsuddeen et al., 2013	Cross sectional study	Saudi Arabia	50 cases	Lower intake of fluid, and improper diet and sedentary lifestyle	Increased risk of kidney stone formation
Mendel et al., 2013	Cross sectional study	USA	HPFS: 51529 males NHS I: 121700 female nurses NHS II: 116430 female nurses	Restriction in dietary animal protein intake and increased intake of fruits and vegetables	Lower risk of kidney stone formation
Yasui et al., 2013	Case study	Japan	92797 with urolithiasis	Low dietary intake of fruits and vegetables	Increased risk of kidney stone formation
Marak et al., 2013	Household survey	India	196 individuals out of 875 have kidney stone	Engaged in heavy work, history of urinary tract infection, history of stressful events and lower intake water	Higher risk of kidney stone formation
Ferraro et al., 2013	Cohort study	USA	194095 participants (4462 cases)	Consumption of coffee, tea, beer, wine and orange juice	Lower risk of kidney stone formation
Jabbar et al., 2015	Case study	Pakistan	101 cases	Less intake of fluid, increased weight/obesity	Increased risk of kidney stone
Amin et al., 2017	Retrospective descriptive research	Egypt	150 cases	High intake of animal meat, low water intake, high intake of caffeine	Increased risk of kidney stone and high recurrence rate
Ryu et al., 2018	Case control study	Korea	27 cases 20 controls	Higher intake of carbohydrate, protein, and cereals	Increased risk of stone formation
Sandilya and Sandilya, 2019	Retrospective study	India	307 cases	Increased intake of non-vegetarian food	Higher risk of kidney stone formation

kidney stone formation, i.e. high intake of carbohydrate-rich food is directly proportional to the formation of urinary stones (Meschi et al. 2012). Not only this, other studies which are conducted in two different countries also supported the association of carbohydrate-rich food with kidney stone disease, they reported that kidney stone disease had a strong significant correlation with higher intake of cereals, grains, and caffeine (Amin et al. 2017; Ryu et al. 2017). Coming to the prevention of kidney stone formation, increase intake of fruits and vegetables lower the risk of kidney stone (Meschi et al. 2004; Salmeh et al. 2012; Yasui et al. 2013; Mandel et al. 2013) whereas green leafy vegetables which have higher amount of oxalate contains are also risk factors for the formation of kidney stone, consumption of leafy vegetables that contain high oxalate, more than three times per day also resulted in the formation of kidney stones in both men and women (Dai et al. 2013). Less physical activity is also one of the major risk factors for the formation of kidney stone disease. People who are more confined to the sedentary work and perform fewer physical activities work are more prone to the developing of kidney stones (Yasui et al. 2008). Those who are performing moderate physical activity less than 150 minutes per week show a high prevalence of renal calculi like calcium oxalate and uric acid when relating to other persons performing a physical activity more than 150 minutes per week (Shamsudden et al. 2013).

Coming to North East India, Marak et al., (2013) reported that kidney stone disease is significantly higher in those individuals who are more educated, engaged in heavy-duty with history of urinary tract infection and history of stress-

ful events, and those who take a fewer quantity of fluid especially water. It is also reported that the prevalence rate of kidney stone disease in Manipur is 22.4% which is extremely high. Moreover, from a hospital-based study for 7 years and 3 months also reported that the prevalence rate of urolithiasis in Manipur is 11.6% (Singh et al. 1978). In Assam, a retrospective study conducted among the patients admitted in a hospital also reported that most of the patients of kidney stone disease are found to be consuming more non – vegetarian diet (Sandilya and Sandilya 2019).

The high prevalence rate of kidney stone disease in North East India could be the food habits of the people. The widely and most consumed foods of North East India are rice and animal meats (Mahajan et al. 2015), which contain a large number of carbohydrates and proteins that can initiate the formation of kidney stone disease with less physical activity. Besides this, there is also reported literature about the presence of a high amount of fluoride in drinking water from North East India (Singh et al. 2008), which is also one of the risk factors for the formation of kidney stones (Singh et al. 2001). Moreover, North East India as a whole is also in the stone forming belt of the world (Lopez and Hoppe 2010). As per the available data, there is a lack of literature for kidney stone disease from the other states of North East India except Manipur and Assam. Therefore, further in-depth study on the formation of kidney stone disease in northeast India is the need of the hour.

Conclusions

From this systematic review, the wide occurrence of kidney stone disease all

over the world could relate with the food habits of the people, it is evident that higher intake of animal protein, higher consumption of carbohydrate-rich foods, lower intake of fluids especially water, and lower intake of fruits and vegetables are the major risk factors for the formation of kidney stone disease. Consumption of a balanced diet, performing regular physical activities, and avoiding drinking water, which contains a high amount of fluorine, may contribute to the prevention of kidney stone disease.

Utility and Limitations of the study

The present study attempts to understand the effects of food habits especially water intake and nutrients consumption on the kidney stone disease. Though, there is individual variation in the quantity of intake, it is pointed that less water intake, higher intake of animal protein, higher consumption of carbohydrate-rich foods and lower intake of fruits and vegetables can enhance the kidney stone formation. The study also highlights the importance of having proper balanced diet to control the stone formation. At the same time, the study also has few limitations as it is purely based on different published articles, as a result the authors could not provide data to support or reject the proposition claimed. Another limitation could be discounting articles related to climatic and temperature variation of different region in association with the formation of kidney stone.

Authors' Contributions

HK was involved in the conception, literature search, analysis and drafting of the manuscript. SYM was involved in the

idea development, designing and drafting of the manuscript. All the authors read and approved the final version of the manuscript.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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