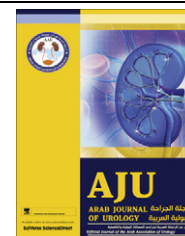




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REVIEW

Metaphylaxis, diet and lifestyle in stone disease

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KEYWORDS

Urolithiasis;
Lifestyle;
Compliance;
Diet;
Alkali load;
Acid load;
Calcium;
Serum

ABBREVIATIONS

BMI, body mass index;
LUT, lower urinary tract; UUT, upper urinary tract; AA-SH, sulphur-containing amino acid; PTH, parathyroid hormone

Abstract Objective: The most common urinary stones (calcium salts, uric acid) form due to genetic factors and lifestyle. This review describes why, if and how medication and lifestyle changes can reduce the risk of formation.

Methods: Previous reports were reviewed to obtain information on three aspects of urolithiasis, i.e. epidemiology, mechanisms linking lifestyle and urolithiasis and lifestyle intervention for preventing urolithiasis.

Results: Epidemiological evidence links the prevalence of urinary stone formation to general lifestyle factors. Detailed analysis has identified individual lifestyle elements that affect the risk of urinary stone formation. Currently there are several concepts that explain the mechanism of stone formation. Urinary markers like calcium, oxalate, phosphate, uric acid and urinary pH are involved in all these concepts. Many studies show that changing (combinations of) specific lifestyle elements has a favourable effect on these urinary markers. Based on this evidence, protocols have been developed that use a combination of these lifestyle changes and medication to prevent stone formation. In well-controlled studies where patients are optimally informed and continuously motivated, these protocols clearly reduce the stone formation rate. In general practice the result is less clear, because the time and tools are insufficient to maintain long-term patient compliance in the use of medication and lifestyle advice.

Conclusion: The risk of stone formation can be reduced in general practice when the patient's compliance is optimised by providing individualised advice, continuous information, and feedback and incorporation of the advice into a regular lifestyle. The use of 'e-tools' might enable this without increasing the time required from the physician.

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Introduction

Most urinary stones formed in patients worldwide contain calcium oxalates, calcium phosphates, uric acid or urates, and form due to genetic factors and lifestyle.

This review describes why, if and how medication and lifestyle factors can reduce the risk of forming stones. Further sections provide epidemiological evidence of links between lifestyle and urinary stone formation, specific lifestyle elements that affect urinary stone formation and its urinary markers, the cascade of lifestyle elements, urinary composition, and stone formation, a protocol for the preventive treatment of stones that is based on the consented protocol used in Germany [1], and finally a discussion of why such protocols reduce stone formation much less in general practice than in research settings. The main reason for the latter is that patient compliance with long-term use of medication and lifestyle advice is low, and the key elements for success are continuous access to practical advice, efforts to maintain patient's motivation, continuous feedback and incorporation of the advice into regular lifestyle. An in-depth discussion of compliance by stone formers with treatment is provided elsewhere in this journal.

Lifestyle and prevalence of urinary tract stone disease

In a review published 40 years ago Prien [3] discussed the prevalence of stone formation throughout the world at that time and the changes in prevalence over time in relation to lifestyle. In any population the first form is endemic bladder stone disease (lower urinary tract, LUT) affecting mainly children. Specific changes in the lifestyle of that population move the disease to upper urinary tract (UUT) stone formation, affecting mainly adults [3]. During this transformation the prevalence first declines and later increases again. Endemic LUT stones contain mainly uric acid, urates and struvite [4]. In Thailand, calcium oxalate is also a major component of LUT stones [5,6]; the background for this is low hygiene and malnutrition, and in Thailand the malnutrition can be accompanied by endemic [7] renal tubular acidosis. A monotonous diet where energy is derived mainly from cereals and vegetables provides high doses of purines that can be converted to uric acid and lead to hyperuricosuria [4]. UTI with urease-producing bacteria increases both urinary pH and ammonium concentration. This favours the precipitation of ammonium–magnesium-phosphate (struvite) and calcium phosphates. In combination with hyperuricosuria the product can be ammonium urate. When the standard of living increases in an area with endemic bladder stone disease the incidence of bladder stone disease decreases. This has been attributed to the more balanced diet, including more dairy products and animal protein [8,9].

Whereas the change from a 'primitive' lifestyle to an 'intermediate economic' lifestyle [10] reduces the incidence of overall stone formation, further changes in lifestyle, towards the so-called western lifestyle, increases the prevalence of urinary stone formation again, now as UUT stones [10]. Well-balanced might be the

Table 1 Adaptation of the original working hypothesis, from Andersen [10].

	Economy		
	Primitive	Intermediate	Modern
Diet	Unbalanced deficient	Balanced	Unbalanced overloaded
Stone risk site	High, bladder	Low	High, UUT

keyword here. Those vegetarians who succeed in maintaining a well-balanced diet have a low risk of LUT stone disease but also of UUT stone formation [11]. Periods of stone disease were apparent in European countries and Japan between the First and Second World Wars and after World War II [12,13]. In 1971, the situation was one where UUT stones were most prevalent in the economically most-developed countries [3]. The stones contained calcium salts and affected mainly men. In the decades thereafter endemic bladder stone formation has further diminished throughout the world, while the incidence of UUT stone formation increased even further in western countries [14–16]. Again, lifestyle changes appeared to cause this further increase. The highest prevalence of UUT (71% calcium oxalate and 15% uric acid) stone disease has been reported for Arab countries that combined a high economic standard with a hot and dry climate, and local diet components high in oxalate, e.g. 8–13% in Europe and USA vs. 18% in the United Arab Emirates and 20% in Saudi Arabia [17].

Overall it appears that the working hypothesis formulated by Andersen (Table 1) over half a century ago still holds true, and that stone formers are best helped by the advice to maintain a balanced diet and that can be accompanied with medication. But what is a balanced diet for stone formers?

Individual lifestyle elements and the risk of urinary tract stone formation

To appreciate which lifestyle elements these could be, it helps to understand the basic reasons for stone formation. Stones can only form when the urinary tract contains higher concentrations of the stone-forming material than can be kept in solution [18,19]. High concentrations of the mineral components in the urinary tract thus pose a risk of stone formation. For UUT stones the relevant components are calcium, oxalate, phosphate and urate. These can derive from intrinsic pools (calcium from bone or the non-filterable pool in blood), from intrinsic production (uric acid, oxalate) and from the diet (all components). Release from intrinsic pools and intrinsic production both can also be subject to dietary effects. When an attempt is made to prevent stone formation both by medication and lifestyle changes, the intrinsic production, the dietary con-

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