INTRODUCTION

Kidney stone disease, also known as urolithiasis, is a significant global health issue that imposes a substantial burden on both patients and healthcare systems. Kidney stone disease is becoming more prevalent worldwide, affecting 5-10% of the general population.1,2 Kidney stones can cause health burden, including pain, infection, kidney damage, and impaired quality of life, in addition to the direct healthcare costs.3 In addition, Kidney stone disease has a high recurrence rate after 3-5 years, ranging from 21% to 53%.3

Several factors, including urine supersaturation, abnormal urine acidity, and the presence of inhibitors and promoters of stone growth, are involved in the complex pathogenesis of kidney stone formation. Multiple causes can lead to recurrent kidney stones, including persistent urinary tract infections, underlying metabolic disorders such as hypercalciuria or hyperuricosuria, and insufficient dietary habits and fluid intake.4

Even though several epidemiological studies have discussed the association between dietary intake and recurrent kidney stones, limited study comparing the associations between dietary intake in distinct populations and recurrent kidney stones has been reported. Therefore, we conducted a systematic literature review and meta-analysis to compare the associations between dietary intake across populations and recurrent kidney stones.

METHODS

Database Searching and Literature Screening

We did a systematic search up to March 2023, with the database from PubMed, SCOPUS, EMBASE, with following subject terms and keywords were applied: “dietary habit” and “recurrence” or “recurrent” and “urolithiasis” or “kidney calculi” or “kidney tract stone” and “nephrolithiasis” or “kidney stone” or “renal stone” or “renal calculi”. After we identified the articles found, we removed the duplicates and further screened the articles. This systematic review was carried out in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Study Selection

The articles were then evaluated, and the relevance of the articles was determined from the titles and abstracts. The inclusion criteria were articles which critically appraised by experts and comparing the effect of dietary habits on the recurrent of kidney stones within the past 10 years. The exclusion criteria were studies in which the diet was not specified.

The articles were then evaluated using

ABSTRACT

Background: Kidney stone disease is a significant global health issue that imposes a substantial burden on both patients and healthcare systems which affects 5-10% of the general population. There are several factors involved in its pathogenesis including insufficient dietary habits and fluid intake. Therefore, we conducted a systematic review and meta-analysis to compare between dietary intake across populations and recurrent urinary tract stones. This systematic review and meta-analysis aims to compare the associations between dietary intake across populations and recurrent kidney stones.

Methods: Systematic search up to March 2023 were conducted through PubMed, Scopus, EMBASE. The systematic review was conducted according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Means and standard deviation of the nutrient intakes were extracted in patients with urinary stone disease group and control group.

Results: Seven articles were further assessed with two articles were assessed through meta-analysis. Two studies showed that high sodium intake [SMD = 0.29 95% CI = 0.13, 0.71] was found in patient with urinary stone disease, while high water intake [SMD = -0.40 95% CI = -1.14, 0.34] was found in the control group.

Conclusion: Animal protein, processed meat, sodium, and sugary beverages were associated with an increased risk of developing urinary stones, whereas vegetable protein and water intake were associated with a decreased risk.

Keywords: Diet, dietary, kidney stones, nephrolithiasis.

the Newcastle-Ottawa scale for cohort studies, case-control studies, and an adapted version of the scale for cross-sectional studies.5

**Statistical Analysis**
Means and standard deviation of the nutrient intakes were extracted in patients with kidney stone disease group and control group. The nutrients that were further assessed in the analysis were carbohydrate, lipid, protein, fiber, calcium, sodium, magnesium, and water. Heterogeneity was evaluated by I² and I² > 50% indicate a significant heterogeneity. The data is categorized as statistically significant if P<0.05. We used the random model effect for the meta-analysis. All analysis were assessed by RevMan Web.

**RESULTS**

**Literature Search**
A total of 167 articles were retrieved from the database following the application of exclusion criteria and article screening based on the PRISMA method. An additional 44 articles have been omitted because they do not available in full text. After removing duplicates, a total of 133 studies underwent abstract evaluation for their relevance, of which only 7 were included in the analysis. The article screening process is shown in Figure 1.

**Study Characteristics**
The quality assessment of the included articles is shown in Table 1. There were 5 studies with good quality and 2 studies with fair quality. Two studies were further analyzed in meta-analysis as these two studies have the same outcome which was the association between nutrient intake and the risk of kidney stone disease. While five studies were critically assessed qualitatively using Newcastle-Ottawa Scale and the characteristics of are presented in Table 2.

The Dietary Approaches to Stop Hypertension (DASH) diet is a dietary pattern, primarily designed to lower blood pressure and reduce the risk of cardiovascular diseases (CVDs).13 It emphasizes the consumption of fruits, vegetables, whole grains, lean proteins, and low-fat dairy products, while limiting the intake of sodium, added sugars, and saturated fats.13

The traditional Korean diet is characterized by a wide variety of vegetables, fermented foods, and moderate consumption of fish and lean meats. Key components include kimchi (fermented vegetables), doenjang (soybean paste), and gochujang (red chili paste). The Korean diet is rich in fiber, antioxidants, and probiotics, contributing to potential anti-inflammatory effects.14

The Indian diet is diverse, influenced by cultural and regional variations. It typically consists of lentils, legumes, vegetables, rice, and a wide range of spices like turmeric, cumin, and coriander. Traditional Indian diets have been associated with a lower risk of developing type 2 diabetes and obesity, attributed to the high-fiber and phytochemical content.15

<table>
<thead>
<tr>
<th>Study</th>
<th>Study Design</th>
<th>Newcastle-Ottawa Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alblowi, et al (2022)</td>
<td>cross-sectional</td>
<td>5</td>
</tr>
</tbody>
</table>
Table 2. Main characteristics of included articles

<table>
<thead>
<tr>
<th>Study</th>
<th>Country of study</th>
<th>n</th>
<th>Male (%)</th>
<th>Female (%)</th>
<th>Mean age (year)</th>
<th>Type of diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferraro, et al (2017)</td>
<td>United States and United Kingdom</td>
<td>192,126</td>
<td>21.9</td>
<td>78.1</td>
<td>45.5</td>
<td>DASH style diet</td>
</tr>
<tr>
<td>Ryu, et al (2018)</td>
<td>South Korea</td>
<td>47</td>
<td>63.8</td>
<td>36.2</td>
<td>43.3</td>
<td>Korean diet</td>
</tr>
<tr>
<td>Bandegudda, et al (2021)</td>
<td>India</td>
<td>34</td>
<td>70.6</td>
<td>29.4</td>
<td>34.4</td>
<td>Indian diet</td>
</tr>
<tr>
<td>Baharudin, et al (2017)</td>
<td>Malaysia</td>
<td>81</td>
<td>55.6</td>
<td>44.4</td>
<td>57.4</td>
<td>Malaysian diet</td>
</tr>
<tr>
<td>Alblowi, et al (2022)</td>
<td>Saudi Arabia</td>
<td>1,031</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>Middle Eastern diet</td>
</tr>
<tr>
<td>Diangienda, et al (2021)</td>
<td>Congo</td>
<td>132</td>
<td>58.5</td>
<td>41.5</td>
<td>48.1</td>
<td>African diet</td>
</tr>
</tbody>
</table>

Figure 2. Forrest plot of nutrients intake in urinary stone disease group and control group

The Malaysian diet incorporates a fusion of Malay, Chinese, and Indian cuisines. It includes rice, noodles, seafood, poultry, and tropical fruits. Traditional Malaysian foods often feature coconut milk, spices, and palm oil. Studies suggest that the Malaysian diet’s diverse components contribute to an ample supply of essential nutrients and antioxidant compounds. The Mediterranean diet is characterized by high consumption of fruits, vegetables, whole grains, olive oil, nuts, and fish, with moderate consumption of dairy products and wine. Rich in monounsaturated fats and omega-3 fatty acids, this diet has been associated with reduced CVD risk.

The Middle Eastern diet includes a wide range of foods such as grains, legumes, nuts, seeds, and fruits. Olive oil is a prominent source of fat in this diet. The Middle Eastern diet’s emphasis on whole foods provides essential nutrients, fiber, and unsaturated fats. The African diet varies across the continent, but it commonly includes grains like sorghum, millet, and maize, along with vegetables, fruits, and a variety of meats.

Association between Nutrients Intake and Kidney Stone Disease

Two studies that were assessed through meta-analysis showed that patients with kidney stone disease tend to have a higher intake of sodium [SMD = 0.29, 95% CI = -0.13, p value = 0.71] and carbohydrate [SMD = 0.05 95% CI = -0.37, 0.47] more. Water intake in patients with kidney stone disease is lower compared to control group [SMD = -0.40, 95% CI = -1.14, p value = 0.34]. Other nutrients have no significant result towards the kidney stone disease group and control group.

DISCUSSION

Numerous studies have investigated the relationship between dietary intake and the formation of kidney stones. The Nurses’ Health Study, which was conducted in the United States and Europe, is one of the earliest and most well-known studies in this field. This study followed a large group of female nurses for several years and discovered that a high intake of animal protein, especially from red meat and...
poultry, was associated with an increased risk of kidney stone formation, whereas a high intake of vegetable protein was associated with a decreased risk.20

Many subsequent studies have since confirmed and expanded upon these findings. In 2013, a study found that a high consumption of sugar-sweetened beverages was associated with an increased risk of kidney stone formation, whereas a high intake of coffee was associated with a decreased risk.21 Another study found that a high sodium consumption and a low calcium intake were risk factors for the formation of kidney stones.22 Based on the findings of the meta-analysis, it became apparent that individuals with kidney stone disease tended to have elevated sodium intake. Although this association did not reach statistical significance, there is a potential correlation suggesting that decreased sodium consumption may be linked to a reduced risk. Recent studies have investigated that a healthy dietary pattern, characterized by a high intake of fruits, vegetables, whole grains, and lean protein, was associated with a lower risk of kidney stone formation, whereas a Western-style dietary pattern, characterized by a high intake of red and processed meats, sweets, and refined grains, was associated with an increased risk.23

The prevalence of kidney stones differs between different regions. The prevalence of kidney stones is relatively low in Eastern Asia, with estimates ranging from 1% to 8%. In contrast, the prevalence of kidney stones is estimated to be between 5% and 19.1% in Southeast Asia, West Asia, and South Asia.4 In Europe, the prevalence of kidney stones is estimated to be between 5% and 10%, whereas it is 8.8% in the United States.10 In Africa, despite the lack of large epidemiological studies, hospital data indicate an increase in urolithiasis cases.12

Variations in kidney stone prevalence between regions may be attributable to genetics, environmental factors, lifestyle factors, and dietary patterns, among others. In Southeast Asia and South Asia, for instance, the high prevalence of kidney stones may be associated with dietary practices such as a high intake of animal protein, sodium, and fructose, and a low intake of fluids, fruits, and vegetables.8,24,25 In contrast, the low prevalence of kidney stones in Eastern Asia may be attributable to a greater consumption of tea, which contains polyphenols that may prevent the formation of kidney stones.27,28 Europe and the United States may have a higher prevalence of kidney stones due to dietary practices such as a high intake of meat and processed foods and a low intake of fruits and vegetables.8 High temperatures, low humidity, and inadequate water intake may also contribute to the higher prevalence of kidney stones in Africa and Arabian countries.11,12 Overall, the variation in kidney stone prevalence across regions emphasizes the need to identify and address the specific risk factors in each population in order to prevent and manage kidney stone disease.

This study has several limitations as the approximate daily nutrient intake among studies included were different. There were no clear trends which nutrients is the risk factor of kidney stone disease. The populations had a different background especially in terms of nationalities and cultures. Further studies are needed to provide more accurate results to explain the association between diet and kidney stone disease.

CONCLUSION

Patients with kidney stone disease tends to have increased consumption of sodium and carbohydrates alongside decreased water intake, even though the correlation was not significant. The variation in kidney stone prevalence across regions highlights the importance of identifying and addressing the unique risk factors in each population in order to prevent recurrent kidney stone disease.

COMPETING INTERESTS

There were no competing interests disclosed.

ETHICAL STATEMENT

This systematic review and meta-analysis is based on the electronic database, therefore ethical approval is not required.

GRANT INFORMATION

The authors declared that this work was supported by no grants.

AUTHORS’ CONTRIBUTION

ZA and AB responsible for concept and design of the study, definition of intellectual content, literature search, statistical analysis, manuscript preparation, manuscript editing, manuscript review, and guarantor of the study. MS, PB, and TIW responsible for manuscript preparation, manuscript editing, manuscript review, and guarantor of the study.

REFERENCES


