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ORIGINAL

The potential effects of dietary food and beverage intakes on the risk of kidney stone formation

Os efeitos potenciais da ingestão dietética de alimentos e bebidas sobre o risco de formação de cálculos renais

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ABSTRACT

Objective

To determine the effect of nutritional habits on kidney stone formation and recurrence.

Methods

This study was conducted on 44 healthy individuals and 44 patients diagnosed with nephrolithiasis and aging between 20 and 65 years. Participants shared their salt consumption habits, daily fluid consumption amounts and general information about themselves in a questionnaire form. In addition, food and beverage consumption frequencies of participants were recorded through a food frequency questionnaire.

Results

Salt consumption frequencies of patients are higher than that of healthy individuals in both genders (p<0.05). It was found out that male individuals in the patient group salt dishes without tasting more frequently (p<0.05). Daily total water consumption of both genders in patient group is lower than that of healthy individuals (p<0.05). Meat consumption of male patients (51.6±31.35g/day) was found to be higher than that of healthy group (34.1±22.58g/day) (p<0.05). Additionally, individuals in the patient group consume less stinging nettle, corn, plum, loquat, orange juice and lemonade than healthy individuals (p<0.05).

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Conclusion

Results of the study showed that total fluid intake, salt consumption habits, and vegetable, fruit and beverage consumption may be correlated with stone formation risk and nutrition habits may affect stone recurrence.

Keywords: Beverages. Feeding behavior. Food. Kidney calculi. Nutrition.

RESUMO

Objetivo

Determinar o efeito de hábitos nutricionais na formação e recorrência de cálculos renais.

Métodos

Este estudo foi realizado em 44 indivíduos saudáveis e 44 pacientes com diagnóstico de nefrolitíase e envelhecimento entre 20 e 65 anos. Os participantes compartilharam seus hábitos de consumo de sal, quantidades diárias de consumo de líquidos e informações gerais sobre si mesmos em um questionário. Além disso, as frequências de consumo de alimentos e bebidas dos participantes foram registradas por meio de um questionário de frequência alimentar.

Resultados

As frequências de consumo de sal dos pacientes são maiores que as de indivíduos saudáveis em ambos os sexos (p<0,05). Verificou-se que os indivíduos do sexo masculino no grupo de pacientes salgam os pratos sem degustar com maior frequência (p<0,05). O consumo diário total de água de ambos os sexos no grupo de pacientes é menor que o dos indivíduos saudáveis (p<0,05). O consumo de carne de pacientes do sexo masculino (51,6±31,35g/dia) foi maior que o do grupo saudável (34,1±22,58g/dia) (p<0,05). Além disso, indivíduos do grupo de pacientes consomem menos urtiga, milho, ameixa, nêspera, suco de laranja e limonada do que indivíduos saudáveis (p<0,05).

Conclusão

Os resultados do estudo mostraram que a ingestão total de líquidos, os hábitos de consumo de sal e o consumo de vegetais, frutas e bebidas podem estar correlacionados com o risco de formação de pedra e os hábitos de nutrição podem afetar a recorrência da pedra.

Palavras-chave: *Bebidas. Comportamento alimentar. Alimentos. Cálculos renais. Nutrição.*

INTRODUCTION

Kidney stone disease is a common health problem with a multifactorial etiology arising from the interaction of metabolic, genetic and environmental factors [1]. Kidney stone disease, one of the most important preventable causes of morbidity, causes 5 billion dollars of economic loss in the United States every year [2].

Kidney stones often comprise of calcium oxalate (74%) [3]. Stone formation is more common in men than in women [4]. Moreover, nephrolithiasis is increasing in developed and developing countries at an alarming rate [5]. Many factors such as age, gender, race, ethnicity, nutrition, daily water intake, climate, geography, physical activity and Body Mass Index (BMI) affect stone formation [5,6].

There are quite a large number of studies proving the effects of nutrients on kidney stone formation [7-10]. A great majority of such studies show that nutrition has important and effective role on kidney stone formation [10-13]. It is reported that high dietary calorie, animal protein and oxalate intake and low fluid, calcium and potassium consumption are among the most important dietary risk factors in kidney stone formation [13-16].

Although there are a large number of studies examining the correlation between kidney stone formation and nutrition habits, data regarding which foods and beverages can reduce stone formation risk is inadequate. This study was conducted to evaluate the correlation between nutrition habits and kidney stone formation.

METHODS

This study was carried out on 44 healthy individuals and 44 healthy individuals who were adult and diagnosed with kidney stones formation by the doctors. The control group consisted of the healthy individuals. And the control group have similar gender, age and BMI with patient group. Menopausal and pregnant women were not included in this study. Besides, the individuals who have dieted in the last six months, had a disease affecting calcium metabolism, been taking the medicines which affect calcium metabolism, been taking the medicines which affect oxalate, calcium, citrate and pH levels in urine were not included in this study. The ethical committee report of the study was taken from the Ethics Committee of Clinical Investigations of *Kecioren* Training and Research Hospital, dated January 25, 2017 and No.2012-KAEK-15/1263. Signed informed consent was obtained from all patients and this study was conducted in accordance with the Helsinki Declaration.

Using the face-to-face interview technique, the general characteristics of the participant and the salt usage habits and the daily fluid consumption amounts of the individuals were questioned by questionnaire. Additionally, the participants answered the questions in Food Frequency Questionnaire (FFQ) for evaluation of their frequency of consumption dietary food and beverages. The researcher prepared a questionnaire of 119 articles in order to record the consumption frequency of some food and beverages under several main titles including: (a) dairy products (milk, *ayran*, yoghurt, feta cheese and *kashar* cheese); (b) meat and meat products (red meat, chicken, turkey, fish, offal, eggs, legumes and nuts); (c) vegetables (gherkin, broad bean, pumpkin, ladies finger, pea, cow pea, broccoli, brussel sprouts, dill, tomato, mallow, artichoke, basil, highbush cranberry, chicory, stinging nettle, spinach, zucchini, savoy cabbage, cauliflower, locust bean, celery, red pepper, curly lettuce, asparagus, lemon, mushroom, lettuce, parsley, corn, mint, potato, eggplant, chard, leek, sweet basil, fennel, garden rocket, cucumber, purslane, green bean, cress, radish, grape leaves, green pepper, ginger and turmeric); (d) fruits (pineapple, raspberry, pear, avocado, quince, blackberry, green almond, strawberry, mullberry, apple, plum, grapefruit, date, fig, watermelon, melon, apricot, cherry, kiwi, mandarin, mango, medlar, banana, papaya, orange, peach, grape, sour cherry and loquat); (e) beverages (tea, herbal teas, caffeinated coffee and decaffeinated coffee); (f) carbonated beverages (coke, diet coke, sparkling water, soda pop); (g) fruit juices (lemonade, grape juice, apple juice, carrot juice, orange juice, grapefruit juice, peach juice, sourcherry juice, pomegranate juice and turnip juice), and (h) alcoholic beverages (beer, malt drink, wine and other).

Qualitative data obtained from the participants were used to calculate number (n) and percentage values (%). The correlation between categorical variables was examined by means of chi-square test. Mann-Whitney U test was used to compare the measurement values of two independent groups in non-parametric data on the basis of the Average ($\bar{x}$) Standard Deviation (SD) and Median ($\tilde{x}$) values of qualitative data. Statistical significance rates were given between 99% and/or 95% Confidence Interval. Data obtained from the participants were analyzed with IBM Statistical Package for the Social Sciences 20 (SPSS Inc., Chicago, Illinois, United States).

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RESULTS

According to the study, there is a statistically significant correlation between salt consumption of both genders and their state of health ($p<0.05$). It was found out that 37.9% of male patients consume their food with excessive salt, while 6.9% of healthy males do the same. In female participants, 20.0% of patients prefer excessive salt in their food; however, 6.7% of healthy individuals are fond of salty food.

It was found out that male individuals in the patient group salt dishes without tasting more frequently than healthy male individuals do ($p<0.05$). However, such difference was not observed in female participants' salting habits ($p>0.05$) (Table 1).

According to the study, there is a statistically significant correlation between total fluid intake of both genders and their state of health. Daily total fluid intake of both genders in patient group is lower than that of healthy individuals ($p<0.05$) (Table 1). It was found out that the rates of male participants who had kidney stone history in their families are 51.7%, while these rates are in females 53.3% (Table 2).

There is a statistically significant difference between two genders in terms of kidney stone disease history of their fathers ($p<0.05$) (Table 2). Forty percent of male patients' fathers had kidney stone disease, while 37.5% of female patients' brother or sister suffered from the disease.

Although male patients do not consume a special food for treatment of kidney stone disease, 2 female patients consume olive oil and stinging nettle to cure the disease; 37.9% of male patients consume a special beverage for treatment of the disease (highbush cranberry juice: 45.4%, parsley juice: 27.3% and lemon juice: 27.3), while 33.3% of female patients prefer a curing beverage (highbush cranberry juice: 40%, lemon juice: 20%, kefir: 20% and oleaster juice: 20%). However,

Table 1. Salt use and fluid consumption status of individuals. *Ankara*, Turkey, 2018.

Salt use habit/fluid intake	Male				χ^2	*p*	Female				χ^2	*p*
	Patient Group (n=29)		Control Group (n=29)				Patient Group (n=15)		Control Group (n=15)			
	n	%	n	%			n	%	n	%		
Salt use in meals without salt	5	17.3	1	3.4			0	0.0	1	6.7		
Low salt	2	6.9	4	13.8			0	0.0	7	46.6		
Normal	11	37.9	22	75.9	13.231	**0.004***	12	80.0	6	40.0	11.000	**0.012***
Salty	11	37.9	2	6.9			3	20.0	1	6.7		
Salting without tasting												
Yes	16	55.2	5	17.2	9.032	**0.003***	5	33.3	1	6.7	3.333	0.068
No	13	44.8	24	82.8			10	66.7	14	93.3		
Daily total fluid intake												
1000-1500mL	4	13.8	2	6.9			4	26.7	1	6.7		
1500-2000mL	9	31.0	3	10.4			2	13.3	0	0.0		
2000-2500mL	12	41.4	7	24.1	14.836	**0.005***	5	33.3	3	20.0	10.478	**0.033***
2500-3000mL	4	13.8	8	27.6			4	26.7	4	26.6		
≥3000mL	0	0.0	9	31.0			0	0.0	7	46.7		

Note: *$p<0.05$, Chi-square test was applied. More than one option has been added.

there is not a statistically significant difference between the genders of patients and recurrence of stone formation, kidney stone history in the family, expelling stone and consumption of a special food/beverage for treatment ($p>0.05$) (Table 2).

Participants were asked about consumption of 119 foods and beverages considered to be correlated with stone recurrence and the foods found to be statistically different between patient and healthy individuals were given in the Table 3.

Meat consumption of male patients (51.6±31.35g) was found to be higher than that of healthy group (34.1±22.58g) ($p<0.05$). It was found out that male patients consume less stinging nettle, locust bean, red pepper, corn and lemon than healthy males do and the difference is statistically meaningful

Table 2. General characteristics of patients. *Ankara*, Turkey, 2018.

General characteristics of patients	Male (n=29)		Female (n=15)		χ^2	*p*
	n	%	n	%		
Stone formation recurrence						
0	6	20.7	3	20.0	0.398	0.820
1	6	20.7	4	26.7		
2	8	27.6	3	20.0		
>2	9	31.0	5	33.3		
Kidney stone history in the family						
Yes	15	51.7	8	53.3	0.010	0.919
No	14	48.3	7	46.7		
Kinship relation						
Mother	3	20.0	1	12.5	7.901	**0.048***
Father	6	40.0	0	0.0		
Brother or sister	5	33.3	3	37.5		
Uncle	1	6.7	4	50.0		
Passing kidney stone						
Yes	19	65.5	8	53.3	0.619	0.431
No	10	34.5	7	46.7		
Consumption of special food/beverage for kidney stone extraction						
Yes	8	27.6	5	33.3	0.157	0.692
No	21	72.4	10	66.7		
The type of food consumed						
Olive oil	0	0.0	1	50.0		-
Stinging nettle	0	0.0	1	50.0		
Type of consumed beverage						
Parsley juice	3	27.3	0	0.0		
Highbush cranberry juice	5	45.4	2	40.0		
Lemon juice	3	27.3	2	20.0		-
Kefir	0	0.0	1	20.0		
Oleaster juice	0	0.0	1	20.0		

Note: *$p<0.05$, Chi-square test was applied. More than one option has been added.
(-): It has not been evaluated due to the inadequate number of participants in the groups.

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Table 3. Consumption amounts of some food and beverages associated with stone formation. *Ankara*, Turkey, 2018.

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Food and Beverages	Male			Female		
	Patient Group (n=29)	Control Group (n=29)	Z/*p*	Patient Group (n=15)	Control Group (n=15)	Z/*p*
	$\overline{x}$ (Min-Max)	$\overline{x}$ (Min-Max)		$\overline{x}$ (Min-Max)	$\overline{x}$ (Min-Max)	
Red meat	42.8	28.5	Z=-2.596	28.5	28.5	Z=-0.021
	(6.6-142.0)	(3.3-85.7)	***p*=0.009***	(0-85.7)	(13.3-57.1)	*p*=0.983
Fish	13.3	6.7	Z=-1.635	6.7	13.3	Z=-2.069
	(0-85.7)	(0-85.7)	*p*=0.102	(0-57.1)	(6.7-57.1)	***p*=0.039***
Brussel sprouts	0.0	0.0	Z=-0.951	0.0	5.0	Z=-3.046
	(0-5.0)	(0-10.0)	*p*=0.342	(0-5.0)	(0-5.0)	***p*=0.002***
Dill	0.2	0.3	Z=-1.717	0.2	0.3	Z=-2.775
	(0-2.9)	(0-5.0)	*p*=0.086	(0-2.9)	(0.2-2.9)	***p*=0.006***
Mallow	0.0	0.0	Z=-1.678	0.0	2.0	Z=-2.945
	(0-10.0)	(0-10.0)	*p*=0.093	(0-0)	(0-10.0)	***p*=0.003***
Artichoke	0.0	0.0	Z=-0.229	0.0	2.0	Z=-2.950
	(0-42.8)	(0-10.0)	*p*=0.819	(0-0)	(0-10.0)	***p*=0.003***
Stinging nettle	0.0	1.0	Z=-2.010	0.0	5.0	Z=-3.230
	(0-5.0)	(0-10.0)	***p*=0.044***	(0-0)	(0-10.0)	***p*=0.001***
Savoy cabbage	3.3	3.3	Z=-0.213	0.0	6.7	Z=-2.562
	(0-28.5)	(0-57.1)	*p*=0.831	(0-28.5)	(0-28.5)	***p*=0.010***
Locust bean	0.0	1.5	Z=-2.624	0.0	0.0	Z=-1.792
	(0-1.7)	(0-14.2)	***p*=0.009***	(0-14.3)	(0-0)	*p*=0.073
Celery	0.0	0.0	Z=-0.416	0.0	5.0	Z=-2.456
	(0-10.0)	(0-10.0)	*p*=0.677	(0-10.0)	(0-42.8)	***p*=0.014***
Red pepper	0.0	6.1	Z=-2.140	3.1	6.1	Z=-0.802
	(0-52.5)	(0-92.0)	***p*=0.032***	(0-52.5)	(0-52.6)	*p*=0.422
Curly lettuce	5.7	5.7	Z=-1.571	11.4	5.7	Z=-2.917
	(0-20.0)	(0-92.0)	*p*=0.116	(1.3-20.0)	(0.7-92.0)	***p*=0.004***
Lemon	4.7	35.0	Z=-4.033	20.0	35.0	Z=-1.949
	(0-70.0)	(4.7-70.0)	***p*=0.000****	(0-70.0)	(1.2-40.0)	*p*=0.051
Corn	0.0	10.0	Z=-2.038	0.0	6.7	Z=-2.258
	(0-13.3)	(0-57.1)	***p*=0.042***	(0-114.3)	(0-57.1)	***p*=0.024***
Chard	0.0	0.0	Z=-0.067	0.0	5.0	Z=-2.080
	(0-85.7)	(0-42.8)	*p*=0.947	(0-10.0)	(0-10.0)	***p*=0.038***
Pineapple	0.0	1.0	Z=-2.324	0.0	0.0	Z=-1.152
	(0-3.2)	(0-3.2)	***p*=0.020***	(0-27.1)	(0-3.2)	*p*=0.249
Green almond	0.0	3.3	Z=-3.048	0.0	0.0	Z=-0.075
	(0-6.7)	(0-57.1)	***p*=0.002***	(0-28.6)	(0-28.5)	*p*=0.940
Plum	2.0	6.0	Z=-2.419	2.0	4.0	Z=-2.962
	(0-17.1)	(0-34.2)	***p*=0.016***	(0-17.1)	(0-17.1)	***p*=0.003***
Date	0.0	3.3	Z=-3.910	0.0	0.0	Z=-0.229
	(0-3.3)	(0-6.7)	***p*=0.000***	(0-56.6)	(0-28.5)	*p*=0.819

Table 3. Consumption amounts of some food and beverages associated with stone formation. *Ankara*, Turkey, 2018.

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Food and Beverages	Male		Z/*p*	Female		Z/*p*
	Patient Group (n=29)	Control Group (n=29)		Patient Group (n=15)	Control Group (n=15)	
	$\overline{x}$ (Min-Max)	$\overline{x}$ (Min-Max)		$\overline{x}$ (Min-Max)	$\overline{x}$ (Min-Max)	
Orange	4.7 (0-9.3)	9.3 (0-40.0)	Z=-3.226 ***p*=0.001***	4.7 (0-9.3)	9.3 (0-40.0)	Z=-1.078 *p*=0.281
Sour cherry	2.4 (0-4.8)	2.4 (0-20.5)	Z=-1.733 *p*=0.083	1.4 (0-41.0)	2.4 (0-4.8)	Z=-2.534 ***p*=0.011***
Loquat	0.0 (0-6.7)	6.7 (0-57.1)	Z=-3.270 ***p*=0.001***	0.0 (0-6.7)	6.7 (0-13.3)	Z=-2.058 ***p*=0.040***
Caffeinated coffee	17.1 (0-200.0)	34.3 (0-200.0)	Z=-1.186 *p*=0.236	17.1 (0-171.4)	114.0 (0-200.0)	Z=-2.496 ***p*=0.013***
Coke	6.6 (0-228.0)	13.3 (0-400.0)	Z=-1.180 *p*=0.238	0.0 (0-57.1)	57.1 (0-200.0)	Z=-3.257 ***p*=0.001***
Diet coke	0.0 (0-6.7)	6.7 (0-57.1)	Z=-2.035 ***p*=0.042***	0.0 (0-6.7)	0.0 (0-200.0)	Z=-1.089 *p*=0.276
Sparkling water	6.6 (0-200.0)	13.3 (0-200.0)	Z=-1.986 ***p*=0.047***	6.6 (0-114.0)	6.7 (0-200.0)	Z=-0.343 *p*=0.731
Lemonade	0.0 (0-57.1)	6.7 (0-200.0)	Z=-3.210 ***p*=0.001***	0.0 (0-13.3)	13.3 (0-200.0)	Z=-3.917 ***p*=0.000****
Carot juice	0.0 (0-0)	6.7 (0-57.1)	Z=-2.053 ***p*=0.040***	0.0 (0-6.6)	0.0 (0-13.3)	Z=-1.158 *p*=0.247
Orange juice	0.0 (0-13.3)	6.6 (0-200.0)	Z=-2.114 ***p*=0.035***	0.0 (0-13.3)	6.6 (0-200.0)	Z=-2.520 ***p*=0.012***
Peach juice	0.0 (0-57.1)	0.0 (0-114.0)	Z=0.962 *p*=0.336	0.0 (0-13.3)	6.6 (0-200.0)	Z=-2.762 ***p*=0.006***

Note: **p*<0.05 and ***p*<0.001, Mann-Whitney U test was used to compare the measurement values of two independent groups in non-parametric data.

(*p*<0.05). The study also showed that male patients consume less pineapple, green almond, plum, loquat, date and orange than healthy males (*p*<0.05). Similarly, male patients consume less diet coke, sparkling water, carot juice, orange juice and lemonade than healthy males (*p*<0.05).

Fish consumption of female patients (13.5±12.48g) was found to be lower than that of healthy group (14.8±22.17g) (*p*<0.05). The study revealed that female patients consume less brussels sprouts, dill, mallow, artichoke, stinging nettle, savoy cabbage, celery, corn and chard than healthy females do (*p*<0.05). Another result let us know that more curly lettuce is consumed by female patients (*p*<0.05). Additionally, female patients consume less plum, cherry and loquat than healthy females (*p*<0.05). Female patients consume less caffeinated coffee, orange juice, peach juice, coke and lemonade than healthy females do (*p*<0.05) (Table 3).

Consumption of 2.5+ portions of meat and meat products is higher in male patients, while consumption of 5+ portions of fruits and vegetables and 2000+mL of water is higher in healthy males.

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However, these results are not statistically significant ($p>0.05$). Similarly, there is not a statistically significant difference between dairy products, meat and meat products, fruit, vegetable and water consumption of female patients and healthy women ($p>0.05$) (Table 4).

Eighty-eight point 9 percent of patients who have not suffered from stone recurrence, 100.0% of patients who have experienced stone recurrence once and twice and 92.9% of those who have experienced more than twice consume less than 3 portions of dairy products every day; 77.8% of

Table 4. Daily dietary water intake and portions of some food groups of individuals. *Ankara*, Turkey, 2018.

Water/Food Groups	Male				χ^2/p	Female				χ^2/p
	Patient Group (n=29)		Control Group (n=29)			Patient Group (n=15)		Control Group (n=15)		
	n	%	n	%		n	%	n	%	
Dairy products										
≥3 portions/day	1	3.4	1	3.4	χ^2=0.000	1	6.7	1	6.7	χ^2=0.000
<3 portions/day	28	96.6	28	96.6	p=1.000	14	93.3	14	93.3	p=1.000
Meat and meat products										
≥2.5 portions/day	10	34.5	3	10.3	χ^2=3.569	1	6.7	1	6.7	χ^2=0.000
<2.5 portions/day	19	65.5	26	89.7	p=0.059	14	93.3	14	93.3	p=1.000
Vegetable and fruit										
≥5 portions/day	15	51.7	17	58.6	χ^2=0.279	7	46.7	6	40.0	χ^2=0.136
<5 portions/day	14	48.3	12	41.4	p=0.597	8	53.3	9	60.0	p=0.713
Water										
≥2000mL/day	7	24.1	15	51.7	χ^2=3.588	5	33.3	9	60.0	χ^2=1.205
<2000mL/day	22	75.9	14	48.3	p=0.058	10	66.7	6	40.0	p=0.272

Note: Chi-square test was applied.

Table 5. Daily dietary water intake account and consumption portions of some food groups according to stone formation recurrence of individuals. *Ankara*, Turkey, 2018.

Water/Food Groups	0		1		2		>2		χ^2/p
	n	%	n	%	n	%	n	%	
Dairy products									
≥3 portions/day	1	11.1	0	0.0	0	0.0	1	7.1	χ^2=2.112
<3 portions/day	8	88.9	10	100.0	11	100.0	13	92.9	p=0.550
Meat and meat products									
≥2.5 portions/day	2	22.2	2	20.0	4	36.4	3	21.4	χ^2=1.023
<2.5 portions/day	7	77.8	8	80.0	7	63.6	11	78.6	p=0.796
Vegetable and fruit									
≥5 portions/day	7	77.8	4	40.0	4	36.4	7	50.0	χ^2=3.996
<5 portions/day	2	22.2	6	60.0	7	63.6	7	50.0	p=0.262
Water									
≥2000mL/day	3	33.3	4	40.0	2	18.2	3	21.4	χ^2=1.683
<2000mL/day	6	66.7	6	60.0	9	91.8	11	78.6	p=0.641

Note: Chi-square test was applied.

patients with no stone recurrence consume more than 5 portions of fruit and vegetable every day, while 50.0% of patients with more than two recurrences do so. Moreover, 66.7% of patients with no stone recurrence consume less than 2000mL of water every day and 91.8% of those with two recurrences do not exceed that limit. However, there is not a statistically significant difference between number of stone recurrence and consumption of food and food groups included in the Table 5 ($p>0.05$).

DISCUSSION

Salt consumption is among the important factors of kidney stone formation [17]. Nouvenne *et al*. [18] found out in a study that a diet with less amount of salt reduces kidney stone formation risk by decreasing sodium and calcium excretion ($p<0.001$). In addition, hypervolemia resulting from increased dietary salt consumption increases urinary sodium excretion by reducing reabsorption of sodium through kidney tubules [19]. However, a high throughput of sodium is not all bad in terms of stone risk since a high intake of salt is likely to stimulate the thirst response and make the patient drink more. Nevertheless, a high salt diet is one of the scourges of modern society for many other reasons [17]. This study showed that both genders in patient group consume more salt in their food than healthy individuals do ($p<0.05$). Moreover, habit of salting without tasting is more frequent in male patients than healthy males ($p<0.05$) (Table 1). From this fact, it is considered that high salt consumption habit of patient group increases kidney stone formation risk by boosting urinary sodium and calcium excretion [17,19].

It is reported that fluid intake decreases stone formation risk by diluting urine [20,21]. According to study results, daily fluid intake of both genders was found to be lower than healthy individuals ($p<0.05$) (Table 1). This result is a clue that kidney stone recurrence risk may be high in the patient group. Studies in the literature suggest that increased fluid intake decreases calcium phosphate, calcium oxalate and monosodium urate concentration, and thus reduces stone formation risk [20].

Positive family history is one of the most important risk factors of nephrolithiasis [22]. In a study conducted for evaluation of correlation between nephrolithiasis and family history, it was found out that 37.5% of male patients and 27.0% of female patients had positive family history [23]. Supporting above-mentioned results, this study showed that 51.7% of male patients and 53.3% of female patients have kidney stone history in their family (Table 2). Genetic susceptibility is an important risk factor in kidney stone formation like many other chronic diseases [24].

Nephrolithiasis is a highly recurring disease and prevention of stone recurrence during treatment process is as important as the treatment itself [25,26]. The study showed that 79.3% of male patients and 80.0% of female patients have kidney stone formation recurrence (Table 2). High stone recurrence rates are considered to be resulted from inefficient treatment processes.

Traditional and alternative medicine applications have been widely employed from past to present [27]. The study showed that patients with nephrolithiasis consume olive oil, stinging nettle, parsley juice, highbush cranberry juice, lemon juice, kefir and oleaster juice in order to pass the kidney stone (Table 2). As the study was conducted nationwide, the foods and beverages consumed to pass kidney stone may vary from region to region. Recent studies in the literature report that various foods and drinks may have anti-lithogenic [10,28]. In order to use anti-lithogenic foods and drinks in the

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treatment of kidney stone disease further human studies should be carried out, their mechanisms should be examined thoroughly, and correct and effective dose should be determined.

Containing high amount of calcium, dairy products reduce stone formation risk by decreasing intestinal absorption of oxalate [29]. However, there are several studies which suggest that there is not a correlation between dietary calcium intake and stone formation [30,31]. In a study carried out by Taylor & Curhan [32], it was found out that increased dairy products consumption reduces stone formation risk. However, in this study, there is not a gender-based difference between dairy products consumption of patient group and healthy individuals ($p>0.05$) (Table 3). Additionally, 88.9% of patients who have not suffered from stone recurrence, 100.0% of patients who have experienced stone recurrence once and twice and 92.9% of those who have experienced more than twice consume less than 3 portions of dairy products every day. However, there is also not a statistically significant difference between number of recurrence and dairy products consumption ($p>0.05$) (Table 5). Therefore, it is recommended to consume calcium as required rather than limiting dairy products to prevent stone formation [33].

Consumption of animal and vegetable protein in adequate amounts is quite important for health, as well [34]. Nonetheless, it is reported that increased animal protein intake causes an increase in acid production through methionine and cysteine sulphuric acid metabolism [9]. As a result of acid load increase, urinary calcium excretion rises as calcium breakdown scales up and calcium reabsorption decreases in kidneys [9,35]. Moreover, high amount of fat contained in animal protein sources may increase intestinal oxalate absorption says some studies [36]. In this study, meat consumption of male patients was found to be higher than healthy males ($p<0.05$) (Table 3). In line with this data, it is fair to suggest that high meat consumption may increase stone formation risk as it steps up acid production and fat intake (g) [9,35,36].

It is known that fatty acids in fish have important functions regarding human health [37]. For example, it is reported that n-3 fatty acids contained in fish and fish oil may reduce kidney stone formation risk [38]. Some studies have proved that fish oil supplement in the patients with idiopathic calcium oxalate stone reduces urinary oxalate and calcium excretion [39,40]. Additionally, n-3 fat acid supplement shows anti-lithogenic effecy by suppressing prostoglandin E2 production which increases intestinal calcium absorption [40]. In this study, fish consumption of female patients was found to be lower than healthy females ($p<0.05$) (Table 3). It can be concluded that increased n-3 fatty acid intake through high amount of fish consumption in healthy females may reduce kidney stone formation risk by decreasing urinary oxalate and calcium excretion [39,40].

Some studies indicate that fruit and vegetable consumption creates anti-lithogenic effect by reducing calcium excretion and increasing urinary citrate excretion, while some other studies suggest that such effect is caused by phenolic compounds [8,10,41]. In a study carried out by Sorensen *et al*. [10] in 2014, it was found out that individuals with kidney stone disease consumed less amount of fruit and vegetable than healthy individuals did and the difference was statistically significant ($p<0.05$). Similarly, this study demonstrates that male and female patients consume less amount of fruit and vegetable than healthy individuals (Table 3). Thanks to consumption of fruits and vegetables in high amounts, healthy individuals intake more macro and micro-nutrients such as pulp, phenolic compounds, citrate and potassium which are known to have anti-lithogenic effect. Despite such benefits, some vegetables such as spinach, beet, chard, tea, chocolate and nuts which are rich in oxalate may increase stone formation risk [42]. Therefore, it can be recommended for patients with kidney stone not to consume high amounts of vegetables known to be rich in oxalate.

Besides increasing total fluid intake, beverages take important roles in kidney stone formation risk due to their caffeine, alcohol, oxalate, potassium, citrate and similar other content [28,38,43]. In a study carried out by Ferraro *et al*. [43], it was found out that increased caffeine consumption is correlated with stone formation risk. Another study proved that sugar-free sparkling water, coke and orange juice consumption reduces kidney stone formation risk ($p<0.05$) [28]. In addition, numerous studies put forward that increased orange juice and lemonade consumption reduces stone formation risk by scaling up urinary citrate excretion [44,45]. It was found out in this study that male patients consume less diet coke, sparkling water, carrot juice, orange juice and lemonade than healthy individuals ($p<0.05$). Similarly, female patients consume less caffeinated coffee, orange juice, peach juice, coke and lemonade than healthy females ($p<0.05$) (Table 3). In the light of this data, less consumption of above stated beverages by patient group in both genders can be considered as a risk factor in terms of stone formation. These beverages include coke which is not recommended due to its adverse effects on human health. However, it can be considered that coke suppresses stone formation risk thanks to its caffeine content.

The study showed that consumption of 2.5+ portions of meat products is higher in male patients, while consumption of 5+ portions of fruit and vegetable is lower. However, these results are not statistically significant *(*$p>0.05$) (Table 4). Dietary protein intake is one of the most important causes of change in Potential Renal Acid Load (PRAL) value [46]. Protein intake from animal origin mainly leads to the production of acid through methionine and cysteine sulfuric acid metabolism [9]. Additionally, consumption of 2000+mL of water is lower in female patients than healthy females. These results are not statistically significant, as well ($p>0.05$) (Table 4). The fact that individuals in the patient group consume more meat and meat products and less fruit, vegetable and water may boost kidney stone formation risk.

It is reported that increased water, fruit and vegetable consumption decreases kidney stone formation and recurrence risk [10,47]. Taylor *et al*. [48] found out that fruit and vegetable consumption reduces stone formation and recurrence. This study demonstrated that consumption of 5+ portions of fruit and vegetable and 2000+mL of water is higher in patients with no recurrence. However, there is not a statistically significant difference between number of stone recurrence and fruit, vegetable and water consumption ($p>0.05$) (Table 5). This result is a clue that citrate, magnesium and potassium intake due to fruit and vegetable consumption and increased urine volume due to water intake can reduce stone recurrence risk.

CONCLUSION

As a consequence, it can be suggested that general eating habits such as dietary total fluid intake, salt consumption habits, fruit and vegetable consumption, meat and meat products consumption can effect kidney stone formation and recurrence. Therefore, a personal diet plan should be prepared and prescribed for each individual with nephrolithiasis.

CONTRIBUTORS

MA ICER idealized and developed the project studied, collected the data, interpreted and analyzed the data, reviewed the literature and wrote the article. M GEZMEN-KARADAG supervised the development of the project, reviewed the article and approved its final version.

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