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The Association of Household Food Insecurity and the Risk of Calcium Oxalate Stones

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Purpose: Food insecurity has been defined as 'limited or uncertain availability of nutritionally adequate and safe foods', which associated with adverse health consequences in human. Another alarming condition, which is related to several comorbidities is kidney stone. This study aimed to determine the association of household food insecurity and developing kidney stones (calcium oxalate) in adults referred to medical centers of Babol.

Materials and Methods: This case-control study included 200 participants 18-65 years of ages (100 cases, 100 controls). An 18-items food insecurity questionnaire (USDA), a valid and reliable 147-item food frequency questionnaire (FFQ) and demographic characteristics were obtained via interviewing.

Results: Sixty eight percent of cases and 40% of controls were food insecure, respectively. Food insecurity was significantly associated with the risk of kidney stone ($P < .05$). Furthermore, body mass index (BMI) and family history of kidney stone were significantly associated with the risk of kidney stones ($P < .05$).

Conclusion: Food insecurity and BMI were significantly associated with the kidney stone, which shows the importance of availability of nutritionally adequate and safe foods in prevention of the kidney stone.

Keywords: food insecurity; kidney stone; diet; case-control study

INTRODUCTION

Kidney stone is a painful condition[(1)], which is related to several comorbidities such as diabetes mellitus, obesity, metabolic syndrome, hypertension, gastric bypass and chronic kidney disease in adults[(2,3)]. The prevalence of kidney stones has been estimated between 8% to 19% and 3% to 5% among males and females, respectively in western countries[(4,5)]. According to a recent study, which analyzed the 2007-2010 National Health and Nutrition Examination Survey (NHANES) sample, 8.8% (10.6% of men and 7.1% of women) of the American population suffered from kidney stones[(6)]. The prevalence of this disease increased from 0.9% in individuals who were between 15-29 years of age to 8.2% in older ones who were between 60-69 years of age, in Iran[(7)]. It has been previously shown that 80% of kidney stones are calcium oxalate (caox)[(5)], and the most accessible and requested interventions to reduce the risk of kidney stones is dietary modification[(8)]. Following healthy eating, for example, adoption Dietary Approaches to Stop Hypertension (DASH) diet is recommended to reduce the risk of kidney stone. In addition, it is suggested that obesity, higher BMI and weight gain are independently associated with higher risk of kidney stones formation [(9,10)].

Another alarming condition in the world, is food insecurity, which is defined as "limited or uncertain access to adequate food or limited ability to access healthy food through socially acceptable" [(11)]. It has been previously considered that 6.30% of the households in the Paris metropolitan area experienced food insecurity and about 2.50% of the households experienced severe food insecurity[(12)]. In the United States, food insecurity existed in about 16% of population[(13)]. Another study, which was performed in Ontario community in Canada has shown that 70% of households were food insecure of which 17% and 53% were categorized in severe and moderate food insecure groups, respectively[(14)]. The prevalence of food insecurity has been estimated between 30.5% to 50.2% in different parts of Iran[(15-19)]. Although it has been previously shown that 16.3% he-

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Table 1. Classification of the household food security status based on scores

Food security status	Number of positive responses	
	Having child under 18 years old	Having no child under 18 years old
Food secure	0-2	0-2
Food insecure without hunger	3-7	3-6
Food insecure with moderate hunger	8-12	7-8
Food insecure with severe hunger	13-18	9-10

modialysis patients were food insecure[20], to the authors' knowledge there was no study about the association between prevalence of food insecurity and kidney stones. Thus, the aim of this study was to evaluate food insecurity in the patients who suffered from calcium oxalate stones in Iranian adult population.

MATERIALS AND METHODS

Study design, Sample size and Participants

This case control study was performed among adults who lived in Babol, the city located in north of Iran in 2014. Ethics committee of Mashhad University of Medical Sciences approved the study. The study was founded and supported by Mashhad University of Medical Sciences.

To determine sample size in this study, we designed and implemented a pilot study conducted on 24 adults between 18-65 years old, who were selected randomly(12 patients who suffered from calcium oxalate stones and 12 healthy individuals). According to the pilot study, 75% of patients with kidney stones and 50% of the control group were food insecure. Therefore, based on the statistical formula and considering 80% power and an □ level of 0.05, it was necessary to examine 100 cases (patients who suffered from calcium oxalate stones) and 100 controls (healthy individuals) to compare of food security between two groups.

We used purposive sampling method to select participants. 100 cases (with calcium oxalate kidney stone) were assigned after diagnosis of calcium oxalate stone by a urologist using chemical analysis of stone in the laboratory. Inclusion criteria for the case group were adults who were between 18-65 years of ages and had kidney stones (only calcium oxalate) according to physician diagnosis without any underlying diseases (such as diabetes, hypertension, hyperlipidemia and so on). After interviewing with cases, we had to find controls who are matched according to sex, age and place of residence. Thus, among 8 urban and rural health centers of Babol, we selected 5 centers randomly. Then, among people who referred to these centers, we chose healthy adult people, who were matched with the case participants. After that, we explained the study objectives completely to them and informed consents were obtained from participants. Finally, from a total of 100 adults participated in each group, 65 were men and 35 were women and they were between 18 to 65 years old. In each group 48 participants lived in urban and 52 of them lived in rural. **Table 2**. Presents basic data of the study samples. Participants in the two groups were matched according to age, sex and place of residence.

Anthropometric measurement

Participants' height was measured by the meter strip with a precision of 0.1 cm, while the person was attached to the wall without shoes and looking forward. Participants' weight was measured by a beurer flat digital scale with a precision of 0.1 kg, while the person was wearing minimal clothing without shoes. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meter.

Food security assessment

Household food security status have evaluated by the USDA (US Department of Agriculture) questionnaire, which has been used annually in the U.S. Current Population Survey since 1995[21]. The reliability and validity of the questionnaire has evaluated in a previous study in Iran[22].

This 18 items questionnaire examines household food security status in the last 12 months. We completed the questionnaire by interviewing mothers of households. The studied participants were divided into two classifications of participants based on the scores of the questionnaire: food secure and food insecure groups. Food insecure participants were divided into three subgroups: food insecure without hunger, food insecure with moderate hunger and food insecure with severe hunger (**Table 1**). The last two groups (Food insecure with moderate hunger and food insecure with severe hunger) were combined in analysis owing to the low percentage of food insecurity with severe hunger, (27% and 6% in case subjects and control ones, respectively).

Dietary intake

To evaluate dietary intakes, a valid and reliable food frequency questionnaire (FFQ)[23,24], which contained 147 items of foods and beverage was used. The food consumption converted into food material and its value was calculated in grams. Total energy was reported as kilocalorie per day.

Socio-economic and demographic status

Demographic characteristics (including age, sex, place of residence, family size, number of children, having children under 18 years of age, and social and economic characteristics) were collected by a general questionnaire. These characteristics were as follows: education and occupational status of the mother and head of household, residential possession ownership status and living facilities. About living facilities, participants were asked that how many items of these 9 items they have (furniture, handcraft carpet, refrigerator, washing machine, dishwasher, microwave, computer, car, and home). Having less than or equal to 3 items was considered as a low economic status, 4 to 6 items as moderate economic status and 7 to 9 items as good economic status. About landlord, participants were asked to select one of the options of the private house, rent or mortgage, and living with parents or relatives and others[17]. All data were obtained by a well-trained nutritionist who became completely familiar with all questionnaires.

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Table 2. Basic data of the study participants.

Variables	Case group N=100	Control group N=100	*P*-Value
Age(year)			
Under 30	16	16	
30-39	31	31	0.999
40-49	23	23	
50 and more	30	30	
Sex			
Men	65	65	0.999
Women	35	35	
Place of residence			
Village	52	52	0.999
City	48	48	
Family size			
Under 5	83	83	0.999
5 and more	17	17	
Number of children			
Under 4	71	78	0.256
4 and more	29	22	
Having child under 18			
Yes	63	68	0.457
No	37	32	
Occupation of the head			
Unemployed	1	2	
Worker14	14		
Government employee	28	29	0.267
Self-employed	44	50	
Retired 13	5		
Education level of responders			
Pre-university	83	78	0.372
University	17	22	
Education level of heads			
Pre-university	78	68	0.111
University	22	32	
Marital status			
Married	90	89	
Single 10	9		0.845
Widow 0	2		
Economic situation			
Low	24	8	
Middle 5	9	69	0.011
High	17	23	
Home			
Ownership	91	95	0.268
Other	9	5	
Family history of kidney stone			
Yes	60	19	< 0.001
No	40	81	
Food insecurity			
Yes	68	40	< 0.001
No	32	60	
BMI* (kg/m2)			
Under weight	3	0	
Normal	23	39	0.003
Overweight	37	46	
Obese	37	15	
Dietary intake	Median(IQR)	Median(IQR)	
Calorie intake (Kilo-calorie)	3702.2(1362.6)	3179.7(1033.4)	< 0.001
Protein intake (gram)	130.0 (42.2)	107.1(37.3)	< 0.001
Carbohydrate intake (gram)	573.9(240.4)	493.1(165.6)	< 0.001
Fat intake (gram)	119.1(46.7)	91.1(42.5)	< 0.001
Height (cm)	168.0 (17.7)	168.0 (8.0)	0.823
Weight (kg)	78.0 (17.38)	74.4(13)	0.008

Statistical analysis

The classes of food security were determined for cases and controls in separate according to the obtained scores. Descriptive variables were reported by mean, standard deviation (SD). To detect the relationship between variables and food security or calcium oxalate stone disease Chi-squared test, independent t-test, Pearson and Spearman correlation were used. The simple regression method was used to assess the relationship between food security status and all variables. Finally, variables were entered into the model step by step forward to fine variables which had a relationship with food insecurity. The multiple regression method was also used to determine the variables which had the most effect on the kidney stone incidence (family history of kidney stone, food insecurity, fat and protein intake). (To reach this goal all variables, which had a significant relation with kidney stone (included: socioeconomic situation, family history of kidney stone, food insecurity, BMI, weight, macronutrient intake (Calorie [kilo calories], carbohydrate, fat, protein in grams) were entered into the logistic multiple regression). To analyze the data we used the Statistical Package for the Social Sciences (SPSS),

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Table 3. Correlation between kidney stone and effective variables (Multiple regression method).

Independent variable	Wald	Odd Ratios	95% CI of OR	*P*-value
Food insecurity	5.27	2.44	1.14 - 5.24	0.022
Family history	23.26	5.76	2.83 - 11.75	<0.001
Economic situation				
Low	1.75	2.58	0.63 - 10.56	0.185
Middle	3.34	0.96	0.38 - 2.45	0.955
High*				
Education level of heads				
Pre-university	0.21	0.81	0.34-1.94	0.647
University*				

*reference category

version 11.5.

RESULTS

Sixty eight percent of cases and 40% of controls were food insecure, respectively. Forty one percent, 22% and 5% of case subjects were categorized in the food insecurity without hunger, with moderate and severe hunger groups, respectively. In the control subjects, these values were 33%, 7% and 0 %, respectively.

No significant differences were found between case and healthy subjects in age, sex, place of residence, family size, number of children, having child under 18, occupation of head, education level of responders and head and marital status. However, there were significant differences in some variables including economic status, history of kidney stone and BMI between individuals within the case and control groups ($P < .05$). Moreover, the median intake of calories and macronutrients including carbohydrate, protein and fat as well as weight were significantly higher among kidney stone patinas in comparison with the health individuals ($P < .05$) (**Table 2**).

The median of daily total calorie and carbohydrate, protein and fat intake were 3702.2 ± 1362.6 kilo calories, 573.9 ± 240.4 grams, 130.0 ± 42.2 grams, 119.1 ± 46.7 grams, respectively in the case subjects. These values were 3179.7 ± 1033.4 kilo calories, 493.1 ± 165.6 grams, 107.1 ± 37.3 grams and 91.1 ± 42.5 grams, respectively in the control group (**Table 2**). Among the examined variables, 6 variables including economic status, family history of kidney stone, BMI average, obesity status, food insecurity and dietary intake were significantly associated with the kidney stone ($P < .05$). According to the multiple regression test, family history of kidney stone and food insecurity were found to be significant predictors for the kidney stone ($P < .05$) (**Table 3**). Furthermore, regression step by step forward model shows that economic status, family size, education level, place of residence and occupation of the household head were significantly related to the food insecurity ($P < .05$) (**Table 4**).

Table 4. Correlation between food insecurity and effective variables (regression step by step forward model)

Variable	β± SE	*P*-value
Economic situation	-1.6 ± 0.5	0.001
Family size	1.08 ± 0.3	< 0.001
Education level	-3.4 ± 0.8	0.001
Place of residence	1.9 ± 0.5	0.001
Occupation of the head	-1.5 ± 0.5	0.005

DISCUSSION

The main finding of the current study is that household food insecurity has a strong correlation with the kidney stone. According to our knowledge, there are a very few studies about the associations between food insecurity and kidney diseases. A previous study, which was conducted among hemodialysis patients, has shown that 16.3% of patients were food insecure[20]. In another study, which was conducted by Crews et al., food insecurity was related to chronic kidney disease[25]. However, it has been shown that food insecurity had a correlation with the chronic diseases[26,27]. In their study, Fitzgerald et al. showed that food insecurity is associated with increasing type 2 diabetes[28]. Likewise, a significant association was reported between food insecurity and the risk of type 2 diabetes and between food insecurity and bone density osteoporosis in postmenopausal women in Iran[29,30].

The results of the current study showed a significant relationship between BMI and the kidney stone. It is earlier suggested that a low calorie DASH diet and decrease in fat and protein intake to prevent against kidney stone. In addition, carbohydrate rich in fructose (especially high fructose corn syrup) and sucrose were considered as a risk factor to increase the incidence of kidney stone[31]. Similarly, in their article, Turney et al. have shown that total energy intake was associated with a significant increase risk of developing kidney stones [32]. It has been previously shown that food insecure households had low quality diet. Indeed, following diet with low vegetables and fruit, grains, and dairy products, and intake of a greater percent of energy from high-sugar foods were more common among food insecure individuals than the food secure ones[33]. Furthermore, because of financial problems, food insecure households decrease consumption of expensive foods such as fruits, vegetables and dairy and they have low food variety[34], and thus they receive low amount of calcium, citrate and phytate, which are all related to the reduction of the risk of kidney stones[31,35,36]. In addition, to meet calorie requirements, consumption of oils and sweets, bread, pasta, and rice are considered as the most cost-efficient way among food insecure households[34], which all could lead to overweight and obesity. As previously have been shown frequently, overweight and obesity were significantly associated with the risk of kidney stones[6,9,10,37]. Thus, it is not surprising, if considering that food insecurity may lead to the kidney stones.

The results of the present study showed that 68% and 40% of participant's household in case and control groups had mild to severe food insecurity, respectively. Previous studies, which all were conducted in Iran

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showed that the prevalence of food insecurity was varied between 50.2% in Rey, 30.5% in Yazd and 36.6% in Isfahan (center part of Iran) and 37.6% in Dezful placed in south area of the country, which were in line with the results of this study[16-19]. The United States Department of Agriculture (USDA) has reported that, 15.8% of the population (49 million adults and children) were food insecure in 2013, concentrated among low income households[38]. In India, the prevalence of food insecurity was 77.2% among households[39]. Possible reasons for the difference between food insecurity among countries might be due to cultural difference, different evaluation instrument, different income and economic factors. Another reason could be economic crisis and increased cost of foods. On the other hand, in spite of other countries, industrial countries perform a nutrition program such as food Stamp program to help household with low income[40,41].

In line with the results of previous studies[15,17,19], in the current study, the prevalence of food insecurity in the households of the first category (low socioeconomic status) was higher than two others category. Household food insecurity associated with low household income in Seligman et al.[27] and Martin-Fernandez et al.[12] studies. It seems that, households with higher incomes and better economic conditions can choose various foods and can spend much more part of their income for food supply[17].

We found a significant relationship between food insecurity and the place of residence. Population who lives in rural areas were more food insecure in comparison with city dwellers, which might be due to inaccessibility to the shopping centers in rural area. However, although the positive association between food insecurity and place of residence was observed in Sharafkhani et al. study[42], FallahMadvari et al., found no significant correlation between these factors[40].

As previously have been shown frequently[15,19,43-47], in the current study, food insecurity has a significant relationship with family size and number of children. It should be noted that by increasing family size, the need for food will be increased. So, the size and number of meals can also be reduced and food insecurity will appear[17].

In this study, there was a significant relationship between food insecurity and job status of the head of household. The findings showed that food security was higher in households whose head were clerks, which is in line with the results of the studies by Payab et al.[17] and FallahMadvari et al.[40]. Moreover, a significant relationship between food insecurity and job status has observed in studies on Canadian households and rural households in Malaysia[48,49]. To interpretation, it should be considered that higher job status often is accompanied by higher income and better socioeconomic situation, which may result in an increment of accessibility to various and nutritious foods.

This study showed a significant inverse relationship between food insecurity and education level of the mother and head of household. Consistent with this result, previous studies showed a significant relationship between food insecurity and education level of mother and head of household[15,17,19,44,49].

Absence of adequate education limits job opportunity and reduces the ability to earn money. Following the reduction of income, food expenses can be challenging. Low education level also reduces people's nutritional knowledge level and affect all stages of the basket to the table (shopping, preparation, cooking and consumption), which can result in the household food insecurity [17].

To our knowledge this study was the first that focused on kidney stone patients. In interpreting the existing results, some limitations should be noted. Household food insecurity was evaluated in cross-sectional method. Therefore, we cannot conclude if food insecurity in the household was continued or temporary.

CONCLUSIONS

Food insecurity and BMI were significantly associated with the kidney stone, which all show the importance of availability of nutritionally adequate and safe foods in prevention of the kidney stone. Since kidney stone disease is related to painfulness and several medical comorbidities, decreasing in the rate of food insecurity across the population might lead to reduction of negative consequences of the kidney stone in the community.

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