

# Investigating relation of type and frequency of fluid intake with formation of kidney and urinary tract stones: a case-control study

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## ABSTRACT

**Introduction:** Regarding the fact that the pattern of fluid intake in healthy people and people with urinary stones is unknown, and there is also little information about the extent of the use of fluids in preventing urinary stones, the aim of this study was to determine the relationship between the type and frequency of fluid intake with the formation of kidney and urinary tract stones. **Materials and Methods:** In a case-control study, 127 newly diagnosed patients with urinary stones and the same number of healthy people were studied. The control group was matched with cases in terms of age and gender. Patients with diabetes and acute or chronic renal failure were excluded from the study. Data were collected using INSKAP-HQ-Tot questionnaire. Chi-square and Kendall's correlation coefficient were used to analyze the data. **Results:** The results of this study showed that the frequency of water intake ( $P = 0.003$ ), tea ( $P = 0.008$ ), drink ( $P = 0.005$ ), natural fruit juice ( $P = 0.001$ ), industrial juices ( $P = 0.001$ ), Mineral water ( $P = 0.001$ ), yogurt drink ( $P = 0.008$ ) and coffee ( $P = 0.015$ ) was associated significantly with the risk of renal and ureteral stones ( $p < 0.05$ ). **Conclusion:** The findings of this study showed that the risk of urinary stones formation has a significant relationship with the type and quality of fluid intake. Therefore, the precise use of fluid intake can prevent the formation of kidney and urinary tract stones.

**Keywords:** Urinary stones, fluid intake, prevention, Ilam

## Introduction

Urinary tract stones after urinary tract infections and prostate pathologies are the third common disease of the urinary system [1]. The large amount of urine that is produced with high amounts of fluid is the most important point in the treatment and prevention of relapse in people with kidney stones [2]. The large amount of liquids by reducing the concentration of urinary stoning materials [3] and reducing the time of contact of urinary crystals with nephrons reduces the risk of stoning. Ultimately,

the increase in urine volume in patients with kidney stones, which can be easily achieved by increasing the amount of fluid intake, can prevent the recurrence of many kidney stones without the need for any changes in the diet [4].

In a study conducted by Borghe et al in two similar groups, followed by a follow-up of 5 years, 12.1% of patients with high daily water intake had kidney stones recurrence, while in other subjects under study without any treatment this was 27%, which was statistically significant. The study also showed that patients treated with water had on average afflicted from recurrence after 38.7 months, while patients without water use had recurrence after 25.1 months [5].

Using mineral water to compensate for lost water through the lungs, skin, urine and stool, in addition to hydration, the patient can have a greater effect on the contents of the urine and consequently the risk of stoning, due to the presence of substances such as calcium, bicarbonate and magnesium [2].

In the past, people with stoning kidney were advised to consume high levels of water with low calcium and this was due to the fact that most of the kidney stones were calcium stones

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and hypercalciuria was the most common metabolic disorder in these individuals. However, recent studies have questioned the above-mentioned theory [6] and have shown an inverse relationship between water hardness and kidney stone disease [7].

In this regard, the role of using adequate fluids in preventing the formation and recurrence of urinary stones has been reported in various studies [5, 8, 9]. Although there is ample evidence of the effect of daily consumption of 2 liters of water in primary prevention of urinary stones, this working procedure has not yet been implemented as a public health policy. However, other studies also indicate the cost of its effectiveness [8].

Considering the fact that the pattern of fluid consumption in healthy people and people with urinary stones is unclear, and there is also little information about the effect of the use of fluids on the prevention of urinary stones, the aim of this study was to determine the relationship between the type and frequency of fluid intake and the formation of kidney and urinary tract stones.

## Materials and methods

This study was a case-control one in which 127 patients with urinary tract stones and 127 subjects, matched in terms of age and sex with the case group, as control group were entered into the study as participants. The study was done consciously and with the consent of the people. The pattern of food intake was gathered using the INSKAP-HQ-Tot standard questionnaire whose validity and reliability were confirmed in previous studies. Frequency of consumption was related with carbonated beverages, non-alcoholic malt beverage, dough, coffee, natural juices, industrial juices, mineral water and tea. Answers to questions were in the range including: never, rarely, daily, and weekly. Data were collected on demographic and disease characteristics in both case and control groups. Patients were selected from among clients of specialized clinics during whose ultrasound were first identified urinary stones. Patients with acute or chronic renal failure, diabetics, dialysis patients, or under special care were excluded. The control group was selected at the same time period and in specialized clinics from among those without urinary stones based on ultrasound examination. The method of obtaining information from the subjects was conducted by direct interview by trained experts. Then, the data were entered into SPSS software version 16. They were analyzed using descriptive statistics, chi-square and Kendall's correlation coefficient.

## Findings

The findings of this research showed that out of 254 people of the case (n=127) and control (n=127), 180 people (70.9%) were man and 74 people (29.1%) were women. The two groups were matched in terms of age and sex in the groups under study. The demographic characteristics of patients with kidney stones and healthy subjects have been shown in Table 1.

Out of the demographic information, BMI was statistically different between the two groups ( $p = 0.001$ ).

**Table 1. Demographic characteristics of patients with kidney stones and healthy people in Ilam**

Variable	Case n= 127(%)	Control n= 127(%)	P- value
<b>Age:</b>			
<40	63(50/0)	63(50/0)	1.00
40-60	45(50/0)	45(50/0)	
>60	19(50/0)	19(50/0)	
<b>Occupation:</b>			
Manual worker	19(50/0)	19(50/0)	0.91
Employee	34(47/9)	37(52/1)	
Other	74(51/0)	71(49/0)	
<b>education:</b>			
illiterate	19(61/3)	12(38/7)	0.36
Elementary	26(45/6)	31(54/4)	
Diploma and	82(49/4)	84(50/6)	
Academic			
<b>marital status:</b>			
Married	104(51/5)	98(48/5)	0.35
Single	23(44/2)	29(55/8)	
<b>Gender:</b>			
Male	90(50/0)	90(50/0)	1.00
Female	37(50/0)	37(50/0)	
<b>Living place:</b>			
City	99(49/7)	100(50/3)	0.87
Village	28(50/9)	27(49/1)	
<b>The economic situation:</b>			
Weak	19(45/2)	23(54/8)	0.788
medium	78(50/6)	76(49/4)	
Good	30(51/7)	28(48/3)	
<b>Body Mass Index:</b>			
Lack of weight and normal	48(37/2)	81(62/8)	0.001
Overweight	63(63/0)	37(37/0)	
Obese	16(64/0)	9(36/0)	
<b>daily activity:</b>			
No activity	23(55/6)	25(44/4)	0.594
30 minutes	35(54/5)	32(45/5)	
one hour	15(46/2)	22(53/8)	
More than an hour	54(52/9)	48(47/1)	
<b>History of urinary stones in first degree relatives:</b>			
Yes	69(52/3)	63(47/7)	0.451
No	58(47/5)	64(52/5)	

Table 2 shows the association between the frequency of fluid intake and the risk of kidney and urinary tract stones formation. Frequency of water intake was obtained among the groups under study. According to the information obtained, the distribution of water usage frequency in the two groups seems different, so that the water intake frequency by maximally one glass per day in the case group is of more density. Chi-square test was used to determine the correlation between water use frequency and kidney and urinary tract stones, the results of which are presented in Table 2. As can be seen, according to Chi-square statistics ( $p < 0/05$ ), there is a relationship between the frequency of water use and the formation of kidney and

urinary tract stones. The value of Kendall's correlation coefficient showed that low water use frequency increased the risk of kidney and urinary tract stones ( $T = -0.17, P < 0.05$ ).

As shown in the table, the frequency of tea drinking has been reported among the groups under study. According to the information obtained, the distribution of tea intake frequency in both groups seems to be different, so that the tea intake times at least 6 glasses per day in the case group is of more density. As can be seen, according to Chi-square statistics ( $p < 0/05$ ), there is a relationship between the frequency of tea drinking and the formation of kidney and urinary tract stones. Correlation coefficient value indicated that high frequency of tea intake increased the risk of kidney and urinary tract stones ( $T=0.20, P < 0/05$ ).

According to the information obtained, the distribution of the frequency of consumption of beverages in both groups seems different, so that the frequency of consumption of beverages on a weekly and daily basis in the case group is of more density. The Chi-square test was used to determine the relationship between the frequency of drinking use and the formation of kidney and urinary tract stones. The results are presented in Table 2. As can be seen, according to Chi-square statistics ( $p < 0/05$ ), there is a relationship between the frequency of drinking use and the formation of kidney and urinary tract stones. The correlation coefficient of Kendall showed that the high frequency of consumption of beverages increases the risk of the formation of kidney and urinary tract stones ( $T=0.13, P < 0.05$ ).

According to Table 2, the frequency of intakes of natural fruits juices in both groups seems to be different, so that the lack of consumption or low consumption of natural fruit juices in the case group is of more density. Chi-square test was used to determine the correlation between the frequency of natural fruit juices and the formation of kidney and urinary tract stones. The results are presented in Table 2. As can be seen, according to Chi-square statistics ( $p < 0/05$ ), there is a relationship between the frequency of consumption of natural fruit juices and the formation of kidney and urinary tract stones. The correlation coefficient of Kendall showed that normal consumption of natural fruit juices reduced the risk of kidney and urinary tract stones ( $T=0.19, P < 0.05$ ).

The frequency of consumption of industrial fruit juices among the groups under study has been given in Table 2. Since the frequency of more than 20% of the cells was less than 5, the weekly and daily classes were merged. According to the obtained data, the distribution of water consumption frequency of industrial fruits in different groups seems to be different, so that the lack of consumption of industrial fruit juices in the case group is of more density, while the low or high consumption of natural fruit juice in the control group is of higher density.

Chi-square test was used to check the correlation between the consumption frequency of industrial fruit juices and the formation of kidney and urinary tract stones. The results are shown in Table 2. As can be seen, according to Chi-square statistics ( $p < 0/05$ ), there is a relationship between the frequency of consumption of industrial fruit juices and the

formation of kidney and urinary tract stones. The correlation coefficient of Kendall also showed that non-consumption of industrial fruit juices increases the risk of the formation of kidney and urinary tract stones, and their usual consumption reduces the risk of the formation of kidney and urinary tract stones ( $T=0.19, P < 0.05$ ).

According to the obtained data, the distribution frequency of dough usage in both groups seems different, so that the lack of consumption or low consumption of dough in the case group is of more density, whereas weekly and daily consumption of dough in the control group has a higher density. As shown in Table 2, according to Chi-square statistics ( $p < 0/05$ ), there is a relationship between the frequency of dough usage and the formation of kidney and urinary tract stones. The value of Kendall's correlation coefficient showed that non-consumption or low consumption of dough increases the risk of the formation of kidney and urinary tract stones and their usual consumption reduces the risk of the formation of kidney and urinary tract stones ( $T = 0.12, P < 0.05$ ).

According to Table 2, the distribution frequency of mineral water intake in both groups is different, so that the absence of mineral water in the case group is of more density, while daily intake of mineral water in the control group is of more density. As can be seen, according to Chi-square statistics ( $p < 0/05$ ), there is a relationship between the frequency of mineral water use and the formation of kidney and urinary tract stones. The Kendall Correlation Coefficient showed that low consumption frequency of mineral water intake increases the risk of the formation of kidney and urinary tract stones, and its usual or high consumption reduces the risk of the formation of kidney and urinary tract stones ( $T = 0.20, P < 0.05$ ).

Table 2 shows the frequency of coffee intake among the groups under study. Since the frequency of more than 20% of the cells was less than 5, the weekly and daily classes were merged. According to the information obtained, the distribution of coffee intake frequency in both groups seems to be different, so that weekly and daily coffee intake in the case group is more densely charged. As can be seen, according to Chi-square statistics ( $p < 0/05$ ) there is a relationship between the frequency of coffee consumption and the formation of kidney and urinary tract stones. The correlation coefficient of Kendall also showed that high coffee consumption frequency increased the risk of kidney and urinary tract stones ( $T=1.16, P < 0.05$ ).

Table 2 shows the frequency of drinking malt consumption among the groups under study. According to the data, the distribution of drinking malt frequency is similar in both groups.

As can be seen, according to Chi-square statistics ( $p > 0.05$ ), there is no relationship between the frequency of consumption of malt drink and the formation of kidney and urinary tract stones. The correlation coefficient of Kendall was 0.03, which is not significant at 5% level ( $T = 0.03, P > 0.05$ ).

According to the information obtained, distribution of milk intake frequency is similar in both groups.

Chi-square test was used to check the relationship between the frequency of milk consumption and the formation of kidney and

urinary tract stones. The results are presented in Table 2. As can be seen, according to Chi-square statistics ( $p > 0.05$ ), there is no relationship between the frequency of milk consumption and the formation of kidney and urinary tract stones. The correlation coefficient of Kendall was 0.03, which is not significant at 5% level ( $T = 0.03$ ,  $P > 0.05$ )

**Table 2. relationship between fluid intake frequency and the risk of formation of kidney and urinary tract stones**

Variable	Case (n)	Control (n)	Statistic of Chi square ( $\chi^2$ )	Kendall (T) correlation coefficient	P
<b>Water *</b>			<b>14.31</b>	<b>-0.17</b>	<b>0.003</b>
<1 glass per day	23	8			
(2 to 3 glasses) per day	41	30			
(4 to 5 glasses) per day	34	55			
(at least 6 glasses) per day	29	34			
<b>Tea *</b>			<b>11.94</b>	<b>0.20</b>	<b>0.008</b>
<1 glass per day	7	17			
(2 to 3 glasses) per day	36	51			
(4 to 5 glasses) per day	39	32			
(at least 6 glasses) per day	45	27			
<b>Beverage *</b>			<b>12.85</b>	<b>0.030</b>	<b>0.005</b>
(never)	37	42			
(rarely)	45	58			
(weekly)	27	24			
(daily)	18	3			
<b>Natural fruit juice *</b>			<b>17.16</b>	<b>-0.19</b>	<b>0.001</b>
(never)	43	16			
(rarely)	40	49			
(weekly)	38	57			
(daily)	6	5			
<b>Industrial fruit juice *</b>			<b>23.86</b>	<b>-0.19</b>	<b>0.001</b>
(never)	55	21			
(rarely)	36	65			
(daily and weekly)	36	41			
<b>Dough *</b>			<b>11.92</b>	<b>-0.12</b>	<b>0.008</b>
(never)	12	5			
(rarely)	34	18			
(weekly)	48	70			
(daily)	33	34			
<b>Mineral water *</b>			<b>17.67</b>	<b>-0.20</b>	<b>0.001</b>
(never)	9	24			
(rarely)	39	48			
(weekly)	28	26			
(daily)	11	29			
<b>Coffee *</b>			<b>8.35</b>	<b>0.16</b>	<b>0.015</b>
(never)	65	83			
(rarely)	30	29			
(daily and weekly)	32	15			
<b>Malt</b>			<b>5.11</b>	<b>0.03</b>	<b>0.164</b>
(never)	38	32			
(rarely)	37	54			
(weekly)	53	35			
(daily)	9	6			
<b>Milk</b>			<b>1.32</b>	<b>0.03</b>	<b>0.724</b>
(never)	5	4			
(rarely)	12	10			
(weekly)	55	64			
(daily)	55	49			

## Discussion

According to the findings of this study, the fluid use showed a significant relationship with the formation of kidney and urinary tract stones ( $p < 0.05$ ). Increasing fluid intake reduces the

concentration of compounds that can be sedated in the urine. On the other hand, it decreases the free crystalline particles staying time in the urine <sup>[10]</sup>. There are also some evidences indicating that adequate fluid intake prevents the recurrence of urinary stones <sup>[5, 8, 11]</sup>. In the present study, the frequency of the use of water, tea, natural juice, industrial juice, mineral water, dough, beverage and coffee showed a significant relationship with the risk of the formation of kidney and urinary tract stones ( $p < 0.05$ ). In the present research, it has been shown that low water consumption increases the risk of the formation of kidney and urinary tract stones, or, in other words, the usual use of it reduces the risk of the formation of kidney and urinary tract stones, which is also consistent with the results of the study done by Matthew et al <sup>[12]</sup>. Anderson, in his research showed that the risk of recurrence of stones in people who are in the lower quartile is 41% higher than those in the upper quartile <sup>[13]</sup>. In external studies, it has been shown that the consumption of colas and carbonated beverages, by increasing the oxalate secretion, tends to produce oxalate calcium stones <sup>[11]</sup>. Demographic studies in Iran have also recognized the use cola and carbonated drinks as a risk factor for urinary stones, but tea consumption too <sup>[14]</sup>. Anderson's research results showed that consumption of cola-containing drinks due to high phosphorus content, urinary oxalate secretion increases probably the Calcium oxalate stones <sup>[3]</sup>. In our study also it was found that increasing the frequency of use of tea and drink increases the risk of the formation of kidney and urinary tract stones. The findings of this research showed that the usual consumption of liquids such as natural juice, industrial juice, mineral water reduces the risk of the formation of kidney and urinary tract stones; it is consistent with the results of the study of Hesse et al who stated that a diet with high-grade liquids reduces the risk of developing urinary stones <sup>[15]</sup>. Rogers also found in his research that mineral water containing calcium and magnesium plays a role as a prophylactic and therapeutic agent in kidney and urinary tract stones <sup>[16, 17]</sup>. In a prospective study conducted by Aras et al it was found that the use of lemon juice can be a substitute for the treatment of patients with urinary calcium stones <sup>[18]</sup>; it is consistent with our study. In a study done by Karhan et al, it was suggested that a calcium-based diet reduces the risk of kidney stones formation <sup>[19]</sup>; it is consistent with the current study, which states that the usual consumption of dough containing calcium reduces the risk of the formation of kidney and urinary tract stones. In a meta-analysis study carried out by Wang et al, coffee consumption reduced the risk of developing kidney and urinary stones <sup>[20]</sup>. It was not consistent with the present study indicating that increased coffee intake increases the risk of kidney and urinary tract stones formation. In a study conducted by Borghi et al, it was found that increasing fluid intake to the extent that urine volume reaches 2 liters leads to a significant reduction in calcium and oxalate concentrations and reduces the rate of recurrence of stones <sup>[21]</sup>.

Although the fluid intake in stone patients should be increased, there is still little information about the effect of different beverages on urinary stones <sup>[22]</sup>. The results of this research indicate that coffee consumption in our population under study

was high, and coffee intake is more common in patients with stones; besides, there was a significant difference in the frequency of tea drinking. In some researches, the consumption of coffee and alcoholic beverages has been associated with the risk reduction of stone formation and consumption of beverages containing bicarbonate with increased risk of stone formation [22, 23].

The findings are different in relation to tea. In Karhan's research, the use of tea, coffee and alcoholic beverages (with or without caffeine) was associated with a reduction in the risk of urinary stones formation, while there was no relationship between the consumption of drinks containing bicarbonate and the risk of urinary stones formation [22].

## Conclusion

The implication of this study is that the fluid intake can prevent the emergence of diseases related to kidney and urinary tract stones to a considerable extent. In order to prevent the development of kidney stones, the scientific and accurate food programs are necessary; they can be avoided by observing them.

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