






Original Research

Shedding light on pharmacists' knowledge of kidney stones' etiology and treatment

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Received (first version): 17-Jul-2022

Accepted: 04-Aug-2022

Published online: 01-Sep-2022

Abstract

Background: The recurring nature of kidney stones (KS) makes it difficult to control and treat. Patients' education plays a part in reducing disease recurrence. Pharmacists participate in the healthcare services through educating patients with kidney stones about KS preventive measures and medications that greatly reduce the disease frequency and the treatment cost. Insufficient pharmacists' knowledge may affect the services' quality and result in misuse of KS medications. **Objectives:** To evaluate the pharmacists' level of knowledge to provide adequate information about KS preventive measures, medications, and treatments for patients with kidney stones in Jordan. **Methods:** An online descriptive survey was distributed to pharmacists to assess their knowledge about KS causes, prevention, and treatment. The results were analyzed using the SPSS software. **Results:** There were 393 pharmacists participated in this study. Pharmacists demonstrated an overall intermediate level of knowledge about KS. They showed an excellent level of knowledge regarding KS types and etiology, an intermediate level of knowledge about KS preventive measures and treatment, and poor knowledge about home remedies and drugs that promote KS formation. **Conclusion:** Pharmacists knowledge about KS management through diet and medications need to be improved. This could be through focusing on pharmacists' training for the effective implementation of knowledge in the clinical practice. Adopting guidelines by pharmacists may reduce the risk of KS recurrence and provide pharmacist-led patient education about KS management in hospitals and community pharmacies.

Keywords: pharmacists; knowledge; kidney stones; etiology; treatment; Jordan

INTRODUCTION

Kidney stones (KS) are hard deposits made of minerals and salts formed inside the kidneys.¹ Among the different types of KS, calcium stones are the most common followed by uric acid, struvite, and cystine stones.¹ The risk of developing KS is increasing worldwide, the prevalence of KS in the United States was 8.8% in 2012,^{2,3} and in Jordan, it was 6%,⁴ however, this number was based on old data (collected from patients with

kidney stones between the years 2007-2012).

The recurrence nature of this disease disturbs the life quality of the affected individuals and causes complications like urinary tract infection and injury to the ureter that may end up with kidney failure.^{3,5} The KS formation is attributed to general factors including changes in lifestyle, obesity, diet, medical conditions like diabetes and high blood pressure,^{6,7} family history,⁴ and the use of specific medications and supplements.^{6,8} Specific local factors that may increase the incidence of KS in the Middle East and Jordan are the high temperature, arid (dry) weather, diet, and water.^{4,9} The inadequate fluid intake may result in increased urine concentration which may promote KS formation.^{10,11} Unfortunately, there is a lack of studies in Jordan about KS. New studies based on new data that discuss the prevalence and the recurrence of KS are needed to underline the significance of studying this disease.

Several drugs like Acyclovir, Allopurinol, Aminopenicillins, Ceftriaxone, Ephedrine, Guaifenesin, Sulfonamides, Topiramate, Calcium-containing drug, Carbonic anhydrase inhibitors (acetazolamide), and Loop diuretics (furosemide) promote KS formation due to supersaturation, or to their low solubility at certain urine pH. These drugs can crystallize and accumulate in the kidney causing KS formation.¹⁰⁻¹² Patients with kidney stones are treated according to their specific situations including clinical emergencies, and the presence of infections. Patients with kidney stones may receive acetaminophen to relieve mild pain in case of having small stones, while patients with severe pain are usually given other nonsteroidal anti-inflammatory drugs.^{12,13} In the case of large stones, patients

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are given certain drugs (i.e., Nifedipine and Tamsulosin) that relieve spasms and facilitate the passage of stones by relaxing the ureter.¹⁰⁻¹⁴

Diet may contribute to KS as it remarkably affects urine composition and acidity.¹⁵ Many observational and experimental studies have shown that modifying diet according to the type of KS can significantly reduce the chance of KS formation and their recurrence rate.^{15,16} The effect of diet on the formation or elimination of KS depends on the type of stones. For example, patients with calcium stones are recommended to reduce sodium intake, increase citrate intake, and avoid excessive intake of calcium supplements while maintaining an adequate intake of dietary calcium.^{17,18}

In general, and irrespective of stone type, patients with kidney stones are recommended to increase their intake of fluids, low-oxalate fruits and vegetables, and to ensure adequate dietary calcium intake. However, those patients are recommended to reduce their intake of sodium, animal proteins, sugars and added fructose, and soft drinks.^{15,19} Vitamin C supplements are also recommended to be reduced.¹⁶ Many plant-based foods have been reported to reduce the risk of forming kidney stones through several mechanisms.^{19,20} Those include parsley, lemon,²¹ olive oil,²² pomegranate,²³ apple cider,²⁴ celery,²⁵ nettle,²³ green tea, raspberry, and many other plants.²⁰

Healthcare providers have a vital role in educating the patients about the prevention and treatment of this disease. The optimal clinical and non-clinical outcomes towards reducing the cost of treatment, preventing KS recurrence, and improving the KS patients' quality of life require the cooperation of all healthcare providers including physicians, pharmacists, and nurses.²⁶⁻²⁸

Pharmacists' role as a member of the healthcare team in hospitals and community is increasingly valued. Their responsibilities include prescribing and dispensing the correct medications with accurate dosing regimens to the patients.²⁶ In addition, they are involved in patients' education on proper drug usage.²⁷ Even though the use of medications is explained to the patients by several healthcare providers, patients claim that pharmacists provide clearer instructions than others.^{27,28}

Pharmacists nowadays are involved in the primary and secondary health care systems and can provide numerous services to patients, moreover, they are more accessible and easier to reach than physicians, and provide a free consultation about diseases and medications.²⁷

The impact of integrating pharmacists into the primary care teams reflects an improvement in patients' outcomes and satisfaction.²⁸ Pharmacists are strongly recommended to take part in educating patients about the diseases and treatment.²⁹ As pharmacists-provided services have been expanding to involve patient-centred services, they are expected to play a vital role in the future through participating in healthcare preventive services such as conducting patients check-ups, patients counseling, and diseases screening.^{27,30}

Pharmacists must have excellent knowledge about diseases'

etiology and treatment to provide the best service for patients. Insufficient pharmacists' knowledge regarding diseases will affect the services' quality, and lead to misuse of medications. Additionally, it may increase the severity, as well as the frequency of the disease among the patient,^{31,32} and the kidney stone is not an exception.

Patients have poor knowledge about KS formation, composition, and causatives, which necessitates the pharmacists' intervention.³³ In view of the above, this study came to assess the level of pharmacists' knowledge and their readiness to provide suitable information about KS medications and treatments for patients with kidney stones in Jordan.†

Aim

This study aims to assess the pharmacists' knowledge about KS etiology and treatment in Jordan. The aim was approached by evaluating the pharmacists' knowledge about; 1) The etiology of KS. 2) Food, home remedies, and vitamins that affect KS development. 3) Medications that are used to treat patients with KS.

METHODS

Study design

This is a cross-sectional online survey. The questions were prepared by the research team based on the information obtained from the Medical Management of Kidney Stones, American Urology Association (AUA) Guidelines,¹⁷ the national kidney foundation website (www.kidney.org), and the pharmacist's resources for clinical excellence (U.S. Pharmacist website www.uspharmacist.com).¹² The final version of the survey consisted of 35 questions that can be answered by true, false, or I do not know. The questions covered (i) the sociodemographic information of the pharmacists, (ii) the general knowledge about KS types, etiology, food, home remedies, and dietary supplements, and (iii) the specific knowledge about KS medications and treatment. The correct answer for each item of knowledge was given a score of one, whereas the wrong answer was marked as zero. Afterward, the knowledge level was classified according to the total score of each section: 0-50% scored as "Poor knowledge", 51-70% scored as "Intermediate knowledge", and 71-100% scored as "Excellent knowledge".³⁴ The final version of the survey was developed and distributed using *Google Forms* via social media platform. The survey was distributed in Arabic language and translated to English using the forward-backward translation techniques and subjective evaluations of the translated items.³⁵ The STROBE cross-sectional reporting guidelines were used in this study.³⁶

Population and sample

Pharmacists were recruited from Feb to May 2021. Researchers disseminated the survey to several groups of pharmacists in Jordan without applying any restrictions or exclusions to the demographic information. Pharmacists holding diploma, Bachelor's, or graduate studies in pharmacy participated in



this study. The sample size was calculated using the online Raosoft sample size calculator with a confidence interval of 95%, and a 5% margin of error (<http://www.raosoft.com/samplesize.html>).³⁷ The total number of registered pharmacists in Jordan was 25,700 in 2020 according to Jordan Pharmacists Association. A minimum sample size of 379 represented the pharmacists in Jordan. Pharmacists were recruited in this study to increase the statistical robustness. Pharmacists participation was voluntary, pharmacists were informed at the beginning of the survey that participation is optional and their information is highly confidential. Before the survey was distributed it was sent to 32 pharmacists as a pilot study to ascertain the feasibility of study approach. The internal consistency of the study elements was calculated and yielded a Cronbach's alpha of 0.936, which indicated an excellent consistency level of the survey items.

Statistical analysis

Categorical variables including the socio-demographic information and knowledge are expressed as frequencies and percentages. Descriptive and analytical statistics were used to extract the needed statistical measures. Pearson coefficient (*r*) was used to test for the correlation between the knowledge score and the demographic variables. A *p-value* < 0.05 was considered statistically significant. All measures were calculated using the IBM SPSS software (2020) (SPSS Inc., Chicago, IL, USA).

RESULTS

The sociodemographic information of the participants

The sociodemographic information of the 393 pharmacists who participated in this study were summarized in Table 1. Most of the participants were aged between 20 and 35 years. Female participants were dominating over males (64%). Among the participants, 63.1% of them were employed at the time of participation. With regards to participants' educational level, most of the participants (78.4%) had a BSc in pharmacy. Regarding their experience, 1-5 years were the most frequent range of experience among the participants, whereas 21.6% were new graduates with no experience. More than half of pharmacists (58.8%) had their training in retail pharmacies while 14.9% had a combination of more than one place of experience. About 10% of pharmacists reported being diagnosed with KS before. Moreover, 44.8% of the pharmacists had a family member or a spouse diagnosed with KS.

Pharmacist's general knowledge about kidney stones etiology and types

To highlight the pharmacists' knowledge about the etiology of KS, we asked the question "Based on your knowledge, which of the following may lead to kidney stones formation in the future?" (Table 2). Most of the pharmacists (97.5%) agreed that not drinking enough fluids every day may lead to KS. About 60% think that having personal or family history of KS will increase the chance of having KS in the future, which is correct. A large

share of pharmacists (82.4%) thinks that people with acid-base imbalance disorders such as Renal Tubular Acidosis, or with hereditary diseases (76.6%) related to metabolic disorders may lead to KS formation. To test the pharmacist's knowledge about KS types, we asked them to answer the question "Which one of the following is the most common type of kidney stones?" (Table 2). A fairly good share of the participants (74%) was aware of the most common types of kidney stones as calcium oxalate stones which account for the vast majority of all KS cases.

We assessed the pharmacists' general knowledge about food, home remedies, and dietary supplements that promote or inhibit KS formation in the future. The pharmacists were asked to answer the question "Based on your knowledge, what do you think of the following statements?" (Table 3). A large share of the pharmacists was certain (75.8%) that vitamin C may lead to the formation of KS. More than half of the pharmacists (56.2%) think that pomegranate juice improves kidneys' function and prevents KS formation. However, a large share of them was not sure (by answering "I do not know") whether drinking lemon juice with olive oil helps in removing kidney stones (46.8%), celery juice can remove toxins that contribute to kidney stones (46.3), or nettle juice reduces the chance of having KS (67.4%). Interestingly, when the pharmacists were asked about their thoughts regarding the false statement "drinking plenty amount of milk and eating dairy products may increase the chance of developing kidney stones", only 28.5% were able to pick the right answer. A large share of the pharmacists (83.7%) thinks that patients with KS should reduce their intake of foods rich in sodium and salt. About 70% of pharmacists think that patients with calcium stones should eat more fruits and vegetables. Pharmacists were not very confident about the fact that patients with kidney stones should limit their intake of proteins from animal sources, only 51.9% were sure about this information, while 28.2% were hesitant (Table 3).

Pharmacists' specific knowledge about kidney stones treatment

To shed the light on pharmacists' specific knowledge regarding KS treatment, we asked the pharmacists to answer the question "Which of the following statements regarding the treatment for kidney stones is true?" (Table 4). Most of the pharmacists (91.3%) correctly answered the statement "The spontaneous passage of stones through the ureter is related to their size, shape, and location". More than 80.0% of the participants think that patient with KS non-responsive to oral analgesics, should be hospitalized, and more than 60.0% think that Tamsulosin facilitates the passage of ureteral stones by relaxing the ureter wall. About half of pharmacists answered correctly that NSAIDs are the first line of treatment to relief pain related to KS; Nifedipine can be used to relieve spasms and relax the ureter muscles to facilitate the passage of stones, patients with recurrent kidney stones and low urinary citrate should undergo potassium citrate therapy; and patients with high urinary calcium and frequent calcium stones should take thiazide diuretics. To have an insight about the



Table 1. The socio-demographic information and the correlation analysis of the pharmacists				
	Parameter	Percentage (%)	Correlation analysis (Pearson coefficient)	Knowledge Score
1	Age (years)			
	20-35	82.4	<i>r</i>	.110*
	36-49	15.3	<i>p-value</i>	.029
	50-64	2.0		
	65 and more	0.3		
2	Sex			
	Male	35.9	<i>r</i>	.114*
	Female	64.1	<i>p-value</i>	.024
3	Employment status			
	Employed	63.1	<i>r</i>	.001
	Unemployed	39.9	<i>p-value</i>	.978
4	Educational level			
	Diploma in Pharmacy	10.2	<i>r</i>	.006
	Bachelor degree in Pharmacy	78.4	<i>p-value</i>	.905
	Bachelor degree in PharmD	3.3		
	Graduate studies in Pharmaceutical / Medical sciences	8.1		
5	Experience (Years)			
	No experience	21.6	<i>r</i>	.044
	1-5	53.7	<i>p-value</i>	.379
	6-10	7.9		
	11-20	9.7		
	More than 20	7.1		
6	Place of experience			
	Academic teaching	11.5	<i>r</i>	.065
	Clinical pharmacy	2.3	<i>p-value</i>	.201
	Retail (Community) pharmacy	58.8		
	Hospital / Healthcare centers' pharmacy	1.0		
	Others (drug stores, factories, medical representative ..etc)	11.5		
	Combination of more than one place of experience	14.9		
7	Have you ever been diagnosed with kidney stones?			
	Yes	10.4	<i>r</i>	.053
	No	89.6	<i>p-value</i>	.290
8	Do you have a family member or spouse that has been diagnosed with kidney stones?			
	Yes	44.8	<i>r</i>	.005
	No	55.2	<i>p-value</i>	.922

*Correlation is significant at the 0.05 level (2-tailed); r: Pearson Correlation coefficient; P-value: significance level; N: 393



Table 2. General knowledge questions about kidney stones etiology and types

	Based on your knowledge, which of the following may lead to kidney stones formation in the future?	True (%)	False (%)	I do not know (%)	Correct answer
1	Personal or family history of kidney stones	60.1	26.2	13.7	T
2	Not drinking enough fluids every day	97.5	1.5	1.0	T
3	People with acid-base imbalance disorders such as Renal Tubular Acidosis (RTA)	82.4	6.6	10.9	T
4	People suffering from hereditary diseases related to metabolic disorders such as (adenine phosphoribosyltransferase (APRT) deficiency, cystinuria, Dent disease, familial hypomagnesemia with hypercalciuria and nephrocalcinosis (FHHNC))	76.6	9.4	14.0	T
	Which one of the following is the most common type of kidney stones?	Percentage (%)		Correct answer	Incorrect answer
1	Calcium oxalate stones (CORRECT)	74.0		74%	26%
2	Calcium phosphate stones	7.9			
3	Uric acid stones	15.8			
4	Struvite (magnesium ammonium phosphate)	0.8			
5	Cystine stones	1.5			

Table 3. General knowledge questions about food, home remedies, and dietary supplements that promote or inhibit kidney stones' formation

	Based on your knowledge, what do you think of the following statements?	True (%)	False (%)	I do not know (%)	Correct answer
1	Drinking lemon juice with olive oil helps in removing kidney stones	31.0	22.1	46.8	T
2	Pomegranate juice improve kidneys' function and prevent kidney stones	56.2	5.6	38.2	T
3	Apple cider vinegar helps dissolve kidney stones	35.9	21.9	42.2	T
4	Celery juice can remove toxins that contribute to kidney stones	45.8	7.9	46.3	T
5	Drinking plenty amount of milk and eating dairy products may increase the chance of developing kidney stones	43.0	28.5	28.5	F
6	Nettle juice reduces the chance of kidney stones	22.6	9.9	67.4	T
7	Taking nutritional supplements such as ascorbic acid (Vitamin C) may lead to the formation of kidney stones	75.8	10.2	14.0	T
8	Patients with calcium stones should eat more fruits and vegetables	66.9	15.5	17.6	T
9	Patients with kidney stones should limit their intake of animal source protein.	51.9	19.8	28.2	T
10	Patients with kidney stones should reduce their intake of foods rich in sodium and salt	83.7	5.6	10.7	T

pharmacist's specific knowledge regarding the drugs that lead to the formation of kidney stones as a side effect, we asked the participants to answer the question "which of the following drugs promote kidney stone formation as a side effect?" (Table 4). The type of drugs that most of the pharmacists were sure about, was the calcium-containing drugs (76.6%) followed by Sulfonamides (53.7%) and carbonic anhydrase inhibitors such as Acetazolamide (51.1%), respectively. Nevertheless, most of the pharmacists were hesitant with the rest of the medications listed in Table 4, most of the answers were "either false" or "I do not know".

Pharmacists' knowledge description

The pharmacists' knowledge score (percentage of the correct

answers) was calculated and presented in Figure 1. The overall knowledge score for the pharmacists who participated in this study was 60.7%, which is considered an intermediate level of knowledge. Pharmacists had a poor to intermediate levels of knowledge regarding the drugs that promote KS formation and KS treatment, their specific knowledge score was 50.6% (Figure 1). Pharmacists demonstrated an intermediate to excellent levels of knowledge regarding the food, home remedies, dietary supplements, KS types, and KS etiology, their general knowledge score was 69.3%.

Correlation analysis between the knowledge score and the different variables

The knowledge score prevalence among the pharmacists



Table 4. Specific knowledge questions about kidney stones' treatment					
	Which of the following statements regarding the treatment for kidney stones is true?	True (%)	False (%)	I do not know (%)	Correct Answer
1	Small kidney stones are treated with observation and acetaminophen	57	27.5	15.5	T
2	The spontaneous passage of stones through the ureter is related to their size, shape, and location	91.3	2.8	5.9	T
3	Patient with kidney stones non-responsive to oral analgesics, should be hospitalized	82.2	9.4	8.4	T
4	NSAIDs (non-steroidal anti-inflammatory drugs) are the first-line treatment for pain relief from kidney stones	50.4	34.6	15.0	T
5	A drug (Nifedipine) can be used to relieve spasms and relax the ureter muscles to facilitate the passage of stones.	50.1	14.2	35.6	T
6	Tamsulosin facilitates the passage of ureteral stones by relaxing the ureter wall	63.4	10.9	25.7	T
7	Patients with recurrent kidney stones and low urinary citrate should undergo potassium citrate therapy.	48.1	13.7	38.2	T
8	Patients with high urinary calcium and frequent calcium stones should take thiazide diuretics.	52.4	25.4	22.1	T
Which of the following drugs promote kidney stones' formation as a side effect?					
1	Acyclovir	29.5	37.7	32.8	T
2	Allopurinol	39.4	35.6	24.9	T
3	Aminopenicillins (amoxicillin, Ampicillin, ..etc)	22.9	49.9	27.2	T
4	Ceftriaxone	29.5	41.7	28.8	T
5	Ciprofloxacin	35.1	39.9	24.9	T
6	Ephedrine	29.8	27.5	42.7	T
7	Guaifenesin	27	33.6	39.4	T
8	Sulfonamides (Sulphamethoxazole, Sulphasalazine, ..etc)	53.7	18.3	28.0	T
9	Topiramate	31.3	24.4	44.3	T
10	Calcium-containing drug	76.6	9.2	14.2	T
11	Carbonic anhydrase inhibitors (acetazolamide)	51.1	21.4	27.5	T
12	Loop diuretics (furosemide)	45.8	36.1	18.1	T

was 60.7%. The correlation analysis between the knowledge score and the sociodemographic parameters (Table 1) includes employment status, educational level, years of experience, place of experience, having KS, and having a family member or spouse with KS, revealed no significant interaction. However, the pharmacists' age (P-value= 0.029) and sex (P-value= 0.024) showed a significant correlation with the knowledge score.

DISCUSSION

In this study, the Jordanian pharmacists' level of knowledge about the KS disease was assessed. Pharmacists had an overall intermediate level of knowledge regarding the KS disease etiology and treatment. This study is the first in Jordan and the region that discusses the pharmacists' knowledge about the KS disease specifically, the findings of the current study will spot the light on the pharmacists' role in KS management and KS-related patients' education. The survey covered the major points that could affect the pharmacists' level of knowledge

such as employment status, educational level, years and place of experience, moreover, the personal experience of the pharmacists with the KS disease like having KS or a family member with KS were addressed. In addition, this study covered a wide range of KS causatives like food, supplements, and drugs. It also highlighted the most common treatment approaches for KS disease. Further, most of the previous studies about KS were either patients^{12,33} or physicians oriented,³⁸ instead, our study focused on the pharmacists' role in the management of KS. †

†The pharmacists' role in the management of KS was highlighted by Mohammad A et al,¹² the research team prepared a guide for the pharmacists, which involved information about KS diagnosis, management, and treatment, they encouraged pharmacists to consider the drug-induced causes and to counsel patients to stick to a specific diet and therapy plan in order to manage KS.¹² The pharmaceutical care services were shown to have a positive impact on patients, a previous study from Jordan showed that pharmaceutical care for hospitalized patients with chronic kidney diseases reduced the patients'



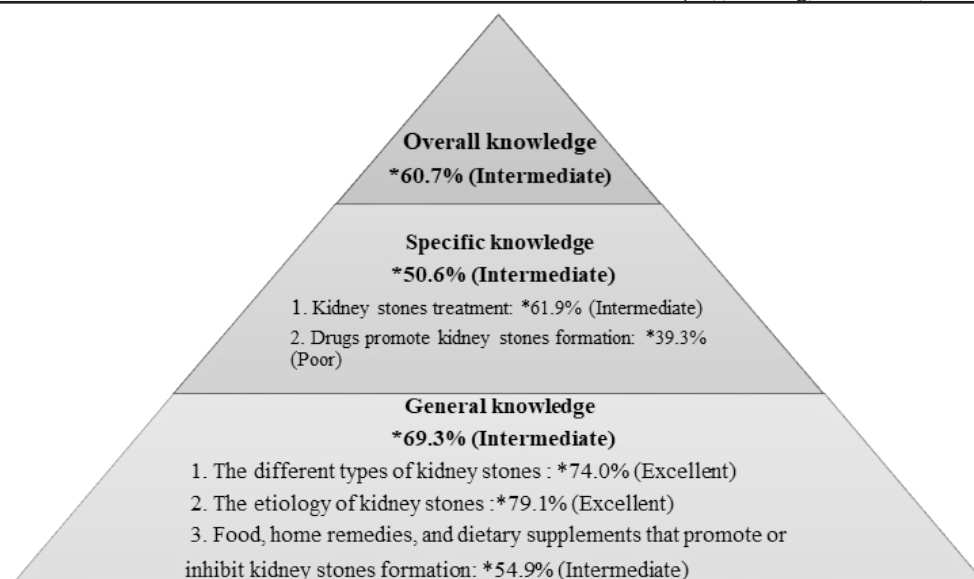


Figure 1. Pharmacists' knowledge description

*Knowledge score. Knowledge score classification: 0-50%: Poor level of knowledge. 51-70%: Intermediate level of knowledge. 71-100%: Excellent level of knowledge

treatment-related problems.²⁹

In this study, pharmacists were able to identify the multiple factors that may lead to KS formation like the decrease in fluid intake, in concordance with the current guidelines that suggest increasing fluid intake to produce two to three liters of urine daily to prevent the recurrence of stones in patients.³⁹⁻⁴¹ However, pharmacists' poor knowledge about the home remedies and vitamins that affect the formation of KS could be attributed to the lack of general knowledge about the medicinal plants or home remedies used by the young pharmacists with few years of experience.

Remarkably, a large share of pharmacists think that taking nutritional supplements such as ascorbic acid (Vitamin C) may lead to the formation of KS, the rate of responses goes in line with the evident evidence reported in the literature which shows that vitamin C supplementation can increase the risk of KS formation since vitamin C is converted into oxalate and thus increases the urinary oxalate level and the chance of forming calcium oxalate stones.¹⁶

Unfortunately, the misconception that consuming dairy products may increase the chance of developing KS was also evident in the pharmacists' responses. The general belief that dairy products can increase the chance of KS formation is mainly attributed to the misconception that calcium, which dairy products are rich of, has the tendency to form insoluble salts that can precipitate and form stones in the urinary tract.^{17,42} In contrast, research has found that maintaining an adequate intake of dietary calcium is necessary to reduce the chance of KS formation.⁴² Furthermore, maintaining an adequate dietary intake of calcium helps to reduce the chance of forming oxalate stones as calcium can bind oxalate in the intestines and thereby

reducing its absorption.²¹

The highest response was about the fact that patients with KS should reduce their intake of foods rich in sodium and salt. This is in agreement with the current evidence which shows that sodium increases the chance of KS formation as it increases calcium excretion in the urine.⁴³ A previous study showed that reducing the amount of salt intake will reduce the chance of KS formation and recurrence.⁴⁴

Most of the pharmacists think that patients with calcium stones should eat more fruits and vegetables, in line with the current evidence of the role of fruits and vegetables in KS formation. Fruits and vegetables are rich in minerals that increase the alkalinity of the urine, resulting in a less favorable milieu for the formation of urate and cysteine stones.¹⁵ They are also rich in citrate, which level is inversely associated with the formation of almost all types of KS.¹⁵ In addition, plants and plant-based drinks have been shown to inhibit the formation of KS due to various beneficial activities such as diuretic and antioxidant activities.²³

Pharmacists were aware of the fact that patients with kidney stones should limit their intake of proteins from animal sources, as animal protein is associated with KS formation. In fact, a high animal protein diet does not only increase the acidity of the urine but also increases urinary calcium and uric acid concentration, which promote KS formation.^{21,38}

Notably, the pharmacists' responses to the diet-related questions were generally unsatisfactory. The lack of the effective implementation of knowledge in the clinical practice is not restricted to the pharmacists who participated in our study, but also to a large share of health care providers including physicians who are not updated with the published guidelines

for preventing the recurrence of KS.³⁸

The poor to intermediate level of knowledge about KS treatment among the pharmacists could be attributed to many factors including; the insufficient pharmacists' experience with the medications used for specific types of diseases, inconsistent provision of pharmacist-led patient education to patients with KS, lack of updated guidelines regarding KS prevention to be followed by the Jordanian pharmacists when educating patients, and the oriented pharmacists training towards counseling patients with chronic diseases like diabetes and hypertension, especially upon the COVID-19 pandemic.^{45,46}

In addition, the newly graduated pharmacists experienced post-graduate workplace challenges that may affect having adequate information about medications.⁴⁷ A similar finding was reported by Abdel-Qader et al, where pharmacists had limited knowledge about psycho-pharmacotherapy,⁴⁸ and by Zawiah et al study, in which hospital and community pharmacists had a low level of knowledge about food-drug interactions.⁴⁹

Finally, it is worth mentioning that pharmacists' low level of knowledge is not the only reason for the low quality of service offered to KS patients, some healthcare practitioners including pharmacists are aware of the preventive measures for recurrent KS. However, they did not employ this knowledge in clinical practice.³⁸

The pharmacists' level of knowledge about KS etiology and treatment can be improved through applying more vigorous effort to clarify the dietary management of KS among Jordanian pharmacists, including more explanatory topics in the pertinent teaching courses, providing adequate training for pharmacy graduates, and disseminating educative messages to the students via different social and professional platforms. There is a need to focus on professional development programs that improve pharmacists' knowledge of KS medications and side effects. ↑ We recommend the policymakers and stakeholders of the pharmacists' syndicate to focus on pharmacists' training on the effective implementation of knowledge in clinical practice. A written leaflets containing information about KS causes, prevention, and medications in the urology clinics and pharmacies are highly endorsed. We encourage healthcare professionals to adopt updated guidelines for the prevention of KS recurrence.

Limitations

This study had some limitations. Despite the great effort the research team employed in distributing the survey, the participation was low but exceeds the minimal sample size, this might affect the correlation analysis results (significance), moreover, a potential selection bias could be that most of the participants were graduates of specific institutes, unfortunately, the graduation institute was not addressed in the survey. Although the research team tried to cover the most common home remedies that may be used to reduce KS

recurrence, some important herbs like parsley were missed.^{20,21} Of note, the pharmacists who participated in this study were mostly new graduates with few years of experience (less than five years), which may limit the generalisability of the results to experienced pharmacists in Jordan.

AUTHORS CONTRIBUTIONS

The authors confirm contribution to the paper as follows: Dr. Ensaf Y. Almomani: Project administration, Conceptualization; Investigation; Supervision; Roles/Writing – original draft; Writing - review & editing. Dr. Wassan Jarrar: Conceptualization; Roles/Writing – original draft; Writing - review & editing. Dr. Amani Alhadid: Conceptualization; Roles/Writing – original draft; Writing - review & editing. Dr. Lama Hamadneh: Conceptualization; Roles/Writing – original draft; Writing - review & editing. Prof. Ahmad Qablan: Methodology; Validation; Writing - review & editing. Dr. Huda Y. Almomani: Conceptualization; Writing - review & editing.

ACKNOWLEDGMENT

The authors would like to thank all the pharmacists who agreed to participate in this study.

ETHICAL APPROVAL

This study was approved by the Institutional Review Board (IRB) committee of the Al Balqa Applied University of Jordan with no need for writing consent for pharmacists' participation. Participation was optional, only pharmacists who agreed to participate in this study answered the survey questions. The pharmacists were informed before participating in this study that all the information in this questionnaire will be used only for scientific research with a high level of privacy.

FUNDING

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

AVAILABILITY OF DATA AND MATERIAL

The original data is available upon request from the corresponding author.

CONFLICTS OF INTEREST STATEMENT

The authors declare no conflicts of interest.

CONSENT TO PUBLISH

All authors of this study were consented for publication.



References

1. JJEES_Vol9_N1_HQ_P4.pdf.2022. http://www.jjees.hu.edu.jo/files/Vol9N1/JJEES_Vol9_N1_HQ_P4.pdf
2. Scales CD, Smith AC, Hanley JM, et al. Prevalence of Kidney Stones in the United States. *European Urology*. 2012;62(1):160-165. <https://doi.org/10.1016/j.eururo.2012.03.052>
3. Parmar MS. Kidney stones. *BMJ*. 2004;328(7453):1420-1424. 2022. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC421787/>
4. Abboud I. Prevalence of Urolithiasis in Adults due to Environmental Influences: A Case Study from Northern and Central Jordan. 2018.
5. Rukin NJ, Siddiqui ZA, Chedgy ECP, et al. Trends in Upper Tract Stone Disease in England: Evidence from the Hospital Episodes Statistics Database. *UIN*. 2017;98(4):391-396. <https://doi.org/10.1159/000449510>
6. Nerli R, Jali M, Guntaka AK, et al. Type 2 diabetes mellitus and renal stones. *Adv Biomed Res*. 2015;4:180. <https://doi.org/10.4103/2277-9175.164012>
7. Borghi L, Meschi T, Guerra A, et al. Essential arterial hypertension and stone disease. *Kidney International*. 1999;55(6):2397-2406. <https://doi.org/10.1046/j.1523-1755.1999.00483.x>
8. Bargagli M, Ferraro PM, Vittori M, et al. Calcium and Vitamin D Supplementation and Their Association with Kidney Stone Disease: A Narrative Review. *Nutrients*. 2021;13(12):4363. <https://doi.org/10.3390/nu13124363>
9. Baatiah NY, Alhazmi RB, Albathi FA, et al. Urolithiasis: Prevalence, risk factors, and public awareness regarding dietary and lifestyle habits in Jeddah, Saudi Arabia in 2017. *Urology Annals*. 2020;12(1):57. https://doi.org/10.4103/JA.UA.13_19
10. Türk C, Petřík A, Sarica K, et al. EAU Guidelines on Diagnosis and Conservative Management of Urolithiasis. *European Urology*. 2016;69(3):468-474. <https://doi.org/10.1016/j.eururo.2015.07.040>
11. Preminger GM, Tiselius HG, Assimos DG, et al. 2007 Guideline for the Management of Ureteral Calculi. *Journal of Urology*. 2007;178(6):2418-2434. <https://doi.org/10.1016/j.juro.2007.09.107>
12. Rattu M, Shah N, Singhal S, et al. The role of pharmacists in the management of acute kidney stones. *US Pharmacist*. 2013;38:HS4-HS8.
13. Frassetto L, Kohlstadt I. Treatment and prevention of kidney stones: an update. *Am Fam Physician*. 2011;84(11):1234-1242.
14. Portis AJ, Sundaram CP. Diagnosis and initial management of kidney stones. *Am Fam Physician*. 2001;63(7):1329-1338.
15. Heilberg IP, Goldfarb DS. Optimum Nutrition for Kidney Stone Disease. *Advances in Chronic Kidney Disease*. 2013;20(2):165-174. <https://doi.org/10.1053/j.ackd.2012.12.001>
16. Ferraro PM, Bargagli M, Trinchieri A, et al. Risk of Kidney Stones: Influence of Dietary Factors, Dietary Patterns, and Vegetarian–Vegan Diets. *Nutrients*. 2020;12(3):779. <https://doi.org/10.3390/nu12030779>
17. Pearle MS, Goldfarb DS, Assimos DG, et al. Medical Management of Kidney Stones: AUA Guideline. *Journal of Urology*. 2014;192(2):316-324. <https://doi.org/10.1016/j.juro.2014.05.006>
18. Wallace RB, Wactawski-Wende J, O'Sullivan MJ, et al. Urinary tract stone occurrence in the Women's Health Initiative (WHI) randomized clinical trial of calcium and vitamin D supplements. *The American Journal of Clinical Nutrition*. 2011;94(1):270-277. <https://doi.org/10.3945/ajcn.110.003350>
19. Gul Z, Monga M. Medical and Dietary Therapy for Kidney Stone Prevention. *Korean J Urol*. 2014;55(12):775-779. <https://doi.org/10.4111/kju.2014.55.12.775>
20. Nirumand MC, Hajjalyani M, Rahimi R, et al. Dietary Plants for the Prevention and Management of Kidney Stones: Preclinical and Clinical Evidence and Molecular Mechanisms. *International Journal of Molecular Sciences*. 2018;19(3):765. <https://doi.org/10.3390/ijms19030765>
21. Prezioso D, Strazzullo P, Lotti T, et al. Dietary treatment of urinary risk factors for renal stone formation. A review of CLU Working Group. *Archivio Italiano di Urologia e Andrologia*. 2015;87(2):105-120. <https://doi.org/10.4081/aiua.2015.2.105>
22. Alenzi M, Rahiman S, Tantry BA. Antirolithic effect of olive oil in a mouse model of ethylene glycol-induced urolithiasis. *Investig Clin Urol*. 2017;58(3):210-216. <https://doi.org/10.4111/icu.2017.58.3.210>
23. Nirumand MC, Hajjalyani M, Rahimi R, et al. Dietary Plants for the Prevention and Management of Kidney Stones: Preclinical and Clinical Evidence and Molecular Mechanisms. *International Journal of Molecular Sciences*. 2018;19(3):765. <https://doi.org/10.3390/ijms19030765>
24. Joshi A, Tallman JE, Calvert JK, et al. Complementary and Alternative Medicine Use in First-time and Recurrent Kidney Stone Formers. *Urology*. 2021;156:58-64. <https://doi.org/10.1016/j.urology.2021.05.084>
25. Stiani SN, Syahidah FM, Fikriani H, et al. Anticalculi activity of apigenin and celery (*Apium graveolens* L.) extract in rats induced by ethylene glycol–ammonium chloride. *Journal of Pharmacy and Bioallied Sciences*. 2019;11(8):556. https://doi.org/10.4103/jpbs.JPBS_202_19
26. PharmacistsImpactonPatientSafety_Web.pdf. Accessed June 5, 2022. https://pharmacist.com/Portals/0/PDFS/Practice/PharmacistsImpactonPatientSafety_Web.pdf?ver=dYeAzwIN3-PG9eSkMMsV-A%3D%3D
27. Tsuyuki RT, Beahm NP, Okada H, et al. Pharmacists as accessible primary health care providers: Review of the evidence. *Can Pharm J (Ott)*. 2018;151(1):4-5. <https://doi.org/10.1177/1715163517745517>



28. Hayhoe B, Cespedes JA, Foley K, et al. Impact of integrating pharmacists into primary care teams on health systems indicators: a systematic review. *Br J Gen Pract.* 2019;69(687):e665-e674. <https://doi.org/10.3399/bjgp19X705461>
29. AbuRuz SM, Alrashdan Y, Jarab A, et al. Evaluation of the impact of pharmaceutical care service on hospitalized patients with chronic kidney disease in Jordan. *Int J Clin Pharm.* 2013;35(5):780-789. <https://doi.org/10.1007/s11096-013-9806-8>
30. Murugan H, Spigner C, McKinney CM, et al. Primary care provider approaches to preventive health delivery: a qualitative study. *Prim Health Care Res Dev.* 2018;19(5):464-474. <https://doi.org/10.1017/S1463423617000858>
31. Saqib A, Atif M, Ikram R, et al. Factors affecting patients' knowledge about dispensed medicines: A Qualitative study of healthcare professionals and patients in Pakistan. *PLOS ONE.* 2018;13(6):e0197482. <https://doi.org/10.1371/journal.pone.0197482>
32. Bruchet N, Loewen P, de Lemos J. Improving the Quality of Clinical Pharmacy Services: A Process to Identify and Capture High-Value "Quality Actions." *Can J Hosp Pharm.* 2011;64(1):42-47.
33. Kadhum H. Assessment of Patient's Knowledge about Avoidance of Recurrent Urolithiasis. 2018. https://www.researchgate.net/publication/326976916_Assessment_of_Patient's_Knowledge_about_Avoidance_of_Recurrent_Urolithiasis_albwlyt_alsalk_hsy_tkrar_mn_hwl_almrdy_marf_tqyym
34. Yusof A, Chia YC, Hasni YM. Awareness and Prevalence of Mammography Screening and its Predictors - A Cross Sectional Study in a Primary Care Clinic in Malaysia. *Asian Pacific Journal of Cancer Prevention.* 2014;15(19):8095-8099. <https://doi.org/10.7314/APJCP.2014.15.19.8095>
35. Sperber A, DeVellis R, Boehlecke B. Cross-Cultural Translation. *Journal of Cross-Cultural Psychology.* 1994;25:501. <https://doi.org/10.1177/0022022194254006>
36. Elm E von, Altman DG, Egger M, et al. Strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *BMJ.* 2007;335(7624):806-808. <https://doi.org/10.1136/bmj.39335.541782.AD>
37. Sample Size Calculator by Raosoft, Inc. Accessed June 24, 2020. <http://www.raosoft.com/samplesize.html>
38. Bos D, Abara E, Parmar MS. Knowledge, attitudes, and practice patterns among healthcare providers in the prevention of recurrent kidney stones in Northern Ontario. *Canadian Urological Association Journal.* 2014;8(11-12):e795-804. <https://doi.org/10.5489/cuaj.1455>
39. Tarplin S, Monga M, Stern KL, et al. Predictors of Reporting Success with Increased Fluid Intake Among Kidney Stone Patients. *Urology.* 2016;88:49-56. <https://doi.org/10.1016/j.urology.2015.10.024>
40. Scales CD, Desai AC, Harper JD, et al. Prevention of Urinary Stones with Hydration (PUSH): Design and Rationale of a Clinical Trial. *American Journal of Kidney Diseases.* 2021;77(6):898-906.e1. <https://doi.org/10.1053/j.ajkd.2020.09.016>
41. Borghi L, Meschi T, Amato F, et al. Urinary Volume, Water and Recurrences in Idiopathic Calcium Nephrolithiasis: A 5-year Randomized Prospective Study. *Journal of Urology.* 1996;155(3):839-843. [https://doi.org/10.1016/S0022-5347\(01\)66321-3](https://doi.org/10.1016/S0022-5347(01)66321-3)
42. Krieger NS, Bushinsky DA. The Relation Between Bone and Stone Formation. *Calcif Tissue Int.* 2013;93(4):374-381. <https://doi.org/10.1007/s00223-012-9686-2>
43. Betz M. Whole Diet Approach to Calcium Oxalate Kidney Stone Prevention. *Journal of Renal Nutrition.* 2022;32(1):e11-e17. <https://doi.org/10.1053/j.jrn.2021.10.005>
44. Siener R. Nutrition and Kidney Stone Disease. *Nutrients.* 2021;13(6):1917. <https://doi.org/10.3390/nu13061917>
45. Taylor AM, Bingham J, Schussel K, et al. Integrating Innovative Telehealth Solutions into an Interprofessional Team-Delivered Chronic Care Management Pilot Program. *JMCP.* 2018;24(8):813-818. <https://doi.org/10.18553/jmcp.2018.24.8.813>
46. Jarab AS, Al-Qerem W, Mukattash TL, et al. Pharmacy and Pharm.D students' knowledge and information needs about COVID-19. *International Journal of Clinical Practice.* 2021;75(3):e13696. <https://doi.org/10.1111/ijcp.13696>
47. Ng JY, Tahir U, Dhaliwal S. Barriers, knowledge, and training related to pharmacists' counselling on dietary and herbal supplements: a systematic review of qualitative studies. *BMC Health Serv Res.* 2021;21(1):499. <https://doi.org/10.1186/s12913-021-06502-4>
48. Abdel Qader DH, Silverthorne J, Al-Jomaa EE, et al. Jordanian pharmacists' knowledge of issues related to using psychotropic medications a cross-sectional study. *IJPR.* 2021;13(3). <https://doi.org/10.31838/ijpr/2021.13.03.045>
49. Zawiah M, Yousef AM, Khan AH, et al. Food-drug interactions: Knowledge among pharmacists in Jordan. *PLoS One.* 2020;15(6):e0234779. <https://doi.org/10.1371/journal.pone.0234779>

