

Research Article

Study on Prevalence and Management of Renal Stones among Omani in-Patients at Sohar Hospital

Aaisha Obaid Zayid Al-Risi, Nida'a Mohammed Ali, Alka Ahuja*

Department of Pharmacy, Oman Medical College, Muscat, Oman

***Corresponding author**

Prof. (Dr.) Alka Ahuja

Email: alkaahuja@yahoo.com

Abstract: Renal stone disease is a multi-factorial disorder resulting from the combined influence of epidemiological, biochemical and genetic risk factors. Keeping the history in various parts of the world in our mind, our research was aimed to study the prevalence of renal stones based on the patients' socio-demographic factors such as sex, age, resident region etc. and to determine the risk factors of renal stones among Omani population in the North Batinah Governorate. Other objectives included study on management of renal stones at Sohar Hospital. All Omani in-patients who had renal stones and were admitted in the hospital from 1st January, 2010 till 31st May, 2012 were included in the study. The results showed that renal stones disease in Omani population was more common in the age group between 30 to 39 years. It occurred in both men and women, but the risk was generally higher in men than in women. No association between the patients' age, gender and their resident place was found in the studies conducted. There are many factors that decided the patient's stay in the hospital such as hospital facilities, beds availability and the requirements of each patient condition. Sohar hospital was able to manage the disease and keep it under control. Around 75% of total patients left the hospital in stable condition.

Keywords: Calculi, renal complications, Chi square tests, Risk factors

INTRODUCTION

Renal stone disease is a multi-factorial disorder resulting from the combined influence of epidemiological, biochemical and genetic risk factors. High dietary intake of animal protein, sodium, refined sugars, fructose, and high cola drinks may increase the risk for developing renal stones. Hereditary factors are also related to stone formation. People with certain medical conditions, such as gout, diabetes, hypertension and those who take certain medications or supplements are at risk for renal stones [1]. In addition to that, people may become more likely to have kidney stones if they had kidney infection or have had renal stones before (Melissa Conrad) [2]. The renal stones (calculi) are hardened mineral deposits that form in the kidney. However, if the stones are large and block the normal urine flow, a prompt management maybe needed. Severe pain on one or both sides of the back, feel a frequent urge to urinate, or a burning sensation during urination, abnormal urine color, chills, fever, and nausea are the main symptoms complained by anyone having renal stones [3,4].

The most common types of renal stones include Calcium stones and are made of calcium compounds, especially calcium oxalate, calcium phosphate and other minerals also may be present. Less than 1% of kidney stones are made of a chemical called

cystine. Struvite stones mostly develop along with urinary infection, so they can also be called as infection stones. They occur more often in women. Sometimes the stones may progress silently, to what is known as staghorn calculus. Men are most likely to have Uric acid stones. About 5 to 10 out of 100 kidney stones are made of uric acid, a waste product normally passed out of the body in the urine. They mostly occur with gout [5].

Management of Renal stones

Very high fluid intake (four quarts a day), limit the amount of protein and salt in the diet. The dosage of the alkalinizing agent should be adjusted to maintain the urinary pH between 6.5 and 7.0 because of the potential deposition of calcium phosphate around the uric acid calculus. Sometimes d-penicillamine, tiopronin, or captoprils are also used. A painkiller and other medication can also be injected to treat the symptoms of nausea and vomiting. Antibiotics may be used to eliminate any infection. Four common procedures are commonly used if a kidney stone is too big to be passed naturally (6-7mm in diameter or larger). Extracorporeal shock wave lithotripsy (ESWL) is the most common, easiest and non-invasive procedure. Percutaneous nephrolithotomy (PCNL) is an alternative procedure of ESWL which involves using a thin telescopic instrument called a nephroscope. Ureteroscopy (Endoscopic treatment) is minimally

invasive procedure, no incision is given as the instruments go through the patient's existing "plumbing" and the patients can go home on the same day. Open surgery is less used since development of ESWL and endoscopic and percutaneous techniques and less than 1% of cases require this type of surgery. It needs a large incision to remove the stone from the urinary tract [6, 7].

The overall probability of forming stones differ in various parts of the world and is estimated to be 1-5% in Asia, 5-9% in Europe and 13% in North America. It is considered high in Mediterranean countries including Oman. It occurs in both men and women but the risk is generally high in men and is becoming more common in young women [8]. Data available on the disease prevalence of various renal diseases in Oman is very limited. However, According to the Annual Health Report of Ministry of Health in 2009 it is stated that around 88 outpatients per 10,000 populations were suffering from kidney Calculus. In addition to that females were suffering more than males with 118 per 10,000 female population compared to 70 per 10,000 male population [9].

In 2011, the Journal of Endourology published a study done by Peter A. *et al* on the antioxidants and self-reported history of kidney stones. The study showed that the prevalence of kidney stones was higher in males, white/non-Hispanics, diabetics, and those with hypertension. (Peter A. *et al.*, 2011) [10].

In 2010, a survey was done by Victoriano Romero *et al* in US to estimate global picture of prevalence, incidence, and associated risk factors of kidney stones. This survey showed clearly that, there has been an increase in the prevalence and incidence of kidney stones in the United States and changes in the environmental factors like diet and climate have the most significant impact (Victoriano Romero, 2010) [11]. In 2009, the Clinical Journal of American Society of Nephrology published a study done by Amar D. Bansal *et al.* The study was carried out in order to analyze the effect behind increased utilization of imaging modalities on detection of asymptomatic stones, performed at the New York Harbor Veterans' Affairs Medical Center. Patients were classified into symptomatic and asymptomatic groups on the basis of their clinical history and concluded that the asymptomatic stones account for 29.8 to 45.7% of all stones detected with abdominal and retroperitoneal ultrasounds. Of stones found on abdominal ultrasounds, 71.4% were asymptomatic, whereas 36.8% of stones found on retroperitoneal ultrasound were asymptomatic. The study came with clear end point that asymptomatic stones have a relatively high prevalence on ultrasound and epidemiologic estimates of prevalence of nephrolithiasis is need to account for increases in utilization of imaging modalities and the resulting detection bias [12]. In 2009, a study on the management

of multiple/ staghorn kidney stones was conducted in India by Madhu S Agrawal. *et al.* [13]. The study comprised of 111 patients who underwent open-technique surgery and 97 patients who underwent percutaneous nephrolithotomy and extracorporeal shockwave lithotripsy. In 2003, Kiriaki K. Stamatelou *et al.* showed clearly that prevalence of kidney stone disease history in the United States population increased between 1980 and 1994. A history of stone disease was strongly associated with race/ethnicity and region of residence [14].

In the United States, a study was carried out by Gray C. *et al* in 1998 to examine the association between the intake of 17 beverages and risk for kidney stones in women. It was concluded that an increase in total fluid intake can reduce risk for kidney stones [15].

The recurrence rate of renal stones is about 75% in 20 years span (Sutherland *et al* 1985). A study has been reported in 1998 in US by J. Michael Soucie *et al* on the relation between geographic variability in Kidney stones prevalence and its risk factors. Information on self-reported, physician-diagnosed kidney stones collected from 1,167,009 men and women, aged ≥ 30 years, and self administered questionnaire was used to collect information on risk factors for stones. The study results provided evidence that high temperature and sunlight levels are important risk factors for stones. (Michael Soucie, 1996) [16-18].

Keeping the history in various parts of the world in our mind, our study was aimed to describe the prevalence of renal stones based on the patients' socio-demographic factors such as sex, age, resident region etc. and to determine the risk factors of renal stones among Omani population in the North Batinah Governorate. Other objectives included study on management of renal stones at Sohar Hospital.

MATERIALS AND METHODS

Type of study

This was a hospital based retrospective study in which the in-patients electronic files stored in the database at Sohar hospital were reviewed. The study included describing data collected in terms of their level of measurement and summarizing them in form of tables, graphs and numericals with different nominal and ordinal scales.

Sample Design

All Omani in-patients who had renal stones and were admitted in the hospital from 1st January, 2010 till 31st May, 2012 were included in the study.

Methodology

The study was carried out after receiving approval from the Research and Ethical Review & Approve Committee, Directorate General of Health

services - North Batinah Governorate in March, 2012. The patients were classified according to their socio-demographic factors which included sex, age group, resident place, being referred to other hospital, leaving the hospital in stable condition, well controlled case within admission and collection of information about the disease from different sources. The questionnaire

was distributed to three different clinics and health centers and answers to questions given in the questionnaire and interpretation of the results was done as graphs and charts. SPSS program was used to analyze the collected patients' data. The Questionnaire distributed to the patients is included in Table 1.

Table 1: Questionnaire distributed to the patients

Age:
Gender: male/ Female

- Are you suffering from kidney stones?
 Yes No Not sure Any previous history
- Has any of your relatives been through this?
 Yes No Not sure Previous history
- How many glasses of water do you drink daily?
 One glass only 2-3 glasses 4-5 glasses 6-8 glasses
- What is the source of water you drink?
 Desalinated water Well water Mineral water I don't know
- How much salt you use in your food
 I prefer very salty foods I prefer moderately salty foods
 I prefer my food with little salt I don't like to eat any salty food
- How many cups of coffee/tea do you drink daily?
 1 cup only 1-2 cups
 2-4 cups 4-6 cups
- Are you suffering from any of the following diseases along with kidney stones?
Hypertension, Hyperthyroidism, Gout, Longstanding diarrhea or Diabetes

Each question represented one risk factor or more for the disease prevalence and the answers/ results were interpreted as graphs.

RESULTS AND DISCUSSION

According to the patient's electronic files stored in the database at Sohar hospital, a total of 177 patients were found to be diagnosed with renal stones and were admitted at Sohar Hospital during the period starting from 1st January, 2010 till 31st May, 2012.

Patients' socio-demographic factors
Patients' Age

Female patients ranged from 6 to 61 years and male patients ranged from 2 to 72 years as shown in Figures 1, 2 and Table 2. Plot of Age Groups (years) vs Percentage is shown in Figure 3 which shows that around 32.2% of patients' age ranged from 30-39 years, and around 9% were less than 20 years old.

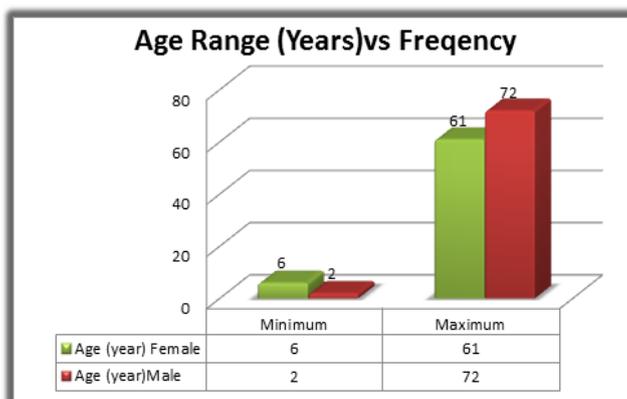


Fig. 1: Plot of Age Range of Different Gender Groups vs Frequency

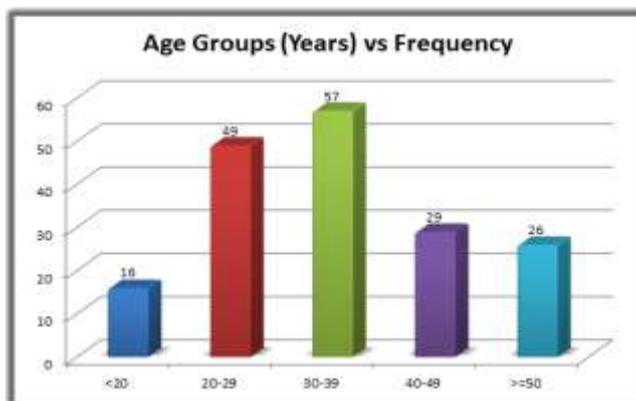


Fig. 2: Plot of Age Groups (years) vs Frequency

Table 2: Classification of groups according to the age
Age Groups (Years)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<20	16	9.0	9.0	9.0
	20-29	49	27.7	27.7	36.7
	30-39	57	32.2	32.2	68.9
	40-49	29	16.4	16.4	85.3
	>=50	26	14.7	14.7	100.0
Total		177	100.0	100.0	

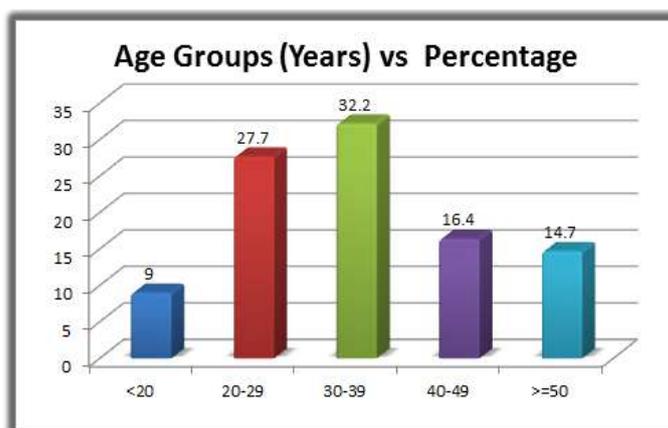


Fig. 3: Plot of Age Groups (years) vs Percentage

Patients' Gender

According to the data collected, there were 67 (37.9%) female patients and 110 (62.1%) male patients

having renal stones who were admitted at Sohar hospital during the study period. Figure4 represents the data.

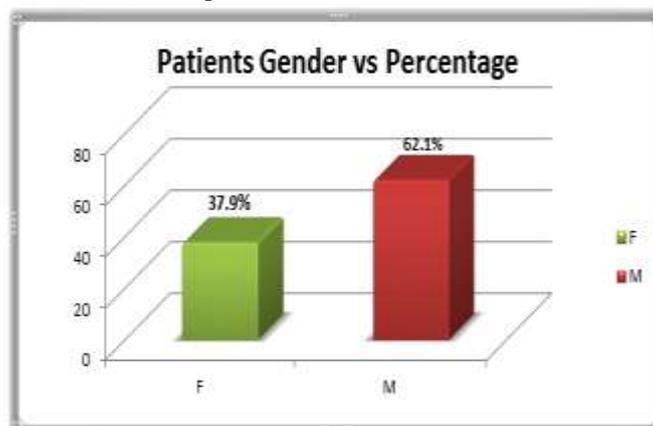


Fig. 4: Plot of Age Groups (years) vs Percentage

Relationship between Patients’ age and Gender

To study the relationship between the patients’ age and gender the data was arranged in a contingency

Table(Age group * Sex Cross tabulation), Chi-Square Test was performed. The results are shown in Tables 3 and 4.

Table 3: Table showing age group and Sex Tabulation

Age Groups (Years) * Sex Cross tabulation				
Count				
		Sex		Total
		F	M	
Age group	<20	7(6.06) ¹	9(9.94)	16
	20-29	16(18.5)	33(30.5)	49
	30-39	25(21.6)	32(35.5)	57
	40-49	11(10.9)	18(18.02)	29
	>=50	8(9.84)	18(16.16)	26
Total		67	110	177
1.expected value				

Table 4 : Table showing Chi – square test values

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.229 ^a	4	.694
Likelihood Ratio	2.237	4	.692
N of Valid Cases	177		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.06.

The expected value of (2.229) indicates that there is no association between patients’ age and gender in terms of their suffering from renal stones. The significance level (P value) for this statistical test is 0.694 which is actually more than the critical value (0.05) and ensures that the relation between the pervious parameters is not significant.

Patients’ Resident Place

The patients admitted at Sohar hospital came from all wilayat of North Batinah region. The distribution is shown in Figure5.

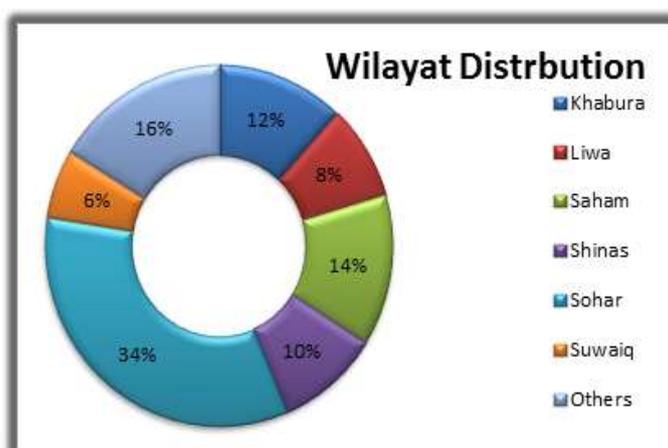


Fig. 5: Percentage of patients from different wilayats

34% of total patients were from Sohar, whereas from other areas the distribution was as follows:

14% from Saham, 12% from Khabura, 10% from Shinas, 8% from Liwa , 6% from Suwaiq, and 16% from other places.

Patients’ Admission

Break up of Percentage of patients admitted in the hospital year wise are shown in Table 5.

Table 5: Table showing the number of patients admitted during a time period

Year of Admission	Frequency	Percent	Cumulative Percent
1 st January , 2010 till 31 st January, 2010	89	50.3	50.3
1 st January, 2011 till 31 st December, 2011	63	35.6	85.9
1 st January, 2012 till 31 st May, 2012	25	14.1	100.0
	177		

Total patients having renal stones and admitted at Sohar hospital from 1stJanuary , 2010 till 31st January, 2010 were 89 in number.

Total patients having renal stones and admitted at Sohar hospital from 1st January, 2012 till 31st May, 2012 were 25 in number.

Total patients having renal stones and admitted at Sohar hospital from 1st January, 2011 till 31st December, 2011 were 63 in number.

It is very clear from the data that the number of patients decreased dramatically from 2010 (50.3%) to 2011(35.6%) to 2012(14.1%).

Admission Period

Table 6 represents the number of days that the patient stayed in the hospital.

Table 6: Table showing the admission period for the patients

Admission Period (Days)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	91	51.4	51.4	51.4
	2	44	24.9	24.9	76.3
	3	17	9.6	9.6	85.9
	4	6	3.4	3.4	89.3
	5	9	5.1	5.1	94.4
	6	2	1.1	1.1	95.5
	9	2	1.1	1.1	96.6
	10	3	1.7	1.7	98.3
	14	1	.6	.6	98.9
	16	1	.6	.6	99.4
	31	1	.6	.6	100.0
Total		177	100.0	100.0	

There are many factors that decided the admission period for each patient which included hospital facilities, beds availability and the requirements of each patient condition.

Based on the previous two tables, admission period for female and male patients can be compared as following:

By revising the patients’ file, it was found that the admission period ranged from one day to 31 days, with an arithmetic average (Mean) of 2.37days. To describe the data cluster or scatter in distribution, the variance (9.610) and standard deviation (3.100) were calculated respectively.

Admission period for female patients ranged from one to sixteen days, with mean value of 2.57days, while it ranged from one to thirty one days for male patients, with mean value of 2.25days. The results are shown in Figure6.

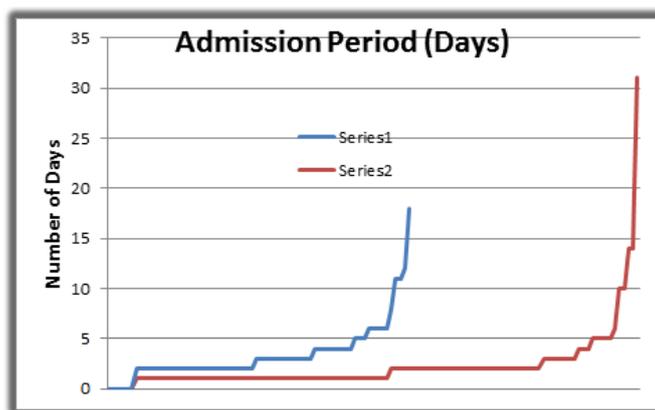


Fig. 6: Plot of admission period for female and male patients

This graph compares the admission period for female and male patients, and clearly shows that the male patients stayed in the hospital for more number of days than the female patients.

Management and its Outcome

Renal stones management at Sohar Hospital

By revising the care management pattern which was provided in every patient’s electronic file, the process of management for each patient was written day by day and step by step.

In general, all the patients had gone through CT-scan or Intravenous Pyelogram (IVP) along with some laboratory tests.

Sohar hospital depended mainly on medications and difficult and very serious patients were referred to SQUH or any other hospital.

Management Outcome

No renal failure or any such complication associated with all the cases occurred during the period from 01/January/2010 to 31/May/2012.

The patients were classified into three groups according to their management outcome. The statistics is shown in Table 7.

Table 7: Table showing the management of patients treated during a time period

		Management Outcome			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Referred to other hospital	36	20.3	20.3	20.3
	Left the hospital in stable condition	132	74.6	74.6	94.9
	Well controlled cases within admission	9	5.1	5.1	100.0
	Total	177	100.0	100.0	

Table 8: Table showing the statistical evaluation of management of patients treated during a time period

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.304 ^a	2	.192
Likelihood Ratio	3.440	2	.179
N of Valid Cases	177		

a. 1 cell (16.7%) has expected count less than 5. The minimum expected count is 3.41.

36 patients (20%) were referred to other hospitals for an additional evaluation and better management including ESWL, PCNL or any other procedure. Only 9 patients were able to pass the stone within a few days of admission and 132 patients (74.5%) left the hospital in stable condition indicating

the ability of the hospital to control or manage the disease situation.

Table 9 shows the relationship between the management outcome and the gender of the patients. The statistical evaluation is shown in Table 10.

Table 9: Relationship between the management outcome and the gender of the patients

Management Outcome * Sex Cross tabulation				
Count		Sex		Total
		F	M	
Management Outcome	Referred to other hospital	10(13.6) ¹	26(22.4)	36
	left the hospital in stable case	55(49.9)	77(82.0)	132
	well controlled cases within admission	2(3.41)	7(5.59)	9
Total		67	110	177
1.expected value				

Table 10: Statistical evaluation of the admitted cases

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.304 ^a	2	.192
Likelihood Ratio	3.440	2	.179
N of Valid Cases	177		

a. 1 cell (16.7%) have expected count less than 5. The minimum expected count is 3.41.

The expected value of 3.304 indicates that there is no association between patients' sex and the management outcome. The P value of 0.192 indicates that the relation between the patients' sex and the management outcome is not significant.

Table 11 shows the relationship between the management outcome and the age of the patients. The statistical evaluation is shown in Table 12.

Table 11: Relationship between the management outcome and the patients' age
Management Outcome* Age Groups (Year) Cross tabulation

Count		Age group(years)					Total
		<20	20-29	30-39	40-49	>=50	
Management Outcome	Referred to other hospital	2	7	10	6	11	36
	left the hospital in stable case	13	39	45	21	14	132
	well controlled cases within admission	1	3	2	2	1	9
Total		16	49	57	29	26	177

Table 12: Statistical evaluation of relationship between the patients' age and management outcome of the treatment

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.370 ^a	8	.240
Likelihood Ratio	9.249	8	.322
N of Valid Cases	177		

a. 6 cells (40.0%) have expected count less than 5. The minimum expected count is .81.

Sometimes physicians expect a relation or an association between the management outcomes and the patient's age, but the Chi-Square Test for the association between the management outcomes of renal stones and the patient's age ensures that there is no such expected relationship between them.

Relationship between the management outcome and the year of admission and statistical evaluation are shown in Table 13 and 14.

Table 13: Relationship between the management outcome and year of admission

Management * year of admission Cross tabulation					
Count					
		year of admission			Total
		2010	2011	2012	
Management Outcome	Referred to other hospital	24(18.1) ¹	7(12.8)	5(5.08)	36
	left the hospital in stable case	58(66.4)	55(46.9)	19(18.6)	132
	well controlled cases within admission	7(4.53)	1(3.20)	1(1.27)	9
Total		89	63	25	177
1. expected value					

Table 14: Statistical evaluation of relationship between the management outcome and year of admission

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.919 ^a	4	.042
Likelihood Ratio	10.611	4	.031
N of Valid Cases	177		
a. 3 cells (33.3%) have expected count less than 5. The minimum expected count is 1.27.			

The hospital facility in each year including the medical staff, number of beds available and even the quality of medication used, can build clear association between the management outcome and the year of admission. Chi-Square Test showed expected value of 9.919 and P value of 0.042 which is <0.05, so it is significant.

Questionnaire study results were very interesting. Only 25 questionnaires out of 30 which were distributed to three different clinics and health centers were duly filled by 14 female and 11 male patients, within different age groups during their presentation in the clinic. Each question represented one risk factor or more for the disease prevalence and the answers/ results were interpreted as graphs as shown in figures A7 to A13.

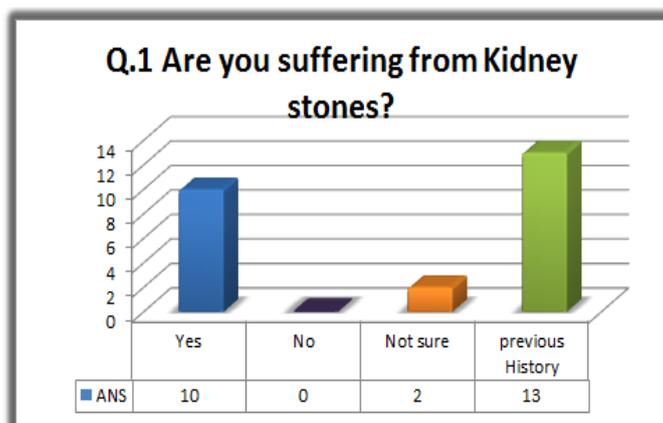


Fig. 7: Plot of response to Question 1vs Frequency

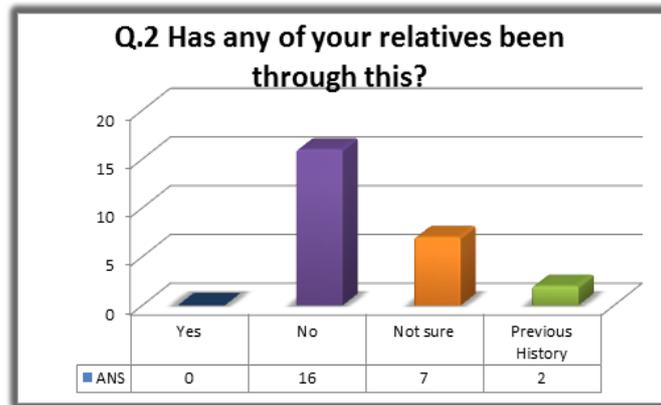


Fig. 8: Plot of response to Question 2vs Frequency

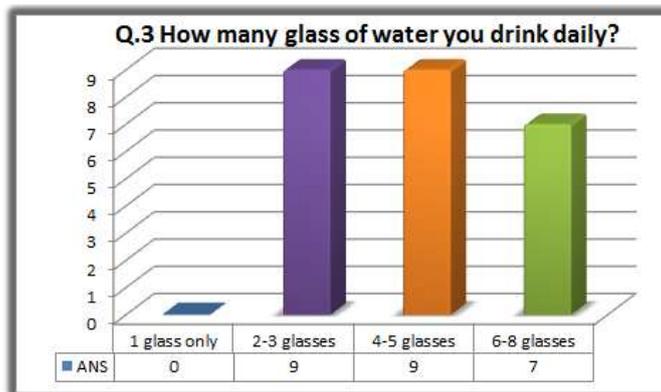


Fig. 9: Plot of response to Question 3vs Frequency

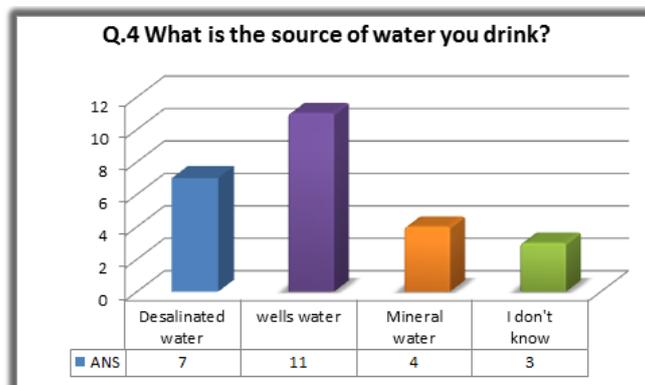


Fig. 10: Plot of response to Question 4vs Frequency

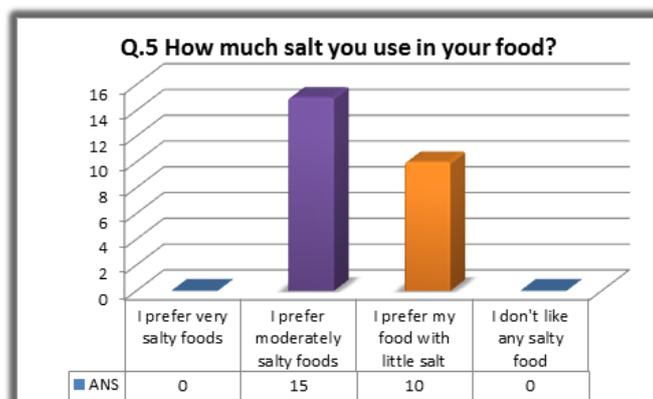


Fig. 11: Plot of response to Question 5 vs Frequency

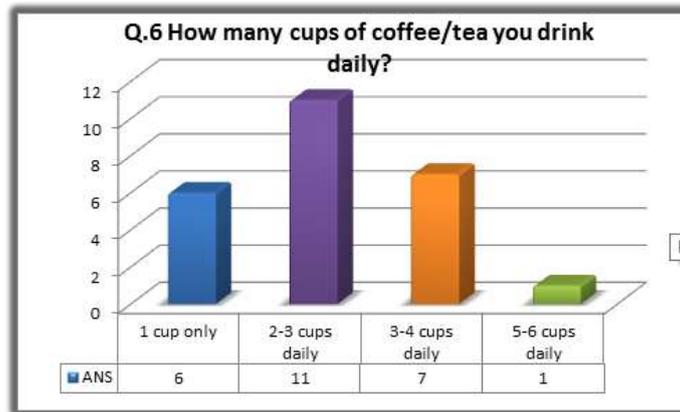


Fig. 12: Plot of response to Question 6 vs Frequency

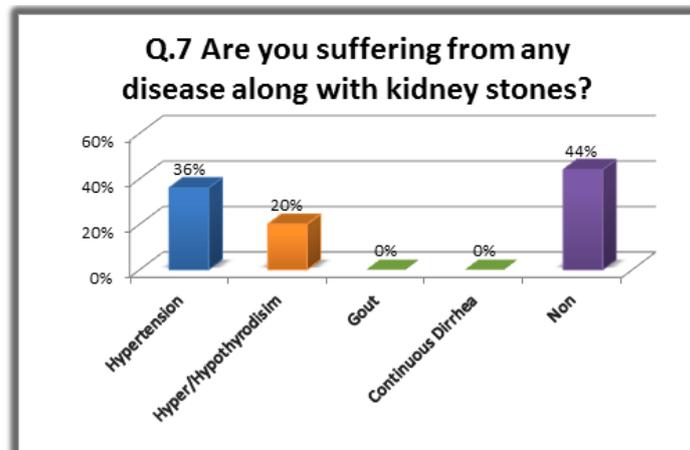


Fig. 13: Plot of response to Question vs Frequency

10 out of 25 patients examined were suffering from kidney stones and 13 of them had suffered in the past. 16 patients did not have any of their relatives with renal stones while 7 of them had.

7 patients out of 25 had good habits of drinking 6-8 glasses of water, which is actually the right amount to drink daily. 11 patients out of 25 depended on the wells as a source of their drinking water, while four patients only had mineral water which is actually advised by all the physicians for any patient with renal stones.

15 patients out of 25 preferred moderately salty food and 10 of them preferred food with little salt.

Drinking coffee/tea in logical amount may prevent the stone formation, but on the other hand excessive intake of coffee/tea as it's a common habit for Omani people may contribute as a risk factor for the disease prevalence.

The percentage of patients suffering from diseases along with kidney stones is listed in Table 15.

Table 15: Prevalence of diseases along with presence of kidney stones

Name of the Disease	No. of Pts	%
Hypertension	9	36%
Hyper/Hypothyroidism	5	20%
Gout	0	0%
Continuous Diarrhea	0	0%
Non	11	44%
Total	25	100%

Certain medical conditions, such as gout, diabetes and hypertension and those who take certain medications or supplements are at risk for renal stones.

9 patients out of 25 had hypertension along with renal stones, and 5 of them complained from thyroid disorders.

CONCLUSION

Renal stones disease is not related to any age group, but in Omani population it was seen that it was more common in the age group between 30 to 39 years. It occurred in both men and women, but the risk was generally higher in men than in women. No association between the patients' age, gender and their resident place was found in the studies conducted.

There are many factors that decided the patient's stay in the hospital such as hospital facilities, beds availability and the requirements of each patient condition.

Sohar hospital was able to manage the disease and keep it under control. Around 75% of total patients left the hospital in stable condition.

The variation in the hospital facilities from one year to another can affect the management outcome in a significant manner.

Renal stone is a multi-factorial disorder resulting from the combined influence of diet, epidemiological, environmental and genetic/ hereditary risk factors. Patients' diet including like high salt intake and excessive coffee/tea intake may increase the risk for stones formation. Some medical conditions such as hypertension, thyroid disorder, and gout may put the patient at risk to develop renal stones.

ACKNOWLEDGEMENT

The authors are thankful to Sohar hospital and other clinics for sharing the data base of the patients and making this study possible.

REFERENCES

1. Kidney; Available from <http://www.rightdiagnosis.com/organ/kidney.htm>
2. Kidney Stones; Available from http://www.medicinenet.com/kidney_stone/article.htm
3. Kidney Stones / Renal calculi; Available from <http://health.hpathy.com/kidney-stone-symptoms-treatment-cure.asp>
4. Mute VM; Lithiasis: A Review. Available from <http://www.pharmainfo.net/reviews/lithiasis-review>.
5. Poinier AC, Vachharajani TJ; Types of Kidney Stones - Topic Overview. Available from <http://www.webmd.com/kidney-stones/types-of-kidney-stones>
6. Wolf JS Jr; Nephrolithiasis Treatment & Management; Available from: <http://emedicine.medscape.com/article/437096-treatment#aw2aab6b6b1aa>.
7. Tertzakian GM, Greenberger ML, Pearce WF, Williams SB; Kidney Stones: Causes, Prevention, and Available from:

- Treatment <http://www.ocurology.com/stones.html>
8. Toumi H; 25% of people in GCC suffer from kidney stone. Available from <http://gulfnnews.com/news/gulf/qatar/25-of-people-in-gcc-suffer-from-kidney-stone-1.743451>.
 9. Ministry of Health; The Annual Health Report. Chapter 9, 2009: 9-20.
 10. Holoch PA, Tracy CR; Antioxidants and Self-Reported History of Kidney Stones. *J Endourol.*, 2011; 25(12):1903-1908.
 11. Romero V, Akpinar H, MD, Assimos DG; A Global Picture of Prevalence, Incidence, and Associated Risk Factors, 2010; 12(2-3): e86-e96.
 12. Bansal AD, Hui J, Goldfarb DS; Asymptomatic Nephrolithiasis Detected by Ultrasound. *Clin J Am Soc Nephrol.*, 2009; 4(3): 680-684.
 13. Agrawal MS, Yadav A, Yadav H, Singh AK, Lavania P, Jaiman R; Management of multiple/staghorn kidney stones: Open surgery versus PCNL (with or without ESWL), 2009; 25(4): 474-478.
 14. Stamatelou KK, Francis ME, Jones CA, Nyberg LM, Curhan GC; Time trends in reported prevalence of kidney stones in the United States: 1976-1994, *Kidney Int.*, 2003; 63(5):1817-23.
 15. Curhan GC, Willett WC, Speizer FE, Stampfer MJ; Beverage use and risk for kidney stones in women. *Ann Intern Med.*, 1988; 1;128(7):534-540.
 16. Soucie M, Coates RJ, McClellan W, Austin H, Thut M; Relation between Geographic Variability in Kidney Stones Prevalence and Risk Factors for Stones. *Am J Epidemiol.*, 1996; 143 (5): 487-495.
 17. Lieske JC, Peña de la Vega LS, Slezak JM, Bergstralh EJ, Leibson CL, Ho KL, Gettman MT; Renal stone epidemiology in Rochester, Minnesota: an update, *Kidney Int.*; 2006; 69(4):760-764.
 18. Scales CD Jr, Curtis LH, Norris RD, Springhart WP, Sur RL, Schulman KA, Preminger GM; Changing gender prevalence of stone disease, *J Urol.*, 2007; 177(3):979-982.