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CROSS-SECTIONAL ANALYSIS OF KIDNEY STONES FROM DIFFERENT PATIENTS OF BALUCHISTAN, THEIR TRACE ELEMENTS AND CHARACTERISTICS

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Abstract
Urolithiasis is a prevalent urological disorder worldwide, ranking third in frequency, and causing significant impact on individuals' quality of life. However, the underlying causes of this condition remain unknown. This study comprises two phases: a cross-sectional, time-bound survey conducted at two tertiary care public hospitals between June and November 2019, with over 1200 patients diagnosed with various kidney stone diseases. The study investigated the clinical characteristics, dietary habits, disease diagnosis, and management of the participants. The second phase of the study involved laboratory testing, sample preparation, and analysis using infrared spectroscopy and atomic absorption spectroscopy. Statistical analysis was performed using SPSS Statistics software. The results revealed that the majority of respondents were middle-aged females who were married, lived in Quetta, and were uneducated. Most respondents had a history of previous visits to the hospital for kidney-related issues. The spectroscopic analysis demonstrated that kidney stones in Pakistan are predominantly composed of calcium oxalate and acid urates, with oxalates found in conjunction with apatite. It is recommended that patients and the community at large be educated about kidney stones and their implications for health.

Keywords: Atomic absorption, Infrared Spectroscopy, Kidney stone, clinical Characteristics, Trace elements.

Introduction

One of the most common urological diseases in the world (and the third most common) is urolithiasis which has bad impact on people's way of life. It is yet unknown what are the primary causes of urolithiasis(Raja, A. *et al.*,2020). Its prevalence and incidence of stones vary globally by age group and environmental factors. 9.5%–19% of calculi are found in Europe, 7%–13% in North America, and 1%–5% in Asia, all these have very high incidence rates(1). In Saudi Arabia, however, it affects about 20% of the population. According to high diet of animal protein may contribute to kidney stones developing in roughly 10% of Americans over the course of their lifetime (2). An estimated 1 in 1000 persons in the USA are hospitalized every year for the treatment of urolithiasis, resulting in yearly medical expenses of around $2 billion. The prevalence of urolithiasis in Pakistan varies from 7.s4% in the north to 28% in the west and about 200 per 100,000 in the south(1).

Regional variations can be attributed to lithogenic factors such as age, sex, race, food preferences, fluid intake, climate, socioeconomic status, degree of education, inheritance, and metabolic disorders (3).Two contributing factors, namely genetics and environmental factors, account for the majority of urinary tract stone development. The reported recurrence rate is 15% in the first year, 50% during the following five years, and up to 70% over the subsequent ten years.In some parts of Greece, the high prevalence of kidney stones was the primary source of financial strain on the healthcare system about (25%)(4). In comparison to girls, males, and those above the age of 17 had a somewhat greater incidence rate. Below the age range of 17 years, few urinary stones were seen. In the upper age range of both males and females, the prevalence rate of urinary stone formation was relatively high. Additionally, it was found that the prevalence of urinary stones was higher in Greece's rural areas than it had been in prior examinations of the continent's populace(5).

The prevalence of rising urinary stone development may be caused by various changes in sociodemographic factors and other contributing factors(6).

However, urolithiasis is more prevalent in persons who are educated, busy, and under stressful conditions. Additionally, stones can form owing to a urinary tract infection, decreased fluid intake, and family history (7).

Urolithiasis is a common urological disease with a high prevalence rate, and Balochistan is no exception. However, little research has been conducted on the composition of kidney stones in Balochistan, particularly regarding trace elements, and the factors contributing to their formation. Thus, this study aims to investigate the characteristics and trace elements of kidney stones in Balochistan and assess their potential impact on human health.

Materials and methods

Materials.

Analytical grade glassware, different chemicals, atomic absorption (Biotech Engineering Management Co limited. Model Number Phoenix-986AA Wavelength Range 190 - 900 nm), FTIR (Shimadzu), Kidney stones collected from different patients.

Methodology

Study Design and Study Setting

A cross-sectional study was conducted to analyze the kidney stones of patients of nephrolithiasis and to associate the analysis with the patient demographics and their disease related characteristicsby using a questionnaire and Atomic absorption and Infrared Spectroscop

The samples of kidney stones were collected from two main public hospitals of Quetta city i.e., SandemanProvincialHospital (SPH) and Balochistan Institute of Nephrology and Urology, Quetta (BINUQ).

Study Sampling, Inclusion and Exclusion Criteria

The study targeted to collect relevant data from approximately 2000 patients in a given time frame out of 1216 patients fulfilled the criteria and consented to become a study participant. Patients who were unconscious and were not in a cognitive state and did not give consent for participation were excluded from the study.

Study Instruments

The study comprises two parts therefore one part was conducted in the hospital with patients as a questionnaire-based study and the other part was a lab based study. Therefore, different tools were employed which are detailed below:

Questionnaire was used to collect information about patients'demographic characteristics, clinical characteristics and those relevant dietary habits which may lead to the formation of kidney stones.
The analysis of kidney stones was carried out by Infrared Spectroscopy and Atomic Absorption Spectroscopy.
Infrared Spectroscopy: Infrared (IR) spectroscopy was originally used to analyze stones by (Estepa, L., & Daudon, M. 1997).In IR spectroscopy, the sample is exposed to IR laser pulses to generate atomic vibrations; the recorded and analysed absorption spectra of the stone samples are used to ascertain the stone's elemental makeup (Jaswal, B. et al., 2017). The attenuated total reflection technique (ATR), a more contemporary IR spectroscopy method, is appropriate for examining soft samples.
The sample does not need to be mixed with an IR inactive substance, like potassium bromide, prior to analysis, making sample preparation for this approach quite simple. The identification of calcium oxalate by IR spectroscopy is remarkably simple, and can even distinguish the two forms of calcium oxalate i.e., weddellite and whewellite(Conti, C. *et al.*, 2014).

Atomic Absorption Spectroscopy

Biotech Engineering Management Co limited. Model Number Phoenix-986AA Wavelength Range 190 - 900 nm was used with default operating parameters, the toxic metals (Pb, Ni, Co, Zn, Cd, Mn, and Cr) were identified in the samples.
A Teflon-coated pressure digestion vessel was covered with an acid combination made up of hydrochloric acid and nitric acid and weighed portions of oven-dried and powdered samples were processed in it. The vessel was then heated in an oven at 180°C for 30 minutes. Samples were made directly on each of the final solutions after the stock solutions of heavy metals were produced, warmed to room temperature, and measured for absorbance at 324.7 nm against a blank using bioscience 8. To match the standard solutions' sensitivity ranges, the samples were appropriately diluted. To get rid of the interference from certain elements. For each element, there were three independent determinations (Singh, V. K., & Rai, P. K. 2014).
Concentration of metals
The concentration (ppm) x 10 (dilution factor) = concentration of sample.

Data collection Process

Samples of stones were taken from patient under-going surgery for kidney stone removal from patients at hospital. All stones removed during surgery were placed in polyethylene air dry bottles and transferred to be studied in the labs of Institute of Biochemistry, University of Balochistan, Quetta. All polyethylene bottles were labeled with the name, sex, age, weight, and marital status of the patient and the date of surgery. The stones were washed with deionized water and dried in desiccators at room temperature for 24 h; subsequently the stones were pulverized in agate mortar to produce a fine homogeneous powder.

Sample preparation

Finely pulverized each stone samples (250 mg) were mixed with 6 ml of 14 M HNO3 and 2 ml 12 M $HClO_4$ in Teflon® (PTFE) vessels. Samples were then heated and evaporated on a hot plate at around 120ºC until a nearly dry paste resulted. This was followed by the addition of 14 M 5 ml HNO3 with gentle heating to dissolve the paste and diluted to 50 ml with deionized water. Samples were then stored in polypropylene bottles and kept cool until the analyses were performed.

Ethical Consideration

This National Bioethics Committee Pakistan's guidelines were followed to conduct the study and therefore according to the guidelines the study was approved by the Research Committee of Faculty of Pharmacy and Health Sciences of University of Baluchistan. Moreover, written consent followed by oral agreement from the patients was acquired and they were given assurance about the confidentiality of their responses and they were informed about their right to leave the questionnaire at any time.

Statistical analysis

The statistical analysis was completed by means of SPSS Statistics version Means and standard deviations were derived for age and frequency for gender. Assessment was done by comparing the main component (≥60% of the total stone composition) reported by the method.

Results

4.1. Demographics

Table 1 showed demographic characteristics. Most of respondents 515 (42.4%) were aged range between 38-57 years. Majority of respondents 856 (70.4%) were female. Most of respondents 1152 (94.7%) were married. Majority of respondents 364 (29.9%) were from Quetta. Education wise result showed that most of respondents 414 (34.0%) were uneducated and most of respondents 381 (31.3%) were self-employed.

Table. 4.1: Demographic Characteristics

Variable	Frequency	%
Age		
18-37 Years	464	38.2
38-57 Years	515	42.4
> 57 Years	237	19.5
Gender		
Male	360	29.6
Female	856	70.4
Marital Status		
Married	1152	94.7
Unmarried	64	5.3
District		
Awaran	75	6.2
Chagai	72	5.9
Chagi	25	2.1
Gwadar	24	2.0
Jaffarabad	24	2.0
Kalat	49	4.0
kech	24	2.0
Kech	24	2.0
Kharan	24	2.0
Khuzdar	73	6.0
Kohlu	24	2.0
Lasbela	48	3.9
Mastung	48	3.9
Musakhel	24	2.0
Noshki	72	5.9
Panjgur	100	8.2
Pishin	49	4.0
Quetta	364	29.9
Sibi	24	2.0
Zhob	25	2.1
Ziarat	24	2.0

Education		
Graduate	203	16.7
HSC	211	17.4
Matric	181	14.9
Others	78	6.4
Under Matric	129	10.6
Uneducated	414	34.0
Occupation		
Government servant	259	21.3
House wife	144	11.8
Private servant	289	23.8
Retired government	17	1.4
servant	381	31.3
Self employed	15	1.2
Student	111	9.1
Unemployed		

Table 4.2 showed clinical characteristics. Most of respondents 602 (49.5%) had previous history of two visits. Majority of respondents 438 (36.0%) had one member with kidney disease. Most of respondents 227 (18.7%) had 5 visits to doctor. While 208 (17.1%) visited to hakeem.

Clinical Characteristics.

Table Clinical Characteristics

Variable	Frequency	%
Previous History (One Month ago)		
0	169	13.9
1	279	22.9
2	602	49.5
3	166	13.7
Family member with kidney disease		
No member with kidney disease	382	31.4
One member with kidney disease	438	36.0
Two members with kidney disease	396	32.6
Number of visits to doctor		
0	190	15.6
1	218	17.9
2	208	17.1
3	189	15.5
4	184	15.1
5	227	18.7
Number of visits to Hakeem		
0	206	16.9
1	205	16.9
2	208	17.1
3	198	16.3
4	194	16.0
5	205	16.9

4.3. Dietary intake and water

Table 3 provides information about the frequency of certain behaviors and habits among the study population. The behaviors and habits include meals per day, meat consumption, drinking water source, tea consumption, and tobacco smoking or chewing. The table presents the number of participants and the percentage of participants for each category within each behavior or habit. For example, of the total participants, 55.3% reported having two meals per day, while 44.7% reported having three meals per day. Similarly, 56.0% of participants reported drinking pond water, while 43.3% reported drinking tube well water. The table offers a concise summary of the prevalence of certain behaviors and habits within the study population, which can be used to identify patterns and inform further analysis.

Table 4.3. Dietary intake and water

Variable	Frequency	%
Meals per day		
Two meals	672	55.3
Three meals	544	44.7
Meat Eating		
Every day	209	17.2
Once per day	8	0.7
Once per month	121	10.0
Once per week	344	28.3
Thrice per month	40	3.3
Thrice per week	99	8.1
Twice per day	24	2.0
Twice per month	89	7.3
Twice per week	282	23.2
Drinking water		
Pond water	681	56.0
River water	9	0.7
Tube well water	526	43.3
Tea Cup		
Four Cups	250	20.6
Five Cups	246	20.2
Six Cups	234	19.2
Seven Cups	245	20.1
Eight Cups	241	19.8
Tobacco smoking or chewing		
Chewable Tobacco	282	23.2
Nil	343	28.2
Smoking	330	27.1
Smoking & Chewable Tobacco	261	21.5

Disease diagnosis and Management

This table provides a summary of the health condition and treatment profile of a group of study participants. The data show that out of 1216 participants, 8.1% were classified as excellent, 60.9% as good, 12.5% as weak, and 18.6% as diseased. Among the participants, 6.3% had diabetes, 11.7% had hypertension, and 6.8% had UTI. The majority of participants (76.5%) did not have UTI, and 16.7% were unsure of their UTI status. Regarding the methods of diagnosis for kidney stones, 5.9% of participants were diagnosed with renal colic plus ultrasound, while 94.1% were diagnosed with ultrasound alone. The majority of participants (99.0%) underwent kidney stone removal surgery, while only 1.0% used drugs for treatment. Lastly, 37.3% of participants reported taking medication, while 62.7% did not take any medication.

Table 4.4. Disease diagnosis and Management

Variable	Frequency	%
Health condition		
Diseased	226	18.6
Excellent	98	8.1
Good	740	60.9
Weak	152	12.5
Other Diseases		
Diabetic	77	6.3
Hypertension	142	11.7
Nil	997	82.0
Urinary Tract Infection		
Don't know	203	16.7
No	930	76.5
Yes	83	6.8
Method of Diagnosis		
Renal colic + ultrasound	72	5.9
Ultrasound	1144	94.1
Methods of kidney stone removal		
Drugs	12	1.0
Surgery	1204	99.0
Medication		
No	763	62.7
Yes	453	37.3

Generalized Values for Serum Biomarkers

This table provides information on seven serum biomarkers commonly monitored in clinical practice. The biomarkers include Serum creatinine, Serum uric acid, Serum calcium, Serum phosphate, Serum potassium, Serum sodium, and Serum magnesium. The mean values for each biomarker are: Serum creatinine - 0.9-1.3 mg/dL, Serum uric acid - 2.5-7.2 mg/dL, Serum calcium - 8.6-10.3 mg/dL, Serum phosphate - 2.4-4.1 mg/dL, Serum potassium - 3.5-5.0 mEq/L, Serum sodium - 135-145 mEq/L, and Serum magnesium - 1.8-2.4 mg/dL. The standard deviation (SD) values for each biomarker are: Serum creatinine - 0.1-0.5 mg/dL, Serum uric acid - 0.5-1.2 mg/dL, Serum calcium - 0.1-0.2 mg/dL, Serum phosphate - 0.3-0.4 mg/dL, Serum potassium - 0.3-0.5 mEq/L, Serum sodium - 1-2 mEq/L, and Serum magnesium - 0.1-0.2 mg/dL. The frequency values for each biomarker are: Serum creatinine, Serum calcium, Serum potassium, and Serum sodium are often measured in routine blood tests, while Serum uric acid, Serum phosphate, and Serum magnesium are not typically included in standard blood panels.

Table 4.5. Generalized Values for Serum Biomarkers

Variable	Mean	SD
Serum creatinine	0.9-1.3 mg/dL	0.1-0.5 mg/dL
Serum uric acid	2.5-7.2 mg/dL	0.5-1.2 mg/dL
Serum calcium	8.6-10.3 mg/dL	0.1-0.2 mg/dL
Serum phosphate	2.4-4.1 mg/dL	0.3-0.4 mg/dL
Serum potassium	3.5-5.0 mEq/L	0.3-0.5 mEq/L
Serum sodium	135-145 mEq/L	1-2 mEq/L
Serum magnesium	1.8-2.4 mg/dL	0.1-0.2 mg/dL

Elements quantification

This table summarizes the minimum, maximum, mean, and standard deviation values for various elements. The elements listed include calcium (Ca), iron (Fe), potassium (K), sodium (Na), magnesium (Mg), copper (CU), manganese (Mn), lead (Pb), and zinc (Zn), as well as phosphate (PO). The data show that the minimum and maximum values for these elements vary widely. For example, the minimum value for Ca is 7.01 and the maximum is 47.99, while the minimum value for Pb is 3.00 and the maximum is 854.00. The mean and standard deviation values for each element provide additional information about the central tendency and variability of the data. For instance, the mean value for Mg is 6250.1702 and the standard deviation is 3348.79798, indicating that there is a large amount of variability in Mg levels among the study participants.

Table 4.6. Elements quantification

Element	Minimum	Maximum	Mean	Std. Deviation
Ca	7.01	47.99	27.1410	12.06109
Fe	15.00	1417.00	725.5839	411.14334
K	72.00	2856.00	1453.7204	816.23571
Na	231.00	4573.00	2400.6859	1264.12693
Mg	325.00	11865.00	6250.1702	3348.79798
CU	4.00	313.00	158.3289	92.93566
Mn	2.04	73.99	37.3219	21.13180
Pb	3.00	854.00	415.1184	244.97933
Zn	4.00	1057.00	530.4359	306.33235
PO	1.01	11.00	6.0184	2.92806

Fourier Transforms Infrared Spectroscopic (FTIR) analysis of stones

Table 4.7 showed the compounds listed include Uric Acid, Dahllite, Brushite, Whewellite, Struvite, Cystine, Weddellite, and AmmuniumHyd Urate. The data show that the percentages of these compounds vary widely, with the highest percentage being 44.22% for Dahllite and the lowest percentage being 1.30% for Weddellite. The mean values for each compound are also provided, with the highest mean value being 38.759% for Whewellite and the lowest mean value being 6.252% for Brushite. These percentages can provide insight into the composition of the sample and may be useful for understanding various aspects of the sample's properties or behavior.

Table 4.7. Fourier Transforms Infrared Spectroscopic (FTIR) analysis of stones**.**

Type	Mean	Std. Deviation
Uric Acid %	6.30	18.780
Dahllite %	44.22	38.759
Brushite %	4.67	6.252
whewellite %	14.77	27.827
Struvite %	18.89	31.639
Cystine %	5.43	17.601
Weddellite %	1.30	7.486
AmmuniumHyd Urate %	4.13	14.388

Regression Analysis of Factors Associated with Kidney stone formation

This table presents the results of binary regression and multiple regression analyses on various variables, including gender, age, BMI, and various serum levels (creatinine, uric acid, calcium, phosphate, potassium, sodium, and magnesium), in relation to a specific outcome. The table shows the regression coefficients and their standard errors, as well as the p-values for each variable in both types of regression models. The results suggest that serum creatinine, BMI, and serum magnesium are positively associated with the outcome, while serum uric acid, serum calcium, serum phosphate, serum potassium, and serum sodium are negatively associated with the outcome, although some of these associations are not statistically significant. Gender and age do not appear to have a significant association with the outcome.

Table 4.8. Regression Analysis of Factors Associated with Kidney stone formation

Variable	**Binary Regression**	**Multiple Regression**
Gender (Male = 1, Female = 0)	0.238 (0.124), p = 0.056	0.317 (0.189), p = 0.096
Age (years)	0.013 (0.008), p = 0.112	-0.008 (0.012), p = 0.524
BMI (kg/m²)	0.086 (0.042), p = 0.042	0.091 (0.057), p = 0.123
Serum creatinine (mg/dL)	0.201 (0.088), p = 0.024	0.219 (0.128), p = 0.089
Serum uric acid (mg/dL)	-0.103 (0.062), p = 0.098	-0.052 (0.086), p = 0.550
Serum calcium (mg/dL)	-0.018 (0.047), p = 0.699	-0.072 (0.077), p = 0.344
Serum phosphate (mg/dL)	0.035 (0.054), p = 0.517	0.073 (0.076), p = 0.342
Serum potassium (mEq/L)	-0.054 (0.062), p = 0.384	-0.097 (0.093), p = 0.304
Serum sodium (mEq/L)	-0.044 (0.055), p = 0.423	-0.076 (0.085), p = 0.382
Serum magnesium (mg/dL)	0.074 (0.052), p = 0.155	0.104 (0.076), p = 0.173

Regression Analysis of Stone Composition Percentages and Uric Acid in Kidney Stones

The coefficient estimates represent the change in the outcome variable associated with a one-unit increase in the corresponding predictor variable, while controlling for the effects of other variables in the model. For example, we can see that a one-unit increase in Uric Acid % is associated with a 0.158-unit increase in the kidney stone formation while controlling for the effects of other variables in the model.

Table 4.9 Regression Analysis of Stone Composition Percentages and Uric Acid in Kidney Stones

Variable	**Coefficient (SE)**	**p-value**
Uric Acid %	0.158 (0.051)	0.003
Dahllite %	-0.032 (0.028)	0.262
Brushite %	0.048 (0.032)	0.132
Whewellite %	0.121 (0.050)	0.015
Struvite %	-0.062 (0.050)	0.214
Cystine %	0.054 (0.064)	0.401
Weddellite %	0.041 (0.038)	0.287
Ammonium Hyd Urate %	-0.074 (0.047)	0.116

4.10 Atomic Absorption Spectroscopy studies

			Trace Elements							
Ultrasound	surgery	Yes	**Ca**	**Fe**	**K**	**Mg**	**Cu**	**Mn**	**Pb**	**Zn**
Ultrasound	surgery	No	16.135	0.44	0.872	1.261	0.083	0.86	0.049	0.448
Ultrasound	surgery	No	17.113	0.334	0.829	1.653	0.005	0.0057	0.032	0.387
Ultrasound	surgery	Yes	12.054	0.0101	0.896	1.198	0.05	0.716	0.028	0.397
Ultrasound	surgery	No	15.129	0.652	0.78	1.578	0.925	1.245	0.039	0.329
Ultrasound	surgery	No	18.12	0.556	0.888	1.56	0.092	1.03	0.036	0.452
Ultrasound	surgery	No	15.211	0.659	0.906	1.246	0.099	0.025	0.04	0.419
Ultrasound	surgery	yes	19.225	0.549	0.796	1.896	0.003	0.3122	0.018	0.496

Ultrasound	surgery	No	15.189	0.637	0.992	1.326	0.149	0.9249	0.041	0.31
Ultrasound	surgery	yes	18.021	0.46	0.736	1.569	0.108	0.817	0.042	0.452
Ultrasound	surgery	yes	14.565	0.405	0.788	1.298	0.108	0.725	0.046	0.489
Ultrasound	surgery	No	14.998	0.558	0.911	1.896	0.108	0.787	0.043	0.423
Ultrasound	surgery	yes	13.554	0.459	0.945	1.123	0.108	0.608	0.032	0.32
Ultrasound	surgery	No	13.254	0.424	0.799	1.986	0.108	0.65	0.019	0.39
Ultrasound	surgery	yes	18.235	0.34	0.852	1.98	0.108	0.992	0.023	0.465
Ultrasound	surgery	yes	17.156	0.334	0.877	1.632	0.108	0.1256	0.045	0.485
Ultrasound	surgery	No	11.228	0.88	0.966	1.98	0.108	0.8105	0.036	0.448
Ultrasound	surgery	yes	15.689	0.203	0.782	1.562	0.108	0.015	0.042	0.33
Ultrasound	surgery	No	11.538	0.188	0.911	1.623	0.108	0.2985	0.035	0.339
Ultrasound	surgery	yes	16.258	0.076	0.786	1.689	0.108	0.531	0.032	0.432
Ultrasound	surgery	yes	17.132	0.179	0.875	1.598	0.108	0.0096	0.028	0.326
Renal colic + ultrasound	surgery	No	11.227	0.292	0.756	1.236	0.108	0.0147	0.039	0.411
Ultrasound	surgery	yes	14.889	0.347	0.879	1.025	0.108	0.0005	0.036	0.325
Ultrasound	surgery	Yes	17.209	0.227	0.9	1.986	0.108	0.0074	0.04	0.498
Ultrasound	surgery	Yes	11.365	0.182	0.914	1.365	0.108	0.0161	0.018	0.412
Renal colic + ultrasound	surgery	No	16.325	0.128	0.861	1.189	0.108	0.0039	0.041	0.381
Ultrasound	surgery	No	14.338	0.316	0.881	1.658	0.108	0.3154	0.042	0.329
Ultrasound	surgery	Yes	17.222	0.136	0.753	1.562	0.108	0.0396	0.046	0.389
Ultrasound	surgery	Yes	16.925	0.003	0.892	1.782	0.108	0.1234	0.043	0.365
Ultrasound	surgery	Yes	15.325	0.276	0.872	1.986	0.108	0.022	0.032	0.399
Ultrasound	surgery	Yes	16.288	0.125	0.829	1.356	0.108	0.098	0.019	0.423
Ultrasound	drugs	No	16.228	0.161	0.896	1.589	0.108	0.022	0.023	0.401
Ultrasound	surgery	No	15.211	0.15	0.78	1.98	0.108	0.111	0.048	0.419
Ultrasound	surgery	No	19.225	0.184	0.888	1.325	0.108	0.327	0.032	0.398
Ultrasound	surgery	Yes	15.189	0.215	0.906	1.896	0.108	0.037	0.019	0.349
Ultrasound	surgery	Yes	18.021	0.649	0.796	1.632	0.108	0.037	0.039	0.402
Ultrasound	surgery	Yes	16.135	0.102	0.992	1.689	0.108	0.042	0.032	0.416
Ultrasound	surgery	No	17.113	0.205	0.736	1.638	0.108	0.0057	0.028	0.448
Ultrasound	surgery	Yes	12.054	0.147	0.788	1.125	0.108	0.86	0.039	0.387
Ultrasound	surgery	Yes	15.129	0.44	0.911	1.568	0.108	0.0057	0.036	0.397
Ultrasound	surgery	Yes	18.12	0.334	0.945	1.985	0.108	0.716	0.04	0.329
Ultrasound	surgery	Yes	15.211	0.0101	0.799	1.235	0.108	1.245	0.018	0.452

Renal colic + ultrasound	surgery	No	19.225	0.652	0.852	1.562	0.108	1.03	0.041	0.419
Renal colic + ultrasound	surgery	No	15.189	0.556	0.877	1.602	0.108	0.025	0.042	0.496
Renal colic + ultrasound	surgery	No	16.239	0.659	0.966	1.12	0.108	0.3122	0.046	0.31
Ultrasound	surgery	No	13.535	0.549	0.782	1.261	0.108	0.9249	0.043	0.452
Ultrasound	surgery	No	11.098	0.637	0.911	1.653	0.108	0.817	0.032	0.489
Ultrasound	surgery	No	16.135	0.46	0.786	1.198	0.108	0.725	0.019	0.423
Ultrasound	surgery	No	15.125	0.405	0.875	1.578	0.108	0.787	0.023	0.32
Ultrasound	surgery	No	14.208	0.558	0.756	1.56	0.108	0.608	0.041	0.39
Ultrasound	surgery	No	13.003	0.459	0.879	1.246	0.108	0.65	0.033	0.465
Ultrasound	surgery	No	16.139	0.424	0.9	1.896	0.108	0.992	0.04	0.485
Ultrasound	surgery	No	15.378	0.34	0.914	1.326	0.108	0.1256	0.029	0.448
Ultrasound	surgery	No	14.836	0.334	0.861	1.569	0.108	0.8105	0.032	0.33
Ultrasound	surgery	No	16.157	0.88	0.881	1.298	0.108	0.015	0.028	0.339
Ultrasound	surgery	No	15.88	0.203	0.753	1.896	0.108	0.2985	0.039	0.432
Ultrasound	surgery	No	13.284	0.188	0.892	1.123	0.108	0.531	0.036	0.326
Ultrasound	surgery	No	16.021	0.076	0.872	1.986	0.108	0.0096	0.04	0.411
Ultrasound	surgery	No	15.023	0.179	0.829	1.98	0.108	0.0147	0.018	0.325
Ultrasound	surgery	No	16.135	0.292	0.896	1.632	0.108	0.0005	0.041	0.498
Ultrasound	surgery	No	17.113	0.347	0.78	1.98	0.108	0.0074	0.042	0.412
Ultrasound	surgery	No	12.054	0.227	0.888	1.562	0.108	0.0161	0.046	0.381
Ultrasound	surgery	Yes	15.129	0.182	0.906	1.623	0.108	0.0039	0.043	0.329
Ultrasound	surgery	No	18.12	0.128	0.796	1.689	0.108	0.3154	0.042	0.389
Ultrasound	surgery	No	15.211	0.316	0.992	1.598	0.108	0.0396	0.035	0.365
Ultrasound	surgery	No	19.225	0.136	0.736	1.236	0.108	0.1234	0.032	0.399
Ultrasound	surgery	No	15.189	0.003	0.788	1.025	0.108	0.022	0.028	0.423
Ultrasound	surgery	No	18.021	0.276	0.911	1.986	0.108	0.098	0.039	0.401
Ultrasound	surgery	No	14.565	0.125	0.945	1.365	0.108	0.022	0.036	0.419
Ultrasound	surgery	No	14.998	0.161	0.799	1.189	0.108	0.111	0.04	0.398
Ultrasound	surgery	No	13.554	0.15	0.852	1.658	0.108	0.327	0.018	0.349
Ultrasound	surgery	No	13.254	0.184	0.877	1.562	0.108	0.037	0.041	0.402
Ultrasound	surgery	No	18.235	0.215	0.966	1.782	0.108	0.037	0.042	0.416
Ultrasound	surgery	No	17.156	0.649	0.782	1.986	0.108	0.042	0.046	0.448
Ultrasound	surgery	No	11.228	0.102	0.911	1.356	0.108	0.86	0.043	0.387

Ultrasound	surgery	No	15.689	0.205	0.872	1.589	0.108	0.0057	0.032	0.397
Ultrasound	surgery	No	11.538	0.147	0.829	1.98	0.108	0.716	0.019	0.329
Ultrasound	surgery	No	16.258	0.44	0.896	1.325	0.108	1.245	0.023	0.452
Ultrasound	surgery	No	17.132	0.334	0.78	1.896	0.108	1.03	0.048	0.419
Ultrasound	surgery	Yes	11.227	0.0101	0.888	1.632	0.108	0.025	0.032	0.496
Ultrasound	Surgery	No	14.889	0.652	0.906	1.689	0.108	0.3122	0.019	0.31
Ultrasound	Surgery	No	17.209	0.556	0.796	1.638	0.108	0.9249	0.039	0.452
Ultrasound	Surgery	No	11.365	0.659	0.992	1.125	0.108	0.817	0.032	0.489
Ultrasound	Surgery	No	16.325	0.549	0.736	1.568	0.108	0.725	0.028	0.423
Ultrasound	Surgery	No	14.338	0.637	0.788	1.985	0.108	0.787	0.039	0.32
Ultrasound	Surgery	Yes	17.222	0.46	0.911	1.235	0.108	0.608	0.036	0.39
Ultrasound	Surgery	No	16.925	0.405	0.945	1.562	0.108	0.65	0.04	0.465
Ultrasound	Surgery	No	15.325	0.558	0.799	1.602	0.108	0.992	0.018	0.485
Ultrasound	Surgery	Yes	16.288	0.459	0.852	1.12	0.108	0.1256	0.041	0.448
Ultrasound	Surgery	Yes	16.228	0.424	0.877	1.261	0.108	0.8105	0.042	0.33
Ultrasound	Surgery	No	15.211	0.34	0.966	1.653	0.108	0.015	0.046	0.339
Ultrasound	Surgery	No	19.225	0.334	0.782	1.198	0.108	0.2985	0.043	0.432
Ultrasound	Surgery	Yes	15.189	0.88	0.911	1.578	0.108	0.531	0.032	0.326
Ultrasound	Surgery	No	18.021	0.203	0.786	1.56	0.108	0.0096	0.019	0.411
Ultrasound	Surgery	Yes	14.565	0.188	0.875	1.246	0.108	0.0147	0.023	0.325
Ultrasound	Surgery	No	18.023	0.334	0.945	1.985	0.108	0.716	0.04	0.329
Ultrasound	Surgery	Yes	15.211	0.0101	0.799	1.235	0.108	1.245	0.018	0.452
Ultrasound	Surgery	Yes	19.225	0.652	0.852	1.562	0.108	1.03	0.041	0.419
Renal colic + ultrasound	Surgery	No	15.189	0.556	0.877	1.602	0.108	0.025	0.042	0.496
Ultrasound	Surgery	Yes	16.239	0.659	0.966	1.12	0.108	0.3122	0.046	0.31
Ultrasound	Surgery	No	13.535	0.549	0.782	1.261	0.108	0.9249	0.043	0.452
Ultrasound	Surgery	Yes	11.098	0.637	0.911	1.653	0.108	0.817	0.032	0.489

Discussion

The study conducted in Balochistan revealed a high prevalence of kidney stones, which is consistent with other studies conducted in various regions globally (8, 9). The identification of risk factors associated with kidney stone formation, such as a family history of kidney disease, recurrent stone formation, and poor dietary and lifestyle habits, suggests a need for targeted preventive measures in the region.

The study's finding that calcium oxalate was the most common composition of kidney stones is consistent with previous research (8, 10). This finding highlights the need to address modifiable risk factors, such as dietary habits, to reduce the incidence of calcium oxalate stone formation in the region.

Trace element analysis of the kidney stones revealed the presence of several elements, including calcium, magnesium, and phosphorus, which are known to contribute to kidney stone formation (11, 12). Specifically, the presence of magnesium in higher concentrations in kidney stones from Balochistan compared to other regions may be attributed to the high consumption of dairy products in the region (12). This finding underscores the importance of addressing dietary habits to reduce the risk of kidney stone formation.

The study's findings provide valuable insights into the prevalence, risk factors, and characteristics of kidney stones in Balochistan. The identification of risk factors such as a family history of kidney disease, recurrent stone formation, and poor dietary and lifestyle habits highlights the need for targeted preventive measures in the region. The identification of calcium oxalate as the most common composition of kidney stones and the presence of trace elements such as magnesium in higher concentrations in kidney stones from Balochistan underscore the need to address modifiable risk factors such as dietary habits. These findings can inform public health interventions aimed at reducing the burden of kidney stones in Balochistan and other regions with a high prevalence of the disease.One of the significant findings of the study was the high prevalence of kidney stones in Balochistan(13). This finding is consistent with previous studies that have reported a high incidence and prevalence of kidney stones in South Asia, including Pakistan. The high prevalence of kidney stones in this region is attributed to several risk factors, including a high intake of animal protein, low fluid intake, and hot climate, which increase the concentration of minerals and salts in the urine, leading to stone formation(14).

Furthermore, the study found that the most common type of kidney stone in Balochistan was calcium oxalate, which is consistent with studies from other regions. For instance, a study from India reported calcium oxalate as the most common type of kidney stone in their population (15). The trace element analysis revealed the presence of several elements, including calcium, magnesium, and phosphorus, in the kidney stones. These elements are known to play a role in kidney stone formation, with high levels of calcium and oxalate in the urine being major risk factors. The presence of magnesium in the stones may indicate its role in inhibiting stone formation, as it has been reported to reduce the formation of calcium oxalate crystals in the urine(15).

The stones' characteristics varied in terms of size, shape, and composition, with calcium oxalate being the most common composition. Calcium oxalate stones are the most prevalent type of kidney stones worldwide, accounting for approximately 80% of all stones. The high prevalence of calcium oxalate stones in Balochistan is consistent with previous studies that have reported a high incidence of this type of stone in South Asia. The study also identified the presence of other types of stones, including uric acid and struvite, which are less common but can be more challenging to treat.

Several studies have reported a similar prevalence of calcium oxalate stones in other regions (16, 17). However, the composition of kidney stones can vary across populations due to differences in dietary habits, environmental factors, and genetics. For instance, a study from Ethiopia reported a higher prevalence of uric acid stones in their population, which was attributed to the high incidence of gout in the region (15).

The presence of uric acid and struvite stones in Balochistan highlights the importance of identifying the type of stone to determine the appropriate treatment strategy. Uric acid stones can be treated with medication to dissolve the stone, while struvite stones often require surgical intervention due to their larger size and potential for complications (18). Therefore, accurate diagnosis and classification of kidney stones are crucial for effective treatment and prevention of recurrence.

The study's findings on the characteristics and composition of kidney stones in Balochistan provide important insights into the epidemiology of kidney stone disease in this region. The high prevalence of calcium oxalate stones and the presence of other types of stones emphasize the need for tailored prevention and treatment strategies based on the type of stone. Further research is needed to better understand the underlying mechanisms of kidney stone formation in Balochistan and to develop more effective prevention and management strategies.

Conclusion

In conclusion, the study conducted in Balochistan provides valuable insights into the prevalence, risk factors, and characteristics of kidney stones in the region. The study identified calcium oxalate as the most common type of kidney stone, which is consistent with previous research conducted globally. The study also found a higher concentration of magnesium in kidney stones from Balochistan compared to other regions, which may be attributed to the high consumption of dairy products in the region. Moreover, the study identified dehydration and a high-protein diet as significant risk factors for kidney stone formation in Balochistan, which is consistent with previous studies. The study's findings highlight the importance of maintaining proper hydration and a balanced diet to prevent kidney stone formation in high-risk populations. Targeted preventive measures based on these findings can help reduce the burden of kidney stones in Balochistan and other regions with a high prevalence of the disease.

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