Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/s3c8fe04

PREVALENCE OF RENAL CALCULI AND ASSOCIATED RISK FACTORS IN PATIENTS WITH FLANK PAIN: A CROSS-SECTIONAL STUDY

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Abstract

Background: Renal caliculi are a common cause of flank pain and impose a significant burden on healthcare systems worldwide. This study aimed to evaluate the prevalence of Renal Calculi in patients presenting with flank pain and assess the surgical outcomes of various stone removal procedures, with a focus on demographic and lifestyle-related risk factors.

Methods: This cross-sectional, hospital-based observational study included 250 patients with flank pain who underwent ultrasound imaging for the diagnosis of renal stones. Demographic data, lifestyle factors, and ultrasound findings were recorded. Of the patients diagnosed with Renal Calculi (n=90), surgical outcomes for extracorporeal shock wave lithotripsy (ESWL), ureteroscopy (URS), and percutaneous nephrolithotomy (PCNL) were analyzed. Statistical analysis was performed using descriptive statistics.

Results: The prevalence of Renal Calculi in patients with flank pain was 36%, with the highest prevalence in the 46–60 year age group. Males had a higher prevalence (43.3%) than females (25%). Higher BMI, smoking, inadequate hydration, and high dietary salt intake were significantly associated with renal stone formation. PCNL had the highest success rate (100%) with no complications, while ESWL (87.5%) and URS (83.3%) had moderate success rates and mild to moderate complication rates.

Conclusion: Renal caliculi are highly prevalent in males, obese individuals, smokers, and those with high salt intake. PCNL is the most effective and safest surgical method for large renal stones. Public health efforts should focus on promoting hydration, dietary modifications, and weight management to prevent renal stones.

Keywords: Renal stones, prevalence, ultrasound, PCNL, ESWL, ureteroscopy, surgical outcomes

Introduction

Renal calculi represent a significant global health concern, with their prevalence influenced by various geographical, dietary, and genetic factors [1][2]. The associated symptoms, particularly flank pain, often necessitate diagnostic imaging for confirmation [3]. Ultrasound has emerged as a crucial tool in this context due to its safety, cost-effectiveness, and absence of radiation exposure [4]. Recent epidemiological studies indicate a rising global incidence of kidney stones, potentially linked to shifts in lifestyle and dietary habits [5][6]. However, reported prevalence rates vary considerably across

regions, underscoring the need for localized research to accurately identify prevalence and associated risk factors in specific populations [7]. Given the increasing prevalence of kidney stones and the significant healthcare burden they impose, this study is both timely and necessary. Understanding the role of demographic and lifestyle factors in renal stone formation is vital for developing targeted prevention and treatment strategies [3]. This research focuses on patients presenting with flank pain, aiming to streamline the diagnostic process by reducing unnecessary imaging and ensuring prompt treatment [4].The primary objectives of this study are to determine the prevalence of Renal Calculi in patients with flank pain using ultrasound imaging, assess the correlation between renal stone occurrence and demographic factors such as age and gender, and investigate the relationship between lifestyle factors and renal stone prevalence. Ultimately, the study aims to provide updated and localized data on renal stone prevalence, contributing to the development of health policies and strategies for managing and preventing this condition [5].

Materials and Methods

The present cross-sectional, hospital-based observational study was conducted over a period of six months at the Department of Radiodiagnosis in Saraswati Medical College, Unnao, India and thus aimed to study the prevalence of renal colic presenting as flank pain. Convenience sampling of 250 (n=250) patients presenting for ultrasound imaging with complaints of unilateral or bilateral flank pain was conducted for this study. The inclusion criterion included adults aged 18 years and above, presenting with flank pain, and who gave informed consent. The exclusion criteria included pregnant women, patients with a history of previous kidney stone surgery, and those currently on treatment for renal stones.The study gained approval from the Institutional Ethics Committee and was in line with the principles set out in the Declaration of Helsinki. Informed consent was taken from all patients before enrolling them into this study. Imaging was performed using a logiq v5 ultrasound machine, biased with a 3.5 MHz transducer. The imaging procedure was shared in consideration of its non-invasive nature and no ionizing radiation.

All ultrasound scans of the kidneys and abdomen were done based on a standardized protocol. Patients were positioned in a supine and lateral position to ensure proper visualization of both kidneys. The ultrasound presence of renal colics was decided based on hyperechoic foci with posterior acoustic shadowing. The number and size of the stones, their location, along with incidental findings like hydronephrosis or evidence of obstruction, would be recorded by the radiologist. In the collection of demographic data, a standardized questionnaire was employed for patients, including age, sex, and lifestyle variables such as smoking, diet, and water intake. Anthropometric measurements were used to determine the BMI of each patient by weight in kilograms divided by height in meters squared and categorized according to the WHO BMI classification into underweight, normal, overweight, or obese. Besides demographic and lifestyle data, drug use was measured, including prescription history of NSAIDs like ibuprofen for pain, in oral doses of 400 mg, while diuretics, such as hydrochlorothiazide, at 12.5 mg orally once daily, and related drugs to urinary conditions.The resultant data were then analyzed using SPSS version 25.0, IBM Corp., Armonk, NY..The outcome of interest was ultrasound-detected prevalence of Renal Calculi in patients presenting with flank pain that gave a holistic view of the risk factors that might be associated with the formation of renal stones.

RESULTS

The study enrolled a total of 250 patients who presented with flank pain and underwent ultrasound imaging. Prevalence of Renal Calculi by Age (Table 1) outlines the distribution of renal stone diagnoses among different age groups. The study illustrates a rising prevalence of stones with increasing age until the 46-60 year group, followed by a slight decrease in the oldest age group.

Table 1. Prevalence of Renal Calculi by Age

Age (years)	Total Patients (n=250)	Patients with Renal Calculi (n=90)	Prevalence (%)
18-30	60	15	25%
31-45	70	25	35.7%
46-60	80	35	43.8%
>60	40	15	37.5%

Prevalence of Renal Calculi by Gender (Table 2) shows the gender-specific prevalence of renal stones. Males have a significantly higher prevalence compared to females, highlighting potential gender-related differences in susceptibility to renal stones.

Table 2. Prevalence of Renal Calculi by Gender

Gender	Total Patients (n=250)	Patients with Renal Calculi (n=90)	Percentage (%)
Male	150	65	43.3%
Female	100	25	25%

Prevalence of Renal Calculi by BMI (Table 3) details the association between body mass index categories and the presence of renal stones. It reveals that individuals with higher BMI, specifically those classified as overweight and obese, are more likely to develop renal stones.

Table 3. Prevalence of Renal Calculi by BMI

BMI (kg/m²)	Total Patients (n=250)	Patients with Renal Calculi (n=90)	Prevalence (%)
Underweight (<18.5)	15	3	20%
Normal (18.5-24.9)	105	25	23.8%
Overweight (25-29.9)	85	40	47.1%
Obese (≥30)	45	22	48.9%

Prevalence of Renal Calculi by Lifestyle Factors (Table 4) compares the prevalence of stones among smokers versus non-smokers. The results indicate a higher prevalence among smokers, suggesting potential lifestyle impacts on renal stone formation.

Table 4. Prevalence of Renal Calculi by Lifestyle Factors

Lifestyle Factors	Total Patients (n=250)	Patients with Renal Calculi (n=90)	Prevalence (%)
Smokers	100	45	45%
Non-smokers	150	45	30%

Prevalence of Renal Calculi by Hydration Habits (Table 5) provides insights into how hydration levels affect the prevalence of renal stones. Patients with inadequate hydration show a higher incidence of stones, underscoring the importance of fluid intake in stone prevention.

Table 5. Prevalence of Renal Calculi by Hydration Habits

Hydration Habits	Total Patients (n=250)	Patients with Renal Calculi (n=90)	Prevalence (%)
Adequate (≥2 L/day)	120	35	29.2%
Inadequate (<2 L/day)	130	55	42.3%

Prevalence of Renal Calculi by Dietary Salt Intake (Table 6) examines the correlation between dietary salt intake and stone prevalence. The results indicate a higher prevalence with increased salt consumption, pointing to diet as a modifiable risk factor.

Table 6. Prevalence of Renal Calculi by Dietary Salt Intake

Salt Intake	Total Patients (n=250)	Patients with Renal Calculi (n=90)	Prevalence (%)
Low (<5g/day)	80	20	25%
Moderate (5-10g/day)	110	35	31.8%
High (>10g/day)	60	35	58.3%

Surgical Outcomes by Stone Removal Method (Table 7) displays the success and complication rates associated with three different surgical techniques used for stone removal. Percutaneous Nephrolithotomy (PCNL) shows the highest success rate and no complications, suggesting its efficacy and safety for larger or complex stone cases.

Table 7. Surgical Outcomes by Stone Removal Method

Stone Removal Method	Total Patients with Renal Calculi (n=90)	Successful Stone Removal (n=80)	Success Rate (%)	Complications (n=15)	Complication Rate (%)
Extracorporeal Shock Wave Lithotripsy (ESWL)	40	35	87.5%	5	12.5%
Ureteroscopy URS)	30	25	83.3%	5	16.7%
Percutaneous Nephrolithotomy (PCNL)	20	20	100%	0	0%

Complications Post-Surgery by Severity (Table 8) categorizes the complications following surgery into mild, moderate, and severe based on their clinical impact. These results provides a clear view of the potential risks associated with each type of surgical intervention, useful for clinical decision-making and patient counseling.

Table 8. Complications Post-Surgery by Severity

Complication Type	Total Complications (n=15)	Mild (n=7)	Moderate (n=5)	Severe (n=3)
Infection	6	3	2	1
Bleeding	4	2	1	1
Urinary Tract Obstruction	3	1	1	1
Residual Stone Fragments	2	1	1	0

DISCUSSION

This study adds to the growing body of evidence on renal stone prevalence and management, emphasizing the significant role of demographic and lifestyle factors in stone formation. The higher prevalence of Renal Calculi observed in males aligns with earlier findings that suggest men are more prone to nephrolithiasis due to anatomical and hormonal differences, along with lifestyle factors such as smoking and higher rates of obesity [6,7]. These results support previous studies indicating that men, particularly those in the 46-60 age group, are at higher risk of developing Renal Calculi [6]. The association between higher BMI and increased stone prevalence also reflects prior research linking obesity to an altered urinary composition, which promotes stone formation [8].

Lifestyle factors such as smoking and inadequate hydration were strongly associated with increased stone formation in this study. Smoking is known to induce oxidative stress and impair kidney function, which can contribute to stone formation, a finding that has been supported by prior epidemiological studies [9]. Inadequate hydration, leading to concentrated urine, was also found to increase the risk of stone formation, reinforcing the importance of proper fluid intake as a preventive

measure [10]. These results are consistent with studies that highlight hydration as a critical factor in reducing renal stone risk [11].

High dietary salt intake was another significant risk factor, which aligns with previous findings that suggest high salt consumption increases urinary calcium excretion, a key factor in calcium oxalate stone formation [12]. This supports dietary recommendations aimed at reducing salt intake to prevent kidney stone recurrence, as highlighted in earlier research [12,13].

Regarding surgical interventions, percutaneous nephrolithotomy (PCNL) showed the highest success rate with no complications, particularly for large stones, which is consistent with current guidelines recommending PCNL as the preferred method for managing complex or larger stones [14]. The moderate success rates and higher complication rates observed with extracorporeal shock wave lithotripsy (ESWL) and ureteroscopy (URS) reflect well-known limitations of these techniques in treating larger stones or stones located in difficult-to-reach areas [15]. Similar trends have been reported in the literature, where ESWL and URS are generally effective for smaller stones but carry higher risks of complications such as infection or bleeding in more complex cases [16].

Weaknesses and Pitfalls

This study has several limitations. Its cross-sectional design limits the ability to infer causality between the observed risk factors and renal stone formation. Additionally, the sample size, while adequate, may not fully represent the broader population, particularly those outside the studied age and demographic groups. The reliance on ultrasound alone for diagnosis, though non-invasive and radiation-free, may have missed smaller stones or misclassified other abdominal conditions, as ultrasound has known limitations in sensitivity and specificity for certain types of stones. Future studies should consider using a combination of diagnostic tools to enhance accuracy and conduct longitudinal studies to explore causal relationships and long-term outcomes.

New Hypotheses and Recommendations

The findings of this study suggest further exploration of genetic predispositions in populations with higher renal calculi prevalence, particularly in males and individuals with higher BMI. Investigating the molecular mechanisms that link obesity, smoking, and dietary factors to renal stone formation could lead to more targeted preventive and therapeutic strategies. Moreover, public health campaigns should prioritize lifestyle interventions, such as promoting hydration and reducing salt and smoking, to mitigate renal stone risks.

Conclusion

The results of this study highlight the significant role of demographic and lifestyle factors in renal calculi formation and offer insights into the success and risks associated with different surgical procedures. These findings should inform clinical practice, encouraging a proactive approach to prevention and a careful, tailored approach to surgical treatment.

Conflict of Interests:

The authors declare no conflict of interests.

Sources of Funding:

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

Abbreviations:

BMI: Body Mass Index
ESWL: Extracorporeal Shock Wave Lithotripsy
PCNL: Percutaneous Nephrolithotomy

URS: Ureteroscopy
NSAIDs: Nonsteroidal Anti-Inflammatory Drugs
WHO: World Health Organization
SPSS: Statistical Package for the Social Sciences

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