SJIF Impact Factor: 6.711

WORLD JOURNAL OF ADVANCE HEALTHCARE RESEARCH

ISSN: 2457-0400
Volume: 9.
Issue: 5
Page N. 122-128
Year: 2025

Original Article www.wjahr.com

THE ASSOCIATION BETWEEN OBESITY AND RENAL STONE FORMATION IN POSTMENOPAUSAL WOMEN

Sarah Dhari Khamees[1]*, Manal Ibrahim Muslim[2] and Omer Fawzi Hussein[3]

[1]Al-Rusafa Health Directorate, Baghdad, Iraq.
[2]Ministry of Health, Baghdad, Iraq.
[3]Medical College, University of Baghdad, Baghdad, Iraq.

Article Received date: 17 March 2025 **Article Revised date:** 07 April 2025 **Article Accepted date:** 27 April 2025

***Corresponding Author: Sarah Dhari Khamees**
Al-Rusafa Health Directorate, Baghdad, Iraq.

ABSTRACT

Background: Obesity is a disease with extensive systemic effects and is strongly associated with comorbidities that elevate the risk of renal stone formation. The increasing prevalence of renal stones is likely influenced by lifestyle factors such as obesity and dietary habits. Adults with a BMI ≥40 kg/m² have an elevated risk of diabetes, hypertension, and hyperlipidemia, which are linked to kidney stone development. **Objective:** To evaluate the relationship between obesity and renal stone formation in postmenopausal women in relation to other risk factors and comorbidities. **Patients and Methods:** A cross-sectional comparative study was conducted on 450 postmenopausal women with renal stones. Patients were categorized based on BMI into an obese group (300) and a non-obese group (150). Data were analyzed using SPSS-25, with significance assessed using Pearson Chi-square test at $P \leq 0.005$. **Results:** The majority (68.7%) were aged 40–49 years. Most women were married (51.1%) and 38.2% had higher education. Significant differences were found between obese and non-obese groups in marital status, residency, and education. Menopause occurred between 40–45 years in 83.6%, with 72% experiencing natural menopause. Common comorbidities included diabetes (42.7%), hypertension (34.7%), and cardiovascular disease (25.3%), all significantly associated with obesity. A family history of renal stones was reported in 41.6%. HRT use (10.2%) was exclusive to obese women, primarily for UTIs, hot flashes, and bone loss. Obese patients also showed higher use of thiazides, vitamin D, and PPIs. Significant differences were found in LDL, TAG, and urea levels. Obesity was strongly linked to increased urinary excretion and lower pH, contributing to stone risk. **Conclusion:** Obesity plays a major role in renal stone formation among postmenopausal women, in association with several metabolic and hormonal risk factors.

KEYWORDS: Obesity, Renal stone, Postmenopausal, women.

INTRODUCTION

Kidney stones are a major health issue worldwide and a leading cause of morbidity. The lifetime prevalence of symptomatic nephrolithiasis is approximately 10% in men and 5% in women, with associated treatment costs exceeding $2 billion annually.[1] The majority of kidney stones—about 80%—contain calcium, with calcium oxalate making up the predominant type. Identifying common and modifiable risk factors for kidney stone formation could provide valuable insights into novel approaches for treatment and prevention.[2] Obesity is increasingly recognized as a key risk factor for kidney stone development. It is associated with insulin resistance and compensatory hyperinsulinemia, both of which are metabolic disturbances implicated in the pathogenesis of calcium-containing kidney stones. Insulin resistance is known to impair renal ammonium production, a crucial factor in maintaining urine pH, which in turn affects stone formation. Notably, urine pH has been shown to have an inverse relationship with body weight, supporting the hypothesis that metabolic changes in obese individuals contribute to the formation of kidney stones.[3] Additionally, individuals with larger body sizes tend to excrete higher levels of uric acid and oxalate in their urine—both of which are established risk factors for calcium oxalate stone formation. Men weighing over 120 kg were found to excrete 37% more uric acid than men under 100 kg, with similar patterns observed in women. Urinary oxalate excretion has also been linked to increased lean body mass, possibly reflecting elevated endogenous oxalate production.[4,5] Body mass index (BMI), which reflects the balance

between energy intake and expenditure over time, is a useful measure for understanding an individual's metabolic health. Interventions aimed at reducing dietary energy intake or increasing energy expenditure could potentially mitigate the risk of stone formation associated with elevated BMI.[6] Menopause, a natural and inevitable part of aging in women, also emerges as a potential risk factor for kidney stones. With women now living significantly longer post-menopause—often for one-third of their lives—renal stone formation poses a growing health concern in this demographic. Despite the increased risk, there is currently no specialized management strategy targeting stone prevention in postmenopausal women.[7] To date, no prospective study in Iraq has examined the relationship between body size and kidney stone risk specifically in postmenopausal women. It also remains uncertain whether weight gain or central adiposity measures, such as waist circumference, are linked to stone formation in this population.[8] The aim of study is to evaluate the relationship between obesity and renal stone formation in postmenopausal women in relation to other risk factors and comorbidities.

METHOD

A cross-sectional study was conducted to evaluate the relationship between obesity and renal stone formation in postmenopausal women. The study was carried out over six months, from February 1 to July 30, 2024. Data were collected three days per week, for four hours each day during regular working hours. The study was conducted at the urology consultation clinics of Al-Kadhamyia and Al-Karama hospitals in Baghdad, Iraq. A convenient sample of 450 postmenopausal women diagnosed with renal stones was selected. Based on body mass index (BMI), participants were categorized into two groups: the obese group (BMI ≥30) with 300 patients and the non-obese group (BMI <30) with 150 patients. **Inclusion criteria** included all postmenopausal women with renal stones who voluntarily agreed to participate in the study. **Exclusion criteria** included premenopausal women and postmenopausal women with other renal diseases but no renal stones.

Data were collected through direct interviews using a structured questionnaire divided into four sections.

- Section one captured sociodemographic data: age, marital status, residence, and educational level.
- Section two focused on medical history, including age and type of menopause, comorbidities, history of renal stones, surgical interventions, and family history of stones.
- Section three recorded medication use, including hormone replacement therapy (HRT), its type, and reasons for usage.
- Section four included laboratory findings such as urinalysis, lipid profile, and kidney function tests.

Ethical approvals were obtained from the Scientific Committee of the Arab Board of Health Specializations and the Baghdad Health Directorate. Informed verbal consent was obtained from all participants. Data were analyzed using SPSS version 27. Descriptive statistics such as frequencies and percentages were presented using tables and graphs. The Chi-square test assessed associations between categorical variables, while the Independent T-test evaluated differences in parametric variables between the two groups. A p-value <0.05 was considered statistically significant.

RESULTS

The current study included 450 female postmenopausal patients presented with renal stone, 300 of them were obese and 150 with normal BMI. Patients were aged 40 – 49 years(31.3%) and 50 – 59 years(68.7%). Married patients were 51.1% while unmarried (divorced, widow, single) were 48.9%. Patients living in urban areas were 64.2% and in rural areas were 35.6%. About 38.2% of patients received high education, 29.6% secondary education, 18.2% were illiterate and 14% had primary education. There was significant difference between cases and controls regarding marital status, residency and education (Table 1 and 2).

Table 1: Distribution of study sample by sociodemographic characters.

		(Obese)		(Non-obese)		Total
		No	%	No	%	
Age	40 – 49 years	91	30.3	50	33.3	141(31.3%)
	50 – 59 years	209	69.7	100	66.7	309(68.7%)
Marital status	Married	175	58.3	55	36.7	230(51.1%)
	Unmarried	125	41.7	95	63.3	120(48.9%)
Residency	Urban	183	61	106	70.7	289(64.2%)
	Rural	117	39	44	29.3	161(35.6%)
Education	Illiterate	71	23.7	11	7.3	82(18.2%)
	Primary	51	17	12	8	63(14%)
	Secondary	75	25	58	38.7	133(29.6%)
	High	103	34.3	69	46	172(38.2%)

Table 2: Comparison of demographic data of included patients.

		(Obese)		(Non-obese)		P value
		No	%	No	%	
Marital status	Married	175	58.3	55	36.7	0.001[HS]
	Unmarried	125	41.7	95	63.3	
Residency	Urban	183	61	106	70.7	0.044[S]
	Rural	117	39	44	29.3	
Education	Illiterate	71	23.7	11	7.3	0.001[HS]
	Primary	51	17	12	8	
	Secondary	75	25	58	38.7	
	High	103	34.3	69	46	

Using Chi-square test, NS: non-significant, HS: significant

Age of menopause in included patients was between 40 – 47 years (16.4%) and 48 – 55 years (83.6%). Menopause was natural in 72% and surgical in 28%. Most common co-morbidity was DM (42.7%), hypertension (34.7%), then CVS (25.3%). Previous renal stones were reported in 26.7%, previous stone operation was reported in 16%. Family history of renal stones was positive in 41.6%. There was significant difference between cases and controls regarding presence of hypertension, DM and cardiovascular diseases. Moreover, there was significant difference between cases and controls regarding presence of previous renal stones and previous stone operation (Table 3 and 4).

Table 3: Distribution of included patients according to past medical history.

		(Obese)		(Non-obese)		Total
		No	%	No	%	
Age of menopause	40 – 47years	46	15.3	28	18.7	74(16.4%)
	48– 55 years	254	84.7	122	81.3	376(83.6%)
Type of menopause	Surgical	94	31.3	32	31.3	126(28%)
	Natural	206	68.7	118	78.7	324(72%)
Co- morbidities	Hypertension	116	38.7	40	26.7	156(34.7%)
	Diabetes mellitus	139	46.3	53	35.3	192(42.7%)
	Hypothyroidism	64	21.3	29	19.3	93(20.7%)
	Hyperthyroidism	11	3.7	14	9.3	25(5.6%)
	CVS	97	32.2	17	11.3	114(25.3%)
Previous renal stones	Present	94	31.3	26	17.3	120(26.7%)
	Absent	206	68.7	124	82.7	330(73.3%)
Previous stone operation	Present	57	19	15	10	72(16%)
	Absent	243	81	135	90	378(84%)
Family history of renal stones	Present	126	42	61	40.7	187(41.6%)
	Absent	174	58	89	59.3	263(57.4%)

Table 4: Comparison of past medical history of included patients.

		(Obese)		(Non-obese)		P value
		No	%	No	%	
Co- morbidities	Hypertension	116	38.7	40	26.7	0.014[S]
	Diabetes mellitus	139	46.3	53	35.3	0.02[HS]
	CVS	97	32.2	17	11.3	0.001[HS]
Previous renal stones	Present	94	31.3	26	17.3	0.001[HS]
	Absent	206	68.7	124	82.7	
Previous stone operation	Present	57	19	15	10	0.014[S]
	Absent	243	81	135	90	

Using Chi-square test, NS: non-significant, HS: significant, CVS: cardiovascular disease

Most common drug used among included participants was calcium (49.3%), PPI (47.1%) then vitamin D (45.6%) and thiazide (27.5%). Hormone replacement therapy use was reported in 46 patients (10.2%) all of them were obese, 23 patients were past users, and 23 patients were current users. Most common cause of use was recurrent UTI (56.6%), hot flushed (21.7%) and decreased bone mass (17.4%). There was significant difference between cases and controls regarding use of thiazide, vitamin D, PPI and HRT (Table 5,6, Figures 2 and 3).

Table 5: Distribution of study sample according to drug history.

		(Obese)		(Non- obese)		Total
		No	%	No	%	
Drug history	Thiazide	98	32.7	26	17.3	124(27.5%)
	Calcium	146	48.7	76	50.7	222(49.3%)
	Vitamin D	117	39	88	58.7	205(45.5%)
	Proton pump inhibitor	155	51.7	57	38	212(47.1%)
	Laxatives	78	26	28	18.7	106(23.5%)
Hormone replacement therapy (HRT)	Past user	23	7.7	0	0	
	Current user	23	7.7	0	0	
	Never used	254	84.6	150	100	
Type (total: 46)	Topical	27	58.7			
	Systemic	19	41.3			
Cause of HRT use	Recurrent UTI	26	56.6			
	Hot flushes	10	21.7			
	Decreased bone mass	8	17.4			
	Urgency	2	4.3			

Table 6: Comparison of included patients according to drug history.

		(Obese)		(Non-obese)		P value
		No	%	No	%	
Drug history	Thiazide	98	32.7	26	17.3	0.001[HS]
	Vitamin D	117	39	88	58.7	0.001[HS]
	Proton pump inhibitor	155	51.7	57	38	0.006[HS]
Hormone replacement therapy (HRT)	Past user	23	7.7	0	0	0.001[HS]
	Current user	23	7.7	0	0	
	Never used	254	84.6	150	100	

Urine samples were acidic (54.7%) or alkaline (45.3%). Presence of pus cells in urine samples was evident in 44% of patients. Most common type of urine crystals was Ca oxalate (55.3%) followed by Ca phosphate (17.7%) and urate (16.3%). There was significant difference between cases and controls regarding urine pH, urine pus cells and urine crystals. Moreover, there was significant difference between cases and controls regarding serum LDL, TAG and serum urea (Table 7,8).

Table 7: Distribution of included patients according to laboratory investigations.

		(Obese)		(Non-obese)		total
		No	%	No	%	
Urine pH	Acidic	164	54.7	42	28	206(45.7%)
	Alkaline	136	45.3	108	72	244(54.2%)
Urine pus cells	Present	180	60	120	40	300(66.6%)
	Absent	51	34	99	66	150(33.3%)
Urine crystals	Ca oxalate	166	55.3	62	41.3	228(50.6%)
	Ca phosphate	53	17.7	31	20.7	84(18.6%)
	Urate	49	16.3	49	16.3	98(21.7%)
	Ammonium	32	10.7	32	21.3	64(14.2%)
LDL (mg/dl)	Mean ± SD	125.5 ± 25.7		93±6		
	Range	80 - 200		81 - 120		
HDL (mg/dl)	Mean ± SD	33.5 ± 7.8		36±9		
	Range	22 - 55		23 - 56		
TAG (mg/dl)	Mean ± SD	187.1 ± 53.5		127.1 ± 23.2		
	Range	120 – 400		110-190		
Serum urea (mg/dl)	Mean ± SD	173.9 ± 64.2		65±9		
	Range	24 - 400		22 - 81		
Serum creatinine (mg/dl)	Mean ± SD	1.27 ± 0.5		0.9±0.5		
	Range	0.3 – 2.30		0.4 – 1.9		

Table 8: Comparison of included patients according to laboratory investigations.

		(Obese)		(Non-obese)		P value
		No	%	No	%	
Urine pH	Acidic	164	54.7	42	28	0.001[HS]
	Alkaline	136	45.3	108	72	
Urine pus cells	Present	180	60	120	40	0.001[HS]
	Absent	51	34	99	66	
Urine crystals	Ca oxalate	166	55.3	62	41.3	0.001[HS]
	Ca phosphate	53	17.7	31	20.7	
	Urate	49	16.3	49	16.3	
	Ammonium	32	10.7	32	21.3	
LDL (mg/dl)	Mean ± SD	125.5 ± 25.7		93±6		0.011[S]
	Range	80 - 200		81 - 120		
TAG (mg/dl)	Mean ± SD	187.1 ± 53.5		127.1 ± 23.2		0.001[HS]
	Range	120 – 400		110-190		
Serum urea (mg/dl)	Mean ± SD	173.9 ± 64.2		65±9		0.001[HS]
	Range	24 - 400		22 - 81		

DISCUSSION

Hormonal fluctuations during the pre- and postmenopausal phases, coupled with lifestyle stressors, contribute to physiological and metabolic changes that may promote renal stone formation. This study focused on postmenopausal women with renal stones, particularly examining the association with obesity. Among the 450 postmenopausal participants, 66.7% were obese, and 33.3% had a normal BMI.

Prevalence of obesity: The obesity rate in our study was considerably higher than the 41.1% reported by Qian et al. (2022) in China,[9] and the 35% found by Sorensen et al. (2014) in the USA.[10] These discrepancies may stem from differences in lifestyle, diet, sample size, and population characteristics. Despite variations in prevalence, both studies identified a significant relationship between obesity and kidney stone risk.

Age distribution: The majority of participants were aged 50–59 years (68.7%), contrasting with Tang et al. (2023) in Taiwan, who reported a mean age of 61 ± 6 years.[7] Similarly, Sorensen et al. (2014) noted a higher proportion of older women.[10] These differences may relate to variations in study populations, demographics, and healthcare access.

Marital and Educational status: Marital status (51.1% married) aligned with Qian et al. (2022)[49] but disagreed with Tang et al. (2023), who found a 96% marriage rate.[7] Cultural norms likely explain this difference. Education levels showed that 38.2% had higher education, consistent with Tang et al.'s findings.[7] Notably, non-obese women were more likely to be educated, unmarried, and urban residents, aligning with Pengpid and Peltzer (2021).[11]

Menopause Age and Type: Most women experienced menopause between 48–55 years (83.6%), consistent with Qian et al. (2022).[9] Natural menopause was present in 72%, similar to findings by both Qian et al. (2022),[9] and Tang et al. (2023).[7]

Comorbidities: Diabetes mellitus (42.7%), hypertension (34.7%), and cardiovascular disease (25.3%) were the most common comorbidities. This contrasts with Mai et al. (2019), who found hypertension more prevalent.[12] The higher diabetes rate in our study may reflect regional dietary habits and genetic factors. Obese women were significantly more likely to have these conditions, supported by studies from Chandrasekaran and Weiskirchen (2024),[13] Seravalle and Grassi (2024),[14] and Welsh et al. (2024),[15] highlighting the interlinked risks of obesity, diabetes, hypertension, and cardiovascular disease.

Renal Stone History and Family History: Prior renal stones (26.7%) and surgeries (16%) were more prevalent than reported by Tang et al. (2023).[7] A family history of renal stones was seen in 41.6% of participants, agreeing with Prochaska et al. (2018),[16] reinforcing the genetic predisposition.

Hormone Replacement Therapy (HRT): HRT usage (10.2%) was limited to obese participants, lower than rates reported by Tang et al. (2023)[7] and Sorensen et al. (2014).[10] In contrast to prior studies, UTIs were the most common reason for HRT in our study, followed by hot flashes and bone loss.[17]

Medication and Supplement Use: Obese women showed higher use of thiazides, PPIs, and vitamin D, reflecting comorbidity burdens and clinical management needs.[14, 18,19] Interestingly, vitamin D use was more prevalent among non-obese women, possibly due to diet-linked deficiencies.

Urinalysis and Lipid profile: Obese women showed lower urine pH, and higher urinary excretion of calcium, oxalate, and uric acid, aligning with known metabolic pathways for stone formation.[20-23] Significant

associations with urine crystals and pus cells further underscore the role of infection and metabolic dysfunction. The lipid profile also differed significantly, with higher LDL and TAG and lower HDL than reported by Qian et al. (2022),[9] likely due to lifestyle differences. These findings reinforce the established link between obesity, dyslipidemia, and renal stone risk.[24,25]

CONCLUSION

This study found that most postmenopausal women with renal stones were aged 50–59, married, and urban residents. Menopause mainly occurred between 48–55 years, with natural menopause being most common. Diabetes, hypertension, and cardiovascular disease were prevalent comorbidities, especially among obese participants. Obese women had higher usage of thiazides, PPIs, and HRT, while non-obese women used more vitamin D. Obesity was linked to increased renal stone risk through altered urine composition and dyslipidemia, particularly elevated TAG and LDL.

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