

## Hypertension, Sedentary Lifestyle and Kidney Disease in Adults: An Ultrasound-Based Cross-Sectional Study from Pakistan

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### Abstract

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**Background:** Chronic kidney disease is a silent global health issue, with hypertension and sedentary lifestyle recognized as modifiable risk factors. Elevated blood pressure may both cause and result from renal dysfunction, while physical inactivity can exacerbate metabolic disturbances affecting kidney health.

**Objective:** To evaluate structural kidney abnormalities via ultrasonography and their association with hypertension, sedentary lifestyle, and body mass index in adults attending a hospital in Swabi, Pakistan.

**Methods:** This cross-sectional study enrolled 125 adults at the District Headquarter Hospital, Swabi, from August 2023 to January 2024. Data were collected using a structured questionnaire. Abdominal ultrasonography (Mindray, 3–5 MHz convex transducer) assessed renal stones, cysts, and hydronephrosis. Blood pressure and self-reported physical activity were recorded. Associations

were analyzed using SPSS version 25;  $p < 0.05$  was considered significant.

**Results:** Mean age was  $43.8 \pm 18.2$  years; 55.2% were male. Renal stones were most frequent (right 37.6%, left 22.4%), followed by cysts (right 12.8%, left 4.8%) and mild hydronephrosis (10.4%). No significant associations were observed between kidney abnormalities and hypertension, sedentary lifestyle, or BMI (all  $p > 0.05$ ).

**Conclusion:** Structural kidney abnormalities are common in this hospital-based cohort, while traditional risk factors showed no significant associations. Ultrasonography is a valuable tool for early detection, and further prospective studies with functional and biochemical markers are needed to clarify determinants of kidney disease.

## Introduction

Chronic kidney disease (CKD) is a major global public health concern, affecting approximately 10% of the adult population worldwide and posing a substantial burden in terms of cardiovascular morbidity, premature mortality, and escalating healthcare costs, particularly in low- and middle-income countries (LMICs) (1,2). The burden of CKD is disproportionately higher in South Asia, where delayed diagnosis, limited screening, and a rising prevalence of non-communicable diseases exacerbate adverse renal outcomes (3). The global prevalence of CKD stages 1-5 is estimated at 13.4%, yet a large portion of cases remains undiagnosed, especially in resource-poor settings(4). In Pakistan, the disease burden is particularly high, with reported CKD prevalence ranging broadly from 12.5% to 29.9% across different populations(5,6). Hypertension remains one of the most important modifiable risk factors for kidney disease, promoting progressive nephron injury through sustained elevations in systemic and intraglomerular pressure (7).

The primary drivers of kidney injury are intertwined metabolic and cardiovascular comorbidities, notably diabetes mellitus and hypertension (8). Physical inactivity has been associated with metabolic dysregulation, chronic inflammation, and endothelial dysfunction, all of which may adversely affect renal structure and function (9). Obesity is linked to glomerular hyperfiltration and structural renal changes, whereas undernutrition may reduce nephron reserve and increase susceptibility to kidney injury, particularly in resource-constrained populations (10). However, existing evidence regarding the relationship between these factors and kidney disease remains inconsistent, especially in cross-sectional studies.

Most epidemiological studies assessing kidney disease rely on biochemical markers such as serum creatinine and estimated glomerular filtration rate (eGFR), which are widely used for evaluating renal function at the population level (11). Renal ultrasonography provides a non-invasive, accessible, and cost-effective method for detecting morphological kidney changes and is particularly useful in LMIC settings(12). Despite its utility, ultrasound-based population studies examining kidney disease in relation to lifestyle and cardiometabolic risk factors are scarce in Pakistan.

Therefore, this cross-sectional study aimed to assess the association between hypertension, sedentary lifestyle, and BMI categories with ultrasound-detected kidney disease among adult participants presenting to a district headquarter hospital in Swabi, Pakistan. By addressing a critical regional evidence gap, this study seeks to inform early detection strategies and context-specific preventive interventions.

## Material and Methods

This cross-sectional study was conducted at the Department of Radiology, District Headquarter Hospital, Swabi, Pakistan, over six months from January to June 2025 and included 125 adult patients undergoing abdominal or pelvic ultrasonography. The study included patients with functional kidneys, documented blood pressure measurements, and available information on physical activity levels, while patients

with advanced cardiovascular disease, liver cancer, or a history of prior kidney surgery were excluded.

Ultrasonography was performed using a high-resolution Mindray machine with a 3–5 MHz convex transducer. Kidney assessment included measurements of size, volume, echogenicity, and identification of structural abnormalities. Blood pressure was measured using a sphygmomanometer. Hypertension was defined as self-reported hypertension, elevated measured blood pressure, or current use of antihypertensive medication. Physical activity was self-reported and categorized as sedentary or physically active.

Ethical approval was obtained from the Department of Diagnostic Medical Sonography, Women University Swabi, and the District Headquarter Hospital, Swabi. Written informed consent was obtained from all participants, and strict measures were implemented to ensure data confidentiality.

Data were collected using a pre-designed questionnaire capturing sonographic findings and relevant patient history. Data analysis was performed using SPSS version 25. Quantitative and qualitative variables were summarized using appropriate descriptive statistics. Associations between categorical variables were assessed using the Chi-square test, Fisher’s exact test, or the Monte Carlo test, where applicable. A p-value of <0.05 was considered statistically significant.

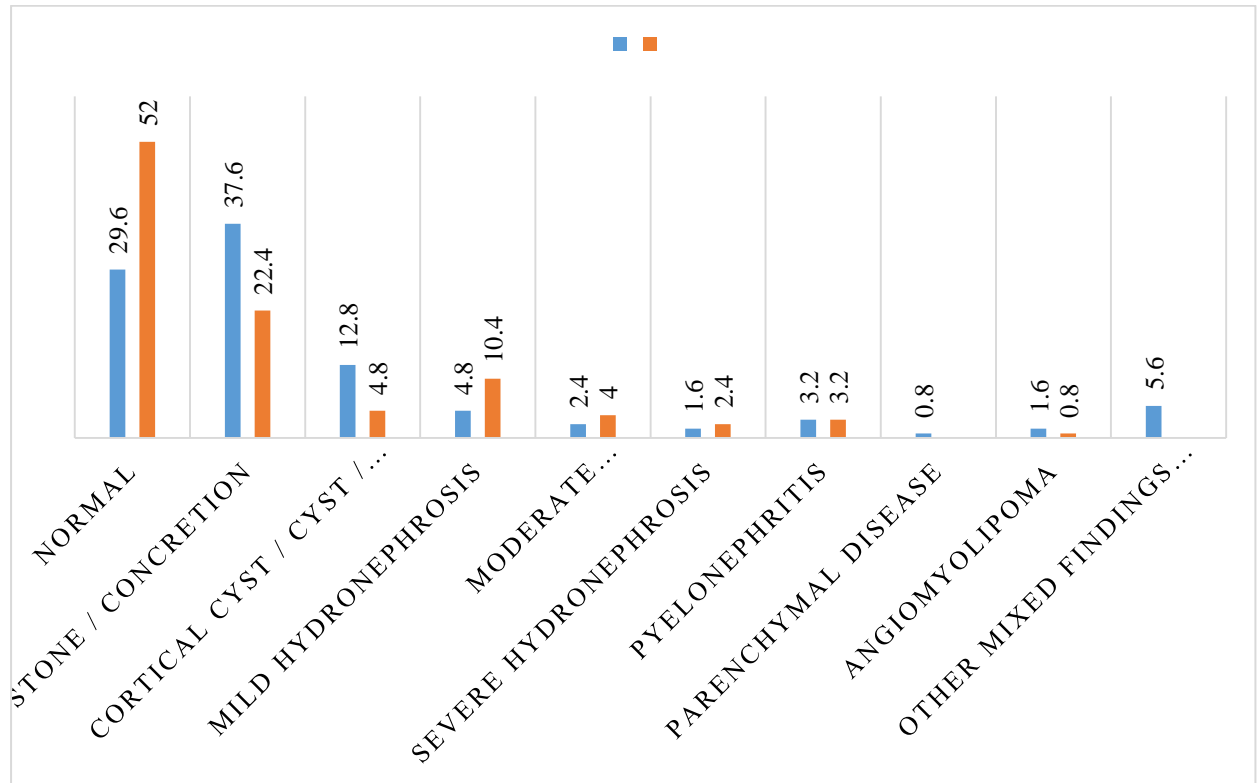
## Results

A total of 125 participants were enrolled in the study. The mean age was **43.79 ± 18.16 years**. The mean weight and height were **71.45 ± 13.77 kg** and **1.76 ± 0.18 m**, with a mean BMI of **20.25 ± 3.21 kg/m<sup>2</sup>**. Most participants had a **normal BMI (69.6%)**, followed by **underweight (26.4%)** and **overweight (4.0%)** categories. Males comprised **55.2%** of the sample, while females represented **44.8%**. Hypertension was present in **55.2%** of participants. A sedentary lifestyle was reported by **39.2%**, whereas **60.8%** engaged in physical activity (Table 1).

**Table 1: Demographic Characteristics of the Participant (n = 125)**

<b>Variable</b>		<b>Mean ± SD / n (%)</b>
<b>Age (years)</b>		43.79 ± 18.16
<b>Weight (kg)</b>		71.45 ± 13.77
<b>Height (m)</b>		1.76 ± 0.18
<b>BMI (kg/m<sup>2</sup>)</b>		20.25 ± 3.21
<b>BMI Category</b>	Underweight	33 (26.4)
	Normal	87 (69.6)
	Overweight	05 (4.0)
<b>Gender</b>	Male	69 (55.2)
	Female	56 (44.8)
<b>Hypertension</b>	Yes	69 (55.2)
	No	56 (44.8)
<b>Sedentary Lifestyle</b>	Yes	49 (39.2)
	No	76 (60.8)

Ultrasonography revealed that 52% of left kidneys and 29.6% of right kidneys were normal. Renal stones were the most common abnormality, observed in 22.4% of left kidneys and 37.6% of right kidneys, while cystic lesions were more frequent in the right kidney (12.8% vs. 4.8%). Mild hydronephrosis was noted in both kidneys, predominantly in the left (10.4%). Overall, renal stones and cystic lesions constituted the main kidney abnormalities in this cohort (Figure 1).



**Figure 1. Distribution of Ultrasonographic Kidney Abnormalities Expressed as Percentage**

Overall kidney disease status was not significantly associated with hypertension, sedentary lifestyle, or body mass index (BMI) category. Kidney abnormalities were observed in 78.3% of participants with hypertension and 76.8% of those without hypertension ( $p = 0.50$ ). Similarly, sedentary individuals had a higher prevalence of kidney abnormalities compared with non-sedentary participants (81.6% vs. 75.0%), though this difference was not statistically significant ( $p = 0.38$ ). Across BMI categories, kidney abnormalities were most frequent among underweight participants (81.8%), but no significant association was found ( $p = 0.62$ ). (Table 2)

**Table 2: Association of Kidney Disease with Hypertension, Sedentary Lifestyle, and BMI Category**

Factor		Normal Kidney n (%)	both Abnormal either or both Kidney n (%)	p-value
Hypertension	Yes	15 (21.7%)	54 (78.3%)	0.50
	No	13 (23.2%)	43 (76.8%)	
Sedentary	Yes	9 (18.4%)	40 (81.6%)	0.38

<b>Lifestyle</b>	No	19 (25.0%)	57 (75.0%)	
<b>BMI Category</b>	Underweight	6 (18.2%)	27 (81.8%)	0.62
	Normal weight	20 (23.0%)	67 (77.0%)	
	Overweight	2 (40.0%)	3 (60.0%)	

## Discussion

In this hospital based cross sectional study of 125 adults undergoing diagnostic kidney ultrasonography at the District Headquarter Hospital in Swabi, Pakistan, we identified a high proportion of structural kidney abnormalities. Renal stones comprised the most frequent finding in both kidneys, with a notably higher percentage in the right kidney, followed by cystic lesions and mild hydronephrosis. Despite more than half of the participants having hypertension and over one third reporting a sedentary lifestyle, we observed no statistically significant associations between kidney abnormalities and hypertension, sedentary lifestyle, or BMI categories in this clinical cohort.

The high frequency of renal stones detected by ultrasonography in our cohort is consistent with findings from other hospital-based studies in Pakistan, such as those by Khan et al. and Ahmad et al., which reported substantial rates of nephrolithiasis among patients undergoing renal imaging or urological evaluation (13,14).

The absence of a significant association between hypertension and structural kidney abnormalities in our study contrasts with evidence suggesting a link between nephrolithiasis and hypertension. A meta-analysis by Shang et al. reported that individuals with kidney stones had a significantly increased risk of hypertension compared with those without stones (pooled OR 1.43; 95% CI 1.30–1.56) (15). These population-level associations may not reflect structural changes detectable by ultrasound. The lack of significance in our hospital-based cohort may be due to limited power, selection bias, or ultrasonography's inability to detect microvascular or functional renal damage.

Sedentary lifestyle has been identified in epidemiologic studies as a modifiable behavior associated with adverse renal outcomes, including chronic kidney disease markers such as reduced estimated glomerular filtration rate and albuminuria (16). In our cohort, sedentary behavior was more common among participants with kidney abnormalities than among those without; however, this difference did not reach statistical significance. Measurement limitations related to self reported physical activity levels and the heterogeneity in activity definitions may contribute to these findings.

The association between BMI and kidney stone disease is complex. Systematic reviews by Garg et al. have reported inconsistent findings, with some studies demonstrating an increased risk among individuals with obesity, while others observed no definitive association (17). In the present cohort, overweight participants were few, and no statistically significant relationship with kidney abnormalities was identified, likely reflecting limited sample size and reduced statistical power to detect differences across BMI categories.

This hospital-based study has limitations, including its cross-sectional design, reliance on self-reported physical activity, absence of biochemical kidney assessments, and single-center setting, which may limit generalizability. Future studies should use prospective cohorts with serial imaging, functional biomarkers (e.g., eGFR, microalbuminuria), and multicenter designs to better evaluate risk factors and underlying mechanisms.

## Conclusion

In this hospital-based cross-sectional study, structural kidney abnormalities particularly renal stones and cystic lesions were frequently identified among adults undergoing ultrasonography in Swabi, Pakistan. Traditional risk factors, including hypertension, sedentary behavior, and BMI, were not significantly associated with these structural changes, suggesting that other determinants, such as genetic predisposition, dietary factors, and metabolic conditions, may play a more prominent role in kidney pathology in this clinical setting. These findings underscore the value of ultrasonography as a diagnostic tool for early detection of renal abnormalities and highlight the need for prospective, multicenter studies incorporating functional and biochemical assessments to elucidate the mechanisms and modifiable risk factors contributing to kidney disease in hospital-based populations.

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## Author contributions

Aisha Saleh and Faiza Gul contributed to conceptualization, methodology, investigation, validation, and writing of the original draft. Saman Batool, Qurat ul Ain, Laiba Ijaz, Wajeeha Rowaid, Fareeha Waris, and Hooria Javed contributed to methodology, data curation, visualization, validation, and review & editing of the manuscript. All authors have read and approved the final version of the manuscript.

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**Data Availability:** The data supporting the findings of this study are available from the corresponding author upon reasonable request.

## Declarations

**Conflict of Interest:** The authors declare no competing financial or personal interests that could have influenced the work reported in this study.

**Ethical Approval and Informed Consent:** Ethical approval for the study was obtained from the Institutional Review Board of District Headquarter Hospital, Swabi. Written informed consent was obtained from all participants after explaining the aims and objectives of the study.

## References

- Hill NR, Fatoba ST, Oke JL, Hirst JA, O’Callaghan CA, Lasserson DS, et al. Global Prevalence of Chronic Kidney Disease – A Systematic Review and Meta-Analysis. *PLOS ONE* [Internet]. 2016 Jul 1 [cited 2025 Dec 23];11(7):e0158765. Available from: <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0158765>
- Jha V, Garcia-Garcia G, Iseki K, Li Z, Naicker S, Plattner B, et al. Chronic kidney disease: Global dimension and perspectives. *The Lancet* [Internet]. 2013 Jul 20 [cited 2025 Dec 23];382(9888):260–72. Available from: <https://www.thelancet.com/action/showFullText?pii=S014067361360687X>
- Stanifer JW, Muiro A, Jafar TH, Patel UD. Chronic kidney disease in low- and middle-income countries. *Nephrology Dialysis Transplantation* [Internet]. 2016

- Jun 24 [cited 2025 Dec 23];31(6):868. Available from: <https://pmc.ncbi.nlm.nih.gov/articles/PMC4876969/>
- Khan A, Cheema MF, Fatima R, Cheema SS, Butt Z, Gillani S, et al. Prevalence of Chronic Kidney Disease in a High-Risk Population in Urban Lahore, Pakistan: A Cross-sectional Study. *Cureus*. 2024;16(6).
- Jessani S, Bux R, Jafar TH. Prevalence, determinants, and management of chronic kidney disease in Karachi, Pakistan - A community based cross-sectional study. *BMC Nephrology* [Internet]. 2014 Jun 13 [cited 2025 Dec 24];15(1):90-. Available from: <https://link.springer.com/article/10.1186/1471-2369-15-90>
- Imtiaz S, Alam A, Imtiaz Professor of Nephrology S. Epidemiology and demography of Chronic Kidney Disease in Pakistan- A review of Pakistani literature. *Pakistan Journal of Kidney Diseases* [Internet]. 2023 Mar 26 [cited 2025 Dec 24];7(1):2–7. Available from: <https://pjkd.com.pk/index.php/pjkd/article/view/209>
- Ku E, Lee BJ, Wei J, Weir MR. Hypertension in CKD: Core Curriculum 2019. *American journal of kidney diseases: the official journal of the National Kidney Foundation* [Internet]. 2019 Jul 1 [cited 2025 Dec 23];74(1):120–31. Available from: <https://pubmed.ncbi.nlm.nih.gov/30898362/>
- Kanwal K, Khan M, Kalsoom Zahid, Marwa Noor, Nimra Abid, Waleeja Naz, et al. Ultrasound Comparison of Renal Changes in Diabetic and Non-Diabetic Adult in Swabi. *Journal of Health and Rehabilitation Research*. 2024;4(2):1429–33.
- Stanifer JW, Muiru A, Jafar TH, Patel UD. Chronic kidney disease in low- and middle-income countries. *Nephrology, dialysis, transplantation: official publication of the European Dialysis and Transplant Association - European Renal Association* [Internet]. 2016 Jun 24 [cited 2025 Dec 23];31(6):868–74. Available from: <https://pubmed.ncbi.nlm.nih.gov/27217391/>
- Hall ME, do Carmo JM, da Silva AA, Juncos LA, Wang Z, Hall JE. Obesity, hypertension, and chronic kidney disease. *International journal of nephrology and renovascular disease* [Internet]. 2014 Feb 18 [cited 2025 Dec 23];7:75–88. Available from: <https://pubmed.ncbi.nlm.nih.gov/24600241/>
- Levey AS, Stevens LA, Schmid CH, Zhang Y, Castro AF, Feldman HI, et al. A new equation to estimate glomerular filtration rate. *Annals of internal medicine* [Internet]. 2009 May 5 [cited 2025 Dec 24];150(9):604–12. Available from: <https://pubmed.ncbi.nlm.nih.gov/19414839/>
- Moghazi S, Jones E, Schroeppe J, Arya K, McClellan W, Hennigar RA, et al. Correlation of renal histopathology with sonographic findings. *Kidney international* [Internet]. 2005 [cited 2025 Dec 23];67(4):1515–20. Available from: <https://pubmed.ncbi.nlm.nih.gov/15780105/>
- Khan TM, Anwar MS, Shafique Z, Nawaz FK, Karim MS, Saifullah D, et al. Risk Factors of Nephrolithiasis in a Tertiary Care Hospital in Rawalpindi: A Descriptive Cross-Sectional Study. *Cureus* [Internet]. 2022 Jun 24 [cited 2025 Dec 23];14(6):e26274. Available from: <https://pmc.ncbi.nlm.nih.gov/articles/PMC9308900/>
- Janssens U. Functional hemodynamic monitoring. Vol. 119, *Medizinische Klinik - Intensivmedizin und Notfallmedizin*. 2024. p. 614–23.
- Shang W, Li Y, Ren Y, Yang Y, Li H, Dong J. Nephrolithiasis and risk of hypertension: a meta-analysis of observational studies. *BMC nephrology* [Internet]. 2017 Nov 29 [cited 2025 Dec 23];18(1). Available from: <https://pubmed.ncbi.nlm.nih.gov/29187160/>
- Feng X, Wu W, Zhao F, Xu F, Han D, Guo X, et al. Association between physical activity and kidney stones based on dose–response analyses using restricted cubic splines. *European Journal of Public Health* [Internet]. 2020 Dec 11 [cited

2025 Dec 23];30(6):1206–11. Available from:  
<https://dx.doi.org/10.1093/eurpub/ckaa162>  
Garg M, Joseph P, Johnson H, Lawrence JV, Somani B, Rai BP, et al. Obesity and BMI score as risk factors for urolithiasis: a systematic review over 30 years. *Current opinion in urology* [Internet]. 2025 Jul 1 [cited 2025 Dec 23];35(4):338–46. Available from: <https://pubmed.ncbi.nlm.nih.gov/40325962/>