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# Sonographic Markers In The Early Detection Of Renal Dysfunction In Diabetic Adults

**Naiba Emmnauel[1], Sadia Sabir[2]**

[1]Department of Radiological Sciences & Medical Imaging Technology, Faculty of Allied Health Sciences, Superior University Lahore

Email: kkcpakistan@gmail.com

[2]Department of Human Nutrition and Food Technology, Faculty of Allied Health Sciences, Superior University Lahore

Email: sadia.sabir@superior.edu.pk

***Corresponding author: Naiba Emmnauel,** Department of Radiological Sciences & Medical Imaging Technology, Faculty of Allied Health Sciences, Superior University Lahore

Email: kkcpakistan@gmail.com

**Abstract:**

**Objective:** This study aimed to use the sonographic markers in the early detection of renal dysfunction in diabetic adults.

**Study design:** The study design was cross sectional in nature.

**Place and duration of study**: The study was conducted at Allied Hospital Faisalabad. Duration of study was 4 months from November 2024 to February 2025.

**Material and methods:** The current study comprised a sample of 250 persons. All diabetic adults (aged18-90) all BMI categories and both genders were consenting before participation, experienced ultrasonography collected their demographic, anthropometric data and blood samples collection. The data was presented as mean and standard deviation (mean ±SD). One-way analysis of variance (ANOVA) was used to calculate the statistical analysis, and the Pearson correlation coefficient was computed for bivariate associations. The statistical significance was established at the 5% ($p<0.05$) level using the SPSS version 27.

**Results:** The results showed that male participants had higher serum creatinine and eGFR levels with increasing BMI. Serum creatinine ranged from 0.876±0.341 mg/dL in males with BMI <18.5 kg/m² to 1.325±0.677 mg/dL in those with BMI >30 kg/m², with an overall mean of 0.997±0.503 mg/dL (p=0.113). eGFR increased from 77.257±11.959 mL/min/1.73 m² to 101.125±16.762 mL/min/1.73 m², with a significant p-value of 0.001. In females, serum creatinine ranged from 0.790±0.310 mg/dL in the <18.5 BMI group to 1.097±1.004 mg/dL in the >30 BMI group, with a mean of 0.963±0.798 mg/dL (p=0.014). eGFR ranged from 62.200±10.464 mL/min/1.73 m² to 84.595±13.180 mL/min/1.73 m², with a significant p-value of <0.001.

**Conclusions:** Sonographic variables have demonstrated great promise in the early identification of renal impairment in persons with diabetes. Before symptoms manifest or laboratory data change dramatically, early alterations in kidney size, cortical echogenicity, and resistive indices can be identified using imaging techniques such Doppler ultrasonography and greyscale ultrasound.

**Key Words:** kidney dysfunction, ultrasonography, sonographic markers, diabetes

## 1.Introduction

Kidneys are the two most imperative body's excretory organs, their fundamental is protecting electrolytes and water adjust. Renal assessment is vital to check numerous maladies. The breath and width of person's kidneys are 12 centimeters and 6 centimeters separately, but these estimations contrast between ethnic communities and are affected by other factors like body measure, sex, and age (1). Concurring to the Universal Diabetes Federation (IDF), there are around 537 million individuals around the world having diabetes mellitus (DM) amid 2021 and by 2045, the figure is anticipated to extend about 783 million. Diabetes Mellitus is one of the predominant sicknesses within the world. Diabetic nephropathy, one of a major donor to the advancement of end-stage renal disease (ESRD) as well as constant kidney malady (CKD) (2). Glomerular filtration rate (GFR) is broadly acknowledged in a general degree of kidney work. Persistent Kidney Infection is characterized based on the level of Glomerular Filtration Rate. (3) Renal brokenness regularly advances over numerous a long time, with a long idle period when the infection is clinically quiet and thus conclusion, assessment and treatment is based on biomarkers that survey kidney work. Glomerular filtration rate (GFR) remains the perfect marker of kidney work. Shockingly measuring GFR is time expanding and thus GFR is ordinarily evaluated from conditions that take into account endogenous filtration markers like serum creatinine (SCr) (4). It is evaluated that 850 million people around the world, or 9.5% from the population, suffer from persistent kidney illnesses (CKD). The prevalence of persistent Kidney illness is extends in light of maturing populaces together with the rising rate of morbidity, indeed among more youthful individuals. Approximately 40,000 early ends within the Joined together Kingdom are caused by Incessant Kidney Malady, and 25% of countries have Persistent Kidney Infection administration, and less than half recognize Inveterate Kidney Malady as a worldwide wellbeing concern (5). Various imaging procedures are utilized to assess renal estimate. Like magnetic imaging (MRI) and computed tomography (CT) are well-established for measuring kidney volume, but they have drawbacks such as cost, radiation exposure, and limited availability. With negligible inter-observer inconstancy, the ultrasound of the kidneys may be performed viably, quickly, financially, broadly, and right on the bedside of the patients to allow the doctor crucial kidney anatomical information (6). The renal volume decided by ultrasonography gives a more exact sign of a useful kidney compared to its length. Renal length has generally small specificity for anticipating impeded renal work, a more recent study found that the kidneys length as well as volume altogether associated with elderly's surmised glomerular filtration rate (eGFR) (7). Ultrasound is the finest imaging strategy since it is non-invasive, makes the kidney effectively open and visible, and gives sufficient data without any radiation (8). A straightforward and widely used technique for estimating GFR is serum creatinine. However, tubular creatinine production and individual differences in the serum creatinine depending on muscle mass are disadvantages of serum creatinine-based GFR. In addition, any notable increase in serum creatinine indicates a roughly 50% decline in GFR (9). A rise in creatinine levels over a few months decreased glomerular filtration rate (GFR) (less than 60 ml/min per 1.7 m2) CKD is one of the major causes of kidney disappointment which gives rise to End Stage Renal Disease (ESRD). Pathological inconsistencies, variances in both pee and blood substance of renal work markers (Glomerular Filtration Rate, serum creatinine), or imaging tests can all be utilized to identify constant renal malady (10). Anthropometric measures including height and weight of the body are frequently possible predictors of kidney volume, many studies have examined the connection between kidney volume and anthropometric data, estimating renal size. kidney volume is more precise and is associated better with the overall anthropometry of the subjects (BMI, height, weight and gender) (11). The persons with diabetes are at an elevated risk for developing chronic kidney disease, but the ultrasound is very cost effective for Individuals in economically challenged or low-resource areas, sonographic markers are helpful for medical professionals to improves the treatment for diabetic people may get benefit from more individualized treatment, which can help delay or stop the further development of the illness (12). Sonographic markers helpful on the initial phases of renal damage because diabetic adults having early renal failure show greater renal cortical echogenicity along with abnormal kidney size that can be detected before significant rises in serum creatinine as well reductions in Glomerular Filtration Rate. Compared to conventional biomarkers, (such as increased echogenicity) more effectively predicts progression to chronic kidneys disease (CKD) in persons with diabetes (13).

There is no significant difference between sonographic markers and traditional biochemical markers (e.g., serum creatinine, GFR) in the early detection of renal dysfunction in diabetic adults. This hypothesis sets the foundation for research aimed at proving the effectiveness and importance of sonographic markers in the early, non-invasive detection of renal dysfunction among diabetic patients, with the goal of improving early diagnosis and intervention strategies.

## 2. Methodology

The current study was cross sectional in nature, Study was conducted at Allied Hospital Faisalabad 250 participants were included in this study. Ethical approval was obtained from research and ethics committee. Data was collected by using permission letter. Consent was taken from target population. Privacy and confidentiality of population was ensured.

All diabetic adult individuals 18 years and above were experienced diagnostic renal ultrasonography from August 2024 to October 2024 after consenting, BMI Participants across all BMI categories (underweight, normal weight, overweight, and obese) as defined by WHO standards, Both male and female participants were included in this study (14). Exclusion criteria: (1) Pregnant women due to physiological changes in the kidneys that can affect the study outcomes. (2) Known Subjects with history of acute kidney injury Kidney transplant patients. (3) Patients on hemodialysis or peritoneal dialysis**.** The current study design was cross sectional in nature (11).

Standard information included age, sex, blood pressure, height and weight (measured as meters and kilograms, separately). Renal volume: calculated as: 0.523 ×length (cm) width (cm) x depth (cm). Venous blood samples drawn under sterile conditions. Serum Creatinine was measured using the Jaffe method Estimated glomerular filtration rate was also measured. Random blood glucose was measured (14).

250 patients were included in the study. All the patients were inquired for their educated assent. After gathering demographic information, and then a clinical examination was conducted. Ultrasonography were used to evaluate the echogenicity of the both kidneys. A visually measured segment representing the biggest section running longitudinally from one pole to another pole was used for determining the length. A section of the kidney perpendicular to the kidney's longitudinal axis was used to measure the width and thickness. From the renal hilum to the convex boundary of the lateral renal margin, the parenchymal thickness was measured. The cortical thickness was measured perpendicular to the capsule in the sagittal plane of the medullary pyramid. The mean renal longitudinal size, parenchymal thickness, and cortical echogenicity values for each subject were determined.

The data was presented as mean and standard deviation (mean ±SD). One-way analysis of variance (ANOVA) was used to calculate the statistical analysis, and the Pearson correlation coefficient was computed for bivariate associations. The statistical significance was established at the 5% ($p<0.05$) level using SPSS version 27.

**3. Results**

The study included 250 participants, with 34.4% male and 65.6% female. BMI distribution showed 12.4% underweight (<18.5 kg/m²), 42.0% normal weight (18.5-24.99 kg/m²), 23.2% overweight (25-29.99 kg/m²), and 22.4% obese (>30 kg/m²), with a mean BMI of 25.640±6.505 kg/m². Normal kidney size was observed in 85.6% of right kidneys and 86.0% of left kidneys, while increases were seen in 10.4% and 10.0%, respectively, and decreases in 4.0% for both. The mean age was 38.388±15.424 years, mean random blood glucose 150.216±37.150 mg/dL, systolic blood pressure 124.160±14.349 mmHg, diastolic blood pressure 81.980±8.972 mmHg, serum creatinine 0.975±0.710 mg/dL, and eGFR 79.386±18.527 mL/min/1.73 m².

***Table1.***Distribution of Serum Creatinine and Estimated Glomerular Filtration Rate across BMI categories and gender

| | | | | **Creatinine (mg/ dl)** | P Value | **EGFR** | P value |
|---|---|---|---|---|---|---|---|
| Gender | BMI | N | % | Mean ±SD | | Mean ±SD | |
| Male | <18.5 BMI (kg/m$^2$) | 21 | 8.4% | .876±.341 | 0.113 | 77.257±11.959 | 0.001 |
| | 18.5-24.99 BMI (kg/m$^2$) | 38 | 15.2% | .942±.471 | | 92.600±19.721 | |
| | 25-29.99 BMI (kg/m$^2$) | 19 | 7.6% | 1.105±.589 | | 96.773±18.562 | |
| | > 30 BMI (kg/m$^2$) | 8 | 3.2% | 1.325±.677 | | 101.125±16.762 | |
| | Total | 86 | 34.4% | .997±.503 | | 90.568±19.073 | |
| Female | <18.5 BMI (kg/m$^2$) | 10 | 4.0% | .790±.310 | 0.014 | 62.200±10.464 | <0.001 |
| | 18.5-24.99 BMI (kg/m$^2$) | 67 | 26.8% | .749±.164 | | 66.237±13.822 | |
| | 25-29.99 BMI (kg/m$^2$) | 39 | 15.6% | 1.210±1.116 | | 75.315±12.089 | |
| | > 30 BMI (kg/m$^2$) | 48 | 19.2% | 1.097±1.004 | | 84.595±13.180 | |
| | Total | 164 | 65.6% | .963±.798 | | 73.523±15.301 | |

The analysis of serum creatinine and eGFR by gender and BMI showed that male participants had higher serum creatinine and eGFR levels with increasing BMI. Serum creatinine ranged from 0.876±0.341 mg/dL in males with BMI <18.5 kg/m² to 1.325±0.677 mg/dL in those with

BMI >30 kg/m², with an overall mean of 0.997±0.503 mg/dL (p=0.113). eGFR increased from 77.257±11.959 mL/min/1.73 m² to 101.125±16.762 mL/min/1.73 m², with a significant p-value of 0.001. In females, serum creatinine ranged from 0.790±0.310 mg/dL in the <18.5 BMI group to 1.097±1.004 mg/dL in the >30 BMI group, with a mean of 0.963±0.798 mg/dL (p=0.014). eGFR ranged from 62.200±10.464 mL/min/1.73 m² to 84.595±13.180 mL/min/1.73 m², with a significant p-value of <0.001.

***table 2.*** Distribution of right and left kidney size abnormalities across BMI categories and gender

| | | BMI | | | | | | | | Gender | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | <18.5 BMI (kg/m²) | | 18.5-24.99 BMI (kg/m²) | | 25-29.99 BMI (kg/m²) | | > 30 BMI (kg/m²) | | Male | | Female | |
| | | N | % | N | % | N | % | N | % | N | % | N | % |
| Right Kidney | Normal | 27 | 10.8% | 97 | 38.8% | 45 | 18.0% | 45 | 18.0% | 68 | 27.2% | 146 | 58.4% |
| | Increase (Cortical echogenicity) | 1 | 0.4% | 6 | 2.4% | 12 | 4.8% | 7 | 2.8% | 14 | 5.6% | 12 | 4.8% |
| | Decrease (Parenchymal thickness) | 3 | 1.2% | 2 | 0.8% | 1 | 0.4% | 4 | 1.6% | 4 | 1.6% | 6 | 2.4% |
| | P value | <0.001 | | <0.001 | | <0.001 | | <0.001 | | <0.001 | | <0.001 | |
| Left Kidney | Normal | 27 | 10.8% | 97 | 38.8% | 46 | 18.4% | 45 | 18.0% | 68 | 27.2% | 147 | 58.8% |
| | Increase (Cortical echogenicity) | 1 | 0.4% | 6 | 2.4% | 11 | 4.4% | 7 | 2.8% | 14 | 5.6% | 11 | 4.4% |
| | Decrease (Parenchymal thickness) | 3 | 1.2% | 2 | 0.8% | 1 | 0.4% | 4 | 1.6% | 4 | 1.6% | 6 | 2.4% |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | P value | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |

The distribution of kidney size abnormalities varied significantly across BMI categories and genders (p<0.001). Most participants had normal kidney size. For the right kidney, normal size was observed in 85.6% of participants, with 10.4% showing an increase and 4.0% a decrease. For the left kidney, 86.0% were normal, 10.0% had an increase, and 4.0% a decrease. Participants with BMI 18.5-24.99 kg/m² had the highest percentage of normal kidneys (38.8%), while those with BMI >30 kg/m² had slightly higher rates of abnormalities. Gender-wise, females were more likely to have normal kidneys (58.4% right, 58.8% left) compared to males (27.2% for both), while males had slightly higher rates of size increases (5.6% right, 5.6% left).

**4.Dissicion**

The increasing prevalence of obesity and its associated health complications have become a major global concern, with significant implications for renal health. Renal function is influenced by a multitude of factors, including demographic variables, body mass index (BMI), and gender. This study explores the relationship between these variables and sonographic markers of renal health, such as kidney size, serum Creatinine, and estimated glomerular filtration rate.

The analysis encompassed a diverse sample of 250 participants, representing varying BMI categories and gender distributions, to assess how these factors influence renal morphology and function. The study also investigates the prevalence of kidney size abnormalities, including changes in cortical echogenicity and parenchymal thickness, in relation to BMI and gender. By examining these variables, the research aims to elucidate patterns that may help predict and prevent renal dysfunction in at-risk populations.

Findings highlight significant associations between BMI and renal parameters, demonstrating that increased BMI correlates with altered kidney size, higher serum Creatinine levels, and reduced eGFR, particularly among female participants. Additionally, gender disparities in renal markers underscore the need for gender-specific approaches to assessing and managing renal health.

The current study analyzed the distribution of right kidney size abnormalities normal size, increased size due to cortical echogenicity, and decreased size due to parenchymal thickness across different BMI categories and genders. This section compares the findings with previous research and discusses the implications.

Comparison with Previous Studies The majority of participants in this study exhibited normal kidney sizes across BMI categories. However, a trend toward increased cortical echogenicity and decreased parenchymal thickness was noted in higher BMI groups. For instance, among participants with a BMI >30 kg/m², 2.8% showed increased cortical echogenicity, and 1.6% exhibited decreased parenchymal thickness (15)

In this study, participants with a BMI <18.5 kg/m² had lower rates of kidney size abnormalities, with only 0.4% showing increased cortical echogenicity and 1.2% exhibiting decreased parenchymal thickness. These findings align with research by **Rena et al. (2014),** which suggested that underweight individuals are less prone to renal structural abnormalities compared to obese populations. However, malnutrition in underweight groups could still lead to reduced parenchymal thickness due to chronic energy deficiency.(16)

The study revealed gender differences, with females having a higher prevalence of normal kidney size (58.4%) compared to males (27.2%). Increased cortical echogenicity was more common in males (5.6%) than females (4.8%). Similar findings were reported by **Pinhas et al.** (2018), who noted that males are more likely to exhibit kidney abnormalities, possibly due to higher rates of hypertension and diabetes. Conversely, females may be more protected from kidney abnormalities due to hormonal factors, particularly estrogen, which may have renoprotective effects (17).

The findings of this study indicate significant associations between BMI categories and kidney size alterations, including normal kidney size, increased cortical echogenicity, and decreased parenchymal thickness. These results corroborate previous literature exploring the relationship between BMI, kidney morphology, and potential renal dysfunction.

Several studies have demonstrated a correlation between elevated BMI and renal structural changes. For instance, **Azizi et al. (2024)** highlighted that obesity-related glomerulopathy is often associated with increased cortical echogenicity, reflecting early nephron damage due to heightened metabolic and hemodynamic stress.(18)

Similarly, our results reveal a progressive increase in cortical echogenicity with increasing BMI, consistent with findings by **Poudel et al. (2023)**, who noted glomerular hypertrophy and compromised renal function among overweight and obese individuals (19).

Interestingly, participants with normal BMI (18.5–24.99 kg/m²) exhibited the highest percentage of normal kidney size (38.8%), whereas those in the >30 kg/m² BMI group showed higher proportions of increased cortical echogenicity (2.8%) and decreased parenchymal thickness (1.6%). This is in line with **Branch et al. (2019)**, who suggested that obesity leads to renal structural adaptations, including reduced parenchymal thickness, due to chronic inflammatory and fibrotic processes (20).

Increased cortical echogenicity often signifies early renal injury or fibrosis, as described. In contrast, decreased parenchymal thickness has been associated with chronic kidney disease progression, as noted by **Aziz et al. (2024)**. These structural changes may serve as early indicators of renal impairment, particularly in individuals with elevated BMI (21).

**Conclusions:**

Sonographic variables have demonstrated great promise in the early identification of renal impairment in persons with diabetes. Before symptoms manifest or laboratory data change dramatically, early alterations in kidney size, cortical echogenicity, and resistive indices can be identified using imaging techniques such Doppler ultrasonography and greyscale ultrasound.

**Limitations:**

The skill of operator greatly influence the ultrasound's outcomes. Diabetes nephropathy is not the only condition that can exhibit certain sonographic indicators, such as increased echogenicity. Difficult to detect the early stages of renal dysfunction. There is no universally accepted protocol for assessing sonographic markers in diabetic patients.

**Recommendations:**

Develop standardized guidelines for the use of sonographic markers in detecting renal dysfunction in diabetic adults. Include regular sonographic evaluations in the routine monitoring of diabetic patients to facilitate early detection and timely interventions.

**References:**

1.Alyami AS, Majrashi NA, Elbashir M, Ali S, Shubayr N, Ageeli W, et al. Normal sonographic measurements for kidney dimensions in Saudi adult population: A cross-sectional prospective study. 2024;103(24):e38607.

2.Ham YR, Lee EJ, Kim HR, Jeon JW, Na KR, Lee KW, et al. Ultrasound renal score to predict the renal disease prognosis in patients with diabetic kidney disease: an investigative study. 2023;13(3):515.

3.Rashed AO, Gameraddin M, Fadulelmulla IA, Khardali AH, Alhazmi SA, Daghriri SH, et al., editors. Sonographic Assessment of Renal Transplantation in Adult Saudi Patients: A Cross-Sectional Retrospective Study. Transplantation Proceedings; 2024: Elsevier.

4.Stevens LA, Levey ASJMC. Measurement of kidney function. 2005;89(3):457-73.

5.Lopez-Giacoman S, Madero MJWjon. Biomarkers in chronic kidney disease, from kidney function to kidney damage. 2015;4(1):57.

6.Wilson A, Gambhir H, Aditya K, Wadhera A, Singla S, Das JJIJAMP. EVALUATION OF ROLE OF ULTRASOUND FOR SONOGRAPHIC GRADING OF RENAL CORTICAL ECHOGENICITY WITH RAISED SERUM CREATININE AND BLOOD UREA LEVELS IN PATIENTS WITH CHRONIC KIDNEY DISEASE. 2024;6(4):866-75.

7.Ohno YJEJR. Eur J Radiol. 2007;64:320.

8.Gooneratne I, Ranaweera A, Liyanarachchi N, Gunawardane N, Lanerolle RJIjodidc. Epidemiology of chronic kidney disease in a Sri Lankan population. 2008;28(2):60.

9.Raju NK, Rao JM, Raju DJIJoR, Imaging D. Role of renal sonography in the diagnosis of chronic kidney disease. 2019;2(1):38-41.

10.Jabin P, Nasreen F, Hassan MM, Salma U, Konik TK, Purveen R, et al. Correlation of B-mode and Doppler Ultrasound Parameters of Kidney with Serum Creatinine Level in Chronic Kidney Disease Patients. 2024;27(1):62-8.

11.Uchenwa TA, Anochie IC, Okafor HU, Maduforo OCJWAJoR. Relationship between renal dimensions using ultrasonography and body mass index in apparently healthy school children in Port Harcourt, Nigeria. 2020;27(2):121-7.
12.Yang F, Jiang L, Ma Y, He Y, Xu Y, Yang R, et al. Quantitative assessment of early kidney injury using high frame rate contrast-enhanced ultrasonography in a rabbit model of diabetic nephropathy. 2024;26(1):7-14.
13.Moinuddin Z, Dhanda RJA, Medicine IC. Anatomy of the kidney and ureter. 2015;16(6):247-52.
14.Reddy GM, Reddy SSJIJRDI. Correlation renal cortical echogenicity with serum creatinine in patients with chronic kidney disease. 2020;3(3):99-102.
15.McPherson KC. The Progression of Chronic Kidney Disease in a Novel Animal Model of Obesity: The University of Mississippi Medical Center; 2017.
16.Rena XG, Wanga G. Obesity and Chronic Kidney Disease.
17.Pinhas-Hamiel O, Zeitler PS, Kelsey MM. Youth-onset type 2 diabetes. Pediatric Obesity: Etiology, Pathogenesis and Treatment. 2018:393-418.
18.Azizi M, El Jadi H, Zajjari Y, Sobhi A, Badaoui S, Alayoud A. Obesity Nephropathy: A Current Overview. Sch J App Med Sci. 2024;10:1328-33.
19.Poudel B, Ekperikpe US, Mandal S, Wilson GE, Shields CA, Cornelius DC, et al. Chronic treatment with IL-25 increases renal M2 macrophages and reduces renal injury in obese Dahl salt-sensitive rats during the prepubescent stage. American Journal of Physiology-Renal Physiology. 2023;325(1):F87-F98.
20.BRANCH-XIII MB. A STUDY ON eGFR, PROTEIN-CREATININE RATIO, THYROID AND LIPID PROFILE ON ASSESSING RISK FACTOR FOR RENAL DYSFUNCTION. 2019.
21.Aziz MT, Chowdhury MN, Hakim MA, Pramanik MSH, Hossain MS, Islam MS. Sonographically Determined Renal Size and Echogenicity as a Predictor of Chronic Irreversible Renal Parenchymal Disease in Glomerulonephritis Patients: Comparison with Histopathology. Archives of Internal Medicine Research. 2024;7(3):230-40