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Beyond Glycemic Control: A Multicenter Retrospective Cross-Sectional Study of Systolic Blood Pressure and Reduced Kidney Function in Pakistani Adults With Type 2 Diabetes

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Abstract

Background

Diabetic kidney disease is a leading cause of chronic kidney disease (CKD) worldwide but is under-recognized in primary care in low- and middle-income countries. We assessed the proportion of patients with type 2 diabetes (T2DM) attending five clinical sites in Punjab, Pakistan, who had reduced kidney function (estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 m²), and examined its statistical associations with systolic blood pressure and glycemic control.

Methods

In this multicenter retrospective cross-sectional study across five clinical sites (October 2025-April 2026), we reviewed records of 100 patients with T2DM. eGFR was calculated with the race-free Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) 2021 equation; reduced kidney function was defined as eGFR <60 mL/min/1.73 m². We used correlation analysis and an exploratory multivariable logistic regression including systolic blood pressure (SBP), glycated hemoglobin (HbA1c), age, diabetes duration, and sex.

Results

The mean age was 54.4 years (range 22-80); 46% were men. The mean hemoglobin A1C (HbA1C) was 9.3%, and 65% had HbA1c ⩾8.0%. The mean SBP was 144.8 mmHg, and 77% had SBP ⩾140 mmHg. eGFR <60 mL/min/1.73 m² was present in 36% (95% confidence interval (CI) 27.3-45.8%; G3a 9%, G3b 14%, G4 8%, G5 5%). No statistically significant correlation between HbA1c and eGFR was detected (r = −0.131, p = 0.19), whereas SBP (r = −0.586), age (r = −0.530), and diabetes duration (r = −0.424) were inversely correlated with eGFR (all p < 0.001). In the multivariable model, SBP was the only factor independently associated with eGFR <60 (odds ratio (OR) 2.83 per 10 mmHg, 95% CI 1.54-5.20; p < 0.001); no statistically significant association with HbA1c was detected (OR 0.85 per 1%, 95% CI 0.68-1.06). The SBP association was attenuated after additional adjustment for albuminuria (OR 2.04 per 10 mmHg, 95% CI 0.97-4.28). Dialysis had been recommended for all 13 patients with G4-G5 disease, but none were receiving regular dialysis.

Conclusions

In this multicenter clinical sample, SBP was independently associated with reduced kidney function; no statistically significant association between HbA1c and reduced eGFR was detected. Because the design is retrospective and cross-sectional and the analysis exploratory, causality cannot be inferred. Blood pressure control and routine eGFR and albuminuria testing deserve attention in resource-limited settings.

Categories: Internal Medicine, Nephrology, Endocrinology/Diabetes/Metabolism
Keywords: albuminuria, chronic kidney disease, diabetic kidney disease, glycated hemoglobin, outpatients, pakistan, systolic blood pressure, type 2 diabetes

Introduction

Pakistan carries one of the largest diabetes burdens in the world [1]. The second National Diabetes Survey of Pakistan (2016-2017) reported a weighted diabetes prevalence of 26.3%, of which 7.1% were newly diagnosed [2]. Globally, chronic kidney disease (CKD) affected an estimated 697.5 million people in 2017, and diabetic nephropathy accounted for almost a third of CKD disability-adjusted life-years; most of this burden falls in countries with lower sociodemographic index [3]. Diabetic kidney disease develops through interacting metabolic and hemodynamic pathways [4]. CKD attributable to type 2 diabetes is a large and growing problem across Asia [5]. The clinical picture is also changing: reduced estimated glomerular filtration rate (eGFR) without albuminuria has become more common among adults with diabetes [6]. Trial evidence supports both glycemic and blood pressure control. Intensive glucose lowering reduced

microvascular endpoints in UKPDS 33 [7], but in ACCORD, it delayed albuminuria without reducing advanced kidney outcomes [8]. Tight blood pressure control reduced microvascular endpoints by 37% in UKPDS 38 [9], and blood pressure lowering with perindopril-indapamide reduced major vascular events in ADVANCE [10]. ACCORD BP did not show further cardiovascular benefit from a systolic target below 120 mmHg [11]. By contrast, the more recent BPROAD trial in 12,821 patients with type 2 diabetes mellitus (T2DM) found that targeting systolic blood pressure (SBP) <120 mmHg reduced major cardiovascular events compared with <140 mmHg (hazard ratio 0.79) [12]. Current Kidney Disease: Improving Global Outcomes (KDIGO) guidance recommends assessing both eGFR and albuminuria and treating blood pressure as a core part of kidney protection in diabetes [13-15]. In Pakistan, the accuracy of creatinine-based eGFR equations has been questioned [16], and eGFR and urine albumin testing are not consistently used in primary care. Data on which modifiable factors are associated with reduced kidney function in this setting are limited.

This study had two aims. The primary aim was to determine whether SBP is associated with reduced eGFR (<60 mL/min/1.73 m^2), independently of glycemic control, age, diabetes duration, and sex, in adults with T2DM attending five clinical sites in Punjab, Pakistan. The secondary aim was to quantify the burden of kidney disease in this population, as the proportion of patients with reduced eGFR and the proportion with at least one CKD marker (reduced eGFR or albuminuria A2-A3).

Preliminary results of this study were presented as a poster abstract at the American Society of Nephrology (ASN) Kidney Week 2026, held in Denver, Colorado, USA, on October 21-25, 2026 (abstract number FR-PO0561) [17].

Materials And Methods

Design and setting

This was a multicenter retrospective cross-sectional study of records from five clinical sites in Punjab, Pakistan, covering October 2025 to April 2026: Sajjad Medical Clinic, Gujranwala; Saad Hospital & Cardiac Care Centre, Daska; and Kidney Care Center, Lahore Nephrology Clinic and Nisar Clinic, all in Lahore. Laboratory tests were performed at Aga Khan Laboratory and Chughtai Lab, Lahore. The study is reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for cross-sectional studies [18]. Preliminary results were presented as a poster at American Society of Nephrology (ASN) Kidney Week 2026, Denver, Colorado (abstract FR-PO0561).

Participants and record selection

Records were selected as a convenience sample: all available records of adults with T2DM who had complete laboratory and clinical data at the participating sites during the study period were included. Eligibility required a documented physician diagnosis of T2DM; glycated hemoglobin (HbA1c) was not used to include or exclude patients, and patients receiving glucose-lowering treatment were included regardless of current HbA1c. Patients with acute kidney injury (AKI) or acute illness at the time of testing were excluded. Duplicate records across sites were identified by matching patient name and national identity card (CNIC) number before data were anonymized; no duplicates were found. Data collection ended at the close of the study period (April 2026); no sample size was calculated in advance, and the sample comprised all eligible records available by that date.

Index visit and measurements

The index visit was the clinic visit at which blood pressure was recorded, and laboratory tests were ordered; results were reviewed at a follow-up visit, usually within one week. Most patients had a single set of results; where more than one was available, the results ordered at the index visit were used. Data extracted were age, sex, HbA1c, serum creatinine, systolic and diastolic blood pressure, diabetes duration (from medical records or, where unavailable, patient report), and albuminuria category. Blood pressure was the single clinic reading recorded in the patient's file at the index visit. Blood pressure was measured by clinic staff using the standard clinical method, with the patient seated after a period of rest, using a standard sphygmomanometer with an appropriately sized cuff on the upper arm. Serum creatinine was reported in mg/dL by the performing laboratory; the assay method and its traceability to isotope dilution mass spectrometry (IDMS) were not documented on the reports. eGFR was calculated with the race-free Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) 2021 creatinine equation [19] and staged G1-G5 according to KDIGO [13]. Albuminuria was classified as A1, A2, or A3 [13] from the spot urine albumin-to-creatinine ratio (UACR) reported by the laboratory, using cut-offs of <30, 30-300, and >300 mg/g. AKI or acute illness was identified by the treating physician from clinical notes (for example, acute infection, vomiting or diarrhea, or hospital admission) and, where an earlier result was available, a marked rise in serum creatinine; no formal definition was applied. For patients with G4-G5 disease, whether dialysis had been recommended, dialysis status and the reasons for not starting or continuing dialysis recorded in the treating physicians' notes were also extracted.

Definitions

The primary outcome was reduced kidney function, defined as eGFR <60 mL/min/1.73 m^2 on the available

measurement. Because a single measurement cannot confirm chronicity, we use "reduced eGFR" for this outcome. We separately report the proportion with eGFR <60 mL/min/1.73 m² or albuminuria A2-A3 at KDIGO thresholds, referred to as "CKD markers"; persistence beyond three months could not be confirmed. Suboptimal glycemic control was defined as HbA1c ⩾8.0%, and systolic hypertension as SBP ⩾140 mmHg.

Statistical analysis

Continuous variables are summarized as mean ± standard deviation (SD) or median (interquartile range, IQR). Approximately normally distributed variables (age, HbA1c, SBP, diastolic blood pressure) were compared between patients with and without reduced eGFR using Welch's t-test, and skewed variables (diabetes duration, creatinine) using the Mann-Whitney U test; categorical variables were compared using the chi-square test. Proportions are reported with Wilson 95% confidence intervals (CI). Pearson correlation was used for continuous variables (HbA1c, SBP, age, diabetes duration), with Spearman correlation as a sensitivity check. Because albuminuria was available only as an ordinal category (A1-A3), its association with eGFR was assessed with Spearman correlation, and the trend in the proportion with eGFR <60 across categories with the Cochran-Armitage test. Covariates for the primary multivariable logistic regression model (outcome eGFR <60) were chosen a priori on clinical grounds: SBP (primary exposure), HbA1c (comparator exposure), age, diabetes duration, and sex. With 36 events (about seven per variable), the analysis is exploratory. Odds ratios (ORs) are reported per clinically interpretable unit (10 mmHg SBP, 1% HbA1c, 10 years of age, five years of diabetes duration) and, for SBP, per 1-SD increase. The three-variable model (SBP, age, and diabetes duration) presented in the conference abstract [17] is reported as a secondary model. Albuminuria was not included in the primary model because it is a concurrent manifestation of kidney disease measured at the same visit; with cross-sectional data, its temporal relation to SBP and eGFR cannot be determined, and adjusting for it may remove part of the association of interest. A sensitivity model additionally including albuminuria (A3 vs. A1-A2) and a sensitivity analysis excluding the 12 patients with HbA1c <6.5% are reported. The linearity of continuous covariates on the log-odds scale was assessed with quadratic terms and the Box-Tidwell test; collinearity was assessed with the variance inflation factor (VIF). Model fit is reported as Nagelkerke R^2, and discrimination as apparent area under the receiver operating characteristic curve (AUC) with bootstrap optimism correction (1,000 resamples). A two-sided $p < 0.05$ was considered statistically significant. Analyses were performed in Python 3.13.18 using pandas 3.0.5, NumPy 2.5.3, SciPy 1.18.1, statsmodels 0.15.0, and scikit-learn 1.9.1.

Ethics

The study used anonymized routinely collected records and followed the principles of the Declaration of Helsinki. The study was reviewed by the Ethical Review Committee of Saad Hospital & Cardiac Care Centre, Daska, which determined it to be exempt from full ethical review and waived the requirement for individual informed consent (reference SH-2025-145, dated 25 September 2025), before data collection began.

Results

Study population

Screened records were not formally logged; an estimated 160 records were assessed, of which approximately 58 were excluded because of incomplete data, AKI, or acute illness at the time of testing (numbers for each reason were not recorded). Of the 102 records with complete data, two were excluded because review of the clinical file showed no documented diagnosis of T2DM and no glucose-lowering treatment; these two records had been included in error. This left 100 patients for analysis: 56 from Saad Hospital & Cardiac Care Centre, 33 from Sajjad Medical Clinic, and 11 from the three Lahore clinics combined. There were 54 women and 46 men. The mean age was 54.4 ± 13.6 years (range 22-80), and the median diabetes duration was 10.0 years (IQR 6.0-16.2). The mean HbA1c was 9.3 ± 2.5%; 65 patients (65%; 95% CI 55.3-73.6%) had HbA1c ⩾8.0%. The mean SBP was 144.8 ± 13.5 mmHg; 77 patients (77%; 95% CI 67.8-84.2%) had SBP ⩾140 mmHg. Table *1* compares the demographic, clinical, and laboratory characteristics between patients with eGFR <60 and ⩾60 mL/min/1.73 m².

Characteristic	eGFR <60 (n = 36)	SD, IQR or %	eGFR >=60 (n = 64)	SD, IQR or %	Test	Test statistic	p
Age, years (mean, SD)	61.0	8.1	50.6	14.6	Welch's t	4.56	<0.001
Male sex (n, %)	19	52.8	27	42.2	Chi-square	0.66	0.42
HbA1c, % (mean, SD)	9.4	2.3	9.2	2.6	Welch's t	0.49	0.63
HbA1c >=8.0% (n, %)	25	69.4	40	62.5	Chi-square	0.23	0.63
SBP, mmHg (mean, SD)	153.9	9.0	139.7	13.0	Welch's t	6.42	<0.001
SBP >=140 mmHg (n, %)	34	94.4	43	67.2	Chi-square	8.19	0.004
DBP, mmHg (mean, SD)	89.7	1.7	86.6	6.9	Welch's t	3.40	0.001
Diabetes duration, years (median, IQR)	15.0	10.0-20.0	8.0	5.0-15.0	Mann-Whitney U	1,688.5	<0.001
Creatinine, mg/dL (median, IQR)	1.8	1.5-2.5	0.8	0.7-1.0	Mann-Whitney U	2,293.5	<0.001
Albuminuria A1 (n, %)	0	0.0	22	34.4	Chi-square	53.30	<0.001
Albuminuria A2 (n, %)	9	25.0	38	59.4	Chi-square	53.30	<0.001
Albuminuria A3 (n, %)	27	75.0	4	6.3	Chi-square	53.30	<0.001

TABLE 1: Characteristics of patients by kidney function

Age, HbA1c, SBP and DBP were compared by Welch's t-test; diabetes duration and creatinine by the Mann–Whitney U test; categorical variables by the chi-square test (with Yates' correction for 2×2 tables; a single 3×2 test for albuminuria A1–A3).

eGFR: estimated glomerular filtration rate; HbA1c: glycated hemoglobin; SBP: systolic blood pressure; DBP: diastolic blood pressure; SD: standard deviation; IQR: interquartile range; A1–A3: Kidney Disease: Improving Global Outcomes (KDIGO) albuminuria categories (urine albumin-to-creatinine ratio <30, 30–300, and >300 mg/g)

Kidney function and albuminuria

The mean eGFR was 73.3 ± 33.2 mL/min/1.73 m². The median eGFR was 35.5 mL/min/1.73 m² (IQR 27.9-44.2) in patients with eGFR <60 and 94.6 mL/min/1.73 m² (IQR 81.3-108.6) in those with eGFR ⩾60. Thirty-six patients (36%; 95% CI 27.3-45.8%) had eGFR <60 mL/min/1.73 m²: G3a 9%, G3b 14%, G4 8%, and G5 5%. Albuminuria was A1 in 22%, A2 in 47%, and A3 in 31%. The proportion with eGFR <60 was higher across albuminuria categories: 0/22 (0%; 95% CI 0.0-14.9%) in A1, 9/47 (19.1%; 95% CI 10.4-32.5%) in A2, and 27/31 (87.1%; 95% CI 71.1-94.9%) in A3 (p for trend <0.001). Seventy-eight patients (78%; 95% CI 68.9-85.0%) had at least one CKD marker (eGFR <60 or albuminuria A2-A3) at KDIGO thresholds on a single measurement. Dialysis had been recommended for all 13 patients (13%; 95% CI 7.8-21.0%) with G4-G5 disease; none was receiving regular dialysis at the time of the study. Reasons recorded in the treating physicians' notes included cost (about 5,000 Pakistani rupees per session), limited availability of dialysis facilities, and limited understanding of the need for continued treatment despite counselling; the number of patients with each reason was not recorded. Figure *1* shows the distribution of patients across the KDIGO GFR and albuminuria categories, shaded by prognostic risk.

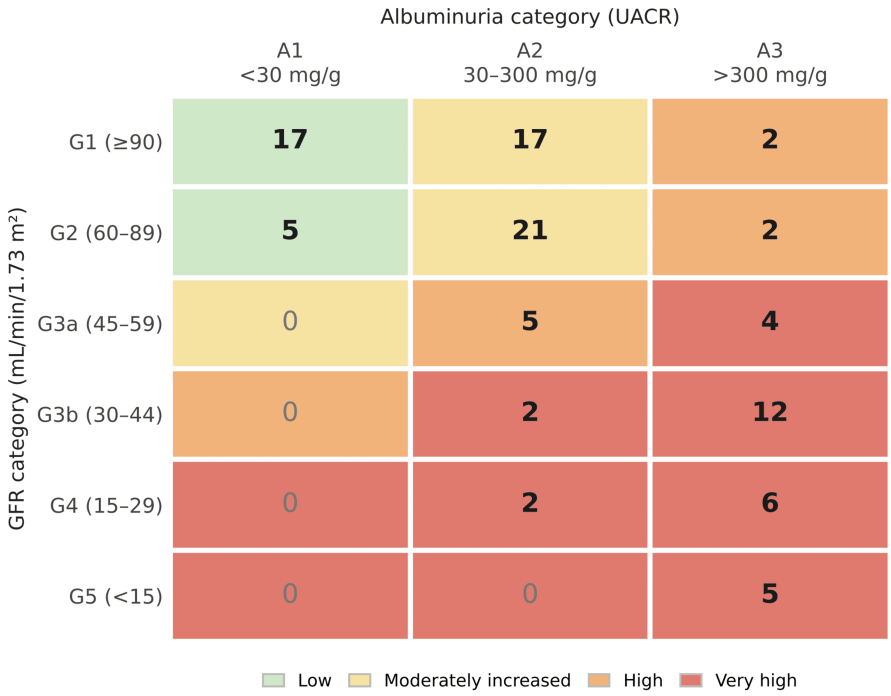


FIGURE 1: Distribution of patients by glomerular filtration rate and albuminuria categories

Numbers are patient counts (n = 100). Cell shading shows KDIGO prognostic risk: low, moderately increased, high and very high. Categories are based on a single available eGFR and UACR measurement per patient; persistence for more than three months was not confirmed, so cells indicate KDIGO risk categories at one time point, not confirmed chronic kidney disease. Seventy-eight patients (78%) fall outside the low-risk cells.

KDIGO: Kidney Disease: Improving Global Outcomes; GFR: glomerular filtration rate; UACR: urine albumin-to-creatinine ratio; eGFR: estimated glomerular filtration rate; G1–G5: KDIGO GFR categories (mL/min/1.73 m²); A1–A3: KDIGO albuminuria categories

Correlates of eGFR

No statistically significant correlation between HbA1c and eGFR was detected ($r = -0.131$, $p = 0.19$). SBP, age, and diabetes duration were each inversely correlated with eGFR, as was albuminuria category (Spearman $\rho = -0.679$, $p < 0.001$). Spearman coefficients for the continuous variables gave the same pattern. Table *2* lists the Pearson and Spearman correlation coefficients of each clinical variable with eGFR.

Variable	Pearson r	t (98 df)	p	Spearman rho	p
Systolic blood pressure	-0.586	-7.17	<0.001	-0.579	<0.001
Age	-0.530	-6.18	<0.001	-0.555	<0.001
Diabetes duration	-0.424	-4.63	<0.001	-0.451	<0.001
Diastolic blood pressure	-0.366	-3.90	<0.001	-0.356	<0.001
HbA1c	-0.131	-1.31	0.19	-0.173	0.09

TABLE 2: Correlation of clinical variables with estimated glomerular filtration rate

Pearson correlation was tested with the t-test for r (98 degrees of freedom); Spearman rank correlation was used as a sensitivity check.

eGFR: estimated glomerular filtration rate; HbA1c: glycated hemoglobin; df: degrees of freedom; r: Pearson correlation coefficient; t: test statistic for Pearson r; rho: Spearman rank correlation coefficient

Figure 2 plots each patient's systolic blood pressure against eGFR, with the fitted regression line.

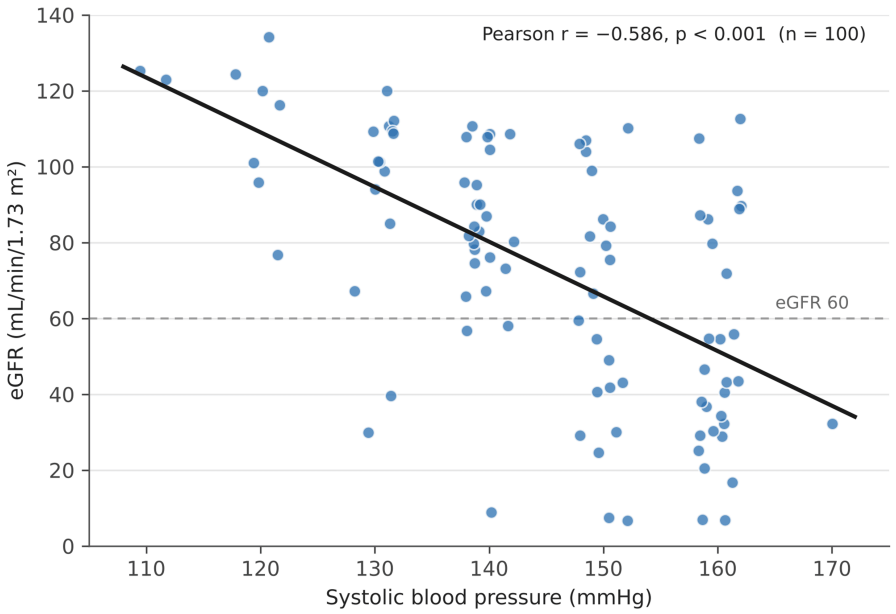


FIGURE 2: Systolic blood pressure and estimated glomerular filtration rate

Each point is one patient (n = 100). Small horizontal jitter (±2 mmHg) has been added because blood pressure was recorded in 10-mmHg steps; the correlation coefficient and regression line were calculated from the original, unjittered values. The solid line is the least-squares regression line (Pearson r = −0.586, p < 0.001); the dashed line marks eGFR 60 mL/min/1.73 m².

eGFR: estimated glomerular filtration rate; r: Pearson correlation coefficient

Multivariable analysis

In the univariable analysis, SBP, age, and diabetes duration were each associated with eGFR <60. In the primary model, SBP was the only factor independently associated with eGFR <60 (OR 2.83 per 10 mmHg, 95% CI 1.54-5.20; p < 0.001; OR 4.05 per 1-SD increase, 95% CI 1.79-9.18). No statistically significant association was detected for HbA1c (OR 0.85 per 1%, 95% CI 0.68-1.06; p = 0.15), age (OR 1.38 per 10 years, 95% CI 0.82-2.33; p = 0.22), diabetes duration (OR 1.20 per five years, 95% CI 0.75-1.90; p = 0.45) or male sex (OR 1.42, 95% CI 0.51-3.98; p = 0.50). The model had Nagelkerke $R^2 = 0.42$ and apparent AUC = 0.84 (optimism-corrected 0.80); VIFs were ⩽2.4, and no significant departure from linearity was detected (all p ⩾ 0.09; borderline for age). In the secondary three-variable model presented in the conference abstract, the SBP association was similar (OR 2.66 per 10 mmHg, 95% CI 1.52-4.66; OR 3.73 per 1-SD increase, 95% CI 1.75-7.92). After excluding the 12 patients with HbA1c <6.5% (n = 88; 35 events), SBP remained independently associated with eGFR <60 (OR 2.86 per 10 mmHg, 95% CI 1.52-5.37). In a sensitivity model additionally adjusted for albuminuria A3, the association of SBP with eGFR <60 was attenuated (OR 2.04 per 10 mmHg, 95% CI 0.97-4.28; p = 0.06), and HbA1c was inversely associated (OR 0.60 per 1%, 95% CI 0.41-0.88). This model was unstable (OR for albuminuria A3 101.7, 95% CI 12.4-832.3; about six events per variable) and is interpreted with caution. Table 3 presents the univariable odds ratios, and Table 4 shows the primary multivariable model for eGFR <60 mL/min/1.73 m^2.

Variable	OR	95% CI lower	95% CI upper	Wald z	p
Systolic blood pressure (per 10 mmHg)	3.13	1.90	5.15	4.49	<0.001
HbA1c (per 1%)	1.04	0.88	1.23	0.47	0.64
Age (per 10 years)	1.99	1.34	2.93	3.45	<0.001
Diabetes duration (per five years)	1.88	1.32	2.67	3.51	<0.001
Male sex	1.53	0.67	3.48	1.02	0.31

TABLE 3: Univariable logistic regression for estimated glomerular filtration rate below 60 mL/min/1.73 m2

Each variable was entered alone in a logistic regression model with eGFR <60 mL/min/1.73 m² as the outcome; p-values are from the Wald test.

eGFR: estimated glomerular filtration rate; HbA1c: glycated hemoglobin; OR: odds ratio; CI: confidence interval; z: Wald test statistic

Variable	OR	95% CI lower	95% CI upper	Wald z	p
Systolic blood pressure (per 10 mmHg)	2.83	1.54	5.20	3.36	<0.001
HbA1c (per 1%)	0.85	0.68	1.06	-1.45	0.15
Age (per 10 years)	1.38	0.82	2.33	1.22	0.22
Diabetes duration (per five years)	1.20	0.75	1.90	0.76	0.45
Male sex	1.42	0.51	3.98	0.67	0.50

TABLE 4: Multivariable logistic regression for estimated glomerular filtration rate below 60 mL/min/1.73 m2 (primary model)

All five variables were entered together in one logistic regression model with eGFR <60 mL/min/1.73 m^2 as the outcome; p-values are from the Wald test. Nagelkerke R^2 = 0.42; apparent AUC = 0.84 (optimism-corrected 0.80). Per 1-SD increase in systolic blood pressure, OR was 4.05 (95% CI 1.79-9.18).

eGFR: estimated glomerular filtration rate; HbA1c: glycated hemoglobin; OR: odds ratio; CI: confidence interval; z: Wald test statistic; AUC: area under the receiver operating characteristic curve; SD: standard deviation

Discussion

One in three patients with diabetes in these clinics had reduced kidney function at the time of testing, and none of the 13 with advanced disease were receiving regular dialysis. In this multicenter clinical sample from Punjab, Pakistan, 36% (95% CI 27.3-45.8%) of patients with T2DM had eGFR <60 mL/min/1.73 m², and more than three-quarters had at least one CKD marker once albuminuria was considered. In the primary model, SBP was the only factor independently associated with reduced eGFR. No statistically significant association between HbA1c and reduced eGFR was detected in this sample; the confidence interval does not exclude a modest association. The SBP association persisted after excluding patients with HbA1c <6.5% but was attenuated after additional adjustment for albuminuria. Selection bias and residual confounding should be considered when interpreting this association.

Blood pressure and glycemia

Our results are consistent with trial evidence that blood pressure is a major modifiable determinant of microvascular outcomes in T2DM [9,10], with recent evidence supporting lower systolic targets in T2DM [12], and with the changing presentation of diabetic kidney disease toward reduced eGFR [6]. Across randomized trials, intensive glucose control reduced microalbuminuria and macroalbuminuria but did not significantly reduce doubling of serum creatinine, end-stage kidney disease, or death from kidney disease [20]. A single HbA1c value may also be a poor marker of long-term glycemic exposure in CKD, because anemia, shortened red-cell survival and treatment changes alter HbA1c [21]. The absence of a statistically significant association with HbA1c should therefore not be read as evidence that glucose control is unimportant.

Reverse causation

Reduced kidney function itself raises blood pressure through sodium retention and activation of the renin-angiotensin system. With one time point, we cannot tell whether high SBP preceded lower kidney function or followed it; a bidirectional relationship is plausible. The association remains relevant to practice, because KDIGO recommends blood pressure control for kidney protection in diabetes [14,15].

Albuminuria and screening

The proportion with lower eGFR was higher across albuminuria categories A1 to A3, and the attenuation of the SBP association after adjustment for albuminuria suggests that SBP, albuminuria, and reduced eGFR are closely interrelated in this sample; the data cannot separate their order. Forty-two patients had albuminuria A2-A3 despite eGFR ≥60 mL/min/1.73 m^2, illustrating the additional abnormalities identified through albuminuria testing. eGFR equations may also perform differently in South Asians [16,22]. Reporting eGFR together with albuminuria in primary care laboratories, as KDIGO recommends, could identify additional patients with abnormal results [13].

Access to kidney replacement therapy

Dialysis had been recommended for all 13 patients with G4-G5 disease, but none was receiving regular dialysis. The reasons recorded in the treating physicians' notes were cost, limited availability, and limited understanding of the need for continued treatment despite counselling; their frequency was not quantified. These observations are consistent with reports of high out-of-pocket dialysis costs in Pakistan [23] and very low national dialysis and transplant rates [24]. Underuse of renin-angiotensin system blockers in Pakistani patients with diabetic nephropathy has also been reported [25].

Strengths and limitations

Strengths include data from five sites, the race-free CKD-EPI 2021 equation, complete albuminuria data, a clinically specified primary model, and consistent results across several sensitivity analyses. The main limitations concern design: the study is retrospective, cross-sectional, and exploratory (36 events, about seven per variable, with no sample size calculated in advance), so it cannot establish causality, and we did not formally test whether the associations of SBP and HbA1c with reduced eGFR differ. Measurement was limited: kidney function and albuminuria were each measured once, so chronicity could not be confirmed; AKI was excluded by clinical judgement rather than formal KDIGO criteria; laboratory results followed blood pressure by up to about one week; blood pressure was a single reading, mostly recorded in 10-mmHg steps; and the creatinine assay method and its IDMS traceability were not documented. Selection may have biased the estimates: the number of records screened was estimated; the sample was a convenience sample requiring complete data, which may have favored patients already suspected of kidney disease; site identifiers were not linked to individual records, so eGFR and case mix could not be compared between sites (56, 33, and 11 patients came from Saad Hospital & Cardiac Care Centre, Sajjad Medical Clinic and the three Lahore clinics, which include specialist kidney clinics); all sites were in one province; and confidence intervals reflect sampling uncertainty only. Finally, data on medications (including renin-angiotensin system blockers and sodium-glucose cotransporter 2 (SGLT2) inhibitors), body mass index, lipids, and smoking were unavailable, so residual confounding is likely; reasons for not receiving dialysis were not quantified; and no kidney biopsies were performed, so non-diabetic kidney disease, which can coexist with T2DM [26,27], cannot be excluded.

Conclusions

Reduced kidney function was common among adults with T2DM attending these clinics and was more closely related to systolic blood pressure than to glycemic control. Given the retrospective, cross-sectional, exploratory design, these findings are hypothesis-generating. Routine eGFR and albuminuria testing, together with attention to blood pressure control, should be evaluated in diabetes care in resource-limited settings. Prospective studies with repeated measurements and treatment data are needed to confirm these findings.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Mobeen Sajjad

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Drafting of the manuscript: Mobeen Sajjad

Critical review of the manuscript for important intellectual content: Mobeen Sajjad, Sammeullah Mirza, Ahsan Sajjad, Rida Amer

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Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Ethical Review Committee of Saad Hospital & Cardiac Care Centre, Daska, Punjab, Pakistan issued approval SH-2025-145. The committee determined the study to be exempt from full ethical review and waived the requirement for individual informed consent, as the study used anonymized, routinely collected records. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **AI use statement:** The authors used Claude(anthropic) as follows: language polishing in Language editing throughout the manuscript. The author reviewed the language edits against the original text to ensure that scientific meaning, numerical results, and references were preserved. The authors confirm that they have reviewed and verified all AI-assisted content and take full responsibility for the work. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Associate Editor authorship:** Mobeen Sajjad was an Associate Editor for the Cureus Journal of Medical Science at the time of submission. To minimize potential bias, this manuscript was handled independently by an alternate Associate Editor with no conflict of interest, and the author was blinded to and had no access to the peer review process, reviewer identities, or editorial decision-making for this submission. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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