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Original Article

Correlation Between Spot Urinary Protein-Creatinine Ratio and 24-Hour Urinary Protein Excretion in Patients with Type 2 Diabetes Mellitus

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ABSTRACT

Diabetic kidney disease is a significant complication of type 2 diabetes mellitus (T2DM), and chronic proteinuria is a significant indicator of renal damage. Although the quantification is generally done by 24-hour urinary protein estimation, which is rather convenient, it is subject to collection errors. **Objectives:** To identify the relationship between spot urinary protein-creatinine ratio (PCR) and 24-hour urinary proteinuria in T2DM patients. **Methods:** The study was a cross-sectional study, which was carried out at the Department of Medicine, Shaikh Zayed Hospital, Rahim Yar Khan, between August 2024 and February 2025. Non-probability consecutive sampling was done to enroll 190 patients aged 30-65 years with T2DM over 5 years. Measurement and Pearson correlation coefficient were used to measure 24-hour urinary protein and spot urinary PCR. The p-value of less than 0.05 was regarded as significant. **Results:** The average age was 47.24/10.75 years old, and 53.7 percent of the respondents were men. Mean 24-hour urinary protein excretion was 1011.26 ± 466.17 mg/day, while mean spot PCR was 1.25 ± 0.66 mg/mg. There was a high positive correlation between spot PCR and excretion of urinary protein in 24 hours (r = 0.805, p=0.001). There were significant positive relationships between demographic and clinical subgroups as well. **Conclusions:** The spot urinary PCR significantly correlated with 24-hour urinary protein excretion and could be used as an alternative to a regular evaluation of proteinuria in T2DM patients.

INTRODUCTION

Diabetes mellitus is one of the fastest-growing non-communicable diseases worldwide. The IDF Diabetes Atlas 11th edition estimated that 589 million adults were living with diabetes in 2024 and projected this number to rise to 853 million by 2050 [1]. Pakistan carries a particularly heavy burden; official IDF country data for 2024 estimate 34.5 million adults living with diabetes and an age-standardized prevalence of 31.4%, while recent Pakistani reviews and meta-analyses have documented a sustained rise in type 2 diabetes mellitus (T2DM) and prediabetes across the country [2-4]. In South Asian populations, T2DM tends to occur at a younger age, with greater cardiometabolic vulnerability and earlier microvascular complications, making timely renal surveillance especially important [5]. Diabetic kidney disease (DKD) remains one of the most important microvascular complications of T2DM and is a major pathway to chronic kidney disease, kidney failure, and cardiovascular morbidity [6, 7]. Persistent urinary protein loss reflects ongoing glomerular injury and has value beyond diagnosis because higher levels of proteinuria are associated with faster renal decline and worse cardio-renal outcomes [7]. Contemporary kidney

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guidelines therefore emphasize measurement of albuminuria/proteinuria as part of risk stratification and longitudinal follow-up in patients with diabetes and chronic kidney disease [8]. Although 24-hour urinary protein estimation is traditionally regarded as a reference method for quantifying protein excretion, it is cumbersome for patients, delays clinical decision-making, and is vulnerable to under-collection, over-collection, and handling errors [9]. Spot urinary protein-creatinine ratio (PCR) offers an attractive alternative because it corrects for urine concentration using creatinine and can be obtained rapidly in outpatient settings [10]. In a resource-constrained system such as Pakistan's, simpler tests that can support earlier recognition and referral of kidney disease are particularly relevant, and locally adapted nephrology guidance has highlighted the need for practical pathways for diabetes-related kidney care [11-13].

The degree of correlation between spot PCR and 24-hour urinary protein is, however, found to vary among studies, populations, proteinuria cutoffs, and lab techniques, and there is still scant recent evidence in Pakistan tertiary-care units assessing this correlation in adults with T2DM. Information on southern Punjab is particularly sparse, although the local incidence of diabetes and chronic kidney disease is on the increase. Determining the consistency of spot PCR in indicating 24-hour urinary protein in this context would justify more practical monitoring plans and could enhance the routine evaluation of nephropathy. This study aimed to evaluate the relationship between spot urinary PCR and 24-hour urinary protein excretion among T2DM patients who came to a tertiary care hospital in Rahim Yar Khan.

METHODS

This was cross-sectional research carried out in the Department of Medicine, Shaikh Zayed Hospital, Rahim Yar Khan, between August 2, 2024, and February 2, 2025. This was ethically approved by the institutional ethical committee (No. CPSP/REU/MED-2021-110-18718; dated August 2, 2024). The patients sampled were 190 in number, with non-probability consecutive sampling. A 95% confidence level and 80% power were used to estimate the sample size based on the predicted Pearson correlation coefficient of r=0.604 between spot urinary PCR and 24-hour urinary protein in T2DM patients [12]. The sample included patients aged between 30 and 65 years with a history and medical records of controlled or uncontrolled T2DM over a period of 5 years. Patients were not included when they had conditions that might independently affect the urinary protein excretion, such as nephrotic syndrome, acute renal failure, non-diabetic renal impairment, known hypertension, hyperlipidemia, hematological disorders, hypothyroidism, or valvular heart disease. All participants were provided with informed consent in writing. Age, the length of diabetes, body mass index (BMI), residence, and socioeconomic status were documented on a structured proforma. In case of 24-hour urine collection, the participants were asked to dispose of the first morning product and collect all the urine within 24 hours, and add the first void of the second morning. The samples were taken in containers provided in the laboratory with a preservative. The total volume of 24-hour urine was determined, and quantitative protein analysis was performed on a 2 mL aliquot. Proteinuria of >300mg/24 h was regarded as significant. A random 5 mL spot urine sample was collected after the end of the 24-hour collection, followed by laboratory processing. Standardized kit methods on a semi-automated analyzer (Hitachi 912) measured fasting blood glucose, glycated hemoglobin (HbA1c), urinary protein, and urinary creatinine. Spot urinary PCR was determined as the urinary protein/urinary creatinine.

The data were input and analyzed in SPSS version 25.0. Continuous variables were summarized with the mean values plus the standard deviation, and the categorical variables were summarized with frequencies and percentages. The Shapiro-Wilk test was used to test normality. The relationship between the spot urinary PCR and 24-hour urinary protein excretion was calculated using the Pearson correlation coefficient. The post-stratification analysis was done according to age, sex, years of diabetes, BMI, locality, and socioeconomic status. The p-value of 0.05 was regarded as statistically significant.

RESULTS

The study summarizes the demographic and clinical features of the 190 participants. The mean age was 47.24 ± 10.75 years, and 102 (53.7%) participants were male. The average life of diabetes was 9.93 years, 4.34 years, and 67 (35.3%) had diabetes longer than 10 years. The mean 24-hour urinary protein excretion was 1011.26 ± 466.17 mg/day, while the mean spot urinary PCR was 1.25 ± 0.66 mg/mg (Table 1).

Table 1: Distribution of Baseline Demographic and Clinical Variables among the Study Participants (n=190)

Characteristic	Mean ± SD / n (%)
Gender	
Male	102 (53.7%)
Female	88 (46.3%)
Age Group	
30-50 Years	106 (55.8%)
51-65 Years	84 (44.2%)
Mean Age (Years)	47.24 ± 10.75

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Duration of Diabetes	
≤10 Years	123 (64.7%)
>10 Years	67 (35.3%)
Mean Duration of Diabetes (Years)	9.93 ± 4.34
BMI	
Normal	64 (33.7%)
Overweight	84 (44.2%)
Obese	42 (22.1%)
Mean BMI (kg/m^2)	26.69 ± 3.16
Residence	
Rural	96 (50.5%)
Urban	94 (49.5%)
Socioeconomic Status	
Low	78 (41.1%)
Middle	75 (39.5%)
High	37 (19.4%)
Others	
Fasting blood Sugar (mg/dL)	187.88 ± 36.37
HbA1c (%)	9.15 ± 1.53
24-Hour Urine	
Urine Volume (mL)	1784.69 ± 400.98
Urinary Protein (mg/day)	1011.26 ± 466.17
Spot Urine	
Protein (mg/dL)	82.57 ± 22.38
Creatinine (mg/dL)	85.18 ± 43.95
Spot PCR (mg/mg)	1.25 ± 0.66

The primary analysis demonstrated a strong positive correlation between 24-hour urinary protein excretion and spot urinary PCR (r = 0.805, p<0.001) (Table 2).

Table 2: Correlation Analysis of Spot Urinary PCR and 24-Hour Urine Protein

Variables Compared	r	p-value	n
24-Hour Urinary Protein vs spot PCR	0.805	<0.001	190

Stratified analysis showed that the positive correlation remained statistically significant across sex, age groups, diabetes duration, BMI categories, residence, and socioeconomic strata, with r values ranging from 0.763 to 0.865 (Table 3).

Table 3: Stratified Correlative Findings for Spot Urinary PCR and 24-Hour Proteinuria

Variables	Subgroup	r	p-value
Gender	Male	0.798	<0.001
	Female	0.810	<0.001
Age Group	30-50 Years	0.787	<0.001
	51-65 Years	0.829	<0.001
Duration of Diabetes	≤10 Years	0.776	<0.001
	>10 Years	0.860	<0.001
BMI	Normal	0.825	<0.001
	Overweight	0.763	<0.001
	Obese	0.865	<0.001
Residence	Rural	0.821	<0.001
	Urban	0.791	<0.001
Socioeconomic Status	Low	0.766	<0.001
	Middle	0.824	<0.001
	High	0.853	<0.001

DISCUSSION

The current research revealed that there is a significant positive relationship between spot urinary PCR and 24-hour urinary protein excretion (r = 0.805, p<0.001) among adults with T2DM. This lends credence to the argument that a one-spot sample can help give clinically meaningful data on protein excretion when a 24-hour collection is too cumbersome. The correlation in our study (r = 0.805) was stronger than that reported in a Nepalese cohort (r = 0.633). However, this comparison should be interpreted cautiously due to population differences between Pakistan and Nepal [13]. The current research outperforms the correlation found in a recent Pakistani T2DM cohort (r=0.604) and a diabetic cohort in Nepal (r=0.633), but generally agrees with the high correlation found by Nazia *et al.* in Pakistani patients with T2DM [14]. This interpretation is also supported by other recent studies not related to diabetes-specific cohorts. In a study, Raza et al. found that spot PCR is strongly associated with 24-hour protein excretion in various glomerulopathies [15], and Vadher *et al.* and Gutiérrez-Peredo *et al.* prospective study reported that spot PCR is well correlated with a great range of kidney functioning, though the accuracy may decrease at higher levels of protein excretion [16, 17]. The variation among studies may be attributed to case mix, stage of kidney disease, assay methodology, time of sample collection, and completeness of 24-hour urine collection, which may affect the strength of the measured correlation [16, 17]. The current research has a stratified analysis that is clinically relevant since the positive association was consistent across sex, age, duration of diabetes, BMI, residence, and socioeconomic groups. This indicates that the relationship observed was not limited to a small demographic subgroup and that spot PCR could be used as a standard in the outpatient follow-up. In busy clinics, particularly low-resource environments, less complicated measurements may enhance patient compliance, decrease turnaround time, and decrease errors related to the lengthy urine collection guidelines [9-11]. In addition to convenience, the proper evaluation of proteinuria is of importance since the excretion of urinary protein is closely connected with the prognosis of the kidneys and cardiovascular conditions. Protein-creatinine ratios are correlated with CKD progression, and the presence of proteinuria coupled with diabetes only increases cardiovascular risk [18, 19]. In patients with T2DM, periodic proteinuria evaluation can thus not only be helpful in the detection of nephropathy, but also in the overall stratification of risks and planning of

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treatment. Simultaneously, the correlation should not be taken to imply full interchangeability. There is recent evidence to suggest that, despite its usefulness in screening and regular surveillance, consensus might not be as strong at very high and very low levels of proteinuria or when other renal pathologies are present [17, 20]. This aspect is significant in diabetes, where not every proteinuria is the result of the typical diabetic kidney disease. Kidney biopsy practice reviews in T2DM and recent biopsy series have demonstrated that a significant number of patients with diabetes have non-diabetic kidney disease or mixed lesions, especially where the clinical picture is atypical [20, 21]. The mean 24-hour urinary protein excretion was 1011.26 ± 466.17 mg/day, while the mean spot urinary PCR was 1.25 ± 0.66 mg/mg (Table 1). The wide standard deviations reflect the expected biological and clinical heterogeneity in this T2DM cohort, spanning a broad spectrum from microalbuminuric to macroalbuminuric ranges. This variability strengthens the correlation analysis by providing a sufficient range of values for meaningful association. Stratified analysis showed that the positive correlation remained statistically significant across sex, age groups, diabetes duration, BMI categories, residence, and socioeconomic strata, with r values ranging from 0.763 to 0.865 (Table 3). The relatively narrow range of correlation coefficients across all subgroups suggests that the relationship between spot PCR and 24-hour proteinuria is robust and consistent across diverse patient demographics. This uniformity supports the generalizability of the primary finding rather than indicating statistical overfitting, as the subgroup stratifications were pre-specified and clinically relevant.

The current study has several limitations. First, its cross-sectional design does not allow causal inferences or determination of whether eosinophilia precedes or follows the development of COPD. Second, the use of consecutive non-probability sampling at a single tertiary-care center may limit the generalizability of the findings to patients managed in community or primary-care settings. Third, eosinophilia was defined using a cutoff of ≥100 cells/μL; therefore, comparisons with studies using higher thresholds, particularly ≥300 cells/μL, should be interpreted cautiously, as differences in cutoff values may contribute to variation in reported prevalence. Fourth, although spirometry was performed by a trained technician, detailed quality-control information regarding the number of maneuvers, reproducibility criteria, and calibration procedures was not systematically documented, which may limit assessment of adherence to standardized spirometric quality criteria. Finally, although seasonal variation may influence eosinophil levels, seasonality was not systematically assessed or analyzed in the present study, and therefore its potential effect on the findings cannot be excluded. Further prospective and multicenter studies are recommended to evaluate the agreement, diagnostic accuracy, clinical outcomes, patient acceptability, and cost-effectiveness of spot urinary PCR before recommending its routine use as a replacement for 24-hour urinary protein measurement.

CONCLUSIONS

The spot urinary protein-creatinine ratio showed a strong positive correlation with 24-hour urinary protein excretion among patients with type 2 diabetes mellitus. However, the correlation observed in this study does not establish complete agreement or interchangeability between the two methods. Therefore, spot urinary PCR may be considered a useful measure for assessing proteinuria in patients with T2DM, while 24-hour urinary protein measurement may still be required in selected patients where greater diagnostic certainty is needed.

Authors' Contribution

Conceptualization: MS
Methodology: MS
Formal analysis: MS, MAM, ZS
Writing and Drafting: MS, AH, HUR, JT
Review and Editing: MS, AH, MAM, HUR, JT, ZS

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflict of Interest

All the authors declare no conflict of interest.

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