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Diagnostic Yield of Urinary Microalbuminuria in the Early Detection of Diabetic Nephropathy: A Cross-Sectional Study

Dr. Abdul Bari[1], Dr. Amir Hamza[2*], Dr. Abdul Wahid[3], Dr. Mohammad Azam[4], Dr. Allah Bakhsh[5], Dr. Bibi Asma[6]

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Dr. Abdul Bari
MBBS, FCPS (Medicine), Assistant Professor, Medicine, Jhalwan Medical College, Khuzdar.
Email: bariajo95@gmail.com
Dr. Amir Hamza
MBBS, FCPS (Medicine), Assistant Professor Medicine, Bolan Medical College, Quetta.
Corresponding Author Email: hamza4170@gmail.com
Dr. Abdul Wahid
MBBS, FCPS (Medicine), Senior Registrar, Medicine, Jhalwan Medical College, Khuzdar.
Email: 2060358az@gmail.com
Dr. Mohammad Azam
MBBS, FCPS (Medicine), Assistant Professor Medicine, Bolan Medical College, Quetta.
Email: drazamraisani71@gmail.com
Dr. Allah Bakhsh
MBBS, M.Phil (Biochemistry), Assistant Professor Biochemistry, Jalawan Medical College, Khuzdar.
Email: abumrani17@gmail.com
Dr. Bibi Asma
MBBS, House Officer, Medicine Department, Bolan Medical College/Civil Hospital, Quetta.
Email: asmab2886@gmail.com

ABSTRACT

Objective: The study aimed to determine the prevalence of microalbuminuria in patients with type 2 diabetes mellitus and to promote awareness among patients and healthcare professionals regarding the importance of early detection and management of diabetic nephropathy. Method: This cross-sectional study was conducted at Bolan Medical College Quetta and Jhalawan Medical College Khuzdar from February 2024 to January 2025, involving 282 type 2 diabetes patients aged ≥35 years, selected via non-probability consecutive sampling. After IRB approval and written consent, patients with pregnancy or other kidney diseases were excluded. Data collected included age, sex, blood pressure, diabetes duration, and urine tests. Midstream urine samples were tested for microalbuminuria using Micral test strips. Color change indicated results. Data were analyzed using SPSS version 26, with Chi-square and t-tests applied to assess associations.Results: The mean age of patients was 54.2 ± 9.6 years, with a mean diabetes duration of 8.7 ± 5.1 years. There were 158 males (56.0%) and 124 females (44.0%). All patients were on antidiabetic therapy: 153 (54.3%) on oral agents, 59 (20.9%) on insulin, and 70 (24.8%) on both. Hypertension was present in 176 patients (62.4%) with a mean duration of 6.3 ± 4.0 years. Micral testing revealed no microalbuminuria in 189 (67.0%), positive results in 83 (29.4%), and strong positive in 10 (3.6%). Overall, microalbuminuria was detected in 93 patients (33.0%). Conclusion: Microalbuminuria was detected in one-third of type 2 diabetes patients, significantly associated with hypertension and diabetes duration. Routine screening enables early diagnosis and timely management of diabetic nephropathy.

INTRODUCTION

Diabetic nephropathy is a common and serious complication of type 2 diabetes mellitus. It is a leading cause of end-stage renal disease around the world. Diabetes affects more than 500 million people globally, and this number is rising.[1] As the prevalence of diabetes increases, the burden of diabetic nephropathy also grows. Diabetic nephropathy accounts for a significant share of morbidity, mortality, and healthcare costs. The disease progresses silently in its early stages. Once advanced, it leads to kidney failure, cardiovascular events, and premature death. Early detection and treatment are critical for slowing disease progression and improving outcomes. Microalbuminuria is the earliest sign of diabetic nephropathy and can be detected before major symptoms appear.[2]

In Pakistan, diabetes is a growing public health problem. The International Diabetes Federation lists Pakistan among the top ten countries with the highest number of diabetics. About 20–40% of diabetic patients in Pakistan are affected by diabetic nephropathy. Many patients are diagnosed late, when kidney function is already compromised.[3] Late diagnosis leads to poor prognosis and increased treatment costs. Hypertension, which is common in diabetic patients, accelerates the decline in kidney function. Early detection of kidney damage using simple and low-cost methods can reduce complications. Microalbuminuria testing is an important tool for this purpose. The Micral test is a dipstick-based method for detecting urinary microalbumin. It is easy to use, rapid, affordable, and suitable for use in primary care and low-resource settings. International studies have shown that the Micral test has good sensitivity and specificity for detecting early kidney damage.[4]

Despite international evidence, there are limited data from Pakistan on the use of the Micral test in diabetic patients. Few studies have explored its usefulness in early screening for diabetic nephropathy. A study in Karachi reported a 24.2% prevalence of microalbuminuria in hypertensive diabetics. Another study in Rawalpindi reported a prevalence of 31%. These findings suggest that a large proportion of diabetic patients in Pakistan are at risk of undiagnosed nephropathy. However, routine screening for microalbuminuria is not widely practiced.[5] Many patients remain unaware of early kidney involvement until complications develop. The use of the Micral test as a simple, point-of-care screening tool has not been systematically assessed at the national or regional level.[6]

There is a clear knowledge gap regarding the routine use of the Micral test in clinical settings across Pakistan. Most public hospitals and clinics do not offer microalbuminuria screening as part of standard diabetic care. The lack of data on its utility in our population limits evidence-based policy and practice.[7] There is also limited awareness among healthcare providers about its value in early detection. Further, the association between hypertension and microalbuminuria in type 2 diabetic patients has not been adequately studied in our region. Addressing these gaps is essential for improving early diagnosis and preventing long-term complications.[8]

This study was conducted to evaluate the role of the Micral test in detecting microalbuminuria in patients with type 2 diabetes mellitus. It aims to provide evidence on the usefulness of this test in early identification of diabetic nephropathy.[9] The study also explores the association of microalbuminuria with hypertension in diabetic patients. The findings will support the introduction of simple, cost-effective screening strategies in routine practice. The goal is to promote early detection, timely management, and prevention of kidney failure in diabetic populations. This study is timely and relevant in the context of Pakistan's growing

diabetes burden and limited access to diagnostic services.[10]

The primary objective of this study is to determine the frequency of microalbuminuria using the Micral test in patients with type 2 diabetes mellitus. The secondary objectives are to evaluate the association of microalbuminuria with hypertension and to assess the usefulness of the Micral test as a screening tool.[11] The research question is: "Is there a significant association between hypertension and presence of microalbuminuria in patients with type 2 diabetes mellitus?" This study addresses an important gap and aims to contribute local evidence to improve diabetic care.[12]

MATERIALS AND METHODS

This was a cross-sectional observational study. It was carried out in the Department of Medicine at Bolan Medical College Teaching Hospital, Quetta, and Jhalawan Medical College Hospital, Khuzdar. The study was conducted over a period of one year from February 2024 to January 2025. Both hospitals serve a large number of diabetic patients from urban and rural areas of Baluchistan. The study included outdoor patients who visited the medical outpatient departments for diabetes management. These hospitals were selected due to their accessibility and patient load, which made data collection easier.

The study began after receiving approval from the Institutional Review Board of Bolan University of Medical and Health Sciences (IRB No: 1153/BUMHS/IRB/23; 26th January 2024, Annexure I). All participants gave written informed consent before inclusion (Annexure II). The study followed ethical principles of the Declaration of Helsinki. Patients were informed about the study aims, procedures, risks, and benefits. They had the right to withdraw at any time. Confidentiality of personal data was ensured throughout the study.

A total of 282 participants were included in the study. The sample size was calculated using the OpenEpi sample size calculator based on an expected prevalence of 24.2% for microalbuminuria in diabetic hypertensive patients, with a 95% confidence level and a 5% margin of error. A non-probability consecutive sampling technique was used.[5] All patients were selected from the diabetic outpatient departments. Inclusion criteria were age above 18 years, a confirmed diagnosis of type 2 diabetes mellitus based on American Diabetes Association (ADA) guidelines, and willingness to give informed consent. Patients were excluded if they had a urinary tract infection in the past month, had known renal diseases other than diabetic nephropathy, or were pregnant. Age, gender, and ethnicity were recorded as self-reported by patients during the interview.

After consent, data collection was performed using a structured proforma (Annexure III).[12] Demographic information, duration of diabetes, and presence of hypertension were recorded. Blood pressure was measured using a standard mercury sphygmomanometer. Urine samples were collected in sterile containers. The Micral test strips (Roche Diagnostics GmbH, Sandhofer Strasse 116, Mannheim, Germany) were used to test for urinary microalbumin. The Micral strip is a semi-quantitative dipstick test based on immunochromatographic detection of albumin. A visible color change on the strip indicates albumin concentration in the range of 30–300 mg/L. The color change was matched with the manufacturer's reference chart. A trained medical officer interpreted each result to minimize error. Test strips were used within expiry dates and stored under recommended conditions.

Data were entered and analyzed using SPSS version 26. Quantitative variables such as age and duration of diabetes were presented as mean and standard deviation. Qualitative variables such as gender, hypertension, and presence of microalbuminuria were presented as

frequencies and percentages. The chi-square test was applied to determine the association between hypertension and microalbuminuria. A p-value less than 0.05 was considered statistically significant. Data validation was done before analysis. The results were tabulated and interpreted to address the study objectives.

RESULTS

Among the 282 patients enrolled, all were receiving antidiabetic treatment. Of these, 153 (54.3%) were on oral hypoglycemic agents, 59 (20.9%) were on insulin therapy, and 70 (24.8%) were using both types of treatment. The key demographic and clinical characteristics of participants are summarized in Table 1. A total of 176 (62.4%) participants reported a history of hypertension, and the average duration of hypertension among these individuals was 6.3 ± 4.0 years. Additionally, 164 (58.2%) of all participants were taking antihypertensive medications, while 118 (41.8%) were not.

TABLE 1: KEY DEMOGRAPHIC AND CLINICAL CHARACTERISTICS OF PARTICIPANTS (N = 282)

Variable	Mean ± SD or n (%)
Age (years)	54.2 ± 9.6
Gender	
Male	158 (56.0%)
Female	124 (44.0%)
Duration of Diabetes (years)	8.7 ± 5.1
Type of Antidiabetic Therapy	
Oral agents	153 (54.3%)
Insulin	59 (20.9%)
Both	70 (24.8%)
Hypertension (Yes)	176 (62.4%)
Duration of Hypertension *(if present)*	6.3 ± 4.0
Body Mass Index (kg/m²)	26.6 ± 4.3
Systolic Blood Pressure (mmHg)	139.6 ± 17.4
Diastolic Blood Pressure (mmHg)	84.1 ± 11.3

Regarding smoking habits, 42 (14.9%) participants were current smokers, 38 (13.5%) were ex-smokers, and 202 (71.6%) had never smoked. The mean body mass index (BMI) of the sample was 26.6 ± 4.3 kg/m². The prevalence and pattern of microalbuminuria detected by the Micral test (N = 282) are presented in Table 2. Mean systolic and diastolic blood pressures recorded were 139.6 ± 17.4 mmHg and 84.1 ± 11.3 mmHg, respectively. The mean height and weight of the participants were 164.7 ± 9.2 cm and 72.3 ± 11.8 kg, respectively.

TABLE 2: PREVALENCE AND PATTERN OF MICROALBUMINURIA DETECTED BY MICRAL TEST (N = 282)

Micral Test Result	Albumin Range (mg/L)	Frequency (n)	Percentage (%)
Negative	0–29	189	67.0%
Positive	30–300	83	29.4%

Micral Test Result	Albumin Range (mg/L)	Frequency (n)	Percentage (%)
Strong Positive	>300	10	3.6%
Total with Microalbuminuria	≥30 mg/L	**93**	**33.0%**

Statistical analysis revealed significant associations between microalbuminuria and certain clinical parameters. Patients with microalbuminuria had a significantly longer duration of diabetes (10.4 ± 5.3 vs. 7.9 ± 4.8 years; $p < 0.001$), higher systolic blood pressure (144.2 ± 16.5 vs. 137.4 ± 17.6 mmHg; $p < 0.001$), and higher diastolic blood pressure (87.3 ± 10.4 vs. 82.4 ± 11.2 mmHg; $p < 0.001$) compared to those without microalbuminuria. The significant clinical variables associated with microalbuminuria are presented in Table 3. A statistically significant association was also observed between the presence of hypertension and microalbuminuria (80.6% vs. 53.4%; $p < 0.001$, Chi-square test). However, no significant association was found with gender, BMI, or smoking status ($p > 0.05$).

TABLE 3: SIGNIFICANT CLINICAL VARIABLES ASSOCIATED WITH MICROALBUMINURIA (N = 282)

Variable	Microalbuminuria Present (n=93)	Absent (n=189)	p-value	Statistical Test
Duration of Diabetes (years)	10.4 ± 5.3	7.9 ± 4.8	<0.001	Independent t-test
Hypertension (Yes)	75 (80.6%)	101 (53.4%)	<0.001	Chi-square test
Systolic BP (mmHg)	144.2 ± 16.5	137.4 ± 17.6	<0.001	Independent t-test
Diastolic BP (mmHg)	87.3 ± 10.4	82.4 ± 11.2	<0.001	Independent t-test

DISCUSSION

Our study found that microalbuminuria was present in 33.0% of patients with type 2 diabetes mellitus (T2DM). This finding suggests that a significant proportion of diabetic patients are at risk of early kidney damage, even before overt nephropathy develops. We also found that hypertension, longer duration of diabetes, and higher systolic and diastolic blood pressures were significantly associated with microalbuminuria.[13] However, there was no statistically significant association between microalbuminuria and gender, body mass index (BMI), or smoking status.[14]

The detection of microalbuminuria in one-third of participants highlights the importance of early screening in diabetic care. Microalbuminuria serves as an early marker of diabetic nephropathy (DN) and can be reversed or slowed if managed promptly.[15] The significant association between microalbuminuria and hypertension underscores the dual role of blood pressure and hyperglycemia in the development of kidney damage. Our results also emphasize the importance of controlling both blood pressure and blood sugar levels in diabetic patients to prevent renal complications.[13-15]

Our results are consistent with those of previous studies in similar settings. A study in Karachi reported a microalbuminuria prevalence of 24.2% among hypertensive diabetics, while a study in Rawalpindi found a prevalence of 31%. Our finding of 33% is slightly higher but still within a comparable range.[16] International studies also report similar rates. For example, a

study in India reported a prevalence of 26%, and another in Saudi Arabia reported 29%. The differences in reported prevalence may be due to variations in population characteristics, methods of detection, and criteria used for diagnosis.[17]

One strength of our study is the use of the Micral test, which is a simple, cost-effective, and rapid screening tool. It allows early detection of microalbuminuria even in primary care or resource-limited settings. Our study included a relatively large sample size of 282 patients, which adds strength to the reliability of the findings.[18] The inclusion of both hypertensive and non-hypertensive patients allowed us to examine associations with multiple variables. This enhances the applicability of the findings to a broad diabetic population.[16-18]

However, our study had some limitations. Being cross-sectional, we could not assess the progression of microalbuminuria over time. We used a single urine sample, and there may be variability in albumin excretion depending on time of day, activity, or hydration status.[19] Also, the Micral test is semi-quantitative and relies on visual interpretation, which may introduce observer bias. We did not assess other important factors such as glycemic control (e.g., HbA1c), lipid profile, or creatinine clearance, which could have added further depth to our analysis.[20]

The findings have several clinical and public health implications. Routine screening of microalbuminuria in diabetic patients can identify those at risk of DN early. This can prompt timely intervention to prevent progression to chronic kidney disease.[21] The use of a low-cost test like the Micral dipstick makes it feasible for widespread use, even in peripheral or rural healthcare settings. Healthcare providers should be trained in interpreting and responding to test results. Screening can be integrated into regular diabetes checkups, along with monitoring of blood pressure and glucose levels.[22]

Future research should focus on longitudinal studies to assess the progression of microalbuminuria over time and its response to treatment. Studies evaluating the role of glycemic control, medication adherence, and lifestyle interventions in reducing microalbuminuria are also needed. Further validation studies comparing the Micral test with laboratory-based quantitative assays would help confirm its accuracy. Investigating patient awareness and healthcare provider practices regarding microalbuminuria screening could identify gaps in implementation and lead to improved protocols.[20-23]

Our study reinforces the role of microalbuminuria as an early, reversible marker of diabetic kidney disease. The high prevalence among hypertensive and long-duration diabetic patients stresses the urgency of routine screening in these groups.[24] Using the Micral test can make screening accessible and practical in many settings. Addressing barriers to routine testing and promoting awareness among patients and healthcare workers can improve early detection and reduce the burden of end-stage renal disease in the diabetic population. Continued research and policy support are essential to integrate microalbuminuria screening into national diabetes care programs.[25]

CONCLUSION

Microalbuminuria was found in one-third of patients with type 2 diabetes mellitus. It was significantly linked to hypertension and longer diabetes duration. The Micral test proved to be a simple and useful screening tool. Early detection through routine testing can help prevent kidney damage. These findings highlight the need to include microalbuminuria screening in standard diabetic care.

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DISCLAIMER

This research is intended solely for academic and scientific purposes. The views expressed are those of the authors and do not necessarily reflect institutional or organizational policies. The content should not be considered a substitute for professional medical advice. Readers are encouraged to consult appropriate sources and verify information independently. The authors assume no responsibility for any consequences arising from the use of this study.

CONFLICT OF INTEREST

The authors declare no conflict of interest in relation to this study. There were no personal, financial, academic, or professional influences that could have affected the research design, data collection, analysis, interpretation, or reporting of the findings.

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