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Original Research Article

Frequency of Microalbuminuria and Its Association with Hypertension, Obesity, and Smoking in Patients with Type 2 Diabetes Mellitus

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Abstract: *Microalbuminuria (MA) is an early marker of diabetic kidney disease and clusters with cardiometabolic risks prevalent in Pakistan. Estimating the burden and identifying correlates among local patients with type 2 diabetes mellitus (T2DM) can guide targeted prevention efforts.* ***Objective:*** *To determine the frequency of MA and its association with hypertension, obesity, and smoking among adults with T2DM.* ***Methods:*** *We conducted a cross-sectional study of consecutively recruited adults with type 2 diabetes mellitus (T2DM) (aged 30–65 years; duration >2 years) attending the Department of Medicine at Ibn-e-Siena Hospital, Multan, Pakistan, over a six-month period (November 2023 to May 2024). The sample comprised 171 participants. MA was defined as a urine albumin-to-creatinine ratio (ACR) of 30–300 mg/g on an early-morning/spot urine sample. Prespecified correlates included hypertension (controlled vs uncontrolled), current smoking (≥10 cigarettes/day for ≥2 years), and obesity (BMI ≥30 kg/m²). Demographics, diabetes duration, and treatment (insulin ± oral agents vs oral agents only) were recorded. Bivariate associations were assessed using χ^2, t-tests, or Wilcoxon tests, as appropriate. Multivariable logistic regression estimated adjusted odds ratios (aORs) with 95% confidence intervals (CIs); model calibration was assessed by the Hosmer–Lemeshow test ($p = 0.62$). Two-sided $p < 0.05$ was considered statistically significant.* ***Results:*** *Mean age was 52.3 ± 8.5 years; 57.9% were men; mean BMI was 28.6 ± 4.2 kg/m²; 63.2% had hypertension, 26.9% smoked, and 33.9% were obese. MA prevalence was 29.8% (51/171). On bivariable analysis, MA increased with age (10.0% at 30–39 to 40.5% at 60–65; $p = 0.010$) and diabetes duration (14.5% at 2–5 years to 47.4% at >10 years; $p < 0.001$) and was higher in hypertensive vs non-hypertensive participants (37.0% vs 17.5%; $p = 0.004$), smokers vs non-smokers (45.7% vs 24.0%; $p = 0.006$), obese vs non-obese (41.4% vs 23.9%; $p = 0.014$), and those on insulin-based therapy vs oral agents only (44.4% vs 21.3%; $p = 0.002$). In multivariable models, independent predictors of MA were longer T2DM duration (per 5 years: aOR 1.64, 95% CI 1.25–2.17; $p < 0.001$), hypertension (aOR 2.14, 1.07–4.27; $p = 0.032$), current smoking (aOR 2.30, 1.17–4.53; $p = 0.016$), obesity (aOR 1.89, 1.01–3.53; $p = 0.048$), insulin-based therapy (aOR 2.25, 1.16–4.37; $p = 0.017$), and older age (per 5 years: aOR 1.18, 1.01–1.38; $p = 0.036$). Sex was not associated (aOR 1.31, 0.68–2.50; $p = 0.41$).* ***Conclusion:*** *Nearly one-third of Pakistani adults with T2DM had MA. Longer diabetes duration, hypertension, obesity, smoking, older age, and insulin-based therapy independently increased the odds of MA. Incorporating routine MA screening and intensifying control of modifiable risks, such as blood pressure, body weight, and tobacco use, should be prioritized within diabetes care pathways to mitigate kidney disease progression.*

Keywords: Albuminuria; Cross-Sectional Studies; Diabetes Mellitus, Type 2; Hypertension; Obesity; Pakistan; Risk Factors; Smoking

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Introduction

Microalbuminuria (MA) represents a critical early marker for kidney damage and is commonly associated with diabetic nephropathy, especially in individuals with Type 2 Diabetes Mellitus (T2DM). The prevalence of MA has been linked to various risk factors, including hypertension, obesity, and smoking, all of which are prevalent in the Pakistani context. The relationship between T2DM and subsequent renal impairment is particularly alarming; a study reported MA prevalence among diabetic patients in Pakistan at approximately 34.6% (1). This prevalence highlights the urgent need for effective screening and preventive measures among populations at risk for renal complications.

Several studies have indicated a robust association between hypertension and the prevalence of microalbuminuria. For instance, a study in Saudi Arabia revealed that the presence of hypertension increased the prevalence rate of microalbuminuria among T2DM patients from 31.2% to 68.5% (2). Similar findings were echoed in earlier research, confirming hypertension as a potent predictor of renal damage in diabetics (3). A nationwide analysis in Pakistan further noted that the prevalence of nephropathy was alarmingly high among patients with uncontrolled hypertension (1). Consequently, hypertension management is essential in mitigating the risk of microalbuminuria in patients with diabetes.

Obesity is another significant risk factor for both T2DM and microalbuminuria. Evidence suggests a strong correlation between body mass index (BMI) and the occurrence of MA; higher BMI levels are associated with a greater likelihood of developing renal complications (3). Studies indicate that obesity exacerbates the diabetic condition, making renal protection strategies imperative for overweight and obese individuals (4). The higher incidence of obesity and associated metabolic derangements in Pakistani society further complicates diabetes management, making it a priority (1).

Smoking remains a considerable modifiable risk factor for deteriorating renal function among patients with T2DM. Research indicates that smoking not only increases the risk of developing diabetic nephropathy but also exacerbates existing kidney damage among those already affected (5). The interplay between smoking and glycemic control is noteworthy, as smokers often show poorer glycemic control, leading to an escalation in diabetes-related complications, including microalbuminuria (6). Furthermore, cessation of smoking has been linked to improved renal outcomes, underscoring the need for smoking cessation programs targeted at diabetic individuals (5).

In summary, the prevalence of microalbuminuria in Pakistan, coupled with its association with hypertension, obesity, and smoking, underscores the multifaceted nature of diabetes management. The interplay of these factors not only increases the risk of renal complications but also poses a

substantial burden on the healthcare system. These findings underscore the need for integrated health strategies that address the multifaceted risks associated with type 2 diabetes mellitus (T2DM) and its complications.

Rationale: Microalbuminuria serves as a pivotal predictor of adverse outcomes in individuals with T2DM, making it crucial to investigate its prevalence and associated factors specifically within the Pakistani demographic, where lifestyle-related complications are rising. Understanding these associations will provide necessary insights for developing targeted interventions aimed at reducing the prevalence of this condition, thereby improving renal outcomes for diabetic patients.

Methodology

This was a cross-sectional study conducted in the Department of Medicine at Ibn-e-Siena Hospital, Multan, over six months following synopsis approval from November 2023 to May 2024. Eligible participants were consecutively recruited adults with type 2 diabetes mellitus (T2DM) who presented to medical services during the study period. The institutional location and CPSP approval date were verified from the approval letter and registration record, and the six-month duration was predefined in the synopsis.

Sampling used a non-probability consecutive approach. The sample size was estimated as n = 171 using the WHO single-proportion formula, with a presumed microalbuminuria prevalence of 20%, a 95% confidence level, and a 6% margin of error; this target was met in full.

Adults aged 30–65 years with a documented Diagnosis of T2DM for more than two years were eligible, irrespective of sex. Patients already receiving ACE inhibitors or angiotensin receptor blockers, pregnant women (confirmed by urine test), and those using systemic corticosteroids within the prior four weeks were excluded. T2DM and other variables were applied exactly as operationalized in the synopsis to preserve internal validity.

Microalbuminuria (primary outcome) was defined as a urine albumin-to-creatinine ratio (UACR) of 30–300 mg/g creatinine measured on an early-morning or spot urine sample. Associated factors were prespecified: hypertension was defined for known hypertensive patients on therapy for more than one year (controlled if blood pressure <140/90 mmHg; uncontrolled if ≥140/90 mmHg); current smoking was defined as >10 cigarettes/day for ≥2 years; and obesity as BMI >30 kg/m² calculated as weight/height²: these operational definitions guided eligibility assessment, data collection, and analysis.

After approval by the institutional ethics review committee and written informed consent, consecutive patients meeting the inclusion criteria were enrolled. Baseline data recorded on a standardized pro forma included age, sex, BMI (with weight measured on a calibrated scale and height on a stadiometer), obesity status, duration of T2DM, current treatment of T2DM, hypertension status, and smoking status. All participants provided an early-morning urine sample for albumin and creatinine to classify microalbuminuria (yes/no) according to the operational definition.

Statistical analysis followed a prespecified plan using SPSS v23. Normality of continuous variables (age, T2DM duration, BMI) was assessed with the Shapiro–Wilk test. Descriptive statistics were expressed as mean ± standard deviation (or median and range for non-normal distributions) and frequencies with percentages for categorical variables (sex, hypertension, smoking, obesity, treatment, microalbuminuria). Bivariable comparisons were performed to screen for associations with microalbuminuria; variables with a p-value ≤ 0.20 at the bivariable stage were entered into a multivariable logistic regression model to identify independent predictors. Odds ratios (ORs) with 95% confidence intervals were reported, and a two-sided $p \leq 0.05$ denoted statistical significance.

Results

A total of 171 adults with type 2 diabetes mellitus (T2DM) aged 30–65 years were included. The mean age was 52.3 ± 8.5 years; 57.9% were men. Overall, microalbuminuria (MA) was present in 29.8% (51/171) of the participants. Hypertension was common (63.2%), 26.9% reported current smoking, and 33.9% met the obesity threshold (BMI ≥30 kg/m²). Patients with MA were older, had a longer duration of diabetes, higher mean BMI, and were more likely to have hypertension, to smoke, and to be on insulin therapy. (Table 1).

To explore correlates of microalbuminuria, we compared patient subgroups. MA prevalence increased with age and diabetes duration and was higher in hypertensive, obese, smokers, and those on insulin therapy. (Table 2).

In univariable analyses (Table 2), microalbuminuria (MA) rose steadily with age and diabetes duration—10.0% at 30–39 years, 22.0% at 40–49, 35.9% at 50–59, and 40.5% at 60–65 (p = 0.010); 14.5% for 2–5 years of T2DM, 33.8% for 6–10 years, and 47.4% for >10 years (p < 0.001). MA was more frequent in hypertensive than non-hypertensive patients (37.0% vs 17.5%, p = 0.004), smokers versus non-smokers (45.7% vs 24.0%, p = 0.006), those with obesity (BMI ≥30) versus without (41.4% vs 23.9%, p = 0.014), and those on insulin ± oral therapy versus oral agents only (44.4% vs 21.3%, p = 0.002). The sex difference was not significant (male, 33.3% vs. female, 25.0%, p = 0.24). In multivariable logistic regression (Table 3), independent predictors of MA included longer T2DM duration (per 5 years: adjusted OR 1.64, 95% CI 1.25–2.17, p < 0.001), hypertension (2.14, 1.07–4.27, p = 0.032), current smoking (2.30, 1.17–4.53, p = 0.016), obesity (1.89, 1.01–3.53, p = 0.048), insulin-based therapy (2.25, 1.16–4.37, p = 0.017), and older age (per 5 years: 1.18, 1.01–1.38, p = 0.036); male sex remained non-significant (1.31, 0.68–2.50, p = 0.41).

Model fit was acceptable (Hosmer–Lemeshow p = 0.62; Nagelkerke R^2 = 0.29), with no concerning multicollinearity (all VIFs <2).

Table 1. Demographic and baseline characteristics (N = 171)

Characteristic	n (%)
Age, years mean ± SD)	52.3 ± 8.5
Age categories	
• 30–39	20 (11.7)
• 40–49	50 (29.2)
• 50–59	64 (37.4)
• 60–65	37 (21.6)
Sex	
• Male	99 (57.9)
• Female	72 (42.1)
BMI, kg/m²	28.6 ± 4.2
Obesity (BMI ≥30)	58 (33.9)
Duration of T2DM, years	7.4 ± 4.0
Duration categories	
• 2–5	62 (36.3)
• 6–10	71 (41.5)
• >10	38 (22.2)
Hypertension (yes)	108 (63.2)
Smoking (current ≥10 cig/day)	46 (26.9)
T2DM treatment	
• Oral hypoglycemics only	108 (63.2)
• Insulin ± oral agents	63 (36.8)
Microalbuminuria present	51 (29.8)

Table 2. Microalbuminuria by demographic and clinical subgroups (row % = within-subgroup prevalence)

Variable (subcategory)	n in subgroup	MA present n (%)	p-value
Sex			
• Male	99	33 (33.3)	0.24
• Female	72	18 (25.0)	

Age group (years)			0.010
• 30–39	20	2 (10.0)	
• 40–49	50	11 (22.0)	
• 50–59	64	23 (35.9)	
• 60–65	37	15 (40.5)	
Duration of T2DM			<0.001
• 2–5 years	62	9 (14.5)	
• 6–10 years	71	24 (33.8)	
• >10 years	38	18 (47.4)	
Hypertension			0.004
• Yes	108	40 (37.0)	
• No	63	11 (17.5)	
Smoking			0.006
• Yes	46	21 (45.7)	
• No	125	30 (24.0)	
Obesity (BMI ≥30)			0.014
• Yes	58	24 (41.4)	
• No	113	27 (23.9)	
Treatment			0.002
• Insulin ± oral	63	28 (44.4)	
• Oral only	108	23 (21.3)	

Table 3. Multivariable logistic regression for factors independently associated with microalbuminuria (N = 171)

Predictor	Adjusted OR	95% CI	p-value
Age (per 5-year increase)	1.18	1.01–1.38	0.036
Male sex (vs female)	1.31	0.68–2.50	0.41
T2DM duration (per 5-year higher)	1.64	1.25–2.17	<0.001
Hypertension (yes)	2.14	1.07–4.27	0.032
Smoking (yes)	2.30	1.17–4.53	0.016
Obesity, BMI ≥30 (yes)	1.89	1.01–3.53	0.048
Insulin ± oral therapy (vs oral only)	2.25	1.16–4.37	0.017

Discussion

The study of microalbuminuria (MA) in adults with Type 2 Diabetes Mellitus (T2DM) provides crucial insights into the renal complications associated with diabetes. Our investigation involving 171 adults with type 2 diabetes mellitus (T2DM) revealed a notable prevalence of microalbuminuria at 29.8%. This aligns with findings from various regions indicating diverse prevalence rates, influenced by genetic, environmental, and lifestyle factors. For example, Ahmed et al. reported a prevalence of 39.8% among patients with concomitant hypertension and diabetes, highlighting the synergy of these conditions in exacerbating renal impairment (7). Moreover, it is significant that 63.2% of our study participants were hypertensive, corroborating studies like that of Abdelwahid et al., which identified similar trends within populations of diabetic patients, where hypertension significantly raised microalbuminuria prevalence (8).

Our results also showed that individuals with MA were generally older, had longer durations of diabetes, and often exhibited higher BMI levels. The association between obesity and MA has been well-documented in past research. For instance, a study by Acharya found that obesity, alongside hypertension and dyslipidemia, significantly elevated the risk of MA, reinforcing the need for comprehensive management strategies targeting these risk factors in diabetic populations (9). In our cohort, the prevalence of obesity (33.9%) and its correlation with MA (41.4% vs. 23.9% in non-obese) align with findings from Muddu et al., where similar prevalence rates were observed, underscoring the critical role of body weight in shaping renal health outcomes among people with diabetes (10). Additionally, smoking emerged as a strong independent predictor of MA in our study, with a prevalence of 45.7% among smokers compared to 24.0% in non-smokers. This corroborates findings from Hieshima et al., who discussed the detrimental effects of smoking on renal function in diabetic patients, emphasizing smoking cessation as a potential intervention to improve renal outcomes (11). Our logistic regression analysis further validated that smoking, like hypertension, is a modifiable risk factor that could be targeted to mitigate the incidence of MA.

Furthermore, the correlation between insulin therapy and MA prevalence in our results (44.4% among those on insulin) suggests that patients requiring insulin treatment may have more severe underlying metabolic derangements that also predispose them to both diabetes complications and, consequently, microalbuminuria. This aligns with recent work by Khan et al., in which insulin therapy was associated with increased rates of microalbuminuria in patients with type 2 diabetes mellitus (T2DM).

Thus, our study's findings are consistent with the contemporary literature, which emphasizes the interplay of age, duration of diabetes, obesity, hypertension, smoking, and insulin use as predominant predictors of microalbuminuria in patients with T2DM. The need for vigilant screening practices in high-risk populations, particularly in Pakistani contexts where such health complications are increasing, cannot be overstated. Our results support the notion that targeted interventions addressing these modifiable risk factors can play a vital role in preventing renal complications among diabetic patients.

Conclusion

Nearly one-third of Pakistani adults with T2DM had MA, with higher odds among those with longer diabetes duration, hypertension, obesity, smoking, and insulin use. Routine MA screening and aggressive control of modifiable risks, blood pressure, body weight, and tobacco use should be prioritized in diabetes care pathways to reduce kidney disease progression.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-24)

Consent for publication

Approved

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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

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Manuscript drafting, Study Design,
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Review of Literature, Data entry, Data analysis, and drafting an article.
KR (House Officer)
Conception of Study, Development of Research Methodology Design,
MM (House Officer)
Study Design, manuscript review, and critical input.
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All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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