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FREQUENCY OF MICROALBUMINURIA IN TYPE 2 DIABETICS WITH NORMAL CREATININE CLEARANCE

Original Research

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ABSTRACT

Background: Microalbuminuria is an early indicator of diabetic nephropathy and a strong predictor of cardiovascular and renal complications in type 2 diabetes mellitus (T2DM). It reflects early glomerular damage and serves as a marker for worsening renal function. Identifying microalbuminuria at an early stage is essential for timely intervention to prevent progression to overt nephropathy and end-stage renal disease. Several demographic, clinical, and lifestyle factors contribute to its development, necessitating further investigation into its prevalence and associated risk factors in diabetic populations.

Objective: This study aimed to determine the prevalence of microalbuminuria in T2DM patients with normal creatinine clearance and examine its associations with demographic, clinical, and lifestyle factors.

Methods: A cross-sectional study was conducted at a tertiary care hospital among 164 T2DM patients. Data were collected on demographic characteristics, including age, gender, and body mass index (BMI), as well as clinical factors such as duration of diabetes, hypertension, dyslipidemia, smoking status, and glycemic control. Blood pressure and HbA1c levels were recorded. Lifestyle factors, including physical activity and dietary adherence, were assessed through structured questionnaires. Microalbuminuria was detected using a midstream urine sample, analyzed with a dipstick test. Associations between microalbuminuria and independent variables were evaluated using chi-square tests, with a p-value of <0.05 considered statistically significant.

Results: Microalbuminuria was detected in 55 patients, accounting for 33.5% of the study population. There was no significant association between microalbuminuria and gender ($p = 0.53$) or age ($p = 0.28$). However, a significant association was observed with diabetes duration, with 32.7% of patients with diabetes for over 10 years having microalbuminuria compared to 22.0% of those with shorter disease duration ($p = 0.01$). Hypertension was significantly more prevalent in the microalbuminuria group (76.4% vs. 53.2%, $p < 0.001$). Poor glycemic control (HbA1c >7.0%) was associated with a higher prevalence of microalbuminuria (63.6% vs. 45.9%, $p = 0.02$). Additionally, a sedentary lifestyle (63.6% vs. 32.1%, $p = 0.04$) and poor dietary adherence (54.5% vs. 22.9%, $p = 0.03$) were significantly associated with microalbuminuria.

Conclusion: The study revealed a high prevalence of microalbuminuria among T2DM patients, strongly associated with poor glycemic control, hypertension, and unhealthy lifestyle behaviors. These findings highlight the importance of early screening, lifestyle modifications, and optimized management of diabetes and hypertension to prevent renal complications.

Keywords: Diabetes Mellitus, Diabetic Nephropathy, Glycemic Control, Hypertension, Microalbuminuria, Physical Activity, Risk Factors.

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INTRODUCTION

Diabetes mellitus has emerged as a major public health challenge due to its rapidly increasing global prevalence. According to the International Diabetes Federation (IDF) Diabetes Atlas 10th edition, it was estimated that 537 million individuals worldwide were living with diabetes in 2021, with projections indicating further growth. Currently, more than 10% of the global population is affected by diabetes, making it a significant contributor to morbidity and mortality. Diabetes mellitus is a complex metabolic disorder characterized by the disruption of carbohydrate, lipid, and protein metabolism, leading to multiple complications, including both macrovascular and microvascular pathologies. Among these complications, diabetic nephropathy remains the leading cause of end-stage renal disease and premature mortality in diabetic patients (1, 2). Diabetic nephropathy progresses insidiously, affecting approximately 20% to 40% of patients with type 2 diabetes mellitus (T2DM) (3). Microalbuminuria, defined as urinary albumin excretion between 30 mg/24 hours and 300 mg/24 hours, represents the earliest stage of diabetic nephropathy and serves as a well-recognized predictor of its progression (4, 5). The presence of microalbuminuria signifies early renal involvement, characterized by subtle but abnormal protein leakage due to glomerular dysfunction. The kidneys, responsible for filtering waste while retaining essential proteins, exhibit compromised filtration capacity in diabetes, leading to albumin leakage in the urine (6). The pathophysiological mechanisms underlying microalbuminuria include glomerular endothelial dysfunction, increased glomerular capillary pressure, and impaired tubular reabsorption, often exacerbated by hypertension and hyperglycemia (7). As diabetic nephropathy progresses, microalbuminuria can advance to overt proteinuria, eventually culminating in end-stage renal disease, necessitating dialysis or renal transplantation (8).

Despite normal creatinine clearance, the presence of microalbuminuria in patients with T2DM suggests early renal impairment, underscoring the need for timely detection and intervention. Early identification of microalbuminuria allows for targeted therapeutic strategies, such as glycemic control, antihypertensive treatment, and lifestyle modifications, to slow the progression of diabetic nephropathy and reduce cardiovascular risks. Given the growing burden of diabetes and its complications, this study aims to determine the frequency of microalbuminuria in type 2 diabetic patients with normal creatinine clearance. Identifying the prevalence of microalbuminuria in this specific population may provide valuable insights into early renal dysfunction and highlight the importance of proactive screening and management strategies to mitigate long-term renal and cardiovascular consequences (9, 10).

METHODS

The study was conducted as a cross-sectional investigation aimed at determining the frequency of microalbuminuria in patients diagnosed with type 2 diabetes mellitus (T2DM) who had normal creatinine clearance. A cross-sectional design was chosen as it allowed for the assessment of microalbuminuria prevalence at a single point in time, providing a comprehensive snapshot of the condition within the target population. The research was carried out in the Internal Medicine Department of Shifa International Hospital, a tertiary care center catering to a diverse range of diabetic patients. This setting ensured access to a representative sample of individuals with normal kidney function, thus enhancing the generalizability of the findings. The study was conducted over six months following formal approval from the hospital's research ethical committee. Ethical principles were strictly adhered to throughout the research process, with informed written consent obtained from all participants before enrollment. Patients were assured of confidentiality, and their participation was entirely voluntary, with the option to withdraw at any stage without consequences.

The sample size was determined using the WHO sample size calculator, with a confidence level of 95%, an absolute precision of 5%, and an anticipated prevalence of microalbuminuria of 36.8%, yielding a required sample size of 164 participants. A non-probability convenience sampling technique was employed to recruit eligible individuals. Inclusion criteria encompassed patients with a confirmed diagnosis of T2DM, a normal serum creatinine level as calculated by the Modification of Diet in Renal Disease (MDRD) formula, and an age range of 25 to 80 years. Both male and female patients were included to ensure a balanced demographic representation. Exclusion criteria were rigorously applied to minimize confounding factors that could affect the accuracy of microalbuminuria measurement. Patients on angiotensin-converting enzyme (ACE) inhibitors were excluded due to their potential influence on albuminuria levels. Pregnant women were omitted as physiological changes during pregnancy could impact urinary albumin excretion. Other exclusions comprised bedridden patients for more than two weeks, individuals with overt proteinuria (>350 mg/day), those diagnosed with

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congestive heart failure, urinary tract infections, or alternative causes of microalbuminuria such as heavy metal exposure, connective tissue disorders, or prolonged nonsteroidal anti-inflammatory drug (NSAID) use. Following recruitment, eligible participants underwent a thorough clinical assessment, including a detailed medical history, physical examination, and neurological evaluation. Body mass index (BMI) was calculated using standard weight and height measurements. Routine laboratory investigations were performed, including serum creatinine measurement, with creatinine clearance calculated via the MDRD formula to ensure accurate renal function assessment. For microalbuminuria detection, a midstream morning urine sample was collected in a sterile container. A test strip was immersed in the urine sample for five seconds and subsequently analyzed against a calibrated color scale after one minute. Microalbuminuria was classified based on albumin concentration as mild (20–50 mg/L), moderate (50–100 mg/L), or severe (100–300 mg/L). To enhance accuracy, each test was conducted twice for every participant, and the mean value was recorded.

Data were systematically entered and analyzed using IBM SPSS version 25. Quantitative variables such as age, BMI, diabetes duration, serum creatinine, and creatinine clearance were expressed as means and standard deviations. Categorical variables, including gender, presence of hypertension, dyslipidemia, and diabetes treatment history, were reported as frequencies and percentages. To control potential effect modifiers such as age, BMI, sex, diabetes duration, hypertension, and dyslipidemia, stratification was applied. Post-stratification analysis was conducted using the Chi-square test to evaluate associations between variables, with a p-value of <0.05 considered statistically significant, ensuring robust and clinically relevant findings.

RESULTS

The study included 164 participants, with a nearly equal distribution of males (54.3%) and females (45.7%). The majority of participants (53.7%) were between 41 and 60 years old, while 24.4% were aged 25–40 years, and 22.0% were between 61–80 years. Regarding body mass index (BMI), 41.5% of participants were classified as overweight, 33.5% had a normal weight, and 25.0% were obese. The duration of diabetes varied, with 43.9% of individuals having diabetes for 5–10 years, 30.5% for less than 5 years, and 25.6% for more than 10 years. Comorbid conditions were frequently observed, with 61.0% of participants having hypertension and 53.7% having dyslipidemia. Most participants (75.6%) were non-smokers. Blood pressure levels among the participants indicated that 41.5% had elevated systolic blood pressure (120–139 mmHg), while 28.0% had high systolic blood pressure (≥140 mmHg). Diastolic blood pressure was elevated (80–89 mmHg) in 42.7% of participants, and 20.7% had high diastolic blood pressure (≥90 mmHg). Glycemic control, assessed through HbA1c levels, revealed that 51.8% of participants had suboptimal control (HbA1c 7.0–9.0%), 24.4% had well-controlled diabetes (HbA1c <7.0%), and 23.8% had poor glycemic control (HbA1c >9.0%).

Regarding diabetes management, 61.0% of participants were treated with oral hypoglycemics, while the remaining participants received insulin therapy or a combination of both. In terms of lifestyle factors, 42.7% of participants led a sedentary lifestyle, 36.6% engaged in moderate physical activity, and 20.7% were physically active. Dietary adherence was moderate in 51.8% of participants, while 33.5% had poor adherence, and only 14.6% demonstrated good adherence to dietary recommendations. Microalbuminuria was detected in 55 participants, representing a prevalence of 33.5%. There was no significant association between gender and microalbuminuria ($p = 0.53$), with similar distributions among males and females in both groups. Age groups also did not show a significant difference in the prevalence of microalbuminuria ($p = 0.28$), although the highest frequency was observed in participants aged 41–60 years. However, a significant association was found between the duration of diabetes and microalbuminuria ($p = 0.01$), with a higher proportion of participants with microalbuminuria having diabetes for more than 10 years (32.7%) compared to those without microalbuminuria (22.0%). Hypertension was significantly more common among individuals with microalbuminuria (76.4%) compared to those without it (53.2%, $p < 0.001$). No significant association was observed between dyslipidemia and microalbuminuria ($p = 0.28$), while smoking status also showed no statistically significant difference between groups ($p = 0.16$).

Systolic blood pressure was significantly associated with microalbuminuria, with a lower proportion of participants in the microalbuminuria group having normal systolic blood pressure (<120 mmHg) compared to those without microalbuminuria (9.1% vs. 41.3%, $p = 0.02$). Similarly, higher HbA1c levels were significantly linked to microalbuminuria, with 63.6% of affected individuals having HbA1c between 7.0–9.0% compared to 45.9% in those without microalbuminuria ($p = 0.02$). Diastolic blood pressure showed a non-significant trend, with more participants in the microalbuminuria group having elevated levels (45.5%) compared to those without microalbuminuria (41.3%). Microalbuminuria was significantly associated with a sedentary lifestyle, with 63.6% of affected individuals being physically inactive compared to 32.1% in the group without microalbuminuria ($p = 0.04$). Dietary adherence also demonstrated a significant difference, with poor adherence being more common in the microalbuminuria group (54.5%) compared to those without

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microalbuminuria (22.9%, p = 0.03). None of the participants with microalbuminuria reported good dietary adherence, highlighting the role of lifestyle factors in the development of microalbuminuria.

Table 1: Demographic and clinical characteristics of the study sample

Characteristic	Frequency (n)	Percentage (%)
Gender		
Male	89	54.3%
Female	75	45.7%
Age Group (years)		
25–40	40	24.4%
41–60	88	53.7%
61–80	36	22.0%
Body Mass Index (BMI)		
Normal weight (18.5–24.9 kg/m²)	55	33.5%
Overweight (25.0–29.9 kg/m²)	68	41.5%
Obese (≥30 kg/m²)	41	25.0%
Duration of Diabetes		
<5 years	50	30.5%
5–10 years	72	43.9%
>10 years	42	25.6%
Hypertension		
Yes	100	61.0%
No	64	39.0%
Dyslipidemia		
Yes	88	53.7%
No	76	46.3%
Smoking Status		
Smoker	40	24.4%
Non-smoker	124	75.6%

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Table 2: Clinical Characteristics of the study sample

Clinical Characteristic	Frequency (n)	Percentage (%)
Systolic Blood Pressure (mmHg)		
Normal (<120)	50	30.5%
Elevated (120–139)	68	41.5%
High (≥140)	46	28.0%
Diastolic Blood Pressure (mmHg)		
Normal (<80)	60	36.6%
Elevated (80–89)	70	42.7%
High (≥90)	34	20.7%
HbA1c Levels (%)		
<7.0	40	24.4%
7.0–9.0	85	51.8%
>9.0	39	23.8%

Table 3: Association of Microalbuminuria with Demographic Factors

Characteristic	Normal (n=109)	Microalbuminuria (n=55)	P-value
Gender			
Male	61 (56.0%)	28 (50.9%)	0.53
Female	48 (44.0%)	27 (49.1%)	
Age Group (years)			
25–40	30 (27.5%)	10 (18.2%)	0.28
41–60	58 (53.2%)	30 (54.5%)	
61–80	21 (19.3%)	15 (27.3%)	
Body Mass Index (BMI)			
Normal weight (18.5–24.9)	42 (38.5%)	13 (23.6%)	0.09
Overweight (25.0–29.9)	42 (38.5%)	26 (47.3%)	

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Characteristic	Normal (n=109)	Microalbuminuria (n=55)	P-value
Obese (≥30)	25 (22.9%)	16 (29.1%)	
Durationof Diabetes			
<5 years	40 (36.7%)	10 (18.2%)	0.01*
5–10 years	45 (41.3%)	27 (49.1%)	
>10 years	24 (22.0%)	18 (32.7%)	
Hypertension			
Yes	58 (53.2%)	42 (76.4%)	0.00*
No	51 (46.8%)	13 (23.6%)	
Dyslipidemia			
Yes	55 (50.5%)	33 (60.0%)	0.28
No	54 (49.5%)	22 (40.0%)	
Smoking Status			
Smoker	23 (21.1%)	17 (30.9%)	0.16
Non-smoker	86 (78.9%)	38 (69.1%)	

*=P< 0.05

Table 4: Association of Microalbuminuria with Clinical Factors

Clinical Characteristic	Normal (n=109)	Microalbuminuria (n=55)	P-value
Systolic Blood Pressure (mmHg)			
Normal (<120)	45 (41.3%)	5 (9.1%)	0.02*
Elevated (120–139)	40 (36.7%)	28 (50.9%)	
High (≥140)	24 (22.0%)	22 (40.0%)	
Diastolic Blood Pressure (mmHg)			
Normal (<80)	45 (41.3%)	15 (27.3%)	0.07
Elevated (80–89)	45 (41.3%)	25 (45.5%)	
High (≥90)	19 (17.4%)	15 (27.3%)	
HbA1c Levels (%)			
<7.0	35 (32.1%)	5 (9.1%)	0.02*

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Clinical Characteristic	Normal (n=109)	Microalbuminuria (n=55)	P-value
7.0–9.0	50 (45.9%)	35 (63.6%)	
>9.0	24 (22.0%)	15 (27.3%)	

*=P< 0.05

Table 5: Association of Microalbuminuria with lifestyle factors

Lifestyle Factor	Normal (n=109)	Microalbuminuria (n=55)	P-value
Physical Activity			
Sedentary	35 (32.1%)	35 (63.6%)	0.04*
Moderate	45 (41.3%)	15 (27.3%)	
Active	29 (26.6%)	5 (9.1%)	
Dietary Adherence			
Poor	25 (22.9%)	30 (54.5%)	0.03*
Moderate	60 (55.0%)	25 (45.5%)	
Good	24 (22.0%)	0 (0.0%)	

*=P< 0.05

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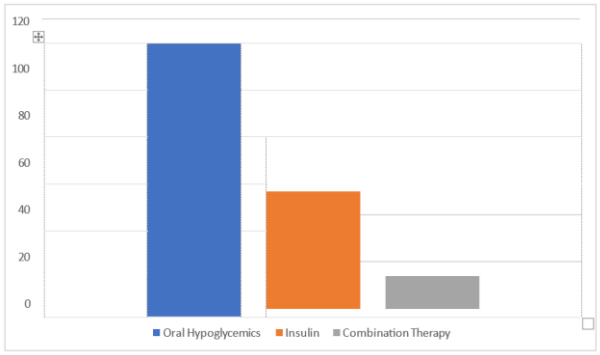

Figure 1 Treatment Types among the study sample

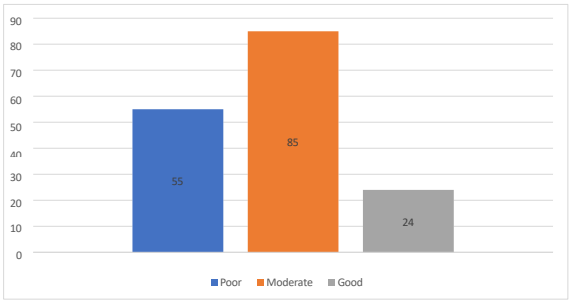

Figure 2 Dietary adherence among the study sample

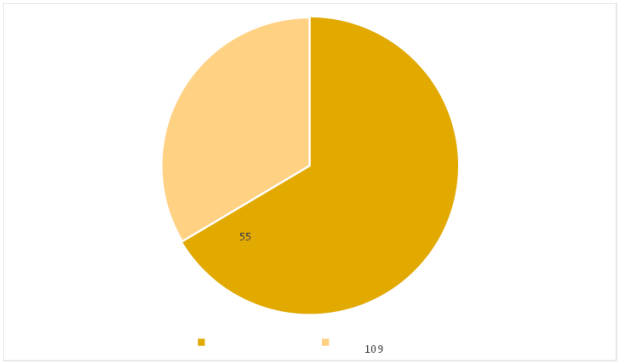

Figure 3 Prevalence of microalbuminuria

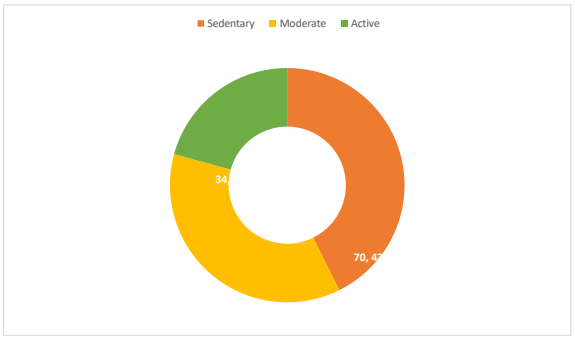

Figure 4 Physical activity among the study sample

DISCUSSION

The findings of this study provide valuable insights into the prevalence and associated factors of microalbuminuria among patients with type 2 diabetes mellitus. The prevalence of microalbuminuria observed in this study was 33.5%, which is notably higher than previous reports from neighboring regions. Studies conducted in Bangladesh and North India reported prevalence rates of 25.0%, 29.72%, and 25.5%, respectively, while another study in Nepal found a prevalence of 20.0% (11,12,13). These variations may be attributed to differences in patient characteristics, ethnic susceptibility, or methodological discrepancies in the assessment of microalbuminuria. The heterogeneity in study populations, including variations in glycemic control, comorbidities, and treatment regimens, could also contribute to the observed differences. The demographic distribution in this study, with a slight predominance of males (54.3%) over females (45.7%), aligns with existing literature, which suggests that gender does not significantly influence the prevalence of diabetes-related complications such as microalbuminuria (14,15). The majority of participants were middle-aged (41–60 years), a pattern consistent with global epidemiological trends indicating that the risk of type 2 diabetes and its complications increases with age (16). The high proportion of overweight (41.5%) and obese (25.0%) participants underscores the strong association between excessive weight and diabetes-related complications. Additionally, the high prevalence of hypertension (61.0%) and dyslipidemia (53.7%) among participants reflects the clustering of cardiovascular risk factors in individuals with type 2 diabetes, which is well documented in previous research (17,18). The co-existence of these metabolic disorders exacerbates the progression of diabetic nephropathy and increases the likelihood of developing microalbuminuria.

The relatively higher prevalence of microalbuminuria in this study compared to other reports may be attributed to suboptimal glycemic control among participants. The majority of individuals had HbA1c levels between 7.0% and 9.0%, indicating inadequate diabetes management, which is a well-recognized risk factor for nephropathy. Poor glycemic control accelerates the progression of diabetic kidney disease by promoting endothelial dysfunction and glomerular injury, leading to increased urinary albumin excretion. The

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association between microalbuminuria and glycemic status was evident, as a significant proportion of participants with microalbuminuria had higher HbA1c levels compared to those without it. These findings are consistent with previous research emphasizing the role of hyperglycemia in the pathogenesis of diabetic nephropathy (19,20). Hypertension was significantly associated with microalbuminuria, with affected individuals exhibiting higher systolic blood pressure compared to those without the condition. Elevated blood pressure is a well-established risk factor for diabetic nephropathy, contributing to increased glomerular pressure and renal damage. The presence of hypertension in a substantial proportion of participants reinforces the necessity of strict blood pressure control in diabetic patients to prevent renal complications. Furthermore, lifestyle factors played a crucial role in the development of microalbuminuria. A sedentary lifestyle was significantly more prevalent among individuals with microalbuminuria, while participants without microalbuminuria were more likely to engage in moderate physical activity. Poor dietary adherence was also significantly associated with microalbuminuria, further emphasizing the need for lifestyle modifications in diabetes management (21.22).

Despite its strengths, the study had certain limitations. The relatively small sample size may have introduced sampling bias, limiting the generalizability of the findings to broader populations. The assessment of microalbuminuria was based on urine dipstick analysis rather than gold-standard quantitative methods, which may have affected the precision of the measurements. Additionally, potential confounding factors such as medication adherence, dietary sodium intake, and genetic predisposition were not extensively evaluated. Future studies should incorporate larger sample sizes, utilize standardized laboratory methods for microalbuminuria detection, and explore additional variables influencing the progression of diabetic nephropathy. Longitudinal studies are warranted to assess the temporal relationship between glycemic control, lifestyle modifications, and the development of microalbuminuria (22). The findings of this study reinforce the critical role of early microalbuminuria screening in patients with type 2 diabetes, particularly those with poor glycemic control, hypertension, and sedentary lifestyles. Given the strong association between microalbuminuria and cardiovascular as well as renal complications, routine monitoring and early intervention strategies, including optimized glycemic and blood pressure management, should be prioritized. The integration of lifestyle interventions alongside pharmacological treatment remains essential to mitigate the burden of diabetic kidney disease and improve long-term patient outcomes.

CONCLUSION

The findings of this study highlight the significant burden of diabetic kidney disease, with microalbuminuria emerging as an early marker of renal dysfunction in individuals with type 2 diabetes. The strong associations observed with prolonged diabetes duration, hypertension, poor glycemic control, sedentary lifestyle, and inadequate dietary adherence emphasize the need for proactive management strategies. Uncontrolled diabetes and its related complications were evident among affected individuals, underscoring the necessity for regular screening, optimized treatment plans, and lifestyle modifications to prevent disease progression. Early detection and intervention remain crucial in reducing the risk of advanced nephropathy and improving long-term health outcomes in diabetic patients.

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AuthorContribution

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Ayesha Aziz	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Hammad Ishaq	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Ayesha Jahanzeb	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Nabeela Sultan	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Sher Afgan Raisani	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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