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Original Research Article

Association Between Lipid Profile Parameters and Urinary Albumin-to-Creatinine Ratio in Newly Diagnosed Type 2 Diabetes

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ABSTRACT
Dyslipidaemia and increased urinary albumin excretion may coexist in patients with type 2 diabetes mellitus (T2DM), potentially reflecting overlapping metabolic and renal abnormalities. However, the relationship between individual lipid profile parameters and urinary albumin-to-creatinine ratio (UACR) may vary across populations. We aimed to evaluate the association between serum lipid profile parameters and UACR among patients with newly diagnosed T2DM. This hospital-based, cross-sectional observational study was conducted at Agartala Government Medical College and Govind Ballabh Pant Hospital, Agartala, Tripura, India, from June 2023 to December 2024. A total of 270 patients with newly diagnosed T2DM were included. Serum total cholesterol, triglycerides, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and very-low-density lipoprotein cholesterol (VLDL-C) were assessed. UACR was calculated using urinary albumin and creatinine concentrations measured in spot urine samples. Associations between UACR and individual lipid parameters were evaluated using Pearson's correlation analysis, with $p < 0.05$ considered statistically significant. The mean age of participants was 39.6 ± 8.1 years, and 51.9% were male. The mean UACR was 39.3 ± 9.0 mg/g. Mean concentrations of total cholesterol, triglycerides, HDL-C, VLDL-C, and LDL-C were 207.8 ± 20.9, 188.6 ± 15.0, 25.4 ± 3.3, 37.7 ± 3.0, and 129.8 ± 15.9 mg/dL, respectively. UACR showed a significant positive correlation with total cholesterol ($r = 0.350$, $p < 0.001$) and a significant negative correlation with HDL-C ($r = −0.295$, $p < 0.001$). A weak positive correlation was observed between UACR and LDL-C ($r = 0.134$, $p = 0.028$). No statistically significant correlations were observed between UACR and triglycerides ($r = 0.005$, $p = 0.930$) or VLDL-C ($r = −0.006$, $p = 0.919$). In patients with newly diagnosed T2DM, UACR was significantly associated with total cholesterol, HDL-C, and LDL-C, whereas no significant linear correlations

were observed with triglycerides or VLDL-C. The strength and direction of the associations differed across lipid parameters. As the study was cross-sectional and the analyses were unadjusted, these findings do not establish causality or independent predictive relationships. Further longitudinal studies with multivariable analysis are warranted.

Keywords: Type 2 diabetes mellitus; urinary albumin-to-creatinine ratio; microalbuminuria; dyslipidaemia; lipid profile; Pearson correlation.

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a major metabolic disorder associated with an increased risk of cardiovascular disease and kidney complications. Dyslipidaemia is a common metabolic abnormality in T2DM and is characterised by alterations in serum triglycerides, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and other lipoprotein fractions. The characteristic diabetic lipid pattern commonly includes elevated triglycerides, reduced HDL-C and qualitative changes in LDL particles, contributing to atherogenic risk[1,2]. Diabetic kidney disease is an important complication of diabetes and may be present at the time T2DM is diagnosed. Current clinical recommendations emphasise the assessment of urinary albumin-to-creatinine ratio (UACR) and estimated glomerular filtration rate (eGFR) for evaluating kidney involvement in people with T2DM. Urinary albumin excretion is an important marker of kidney damage and is associated with cardiovascular risk. However, albuminuria can vary considerably, and its interpretation depends on the measurement method and clinical context[3,4].

The relationship between dyslipidaemia and urinary albumin excretion is clinically relevant because lipid abnormalities and albuminuria may coexist in people with diabetes. Previous studies have discussed the interrelationship between diabetic dyslipidaemia, kidney disease and cardiovascular complications, suggesting that these abnormalities may reflect overlapping metabolic and vascular disturbances[5,6]. Nevertheless, the association may differ among individual lipid parameters, and the relationship observed in one population should not automatically be assumed to apply to another. Evidence from Indian populations has established the importance of evaluating urinary albumin excretion in people with T2DM. Studies conducted in South India have investigated the prevalence of microalbuminuria and its associated factors in diabetic populations[7]. Research in newly diagnosed Indian patients with T2DM has also reported associations between urinary albumin excretion, central obesity and hyperglycaemia[8]. Furthermore, studies have examined the prevalence and risk factors of diabetic nephropathy in urban South Indian populations, reinforcing the importance of early assessment of renal involvement[9].

Although these findings provide a rationale for investigating the relationship between lipid metabolism and urinary albumin excretion, differences in study populations, disease duration, measurement methods and statistical approaches limit direct comparisons across studies. Research examining the association between UACR, lipid abnormalities and glycaemic control have further highlighted the clinical relevance of this relationship[10]. Assessing individual lipid parameters alongside urinary microalbuminuria in newly diagnosed patients may therefore contribute to the understanding of metabolic abnormalities present early in the course of T2DM. The present study aimed to evaluate the association between serum lipid profile parameters and urinary microalbuminuria among patients with newly diagnosed T2DM attending a tertiary care hospital in Tripura, India.

MATERIALS AND METHODS

Study Design and Setting: This hospital-based, cross-sectional observational study was conducted from June 2023 to December 2024 in the Department of Biochemistry, Agartala Government Medical College (AGMC) and Govind Ballabh Pant Hospital (GBP Hospital), Agartala, Tripura, India, in collaboration with the Department of Medicine at the same institution.

Study Population: The study population comprised patients with newly diagnosed type 2 diabetes mellitus (T2DM) attending the diabetic clinic at AGMC and GBP Hospital. A total of 270 participants were included in the final analysis

Inclusion and Exclusion Criteria: Patients with newly diagnosed T2DM, aged

18 years or older, who were willing to participate in the study were eligible for inclusion. Diabetes was defined according to the American Diabetes Association criteria, using HbA1c ≥6.5%, fasting plasma glucose ≥126 mg/dL, 2-hour plasma glucose ≥200 mg/dL during an oral glucose tolerance test, or random plasma glucose ≥200 mg/dL in the presence of symptoms of hyperglycaemia. The exclusion criteria were age below 18 years, pregnancy, chronic alcohol abuse, and unwillingness to provide written informed consent.

Sampling Technique and Data Collection: Participants were recruited according to the specified eligibility criteria during the first three working days of each week until the required sample size was approached. Demographic and clinical information was recorded using a case record form. A clinical history was obtained, and a general physical examination, including blood pressure measurement, was performed.

Biochemical Investigations: Approximately 5 mL of blood was collected from each participant by venepuncture under aseptic precautions. The blood was collected in appropriate sample containers, and serum was separated by centrifugation after clotting. Samples were analysed as soon as possible; when analysis was delayed, aliquots were stored at 2–8°C. The biochemical investigations included fasting blood glucose, postprandial blood glucose, glycated haemoglobin (HbA1c), serum urea, serum creatinine, and serum lipid profile parameters, including total cholesterol, triglycerides, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and very-low-density lipoprotein cholesterol (VLDL-C). LDL-C and VLDL-C were calculated using the Friedewald equation. Biochemical analyses were performed using an XL-640 fully automated clinical chemistry analyser (Transasia Bio-Medicals Ltd., Mumbai, India). Total cholesterol was measured using the cholesterol oxidase–peroxidase (CHOD-PAP) method, triglycerides using the glycerol phosphate oxidase (GPO) method, and HDL-C using a direct enzymatic method.

Measurement of Urinary Albumin and Urinary Creatinine: Spot midstream urine samples were collected in sterile containers for measurement of urinary albumin and urinary creatinine. Urinary albumin was measured quantitatively using an antigen–antibody reaction involving anti-human albumin goat antiserum. The resulting turbidity was measured at 340 nm and 700 nm, and urinary albumin concentration was determined by comparison with a standard calibration curve. Urinary creatinine was measured using an enzymatic method involving creatininase, creatinase, sarcosine oxidase, and a coupled peroxidase reaction. Absorbance was measured at 546 nm. Urine samples were diluted 1:19 with distilled water, and the measured result was multiplied by 20 to account for the dilution.

Calculation of Urinary Albumin-to-Creatinine Ratio: The urinary albumin-to-creatinine ratio (UACR) was calculated from the measured urinary albumin and urinary creatinine concentrations. As specified in the thesis, urinary albumin was expressed in mg/dL and urinary creatinine in g/dL, yielding UACR in mg/g.

Statistical Analysis: Data entry and statistical analysis were performed using IBM SPSS Statistics, version 26.0. Descriptive statistics were used to summarise the study variables. Pearson's correlation analysis was reported for assessing the association between urinary microalbuminuria and serum lipid profile parameters. A p-value below 0.05 was considered statistically significant.

Ethical Considerations: The study was conducted after obtaining approval from the Institutional Ethics Committee of Agartala Government Medical College. The study procedures were explained to eligible participants, and written informed consent was obtained before participation.

RESULTS

Baseline Characteristics of the Study Population: A total of 270 newly diagnosed patients with type 2 diabetes mellitus (T2DM) were included in the study. The mean age of the participants was 39.6 ± 8.1 years, with a range of 25–56 years. The largest proportion of participants belonged to the 31–40-year age group (41.9%), followed by those aged 41–50 years (28.9%), those aged 30 years or younger (17.4%), and those above 50 years (11.9%). Of the 270 participants, 140 (51.9%) were male and 130 (48.1%) were female. The baseline characteristics are presented in Table 1.

Characteristic	Value
Age, years	
Mean ± SD	39.6 ± 8.1
Range	25–56
Age group, n (%)	
≤30 years	47 (17.4)
31–40 years	113 (41.9)
41–50 years	78 (28.9)
>50 years	32 (11.9)
Sex, n (%)	
Male	140 (51.9)
Female	130 (48.1)

Table 1: Baseline Characteristics of the Study Population (N = 270)

Urinary Albumin-to-Creatinine Ratio in the Study Population

The mean urinary albumin-to-creatinine ratio (UACR) was 39.3 ± 9.0 mg/g, with a median of 38 mg/g and a range of 24–60 mg/g. These findings are presented in Table 2.

Parameter	Value
UACR, mean ± SD (mg/g)	39.3 ± 9.0
Median (mg/g)	38
Range (mg/g)	24–60

Table 2: Urinary Albumin-to-Creatinine Ratio in the Study Population (N = 270)

Lipid Profile Characteristics of the Study Population

The mean total cholesterol concentration was 207.8 ± 20.9 mg/dL, while the mean triglyceride concentration was 188.6 ± 15.0 mg/dL. The mean concentrations of HDL-C, VLDL-C, and LDL-C were 25.4 ± 3.3 mg/dL, 37.7 ± 3.0 mg/dL, and 129.8 ± 15.9 mg/dL, respectively. The descriptive statistics for the lipid profile parameters are presented in Table 3.

Parameter	Mean ± SD (mg/dL)	Median (mg/dL)	Range (mg/dL)
Total cholesterol	207.8 ± 20.9	206	160–260
Triglycerides	188.6 ± 15.0	190	140–224
HDL-C	25.4 ± 3.3	25	16–40
VLDL-C	37.7 ± 3.0	38	28–44.8
LDL-C	129.8 ± 15.9	130	90–157.4

Table 3: Lipid Profile Characteristics of the Study Population (N = 270)

Correlation Between Urinary Albumin-to-Creatinine Ratio and Lipid Profile Parameters

Pearson correlation analysis showed a positive correlation between UACR and total cholesterol ($r = 0.350$, $p < 0.001$). A negative correlation was observed between UACR and HDL-C ($r = -0.295$, $p < 0.001$). LDL-C showed a weaker positive correlation with UACR ($r = 0.134$, $p = 0.028$). No statistically significant correlations were observed between UACR and triglycerides ($r = 0.005$, $p = 0.930$) or VLDL-C ($r = -0.006$, $p = 0.919$). The correlation coefficients and corresponding p-values are presented in Table 4.

Parameter	Pearson's Correlation Coefficient (*r*)	*p*-value	Statistical significance
Total cholesterol	0.350	<0.001	Significant
Triglycerides	0.005	0.930	Not significant
HDL-C	−0.295	<0.001	Significant
VLDL-C	−0.006	0.919	Not significant
LDL-C	0.134	0.028	Significant

Table 4: Correlation Between UACR and Lipid Profile Parameters (N = 270)

Note: Statistical significance was defined as p < 0.05.

Abbreviations: *T2DM, type 2 diabetes mellitus; UACR, urinary albumin-to-creatinine ratio; HDL-C, high-density lipoprotein cholesterol; VLDL-C, very-low-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; SD, standard deviation.*

DISCUSSION

The present study evaluated the association between urinary albumin-to-creatinine ratio (UACR) and serum lipid profile parameters among 270 newly diagnosed patients with type 2 diabetes mellitus (T2DM) attending a tertiary care hospital in Tripura, India. The principal findings were significant positive correlations of UACR with total cholesterol and LDL-C, a significant negative correlation with HDL-C, and no statistically significant correlations with triglycerides or VLDL-C. These findings suggest that selected lipid parameters may be associated with urinary albumin excretion in patients with newly diagnosed T2DM. Previous studies have also investigated the relationship between lipid abnormalities and albuminuria, although the strength and direction of associations have varied across study populations[5,6,10–13]. The mean age of the study population was 39.6 ± 8.1 years, and males constituted 51.9% of the participants. The relatively young age profile is relevant because metabolic abnormalities and markers of kidney involvement may be present when T2DM is first diagnosed. Previous studies have documented microalbuminuria among Indian patients with T2DM, highlighting the importance of assessing renal risk early in the course of the disease[7–9]. However, because this study was cross-sectional, it cannot establish when the observed metabolic abnormalities or increased urinary albumin excretion first developed.

Association Between UACR and Total Cholesterol: A significant positive correlation was observed between UACR and total cholesterol (r = 0.350, p < 0.001). This indicates that higher total cholesterol concentrations tended to be associated with higher UACR values in the study population. The finding is consistent with research examining the relationship between urinary albumin excretion and lipid abnormalities in patients with diabetes[5,6,10,11]. Hwang and colleagues investigated the association between UACR and lipid profile parameters and reported relationships between urinary albumin excretion and selected lipid measurements[11]. Other studies have also examined lipid abnormalities in relation to albuminuria in patients with T2DM, suggesting that these metabolic and renal risk markers may coexist[10,12,13]. Nevertheless, differences in study design, population characteristics and statistical methods should be considered when comparing findings across studies. Several mechanisms may contribute to the association between elevated cholesterol and urinary albumin excretion. Insulin resistance can alter lipid metabolism, while oxidative stress, inflammation and endothelial dysfunction may contribute to vascular and glomerular injury[5,6]. These mechanisms provide a possible biological explanation for the observed association; however, they were not directly assessed in the present study. Therefore, the positive correlation does not establish that elevated total cholesterol causes increased UACR.

Association Between UACR and HDL-C: A significant negative correlation was observed between UACR and HDL-C (r = −0.295, p < 0.001), indicating that higher UACR values tended to be associated with lower HDL-C concentrations. This finding is consistent with research investigating the relationship between albuminuria and HDL-C in people with metabolic disorders[10,11,13]. Low HDL-C is a common feature of diabetic dyslipidaemia, which is frequently

associated with insulin resistance and abnormalities in lipoprotein metabolism[2,5,6]. HDL particles also have biological functions related to cholesterol transport and vascular homeostasis. Alterations in HDL concentration and function may therefore coexist with endothelial and renal abnormalities in patients with diabetes. The inverse association observed in this study suggests that lower HDL-C concentrations may accompany greater urinary albumin excretion. However, HDL-C concentration alone does not measure HDL function, and the cross-sectional design does not establish a causal relationship between HDL-C and UACR.

Association Between UACR and LDL-C: LDL-C showed a weak positive correlation with UACR (r = 0.134, p = 0.028). Although this association was statistically significant, its magnitude was small and should be interpreted cautiously. The cross-sectional design and unadjusted correlation analysis do not establish an independent or causal relationship between LDL-C and UACR. Previous research has examined the relationship between lipoprotein abnormalities and urinary albumin excretion in patients with diabetes, with findings varying according to the lipid parameter and characteristics of the study population[10,14]. The weak positive correlation observed here suggests that LDL-C may be associated with UACR, but the magnitude of the relationship was limited. Statistical significance should therefore not be interpreted as evidence of a strong clinical association. In the present study, LDL-C was calculated using the Friedewald equation. This method estimates LDL-C from total cholesterol, HDL-C and triglyceride concentrations rather than measuring LDL-C directly[15]. Subsequent research has highlighted limitations of the Friedewald equation in certain clinical settings and demonstrated that alternative estimation methods may provide different results[16]. The LDL-C findings should consequently be interpreted in the context of the method used to estimate this parameter.

Association Between UACR and Triglycerides and VLDL-C: No statistically significant correlation was observed between UACR and triglycerides (r = 0.005, p = 0.930). Similarly, the correlation between UACR and VLDL-C was negligible and not statistically significant (r = −0.006, p = 0.919). These results indicate that the present study did not demonstrate a significant linear relationship between UACR and either of these lipid parameters. These findings differ from some previous studies that have reported associations between triglyceride concentrations and albuminuria in patients with T2DM[10,11]. Differences in the distribution of lipid values, glycaemic control, patient characteristics and other clinical factors may contribute to the variation between studies. The absence of a significant correlation in the present cohort does not necessarily exclude an association in other populations. VLDL-C was calculated using the Friedewald approach, in which VLDL-C is estimated from triglyceride concentration[15]. Consequently, triglycerides and calculated VLDL-C are mathematically related rather than entirely independent measurements. Nevertheless, neither parameter showed a statistically significant correlation with UACR in this dataset.

Clinical Implications: The significant associations observed between UACR and total cholesterol, HDL-C and LDL-C suggest that selected lipid parameters may provide complementary information when evaluating patients with newly diagnosed T2DM. UACR and estimated glomerular filtration rate are established components of kidney risk assessment in diabetes, while lipid profile evaluation is important for cardiovascular risk assessment and management[3,4]. The relationship between dyslipidaemia, kidney disease and cardiovascular risk has also been discussed in previous clinical and mechanistic literature[5,6]. These findings support the importance of assessing both urinary albumin excretion and lipid abnormalities in patients with newly diagnosed T2DM. However, the present study does not establish that any lipid parameter independently predicts albuminuria or that lowering a particular lipid concentration will reduce UACR. Further research incorporating longitudinal follow-up and multivariable analysis is required to clarify these relationships.

Strengths and Limitations: An important strength of this study is its focus on newly diagnosed patients with T2DM, providing information about the relationship between lipid profile parameters and urinary albumin excretion near the time of diagnosis. The study also evaluated several lipid parameters individually, allowing their

respective correlations with UACR to be compared. Several limitations should be acknowledged. First, the cross-sectional design prevents the establishment of temporal relationships or causal associations. Second, the study was conducted at a single tertiary care hospital, which may limit the generalisability of the findings. Third, a single UACR measurement cannot establish persistent albuminuria; repeat measurements are generally required for confirmation[3,4]. Fourth, the reported Pearson correlations were not adjusted for potential confounding factors, including glycaemic control, blood pressure, adiposity and medication use. Finally, the correlation coefficients presented in this manuscript are based on the thesis-reported values and should be independently verified against the original statistical output before submission. Despite these limitations, the findings contribute to the understanding of the relationship between lipid profile parameters and urinary albumin excretion in newly diagnosed T2DM. The differing directions and magnitudes of the observed correlations also indicate that the relationship is not uniform across all lipid parameters.

CONCLUSION

The present study demonstrated significant correlations between urinary albumin-to-creatinine ratio (UACR) and selected lipid profile parameters in newly diagnosed patients with type 2 diabetes mellitus. UACR showed a significant positive correlation with total cholesterol and LDL-C, whereas a significant negative correlation was observed with HDL-C. No statistically significant correlations were found between UACR and triglycerides or VLDL-C. These findings suggest that the relationship between urinary albumin excretion and lipid profile parameters varies across individual lipid components. Assessment of UACR alongside lipid profile may provide useful information about renal and metabolic risk in patients with newly diagnosed T2DM. However, the cross-sectional design precludes causal inference, and further longitudinal studies are required to clarify these associations.

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