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Association between Obesity and Lipid Profile among Patients with Type 2 Diabetes Mellitus at a Tertiary Care Hospital in Eastern Nepal

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ABSTRACT

Background

Type 2 Diabetes Mellitus (T2DM) is frequently associated with obesity and dyslipidemia, major risk factors for cardiovascular disease. However, evidence on their prevalence and relationship among T2DM patients in Eastern Nepal is limited. This study aimed to determine the prevalence of obesity and dyslipidemia and assess the association between Body Mass Index (BMI) and lipid profile parameters among T2DM patients attending a tertiary care hospital in Eastern Nepal.

Methods

This hospital-based cross-sectional observational study was conducted from February 2026 to March 2026. Enrolled 405 adult patients with Type 2 Diabetes Mellitus (T2DM) attending the Medical Outpatient Department (OPD) of B & C Medical College Teaching Hospital & Research Center. Sociodemographic and clinical data were collected using a structured questionnaire. Anthropometric measurements were performed and fasting lipid profiles were obtained from routine laboratory investigations. Data were analyzed using STATA version 14. Chi-square tests, one-way ANOVA, and multivariate logistic regression were used to assess associations.

Results

The mean age of participants was 52.4 ± 11.8 years, and 44.7% were obese (BMI ≥25 kg/m²). Dyslipidemia was present in 79.3% of patients, with elevated LDL-C (75.8%) being the most common abnormality, followed by hypertriglyceridemia (62.0%), elevated total cholesterol (56.3%), and low HDL-C (53.8%). Obese patients had significantly worse lipid profiles than non-obese patients ($p<0.001$). Multivariate analysis identified obesity (AOR=3.02, 95% CI: 1.72-5.31, $p<0.001$) and T2DM duration >10 years (AOR=1.87, 95% CI: 1.12-3.11, $p=0.016$) as independent predictors of dyslipidemia.

Conclusions

Obesity is significantly associated with dyslipidemia among patients with T2DM in Eastern Nepal. Routine lipid screening and targeted obesity management should be integrated into the care of diabetic patients to reduce cardiovascular risk.

Keywords: Type 2 Diabetes Mellitus; Obesity; Body mass index; Dyslipidemia; Lipid profile; Cardiovascular risk; Eastern Nepal.

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INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder characterized by insulin resistance and progressive beta-cell dysfunction, resulting in persistent hyperglycemia. It is one of the most rapidly growing global public health challenges, with an estimated 537 million adults affected worldwide as of 2021, projected to surpass 783 million by 2045. [1] The burden is disproportionately borne by low- and middle-income countries (LMICs), including Nepal, where urbanization, sedentary lifestyles, and dietary transitions have accelerated its prevalence. [2]

Dyslipidemia is among the most frequent and clinically significant metabolic comorbidities in T2DM. The characteristic pattern includes hypertriglyceridemia, reduced high-density lipoprotein cholesterol (HDL-C), and small dense low-density lipoprotein (LDL) particles, all atherogenic and driving accelerated atherosclerosis in this population. [3] Cardiovascular disease remains the leading cause of mortality among individuals with T2DM, and dyslipidemia substantially mediates this risk. [4] Obesity, particularly visceral adiposity, is both a major risk factor for T2DM and a potent contributor to dyslipidemia. Excess visceral fat promotes insulin resistance through chronic low-grade inflammation, increased free fatty acid flux to the liver, and dysregulated adipokine secretion. [5] These mechanisms impair lipoprotein metabolism, resulting in elevated triglycerides, reduced HDL-C, and increased LDL-C. [6] Body Mass Index (BMI) is the most widely used clinical proxy for adiposity, and Asian populations exhibit cardiometabolic risk at lower BMI thresholds than Western populations, necessitating Asia-Pacific BMI cutoffs. In Nepal, the Nepal STEPS Survey 2019 documented a rising prevalence of overweight and obesity alongside increasing non-communicable disease burden, reflecting epidemiological transition. [7] Hospital-based studies consistently report high dyslipidemia rates among diabetic patients. [8] A study from Province 1 reported obesity in nearly two-fifths of T2DM patients, highlighting coexistence of these conditions in Eastern Nepal. [9] However, region-specific evidence quantifying the association between obesity and dyslipidemia in Eastern Nepal remains limited. This study was therefore conducted to determine the prevalence of obesity and dyslipidemia, and to evaluate the independent association between BMI and lipid profile parameters among T2DM patients at a tertiary care hospital in Eastern Nepal. The findings are expected to inform clinicians and policymakers regarding the need for integrated cardiovascular risk reduction strategies in this growing patient population.

METHODS

Study Design

A hospital-based cross-sectional study was conducted among patients with Type 2 Diabetes Mellitus (T2DM) attending the Medical Outpatient Department (OPD).

Study Area

The study was carried out at the Medical Outpatient Department (OPD) of B & C Medical College Teaching Hospital & Research Center Pvt. Ltd., Birtamode, Jhapa District, Koshi. Data collection was conducted over a two-month period from February 2026 to March 2026.

Study Population

The study population consisted of adult patients aged 25 years and above with a documented diagnosis of Type 2 Diabetes Mellitus (T2DM) according to the American Diabetes Association (ADA) criteria who attended the Medical OPD during the study period. Patients with Type 1 diabetes mellitus, gestational diabetes, secondary diabetes, severe hepatic or renal disease, pregnancy, breastfeeding status, current use of lipid-modifying agents or systemic corticosteroids, incomplete laboratory records, or those unwilling to participate were excluded from the study.

Sample Size

The sample size was calculated using the standard formula for cross-sectional studies, considering an expected obesity prevalence of 39.5% among T2DM patients in Province 1, Nepal, a 95% confidence level, and a 5% margin of error. The minimum calculated sample size was 367 participants. After adding a 10% allowance for non-response, the final

required sample size was 405 participants, all of whom were successfully enrolled in the study.

Sampling Technique

A non-probability sampling technique was use for the selection of participant. All eligible T2DM patients who attended the Medical OPD during the study period and met the inclusion criteria were approached and enrolled consecutively until the desired sample size of 405 participants was achieved.

Data Collection Tools and Technique

Data were collected using a structured interviewer-administered questionnaire designed to obtain information on sociodemographic characteristics, lifestyle behaviors, and clinical profiles. Sociodemographic variables included age, sex, residence, education, occupation, and monthly income, while lifestyle factors included smoking and alcohol consumption. Clinical information such as duration of T2DM, comorbidities, and antidiabetic medications was also recorded. Anthropometric measurements were taken by trained personnel using standardized procedures. Body weight was measured using a calibrated digital weighing scale, and height was measured using a portable stadiometer. Waist and hip circumferences were measured using a non-stretchable measuring tape. Additionally, fasting venous blood samples were collected after at least 8 hours of fasting and analyzed in the hospital's central laboratory for lipid profile parameters using an enzymatic colorimetric method on a Roche COBAS C311 auto-analyzer.

Variables/Measurements

The primary outcome variable of the study was dyslipidemia. Independent variables included sociodemographic factors (age, sex, residence, education, occupation, and monthly income), lifestyle factors (smoking and alcohol consumption), clinical factors (duration of T2DM, comorbidities, and medication use), and anthropometric measurements. Body Mass Index (BMI) was calculated by dividing weight in kilograms by height in meters squared (kg/m²), and obesity was defined as BMI ≥25 kg/m² according to the WHO Asia-Pacific guidelines. Dyslipidemia was defined according to the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) criteria as total cholesterol >200 mg/dL, triglycerides >150 mg/dL, LDL cholesterol >100 mg/dL, and/or HDL cholesterol <40 mg/dL in men or <50 mg/dL in women.

Statistical Analysis Used

The collected data were entered into Microsoft Excel 2019 and subsequently analyzed using STATA version 14.0. Descriptive statistics were presented as frequencies, percentages, means, and standard deviations as appropriate. The Chi-square test was used to assess associations between categorical variables. One-way analysis of variance (ANOVA), followed by Tukey's post-hoc test, was applied to compare mean lipid profile values across BMI categories. Pearson's correlation coefficient was used to evaluate the relationship between BMI and lipid profile parameters. Furthermore, multivariate logistic regression analysis was performed to identify independent predictors of dyslipidemia after adjusting for potential confounding variables. The results were reported as odds ratios (ORs) with corresponding 95% confidence intervals (CIs), and a p-value of less than 0.05 was considered statistically significant.

Ethical Consideration

Ethical approval for the study was obtained from the Institutional Review Committee (IRC) of the hospital (Ref. No.: 004-2026) before the commencement of data collection. Written informed consent was obtained from all participants after explaining the objectives and procedures of the study. Confidentiality and anonymity of participants' information were strictly maintained throughout the research process. Participation was entirely voluntary, and participants were informed of their right to withdraw from the study at any stage without any consequences to their treatment or care.

RESULTS

A total of 405 patients with T2DM were enrolled. The mean age of participants was 52.4 ± 11.8 years. The gender distribution was nearly equal, with 204 males (50.4%) and 201 females (49.6%). The majority of participants were from urban areas (61.2%), and more than half had completed secondary education

or above. The most common age group was 41–55 years (42.5%). Farming (24.2%) and business (27.7%) were the predominant occupations. Regarding duration of T2DM, 40.2% had diabetes for 5–10 years and 23.2% for more than 10 years. The proportions of current smokers and alcohol consumers were 14.3% and 30.1%, respectively. Detailed sociodemographic characteristics are presented in (Table 1).

Table 1. Sociodemographic and Clinical Characteristics of Study Participants (n=405).

Characteristics	Frequency (%)
Age (years)	
25-40	68 (16.8)
41-55	172 (42.5)
56-70	133 (32.8)
>70	32 (7.9)
Sex	
Male	204 (50.4)
Female	201 (49.6)
Residence	
Urban	248 (61.2)
Rural	157 (38.8)
Education	
Illiterate	89 (22)
Primary (1-5)	94 (23.2)
Secondary (6-10)	131 (32.3)
Higher secondary & above	91 (22.5)
Occupation	
Farming	98 (24.2)
Business	112 (27.7)
Housewife	87 (21.5)
Service	76 (18.8)
Unemployed/Retired	32 (7.9)
Duration of T2DM	
< 5 years	148 (36.5)
5-10 years	163 (40.2)
> 10 years	94 (23.2)
Smoking Status	
Never	274 (67.7)
Former	73 (18)
Current	58 (14.3)
Alcohol Consumption	
Never	283 (69.9)
Former/Current	122 (30.1)

The overall prevalence of obesity (BMI ≥25 kg/m²) was 44.7% (n=181). When categorized by WHO Asia-Pacific BMI classifications, 27.7% (n=112) were overweight (BMI 23.0–24.9 kg/m²) and 44.7% were obese (BMI ≥25 kg/m²). Only 3.5% (n=14) were underweight and 24.2% (n=98) had normal weight. The mean BMI of the overall study population was 25.8 ± 4.3 kg/m². Female participants had a higher mean BMI (26.4 ± 4.6 kg/m²) compared to males (25.2 ± 4.0 kg/m²). Table 2 summarizes BMI distribution (Table 2).

Table 2. Distribution of Participants by BMI Category (n=405).

BMI Category (WHO Asia-Pacific)	Frequency (%)
Underweight	14 (3.5)
Normal weight	98 (24.2)
Overweight	112 (27.7)

The overall prevalence of dyslipidemia (any abnormal lipid parameter) was 79.3% (n=321). Elevated LDL-C (>100 mg/dL) was the most frequent abnormality, affecting 75.8% of participants. Hypertriglyceridemia (TG >150 mg/dL) was found in 62.0%, elevated total cholesterol in 56.3%, and low HDL-C in 53.8% of participants. The mean serum levels were: TC 214.6 ± 42.3 mg/dL, TG 186.4 ± 67.8 mg/dL, LDL-C 138.7 ± 38.5 mg/dL, and HDL-C 42.1 ± 10.2 mg/dL. Table 3 presents the lipid profile parameters and prevalence of individual abnormalities.

Table 3. Lipid Profile Parameters and Prevalence of Dyslipidemia (n=405).

Lipid Parameter	Mean ± SD	Abnormal (%)
Total Cholesterol (TC) >200 mg/dL	214.6 ± 42.3 mg/dL	228 (56.3)
Triglycerides (TG) >150 mg/dL	186.4 ± 67.8 mg/dL	251 (62)
LDL-C >100 mg/dL	138.7 ± 38.5 mg/dL	307 (75.8)
HDL-C <40 mg/dL (M) / <50 mg/dL (F)	42.1 ± 10.2 mg/dL	218 (53.8)
Dyslipidemia (any parameter)	—	321 (79.3)

The prevalence of dyslipidemia increased progressively across BMI categories: 57.1% in underweight, 65.3% in normal weight, 81.3% in overweight, and 87.3% in obese patients. This gradient was statistically significant (χ^2 test, $p<0.001$). Table 4 presents the association between

BMI category and dyslipidemia.

Table 4. Association between BMI Category and Dyslipidemia (n=405).

BMI Category	Dyslipidemia		p-value
	Yes (%)	No (%)	
Underweight (<18.5)	8 (57.1)	6 (42.9)	<0.001
Normal (18.5-22.9)	64 (65.3)	34 (34.7)	
Overweight (23.0-24.9)	91 (81.3)	21 (18.8)	
Obese (≥25.0)	158 (87.3)	23 (12.7)	

One-way ANOVA demonstrated significant differences in mean lipid values across BMI categories ($p<0.001$ for all parameters). Obese patients had the highest mean TC (226.3 ± 44.8 mg/dL), TG (208.7 ± 71.2 mg/dL), and LDL-C (148.9 ± 40.1 mg/dL), and the lowest mean HDL-C (38.4 ± 8.9 mg/dL). Post-hoc Tukey's analysis confirmed significant pairwise differences between obese and normal-weight patients for all lipid parameters. Pearson's correlation revealed a significant positive correlation between BMI and TC ($r=0.38$, $p<0.001$), TG ($r=0.44$, $p<0.001$), LDL-C ($r=0.42$, $p<0.001$), and a significant negative correlation between BMI and HDL-C ($r=-0.41$, $p<0.001$). Table 5 summarizes mean lipid values by BMI category.

Table 5. Mean Lipid Profile Values by BMI Category (n=405).

BMI Category	TC (mg/dL)	TG (mg/dL)	LDL-C (mg/dL)	HDL-C (mg/dL)
Underweight	196.2 ± 34.1	148.3 ± 52.1	122.4 ± 30.6	48.6 ± 9.4
Normal weight	204.8 ± 38.7	162.7 ± 59.3	129.3 ± 34.2	46.2 ± 10.1
Overweight	218.4 ± 41.2	191.6 ± 66.4	141.2 ± 37.8	41.8 ± 9.8
Obese	226.3 ± 44.8	208.7 ± 71.2	148.9 ± 40.1	38.4 ± 8.9
p-value	<0.001	<0.001	<0.001	<0.001

On multivariate logistic regression, adjusting for age, sex, duration of T2DM, smoking, and alcohol consumption, obesity (BMI ≥25 kg/m²) remained a significant and independent predictor of dyslipidemia (adjusted OR 3.02; 95% CI 1.72-5.31; $p<0.001$). Duration of T2DM >10 years was also independently associated with dyslipidemia (adjusted OR 1.87; 95% CI 1.12-3.11; $p=0.016$). Age per 10-year increment was additionally significant (adjusted OR 1.29; 95% CI 1.01-1.65; $p=0.042$). Sex, smoking, and alcohol did not emerge as significant independent predictors after adjustment. Table 6 presents crude and adjusted ORs.

Table 6. Multivariate Logistic Regression-Predictors of Dyslipidemia (n=405).

Variable	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
BMI ≥25 kg/m² (Obese vs Normal)	3.64 (2.11-6.28)	<0.001	3.02 (1.72-5.31)	<0.001
Age (per 10-year increment)	1.38 (1.09-1.74)	0.007	1.29 (1.01-1.65)	0.042
Male sex	1.21 (0.78-1.87)	0.391	1.14 (0.72-1.81)	0.573
Duration of T2DM >10 yrs	2.18 (1.34-3.54)	0.002	1.87 (1.12-3.11)	0.016
Current smoker	1.44 (0.83-2.50)	0.196	1.31 (0.74-2.33)	0.357
Alcohol consumption	1.56 (0.98-2.49)	0.062	1.39 (0.85-2.27)	0.186

DISCUSSION

This cross-sectional study of 405 T2DM patients at a tertiary care hospital in Eastern Nepal found a high prevalence of obesity (44.7%) and dyslipidemia (79.3%), with a significant independent association between elevated BMI and dyslipidemia. These findings are clinically important and consistent with the growing evidence linking adiposity to cardiometabolic risk in South Asian populations. The observed obesity prevalence of 44.7% using WHO Asia-Pacific cutoffs (BMI ≥25 kg/m²) is higher than the 39.5% reported by Roy et al. (2022)

from Province 1, Nepal, [9] and reflects the ongoing epidemiological transition in this region. The higher prevalence may be attributable to the predominantly urban study population (61.2%), where sedentary occupations and calorie-dense diets are more prevalent. These findings align with the Nepal STEPS Survey 2019, which documented increasing prevalence of overweight and obesity nationally, particularly in peri-urban and urban settings. [7] The overall prevalence of dyslipidemia (79.3%) in our study is consistent with earlier Nepali data. Shrestha et al. (2012) reported dyslipidemia in approximately 75% of T2DM patients in Nepal. [8] Studies from neighboring India and Bangladesh have similarly documented dyslipidemia in 70-85% of diabetic patients. [7, 13, 14] The predominance of elevated LDL-C (75.8%) and hypertriglyceridemia (62.0%) in the present study mirrors the characteristic pattern of diabetic dyslipidemia described by Betteridge (2000) and others. [3, 15] The gradient increase in dyslipidemia prevalence from normal-weight (65.3%) to obese patients (87.3%), and the significant differences in mean lipid values across BMI categories, are consistent with the well-established mechanistic link between obesity and dyslipidemia. Excess visceral adiposity promotes hepatic overproduction of VLDL particles secondary to increased free fatty acid flux, resulting in hypertriglyceridemia and secondary reductions in HDL-C through lipid-transfer protein exchange . [5, 6] Simultaneously, insulin resistance-heightened in obese individuals-impairs lipoprotein lipase activity, further elevating circulating triglycerides and producing the small, dense LDL particles characteristic of diabetic dyslipidemia. [4, 17] The multivariate logistic regression confirmed obesity as an independent predictor of dyslipidemia (adjusted OR 3.02; 95% CI 1.72-5.31) after adjusting for age, sex, T2DM duration, smoking, and alcohol. The magnitude of this association is similar to that reported in a systematic review by Bhatt et al. (2019) examining South Asian diabetic populations, which found ORs between 2.5 and 4.1 for obesity as a predictor of dyslipidemia. [17] Longer T2DM duration (>10 years) was also an independent predictor (adjusted OR 1.87), consistent with evidence that progressive beta-cell failure and worsening insulin resistance over time further derange lipid metabolism. [18, 19] Interestingly, sex was not a significant independent predictor of dyslipidemia in multivariate analysis, although female patients had a higher mean BMI. This is concordant with evidence suggesting that metabolic risk associated with adiposity in South Asian populations operates largely through BMI-mediated mechanisms rather than sex differences per se. [20] Smoking and alcohol consumption were also non-significant after adjustment, possibly reflecting the relatively modest proportions of current smokers (14.3%) and drinkers (30.1%) in this cohort. The finding that more than half of T2DM patients had low HDL-C (53.8%) is particularly concerning, given that low HDL-C is an independent cardiovascular risk factor and is not adequately addressed by standard antidiabetic therapies. This underscores the need for proactive lifestyle counseling-including weight reduction, increased physical activity, and dietary modification-as primary interventions, consistent with current ADA and ACC/AHA guidelines. [12, 21]

Limitations

This study has several limitations. The cross-sectional design precludes causal inference; it is not possible to determine whether obesity precedes dyslipidemia or vice versa. As a single tertiary-center hospital-based study, findings may not be generalizable to community populations or other regions of Nepal. Single-time measurements of BMI and lipid parameters may not reflect long-term metabolic status. Dietary assessment was not performed, which is a recognized confounder of both obesity and lipid levels. Despite these limitations, the study's relatively large sample size, standardized data collection, and multivariate adjustment for key confounders strengthen the validity of its findings.

Conclusions

This study demonstrates a high prevalence of obesity (44.7%) and dyslipidemia (79.3%) among patients with Type 2 Diabetes Mellitus at a tertiary care hospital in Eastern Nepal. Obesity is a significant and independent predictor of dyslipidemia, with obese patients showing markedly worse lipid

profiles across all parameters. Duration of diabetes and age are additional independent risk factors. These findings highlight the critical importance of integrating routine lipid screening, anthropometric assessment, and targeted obesity management into the comprehensive care of T2DM patients in Nepal. Lifestyle modification interventions focusing on weight reduction and cardiovascular risk factor control should be prioritized in clinical practice and public health programs in Eastern Nepal.

Conflicts of Interest: The authors declare that they have no conflict of interest.

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Ethical and Publication Integrity: Ethical approval for the study was obtained from the Institutional Review Committee (IRC) of the hospital (Ref. No.: 004-2026) before the commencement of data collection.

Availability of data and materials: The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

Authors' Contributions

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