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ORIGINAL RESEARCH

The Burden of Dyslipidemia and Determinant Factors Among Type 2 Diabetes Mellitus Patients at Hawassa University Comprehensive Specialized Hospital, Hawassa, Ethiopia

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Background: Diabetes is a global health challenge with escalating prevalence rates. Cardiovascular complications represent the leading cause of mortality among individuals with diabetes. Notably, dyslipidemia stands as a prominent risk factor for cardiovascular disease in Type 2 diabetes mellitus (T2DM) patients. Timely detection and management of dyslipidemia in these patients hold the potential to deter its progression and substantially reduce the risk of cardiovascular-related morbidity and mortality. This study was aimed at assessing the burden of dyslipidemia and determinant factors among T2DM patients who were being followed at the Endocrinology clinic of Hawassa University Comprehensive Specialized Hospital (HUCSH).

Methodology: An Institutional- based retrospective cross-sectional study was conducted, and samples of 228 patients were selected using a systematic random sampling technique. Data were collected through structured face-to-face interviews using a questionnaire. Bivariate logistic analysis was utilized, and variables with a p-value < 0.25 in this analysis were considered candidates for multivariate logistic analysis. Multivariate logistic regression was employed to identify factors associated with the prevalence of dyslipidemia, with a significance threshold set at $p < 0.05$.

Results: The research revealed an overall prevalence of dyslipidemia among the study participants at 75.9%. The specific manifestations of dyslipidemia were observed as follows: hypertriglyceridemia in 43%, hypercholesterolemia in 25%, elevated low-density lipoprotein in 59.2%, and reduced high-density lipoprotein in 33.3% of the study participants. Factors significantly associated with dyslipidemia included longer diabetes duration, poor physical activity, elevated HbA1C, and obesity.

Conclusion: This study underscores a notably high prevalence of dyslipidemia among T2DM patients. The findings highlight the advocate for clinicians to prioritize routine screening, and effective treatment concerning dyslipidemia and its associated risk factors among individuals with T2DM. It is worth mentioning that this study was conducted in a specific hospital setting and limited time, and hence the findings, and generalizability to other healthcare facilities should be taken cautiously.

Keywords: T2DM, dyslipidemia, cardiovascular

Introduction

Diabetes mellitus, a metabolic disorder characterized by elevated serum glucose levels, affects over half a billion people globally.[1–3] The global prevalence of diabetes is projected to surge to 783 million by 2045, underscoring the urgent need for comprehensive management strategies.[4] Cardiovascular complications are a leading cause of diabetes-related morbidity and mortality, with dyslipidemia playing a central role.[4]

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Dyslipidemia, characterized by abnormal lipid levels, is implicated in over half of all cases of ischemic heart disease globally, resulting in millions of annual fatalities.[5] Sub-Saharan Africa faces a substantial burden, with dyslipidemia emerging as a critical cardiovascular risk factor.[6]

Insulin resistance in Type 2 diabetes mellitus patients is a cornerstone in the genesis of dyslipidemia, involving multifaceted mechanisms.[7] Dyslipidemia is a major modifiable risk factor for cardiovascular disease, accounting for a significant portion of morbidity and mortality in the diabetic population.[8]

Globally, dyslipidemia is responsible for approximately 4 million deaths and 29.7 million disability-adjusted life years, with increasing burdens due to factors such as reduced physical activity, prolonged diabetes duration, and obesity.[2,5,9] In Africa, high prevalence rates of dyslipidemia have been reported, highlighting its critical role as a cardiovascular risk factor.[10–12]

In our country, the prevalence of dyslipidemia among diabetic individuals is also high, with major risk factors including hypertension, high BMI, aging, elevated fasting blood sugar levels, physical inactivity, and longer diabetes duration.[1,2,13] Routine screening for dyslipidemia remains strikingly low, underscoring the need for early detection and intervention.[14]

This study aims to provide early detection and characterization of dyslipidemia in Type 2 diabetes mellitus patients, aiding clinicians in estimating future cardiovascular disease risk. Additionally, identifying associated factors can help in reducing future complications. The findings will serve as a basis for institution-based interventions and national policy improvements, ultimately enhancing healthcare quality and reducing morbidity and mortality in this population.

Methods and Materials

Study Design, Study Area, and Period

We conducted an institution-based cross-sectional study at Hawassa University Comprehensive Specialized Hospital (HUCSH), located approximately 270 kilometers southeast of the Ethiopian capital. HUCSH serves as the largest public hospital in the southwestern region of Ethiopia, offering teaching, diagnostic, and referral services to an estimated population of 18 million. The study focused on Type 2 Diabetes Mellitus (T2DM) patients attending follow-up appointments at the endocrine clinic within HUCSH from June 1 to August 31, 2022 G.C.

Sample Size and Sampling Technique

To determine the sample size, we employed the single population proportion formula with considerations for a 95% confidence interval, a 5% margin of error, a 10% non-response rate, and an estimated prevalence of dyslipidemia in T2DM based on a prior study (68.1%).[2] This yielded a final sample size of 228. Adult T2DM patients aged 18 years and above attending the HUCSH Endocrine clinic for follow-up were recruited using a systematic random sampling technique.

Inclusion Criteria

Adult T2DM patients (age ≥18 years) attending the HUCSH Endocrine clinic, provided that their lipid profile, fasting blood glucose (FBG), and HbA1C results were available within a three-month window prior to data collection. For participants lacking registered data within this period, assessments were conducted during the study.

Exclusion Criteria

Critically ill patients and those who were already taking lipid-lowering drugs at the time of data collection.

Data Collection Techniques

Structured questionnaires were employed to collect data on socio-demographic characteristics, behavioral factors, and clinical information through interviews conducted by trained nurses. The questionnaires were adapted from relevant literature and the World Health Organization's (WHO) Stepwise approach for non-communicable disease surveillance.[14]

Anthropometric Measurements

Height and weight were measured according to World Health Organization (WHO) guidelines for all participants. Body Mass Index (BMI) was calculated as weight in kilograms divided by the square of height in meters and categorized into various groups based on WHO classifications.

Blood Pressure Measurement

Blood pressure was measured using a well-calibrated mercury sphygmomanometer for three consecutive times, with the mean of the last two measurements used for analysis. Hypertension was defined as systolic BP (SBP; ≥140 mmHg) or diastolic BP (DBP; ≥90 mmHg).

Blood Specimen Collection and Investigation

Following overnight fasting, 5 milliliters of venous blood were collected from each participant by a trained medical laboratory technologist. Standard operating procedures were followed during collection. The collected blood was then processed, and serum glucose and lipid profiles (total cholesterol, triglycerides, HDL, and LDL) were analyzed using an ABX Pentra 400 automated clinical chemistry analyzer. Dyslipidemia was defined as the presence of at least one or more lipid profile abnormalities based on established clinical criteria.

Data Analysis

Data were cleaned, edited, entered, and analyzed using SPSS version 26.0. Descriptive statistics were employed to summarize the study variables. Both bivariate and multivariate logistic regression analyses were performed to identify associations between dyslipidemia and independent variables. Variables with a p-value < 0.25 in bivariate analysis were considered candidates for multivariate analysis. Multiple logistic regression analysis was used to identify associated risk factors for dyslipidemia prevalence, with statistical significance set at $p < 0.05$.

Results

A total of 228 participants were included in the study, consisting of 158 females (69.3%) and 70 males (30.7%). The average age was 54.6 ± 11.4 years. The majority of participants (79.4%) fell within the 41–70 years age group, with ages ranging from 25 to 85 years. In terms of marital status, 68.9% (157) were married, and 42.1% (96) had attained a college education or higher. Approximately 65% of participants had a history of diabetes for over 10 years. A notable majority, 72%, also had comorbid hypertension. Regarding BMI, 31.6% (72) of participants were classified as obese, and 61.4% (140) reported low levels of physical activity (Table 1).

Prevalence of Dyslipidemia and Other Biochemical Results Among Study Participants

The mean ±standard deviation (SD) of the TC, TG, LDLC, and HDL-C were 167.9± 55.1, 152.7± 71.2, 105.7± 32.1, 43.9 ± 10.0 respectively (Table 2). The overall prevalence of dyslipidemia among study participants was 75.9% (173). The prevalence of dyslipidemia was highest among age groups ≥30 years 72.4% (155) and females 74.4% (96). When isolated dyslipidemia components were analyzed, hypertriglyceridemia was found in 43% (98), hypercholesterolemia in 75% (171), high level of LDL C in 59.2% (135), and low level of HDL-C in 33.3% (76) study participants. The mean ±standard deviation (SD) of the fasting blood glucose and HbA1C was 171.09 ±70.7 and 8.04 ± 1.72 respectively (Table 2).

Factors Associated with Dyslipidemia

In the bivariate analysis, several potential factors were assessed for their association with dyslipidemia. These included diabetic duration exceeding 10 years (COR (95% CI) = 3.96 (1.71, 9.14)), female sex (COR (95% CI) = 1.56 (0.82, 2.95)), alcohol consumption (COR (95% CI) = 1.93 (0.76, 4.88)), poor physical activity (COR (95% CI) = 4.34 (1.80, 10.4)), high HbA1C (COR (95% CI) = 2.21 (1.19, 4.09)), obesity (COR (95% CI) = 4.15 (1.20, 14.3)), hypertension

Table 1 Socio-Demographic Characteristics of Participants to Assess the Prevalence and Associated Factors of Dyslipidemia Among Adult Type 2 Diabetes Patients Attending in HUCSH Diabetic Clinic in 2022

Variable	Category	Frequency	Percentage
Sex of study participant	Male	70	30.7
	Female	158	69.3
Age category	18–40 years	26	11.4
	41–70 years	181	79.4
	> 70 years	21	9.2
Diabetic duration	< 5 years	33	14.4
	5–10 years	46	20.2
	>10 years	149	65.4
Hypertension	Yes	166	72.8
	No	62	27.2
Cardiac history	Yes	22	9.6
	No	206	90.4
Alcohol	Yes	22	9.6
	No	206	90.4
Smoking	Yes	15	6.6
	No	213	93.4
Physical activity	Poor	140	61.4
	Moderate	56	24.6
	Vigorous	32	14.0
BMI category	Underweight	14	6.1
	Normal weight	70	30.7
	Overweight	72	31.6
	Obese	72	31.6

Table 2 Lipid Profile and Other Biochemical Tests by Gender

Lipid Profile	Total Mean ±SD	Categories	N (%)	Male Mean ± SD	Female Mean ± SD	p-value
TC (mg/dl)	167.9± 55.1	< 200	171(75)	161.8±47.2	170.6± 58.2	0.266
		≥200	57(25)			
LDL-C (mg/dl)	105.7± 32.1	<100	93(40.8)	101.7±28.2	107.5±33.6	0.182
		≥100	135(59.2)			
HDL-C (mg/dl)	43.9± 10.0	< 40	76(33.3)	44±12.5	43.8±8.8	0.90
		≥40	152(66.7)			

(*Continued*)

Table 2 (Continued).

Lipid Profile	Total Mean ±SD	Categories	N (%)	Male Mean ± SD	Female Mean ± SD	p-value
TG (mg/dl)	152.7± 71.2	<150	130(57)	156.3± 80. 3	151.2 ± 66.9	0.612
		≥150	98(43)			
HbA1C level	8.04 ± 1.72	< 7	87(38.2)	8.0 ±1.84	8.0±1.68	0.873
		≥ 7	141(61.8)			
FBG level in mg/dl	171.09 ±70.7	< 130	64(28.1)	177.8 ± 73.2	168.1 ± 69.7	0.340
		≥130	164(71.9)			

(COR (95% CI) = 1.78 (0.93, 3.41)), and elevated blood glucose levels (COR (95% CI) = 2.07 (1.09, 3.95)). These variables were selected as candidates for further assessment in the multivariate analysis based on their p-values.

Multivariate Logistic Regression Analysis of Dyslipidemia Predictors

In the multivariate logistic regression models, independent predictors of dyslipidemia in diabetic patients were identified after adjusting for other variables. Specifically, Type 2 diabetic patients with a duration of more than 10 years were found to be three times more likely to develop dyslipidemia (AOR: 3.2, 95% CI: 1.13–9.06) compared to those with less than 5 years of diabetic history. Diabetic patients with poor levels of physical activity were approximately four times more likely to develop dyslipidemia (AOR: 4.41, 95% CI: 1.57–12.3) compared to physically active diabetic patients. Obese Type 2 diabetic patients exhibited a higher likelihood of developing dyslipidemia (AOR: 3.58, 95% CI: 1.26–10.1) in comparison to non-obese diabetic patients. Diabetic patients with higher HbA1C values were also more likely to develop dyslipidemia (AOR: 2.5, 95% CI: 1.13–5.53) than those with lower HbA1C values. (Table 3).

Table 3 Multivariate Analysis to Identify Factors of Dyslipidemia Among Adult T2DM Patients in HUCSH, 2022

Variables	Categories	Dyslipidemia		COR (95% CI)	AOR (95% CI)	P value
		Yes (n, %)	No (n, %)			
Sex	Male	49(70.0)	21(30.0)	1	1	0.060
	Female	124(78.5)	34(21.5)	1.56(0.82,2.95)	2.29(0.96,5.48)	
Body mass index (kg/m2)	Normal	50(75)	20(25)	1	1	
	Underweight	8(57.1)	6(42.9)	1.87(0.57, 6.0)	0.42(0.09,2.01)	0.282
	Overweight	54(71.4)	18(28.6)	2.250(0.68,7.36)	1.02(0.41,2.51)	0.958
	Obese	61(84.7)	11(15.3)	4.159(1.20,14.3)	3.58(1.26,10.1)	0.016*
Hypertension	Yes	131(67.7)	35(32.3)	1.78(0.93,3.41)	1.36(0.60,3.08)	0.455
	No	42(78.9)	20(21.1)	1	1	
Duration of DM	<5	20(60.6)	13(39.4)	1	1	
	5–10	25(54.3)	21(45.7)	0.77(0.31,1.91)	0.66(0.21,2.02)	0.468
	>10	128(85.9)	21(14.1)	3.96(1.71,9.14)	3.21(1.13,9.06)	0.027*

(*Continued*)

Table 3 (Continued).

Variables	Categories	Dyslipidemia		COR (95% CI)	AOR (95% CI)	P value
		Yes (n, %)	No (n, %)			
HAC1	<7	58(66.7)	29(33.3)	1	1	
	≥7	118(81.6)	26(18.4)	2.21(1.19,4.09)	2.50(1.13,5.53)	0.023*
Fasting blood glucose (mg/dl)	<130gm/dl	42(65.6)	22(34.4)	1	1	0.106
	>130gm/dl	131(79.9)	33(20.1)	2.07(1.09,3.95)	1.98(0.86,4.54)	
Alcohol consumption	Yes	14(63.6)	8(36.4)	1.93(0.76, 4.88)	1.31(0.38,4.53)	0.666
	No	159(77.2)	47(22.8)	1	1	
Physical activities	Poor	123(87.9)	17(12.1)	4.34(1.80,10.4)	4.41(1.57,12.3)	0.005*
	Moderate	30(53.6)	26(46.4)	0.69(0.28,1.68)	0.60(0.20,1.79)	0.366
	Vigorous	20(62.5)	12(37.5)	1	1	

Notes: *Significant at a p-value <0.05 level.

Discussion

Dyslipidemia is one of the key modifiable risk factors for CVD, which was the main cause of morbidity and mortality in T2DM patients (10). The rate of dyslipidemia will increase if it is not promptly and effectively controlled, which will increase the burden of CVD. In order to manage dyslipidemia and lessen the burden of CVD, it is crucial to identify any potential associated factors. The goal of the current study was to determine the prevalence of dyslipidemia and related risk factors in HUCSH T2DM patients. In the current study, the overall prevalence of dyslipidemia in T2DM patients is 75.9%. Poor physical activity, longer duration of diabetes, abnormal FBG, and obesity were independent predictors of dyslipidemia in T2DM patients in this study.

Comparatively, the prevalence of dyslipidemia in this study (75.9%) exceeds rates reported in previous studies conducted in Durame Hospital (65.6%), Jimma (68.1%), Mekele (66.6%) Saudi Arabia (66.5%), and Nigeria (69.3%).[1,2,13,15,16] This discrepancy may be attributed to variations in physical activity levels and dietary habits, influencing the incidence of T2DM and its associated metabolic abnormalities. Conversely, the findings from this study fall below those reported in studies conducted in Maputo, Mozambique (86.7%) and Turbo, Kenya (86%).[12,17] These differences could be attributed to variations in cutoff values, urbanization levels in the respective study settings, dietary patterns, physical activity, and overall lifestyles of the study participants.

Analyzing individual lipid profile abnormalities, the study found that 25% had high total cholesterol (TC), 43% had elevated triglycerides (TG), 59.2% exhibited high levels of low-density lipoprotein cholesterol (LDL-C), and 33.3% had low levels of high-density lipoprotein cholesterol (HDL-C). The prevalence of elevated LDL-C was notably higher, consistent with findings in studies from Durame, Mekelle (Ethiopia), and Central South Africa.[1,11,13] The percentage of patients with elevated LDL-C levels in this study (59%) surpassed the aforementioned studies (48%, 43.8%, and 49.5%). These disparities may arise from variations in cutoff values, urbanization levels, lifestyles, and dietary habits. Hypertriglyceridemia was also a prevalent abnormality, aligning with a study in Saudi Arabia (42.8%) and exceeding rates reported in Hawassa, Ethiopia (29.8%) (14, 15). Elevated triglyceride levels in T2DM can be attributed to increased production and reduced clearance of triglyceride-rich lipoproteins, stemming from insulin resistance and hyperglycemia. The study identified a higher prevalence of hypercholesterolemia compared to reports from Jimma, Ethiopia (2), but was comparable to findings in Durame (1). Nevertheless, the current study's results were lower than those reported in Hawassa, Ethiopia (34.6), Mekelle, Ethiopia (30.8), and Saudi Arabia (35.5).[13–15]

The study established a significant correlation between dyslipidemia and poor physical activity. Diabetic patients with inadequate physical activity demonstrated a 4.4-fold higher risk of dyslipidemia compared to those engaging in vigorous physical activity (AOR: 4.41; [95% CI: 1.57, 12.3]). This aligns with findings in studies from Kenya, Saudi Arabia, and

Jimma, Ethiopia.[2,12,15] The increased energy expenditure during physical activity potentially prevents excess energy from being stored as lipids, contributing to a lower fat mass-to-fat-free mass ratio.

Furthermore, obese patients exhibited a 3.5-fold greater likelihood of developing dyslipidemia compared to those with normal weight (AOR: 3.58; [95% CI: 1.26, 10.1]). Similar observations were reported in studies conducted in Saudi Arabia, Spain, Thailand, Kenya, and Ethiopia, particularly in Durame and Jimma.[1,2,12,15,18,19] This could be attributed to the tendency for lipid components to concentrate with increased BMI. However, a 2019 cross-sectional study in Nigeria found no association between obesity and dyslipidemia.[16]

Likewise, patients with a diabetic duration exceeding ten years were 3.2 times more likely to develop dyslipidemia compared to those with less than five years (AOR: 3.21; [1.13, 9.06]). This association mirrors findings in cross-sectional studies conducted in Saudi Arabia, Eritrea, and Durame, Ethiopia.[1,10,15]

Similarly, diabetic patients with higher HbA1C levels were 2.5 times more likely to develop dyslipidemia than those with lower HbA1C levels (AOR: 2.5; [95% CI: 1.13, 5.53]). This trend is consistent with cross-sectional studies carried out in Spain, China, the United Arab Emirates, Eritrea, and Kenya.[10,12,15,18,20,21] This correlation arises from the close relationship between blood glucose and lipid metabolism, both of which tend to rise with increasing body weight.

Limitations

The study is conducted in a specific hospital setting, which may limit generalizability to other healthcare facilities. Given the cross-sectional nature of the study design, it is important to note that causal relationships between dyslipidemia and the examined risk factors cannot be established. Limited study duration was another shortcoming of our study.

Conclusions

This study underscores a notably high prevalence of dyslipidemia among T2DM patients. Factors such as inadequate physical activity, prolonged diabetes duration, obesity, and elevated blood glucose levels were identified as significant contributors. Given the substantial impact of dyslipidemia on cardiovascular health, widespread screening and regular monitoring of lipid profiles in Type 2 diabetes patients are imperative. Implementing targeted interventions, including lifestyle modifications and appropriate therapeutics, is crucial in managing this dual burden. It is worth mentioning that this study was conducted in a specific hospital setting and limited time, and hence the findings, and generalizability to other healthcare facilities should be taken cautiously.

Data Sharing Statement

The original data for this study will be available from the corresponding author on a reasonable request.

Ethical Considerations

Ethical clearance for this study was obtained from the Hawassa University Institutional Review Board (IRB) with reference number: IRB/198/14. A letter of cooperation was issued to HUCSH administrative offices. Prior to enrollment, written informed consent was obtained from each study participant after a detailed explanation of the study's purpose and procedures. Participants were assured that their responses would be kept confidential. The study adhered to the principles outlined in the Declaration of Helsinki.

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Author Contributions

All authors played significant roles in the conception, design, data acquisition, analysis, and interpretation. They contributed to drafting and critically revising the article for important intellectual content. Each author agreed to submit to the present journal and gave final approval for the version to be published. Furthermore, they are committed to being accountable for all aspects of the work.

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The authors declared that they have no competing interests in this work.

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