


# Predictors of Lipid Profile Abnormalities Among Patients with Metabolic Syndrome in Southwest Ethiopia: A Cross-Sectional Study

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**Background:** Lipid profile abnormalities are an integral part of metabolic syndrome (MetS) and major underlying causes of cardiovascular disease (CVD) and type-2 diabetes mellitus (T2DM). Lipid profile abnormalities in a patient with MetS are resulted due to the presence of central obesity and insulin resistance. In Ethiopia, the burden and predictors of lipid profile abnormalities in a patient with MetS are not well known. Thus, this study aimed to determine the prevalence of lipid profile abnormalities and predictors among patients with MetS in southwest Ethiopia.

**Methods and Materials:** A cross-sectional study was conducted among 381 patients with MetS from September to December 2019 with a response rate of 100%. A structured questionnaire was used to collect data on socio-demographic and behavioral factors. Waist circumference, height, weight, and blood pressures were measured. The venous blood sample was collected for glucose and lipid profile determination. Data were entered and analyzed by using SPSS version 21. Binary logistic regression and Pearson's correlation analyses were performed. A p-value was set at a <0.05 for statistical significance.

**Results:** In this study, about 58% of participants were at least one or more lipid profile abnormalities with the 95% CI (52.8–62.7). About 67.2%, 44.6%, 18.4%, and 14.2% of study participants were low HDL, high TG, LDL, and TC, respectively. Central obesity (adjusted odds ratio (AOR): 1.89, 95% CI: 1.14–3.14), increasing age (AOR: 2.08, 95% CI: 1.27–3.4), higher BMI (AOR: 2.06, 95% CI: 1.23–3.4), being hypertensive (AOR: 3.48, 95% CI: 2.12–5.7) and increasing blood glucose level (AOR: 2.34, 95% CI: 1.36–4.03) were independent predictors of lipid profile abnormalities (dyslipidemia).

**Conclusion:** In this study area, a high (58%) prevalence of dyslipidemia was observed in study participants, and increasing age, higher BMI, central obesity, hypertension, and high blood glucose level were identified as independent predictors of dyslipidemia among patients with MetS. Prevention and control of dyslipidemia and its predictors among patients with MetS were recommended.

**Keywords:** metabolic syndrome, lipid profile abnormalities, Ethiopia

## Introduction

Metabolic syndromes are a growing major public health concern worldwide, and it affects both developed and developing countries.<sup>1</sup> A study reported 37.05%, 34.1%, 69.1%, and 21.6% prevalence of MetS in Iran,<sup>2</sup> Brazil,<sup>3</sup> Ghana,<sup>4</sup> and Indonesia,<sup>5</sup> respectively. Whereas a large number of the population were affected in different parts of Ethiopia, the proportion varies from 20.3% to 55.1% across the country.<sup>6–8</sup>

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A sedentary way of life, increase in urbanization, surplus energy intake, and increasing burden of obesity were factors that contribute to the increasing global burden of MetS.<sup>9</sup>

Metabolic syndrome consists of different abnormalities that include raised blood pressure, lipid profile abnormalities (elevated triglycerides (TG) and low high-density lipoprotein cholesterol (LDL)), raised fasting blood glucose, and central obesity.<sup>10</sup> The major underlying pathophysiology for the development of MetS is mainly based on insulin resistance and central obesity.<sup>11</sup> The continuous increase in the global burden of MetS leads to serious public health concerns; it increases the risk of CVD and T2DM and also contributes to CVD-related morbidity and mortality.<sup>12</sup>

Dyslipidemia is an integral part of MetS and the major underlying causes of CVD and T2DM in a patient with MetS.<sup>13–16</sup> Dyslipidemia associated with the MetS was elevated triglycerides, low high-density lipoprotein (HDL), and high LDL.<sup>17–19</sup> The presence of insulin resistance and central obesity in individuals with MetS have been associated with a cluster of lipid profile abnormalities.<sup>20,21</sup> Insulin resistance and compensatory hyperinsulinemia in individuals with MetS lead to the overproduction of LDL particles.<sup>11,21</sup> A relative deficiency of lipoprotein lipase resulted in a decreased clearance of fasting and postprandial triglyceride-rich lipoproteins (TRLs) and the decreased production of HDL particles.<sup>22</sup> The resulting increased concentration of cholesteryl ester-rich fasting and postprandial TRLs is the central lipid profile abnormality of the MetS.<sup>21</sup> Resistance to insulin action or insulin deprivation is associated with increased lipolysis, intra-abdominal fat, which is metabolically very active, releases free fatty acid into the portal circulation, and the liver converts free fatty acid into triglycerides; this may probably result in hypertriglyceridemia.<sup>20</sup> Hypertriglyceridemia is one of the most common MetS components and is an important consideration in the formulation of cardiovascular preventive programs because elevated triglycerides confer an increased risk of CVD.<sup>13,20</sup> Also, elevated levels of LDL are a major risk factor for CVD, and its reduction is the primary target of pharmacotherapy.<sup>20,21</sup>

Determining the prevalence of dyslipidemia in a patient with MetS is vital to promote a patient's health care and to prevent CVD-related morbidity and mortality. In Ethiopia, different studies reported a high prevalence of

MetS,<sup>6,8</sup> however, the burden and predictors of dyslipidemia in a patient with MetS are not well known.

Determination of the prevalence and its predictors of lipid profile abnormalities is important for the management of the patient with MetS and formulation of cardiovascular preventive measures to reduce its risk and complication. Therefore, this study aimed to determine the prevalence and predictors of dyslipidemia and to assess the relationships of lipid profile with fasting blood glucose, blood pressure, and anthropometric indices in patients with MetS in Ethiopia.

## Method and Materials

### Study Area

The study was conducted in Jimma Medical Center, which is located 352 km far from Addis Ababa, the capital city of Ethiopia. Jimma Medical Center provides teaching, diagnostic, and referral service in the southwestern part of the country, and its catchment area population is around 15 million inhabitants. The study was conducted among patients admitted with MetS in Jimma Medical Ward.

### Study Design and Period

A cross-sectional study was conducted from September to December 2019.

### Sample Size and Sampling Technique

A single population proportion formula was used to determine sample size by considering the following assumption; a 95% confidence interval (CI), a 5% margin of error, and a 45.1% magnitude of high serum TG value in a patient with MetS.<sup>8</sup> The final sample size of the study was 381. All identified MetS patients (age  $\geq 18$  years) who had been admitted to Jimma Medical Ward were conclusively included in the study until attaining sample size.

### Inclusion Criteria

Study participants with waist circumference ( $\geq 102$  cm for men and  $\geq 88$  cm for women), raised triglyceride level  $\geq 150$  mg/dl, reduced HDL ( $< 40$  mg/dl in men,  $< 50$  mg/dl in women), raised blood pressure (systolic blood pressure (SBP)  $\geq 130$  or diastolic blood pressure (DBP)  $\geq 85$  mm Hg) and raised fasting plasma glucose  $\geq 110$  mg/dl, who fulfills Adult Treatment Panel III criteria for MetS, were included in the study.<sup>23</sup>

## Exclusion Criteria

Study participants who had a pregnancy, malignancy, known history of chronic liver, cardiac problems, renal diseases, and severely ill patients were excluded from the study.

## Data Collection Methods and Techniques

A structured questionnaire was used to collect data on socio-demographic, economic, and behavioural characteristics.

## Physical Examination

Anthropometric measurements were administered by trained professional nurses by using a standardized protocol. Waist circumference was measured at the midpoint between the lower margin of the least palpable rib and the top of the hip or minimal waist using stretch-resistant tape; then, central obesity was defined as waist circumference  $\geq 102$  cm for men and  $\geq 88$  cm for women. Height and weight were measured from all study participants based on World health organization (WHO) guideline, and body mass index (BMI) was determined as weight in kilogram divided by the square of height in meter and categorized as overweight (BMI = 25–29.9 kg/m<sup>2</sup>), and obese (BMI  $\geq 30$  kg/m<sup>2</sup>). Blood pressure was measured digitally by using Micro life BP (Micro life BP A50, Switzerland) from the right upper arm. Hypertension in patients with metabolic syndrome was defined as systolic blood pressure (SBP;  $\geq 130$  millimeters of mercury [mmHg]) or diastolic blood pressure (DBP;  $\geq 85$  mmHg).

## Blood Specimen Collection and Analysis

Four milliliters of the blood sample were collected from each participant for serum glucose and lipid profile analysis. After the drawn sample stayed for 30 minutes at room temperature, serum was separated from the collected blood sample by using Rotanta 960 centrifuge (at 4000 rpm for 5 minutes). The serum lipid parameters (TG, LDL, HDL, and total cholesterol (TC)) and glucose were measured by ABX Pentra chemistry analyzer (Horiba ABX, France) following the manufacturer's instructions and standard operating procedures of the hospitals. Lipid profile abnormalities (dyslipidemia) in patients with MetS were defined as the presence of at least one or more lipid profile abnormalities from the following; TG  $\geq 150$  milligram per deciliter (mg/dl), HDL  $\leq 40$  mg/dl in men, and  $\leq 50$  mg/dl in women, TC  $\geq 200$  (mg/dl), or LDL ( $\geq 100$  mg/dl).

## Operational Definition

Metabolic syndrome was defined according to the Adult Treatment Panel III criteria definition, as the presence of any three of the following: waist circumference  $\geq 102$  cm in men or  $\geq 88$  cm in women; blood pressure  $\geq 130/\geq 85$  mm Hg; fasting blood glucose  $\geq 100$  mg/dl; TG  $\geq 150$  mg/dl and low HDL-C  $< 40$  mg/dl in men or  $< 50$  mg/dl in women.<sup>23</sup>

Alcohol consumption: study participants who consume more than 3–4 units for men and more than 2–3 units for women daily during the time of the data collection.<sup>24</sup>

Smoking cigarette: study participants who had the habit of smoking one or more manufactured or hand-rolled tobacco during the study period. Physical activity: study participants who were involved in moderate physical activities such as walking, cycling, or doing that had significant benefits for health with expending energy.<sup>25</sup>

Fruit and vegetable consumption: study participants who had the habit of consumption of fruit and vegetables at least once per day during the time of the data collection.<sup>26</sup>

## Data Analysis and Interpretation

Data were entered and analyzed by using SPSS version 21 (SPSS, Chicago, IL, USA). Data were described as frequency, percentage, mean, and standard deviation tables. Binary logistic regression analyses (bivariate and multivariable) were performed to identify independent predictors of dyslipidemia. Crude (COR) and adjusted odds ratio (AOR) with their respective 95% CI were calculated. The candidate predictors for multivariate analysis were identified in bivariate analysis by considering p-value  $< 0.25$ .<sup>6</sup> Multivariable analysis was used to control confounding variables and identify independent predictors for the prevalence of dyslipidemia. Variables in a multivariate analysis with a p-value  $< 0.05$  were taken as significantly associated predictors with dyslipidemia. Pearson's correlation was used to see relationships between lipid profile and other components of MetS. P-value  $< 0.05$  was considered statistically significant.

## Results

A total of 381 patients with MetS were included in this study, with a response rate of 100%; about 58% (n=221) were females. The mean ( $\pm$ SD) ages of the study participants were  $50.2 \pm 14.4$  years, which range from 18 to 79 years. About 68% (259), 40.2% (153), 73.8% (281) of study participants had central obesity, hypertension, and fasting blood

**Table 1** Socio-Demographic, Behavioural, and Other Related Characteristics of a Patient with Metabolic Syndrome in Southwest Ethiopia from September to December 2019

Characteristics	Categories	n (%)
Residence	Urban	210 (55.1%)
	Rural	171(44.9)
Age in years	<50	183(48)
	≥50	198(52)
Sex	Female	221(58)
	Male	160(42)
Marital status	Single	87(22.8)
	Married	294(77.2)
Educational level	Illiterate	214(56.2)
	Primary	55(14.4)
	Secondary	73(19.2)
	Collage/University	39(10.2)
Monthly income in ETB*	<1500	120(31.5)
	≥1500	261(68.5)
Occupation	Farmer	73(19.2)
	Merchant	183(48)
	Government employee	98(25.7)
	Daily laborer	16(4.2)
	Students	11(2.9)
Drug intake	No	52(13.6)
	Yes	329(86.4)
Overweight	No	208(54.6)
	Yes	173(45.4)
Obese	No	262(68.8)
	Yes	119(31.2)
Central obesity	No	122(32)
	Yes	259(68)
Hypertension	No	228(59.8)
	Yes	153(40.2)
Fasting blood sugar	<110 mg/dl	100(26.2)
	≥110 mg/dl	281(73.8)

(Continued)

**Table 1** (Continued).

Characteristics	Categories	n (%)
Smoking cigarette	No	323(84.8)
	Yes	58(15.2)
Alcohol consumption	No	305(79.3)
	Yes	79(20.7)
Consumption of fruit or vegetable	No	17(4.5)
	Yes	364(95.5)
Physical activities	No	246(64.6)
	Yes	135(35.5)

**Abbreviations:** \*ETB, Ethiopian birr; mg/dl, milligram per decilitre.

glucose  $\geq 110$  mg/dl, respectively. The mean ( $\pm$ SD) of BMI, waist circumference, SBP, DBP, and fasting blood glucose was  $26.8 \pm 4.19$  kg/m<sup>2</sup>,  $99.2 \pm 8.5$ cm,  $138.7 \pm 18.6$ mmHg,  $88.8 \pm 9.7$  mmHg, and  $153.04 \pm 60.34$  mg/dl, respectively (Table 1).

## The Prevalence of Dyslipidemia Among Patients with Metabolic Syndrome

The overall prevalence of dyslipidemia among patients with MetS was 58% (221) with 95% CI (52.8–62.7). The mean ( $\pm$ SD) of TG, HDL, LDL, and TC was  $147.2 \pm 39.6$  mg/dl,  $47.8 \pm 11.2$  mg/dl,  $85.8 \pm 21.5$ mg/dl, and  $148.4 \pm 44.6$ mg/dl, respectively. High proportions of dyslipidemia were found in urban dwellers 61% (128) and the age group  $\geq 50$  years 66.2% (131). The percentages of dyslipidemia were 68.4% (54), 68.1% (81), 64.5% (167), 72.5% (111), and 62.6% (176) in alcohol consumers, higher BMI, having central obesity, hypertensive and fasting blood glucose level  $\geq 110$  mg/dl, respectively (Table 2). Individual lipid profile abnormality of high TG, low HDL, high LDL, and TC were identified in 44.6% (170), 67.2% (256), 18.4% (70), and 14.2% (54) of study participants, respectively.

## Correlation Analysis

Correlation analyses of lipid profile with other MetS components were performed. Accordingly, serum level of TG showed statistically positive correlation with central obesity ( $r=0.21$ ,  $p<0.001$ ), fasting blood glucose ( $r=0.27$ ,  $p<0.001$ ), and hypertension ( $r=0.24$ ,  $p<0.001$ ). Serum concentration of HDL showed statistically positive correlation with overweight ( $r=0.1$ ,  $p=0.04$ ) (Table 3).

**Table 2** Multivariate Analysis of Predictors with Dyslipidemia Among Patients with Metabolic Syndrome in Southwest Ethiopia from September to December 2019

Predictors	Categories	Dyslipidaemia		AOR(95% CI)	P-value
		No	Yes		
Residence	Urban	82(39)	128(61)	1.16(0.7–1.93)	0.54
	Rural	78(45.6)	93(54.4)	1	
Age in years	<50	93(50.8)	90(49.2)	1	
	≥50	67(33.8)	131(66.2)	2.08(1.27–3.4)	0.004**
Marital status	Single	43(49.4)	44(50.6)	1	
	Married	117(39.8)	177(60.2)	0.92(0.5–1.6)	0.79
Educational level	Illiterate	85(39.7)	129(60.3)	1.92(0.85–4.3)	0.11
	Primary	24(43.6)	31(56.4)	1.73(0.68–4.4)	0.24
	Secondary	30(41.1)	43(58.9)	1.9(0.78–4.6)	0.15
	Collage/University	21(53.8)	18(46.2)	1	
Monthly income	<1500	56(46.7)	64(53.3)	1	
	≥1500	104(39.8)	157(60.2)	1.35(0.8–2.2)	0.23
Obese	No	122(46.6)	140(53.4)	1	
	Yes	38(31.9)	81(68.1)	2.06(1.23–3.4)	0.006**
Central obesity	No	68(55.7)	54(44.3)	1	
	Yes	92(35.5)	167(64.5)	1.89(1.14–3.14)	0.013**
Hypertension	No	118(51.8)	110(48.2)	1	
	Yes	42(27.5)	111(72.5)	3.48(2.12–5.7)	<0.001**
Fasting blood sugar	<110 mg/dl	55(55)	45(45)	1	
	≥110 mg/dl	105(37.4)	176(62.6)	2.34(1.36–4.03)	0.002**
Smoking cigarette	No	140(43.3)	183(56.7)	1	
	Yes	20(34.5)	38(65.5)	1.4(0.7–2.7)	0.33
Alcohol consumption	No	135(44.7)	167(55.3)	1	
	Yes	25(31.6)	54(68.4)	1.5(0.85–2.8)	0.15

**Notes:** \*\*Significantly associated predictors with dyslipidemia with p value<0.05, 1; reference category.

**Abbreviations:** AOR, adjusted odds ratio; CI, confidence interval; mg/dl, milligram per decilitre.

## Independent Predictors of Dyslipidemia

In the bivariate analysis: being urban dweller, increasing age, being married, illiteracy, secondary in educational status, higher monthly income, smoking, alcohol consumption, being obese, having central obesity, hypertension, and high fasting blood glucose levels were identified as candidate predictors for multivariate analysis by considering p-value <0.25.

A significantly high prevalence of dyslipidemia was observed in older study participants (66.2%) as compared to younger participants (AOR: 2.08, 95% CI: 1.27–3.4, p=0.004). Obese MetS patients were 2 times higher odds of dyslipidemia compared to normal patients. The MetS patients having central obesity were nearly 2 times more likely to develop dyslipidemia (AOR: 1.89, 95% CI: 1.14–3.14) compared to normal counterparts. A higher



**Table 3** Correlation Analysis of Lipid Profile with Fasting Blood Glucose, Hypertension, and Anthropometric Indices in Patients with Metabolic Syndrome

Metabolic Syndrome Component	TG		HDL		LDL		TC	
	r	p	r	p	r	p	r	p
Fasting blood glucose	0.27	<0.001	-0.05	0.28	0.15	0.003	0.16	0.001
Hypertension	0.24	<0.001	-0.04	0.4	0.22	<0.001	0.23	<0.001
Central obesity	0.21	<0.001	-0.04	0.35	0.08	0.08	0.18	<0.001
Overweight	0.007	0.89	0.1	0.04	-0.02	0.66	0.006	0.9
Obesity	0.12	0.019	-0.09	0.07	0.11	0.02	0.18	<0.001

**Abbreviations:** r, Pearson correlation coefficients; p, p-value for the correlation; TG, triglycerides; HDL, high-density lipoprotein cholesterol; LDL, low-density lipoprotein cholesterol; TC, total cholesterol.

proportion of dyslipidemia (72.5%) was found in a MetS patient with hypertension than a non-hypertensive one, which was significant (AOR: 3.48, 95% CI: 2.12–5.7). The study participants with higher blood glucose values were 2 times more likely to develop dyslipidemia than their normal counterparts (AOR: 2.34, 95% CI: 1.36–4.03) (Table 2).

## Discussion

Individuals with MetS exhibit a characteristic pattern of serum lipid profile abnormalities. Identification of predictors of dyslipidemia among patients with MetS was important to employ effective risk factor modification and to hasten CVD-related morbidity and mortality. Thus, this study aimed to determine the prevalence and predictors of dyslipidemia and to assess its relationship with anthropometric indices, hypertension, and fasting blood glucose among patients with MetS in southwest Ethiopia.

In the current study, 58% of patients with MetS had at least one or more lipid profile abnormalities (dyslipidemia). This observation was consistent with studies conducted in Ethiopia.<sup>27,28</sup> On the contrary, a higher burden of dyslipidemia was reported from Kenya 86.1%,<sup>29</sup> Nigeria 69.3%,<sup>30</sup> and Iran 75.3%.<sup>31</sup> However, a lower burden of dyslipidemia was observed in China 49.06%.<sup>32</sup> Those observed differences might be due to variations in lifestyle and genetic disposition of the study participants.

Among patients having MetS; 44.6%, 67.2%, 18.4%, and 14.2% of study participants had high TG, low HDL, high LDL, and high TC, respectively. The serum concentration of TG showed a statistically positive correlation with central obesity, hypertension, higher BMI, and fasting blood glucose. Besides, HDL showed a statistically positive correlation with overweight.

The present study found that 44.6% % of the study participants had high serum TG concentrations. An increase in serum TG level in a MetS patient might be due to resistance to insulin action or insulin deprivation, which was associated with increased lipolysis, intra-abdominal fat, which is metabolically very active, releases free fatty acid (FFA) into the portal circulation and the liver converts FFA into triglycerides, which result in high serum TG level.<sup>21,22</sup> This finding was in line with studies reported in India,<sup>33</sup> Iran,<sup>31</sup> Brazil,<sup>34</sup> Malaysia,<sup>35</sup> and Central America;<sup>36</sup> however, this finding is lower than a study reported from Gondar, Ethiopia 56.6%,<sup>37</sup> Hawassa, Ethiopia 68.1%,<sup>38</sup> and Brazil 57.9%,<sup>39</sup> but higher than a report from Iran.<sup>31</sup> The discrepancy in the burden of dyslipidemia might be due to differing cut points in some studies and dietary differences of the study participants.

High levels of TG and low levels of HDL in patients with MetS result from decreased clearance of these lipoproteins from the circulation. Hepatic lipoprotein lipase (LPL) is a major enzyme responsible for clearing TG-containing lipoproteins from the circulation, and the presence of insulin resistance in a patient with MetS is associated with impaired LPL activity, which causes HDL levels to decline.<sup>20,22</sup> The low HDL level was the most frequent lipid profile abnormality (67.2%) found in this study, which was comparable with the study finding from Indonesia,<sup>18</sup> the Philippines,<sup>40</sup> Amazon, Brazil,<sup>3</sup> and Nepal.<sup>41</sup> Our finding was higher than the study findings reported from Tigray, Ethiopia 34.4%,<sup>8</sup> Addis Ababa, Ethiopia 48.6%,<sup>6</sup> India 19.4%,<sup>33</sup> and Central America 48.1%.<sup>36</sup> This might be attributed due to an increase in urbanization, obesity, and reduced physical activity.

The elevated levels of LDL are a major risk factor for CVD, and its reduction is the primary target of

pharmacotherapy.<sup>20,21</sup> In the current study, 18.4% of the MetS patients had a high LDL level. This observation was in agreement with the finding reported from Ethiopia,<sup>42</sup> the Philippines,<sup>40</sup> and Iran,<sup>31</sup> whereas our finding was much lower than the studies finding reported from Nepal 64.4%,<sup>41</sup> and Ethiopia 43.8%,<sup>27</sup> but higher than the report from India 9.7%.<sup>33</sup> Our study finding revealed a lower prevalence of elevated total cholesterol (14.2%) compared to studies conducted in Brazil 54.8%,<sup>34</sup> and the Philippines 41%,<sup>40</sup> but it was consistent with a study reported from Jiangxi province, China 15.68%,<sup>32</sup> Chongqing, China 14.7%,<sup>43</sup> India 13.8%,<sup>33</sup> and Addis Ababa, Ethiopia 11.8%.<sup>44</sup>

In the present study, serum concentration of TG showed a statistically positive correlation with central obesity, fasting blood glucose, and hypertension. In addition, the serum concentration of HDL showed a statistically positive correlation with overweight. This observation was in agreement with a study conducted in Ethiopia,<sup>45</sup> Brazil,<sup>34</sup> and Nepal.<sup>46</sup>

After adjusting for confounders, we found that increasing age, higher BMI, central obesity, high blood glucose value, and hypertension were independent predictors of dyslipidemia among MetS patients. Therefore, cardiovascular preventive measures to reduce its risk and complication should be used to prevent and control dyslipidemia among patients with MetS. A significantly high burden of dyslipidemia (66.2%) was observed in older study participants, and older age was an independent predictor of dyslipidemia. This finding is in line with studies done in Ethiopia,<sup>27</sup> and China.<sup>32,43</sup>

In our study, obesity was significantly associated with dyslipidemia. Obese MetS patients had 2 times higher odds of dyslipidemia compared to normal patients. This finding was in agreement with the study reported in China<sup>32,43</sup> and Kenya.<sup>29</sup>

The current study revealed that there is a statistically significant association between dyslipidemia and central obesity. The MetS patients having central obesity were nearly 2 times more likely to develop dyslipidemia compared to their normal counterparts. A similar finding was reported from China<sup>43</sup> and Thailand.<sup>47</sup>

A higher proportion of dyslipidemia (72.5%) was found in a MetS patient with hypertension than a non-hypertensive one in this study. The burden of dyslipidemia was significantly associated with hypertension. This finding was in agreement with studies reported from Ethiopia,<sup>27,28</sup> and Nepal.<sup>46</sup>

In this study, dyslipidemia was significantly associated with fasting blood glucose. The study participants with higher blood glucose values were 2 times more likely to develop dyslipidemia than normal glucose values. A similar observation was reported from Ethiopia,<sup>28</sup> and Kenya.<sup>29</sup>

## Conclusion

In this study, a high (58%) burden of lipid profile abnormalities was observed in patients with metabolic syndrome, and increasing age, higher BMI, central obesity, hypertension, and high blood glucose level were independent predictors of dyslipidemia. The findings of this study should be considered for the prevention and control of dyslipidemia and its predictors among patients with metabolic syndrome.

## Limitation of the Study

Our study results should be interpreted under consideration of the following limitation; liver enzymes, insulin resistance, and Hgb A1C levels were not assessed due to logistic constraint, and causality link between dyslipidemia and independent predictors is not inferred due to the cross-section nature of the study. We did not include non-metabolic syndrome subjects with and without dyslipidemia as a comparison group which may provide additional insight.

## Data Sharing Statements

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

## Ethical Consideration

Ethical clearance was obtained from the Jimma University Institutional Review Board (IRB)/committee. It was sought while we were students in Jimma University. A letter of cooperation was written to JUMC administrative offices. Written informed consent was obtained from each study participant after explaining the purpose and procedures of the study before enrolling in the study and those willing to participate were included. The entire study groups were informed that their response will be kept confidential. All necessary results of the participant were communicated with the physician for proper management. This study was conducted in accordance with the Declaration of Helsinki.

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## Author Contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agreed to be accountable for all aspects of the work.

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## Disclosure

The authors declared that they have no conflicts of interest for this work.

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