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Prevalence and Risk Factors of Dyslipidemia Among Adults: A Community Based Study in Addis Ababa, Ethiopia

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Abstract: Dyslipidemia is the leading population-level risk factor for ischemic heart disease in Africa. There were inadequate data regarding the prevalence and associated factors of dyslipidemia. So, this survey aimed to identify the prevalence and associated factors of dyslipidemia among participants aged 18 years and above in Addis Ababa city, capital of Ethiopia. This cross-sectional community-based survey was conducted from June to October 2018; in the Ethiopian capital of Addis Ababa. Participants 18 years of age and older were selected by using a multi-stage probability sampling method. The data was gathered through an in-person interview. The WHO phased-in approach was used for data collection. In addition, respondents' height, weight, waist, hip, blood pressure, and laboratory investigations were performed in keeping with standard procedures. We used multiple logistic regressions to analyze the data and, Odds ratios with 95% confidence intervals were also calculated to assess the factors that had an association. Four hundred fifty 77.3 % (95% CI: 73.9-80.7) of study respondents had a minimum of one kind of lipid abnormalities. Hypertriglyceridemia and low HDL-cholesterol were the more common dyslipidemia 41.4% (95% CI: 37.4–45.4) and 41.1% (95% CI: 37.1–45.1), respectively. Among all respondents who had at least one type of dyslipidemia 433 (96.2%) were, newly diagnosed during the survey. In multivariable logistic regression, analysis being male, age≥30 years, raised blood glucose, sitting per day for more than 3 hours, and being hypertensive were the factors associated with hypertriglyceridemia; being female, obese and raised blood glucose were the factors significantly related with low HDL-C; being female, age ≥30 years and hypertensive were the factors associated with hypercholesterolemia. Low HDL-Cholesterol and hypertriglyceridemia were the more common dyslipidemia. With a large proportion unaware of their status, intervention measures have to be taken targeting the modifiable risk factors and screening programs for adults with risk factors.

Keywords: Dyslipidemia, Hypertriglyceridemia, Hypercholesterolemia, Low HDL-C, Prevalence, Risk Factors

1. Introduction

Non-Communicable Diseases (NCDs) are by far one of the leading causes of death in the world. About 41 million deaths occurred from non-communicable diseases (NCDs), representing 71% of the total of 57 million deaths in 2016. A considerable part of such deaths was caused by the four major NCDs, specifically: cardiovascular disease (17.9 million deaths; accounting for 44% of all NCD deaths); cancer (9.0 million deaths; 22%); chronic respiratory disease (3.8 million deaths; 9%); and diabetes (1.6 million deaths; 4%) [1-3].

Cardiovascular diseases (CVD) caused by arterial vessel wall atherosclerosis and thrombosis are the most frequent cause of premature death and disability-adjusted life years (DALY) in Europe; and, it has also become more prevalent in developing countries. Cardiovascular diseases are the result of modifiable and unmodifiable risk factors [4]. Modifibility factors, arterial hypertension, type 2 diabetes, and dyslipidemia are included. Furthermore, dyslipidemia is a key risk factor for CVD [5].

The definition of dyslipidemia is a condition that occurs as a result of plasma lipid abnormalities. Dyslipidemia could be due to bad cholesterol (high Low-Density Lipoprotein Cholesterol (LDL-C)), elevated plasma Total Cholesterol (TC), reduced good cholesterol (High-Density Lipoprotein Cholesterol (HDL-C) levels, and elevated Triglycerides (TG), occurring either singly or in combinations [6]. In medical practice guidelines, dyslipidemia is frequently defined as elevated total cholesterol (TC) or low-density lipoprotein cholesterol (LDL-C) but is also frequently extended to include other lipid abnormalities such as non-optimal triglyceride (TG) and the good cholesterol (HDL-C) levels [7, 8].

More than half of the world's cases of coronary cardiac disease are associated with dyslipidemia. The disease is also responsible for more than 4 million deaths a year, stated by World Health Organization (WHO) estimates. Various epidemiological studies showed that a considerable number of people aged 80 and over are affected by dyslipidemia [9].

Research has shown that abnormal levels of blood lipids are associated with a high risk of coronary artery disease, heart attack, and coronary death. The pathogenicity of atherosclerosis and cardiovascular disease; is also determined by the cholesterol level [10].

In 2008, according to the WHO estimate, the worldwide prevalence of increased total cholesterol in adults (≥ 5.0 mmol/l) was estimated to be 39%, and a third of ischemic heart disease is attributable to this risk factor. It is estimated that more than 2.5 million deaths are caused by increased cholesterol levels each year; the risk of heart disease also increases and, moreover three-quarters of those deaths from non-communicable diseases (NCDs) (28 million) occurred in low- and middle-income countries [2, 9]. In addition, the INTERHEART study showed that dyslipidemia is the major risk factor of ischemic heart disease in the African population [11].

The prevalence of dyslipidemia varies from one country to another. Mexico and Lima (Peru) study found that 50.1% and 68.1% of adults exhibited lipid abnormalities, respectively [12]. In addition, studies in China and Beijing showed that 43.3% and 35.4% of the adults studied had at least one type of lipid abnormality, respectively [13, 14]. Coming to Africa, a Nigerian study showed 58.1% of adult study participants were dyslipidemic; the Ugandan research showed that the prevalence of low High-Density Lipoprotein-cholesterol (HDL-c) was 71.3% [15, 16].

Ethiopia's first national survey found that low-density lipoprotein-cholesterol (HDL-c) prevalence was 68.7%; additionally, grave monitoring in Addis Ababa, Ethiopia, showed that 51% of deaths were attributed to non-communicable diseases. Of the total number of deaths, the primary cause was cardiovascular disease 24%, hypertension about 12%, while 11% of deaths were attributed to stroke [17].

There are several factors involved in increasing the risk of dyslipidemia. Among these, modifiable risk factors include a high saturated or trans-fat diet, physical inactivity, smoking, and obesity. Risk factors cannot be changed, such as age and sex. Secondary causes include insulin-resistant diabetes, high blood pressure, and hypothyroidism [18, 19].

To date, little data was available on the extent and determining factors of lipid abnormalities at the community level in Ethiopia, including the Addis Ababa study area. Within these few data, the prevalence of dyslipidemia was high [20]. In addition, our study area represents the enormous urban center in Ethiopia, home to approximately 25% of the country's urban population [21].

These few studies were done with settlement workers and clients in health facilities [22, 23]. Even though; only one study was done at the national level using all the World Health Organization STEPS survey tools [19]. But the current study uses the World Health Organization's three progressive tools to assess the magnitude and associated factors of dyslipidemia in adults in Addis Ababa.

2. Methods

2.1. Study Setting and Design

This study is part of a larger study that has many objectives. This cross-sectional community-based study conducted from 1 June to 30 October 2018 aimed to identify the prevalence and associated factors of dyslipidemia among adults aged 18 years and above in Addis Ababa. Addis Ababa is the Ethiopian capital. Administratively, Addis Ababa is divided into ten sub-cities (currently eleven) and 116 weredas [24, 25]. According to the Federal Democratic Republic of Ethiopia, Central Statistical Agency Population Projection of Ethiopia, Addis Ababa had a population of 3,433,999 in 2017 [25, 26].

2.2. Selection of the Study Participants

The multi-stage cluster sampling technique was used by first identifying seven of the ten sub-cities based on pre-established criteria, including the location of the area, population density, and socioeconomic status. Then, a wereda has been randomly chosen from each selected sub-cities.

Following this, two 'ketenas' were randomly selected from the selected weredas, which are the smallest geographical units in the weredas. In the end, from each ketena, the first household was randomly selected, while subsequent households were selected based on proximity to the first and the preceding households [25].

A total of 3,724 eligible adults aged 18 and over were interviewed at the selected households. The required sample size was determined using the single population proportion formula by considering: prevalence of hypertension 31.5% from a previous study done in Addis Ababa, Ethiopia [21], $\alpha = 0.05$ ($z = 1.96$), the margin of error 2%, design effect of 1.5 and 20% possible non-response rate. We also determined the sample size; for the prevalence of diabetes mellitus and dyslipidemia. Since the study has multiple objectives, we determined the sample size for the risk factors of hypertension, diabetes Mellitus, and dyslipidemia by using two population proportion formulas. But the maximum sample size attained during the single population proportion formula considering the prevalence of hypertension. As well, the total sample size for each sub-city was determined using the probability proportional sampling method.

Then, the interview and physical measurements were done from the total participants; but to address the biochemical measurements, 20% of the study participants who participated in the interview and physical measurements; were selected using a simple random sampling technique. According to World Health Organization, for resource-limited countries, biochemical measurement can be done from the sub-sampling of 20% of the total sample size [27].

2.3. Data Collection Instruments and Measurements

All the three WHO STEPS instrument was adapted to collect data on the selected information including socio-demographic, behavioral, physical, and biochemical measurements as a part of the core and expanded modules [27]. The data were collected via face-to-face interviews by trained baccalaureate nurses and laboratory technicians. We measured weight and height by using a weighing scale and height measuring scales. Weight and height were measured, as participants were standing without shoes and wearing lightweight clothing. Height was recorded to the nearest 0.5 cm; weight was also recorded to the nearest 100g. Body Mass Index (BMI) was calculated as weight in kilograms divided by height in meters squared (weight (kg)/height (m^2) and classified as underweight (<18.5), normal (18.5–24.9), overweight (25–29.9) and obese (≥ 30.0) [27].

Waist circumference was measured at the level of the iliac crest using a non-stretch tape measure. Hip circumference was measured at the maximum circumference of the hip and, waist-to-hip ratio (WHR) was calculated as a ratio of waist and hip circumference [27].

The global physical activity questionnaire (GPAQ) section of the STEPS instrument was used for assessment of physical activity, and total physical activity was presented in MET (metabolic equivalent) minutes per week it is commonly used to express the intensity of physical activities and are also used for the analysis of GPAQ data. The instrument looks into three major domains of day-to-day activities; work (including domestic work), transport, and recreational activities. The level of total physical activity was subsequently classified into high, moderate, or low using the GPAQ analysis guideline provided along with the STEPS instrument [25, 27].

We measured blood pressure on the left arm using a standardized digital automatic blood pressure monitor. Respondents were asked to remain seated, relaxed, and blood pressure measurements were taken as per WHO steps protocol. In summary three blood pressure measurements were taken with at least a 3 minutes interval between each measure. The mean value of the 2nd and 3rd measures was used for analysis [27]. Then the Blood pressure (BP) was classified according to the Seventh Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC VII) [28].

The principal investigator gave training for the data collectors and supervisors. Then during data collection, daily checks were carried out by field supervisors and the principal investigator to ensure the quality of the interview.

Biochemical measurement

After the interview, selected respondents were advised to be fasting after dinner for at least 8 hours for blood sample collection. The fasting capillary blood glucose measurement was determined using a glucometer. Raised blood glucose is defined according to WHO [29]. Meanwhile, 5 ml of venous blood was collected from the study participants to measure cholesterol, HDL-C, and triglyceride. Then the sample was centrifuged to separate the serum and transported to the hospital for analysis. The samples were then analyzed using the enzymatic colorimetric method by the Mindray BS-200 Chemistry Analyzer at the Armed Forces Comprehensive Specialized Hospital. The definition of dyslipidemia was according to the third report of the National Cholesterol Education Program Adult Treatment Panel (NCEP ATP III) criteria [30].

2.4. Operational Definitions

Hypertension: defined as mean measured blood pressure of ≥ 140 mmHg systolic and/or the mean measured diastolic blood pressure of ≥ 90 mmHg or self-reported history of hypertension.

Body Mass Index (BMI): calculated as weight in kilograms divided by height in meters squared (weight (kg)/height (m^2). BMI was categorized as per the World Health Organization guidelines [27], underweight (BMI <18.5), normal (BMI ≥18.5 to ≤ 24.9), overweight (BMI ≥ 25.0 to ≤ 29.9) or obese (BMI ≥ 30.0).

Waist to hip ratio: calculated as waist circumference in cm divided by hip circumference in cm and it was used as a measure of abdominal obesity. Waist to hip ratio ≥ 0.94 m in men and ≥ 0.80 m in women is defined as having abdominal obesity [31].

High physical activity: a person reaching any of the following criteria is classified in this category:

a. Vigorous-intensity activity on at least 3 days achieving a minimum of at least 1,500 MET-minutes/week OR
b. 7 or more days of any combination of walking, moderate- or vigorous intensity activities achieving a minimum of at least 3,000 MET-minutes per week [27].

Moderate physical activity: a person, not meeting the criteria for the "high" category, but meeting any of the following criteria is classified in this category:

a. 3 or more days of vigorous-intensity activity of at least 20 minutes per day OR
b. 5 or more days of moderate-intensity activity or walking of at least 30 minutes per day OR
c. 5 or more days of any combination of walking, moderate- or vigorous intensity activities achieving a minimum of at least 600 MET-minutes per week [27].

Low physical activity: a person, not meeting any of the above mentioned criteria under moderate or high physical activities falls in this category.

Raised fasting blood glucose was defined as capillary whole blood value ≥126 mg/dl.

Dyslipidemia- was defined according to the third report of National Cholesterol Education Program Adult Treatment Panel (NCEP ATP III) criteria [30] with the following cut off values:

Hypercholesterolemia-serum TC level ≥ 200 mg/dl;

Hypertriglyceridemia–serum TG level ≥ 150 mg/dl;

Low HDL-C– serum HDL-C level < 40 mg/dl for men and <50 mg/dl for women;

Isolated dyslipidemia was defined as follows:

Isolated hypercholesterolemia-serum TC ≥ 200 mg/dl without hypertriglyceridemia;

Isolated hypertriglyceridemia–serum TG ≥ 150 mg/dl without hypercholesterolemia;

Isolated low HDL-C–HDL-C < 40 mg/dl for men and < 50 mg/dl for women without hypertriglyceridemia and hypercholesterolemia;

Mixed hyperlipidemia was defined as having triglycerides ≥150 mg/dl and total cholesterol ≥ 200 mg/dl;

2.5. Data Analysis

Double data entry was done using the EpiData 3.1 statistical software, and then exported to IBM SPSS software version 23 for analysis. Binary logistic regression was applied to identify the risk factors for dyslipidemia. Initially, possible risk factors were assessed using bivariate analyses a p-value of < 0.20 was used as criteria to include it in the multivariable logistic regression model to control the confounding factors. The statistical significance was accepted when the p-value < 0.05. We applied Hosmer-Lemeshow goodness-of-fit test to assess whether the necessary assumptions for the application of multiple logistic regression was fulfilled or not. Odds Ratios (OR) with 95% confidence intervals (CI); were also calculated.

2.6. Ethical Clearance

We obtained ethical clearance from the Addis Ababa University, College of Health Sciences Institutional Review Board (IRB), and the city government of Addis Ababa Health Bureau Ethical Review Committee (ERC). Moreover, we obtained a permission letter from the selected sub-city health offices. After that, the purpose of the study was explained to the study participants then they gave verbal and written consent. Participants having high blood pressure, high blood glucose level and, or abnormal lipid profiles during the study period was referred and informed to go to nearby health facilities for further diagnosis and management [25].

3. Results

3.1. Description of the Study Participants

From the total of 3560 participants who were given consent for the interview (step one) and physical measurement (step two) questionnaires, one out of five (20%) of the study respondents selected using random sampling techniques for step three (biochemical assessment), and in this work, a total of 582 respondents participated.

The age of the respondents ranges from 18 to 95 years. The mean age was 43.7±16.3 years. Nearly half of the participants (44.3%) were between 30-49 years of age, more than two-thirds (72.2%) of the participants were females. More than three-fourth (77.8%) were Orthodox Christians, followed by Muslim religion (12.5%). One-third (33.3%) were housewives; nearly two-thirds (61.0 %) were currently married (Table 1).

Table 1. *Background characteristics of the study respondents. Addis Ababa, Ethiopia, October 2018.*

Characteristics	Frequency	Percent
Sex		
Male	162	27.8
Female	420	72.2
Religion		
Orthodox	453	77.8
Muslim	73	12.5
Protestant	49	8.4
Catholic	5	0.9
Other	2	0.4
Employment status		
Government employee	86	14.8
Non-government employee	29	5.0
Self employed	151	25.9
Student	24	4.1
Housewife	194	33.3
Daily labourer	6	1.0
Merchant	6	1.0
Unemployed (able to work)	32	5.5
Unemployed (unable to work)	9	1.5
Retired (pensioner)	45	7.7
Age in years		
18-29	122	21.0
30-49	258	44.3
50 and above (50-95)	202	34.7
Family size		
1-4	482	82.8
≥5	100	17.2
Marital status		
Never married	108	18.6
Currently married	355	61.0
Separated	14	2.4
Divorced	30	5.2
Widowed	73	12.5
Non response	2	0.3
Highest education level		
Primary	191	32.8
Secondary	82	14.1
Preparatory	74	12.7
Technique	12	2.1
College and above	84	14.4
Not attended formal education	139	23.9

Behavioral and physiological characteristics of the study participants

Overall about 11 (1.9%) of the survey participants were current smokers (smoking cigarettes daily and non-daily). The mean age of smokers to start smoking was 20.8 ± 5.13 years. Ten (1.7%) were ever smoked cigarettes. Nineteen (3.3%) were passive smokers or second-hand smoke (Table 2).

Nearly two-thirds 174 (29.9%) drank alcohol for the last one year, and 111 (19.1%) drank alcohol for the last one month. The word Binge is defined as drinking alcohol five or more (for men); or four or more (for women) in one moment and, our finding revealed that 21 (3.6%) of men and 15 (2.6%) of women categorized under binge drinker (Table 2).

More than half 328 (56.4%) of them consume fruits, a minimum of once a week, and the average fruit utilization in a week was 2.03 (±1.36) days; moreover, most 312 (53.6%) consumed fruit 1-2 servings a day with an average of 1.34 (±0.58) times a day. In addition, four-fifth 466 (80.1%) of the respondents consumed vegetables a minimum of one time a week with an average of 2.37 (± 1.43) per week, and three fourth 438 (75.2%) of them consumed it 1-2 times a day with an average serving time a day was 1.57 (±0.63). More than half 351 (60.3%) of participants responded that they frequently utilized palm oils; only 223 (38.3%) prepared their food using vegetable oils like Niger, sunflower, and sesame. Almost all (93.0%) of respondents consume fruits and or vegetables less than five times a day (Table 2).

Table 2. *Descriptive characteristics of the study participants according to gender. Addis Ababa, Ethiopia, October 2018.*

Variables	Men (N=162)	Women (N=420)	Overall (N=582)
Lifestyle, diet and exercise			
Smoking			
Current smoker	8 (4.9)	3 (0.71)	11 (1.9)
Ex- smoker	8 (4.9)	2 (0.48)	10 (1.7)
Never smoker	146 (90.1)	415 (98.8)	561 (96.4)
Khat			
Yes	14 (8.6)	5 (1.2)	19 (3.3)
No	148 (91.4)	415 (98.8)	563 (96.7)
Alcohol consumption			
Current drinker	77 (47.5)	97 (23.1)	174 (29.9)
No drinking	85 (52.5)	323 (76.9)	408 (70.1)
5+serving fruit/veg. per day[1]			
Yes	4 (5.0)	17 (7.7)	21 (7.0)
No	76 (95.0)	204 (92.3)	280 (93.0)
Type of oil used in cooking			
Liquid	58 (35.8)	165 (39.3)	223 (38.3)
Solid at room temperature	102 (63.0)	249 (59.3)	351 (60.3)
Don't know	2 (1.2)	6 (1.4)	8 (1.4)
Level of physical activity[2]			
High	33 (20.4)	18 (4.3)	51 (8.8)
Moderate	104 (64.2)	272 (64.8)	376 (64.6)
Low	25 (15.4)	130 (31.0)	155 (26.6)
Walk for 10' per day			
Yes	151 (93.2)	388 (92.4)	539 (92.6)
No	11 (6.8)	32 (7.6)	43 (7.4)
Anthropometric indicators			
Body Mass Index[3]			
Normal (18.5-24.9)	94 (58.0)	178 (42.6)	272 (46.9)
Underweight (<18.5)	10 (6.2)	29 (6.9)	39 (6.7)
Overweight (25.0-29.9)	48 (29.6)	139 (33.3)	187 (32.2)
Obese (>=30)	10 (6.2)	72 (17.2)	82 (14.1)

[1] Missing data on fruit/vegetable servings for 82 males and 199 females
[2] Missing data on Body Mass Index for 2 females
[3] Overall levels of physical activity based on total minutes spent in vigorous and moderate activity each week.

3.2. Prevalence of Dyslipidemia

The Mean Total Cholesterol (TC) and High-Density Lipoprotein Cholesterol (HDL-c) were 182.7 (± 48.4) and 50.0 (± 12.9), respectively. The median Triglyceride (TG) level was 136.5 (IQR 94, 192) (Figure 1).

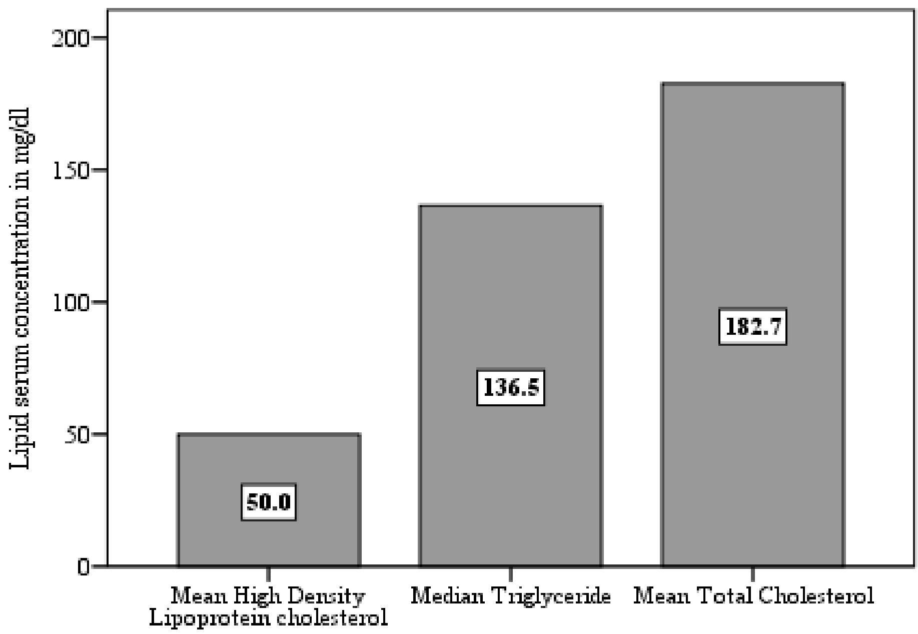

Figure 1. *Serum concentration of High-Density Lipoprotein cholesterol, Total Cholesterol and Triglycerides levels in Addis Ababa, Ethiopia, October 2018.*

The two more prevalent dyslipidemias were; hypertriglyceridemia and low HDL-cholesterol 41.4% (95% CI: 37.4–45.4) and 41.1% (95% CI: 37.1–45.1), respectively. The prevalence of Low HDL-C and hypercholesterolemia were higher among women 45.7% and 36.2 as compared to men 29.0% and 28.4 respectively; on the contrary, the prevalence of hypertriglyceridemia was higher among men 48.8% as compared to women 38.6%; moreover, the findings were statistically significant with p-value 0.001, 0.03 and 0.02 respectively.

Four hundred fifty 77.3% (95% CI: 73.9-80.7) of the study participants had at least one type of dyslipidemia (lipid abnormality). One hundred thirty-one (22.5%) participants have isolated low HDL-C, 111 (19.1%) isolated triglyceridemia, and 75 (12.9%) isolated cholesterolemia. Moreover, 130 (22.3%) had mixed hyperlipidemia. Among four hundred fifty respondents who had at least one type of dyslipidemia, 433 (96.2%); were newly diagnosed.

3.3. Factors Associated with Dyslipidemia

The multivariable analysis result showed that sex and age were associated with hypertriglyceridemia. The odds of hypertriglyceridemia increased with increased age. The odds of hypertriglyceridemia increased by nearly three times AOR =2.72 (95% CI: 1.60-4.62) among respondents aged 30-49 years, and it was more than two times AOR=2.26 (95% CI: 1.27-4.02) higher among respondents aged 50 years and above as compared to those 18–29 years old. The chance of high TG level was reduced by 38% AOR= 0.62 (95% CI: 0.41-0.94) among females compared to males.

From modifiable and other factors, raised blood glucose, sitting more than 3 hours per day, and having hypertension were related to hypertriglyceridemia. The odds of hypertriglyceridemia increased by two times AOR= 2.07 (95% CI: 1.25-3.44) among respondents with raised blood glucose levels contrasted to their counterparts. Furthermore, the odds of hypertriglyceridemia increased by nearly twice AOR=1.57 (95% CI: 1.03-2.38) among respondents sitting more than 3 hours per day contrasted to their correspondent. Moreover, the odds of hypertriglyceridemia increased twice, AOR=2.28 (95% CI: 1.56-3.33), among hypertensive respondents, compared to their counterparts.

Our analysis also showed that sex, body mass index and raised blood glucose were associated with low HDL-c levels. The odds of low HDL-c level increased twice AOR= 2.13 (95% CI: 1.39-3.27) among females related to males. The odds of low HDL-c level also increased twice AOR=1.98 (95% CI: 1.16-3.39) among obese respondents related to having a normal body mass index. In addition, the odds of low HDL-c level was more than two times higher AOR=2.32 (95% CI: 1.41-3.81) among respondents having raised blood glucose levels related to their counterparts.

Furthermore, sex, age, and being hypertensive were the significant risk factors for hypercholesterolemia. The odds of hypercholesterolemia was increased by one and half time AOR= 1.55 (95% CI: 1.02-2.36) among females compared to males. The odds of hypercholesterolemia increased with increasing age. The odds of hypercholesterolemia increased by more than five times AOR =5.22 (95% CI: 2.65-10.28) among participants aged 30-49 years, and it was more than six times higher AOR=6.42 (95% CI: 3.17-13.0) among participants aged 50 years and above related to those 18–29 years old.

Moreover, the odds of hypercholesterolemia increased nearly twice AOR=1.57 (95% CI: 1.07-2.31) among hypertensive respondents compared to counterparts.

In our study, behavioral factors, including alcohol use and type of physical activity, were not statistically associated with dyslipidemia.

Table 3. *Multivariable logistic regression analysis on the prevalence of dyslipidemia among respondents in Addis Ababa, Ethiopia, October 2018.*

Variables	Hypertriglyceridemia ≥150 mg/dl		Low HDL-c < 40 for male and < 50 mg/dl for female		Hypercholesterolemia ≥200 mg/dl	
	N (%)	Adjusted OR (95% CI)	N (%)	Adjusted OR (95% CI)	N (%)	Adjusted OR (95% CI)
	241 (41.4)		239 (41.1)		198 (34.02)	
Sex						
Male	79 (48.8)	1.00	47 (29.0)	1.00	46 (28.4)	1.00
Female	162 (38.6)	0.62 (0.41-0.94) *	192 (45.7)	2.13 (1.39-3.27) **	152 (36.2)	1.55 (1.02-2.36)*
Age						
18-29	25 (20.5)	1.00	54 (344.3)	1.00	11 (9.0)	1.00
30-49	114 (44.2)	2.72 (1.60-4.62) *	102 (39.5)	0.73 (0.45-1.18)	97 (37.6)	5.22 (2.65-10.28) **
≥50	102 (50.5)	2.26 (1.27-4.02) *	83 (41.4)	0.74 (0.44-1.25)	90 (44.6)	6.42 (3.17-13.0) **
Alcohol						
No	165 (40.4)	1.00	175 (42.9)		142 (34.8)	1.00
Yes	76 (43.7)	0.91 (0.59-1.34)	64 (36.8)		56 (32.2)	0.84 (0.56-1.27)
BMI						
18.5-24.9	104 (38.2)	1.00	93 (34.2)	1.00	84 (30.9)	1.00
<18.5	8 (20.5)	0.59 (0.25-1.42)	14 (35.9)	1.12 (0.55-2.29)	5 (12.8)	0.67 (0.28-1.59)
25-29.9	85 (45.5)	1.16 (0.77-1.77)	83 (44.4)	1.44 (0.97-2.13)	71 (38.0)	1.13 (0.75-1.69)
≥ 30	43 (52.4)	1.27 (0.72-2.23)	47 (57.3)	1.98 (1.16-3.39) *	38 (46.3)	1.46 (0.85-2.52)
High physical activity						
No	218 (41.1)	1.00	216 (40.7)	1.00	187 (35.2)	1.00
Yes	23 (45.1)	1.43 (0.75-2.75)	23 (45.1)	0.58 (0.31-1.09)	11 (21.6)	1.53 (0.78-3.01)
Raised blood glucose						
No	189 (38.1)	1.00	188 (37.9)	1.00	161 (32.5)	1.00
Yes	52 (60.5)	2.07 (1.25-3.44) *	51 (59.3)	2.32 (1.41-3.81) *	37 (43.0)	0.73 (0.39-1.36)
Abdominal obesity						
No	60 (34.7)	1.00	57 (32.9)		47 (27.2)	1.00
Yes	181 (44.3)	1.38 (0.85-2.24)	182 (44.5)		151 (36.9)	1.44 (0.98-2.11)
Sitting per day						
≤ 3 hrs	172 (38.4)	1.00	194 (43.3)	1.00	144 (32.1)	1.00
>3hrs	69 (51.9)	1.57 (1.03-2.38) *	45 (33.8)	0.69 (0.45-1.05)	53 (39.8)	1.15 (0.74-1.78)
Hypertension						
No	110 (31.3)	1.00	145 (41.2)		96 (27.3)	1.00
Yes	131 (57.0)	2.28 (1.56-3.33) **	94 (40.9)		102 (44.3)	1.57 (1.07-2.31) *

P-value < 0.05 * and <0.001**.

4. Discussion

This is one of a few community-based studies conducted in Addis Ababa, Ethiopia. So, to fill this gap, the present study aimed to determine the prevalence and associated factors of dyslipidemia among adults aged 18 years and above, Addis Ababa, Ethiopia.

Our finding showed that more than three fourth of the study participants have at least one type of lipid abnormality and, this study is comparable with other community-based studies done in India the overall dyslipidemia was 79%, and dyslipidemia from four regions was 76.9%, 77%, 80%, and 82.9%; South Africa community-based study also showed that 67.3% of study participants had dyslipidemia; Egypt study showed that 63.8% of university students aged 17 to 24 years had at least one type of dyslipidemia [6, 32, 33]. From our findings, we can see that dyslipidemia is a widely prevalent health problem affecting the adult Addis Ababa population and putting them at enormous risk for CVD [9].

Using the National Cholesterol Education Program Adult Treatment Panel (NCEP ATP) III criteria; Hypertriglyceridemia (≥150 mg/dl) and low HDL-cholesterol (< 40 for males and < 50 mg/dl for females) were more prevalent dyslipidemia in the study participants. The finding was comparable with other studies conducted in Ethiopia (national survey), Mekelle (Ethiopia), Nigeria, India (ICMR–INDIAB study), Iran, Latin America, and the Caribbean [16, 18, 19, 32, 34-36].

On the contrary, a Nigerian study showed that hypercholesterolemia was the most prevalent dyslipidemia, followed by the low HDL-C and hypertriglyceridemia 31.7%, 10.6%, and 8.7% respectively [37].

In our study, the prevalence of hypertriglyceridemia was 41.4%. It was the first most dyslipidemia in the study area. Our finding was comparable and slightly higher with a community-based study conducted at Mekelle (Ethiopia) (36.0%), Beijing (China) (35.6%), a systematic review in Latin America and the Caribbean reported the pooled prevalence (43.12%). But it is higher than a study conducted in Ethiopia National survey report (21.0%), Nigeria (21.4%), India (29.5%), Turkey (30.5%), and Iran (28.8%). Even though our finding is lower than South Africa (59.3%); and the Pan-European studies (47-57% and 44-48% among men and women) [14, 16, 18, 19, 32, 34-36, 38).

The second most dyslipidemia was low HDL cholesterol. The prevalence of low HDL cholesterol was 41.1%. Our finding was comparable with Nigeria (42.8%) and Iran (42.3%) studies. But it is higher than the Turkey study (21.1%) and; lower than a community-based study conducted in Ethiopia (national survey) (68.7%), India (72.3%), and Latin America and the Caribbean (48.27%) studies [16, 19, 32, 35, 36, 38).

In the present study, the prevalence of hypercholesterolemia was 34.02%. It was the least prevalent. Our finding was comparable with community-based research conducted at Mekelle, Ethiopia (33.5%), Turkey's community-based study (37.5%). But our finding was higher than that in Ethiopia National survey report (7.1%), Nigeria (2.6%), India (13.93), and Iran (13.4%) [16, 19, 32, 34, 35, 38] and lower than Beijing (China) study (42.7%) [14].

The difference could be due to variations in the exposure to behavioral risk factors like alcohol, cigarette, dietary habit, and physical activity of the two populations. Additionally, physiological factors like the magnitude of obesity, family history of dyslipidemia could affect the outcome variable. The other might be the variation in the socio-demographic characteristics, sample size, and genetic factors.

From those risk factors that cannot change, age and sex are associated with dyslipidemia. Aging is associated with unwanted changes in body composition that expose older adults to several metabolic complications. It is recognized that body fat increases with age and is preferentially accumulated in the abdominal region (abdominal obesity), thereby increasing the risk of Cardio Vascular Diseases (CVD) and other non-communicable diseases in older adults [39].

Moreover, increasing age is, accompanied by the change of carbohydrate and lipid metabolism, which leads to metabolic syndrome. With increasing age, the total cholesterol, triglyceride concentration increase, while HDL-c decreases [40]. Similarly, our study showed that the odds of dyslipidemia, especially triglyceridemia and cholesterolemia, increased with increasing age; but did not show a significant association with low HDL-c levels, this finding is partially and fully in line with other studies [13, 14, 40-44].

Research related to the significant role of ethnicity and sex in the formation of hyperlipidemia has been controversial [45]. However, our study showed that females had considerably higher levels of abnormality of lipid than counterparts, except hypertriglyceridemia higher among males; this finding is consistent with other findings [13, 14, 32, 38, 42, 44, 46].

Different studies showed that having excess body fat is related to a scope of disorders, including lipid abnormality, high blood glucose, and increased blood pressure [47, 48]. Overweight and obesity negatively affect the entire metabolism of lipids and proteins but more consistently lower HDL-C levels [49]. Similarly, our study showed that obese people had two times higher odds of low HDL-C levels compared to those with normal BMI. This finding was in line with previous reports from Nigeria, China, and Turkey [13, 14, 37, 38, 44].

In our study, comorbid conditions like hypertension and raised blood glucose are the risk factor for dyslipidemia. And different studies showed that hypertension and raised blood glucose are the risk factors for CVD morbidity and mortality [50]. Hypertension was independently associated with hypertriglyceridemia and hypercholesterolemia. The odds of hypertriglyceridemia increased by two times, whereas the odds of hypercholesterolemia also increased by 1.5 times among participants who have dyslipidemia compared to their counterparts. And our finding is in line with other studies [14, 37, 51].

Moreover, raised blood glucose is also associated with hypertriglyceridemia and low HDL-C level and, this finding is also in line with others [13, 14, 44, 51].

Previous studies have done so far suggested that the drinking of alcohol and high physical activity were; significantly associated with dyslipidemia. In contradiction in this study, the above variables were not significantly associated with dyslipidemia. The difference in these results may be due to the inadequate frequency of these factors in the community. The study design is cross-sectional has its limitation, lacks to differentiate which comes first, whether the explanatory or the outcome (dyslipidemia) variables. Lack of some details on exposures such as alcohol consumption, smoking, and Khat chewing is another limitation although, khat chewing and smoking are generally low among adults of this age in the study area. Some of the information was based on self-reporting, which leads to unable to memorize past events.

5. Conclusions

The prevalence of dyslipidemia among adults in Addis Ababa city shows an unseen distribution of the disease in the study population. In spite of the fact that the study was done in the metropolis, a significant portion of dyslipidemic respondents (96.2 %) were oblivious of having the disease. Increasing age, sex, obesity, raised blood glucose, hypertension, and sitting greater than three hours per day were remarkably associated with dyslipidemia.

Therefore, we recommend that the health system needs to develop a strategy to implement a selective screening program for dyslipidemia in this community. Intervention measures have to be taken targeting the modifiable risk factors associated with dyslipidemia. More curiosity should be given to those participants with the concurrent medical condition since hypertension and raised blood glucose are the factors associated with dyslipidemia. And all of them are risk factors for CVD morbidity and mortality. Thus, screening programs for adults for dyslipidemia especially, in high-risk groups, are of paramount importance.

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