

Review

Dyslipidemia and its associated factors in Ethiopia: a systematic review and meta-analysis

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Abstract

Introduction Dyslipidemia is a major risk factor for cardiovascular disease, with its prevalence steadily rising in both developed and developing nations. An unhealthy lifestyle significantly contributes to the development of dyslipidemia, with smoking being a well-known risk factor.

Methods A comprehensive search was conducted across several databases, including Google Scholar, Web of Science, African Journals Online (AJOL), HINARI, and PubMed/MEDLINE. Articles published up until June 24, 2024, were considered for inclusion. Data extraction and organization were carried out using Microsoft Excel, while analysis was performed using STATA/MP 17.0. The quality of the included studies was evaluated using the Newcastle–Ottawa Scale (NOS). To analyze the pooled data, a weighted inverse variance random effects model with a 95% confidence interval was applied. Heterogeneity among studies was assessed using Cochrane's I² statistics, and Egger's test was conducted to detect potential publication bias. The association between dyslipidemia and its associated factors was examined using the log odds ratio, with a p-value of less than 0.05 considered statistically significant.

Results A total of 44 articles involving 12,395 participants were included. The overall pooled prevalence of dyslipidemia in Ethiopia was 56.60% (95% CI 50.40–62.80). Dyslipidemia was observed across various population groups, with notable prevalence rates associated with different risk factors. Among individuals with insufficient physical activity, the prevalence was 30.12% (95% CI 22.53–37.70). In those who smoked cigarettes, it was observed in 6.81% (95% CI 4.27–9.34). Among chronic alcohol consumers, the prevalence of dyslipidemia was 15.75% (95% CI 9.65–21.86). Furthermore, 30.12% (95% CI 22.53–37.70) of dyslipidemia was reported among individuals with inadequate physical exercise.

Conclusions The prevalence of dyslipidemia in Ethiopia was 56.60%, indicating a significant public health concern. The condition is particularly prevalent among individuals with insufficient physical activity, smoking habits, and chronic alcohol consumption, suggesting strong associations with these modifiable risk factors. To reduce dyslipidemia, public health initiatives should focus on promoting physical activity, anti-smoking campaigns, and educating on the risks of excessive alcohol use. Health professionals should also prioritize early detection and management in high-risk groups to reduce long-term cardiovascular risks.

Keywords Dyslipidemia · Cigarette smoking · Alcohol consumption · Poor physical exercise · Poor fruit and vegetable consumption

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Abbreviations

AIDS	Acquired Immunodeficiency Syndrome
AJOL	African Journals Online
AOR	Adjusted Odds Ratio
BMI	Body Mass Index
CI	Confidence Interval
HIV	Human Immunodeficiency Virus
NOS	Newcastle Ottawa Scale
PRISMA	Preferred Reporting Items for Systematic Review and Meta-analysis
SNNP	South Nation Nationalities and People
DM	Diabetes Mellitus

1 Introduction

Dyslipidemia refers to abnormal levels of lipids (cholesterol and/or fats) in the blood, indicating a disorder in lipoprotein metabolism, which can involve either overproduction or deficiency [1]. It is characterized by elevated levels of total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL), and reduced high-density lipoprotein cholesterol (HDL) in the blood, factors that are preventable yet contribute to cardiovascular disease [2]. It poses a global public health challenge, with prevalence rates varying widely due to socioeconomic, cultural, and ethnic factors [3]. Although it is a modifiable risk factor for many chronic diseases, dyslipidemia continues to be a leading contributor to disease burden in both developed and developing countries [4]. Awareness, treatment, and management of dyslipidemia remain inadequate despite its high prevalence [5], affecting diverse populations, including children and adolescents [6].

Dyslipidemia is a significant risk factor for atherosclerosis and various cardiovascular diseases [7], with its prevalence rising steadily in both developed and developing nations [8]. It is notably common among individuals with conditions like diabetes mellitus, hypertension, HIV/AIDS, and psychiatric disorders, with a prevalence reaching 81.5%. There are significant gender differences in its occurrence, and key risk factors such as advanced age, obesity, and physical inactivity are strongly linked to the condition [9, 10]. Dyslipidemia is closely linked to an increased risk of cardiovascular diseases, particularly atherosclerosis, which accounted for more than 17 million deaths worldwide in 2015 [11].

An unhealthy lifestyle plays a crucial role in the development of dyslipidemia [12]. Among these, smoking is a well-known risk factor, associated with elevated triglyceride levels and decreased high-density lipoprotein cholesterol [13]. Compared to other factors affecting blood lipids, such as alcohol consumption, body mass index (BMI), and age, smoking has the most significant impact and is recognized as an independent risk factor for dyslipidemia [14]. Both current and former smokers have a higher odds ratio of developing dyslipidemia compared to non-smokers [13]. Alcohol consumption is another contributing factor to dyslipidemia [15]. It is also a leading cause of chronic liver disease worldwide and has the potential to cause severe hypertriglyceridemia. This can occur either independently or in conjunction with other disorders related to lipid metabolism, exacerbating the overall risk to health [16].

Unhealthy diets and physical inactivity further increase the risk of dyslipidemia and contribute to cardiovascular diseases, including heart attacks and strokes [16]. Diet patterns rich in vegetables, fruits, seafood, legumes, soy products, and grains are inversely associated with hypercholesterolemia [17].

Despite the availability of screening tests, dyslipidemia remains underdiagnosed and undertreated. Assessing health behavior patterns following diagnosis could improve lifestyle interventions for managing dyslipidemia [8]. Conducting a systematic review and meta-analysis is an important study as it provides a comprehensive evaluation of the prevalence of dyslipidemia in Ethiopia and identifies the key factors contributing to its rise. Given the increasing burden of non-communicable diseases in Ethiopia, understanding the prevalence of lipid abnormalities can help inform targeted public health interventions. This review synthesizes existing data to offer precise estimates, ultimately guiding efforts to reduce its impact on the Ethiopian population and improve overall cardiovascular health. Therefore, this study aimed to assess the pooled prevalence of dyslipidemia and its associated factors in Ethiopia.

2 Methods

2.1 Reporting

The findings were reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Table S1) [18].

2.2 Databases and searching strategies

A comprehensive search was conducted across several databases, including Google Scholar, Web of Science, African Journals Online (AJOL), HINARI, and PubMed/MEDLINE, to identify studies on dyslipidemia and its associated factors in Ethiopia. To ensure comprehensive coverage of relevant articles, a range of search engines was employed, using terms related to dyslipidemia such as "dyslipidemia," "lipid abnormality," "abnormal lipid profile," "hyperlipidemia," "lipid levels," "cholesterol," "triglycerides," "LDL," "HDL," and "lipid metabolism." Prevalence-related keywords included "prevalence," "incidence," "proportion," "magnitude," "percentage," "rate," and "burden." Terms for associated factors and conditions comprised "smoking," "alcohol consumption," "substance abuse," "physical inactivity," "sedentary lifestyle," "obesity," "diabetes," "hypertension," "age," "gender," "socioeconomic status," "psychological stress," "diet," and "behavioral risk factors." For Ethiopia, keywords such as "Ethiopia," "Ethiopian population," "Ethiopian adults," and "sub-Saharan Africa" were used. The Boolean operators "AND" and "OR" were carefully applied to combine these terms and ensure a thorough literature search (Table 1).

2.3 Screening of studies

After collecting all relevant articles from various databases, they were exported to EndNote Reference Citation Manager software version 8 (Thomson Reuters, Stamford, CT, USA) [19]. The articles were then organized, and cleaned, and duplicates were removed. Four authors (AG, TA, MG, and BTA) independently assessed each article based on a predetermined inclusion criterion, evaluating titles, abstracts, relevance, and outcomes of interest. Any disagreements that arose during the screening process were resolved through discussion.

2.4 Data extraction

From the data extraction sheet, the first and last authors collected key information, including the names of the researchers, the publication year, the region where the studies were conducted, the sample size, and the prevalence of dyslipidemia in various populations. Factors such as cigarette smoking, alcohol consumption, physical inactivity, and insufficient intake of fruits and vegetables were specifically considered for dyslipidemia prevalence. Furthermore, the odds ratios and their corresponding 95% confidence intervals for the identified associated factors were extracted to assess the strength and precision of these relationships. Any disagreements between authors during the selection process were resolved through consensus before proceeding with the analysis. The second and third authors review and verify the accuracy of the information. They carefully assessed the data to ensure it was correct and reliable, cross-checking sources to confirm that all details were accurate.

2.5 Eligibility of studies

Different studies that examine dyslipidemia and its associated factors in Ethiopia were included. In terms of the population, only studies that involve Ethiopian populations from various regions within the country, including both urban and rural populations were considered. The study population consisted of patients with chronic diseases and the general adult population. Studies that explore factors associated with dyslipidemia, such as smoking, alcohol consumption, physical inactivity, poor diet (like low fruit and vegetable intake), obesity, diabetes, hypertension, and socioeconomic status are eligible. Only studies that report on the prevalence, incidence, or odds of dyslipidemia, based on lipid profile abnormalities (such as elevated cholesterol, LDL, triglycerides, or low HDL levels) were included. Only studies published

Table 1 Searches on different databases to find articles conducted on dyslipidemia and its associated factors in Ethiopia

Databases	Searching terms	Number of studies
MEDLINE/ PubMed	"Dyslipidemia" OR "lipid abnormality" OR "abnormal lipid profile" OR "hyperlipidemia" OR "cholesterol" OR "triglycerides" OR "LDL" OR "HDL" OR "lipid metabolism" AND "prevalence" OR "incidence" OR "proportion" OR "magnitude" OR "percentage" OR "rate" OR "burden" AND "smoking" OR "alcohol consumption" OR "substance abuse" OR "physical inactivity" OR "sedentary lifestyle" OR "obesity" OR "diabetes" OR "hypertension" OR "age" OR "gender" OR "socioeconomic status" OR "psychological stress" OR "diet" OR "behavioral risk factors" AND "Ethiopia" OR "Ethiopian population" OR "Ethiopian adults" OR "sub-Saharan Africa"	128
Google Scholar	"Dyslipidemia" OR "lipid abnormality" OR "abnormal lipid profile" OR "hyperlipidemia" OR "cholesterol" OR "triglycerides" OR "LDL" OR "HDL" OR "lipid metabolism" AND "prevalence" OR "incidence" OR "proportion" OR "magnitude" OR "percentage" OR "rate" OR "burden" AND "smoking" OR "alcohol consumption" OR "substance abuse" OR "physical inactivity" OR "sedentary lifestyle" OR "obesity" OR "diabetes" OR "hypertension" OR "age" OR "gender" OR "socioeconomic status" OR "psychological stress" OR "diet" OR "behavioral risk factors" AND "Ethiopia" OR "Ethiopian population" OR "Ethiopian adults" OR "sub-Saharan Africa"	166
Other databases	"Dyslipidemia" OR "lipid abnormality" OR "abnormal lipid profile" OR "hyperlipidemia" OR "cholesterol" OR "triglycerides" OR "LDL" OR "HDL" OR "lipid metabolism" AND "prevalence" OR "incidence" OR "proportion" OR "magnitude" OR "percentage" OR "rate" OR "burden" AND "smoking" OR "alcohol consumption" OR "substance abuse" OR "physical inactivity" OR "sedentary lifestyle" OR "obesity" OR "diabetes" OR "hypertension" OR "age" OR "gender" OR "socioeconomic status" OR "psychological stress" OR "diet" OR "behavioral risk factors" AND "Ethiopia" OR "Ethiopian population" OR "Ethiopian adults" OR "sub-Saharan Africa"	4
Total retrieved articles		298
Included studies		44

in English published until June 2024 were included. However, interventional studies, clinical trials, systematic reviews, meta-analyses, narrative reviews, qualitative studies, case reports, and policy statements were excluded. Additionally, articles without full text were excluded after two attempts to contact the corresponding author via email.

2.6 Measurement of the study results

The outcome variable of this study was dyslipidemia, which is measured using the criteria of the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) criteria of 2002. Then, to be dyslipidemia, patients should have at least one of the following lipid profiles in their serum/plasma: total cholesterol TC ≥ 200 mg/dl, Low-density lipoprotein cholesterol LDL-c ≥ 130 mg/dl, high-density lipoprotein cholesterol HDL < 40 mg/dl and Triglyceride TGs ≥ 150 mg/dl [20].

2.7 Quality assessment

Each author also independently assessed the quality of the articles using the Newcastle Ottawa Scale (NOS) for cross-sectional studies [21]. The evaluation focused on the studies' methodological quality, comparability, results, and statistical analysis. Studies that scored 7 out of 10 or higher were considered to be of high quality. High-quality studies, scoring 7 or above on the NOS, demonstrate strong methodology and minimal bias, while medium-quality studies, with scores between 4 and 6, show moderate rigor but some limitations in design or execution. Low-quality studies, scoring 3 or below, suffer from significant methodological flaws, such as poor participant selection or unreliable outcomes, leading to higher bias and reduced trustworthiness. Disagreements between the authors were resolved through discussion.

2.8 Data processing and analysis

Data extraction, editing, sorting, and cleaning were performed using a Microsoft Excel spreadsheet, after which the data was exported to STATA version 17 for analysis [22]. A weighted inverse variance random effects model with a 95% confidence interval was applied to pool the data [23]. The Cochrane Q-test and I^2 statistic were used to assess the heterogeneity among the studies [24]. To identify the sources of heterogeneity, subgroup analysis, and sensitivity analysis were conducted. Additionally, Egger's test was used to check for publication bias, and a funnel plot was generated to illustrate the distribution of the included studies [25]. To address any potential publication bias, a trim-and-fill analysis was performed. The association between dyslipidemia and its influencing factors was examined using a log odds ratio. A p-value of less than 0.05 was considered statistically significant.

3 Result

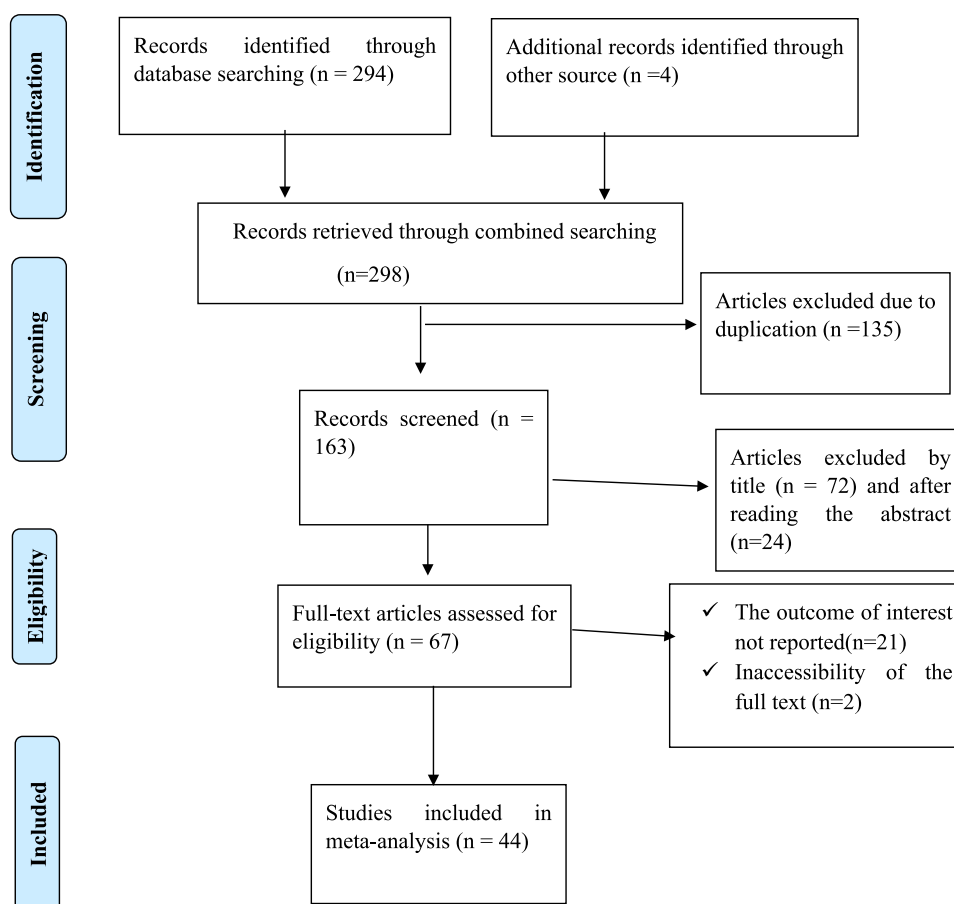
3.1 Selection of articles

A comprehensive search across various databases using specific was conducted, and keywords yielded 298 articles. After removing duplicates, 135 studies remained. Out of these, 96 were excluded based on their titles and abstracts, 2 were excluded because the full text could not be obtained, and 21 were excluded for not reporting the outcome of interest. Ultimately, 44 full-text articles that met the inclusion criteria were selected for the final analysis (Fig. 1).

3.2 Study characteristics

A total of 44 articles involving 12,395 participants were included to determine dyslipidemia and associated factors in Ethiopia. These studies were conducted across various regions of Ethiopia until June 2024. Specifically, 14 studies were conducted in the Oromia region [26–38], 10 in Addis Ababa [39–48], 10 in the Amhara region [49–58], 7 in South Nation Nationalities and people's region (SNNP) [59–65], and 3 in Tigray region [66–68]. Regarding patient types, 19 studies focused on diabetic patients, 12 on HIV/AIDS patients, 5 on the general adult population, 4 on cardiac patients, 2 on psychiatric patients, 2 on H. pylori-infected patients, and 1 on women using contraception. All included articles were cross-sectional in design, with sample sizes ranging from 48 to 1,180 participants (Table 2).

Fig. 1 PRISMA flow chart diagram to select articles done on dyslipidemia in Ethiopia



3.3 Prevalence of dyslipidemia

The overall pooled prevalence of dyslipidemia in Ethiopia was 56.60% (95% CI 50.40–62.80) (Fig. 2). Dyslipidemia was observed among different population groups, including cigarette smoking at 6.81% (95% CI 4.27–9.34), chronic alcohol consumption at 15.75% (95% CI 9.65–21.86), inadequate physical exercise at 30.12% (95% CI 22.53–37.70), and insufficient fruit and vegetable consumption at 31.96% (95% CI 16.44–47.49).

3.4 Heterogeneity and publication bias

Heterogeneity within the studies was detected ($I^2 = 98.53\%$, $p < 0.001$). A symmetrical distribution of the included articles was visible in the funnel plot and Egger's test revealed a statistically insignificant result ($p = 0.677$), indicating the absence of publication bias (Fig. 3).

3.5 Sub-group analysis

Subgroup analysis was performed based on region and patient categories. Regionally, the highest prevalence of dyslipidemia associated with cigarette smoking was observed in the Amhara region, at 10.85% (95% CI 2.64–19.07). The highest prevalence of dyslipidemia associated with insufficient physical activity was found in the SNNP region, at 39.27% (95% CI 14.58–63.96). Similarly, the highest prevalence of dyslipidemia related to alcohol consumption was reported in Addis Ababa, at 27.4% (95% CI 22.82–32.14). Additionally, the highest prevalence of dyslipidemia associated with poor fruit and vegetable intake was recorded in the Oromia region, at 39.25% (95% CI 28.19–47.06) (Table 3).

Table 2 The features of the included studies used to evaluate the prevalence of dyslipidemia and its associated factors in Ethiopia

Author	Region	Population	Sample size	Dyslipidemia (%)	Cigarette smokers (%)	Alcohol drinkers (%)	Poor regular physical exercise (%)	Low consumption of fruit & vegetable (%)
Addisu et al. [26]	Oromia	Cardiac patients	269	76.6	5.6	9.3	31.2	45.4
Abdissa et al. [27]	Oromia	Diabetic patient	390	81.5	10.3	30.5	28.7	
Gebregeziabihier et al. [66]	Tigray	Adult population	321	66.7				
Ambachew et al. [59]	SNNP	Diabetic patient	295	43.7				
Haile et al. [28]	Oromia	Diabetic patient	248	68.1	6.5	12.9	44.8	
Kemal et al. [39]	Addis Ababa	HIV/AIDS patients	353	74.8	2.8	27.5	23.5	32.0
Hirigo et al. [60]	SNNP	Psychiatry patients	245	58.4	4.9	2.9	49.8	
Tadewos et al. [61]	SNNP	HIV/AIDS patients	226	38.5				
Abdu et al. [29]	Oromia	<i>H. pylori</i> -infected patients	369	77.5		5.7		13.3
Abera et al. [62]	SNNP	Cardiac patients	319	80.3	1.6	3.4	14.4	
Assefa et al. [40]	Addis Ababa	HIV/AIDS patients	288	55.2				
Gebrie et al. [49]	Amhara	HIV/AIDS patients	407	63.9				
Tilahun et al. [50]	Amhara	HIV/AIDS patients	114	73.7				
Belete et al. [51]	Amhara	Adult population	1180	26.4	4.9	19.6	13.1	43.8
Sufa et al. [30]	Oromia	Women with contraceptive	365	34.8	0.3	0.8	26.3	
Angassa et al. [31]	Oromia	Adult population	335	67.8	5.4	53.7	21.2	57.3
Fentie et al. [32]	Oromia	Psychiatry patients	96	63.5	15.6	22.9	44.8	
Bayenes et al. [41]	Addis Ababa	HIV/AIDS patients	114	73.7				
Nigatie et al. [52]	Amhara	<i>H. pylori</i> -infected patients	117	71.8		12.0	17.1	
Kelemework et al. [63]	SNNP	Diabetic patient	228	75.9		6.1	53.9	
Abera et al. [67]	Tigray	Diabetic patient	421	11.9				
Mohammed et al. [42]	Addis Ababa	Adult population	504	63.9				
Mohammed et al. [53]	Amhara	Cardiac patients	384	93.2	6.8	9.4	43.8	39.8
Bekele et al. [65]	SNNP	Diabetic patient	224	65.6				
Woyesa et al. [33]	Oromia	HIV/AIDS patients	48	41.7				
Woyesa et al. [33]	Oromia	Diabetic patient	48	37.5				
Tamiru et al. [34]	Oromia	Diabetic patient	197	63.5				
Yazie et al. [43]	Addis Ababa	HIV/AIDS patients	66	74.2				
Zenebe et al. [35]	Oromia	Adult population	264	18.2				
Wube et al. [64]	SNNP	Diabetic patient	314	91.1		9.2		
Fiseha et al. [54]	Amhara	HIV/AIDS patients	392	59.9				
Ambisa Lamesa et al. [36]	Oromia	HIV/AIDS patients	150	72.0				
Berhane et al. [37]	Oromia	HIV/AIDS patients	313	48.2				
Kebede et al. [55]	Amhara	Diabetic patient	327	59.0	19.6	19.3		
Kifle et al. [56]	Amhara	Cardiac patients	372	48.4	6.7	10.5	12.1	17.7
Seyoum et al. [45]	Addis Ababa	Diabetic patient	302	18.5				

Table 2 (continued)

Author	Region	Population	Sample size	Dyslipi- demia (%)	Cigarette smokers (%)	Alcohol drinkers (%)	Poor regular physi- cal exercise (%)	Low consumption of fruit & vegetable (%)
Siraj et al. [46]	Addis Ababa	Diabetic patient	146	47.3				
Mideksa et al. [68]	Tigray	Diabetic patient	336	22.6				
Ezra Belay et al. [48]	Addis Ababa	HIV/AIDS patients	70	80.0				
Belay et al. [44]	Addis Ababa	Diabetic patient	80	48.8				
Biadgo et al. [57]	Amhara	Diabetic patient	159	51.6				
Mamo et al. [38]	Oromia	Diabetic patient	77	41.6				
Melaku et al. [47]	Addis Ababa	Diabetic patient	581	20.0				
Wolde et al. [58]	Amhara	Diabetic patient	341	38.1				

SNNP: South Nation Nationalities and People

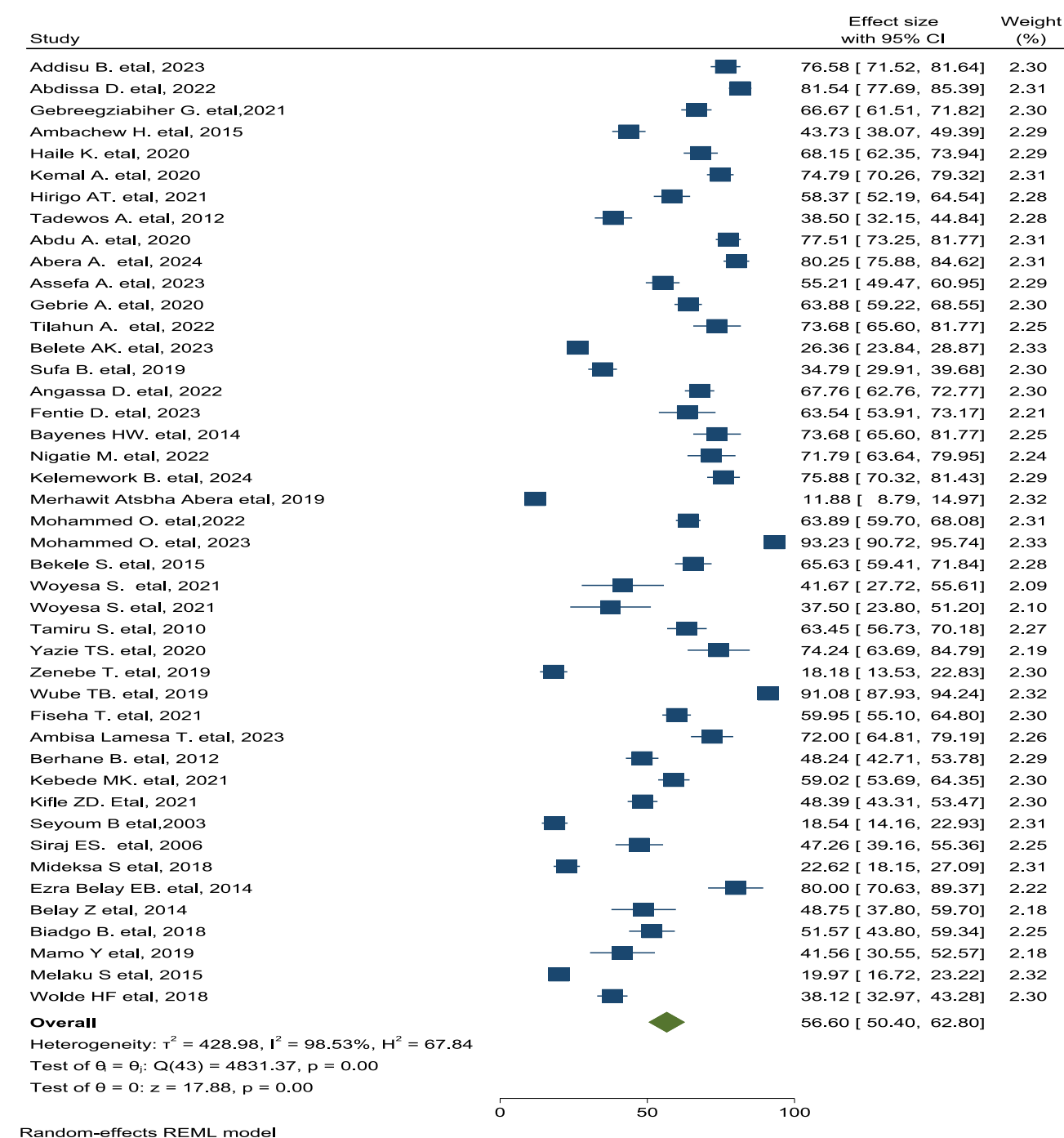


Fig. 2 Forest plot displays the pooled prevalence of dyslipidemia in Ethiopia

In terms of patient categories, the highest prevalence of dyslipidemia due to inadequate physical activity was found among psychiatry patients, at 48.38% (95% CI 43.08–53.67). Among smokers, dyslipidemia was most prevalent in diabetic patients, at 11.48% (95% CI 6.19–16.76). Furthermore, dyslipidemia associated with poor fruit and vegetable consumption was more common in cardiac patients, at 34.20% (95% CI 17.60–50.80) (Table 4).

3.6 Sensitivity analysis

A leave-one-point sensitivity analysis conducted using the random-effects model revealed that all points were estimates within the overall 95% confidence interval (50.40–62.80), indicating the absence of any influential study (Table 5).

Fig. 3 Funnel plot with 95% confidence limits on the pooled prevalence of dyslipidemia in Ethiopia

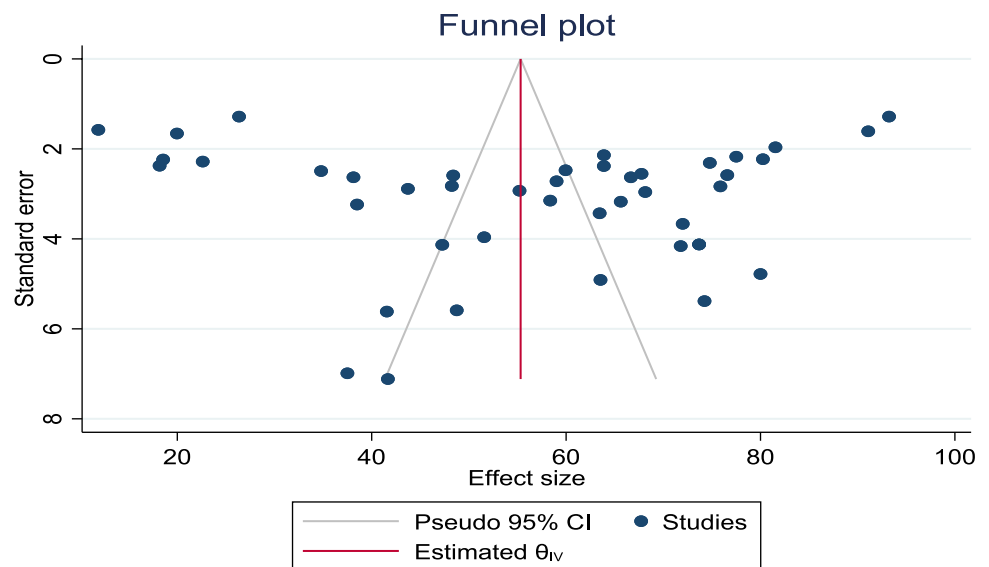


Table 3 The pooled prevalence of dyslipidemia based on region categories in Ethiopia

Variables	Subgroup	Studies	Prevalence (95%CI)	I ² (%)	P-value
Cigarette smoking	Addis Ababa	1	2.83 (1.10–4.56)	–	–
	Amhara	3	10.85 (2.64–19.07)	95.59	<0.001
	Oromia	4	6.18 (0.59–11.77)	95.40	<0.001
	SNNP	1	4.90 (2.20–7.60)	–	–
Alcohol drinking	Addis Ababa	1	27.4 (22.82–32.14)	–	–
	Amhara	4	12.62 (8.19–17.06)	81.40	<0.001
	Oromia	5	19.09 (0.63–37.54)	99.52	<0.001
	SNNP	3	5.92 (2.23–9.60)	81.05	<0.001
Low consumption of fruit and vegetable	Addis Ababa	1	32.01 (27.14–36.88)	–	–
	Amhara	2	28.74 (7.08–50.50)	97.92	<0.001
	Oromia	2	39.25 (28.19–47.06)	84.40	<0.001
Poor physical exercise	Addis Ababa	1	23.51 (19.09–27.94)	–	–
	Amhara	4	21.46 (6.78–36.13)	98.45	<0.001
	Oromia	6	32.33 (24.68–39.98)	91.75	<0.001
	SNNP	3	39.27 (14.58–63.96)	98.38	<0.001

SNNP: South Nation Nationalities and People

3.7 Factors associated with dyslipidemia

In this study, dyslipidemia was significantly associated with the level of physical activity and alcohol consumption. Consequently, participants who had poor physical activity behavior were 3.16 times more likely to have dyslipidemia than those who had regular physical exercise: (AOR = 3.16; CI 2.16–4.16) (Fig. 4). Furthermore, participants who are chronic alcohol drinkers were 2.82 times more likely to have dyslipidemia than their counterparts: (AOR = 2.82; 2.21–3.43) (Fig. 5).

Table 4 The pooled prevalence of dyslipidemia based on population type in Ethiopia

Variables	Subgroup	Studies	Prevalence (95%CI)	I ² (%)	P-value
Cigarette smoking	Adult population	2	5.01 (3.91–6.11)	0.000	0.74
	Cardiac patients	4	4.99 (2.37–7.61)	82.10	<0.001
	Diabetic patients	3	11.48 (6.19–16.76)	90.36	<0.001
	Psychiatry patients	2	9.71 (6.75–20.17)	86.41	0.001
Alcohol drinking	Adult population	2	3.09 (1.11–6.72)	99.25	<0.001
	Cardiac patients	4	7.98 (4.65–11.31)	82.16	<0.001
	Diabetic patients	5	18.00 (9.55–26.45)	96.48	<0.001
	H. pylori-infected patients	2	8.23 (2.19–14.26)	73.44	0.05
	Psychiatry patients	2	12.46 (7.18–32.10)	95.15	<0.001
	Adult population	2	13.28 (9.82–16.74)	94.85	<0.001
	Cardiac patients	3	34.20 (17.60–50.80)	97.16	<0.001
	Adult population	2	16.92 (9.03–24.80)	90.83	<0.001
Poor physical exercise	Cardiac patients	4	25.28 (10.64–39.92)	97.87	<0.001
	Diabetic patients	3	42.32 (27.78–56.87)	94.93	<0.001
	H. pylori-infected patients	1	17.09 (10.27–23.92)	–	–
	HIV/AIDS patients	1	23.51 (19.09–27.94)	–	–
	Psychiatry patients	2	48.38 (43.08–53.67)	0.00	0.40
	Women with contraceptive	1	26.30 (21.78–30.82)	–	–

4 Discussion

In this review, the overall pooled prevalence of dyslipidemia in Ethiopia was 56.60% (95% CI 50.40–62.80), with significant variations observed across different groups, including individuals with inadequate physical activity (30.12%), cigarette smokers (6.81%), chronic alcohol consumers (15.75%), and those with insufficient fruit and vegetable intake (31.96%). The highest prevalence of dyslipidemia among cigarette smokers was found in the Amhara region (10.85%), while the highest rate associated with inadequate physical activity was in the SNNP region (39.27%). For alcohol consumption, Addis Ababa had the highest prevalence (27.4%), and the highest prevalence related to insufficient fruit and vegetable intake was observed in Oromia (39.25%). In terms of patient categories, psychiatry patients with low physical activity had the highest prevalence of dyslipidemia (48.38%), diabetic smokers had the highest prevalence (11.48%), and cardiac patients with poor dietary habits had the highest prevalence (34.20%).

The prevalence of dyslipidemia in this study is higher than in studies conducted in Saudi Arabia, 40% [69], Jourdan, 44.3% [70], and China, 20.33% [71]. The potential reason for this variation might be the difference in the study settings. In Ethiopia, many chronically ill patients are often not diagnosed early, which may lead to a higher prevalence of undiagnosed or poorly managed conditions. Additionally, there is a difference in the diagnostic approaches used for chronic diseases in Ethiopia compared to other countries. Limited access to healthcare facilities, differences in medical infrastructure, and varying diagnostic protocols may contribute to the higher reported rates of dyslipidemia in the Ethiopian population. These factors could result in a delay in early detection and intervention, exacerbating the health outcomes in individuals with chronic illnesses.

The current finding is also inconsistent with the findings of studies done in Nigeria, 58.9% [72] and China, 19.2% [73]. This variation may result from differences in diagnostic approaches and study designs. This study is a systematic review and meta-analyses, which contribute to a broader understanding of dyslipidemia's prevalence and impact in different contexts. In 2000, the Global Burden of Disease Study highlighted dyslipidemia as a significant contributor to Ethiopia's health burden, particularly related to cardiovascular diseases. While specific prevalence rates were not provided, dyslipidemia was identified as a key risk factor for increased morbidity and mortality from heart disease and stroke in the country [74].

Based on region, the highest prevalence of dyslipidemia related to inadequate physical exercise was observed in studies from the SNNP region. This higher prevalence may be attributed to the fact that a significant portion of participants from the SNNP region were diabetic patients, who are at a higher risk for dyslipidemia compared to other groups [63, 64]. Similarly, the highest prevalence of dyslipidemia was observed in studies involving psychiatric

Table 5 Sensitivity analysis of the pooled prevalence of dyslipidemia in Ethiopia

Study omitted	Estimate	95% Conf. Interval	
Addisu et al. [26]	56.710178	48.723343	64.697014
Abdissa et al. [27]	56.595894	48.633945	64.557838
Gebreegziabiher et al. [66]	56.936703	48.915215	64.958191
Ambachew et al. [59]	57.462379	49.457844	65.466919
Haile et al. [28]	56.905392	48.901794	64.908981
Kemal et al. [39]	56.750553	48.744331	64.756775
Hirigo et al. [60]	57.126774	49.118507	65.13504
Tadewos et al. [61]	57.579952	49.598835	65.561073
Abdu et al. [29]	56.688278	48.694096	64.682457
Abera et al. [62]	56.624275	48.653271	64.595276
Assefa et al. [40]	57.199718	49.18195	65.217491
Gebrie et al. [49]	57.000401	48.955902	65.044891
Tilahun et al. [50]	56.782082	48.813053	64.751114
Belete et al. [51]	57.865582	50.071957	65.65921
Sufa et al. [30]	57.667244	49.684151	65.650337
Angassa et al. [31]	56.911396	48.888577	64.934219
Fentie et al. [32]	57.013573	49.042938	64.984207
Bayenes et al. [41]	56.782082	48.813053	64.751114
Nigatie et al. [52]	56.825069	48.853516	64.796623
Kelemework et al. [63]	56.727036	48.743404	64.710663
Abera et al. 2019	58.201645	50.731518	65.671768
Mohammed et al. [42]	57.000072	48.933334	65.066811
Mohammed et al. [53]	56.325169	48.812244	63.838089
Bekele et al. 2015	56.962807	48.962048	64.963562
Woyesa et al. [33]	57.488327	49.535004	65.44165
Woyesa et al. [33]	57.579834	49.628281	65.531387
Tamiru et al. [34]	57.011005	49.015404	65.006607
Yazie et al. [43]	56.77718	48.818264	64.736092
Zenebe et al. [35]	58.049099	50.209206	65.889
Wube et al. [64]	56.374287	48.613533	64.13504
Fiseha et al. [54]	57.092113	49.048607	65.13562
Ambisa Lamesa et al. [36]	56.818714	48.840656	64.796776
Berhane et al. [37]	57.359676	49.343178	65.376175
Kebede et al. [55]	57.112869	49.084835	65.1409
Kifle et al. [56]	57.3554	49.325989	65.384811
Seyoum et al. [45]	58.043133	50.21505	65.871216
Siraj et al. [46]	57.37756	49.39814	65.356979
Mideksa et al. [68]	57.948441	50.067474	65.829407
Ezra Belay et al. [48]	56.64423	48.690029	64.598427
Belay et al. [44]	57.34013	49.375515	65.304741
Biadgo et al. [57]	57.280781	49.29557	65.265991
Mamo et al. [38]	57.499249	49.538864	65.459633
Melaku et al. [47]	58.012211	50.270714	65.753708
Wolde et al. [58]	57.591167	49.595745	65.586594
Combined	56.60	50.40–62.80	

patients, followed by diabetic patients. This may be attributed to the fact that many psychiatric disorders and their treatments have a notable effect on lipid metabolism. Furthermore, psychiatric patients often have unhealthy eating habits, engage in little physical activity, and lead more sedentary lifestyles. Likewise, in individuals with diabetes, insulin resistance causes an increase in the production of very low-density lipoprotein and a decrease in the clearance

Fig. 4 The overall pooled odds ratio of the association between poor physical activity behavior and dyslipidemia in Ethiopia

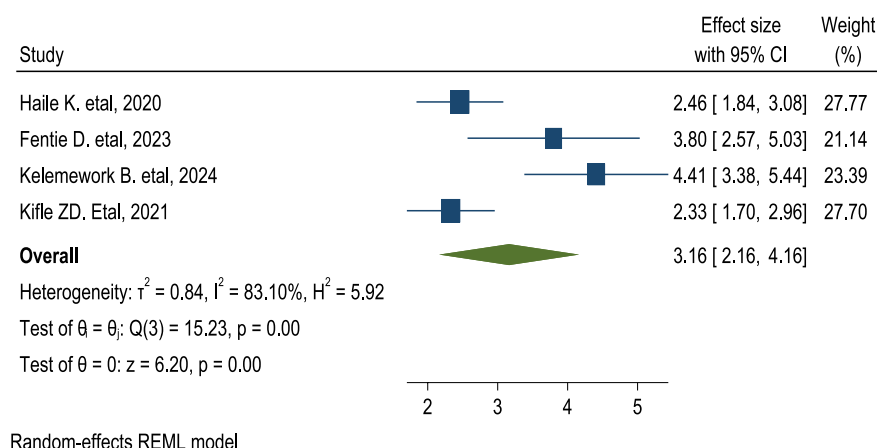
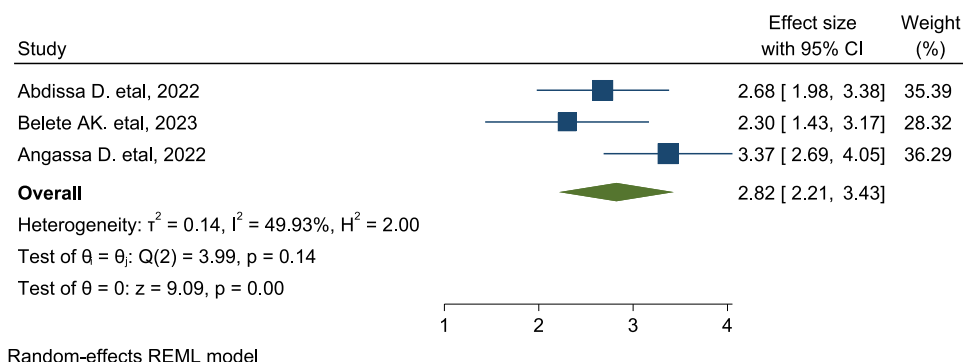


Fig. 5 The overall pooled odds ratio of the association between alcohol consumption behavior and dyslipidemia in Ethiopia



of triglycerides from the bloodstream, both of which contribute to dyslipidemia. Additionally, high blood sugar levels can interfere with lipid metabolism, leading to higher triglyceride levels [75].

Dyslipidemia was significantly associated with levels of physical exercise and alcohol consumption. Chronic alcohol drinkers were 2.82 times more likely to develop dyslipidemia compared to non-drinkers. This is because, chronic alcohol abuse impacts nearly every organ system, leading to severe conditions such as chronic liver disease, which in turn causes significant hypertriglyceridemia and disturbances in lipid metabolism [16]. Additionally, participants who had poor physical exercise behavior were 3.16 times more likely to have dyslipidemia than those who had regular physical exercise. The reason behind this is that poor physical exercise causes an abnormal fat distribution that leads to obesity [39].

4.1 Strengths and limitations of the study

A comprehensive national review of the literature with a clear focus on different populations and conditions of patients, the use of robust statistical methods to analyze pooled data, detailed meta-regression, and subgroup analysis to identify sources of heterogeneity, and the treatment of publication bias were the strengths of the study. However, significant heterogeneity among included studies, which could affect the reliability of pooled estimates, limited studies conducted in Ethiopia, which may not be generalizable to other settings, and the absence of a registered protocol in PROSPERO, which is a common practice for systematic reviews, which may affect the transparency and reproducibility of the review process, were the limitations of the study.

5 Conclusion

This study provides a comprehensive analysis of the prevalence of dyslipidemia in Ethiopia, revealing a high overall prevalence, with significant associations with factors such as insufficient physical activity, cigarette smoking, chronic alcohol consumption, and inadequate fruit and vegetable intake. The findings underscore the regional and patient category differences in prevalence, highlighting the need for targeted interventions in specific populations like psychiatric and

diabetic patients. The study also emphasizes the critical role of physical activity and alcohol consumption in the development of dyslipidemia. Given these insights, future research should focus on exploring effective strategies for preventing and managing dyslipidemia, particularly in high-risk groups, and on understanding the broader socio-economic and cultural factors that may contribute to these lifestyle behaviors. Further studies should also aim to assess the long-term impact of lifestyle modifications on dyslipidemia management, with a focus on developing region-specific public health policies and interventions.

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Author contributions AG designed the study, designed and ran the literature search and methodology. All authors (AG, TA, MG, and BTA) acquired data, screened records, extracted data, assessed the eligibility of the studies, and assessed the risk of bias. AG did the statistical analysis and wrote the report. All authors provided critical conceptual input, edited the manuscript, and critically reviewed the report. Finally, all authors read and approved the final manuscript.

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Availability of data and materials All related data have been presented within the manuscript. The dataset supporting the conclusions of this article is available upon request from the authors.

Declarations

Ethics approval and consent to participate Not applicable.

Consent for publication Not applicable.

Clinical trial number Not applicable.

Competing interest The authors declare no competing interests.

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