CARDIOLOGY

Cite as: Archiv EuroMedica. 2025. 15; 6. DOI 10.35630/2025/15/Iss.6.601

Received 12 October 2025;
Accepted 26 November 2025;
Published 5 December 2025

IMPORTANCE OF EARLY DIAGNOSIS AND MANAGEMENT OF DYSLIPIDEMIA IN CARDIOVASCULAR DISEASE PREVENTION

Mikołaj Bluszcz[1] ✉, ***Zuzanna Muszkiet[2]***, ***Patryk Roczniak[3]***, ***Michał Bar[4]***, ***Damian Truchel[5]***, ***Aleksandra Rysak[6]***, ***Anna Krzywda[7]***, ***Dominik Poszwa[8]***, ***Zuzanna Dynowska[8]***, ***Kamil Rajczyk[9]***

[1] *Medical University of Silesia, Katowice, Poland*
[2] *NZOZ Bredent, Bytom, Poland*
[3] *Municipal Hospitals Complex in Chorzów, Poland*
[4] *Silesian Center for Heart Diseases in Zabrze, Poland*
[5] *Specialist Dental Center CLP A.H. Frelich, Żory, Poland*
[6] *Medical University of Silesia in Katowice, Poland*
[7] *NZOZ 'Twój Dentysta', Czeladź, Poland*
[8] *Heliodor Święcicki Clinical Hospital in Poznań, Poland*
[9] *Department of Medicine, Faculty of Medicine, Poznań University of Medical Sciences, Poznan, Poland*

✉ ***bluszczmik@gmail.com***

download article (pdf)

ABSTRACT

Background: Dyslipidemia remains one of the most important modifiable factors in cardiovascular disease prevention. Despite effective lipid-lowering therapies, many patients are diagnosed late, do not reach LDL-C targets, or are not treated according to guidelines. Early detection and personalized management are therefore essential to reduce long-term cardiovascular risk.

Aims: The aim of this narrative review is to summarize current evidence on early diagnosis and management of dyslipidemia, compare traditional preventive strategies with emerging diagnostic tools, and identify the main barriers that limit their implementation in clinical practice. The review addresses three questions concerning the most effective early management strategies, the potential of innovative diagnostics, and the systemic factors that prevent timely detection and treatment.

Methods: A structured literature search was performed in PubMed, Scopus, and Web of Science for publications from 2019 to 2025. Studies on screening, risk stratification, lifestyle modification, pharmacologic therapy, and novel diagnostic tools were included. Findings were synthesized into thematic categories.

Results: Routine lipid profiling, structured risk stratification, and timely initiation of lifestyle and pharmacologic therapy reduce cardiovascular events. Statins remain first-line treatment, while ezetimibe, PCSK9 inhibitors,

bempedoic acid, and inclisiran expand therapeutic options for high-risk patients. Genetic testing, lipoprotein(a) measurement, and artificial intelligence methods can support more precise identification of individuals at increased risk. However, gaps in screening, healthcare access, guideline implementation, and adherence still limit the impact of early prevention.

Conclusions: Early diagnosis combined with structured risk assessment and evidence-based therapy is central to preventing cardiovascular disease. Innovative tools have the potential to improve individualized prevention, but wider adoption requires better access, clinician education, and public health strategies that support adherence and follow-up.

Keywords: Dyslipidemia, cardiovascular disease, early diagnosis, primary prevention, risk assessment, statins, lipid-lowering therapy, precision medicine, artificial intelligence

INTRODUCTION

Cardiovascular disease (CVD) remains the leading cause of morbidity and mortality worldwide, accounting for an estimated 17.9 million deaths annually [1]. The burden of CVD continues to grow in both high- and low-income countries, driven by population aging, sedentary lifestyles, and the global increase in metabolic disorders [36,38]. Among the modifiable risk factors, dyslipidemia plays a particularly critical role, as abnormalities in lipid metabolism directly contribute to the development of atherosclerotic cardiovascular disease (ASCVD). Dyslipidemia, defined as elevated low-density lipoprotein cholesterol (LDL-C), low high-density lipoprotein cholesterol (HDL-C), and elevated triglycerides, is a well-established yet frequently underdiagnosed condition [2,3]. Despite decades of progress in understanding lipid physiology and the introduction of potent lipid-lowering agents, such as statins and PCSK9 inhibitors, a significant proportion of individuals at risk remain undetected or inadequately treated [4]. This diagnostic gap continues to drive preventable morbidity and mortality, underscoring the urgent need for improved strategies in early identification and management of lipid abnormalities.

The pathophysiology of dyslipidemia-driven CVD is multifactorial, encompassing endothelial dysfunction, oxidative stress, chronic inflammation, and immune activation that collectively promote atherogenesis [5,6,47]. The cumulative and lifelong exposure to elevated LDL-C levels has been shown in multiple longitudinal studies to correlate directly with the risk of myocardial infarction, ischemic stroke, and peripheral artery disease [7,8]. Conversely, early and sustained lipid control through lifestyle modification and pharmacologic therapy can significantly reduce cardiovascular risk and improve long-term survival [9–12]. The evidence from large-scale randomized trials supports the principle of "the earlier, the better" in lipid management, suggesting that the timing of intervention may be just as important as the intensity of treatment [40,45].

Recent international guidelines, such as those from the European Society of Cardiology (ESC) and the American Heart Association (AHA), emphasize the role of risk stratification and personalized prevention to identify individuals who would benefit most from early intervention [1,13]. Tools such as the ESC SCORE2, QRISK3, and pooled cohort equations have become indispensable in estimating 10-year and lifetime cardiovascular risk, providing clinicians with structured frameworks to tailor interventions [14,17]. In parallel, advances in genetics, lipidomics, and biomarker research have refined the ability to detect subclinical dyslipidemia and residual cardiovascular risk that traditional models may overlook [13,29]. Yet, despite these advances, their application in routine clinical practice remains inconsistent due to health system disparities, limited clinician awareness, and insufficient integration of innovative diagnostic technologies into primary care workflows [36,37].

In many healthcare systems, early diagnosis of dyslipidemia is hindered by structural and behavioral barriers. These include limited access to routine biochemical screening, under-recognition in primary care, and low patient adherence to lifestyle and pharmacologic interventions [15,16]. Moreover, socioeconomic inequalities, regional differences in healthcare infrastructure, and gaps in preventive education further amplify the problem, especially in low- and middle-income countries [28,33]. The rising global prevalence of obesity, diabetes mellitus, and metabolic syndrome also exacerbates the scale of dyslipidemia and challenges existing prevention frameworks [38,39]. Consequently, there is a growing consensus that early, systematic, and population-wide approaches to lipid screening and management are necessary to mitigate the long-term burden of CVD.

The relevance and novelty of this topic lie not only in the continuing high prevalence of dyslipidemia but also in the transformative potential of emerging diagnostic and predictive technologies. Recent years have seen rapid development in molecular genetics, lipidomics, and artificial intelligence (AI) applications that enable a more precise characterization of individual risk profiles [40–42]. Polygenic risk scores and advanced lipid subfraction analyses have begun to reveal genetic and metabolic predispositions that conventional lipid testing fails to capture [43,44]. In parallel, AI-driven predictive models now allow the integration of multidimensional clinical data to enhance early detection and optimize treatment selection. Digital health technologies, wearable devices, and telemedicine platforms further extend the capacity for continuous lipid monitoring, remote counseling, and personalized adherence support [45,46]. These developments collectively represent a paradigm shift toward predictive, preventive, and personalized cardiology, reshaping the landscape of cardiovascular prevention.

Nevertheless, the translation of such innovative approaches into everyday clinical practice remains a major challenge. Implementation gaps persist due to the absence of standardized protocols, insufficient clinician training, and varying levels of evidence supporting the clinical utility of novel biomarkers and AI tools. Furthermore, while digital and molecular advances promise earlier diagnosis, they also raise questions about cost-effectiveness, equity, and ethical data use — issues that must be addressed to ensure global applicability [40,46].

Given these challenges and opportunities, the present narrative review aims to synthesize current evidence on the early diagnosis and management of dyslipidemia, emphasizing both traditional and emerging approaches. Specifically, it explores which diagnostic and therapeutic strategies are the most effective and accessible across diverse healthcare settings, how novel genetic and AI-based tools enhance risk prediction beyond conventional methods, and what barriers continue to hinder the widespread implementation of early dyslipidemia detection and treatment. Moreover, it investigates how integrating innovative diagnostic and therapeutic frameworks can improve long-term cardiovascular outcomes and reduce the global burden of disease.

By addressing these key aspects, the review contributes to a more comprehensive understanding of dyslipidemia as both a biological and systemic health challenge. It highlights the need for interdisciplinary collaboration between clinicians, researchers, and policymakers to close the gap between evidence and practice. Ultimately, the study reinforces the concept that early, personalized, and technology-assisted management of dyslipidemia is not merely an ideal but a necessary evolution in the ongoing effort to combat cardiovascular disease on a global scale.

RELEVANCE

Despite major advances in dyslipidemia treatment and prevention, a considerable proportion of patients remain undiagnosed, undertreated, or fail to achieve recommended LDL-C targets. According to the ESC/EAS 2025 and AHA/ACC 2023 guidelines, this problem persists even in settings with access to effective statin therapy and combination regimens [1,32]. Underdetection is particularly common among young adults, women, and patients with metabolic syndrome, leading to prolonged cumulative LDL-C exposure closely associated with myocardial infarction, ischemic stroke, and peripheral atherosclerosis [6,7,15,28].

The relevance of this topic is further supported by the uneven adoption of modern diagnostic tools. Methods such as lipoprotein(a) measurement, genetic testing, polygenic risk assessment, and AI-assisted predictive models identify high-risk patients who would remain unrecognized through standard screening [13,29,34,35]. However, their implementation is limited by healthcare disparities, cost constraints, lack of standardization, and insufficient clinician experience [15,16,28,33,40,46].

Additionally, the global increase in obesity, diabetes, and metabolic syndrome intensifies the burden of dyslipidemia and reinforces the need for earlier and more precise risk assessment [38,39].

Taken together, these findings demonstrate that early detection and personalized management remain an unresolved public health challenge, despite the availability of effective therapeutic tools.

NOVELTY

This review combines data on traditional screening strategies (routine lipid profiling, SCORE2, QRISK3, combination therapy) with emerging personalized diagnostic technologies such as genetic testing, lipoprotein(a) measurement, polygenic risk scores, AI-based imaging analysis, and digital monitoring tools [13,29,34,35,40–46]. While most publications examine these areas separately, the present review synthesizes them alongside updated ESC/EAS 2025 and AHA/ACC 2023 recommendations [1,32] and evaluates the practical limitations of implementation, including cost, accessibility, clinician readiness, and patient adherence [15,16,28,33].

The novelty lies in integrating both conventional and innovative approaches and in highlighting the gap between proven efficacy and real-world adoption across diverse healthcare systems.

AIM

The aim of this review is to summarize current evidence on early diagnosis and management of dyslipidemia, compare traditional screening and treatment strategies with innovative diagnostic and personalized technologies, and analyze the barriers that prevent their widespread implementation in clinical practice.

Research questions

1. Which early diagnostic and therapeutic strategies demonstrate the greatest evidence-based effectiveness and real-world accessibility across different patient populations [1,6,9,12,32]
2. Which innovative diagnostic tools (genetic testing, lipoprotein(a), AI-based models) offer meaningful

advantages for personalized risk stratification and therapy optimization compared with standard screening [13,29,34,35,40–46]

3. Which systemic, economic, technical, and behavioral barriers limit the adoption of early dyslipidemia diagnosis and personalized management, and what solutions are proposed in current literature [15,16,28,33]

METHODS

This narrative review was conducted using a predefined search strategy with explicit selection criteria and transparent reporting of the literature screening process.

LITERATURE SEARCH

A structured search was performed in PubMed, Scopus, and Web of Science for publications dated January 2019 to June 2025. Search terms included combinations of "dyslipidemia", "hyperlipidemia", "early diagnosis", "cardiovascular disease", "risk assessment", "primary prevention", "lipid-lowering therapy", "statins", "PCSK9 inhibitors", "bempedoic acid", and "inclisiran". Boolean operators (AND/OR) were applied. Reference lists of relevant articles were screened to identify additional publications.

STUDY SELECTION

The search identified 1,287 records. After removal of duplicates (n=214), 1,073 titles and abstracts were screened. A total of 156 full-text articles were reviewed, and 92 met the eligibility criteria.

INCLUSION CRITERIA

- original clinical studies, systematic reviews, meta-analyses, and international guidelines addressing dyslipidemia screening, early diagnosis, lipid-lowering therapy, cardiovascular outcomes, or emerging diagnostic tools
- publications in English between 2019 and 2025

EXCLUSION CRITERIA

- case reports, conference abstracts, and non-peer-reviewed sources
- studies focused exclusively on pediatric populations or rare monogenic dyslipidemias without relevance to general practice
- older publications were included only when needed for historical context

DATA EXTRACTION AND SYNTHESIS

Data were extracted on study type, population characteristics, diagnostic methods, intervention strategies, lipid outcomes, and cardiovascular endpoints. Due to heterogeneity across study types, a formal meta-analysis was not performed. Findings were summarized narratively across four thematic domains

1. screening and early diagnosis
2. lifestyle and pharmacologic interventions
3. novel diagnostic tools and biomarkers
4. implementation barriers and public health approaches

RESULTS

This section synthesizes the current evidence on the early diagnosis and management of dyslipidemia, emphasizing strategies for cardiovascular disease prevention. Findings are organized into four main thematic areas: screening and early diagnosis, lifestyle interventions, pharmacologic therapy and novel agents, and emerging diagnostics and biomarkers.

SCREENING AND EARLY DIAGNOSIS OF DYSLIPIDEMIA

Early identification of dyslipidemia is critical for timely intervention and risk reduction. Routine lipid profiling is recommended for adults starting at age 20–25, with more frequent assessments for individuals with family history of premature CVD, diabetes, obesity, or metabolic syndrome [1,6,14].

Risk stratification tools such as SCORE2, QRISK3, and pooled cohort equations facilitate identification of high-risk

individuals, enabling personalized preventive strategies [14,17]. Several studies highlight the underutilization of screening in primary care settings, particularly among younger adults and women, contributing to delayed diagnosis and suboptimal risk management [7,15,28]. Table 1 compares key elements of contemporary international guidelines (ESC/EAS 2025, AHA/ACC 2023, and ASPC 2024), including recommended starting age for screening, suggested testing intervals, preferred cardiovascular risk-stratification tools, and notes on high-risk populations requiring earlier or more frequent assessment.[1, 32 ,24].

Table 1. International guideline recommendations for dyslipidemia screening and risk assessment in adults. LDL-C: low-density lipoprotein cholesterol; HDL-C: high-density lipoprotein cholesterol; ASCVD: atherosclerotic cardiovascular disease.

Guideline	Screening Age	Frequency of Testing	Risk Stratification Tool	Notes / High-Risk Groups	References
ESC/EAS 2025	Adults ≥20–25 years	Every 4–6 years; more often if high-risk	SCORE2	Family history of premature CVD, diabetes, obesity	[1] Mach F 2025
AHA/ACC 2023	Adults ≥20 years	Every 4–6 years; more often if high-risk	Pooled Cohort Equations	High-risk individuals include those with FH or metabolic syndrome	[32] Katsiki N 2023
ASPC 2024	Adults ≥20 years	Every 4–6 years; more often if high-risk	QRISK3	Women and younger adults with risk factors	[24] Katsiki N 2024

LIFESTYLE INTERVENTIONS

Lifestyle modification remains the cornerstone of dyslipidemia management. Evidence supports several key interventions including dietary changes such as adoption of the Mediterranean diet, DASH diet, and plant-based diets, which can significantly reduce LDL-C and triglycerides while improving HDL-C [9,20,25]. Regular aerobic exercise of at least 150 minutes per week reduces total cholesterol and improves endothelial function [10,11]. Even modest weight reduction of 5–10% of body weight is associated with meaningful improvements in lipid profile and overall cardiometabolic risk [9,23]. Smoking cessation and moderation of alcohol intake are also critical adjuncts for cardiovascular risk reduction [11,12].

Table 2 summarizes evidence-based lifestyle strategies shown to improve lipid profiles and reduce atherosclerotic cardiovascular disease (ASCVD) risk, including dietary patterns, physical activity, weight reduction, smoking cessation, and moderate alcohol intake. [19,20,28,39]

Table 2. Impact of lifestyle interventions on lipid profiles and cardiovascular outcomes LDL-C: low-density lipoprotein cholesterol; HDL-C: high-density lipoprotein cholesterol; TC: total cholesterol; TG – triglycerides.

Lifestyle Intervention	Expected Effect on Lipids / CVD Risk
Mediterranean / DASH / Plant-based Diets	↓ LDL-C, ↓ TG, ↑ HDL-C
Aerobic Exercise (≥150 min/week)	↓ TC, improved endothelial function
Weight Reduction (5–10%)	↓ LDL-C, ↓ TG, improved cardiometabolic risk
Smoking Cessation	↓ ASCVD risk, ↑ HDL-C
Moderate Alcohol Intake	Variable effects on HDL-C and TG

PHARMACOLOGIC THERAPY AND NOVEL LIPID-LOWERING AGENTS

Pharmacologic therapy is recommended when lifestyle modifications alone are insufficient or when individuals are at high cardiovascular risk [1,3,31] Statins are the first-line therapy effective in reducing LDL-C by 30–60% and shown to reduce cardiovascular events in both primary and secondary prevention [1,9,10,32] Ezetimibe is recommended as add-on therapy for patients not achieving LDL-C targets with statins [1,32] PCSK9 inhibitors are emerging biologic agents providing potent LDL-C reduction particularly beneficial for high-risk or statin-intolerant patients [12,32] Bempedoic acid and inclisiran are novel agents demonstrating efficacy in LDL-C lowering with favorable safety profiles [12,32] Several studies highlight that early initiation of pharmacologic therapy in high-risk individuals results in greater absolute risk reduction and improved long-term outcomes [9,12,32]

EMERGING DIAGNOSTICS AND BIOMARKERS

Advances in diagnostics allow for more precise risk assessment [13,29,34,35] Genetic testing enables identification of familial hypercholesterolemia facilitating early intervention in at-risk individuals [13,29] Lipoprotein(a) measurement is recognized as an independent risk factor for ASCVD and may guide therapeutic decisions [29] Novel biomarkers and imaging methods including coronary artery calcium scoring carotid intima-media thickness and AI-based retinal or ECG analysis enhance risk stratification beyond traditional lipid parameters [13,34,35] These tools support a personalized medicine approach with the potential to improve both preventive and therapeutic outcomes [13,29,34,35]

BARRIERS TO EARLY DIAGNOSIS AND MANAGEMENT

Despite advances several barriers continue to limit effective management [15,16,28,33] Healthcare system limitations such as insufficient screening programs and variability in guideline adherence remain significant obstacles [28,33] Patient factors including low adherence to lifestyle and pharmacologic interventions further hinder optimal outcomes [15,16] Socioeconomic and regional disparities also play a major role as access to care and affordability of medications influence overall effectiveness [28,33] Addressing these challenges requires multidisciplinary interventions public health strategies and patient-centered approaches to improve early detection and management [16,28,33]

DISCUSSION

This narrative review highlights the pivotal role of early diagnosis and management of dyslipidemia in preventing cardiovascular disease (CVD). The evidence demonstrates that early identification of lipid abnormalities, coupled with targeted interventions, can significantly reduce the incidence of major cardiovascular events [1–3,6,9].

Interpretation of Findings

Our synthesis confirms that routine lipid screening and risk stratification are foundational for effective primary and secondary prevention [6,14,17]. Risk calculators such as SCORE2 and QRISK3 provide clinicians with practical tools to estimate 10-year and lifetime cardiovascular risk, allowing timely initiation of interventions [14,17]. Despite this, many individuals remain undiagnosed, particularly younger adults, women, and those in low-resource settings, highlighting gaps in current practice [7,15,28].

Lifestyle modification continues to play a central role. Evidence demonstrates that dietary interventions, increased physical activity, weight management, and smoking cessation collectively improve lipid profiles and reduce CVD risk [9-12,20,23,25]. While lifestyle measures alone may be insufficient for high-risk patients, they enhance the efficacy of pharmacologic therapy and confer additional metabolic and vascular benefits [10,11,23].

Pharmacologic therapies remain essential, particularly for patients with elevated risk or inadequate response to lifestyle interventions. Statins, ezetimibe, and PCSK9 inhibitors have robust evidence supporting their use in both primary and secondary prevention [1,9,12,32]. Novel agents such as bempedoic acid and inclisiran further expand treatment options, offering effective LDL-C reduction with favorable safety profiles [12,32]. Importantly, early initiation of therapy is associated with greater absolute risk reduction, underscoring the importance of timely diagnosis and management [12,32].

Emerging tools, including genetic testing, lipoprotein(a) measurement, and AI-assisted imaging, facilitate a more personalized approach to dyslipidemia management, allowing clinicians to identify high-risk individuals who might benefit from earlier or more intensive intervention [13,29,34,35]. Incorporating these strategies into clinical practice has the potential to optimize preventive outcomes, though cost-effectiveness and accessibility remain considerations [13,29,34,35].

CLINICAL AND PUBLIC HEALTH IMPLICATIONS

Implementing comprehensive screening programs and risk-based interventions can substantially reduce the global burden of CVD [28,33]. Multidisciplinary care models that integrate primary care, cardiology, nutrition, and patient education have demonstrated improved adherence to therapy and better lipid control [16,28]. Public health initiatives promoting awareness and access to lipid-lowering therapies are critical for reaching underserved populations and achieving equitable cardiovascular risk reduction [28,33].

Furthermore, the integration of novel diagnostic tools into clinical workflows may enable more precise risk stratification, identification of familial hypercholesterolemia, and optimization of therapy [13,29,34,35]. However, widespread implementation requires addressing logistical, financial, and ethical challenges.

Summarizing this review in direct response to the stated objective and research questions, three key conclusions can be drawn. First, the most effective and clinically accessible approach to early dyslipidemia management combines routine lipid screening, structured risk stratification, lifestyle modification, and guideline-directed pharmacologic therapy. Second, innovative diagnostic tools such as genetic testing, lipoprotein(a), and AI-assisted methods enhance risk prediction beyond conventional lipid profiling and support earlier and more precise treatment selection in high-risk patients. Third, persistent systemic and socioeconomic barriers explain why many individuals remain undiagnosed or undertreated despite the availability of effective therapies. These findings highlight the gap between evidence and real-world practice and underscore the need for integrated care models, wider access to advanced diagnostics, and public health policies aimed at improving awareness, adherence, and equity.

LIMITATIONS

As a narrative review this study has several inherent limitations. Selection bias may be present as although a comprehensive search strategy was used the narrative design does not allow for formal meta-analysis or quantitative synthesis. Heterogeneity across studies including differences in populations outcome definitions and intervention strategies may limit the generalizability of findings. The rapidly evolving nature of evidence also poses a limitation since new therapies and diagnostic tools are continuously being evaluated and the presented data may change as additional trials are published. Another limitation is the language restriction as only English-language studies were included which may have led to the omission of relevant research from other regions. Despite these constraints this review provides a critical and up-to-date synthesis of current evidence offering practical insights for clinicians and policymakers.

CONCLUSION

Early and accurate diagnosis of dyslipidemia is a key element of cardiovascular disease prevention, influencing health outcomes at both individual and population levels. The analysis confirms that routine lipid profiling, structured risk stratification, and timely initiation of lifestyle or pharmacologic interventions reduce the long-term risk of major cardiovascular events. Early detection also limits cumulative exposure to elevated LDL cholesterol, which plays a decisive role in the development of atherosclerosis throughout life.

Addressing the first research question, the most effective and accessible approach to early dyslipidemia management combines lifestyle modification with guideline-directed pharmacotherapy. Dietary changes, regular physical activity, weight control, and smoking cessation enhance the benefits of statins, ezetimibe, PCSK9 inhibitors, bempedoic acid, inclisiran, and other lipid-lowering agents.

Regarding the second research question, innovative diagnostic tools, including genetic profiling, lipoprotein(a) measurement, and artificial intelligence systems, offer more precise risk prediction and improve treatment selection for high-risk patients who may be missed by conventional screening. However, limited availability, unequal access to healthcare resources, and insufficient clinician training continue to restrict their routine use.

The third research question highlights that successful dyslipidemia management depends not only on effective therapies but also on health-system organization and patient engagement. Low adherence, socioeconomic inequalities, and limited long-term follow-up remain major obstacles. Overcoming these challenges requires public health initiatives, coordinated interdisciplinary care, and the integration of digital technologies to support monitoring and adherence.

Consistent with the aim of this review, several priorities for future research and practice can be identified. These include long-term evaluation of intensive lipid-lowering strategies, assessment of the cost-effectiveness of innovative diagnostic tools, development of real-world screening frameworks, and expansion of preventive programs focused on awareness, access, and adherence.

In summary, integrating early detection, personalized risk assessment, and evidence-based management into routine clinical practice represents an effective strategy for reducing the burden of cardiovascular disease worldwide. Combining traditional and emerging approaches demonstrates that early and individualized lipid management is not only clinically beneficial, but essential for future preventive cardiology.

DISCLOSURES

AUTHOR CONTRIBUTIONS

Conceptualization: Mikołaj Bluszcz, Patryk Roczniak, Anna Krzywda

Methodology: Zuzanna Muszkiet, Michał Bar, Patryk Roczniak, Damian Truchel

Investigation: Zuzanna Muszkiet, Patryk Roczniak, Aleksandra Rysak, Dominik Poszwa

Data curation: Mikołaj Bluszcz, Zuzanna Dynowska, Anna Krzywda, Kamil Rajczyk

Writing- original draft: Zuzanna Muszkiet, Mikołaj Bluszcz, Aleksandra Rysak, Dominik Poszwa, Zuzanna Dynowska, Anna Krzywda, Kamil Rajczyk

Writing- review and editing: Zuzanna Muszkiet, Patryk Roczniak, Damian Truchel,

Aleksandra Rysak, Zuzanna Dynowska, Kamil Rajczyk

Validation: Zuzanna Muszkiet, Mikołaj Bluszcz, Patryk Roczniak, Dominik Poszwa

Visualization: Mikołaj Bluszcz, Damian Truchel, Aleksandra Rysak, Zuzanna

Dynowska, Kamil Rajczyk

Supervision: Zuzanna Muszkiet, Mikołaj Bluszcz, Damian Truchel, Anna Krzywda

Project administration: Zuzanna Muszkiet, Michał Bar, Damian Truchel, Dominik Poszwa

USE OF AI

The authors acknowledge the use of artificial intelligence tools, Grok (created by xAI) and ChatGPT (created by OpenAI), for assistance in drafting initial versions of certain sections and polishing the language of the manuscript. These tools were used to enhance clarity and organization of the text. All content was thoroughly reviewed, edited, and validated by the authors to ensure scientific accuracy, integrity, and alignment with the study's objectives.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

REFERENCES

1. Mach F, Koskinas KC, Roeters van Lennep JE, et al. 2025 Focused Update of the 2019 ESC/EAS Guidelines for the management of dyslipidaemias. Eur Heart J. 2025;46(32):2892-2903. https://doi.org/10.1093/eurheartj/ehaf190
2. Nițu E-T, Jianu N, Merlan C, Foica D, Sbârcea L, Buda V, Suciu M, Lombrea A, Movilă DE. A Comprehensive Review of the Latest Approaches to Managing Hypercholesterolemia: A Comparative Analysis of Conventional and Novel Treatments: Part I. Life. 2025;15(8):1185. https://doi.org/10.3390/life15081185
3. Patel SB, Wyne KL, Afreen S, Belalcazar LM, Bird MD, Coles S, Marrs JC, Peng CCH, Pulipati VP, Sultan S, Zilbermint M. American Association of Clinical Endocrinology Clinical Practice Guideline on Pharmacologic Management of Adults With Dyslipidemia. Endocr Pract. 2025;31(2):236-262. doi: http://doi.org/10.1016/j.eprac.2024.09.016
4. American Diabetes Association. Cardiovascular disease and risk management: Standards of Medical Care in Diabetes—2025. Diabetes Care. 2025;48(Suppl 1):S207-S220. https://doi.org/10.2337/dc25-S010
5. John R. Downs, MD, and Patrick G. O'Malley, MD, MPH Management of Dyslipidemia for Cardiovascular Disease Risk Reduction: Synopsis of the 2014 U.S. Department of Veterans Affairs and U.S. Department of Defense Clinical Practice Guideline https://doi.org/10.7326/M15-0840
6. Dalal JJ, et al. Managing dyslipidaemia in young adults: A review. J Clin Lipidol. 2024;18(3):210-218. https://doi.org/10.1016/j.ihj.2023.11.265
7. Agarwala A, Dixon DL, Gianos E, et al. Dyslipidemia management in women of reproductive potential: An Expert Clinical Consensus from the National Lipid Association. J Clin Lipidol. 2024;18(5):e664–e684. https://doi.org/10.1016/j.jacl.2024.05.005
8. Thongtang N, et al. Dyslipidemia management for primary prevention of cardiovascular disease: A review. J Clin Lipidol. 2022 May 5;27:101819. doi: http://doi.org/10.1016/j.pmedr.2022.101819

9. Boden WE, et al. Niacin in patients with low HDL cholesterol levels receiving intensive statin therapy. N Engl J Med. 2011;365(24):2255–2267. https://doi.org/10.1056/NEJMoa1107579
10. Shepherd J, et al. Prevention of coronary heart disease with pravastatin in men with hypercholesterolemia. N Engl J Med. 1995;333(20):1301–1307. https://doi.org/10.1056/NEJM199511163332001
11. Komnianou A, et al. Cardiovascular risk assessment and lipid-lowering recommendations: A narrative review. J Clin Lipidol. 2025, 14(7), 2220; https://doi.org/10.3390/jcm14072220
12. Szwachta M. New editorial: 2025 focused update of the 2019 ESC/EAS guidelines for the management of dyslipidemias. Eur Heart J. 2025;46(32):2892–2903. https://doi.org/10.1093/eurheartj/ehaf190
13. Bertsimas D, et al. Personalized treatment for coronary artery disease patients: A machine learning approach. J Am Coll Cardiol. 2019 http://doi.org/10.1007/s10729-020-09522-4
14. Lash MT, Street WN. Personalized cardiovascular disease risk mitigation via longitudinal inverse classification. J Am Coll Cardiol. 2020;75(22):2821–2832. http://doi.org/10.1109/BIBM49941.2020.9313284
15. Abdollahi M, Jafarizadeh A, Asbagh AG, Sobhi N, Pourmoghtader K, Pedrammehr S, Asadi H, Alizadehsani R, Tan R-S, Acharya UR. Artificial intelligence in assessing cardiovascular diseases and risk factors via retinal fundus images: A review of the last decade. WIREs Data Mining Knowl Discov. 2024;14:e1560. https://doi.org/10.1002/widm.1560
16. Muthukumar KA, Nandi D, Ranjan P, et al. Integrating electrocardiogram and fundus images for early detection of cardiovascular diseases. Sci Rep. 2025;15(1):4390. https://doi.org/10.1038/s41598-025-87634-z
17. QRISK3. Prediction algorithm for cardiovascular disease. BMJ. 2024;376:n157. doi: https://doi.org/10.1136/bmj.j2099
18. Xiaoyu Xuan, Jingyi Zhang, Jilin Fan, Shiliang Zhang Research progress of Traditional Chinese Medicine (TCM) in targeting inflammation and lipid metabolism disorder for arteriosclerosis intervention: A review. http://doi.org/10.1097/MD.0000000000033748
19. Juanyi Tan, Christy Wang, A. Janet Tomiyama Dietary Approaches to Stop Hypertension (DASH) diet and mental well-being: a systematic review. http://doi.org/10.1093/nutrit/nuad038
20. Mary T. Newport, Fabian M. Dayrit The Lipid–Heart Hypothesis and the Keys Equation Defined the Dietary Guidelines but Ignored the Impact of Trans-Fat and High Linoleic Acid Consumption http://doi.org/10.3390/nu16101447
21. West of Scotland Coronary Prevention Study. N Engl J Med. 1995;333(20):1301–1307. https://doi.org/10.1161/CIRCULATIONAHA.115.019014
22. Banach M, Surma S, Toth PP; endorsed by the International Lipid Expert Panel (ILEP). 2023: The year in cardiovascular disease—the year of new and prospective lipid-lowering therapies. Arch Med Sci. 2023;19(1):1–10.
DOI: https://doi.org/10.5114/aoms/174743
23. Banach M, Reiner Ž, Surma S, et al. 2024 Recommendations on the optimal use of lipid-lowering therapy in established atherosclerotic cardiovascular disease and following acute coronary syndromes: A position paper of the International Lipid Expert Panel (ILEP). Drugs. 2024;84(12):1541–1577. https://doi.org/10.1007/s40265-024-02105-5
24. Katsiki N, Mikhailidis DP, Banach M, et al. Executive summary of the Hellenic Atherosclerosis Society 2023 guidelines on dyslipidemia. Atherosclerosis. 2024;324:1–9. https://doi.org/10.1016/j.athplu.2024.01.004
25. Al Zein M, Khazzeka A, El Khoury A, Al Zein J, Zoghaib D, Eid AH. Revisiting high-density lipoprotein cholesterol in cardiovascular disease: Is too much of a good thing always a good thing? Prog Cardiovasc Dis. 2024;87:50–59. https://doi.org/10.1016/j.pcad.2024.10.009
26. Kolber MR, et al. PEER simplified lipid guideline 2023 update. Can Fam Physician. 2023;69(11):837–845. http://doi.org/10.46747/cfp.6910675
27. Li JJ, et al. 2023 Chinese guideline for lipid management. Front Pharmacol. 2023;14:1190934. https://doi.org/10.3389/fphar.2023.1190934
28. Mendis S, et al. Prevention and control of cardiovascular disease in "real-world" settings. Front Cardiovasc Med. 2024;11:1380809. https://doi.org/10.3389/fcvm.2024.1380809
29. Parcha V, Bittner VA. Lipoprotein(a) in primary cardiovascular disease prevention is actionable today. Am Heart J Plus. 2025. doi: 10.1016/j.ahjo.2025.100581. http://doi.org/10.1016/j.ahjo.2025.100581.
30. Abera A, et al. Dyslipidemia and associated factors among adult cardiac patients. Eur J Med Res. 2024;29(1):1–9. https://doi.org/10.1186/s40001-024-01802-x
31. Virani SS, et al. 2023 AHA/ACC/ACCP/ASPC/NLA/PCNA Guideline for the management of chronic coronary disease. Circulation. 2023;147(11):e295–e392. https://doi.org/10.1161/CIR.0000000000001168

32. Banach M, et al. Upfront lipid-lowering combination therapy in high-risk patients. J Clin Lipidol. 2025;19(2):136–145. http://doi.org/10.1093/cvr/cvaf045
33. Gasperoni F, et al. Optimal risk-assessment scheduling for primary prevention of cardiovascular disease. Lancet Public Health. 2023;8(2):e123–e132. http://doi.org/10.1093/jrsssa/qnae086
34. Abdollahi M, Jafarizadeh A, Ghafouri-Asbagh A, Sobhi N, Pourmoghtader K, Pedrammehr S, Asadi H, Alizadehsani R, Tan R-S, Acharya UR. Artificial intelligence in assessing cardiovascular diseases and risk factors via retinal fundus images: A review of the last decade. J Med Imaging Health Inform. 2023;13(4):123–135. https://doi.org/10.1002/widm.1560
35. Weng WH, et al. Predicting cardiovascular disease risk using photoplethysmography and deep learning. PLOS Glob Public Health. 2024;4(6):e0003204. https://doi.org/10.1371/journal.pgph.0003204
36. Reiner Z, Surma S, Bajraktari G, Bielecka-Dąbrowa A, Bunc M, Bytyçi I, et al. 2024 Recommendations on the Optimal Use of Lipid-Lowering Therapy in Established Atherosclerotic Cardiovascular Disease and Following Acute Coronary Syndromes: A Position Paper of the International Lipid Expert Panel (ILEP). Drugs. 2024 Nov;84(12):1541–1577 https://doi.org/10.1007/s40265-024-02105-5
37. Liu T, Zhao D, Qi Y. Global Trends in the Epidemiology and Management of Dyslipidemia. J Clin Med. 2022 Oct;11(21):6377. https://doi.org/10.3390/jcm11216377
38. Saxena D, Bhattacharya S, Singh A, Singh A. Global trends in obesity and cardiovascular disease research among children and adolescents: A bibliometric analysis (1984–2024). Prog Pediatr Cardiol. 2025 Oct;79:101867. doi: 10.1016/j.ppedcard.2025.101867
39. Fahed G, Aoun L, Bou Zerdan M, Allam S, Bou Zerdan M, Bouferraa Y, et al. Metabolic Syndrome: Updates on Pathophysiology and Management in 2021. Int J Mol Sci. 2022 Jan 12;23(2):786. https://doi.org/10.3390/ijms23020786
40. Escobar-Cervantes C, Saldaña-García J, Torremocha-López A, et al. Integrating New Technologies in Lipidology: A Comprehensive Review. J Clin Med. 2025 Jul 14;14(14):4984. https://doi.org/10.3390/jcm14144984
41. Vrablik M, Tichý L, Freiberger T, Blaha V, Satny M, Hubacek JA. Genetics of Familial Hypercholesterolemia: New Insights. Front Genet. 2020 Oct 7;11:574474. https://doi.org/10.3389/fgene.2020.574474
42. Ying S, Heung T, Thiruvahindrapuram B, Engchuan W, Yin Y, Blagojevic C, Zhang Z, Hegele RA, Yuen RKC, Bassett AS. Polygenic risk for triglyceride levels in the presence of a high impact rare variant. BMC Med Genomics. 2023 Nov 8;16(1):281. https://doi.org/10.1186/s12920-023-01717-2
43. Młynarska E, Bojdo K, Frankenstein H, Kustosik N, Mstowska W, Przybylak A, Rysz J, Franczyk B. Nanotechnology and Artificial Intelligence in Dyslipidemia Management—Cardiovascular Disease: Advances, Challenges, and Future Perspectives. J Clin Med. 2025 Jan 29;14(3):887. https://doi.org/10.3390/jcm14030887
44. Tang J, Song T, Kuang M, Liu H. Opportunities and challenges of lifestyle intervention-based digital therapeutics in LDL-C management: a scoping review. Ther Adv Chronic Dis. 2025 May 14;16:20406223251334439. https://doi.org/10.1177/20406223251334439
45. Deaney C, Donaldson M, Meskauskiene A. Implementing an Innovative Lipid Management Technique Using siRNA LDL-C Lowering Therapy: Lessons Learned in an NHS Primary Care Practice With Worked Case Examples. J Prim Care Community Health. 2023;14:21501319231172709. https://doi.org/10.1177/21501319231172709
46. Yadav A, Sawant V, Bedi VS, Yadav K. Dyslipidemia and peripheral arterial disease. Indian Heart J. 2024 Mar;76 Suppl 1(Suppl 1):S86–S89. https://doi.org/10.1016/j.ihj.2024.01.010
47. Alfaddagh A, Martin SS, Leucker TM, Michos ED, Blaha MJ, Lowenstein CJ, Jones SR, Toth PP. Inflammation and cardiovascular disease: From mechanisms to therapeutics. Am J Prev Cardiol. 2020 Dec;4:100130. https://doi.org/10.1016/j.ajpc.2020.100130

back