



The Effect of Physical Activity on Blood Low-Density Lipoprotein Levels: A Systematic Review

*Yanasta Yudo Pratama¹ and Satria Akbar Putra Asmara²

¹Department of Health and Sport, Universitas Negeri Yogyakarta

²Faculty of Medicine, Universitas Islam Indonesia

*Corresponding Author: yanastayudoprata@uny.ac.id

Submitted: Januari 2026

Reviewed: March 2026

Published: September 2026

Abstract

Background: Cardiovascular disease is the leading cause of mortality worldwide, with elevated low-density lipoprotein (LDL) cholesterol representing a major modifiable risk factor. Physical activity is widely recommended to improve lipid profiles, although its effects may vary across populations and exercise protocols. This systematic review aimed to synthesize recent evidence on the effects of physical activity on LDL cholesterol levels in diverse populations.

Methods: A literature search was conducted in January 2026 using PubMed, Google Scholar, and ScienceDirect for studies published between 2022 and 2025. Study selection followed the PRISMA 2020 guidelines. Methodological quality was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Tools and the Cochrane Risk of Bias tool.

Results: Ten studies met the eligibility criteria, involving individuals with diabetes or prediabetes, university students, heart failure, pregnancy, childhood populations, multiple sclerosis, and older adults. Six studies (60%) reported significant reductions in LDL levels following structured physical activity, including aerobic exercise, high-intensity interval training (HIIT), resistance training, and diabetes-specific exercise. Greater benefits were generally observed with supervised moderate-to-vigorous exercise performed for 30–60 minutes per session, 3–5 times weekly, for 8 weeks to 6 months. However, findings were inconsistent in university students and pregnant women.

Conclusion: Structured and supervised physical activity can reduce LDL cholesterol, although effectiveness depends on exercise characteristics, adherence, and population-specific factors. Standardized exercise protocols and further high-quality studies are needed to develop population-specific recommendations.

Keywords: Physical activity, cardiovascular disease, LDL

1. INTRODUCTION

The World Health Organization (WHO) states that cardiovascular disease has been the leading cause of death worldwide in the last 15 years. In 2017, 31% of deaths were estimated to be due to cardiovascular disease. Deaths caused by this disease are predicted to continue to increase until 2030. In Indonesia, PERDOSKI also stated that deaths due to cardiovascular disease will continue to increase (1). One factor that can increase the likelihood of developing cardiovascular disease is low-density lipoprotein

(LDL) (2). Therefore, it is important to manage LDL in the body.

There are at least two ways to manage LDL levels: pharmacologically and non-pharmacologically. Pharmacological therapies such as statins have been widely used, but there are several side effects, such as muscle disorders. Meanwhile, non-pharmacological therapies such as lifestyle changes are more promising because of the minimal side effects (3).

Changing one's lifestyle to include more frequent physical activity is an effective method

because it can reduce LDL levels and strengthen muscles (3,4). The study by Yusiyana et al. showed a significant relationship between physical activity and LDL levels. However, in the study by Damayanti et al., physical activity did not show significant results on LDL levels. Therefore, this systematic literature review is necessary to synthesize the latest findings related to the relationship between physical activity and LDL levels.

2. MATERIALS AND METHODS

This study was conducted as a systematic review to synthesize the current evidence regarding the effects of physical activity on low-density lipoprotein (LDL) levels across different populations. The review was performed in January 2026 following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines.

A systematic literature search was conducted using three electronic databases: PubMed, Google Scholar, and ScienceDirect. Eligible studies were published between 2022 and 2025. The search strategy combined keywords related to physical activity and LDL cholesterol, as presented in Table 1.

The inclusion criteria were: (1) original quantitative studies, including randomized controlled trials, quasi-experimental studies, and observational studies; (2) full-text articles published between 2022 and 2025; (3) studies investigating the association between physical activity or exercise interventions and LDL levels; and (4) articles published in English or Indonesian. The exclusion criteria included gray literature, conference abstracts, review articles, case reports, letters to the editor, editorials, and studies without sufficient outcome data.

After duplicate removal, two reviewers (YYP and SAPA) independently screened titles, abstracts, and full-text articles according to the

predefined eligibility criteria. Any disagreements during the selection process were resolved through discussion until consensus was achieved. The study selection process is presented in the PRISMA flow diagram (Figure 1).

Data extraction was independently performed by both reviewers using a standardized data extraction form. The extracted information included the first author, publication year, study design, study population, sample characteristics, intervention type, exercise duration, exercise frequency, study location, outcome measurements, statistical analysis, and the main findings related to LDL levels.

The methodological quality of the included studies was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for cross-sectional and quasi-experimental studies, whereas randomized controlled trials were evaluated using the Cochrane Risk of Bias (RoB 2) Tool. The findings were synthesized narratively because of substantial heterogeneity in study populations, exercise interventions, and outcome measurements, which precluded quantitative meta-analysis.

Tabel 1. Search Strategy

Database	Keyword
Google Scholar	("aktivitas fisik" OR "latihan fisik" OR "olahraga") AND ("kadar LDL" OR "kolesterol LDL" OR "profil lipid")
Sciendirect	("physical activity" OR "exercise" OR "sports")
Pubmed	AND ("LDL cholesterol" OR "low-density lipoprotein" OR "lipid profile")

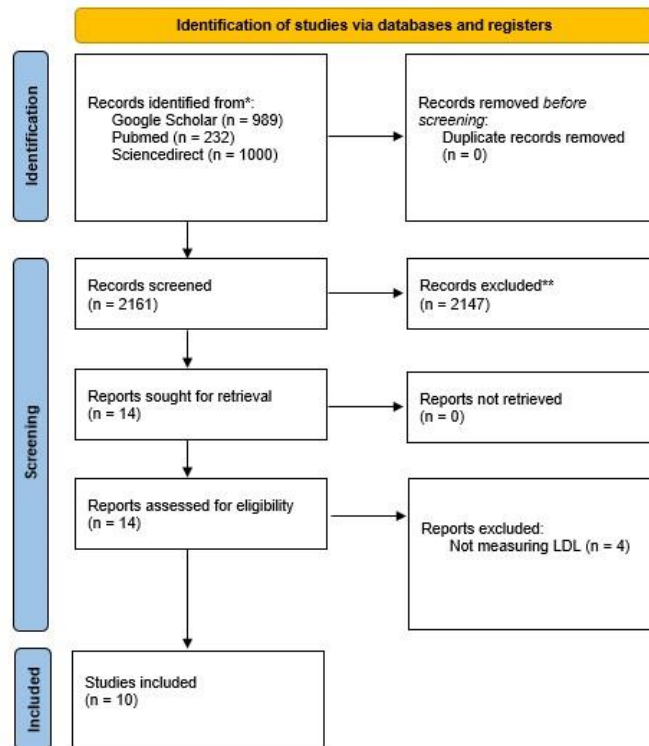


Figure 1. Prisma Flowchart

3. RESULTS

Tabel 2. Data Extraction

Author	Year	Type of study	Measurement	Population	Location	Physical activity	Results
Yusiyana et al (5)	2022	Quasi-experimental	Paired T test	Diabetes mellitus patients	Dr. Sobirin Hospital, Muli Rawas, Indonesia	Diabetes mellitus exercise	Significant relationship with LDL (p = 0.019)
Damayanti et al (6)	2025	Cross-sectional	Spearman rank	Female students	Darussalam Gontor University, Indonesia	-	The relationship with LDL was not significant (p = 0.619)
Galileo et al (7)	2025	Cross-sectional	Spearman rank	Patients with low EF heart failure	Tugurejo Hospital, Semarang, Indonesia	-	Significant relationship with LDL (p=0.001)
Widiastuti et al (8)	2022	Cross-sectional	Spearman rank	Students	Faculty of Medicine, Mataram University, Indonesia	-	The relationship with LDL was not significant (p=0.320)
Jensen et al (9)	2024	Randomized controlled trial	Linear regression	Pregnant women	Denmark	Structured physical activity	The relationship with LDL was not significant at week 28 (p=0.738), week 32 (p=0.707), and

							at delivery (p=0.483)
Amato et al (10)	2024	Randomized controlled trial	Two-way ANOVA & post-hoc test	Multiple sclerosis patients	Paolo Giacone Teaching Hospital	High- intensity interval training	Significant relationship with LDL (P=0.022)
Meng et al (11)	2022	Randomized controlled trial	Two-way ANOVA & post-hoc test	Children aged 11-13 years	School	High- intensity interval training	Significant relationship with LDL (P<0.05)
Strom et al (12)	2022	Randomized controlled trial	Multiple linear regression	Pregnant women	Obstetrics clinics in Eastern North Carolina, USA	Aerobic exercise	LDL at weeks 16 and 36 was not significant (p=0.13 and p=0.67)
Tomeleri et al (13)	2023	Randomized controlled trial	One-way ANOVA & chi- square	Elderly	United States	Resistance exercise	A significant relationship with LDL was found (p<0.05)
Alghadir et al (4)	2024	Randomized trial	Pearson correlation	Patients with diabetes mellitus and prediabetes	Saudi Arabia	Aerobic exercise	In diabetic patients, a significant relationship was found after 3 months (p=0.05) and 6 months (p=0.01) of intervention. In prediabetes patients, a significant correlation was found after 3 months (p=0.01) and 6 months (p=0.001).

Table 3. Risk of Bias

No	Researcher	1	2	3	4	5	6	7	8	Total Score	Description
1.	Widiastuti et al	+	+	+	+	?	-	+	+	6	Moderate
2.	Damayanti et al	+	+	+	+	-	-	+	+	6	Moderate
3.	Galileo et al	+	+	+	+	?	-	+	+	6	Moderate

Table 4. Risk of Bias

	D1	D2	D3	D4	D5	Result
Jensen et al	Low	Low	Low	Low	Low	Low risk
Amato et al	Some concern	Some concerns	High	Low	High	High risk
Meng et al	Low	Some concerns	Some concerns	Low	Low	Some concerns

Strom et al	Some concern	Low	Low	Low	Low	Some concerns
Tolemeri et al	Low	Low	Low	Low	Low	Low risk
Alghadir et al	High	Some concerns	Low	Low	Some concerns	High risk

Table 5. Risk of Bias

Study	D1	D2	D3	D4	D5	D6	D7	D8	D9	Result
Yusiyana et al	+	+	?	-	-	+	+	+	+	Moderate

4. DISCUSSION

The ten included studies involved diverse populations, including patients with diabetes mellitus and prediabetes, university students, patients with heart failure, pregnant women, children aged 11–13 years, patients with multiple sclerosis, and older adults. The interventions comprised diabetes exercise programs, structured physical activity, aerobic exercise, high-intensity interval training (HIIT), and resistance training. Overall, six of the ten studies demonstrated a significant reduction in LDL levels following physical activity interventions. These findings indicate that the effectiveness of physical activity in improving lipid profiles depends not only on the type of exercise but also on the intensity, frequency, duration, supervision, and physiological characteristics of the target population (14,15).

a. Diabetes mellitus and prediabetes patients

The findings of Yusiyana et al. are consistent with those of Alghadir et al., both demonstrating significant reductions in LDL levels following structured physical activity. Although Yusiyana et al. emphasized dietary habits as a contributing factor, the exercise intervention itself likely played a major role in improving lipid metabolism. In Yusiyana et al., participants performed diabetes exercise, a moderate-intensity aerobic program specifically designed for patients with diabetes, whereas Alghadir et al. implemented supervised aerobic exercise for approximately 30–45 minutes per session, three times per week for six months. Supervised exercise ensures adherence to the prescribed exercise intensity and minimizes

variability among participants, thereby producing more consistent metabolic adaptations (4).

From a physiological perspective, regular aerobic exercise enhances lipoprotein lipase (LPL) activity, increases hepatic LDL receptor expression, improves insulin sensitivity, and stimulates fatty acid oxidation, resulting in greater clearance of circulating LDL particles. Improved glycemic control further suppresses hepatic very-low-density lipoprotein (VLDL) production, thereby indirectly reducing LDL concentrations (15,16). These mechanisms explain why prolonged, supervised aerobic exercise is particularly beneficial for patients with diabetes mellitus and prediabetes, who commonly exhibit insulin resistance and dyslipidemia

b. Male and female students

The studies conducted by Damayanti et al. and Widiastuti et al. reported no significant association between physical activity and LDL levels. The observed correlation coefficients were also very weak, suggesting that physical activity alone may not sufficiently influence lipid metabolism in this population. Unlike structured intervention studies, both investigations primarily assessed habitual physical activity without controlling exercise intensity, frequency, or duration.

Several physiological and behavioral factors may explain these findings. University students frequently experience irregular eating habits, inadequate sleep, academic stress, and fluctuating body weight, all of which influence lipid metabolism independently of physical activity. Moreover, young adults generally have normal

baseline lipid profiles; therefore, relatively low levels of habitual physical activity may not produce measurable reductions in LDL concentrations. Exercise-induced improvements in LDL are generally more pronounced among individuals with elevated baseline LDL or metabolic disorders (15,17). Future intervention studies involving students should incorporate structured moderate-to-vigorous aerobic exercise performed at least 150 minutes per week, consistent with the World Health Organization recommendations, to determine whether adequate exercise dosage produces significant lipid improvements (14).

c. Heart Failure Patients

Galileo et al. demonstrated a significant association between physical activity and LDL levels despite a moderate negative correlation. Patients with heart failure often exhibit impaired exercise tolerance due to reduced cardiac output, skeletal muscle dysfunction, endothelial dysfunction, and chronic systemic inflammation. Consequently, physical activity programs for this population generally consist of low-to-moderate intensity aerobic exercise performed 30–60 minutes per session, three to five times per week, with gradual progression according to functional capacity (18).

Regular aerobic exercise improves endothelial function through increased nitric oxide bioavailability, enhances skeletal muscle oxidative capacity, reduces systemic inflammation, and increases lipid utilization during energy metabolism. However, age, medication use, disease severity, and sex remain important determinants of LDL concentrations among patients with heart failure, potentially explaining the relatively modest correlation observed in this population (15,18).

d. Pregnant women

The randomized controlled trials conducted by Jensen et al. and Strom et al. found no significant effects of physical activity on LDL levels during pregnancy. Jensen et al. reported that participants engaged in less than one hour of structured physical activity per week, considerably below the recommendations of at least 150 minutes of moderate-intensity physical activity per week for pregnant women (14).

The absence of significant changes may also be explained by pregnancy-related physiological adaptations. During pregnancy, maternal lipid concentrations naturally increase to provide sufficient cholesterol and fatty acids for fetal growth and placental steroid hormone synthesis. Consequently, elevated LDL concentrations represent a normal physiological adaptation rather than a pathological condition. Therefore, moderate physical activity during pregnancy primarily improves maternal cardiovascular fitness and glucose metabolism rather than substantially lowering circulating LDL concentrations (9,19). Additionally, the relatively short intervention period and limited exercise dosage may have been insufficient to overcome physiological hyperlipidemia associated with pregnancy.

e. Children aged 11–13 years

Meng et al. demonstrated that high-intensity interval training (HIIT) significantly reduced LDL concentrations among obese children aged 11–13 years. The intervention was conducted several times per week over multiple weeks and incorporated repeated bouts of vigorous exercise interspersed with recovery periods. HIIT is recognized as an effective strategy for improving cardiometabolic health in children because it substantially increases energy expenditure while requiring relatively short exercise durations.

Physiologically, HIIT enhances mitochondrial biogenesis, increases fatty acid oxidation, improves insulin sensitivity, and stimulates lipoprotein lipase activity, thereby accelerating LDL clearance from circulation. Since children generally possess greater metabolic flexibility than adults, favorable lipid adaptations can occur relatively rapidly following regular high-intensity exercise (11,20). Furthermore, the prevalence of dyslipidemia in children remains substantially lower than that among older adults, making early intervention particularly valuable for preventing future cardiovascular disease.

f. Multiple sclerosis patients

Amato et al. reported significant improvements in LDL levels following high-intensity interval training supervised by experienced kinesiologists. The intervention ensured that participants exercised at an appropriate intensity while minimizing injury risk

and maximizing adherence. HIIT has emerged as an effective rehabilitation strategy for individuals with multiple sclerosis because it simultaneously improves cardiovascular fitness, muscular endurance, and metabolic function.

From a physiological standpoint, regular high-intensity exercise reduces chronic inflammation, improves mitochondrial efficiency, increases antioxidant capacity, and enhances lipid oxidation. These adaptations contribute to reductions in LDL concentrations while simultaneously improving physical function and quality of life among patients with multiple sclerosis (10,21). Professional supervision remains essential because neurological impairments may affect balance, coordination, and exercise safety.

g. Elderly

Tomeleri et al. demonstrated that resistance training significantly reduced LDL levels among older adults. The intervention involved progressive resistance exercises performed under professional supervision, allowing appropriate adjustments in exercise intensity according to individual functional capacity. Resistance training is particularly important in older adults because ageing is associated with sarcopenia, reduced metabolic rate, insulin resistance, and impaired lipid metabolism.

The reduction in LDL observed following resistance exercise is primarily mediated through increased skeletal muscle mass, enhanced lipoprotein lipase activity, improved insulin sensitivity, and increased utilization of circulating fatty acids for energy production. Resistance exercise also contributes to improved functional independence and reduced cardiovascular risk among older adults (13,22). The presence of trained instructors further ensured exercise safety, appropriate progression, and high adherence, thereby maximizing the physiological benefits of resistance training.

Overall, the evidence indicates that the lipid-lowering effects of physical activity are strongly influenced by exercise modality, intensity, duration, frequency, and participant characteristics. Structured and supervised exercise programs lasting at least 8–24 weeks, particularly aerobic exercise, HIIT, and resistance training, consistently produce greater reductions

in LDL concentrations than unstructured habitual physical activity. Future studies should standardize exercise protocols while controlling dietary intake and medication use to better elucidate the independent effects of physical activity on LDL metabolism across different populations.

5. CONCLUSIONS

Structured and supervised physical activity appears to be an effective non-pharmacological strategy for reducing LDL cholesterol across several populations, with 60% of the included studies demonstrating significant improvements. The most consistent benefits were observed with moderate-to-vigorous exercise performed for 30–60 minutes per session, three to five times per week, over periods of approximately 8 weeks to 6 months. Aerobic exercise, HIIT, resistance training, and diabetes-specific exercise programs may improve LDL metabolism through enhanced lipoprotein lipase activity, insulin sensitivity, fatty acid oxidation, and hepatic LDL receptor activity. However, the effects were not consistent across all populations, particularly among university students and pregnant women, indicating that exercise dosage, adherence, lifestyle factors, physiological conditions, and other confounders may influence outcomes. Overall, physical activity should be considered an important component of cardiovascular risk reduction, while future studies with standardized exercise protocols, larger samples, and longer follow-up are needed to establish population-specific recommendations for LDL reduction.

6. ACKNOWLEDGEMENTS

The authors would like to express their sincere gratitude to Universitas Negeri Yogyakarta for the full support provided to lecturers in conducting and writing this systematic review. This support has been instrumental in facilitating academic development, enhancing research capacity, and promoting the production of high-quality scientific publications. The encouragement and resources provided by the university greatly contributed to the completion of this manuscript.

REFERENCES

1. Sidaria, Huriani E, Nasution SD. Self Care dan Kualitas Hidup Pasien Penyakit Jantung Koroner (PJK). *Jurnal Ilmu Kesehatan*. 2023;7(1).
2. Adelin P, Putra AE, Puspita T, Triyana R, Puspita D. Hubungan Kadar Low Density Lipoprotein dengan Derajat Stenosis Arteri Pasien Penyakit Jantung Koroner RSUP M Djamil Padang Tahun 2021 – 2022. *Health and Medical Journal*. 2024;6(3).
3. Marzuki EJ, Muliono AC. Berbagai Faktor yang Berkontribusi terhadap Kejadian Statin-Associated Muscle Symtoms imbas Atorvastatin. *Damianus Journal of Medicine*. 2024;23(2).
4. Alghadir AH, Gabr SA, Iqbal A. The effects of supervised aerobic training on dyslipidaemia among diabetic older patients. *BMC Endocr Disord*. 2024 Oct 9;24(1):212.
5. Yusiyana, Fitrizah MK, Harison N, Nugraha A. Pengaruh Senam Diabetes Melitus terhadap Profil Lipid Klien Diabetes Melitus Tipe 2 di Rumah Sakit Dr Sobirin Kabupaten Musi Rawas. *Injection: Noursing Journal*. 2022;2(1).
6. Damayanti AY, Fathimah, Setiyani A, Sari FK. Association between Physical Activity and Vitamin C Intake with HDL and LDL Levels among Overweight Students: A Cross-Sectional Study. *ARTERI: Jurnal Ilmu Kesehatan*. 2025;6(3).
7. Galileo DY, Tonang A, Tursinawati Y. Aktivitas Fisik dan Pola Makan terhadap LDL Pasien Gagal Jantung EF Rendah. *Jurnal Ilmu Sosial*. 2025;5(2).
8. Widiastuti IAE, Priyambodo S, Cholidah R. Relationship of Physysical Activity with Body Mass Index and Lipid Profile of First Year of Medical Students Faculty of Medicine University of Mataram. *Jurnal Kedokteran Unram*. 2022;1(2).
9. Jensen IKB, Roland CB, Knudsen S de P, Jessen AD, Alomairah SA, Mortensen OH, et al. Effects of Physical Activity on Blood Lipids and Hemoglobin A1c in Healthy Pregnant Women: The FitMum Randomized Controlled Trial. *Endocrine Practice*. 2024 Oct;30(10):927–36.
10. Amato A, Proia P, Alioto A, Rossi C, Pagliaro A, Ragonese P, et al. High-intensity interval training improves bone remodeling, lipid profile, and physical function in multiple sclerosis patients. *Sci Rep*. 2024 Jul 13;14(1):16195.
11. Meng C, Yucheng T, Shu L, Yu Z. Effects of school-based high-intensity interval training on body composition, cardiorespiratory fitness and cardiometabolic markers in adolescent boys with obesity: a randomized controlled trial. *BMC Pediatr*. 2022 Mar 1;22(1):112.
12. Strom CJ, McDonald SM, Remchak MM, Kew KA, Rushing BR, Houmard JA, et al. The Influence of Maternal Aerobic Exercise, Blood DHA and EPA Concentrations on Maternal Lipid Profiles. *Int J Environ Res Public Health*. 2022 Mar 16;19(6):3550.
13. Tomeleri CM, Cunha PM, Dib MM, Schiavoni D, Kassiano W, Costa B, et al. Effect of Resistance Exercise Order on Cardiovascular Disease Risk Factors in Older Women: A Randomized Controlled Trial. *Int J Environ Res Public Health*. 2023 Jan 9;20(2):1165.
14. Bull FC, Al-Ansari SS, Biddle S, et al. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *Br J Sports Med*. 2020;54(24):1451–1462.
15. Ross R, Blair SN, Arena R, et al. Importance of assessing cardiorespiratory fitness in clinical practice: A case for fitness as a clinical vital sign. *Circulation*. 2020;141:e653–e699.
16. Thompson PD, Arena R, Riebe D, Pescatello LS. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia: Wolters Kluwer; 2021.
17. Lavie CJ, Ozemek C, Carbone S, Katzmarzyk PT, Blair SN. Sedentary behavior, exercise, and cardiovascular health. *Circ Res*. 2019;124(5):799–815.
18. Taylor RS, Long L, Mordi IR, et al. Exercise-based rehabilitation for heart failure. *Cochrane Database Syst Rev*. 2019;(4):CD003331.
19. American College of Obstetricians and Gynecologists. *Physical Activity and Exercise*

- During Pregnancy and the Postpartum Period. Committee Opinion No. 804. Obstet Gynecol. 2020;135:e178–e188.
20. Eather N, Riley N, Miller A, et al. Efficacy of high-intensity interval training for improving health outcomes in children and adolescents: A systematic review. Sports Med. 2019;49(12):1885–1904.
 21. Motl RW, Sandroff BM, Kwakkel G, et al. Exercise in patients with multiple sclerosis. Lancet Neurol. 2020;19(10):848–856.

22. Fragala MS, Cadore EL, Dorgo S, et al. Resistance training for older adults: Position statement from the National Strength and Conditioning Association. J Strength Cond Res. 2019;33(8):2019–2052.