Supplementary Material

The Effectiveness of Physical Exercise in Reducing Common Risk Factors of Atherosclerosis: A Systematic Review

Nada Alhazmi[a,b]

[a]Department of Basic Sciences, College of Science and Health Professions, King Saud bin Abdulaziz University for Health Sciences, Jeddah, Saudi Arabia, [b]King Abdullah International Medical Research Center, Jeddah, Saudi Arabia

No.	Author(s), year	Article title	Patient outcomes	Findings/Conclusions
[1]	Albarrati et al. (2018)	Effectiveness of low to moderate physical exercise training on the level of low-density lipoproteins: A systematic review.	Aerobic training of low and moderate intensity Low-density lipoprotein (LDL) levels. Physical fitness Overall health status	Findings: Both low and moderate-intensity aerobic exercise reduced cholesterol levels, including a significant reduction in LDL levels. The difference in the type of exercise was not significant. Physical exercise further improves overall health status and enhances physical fitness. Conclusion: Aerobic exercise of both low and moderate intensity reduced cholesterol levels and enhanced overall health status.
[2]	Antunes et al. (2020)	Exercise intensity and physical fitness modulate lipoprotein profile during acute aerobic exercise sessions.	Physical exercise of varying intensity Lipoprotein profile, including non-esterified fatty acids (NEFA), triacylglycerol, non-HDL-C, HDL-C, plasminogen inhibitor-1 (PAI-1), leptin, and adiponectin concentrations. Metabolic-endocrine parameters	Findings: High-intensity physical exercise decreased leptin and NEFA levels ($p < 0.05$) while low-intensity physical exercise decreased PAI-1 ($p < 0.05$). Both low and high-intensity physical exercise reduced triacylglycerol levels ($p < 0.05$). HDL-C was reduced only during moderate-intensity physical exercise ($p < 0.05$). Low-intensity, moderate-intensity, and high-intensity physical exercise modulates metabolic-endocrine parameters, although the effect increases relative to the intensity of exercise. Conclusion: Physical exercise reduces cholesterol levels and modulates metabolic-endocrine parameters, although better outcomes are achieved at high intensity.
[3]	Battista et al. (2021)	Effect of exercise on cardiometabolic health of adults with overweight or obesity: Focus on blood pressure, insulin resistance, and intrahepatic fat: A systematic review and meta-analysis.	Physical exercise Systolic and diastolic blood pressure Homeostasis model of insulin resistance Intrahepatic fat	Findings: Physical exercise training reduced both systolic and diastolic blood pressure. Exercise training significantly decreased the homeostasis model of insulin resistance. Physical exercise also reduced intrahepatic fat with a larger effect size after high-intensity interval training. Conclusion: Exercise training is effective in improving cardiometabolic health in adults with overweight/obesity living with comorbidities, with higher outcomes being achieved at high-intensity exercise programs.
[4]	Islam et al. (2023)	Effect of leisure-time physical activity on blood pressure in people with hypertension: A systematic review and meta-analysis.	Leisure time physical activity (LTPA) Systolic pressure Diastolic pressure	Findings: Moderate-intensity LTPA reduced systolic pressure and mean diastolic pressure. Leisure-time walking also reduced systolic pressure by 8.36 mmHg and diastolic pressure by 5.03 mmHg mean. Conclusion: Performing physical activity during free time reduces both systolic and diastolic pressure among adults with hypertension.
[5]	Li & Chen	The effects of different	Physical exercise	Physical exercise reduced BMI, total

	(2021)	exercise modalities in the treatment of cardiometabolic risk factors in obese adolescents with sedentary behavior: A systematic review and meta-analysis of randomized controlled trials.	Cardiometabolic risk factors, including body mass index (BMI), LDL-C, HDL-C, triglyceride, total cholesterol, peak oxygen intake, and HOMA-IR	cholesterol, peak oxygen uptake (VO2peak) and HOMA. However, changes in HDL-C were not statistically significant. Conclusion: Physical exercise reduces cardiometabolic risk factors in persons with sedentary behavior.
[6]	Park et al. (2023)	The effects of physical exercise therapy on weight control: Its regulation of adipocyte physiology and metabolic capacity.	Physical exercise Obesity Insulin control Cardiovascular disease risk	Physical exercise is a major therapeutic strategy for managing obesity, diabetes, and cardiovascular diseases. Exercise promotes fat-burning and suppresses basal metabolic rate. It also lowers blood pressure, cholesterol, and blood sugar. Conclusion: Physical exercise is necessary for patients diagnosed with or at risk of obesity, diabetes, and cardiovascular diseases.
[7]	Perrone et al. (2021)	The effects of reduced physical activity on the lipid profile in patients with high cardiovascular risk during COVID-19 lockdown.	Physical exercise Total cholesterol, LDL-C, HDL-C, and triglycerides	Findings: The level of physical exercise reduced significantly during the COVID-19 lockdown. The change was accompanied by a statistically significant increase in total cholesterol and LDL-C but a reduction in HDL-C. However, an undesirable outcome was an increase in triglycerides, although the change was considered not significant. Conclusions: Reduction in physical activity during lockdown promoted an increase in LDL-C levels and thus raised the risk of ASCVD.
[8]	Liu et al. (2022)	Time-dependent effects of physical activity on cardiovascular risk factors in adults: A systematic review.	Physical exercise Hypertension, lipid profile, blood glucose, waist circumference, inflammatory cytokines.	Findings: There was some evidence that physical exercise reduced blood pressure, reduced LDL-C levels, increased HDL-C levels, reduced triglyceride levels, reduced total cholesterol levels, reduced glucose levels, and reduced waist circumference. However, the authors cautioned that the small sample size and several methodological issues may lead to poor comparability between studies. Conclusion: Further studies should be performed to investigate whether synchronizing the exercise time can affect a person's circadian rhythm or the benefits on cardiovascular health.
[9]	Leitão et al. (2021)	Can exercise help regulate blood pressure and improve the functional capacity of older women with hypertension against the deleterious effects of physical inactivity?	Multicomponent exercise and detraining programs Blood pressure, resting heart rate, and functional capacity	There was a significant improvement in systolic blood pressure, diastolic BP, resting heart rate, agility, lower body strength, upper body strength, and cardiorespiratory capacity. Detraining led to a deterioration of blood pressure. Conclusion: A 9-month multicomponent exercise significantly improved blood pressure and functional capacity but

				was inadequate to restore blood pressure to normal levels. Detraining without exercise reversed blood pressure improvements but maintained functional capacity.
[10]	Kanaley et al. (2022)	Exercise/physical activity in individuals with type 2 diabetes: A consensus statement from the American College of Sports Medicine.	Type of exercise program Obesity/overweight, diabetes, hypertension, and mental health.	Findings: The American Medical Society of Sports Medicine's (AMSSM) consensus statement recommends physical exercise as part of ASCVD prevention practice guidelines. The exercise program could be aerobic, resistance exercise training, combined exercise training, or high-intensity training program. The intervention lowers weight by 5%-7%, reduces the incidence of diabetes by 44%, and reduces symptoms of depression within 12 months. Conclusion: There is a consensus that physical exercise should be part of ASCVD prevention best practice guidelines.
[11]	McCormick et al. (2023)	The effects of HIIT vs. MICT and sedentary controls on blood lipid concentrations in nondiabetic overweight and obese young adults: A meta-analysis.	Intensity of physical training. LDL-C, HDL-C, total cholesterol, and triglyceride.	Findings: High-intensity interval training significantly decreased s of LDL-C and total cholesterol but had no significantly affecting impact on triglyceride and HDL-C. The change was much greater than what was achieved with moderate-intensity interval training programs. Conclusions: The effectiveness of training programs in alleviating the risks of ASCVD rises with intensity.
[12]	Praksch et al. (2019)	Impact of home- and center-based physical training program on cardio-metabolic health and IGF-1 level in elderly women.	Training program Total cholesterol, functional status, and blood glucose levels.	Findings: A training program significantly improved daily physical activity, functional capacity, metabolic status, total cholesterol, HgbA1c, and IGF-1 levels in the training group. Conclusion: Home-based and hospital-based training programs can significantly improve training programs and enhance health.
[13]	Saco-Ledo et al. (2022)	Physical exercise in resistant hypertension: A systematic review and meta-analysis of randomized controlled trials.	Duration of exercise Blood pressure	Findings: Acute exercise creates a short-term reduction in blood pressure, while regular exercise at three sessions per week for 8–12 weeks significantly reduced 24-h. Conclusion: Physical exercise is effective in managing blood pressure and reducing the risk of ASCVD.
[14]	Shakoor et al. (2023)	Effect of moderate-intense training and detraining on glucose metabolism, lipid profile, and liver enzymes in male Wistar rats: A preclinical randomized study.	Physical exercise training and detraining Glucose metabolism and lipid profile	Findings: Physical exercise training improved glucose and lipid metabolism, but the outcomes were reversed soon after the introduction of a detraining program. Conclusion: A physical exercise training program should be sustained for the best outcomes.
[15]	Tao & Li (2023)	Effects of qigong exercise on cardiovascular risk factors in patients with	Qigong exercise, including the duration of the intervention.	Findings: Qigong exercise reduced waist circumference, systolic blood pressure, triglyceride level, diastolic blood

		metabolic syndrome: A systematic review and meta-analysis.	Waist circumference, blood sugar, blood pressure, and lipid profile	pressure, total cholesterol level, and BMI. It also increased HDL-C. Glucose levels were best managed through a 3-month Qigong exercise program compared to a 6-month program. Conclusion: Qigong exercise is an alternative intervention for preventing the risk of ASCVD but evidence on the intervention is inconclusive.
[16]	Wang et al. (2022)	The beneficial effects of exercise on glucose and lipid metabolism during statin therapy are partially mediated by changes in the intestinal flora.	Physical exercise and statin administration Lipid profile and blood glucose levels	Findings: A physical exercise program yielded lower plasma glucose and lipid levels with or without statin administration, and the outcomes were better than those participants who were treated with statins alone. Conclusion: Physical exercise has significant outcomes on glucose and lipid management.
[17]	Wang et al. (2019)	Aerobic exercise reduces triglycerides by targeting apolipoprotein C3 in patients with coronary heart disease.	Physical exercise Triglycerides	Findings: An 8-week physical exercise program significantly decreased triglyceride and the risk of hyperglycemia. Conclusion: Physical exercise targets apolipoprotein C3 (apoC3) levels to reduce triglycerides.
[18]	Wood et al. (2023)	Estimating the effect of aerobic exercise training on novel lipid biomarkers: A systematic review and multivariate meta-analysis of randomized controlled trials.	Aerobic exercise HDL-C, LDL-C, atherogenic lipid ratio	A 12-week physical exercise program increased HDL-C, lowered LDL-C, and improved atherogenic lipid ratios. Conclusion: Aerobic exercise is highly effective in improving the lipid profile.
[19]	Jin et al. (2017)	Effect of isometric handgrip training on resting blood pressure in adults: A meta-analysis of randomized controlled trials.	Isometric hand grip (IHG) training Blood pressure	IHG training significantly improved systolic blood pressure and diastolic blood pressure. Conclusion: IHG is effective in reducing the risk of ASCVD in prehypertensive subjects.