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THE ROLE OF PHYSICAL ACTIVITY IN CARDIOVASCULAR DISEASE PREVENTION: A NARRATIVE REVIEW

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ABSTRACT

Background. Cardiovascular diseases (CVDs) remain the leading cause of mortality worldwide and are strongly associated with modifiable lifestyle factors such as physical inactivity and sedentary behaviour.

Aim. The aim of the review is to analyse the role of physical activity in the prevention of cardiovascular diseases and to summarise the underlying physiological mechanisms responsible for its protective effects.

Material and Methods. This study is based on a narrative review of scientific literature published between 1990 and 2024. The analysis included systematic reviews, meta-analysis, randomised controlled trials, and large cohort studies examining the relationship between physical activity and cardiovascular outcomes.

Results. The findings indicate that regular physical activity significantly reduces cardiovascular risk by improving endothelial function, lowering blood pressure, enhancing lipid metabolism, increasing insulin sensitivity, and reducing systemic inflammation. Additionally, sedentary behaviour has been identified as an independent risk factor contributing to increased cardiovascular morbidity and mortality.

Conclusions. Physical activity plays a fundamental role in the prevention of cardiovascular diseases and should be promoted as a key component of both primary and secondary prevention. Reducing sedentary behaviour alongside increasing activity levels is essential for improving population health outcomes.

KEYWORDS

Physical Activity, Cardiovascular Disease, Prevention, Sedentary Behaviour, Exercise, Cardiorespiratory Fitness

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Introduction

Cardiovascular diseases (CVDs) remain one of the most important public health challenges worldwide. They include coronary artery disease, stroke, heart failure and peripheral vascular disease, and they are strongly associated with modifiable lifestyle factors such as tobacco use, unhealthy diet, obesity, arterial hypertension, dyslipidemia and insufficient physical activity. The global burden of cardiovascular disease is also closely linked to demographic ageing, urbanisation and the progressive replacement of occupational and transport-related movement with sedentary behaviours. Physical inactivity has therefore become not only an individual behavioural problem, but also a systemic public health issue requiring coordinated clinical, educational and environmental responses (Lee et al. 2012; Booth et al. 2012; Kohl et al. 2012).

Regular physical activity is one of the best documented non-pharmacological strategies for reducing cardiovascular risk. The relationship between activity level and cardiovascular outcomes has been demonstrated in large prospective cohorts, epidemiological analyses, clinical trials and meta-analyses. Earlier research, including the Harvard Alumni Study, showed that physically active adults had lower all-cause and cardiovascular mortality compared with inactive individuals (Paffenbarger et al. 1986). Subsequent studies confirmed that both habitual physical activity and cardiorespiratory fitness are strong predictors of future cardiovascular events (Blair et al. 1989; Bassuk and Manson 2003; Nocon et al. 2008; Myers et al. 2015).

The protective effect of physical activity is not limited to one biological pathway. Exercise improves endothelial function, reduces blood pressure, enhances lipid metabolism, increases insulin sensitivity, supports weight control, reduces systemic inflammation and improves autonomic balance. These mechanisms act simultaneously and may explain why physical activity reduces the risk of coronary heart disease, stroke, heart failure and premature death. Importantly, benefits are observed not only among athletes or highly trained people, but also among previously sedentary adults who introduce moderate levels of movement into daily life. Meta-analyses suggest that regular activity may reduce cardiovascular disease risk by approximately 20-30%, with a clear dose-response relationship between activity volume and risk reduction (Warburton et al. 2006; Sattelmair et al. 2011; Li and Siegrist 2012; Lavie et al. 2015)

At the same time, sedentary behaviour has emerged as an independent cardiovascular risk factor. Prolonged sitting, screen time and low levels of non-exercise movement are associated with higher cardiometabolic risk and mortality, even among some individuals who meet formal exercise recommendations. This finding has expanded prevention strategies: current approaches emphasise not only increasing structured exercise, but also reducing total sedentary time and interrupting long periods of sitting (Biswas et al. 2015; Ekelund et al. 2016; Patterson et al. 2018). Therefore, the prevention of cardiovascular disease requires a broad understanding of movement behaviour across the entire day.

The present review summarises current evidence on the role of physical activity in cardiovascular disease prevention. It describes epidemiological findings, biological mechanisms, the importance of sedentary behaviour, practical clinical implications and limitations of existing research. The paper follows the format of a narrative review and aims to provide a clear synthesis useful for health professionals, researchers and public health practitioners.

Research Materials and Methods

Literature Search Strategy

The article was prepared as a narrative review of scientific literature concerning physical activity and cardiovascular disease prevention. A structured search strategy was applied to identify relevant publications indexed in PubMed and other biomedical databases. The search included the following keywords and combinations of keywords: physical activity, exercise, cardiovascular disease, coronary heart disease, stroke, heart failure, hypertension, sedentary behavior, cardiorespiratory fitness, prevention and mortality. The review focused primarily on studies published between 1990 and 2024, while several older landmark studies were included because of their historical importance.

Inclusion and Exclusion Criteria

The inclusion criteria were: articles written in English, studies assessing the association between physical activity or cardiorespiratory fitness and cardiovascular outcomes, systematic reviews, meta-analyses, large prospective cohort studies, randomised controlled trials and scientific guidelines. Studies were excluded if they were not directly related to cardiovascular outcomes, if they focused only on non-human models or if the methodological description was insufficient for interpretation. Priority was given to publications with large samples, longitudinal observation, objective or validated measures of physical activity and clinically relevant outcomes such as cardiovascular mortality, myocardial infarction, stroke, blood pressure, lipid profile or inflammatory markers. The analysed literature included research involving general adult populations, individuals with cardiometabolic risk factors and patients with established cardiovascular disease. Both primary prevention and secondary prevention perspectives were considered. The review did not involve new experiments, human recruitment or collection of primary data. Therefore, institutional review board approval and informed consent were not applicable.

Data Collection and Analysis

Data were extracted narratively from selected publications. The analysis focused on study design, population, type of exposure or intervention, cardiovascular outcomes and main findings. Because this was a narrative review, no new statistical meta-analysis was performed. Results are presented descriptively and organised into thematic implications, and limitations. The strength of the evidence was considered according to the consistency of findings across different study designs and populations.

The reviewed studies commonly used hazard ratios, relative risk, odds ratios, confidence intervals and regression models to evaluate associations between physical activity and cardiovascular outcomes. In the present review, these results were interpreted qualitatively. Statistical significance reported in the original studies was considered, but emphasis was placed on clinical relevance, consistency of results and biological plausibility.

Research Results

The reviewed literature consistently indicates that physical activity plays a significant role in cardiovascular disease prevention. Evidence comes from long-term cohort studies, meta-analyses, randomized trials and international guidelines. The strongest and most reproducible findings concern the inverse association between physical activity or cardiorespiratory fitness and cardiovascular mortality. In addition, exercise favorably affects several intermediate risk factors, including blood pressure, lipid profile, glucose metabolism, body composition, inflammatory markers and endothelial function. The available evidence also suggests that sedentary behavior is not simply the absence of exercise but a distinct behavioral risk factor that requires separate prevention strategies (Warburton et al. 2006; Lavie et al. 2015; Biswas et al. 2015).

Epidemiological Evidence

Epidemiological research provides the foundation for understanding the cardiovascular benefits of physical activity. The Harvard Alumni Study demonstrated that higher levels of activity were associated with reduced mortality, supporting the concept that energy expenditure through movement may influence long-term survival (Paffenbarger et al. 1986). Blair et al. showed that physical fitness was strongly associated with all-cause mortality, and this relationship remained important after adjustment for other risk factors (Blair et al. 1989). Later observation studies and systematic reviews confirmed that physically active individuals experience lower cardiovascular morbidity and mortality (Bassuk and Manson 2003; Nocon et al. 2008).

A key concept in this field is the dose-response relationship. Sattelmair et al. reported that even moderate levels of leisure-time physical activity were associated with reduced coronary heart disease risk, while additional activity produced further benefits (Sattelmair et al. 2011). Similar conclusions were reached by Li and Siegrist who found an inverse association between physical activity and cardiovascular disease risk in a meta-analysis of prospective cohort studies (Li and Siegrist 2012). The PURE study extended these findings to diverse socioeconomic and geographic settings, showing that physical activity was associated with lower mortality and cardiovascular events across countries with different income levels (Lear et al. 2017).

Cardiorespiratory fitness appears to be one of the strongest predictors of prognosis. Myers et al. emphasised that fitness is a powerful clinical marker that may provide prognostic information comparable to or stronger than traditional risk factors (Myers et al. 2015). Fitness reflects not only exercise habits but also integrated cardiovascular, respiratory and muscular function. Therefore, improving fitness through regular activity may represent a direct pathway to lower cardiovascular risk.

Table 1. Selected epidemiological evidence on physical activity and cardiovascular risk. Source: Author's own elaboration.

Study	Design/ population	Main finding	Relevance for prevention
Paffenbarger et al. 1986	Prospective cohort of college alumni	Higher physical activity was associated with lower all-cause mortality.	Early evidence that habitual activity improves longevity.
Blair et al. 1989	Prospective study of men and women	Low physical fitness was a strong predictor of mortality.	Supports fitness as a clinical risk marker.
Sattelmair et al. 2011	Meta-analysis	A dose-response relationship was observed for physical activity and coronary heart disease.	Even moderate activity provides measurable protection.
Lear et al. 2017	International cohort	Physical activity was associated with lower mortality and cardiovascular events across income settings.	Confirms global applicability of activity promotion.
Ekelund et al. 2016	Harmonised meta-analysis	High activity attenuated risk related to sitting time.	Shows the need to increase activity and reduce sedentary behaviour.

Biological Mechanisms

The cardioprotective effect of physical activity is mediated by several biological mechanisms. One of the most important is improvement of endothelial function. Exercise increases shear stress on the vascular wall, which stimulates endothelial nitric oxide production and improves vasodilation. Better endothelial function contributes to lower vascular resistance, improved tissue perfusion and reduces atherosclerotic risk (Green et al. 2004). This mechanism is especially relevant because endothelial dysfunction is considered an early stage in the development of atherosclerosis.

Physical activity also reduces blood pressure. Aerobic and resistance training can lower systolic and diastolic pressure by improving vascular compliance, reducing sympathetic tone and enhancing baroreflex function. Cornelissen and Fagard demonstrated that endurance training is associated with clinically meaningful reductions in blood pressure, particularly among individuals with hypertension (Cornelissen and Fagard 2005). Because hypertension is one of the strongest risk factors for stroke, heart failure and coronary disease, even moderate blood pressure reductions can have substantial population-level effects.

Another important pathway involves lipid metabolism. Regular exercise may increase high-density lipoprotein cholesterol and improve triglyceride metabolism, while also supporting weight management and reducing visceral adiposity. Thompson et al. described exercise as a key element in the prevention and treatment of atherosclerotic cardiovascular disease, partly because of its positive influence on lipid profile and vascular function (Thompson et al. 2003). Exercise also improves insulin sensitivity and glucose uptake in skeletal muscle, thereby reducing the risk of type 2 diabetes and metabolic syndrome, both of which strongly increase cardiovascular risk (Warburton et al. 2006).

Inflammation and oxidative stress are also modified by regular physical activity. Chronic low-grade inflammation contributes to endothelial dysfunction, plaque formation and plaque instability. Exercise training is associated with lower inflammatory activity and improved immune regulation (Gleeson et al. 2011). Montero et al. highlighted the relationship between endothelial dysfunction, inflammation and cardiovascular risk, indicating that exercise-induced improvements in vascular health may have systemic protective effects (Montero et al. 2014). Physical activity also improves mitochondrial function and muscular oxidative capacity, which supports metabolic flexibility and cardiovascular efficiency (Pedersen and Saltin 2015).

Table 2. Physiological effects of physical activity relevant to cardiovascular prevention. Source: Author's own elaboration.

Mechanism	Effect of physical activity	Clinical meaning	Key reference
Endothelial function	Increased nitric oxide availability and improved vasodilation	Better vascular function and lower atherosclerotic risk	Green et al. 2004
Blood pressure	Reduced systolic and diastolic blood pressure	Lower risk of stroke, heart failure and coronary disease	Cornelissen and Fagard 2005
Lipid metabolism	Improved HDL cholesterol and triglyceride metabolism	Reduced atherogenic risk profile	Thompson et al. 2003
Glucose metabolism	Improved insulin sensitivity and glucose uptake	Lower risk of diabetes related cardiovascular complications	Warburton et al. 2006
Inflammation	Reduced chronic low-grade inflammatory activity	Potential slowing of atherosclerotic progression	Gleeson et al. 2011
Mitochondrial function	Improved oxidative capacity and metabolic efficiency	Better cardiorespiratory fitness and endurance capacity	Pedersen and Saltin 2015

Sedentary Behaviour as an Independent Risk Factor

Sedentary behaviour has become a major focus of cardiovascular prevention. It includes waking activities performed in a sitting, reclining or lying posture with low energy expenditure. Unlike insufficient exercise, sedentary behaviour refers to prolonged periods of low movement and may occur even in individuals who perform structured exercise several times per week. This distinction is important because modern occupational and domestic environments promote sitting for many hours each day.

Biswas et al. reported that sedentary time was associated with increased risk of cardiovascular disease, diabetes, cancer and mortality, even after considering physical activity levels (Biswas et al. 2015). Patterson et al. also found that sedentary behaviour was associated with higher mortality risk in a systematic review and harmonised meta-analysis (Patterson et al. 2018). These findings suggest that prevention should include both increasing moderate-to-vigorous physical activity and reducing prolonged sitting.

Ekelund et al. showed that high levels of physical activity may attenuate, but not completely eliminate, the risks associated with sitting time (Ekelund et al. 2016). Therefore, practical recommendations should include regular breaks from sitting, active transport, standing or walking meetings, and workplace interventions that encourage light activity throughout the day. This approach reflects a whole-day movement perspective rather than a narrow focus on exercise sessions alone.

Physical Activity Guidelines and Recommended Dose

International guidelines recommend that adults perform at least 150 to 300 minutes of moderate-intensity aerobic physical activity per week, or 75 to 150 minutes of vigorous-intensity activity, combined with muscle-strengthening activities on two or more days per week. These recommendations are supported by evidence that moderate volumes of activity produce substantial health benefits and that additional activity may produce further improvements (Piercy et al. 2018; Bull et al. 2020).

The dose of physical activity should be interpreted flexibly. For sedentary individuals, any increase in movement is beneficial, and the greatest relative gains often occur when moving from inactivity to some activity. Walking, cycling, swimming, recreational sports, structured exercise and active commuting can all contribute to cardiovascular prevention. This is important from a public health perspective because recommendations must be realistic and adaptable to different ages, health conditions and socioeconomic contexts.

Powell et al. emphasised that physical activity should be considered a central public health priority because it affects multiple chronic diseases simultaneously (Powell et al. 2011). In cardiovascular prevention, the aim is not only to increase exercise volume but also to build sustainable habits. Interventions that are too intensive or poorly adapted to individual capacity may reduce adherence. Therefore, gradual progression, enjoyment, social support and environmental accessibility are important determinants of long-term success.

Exercise in Secondary Prevention and Cardiac Rehabilitation

Physical activity is important not only for primary prevention but also for patients with established cardiovascular disease. Exercise-based cardiac rehabilitation improves functional capacity, quality of life and prognosis after myocardial infarction, coronary revascularisation and in selected patients with heart failure. Gielen et al. described exercise training as a therapeutic strategy capable of improving endothelial function, skeletal muscle metabolism and clinical outcomes in cardiovascular disease (Gielen et al. 2010)

Hambrecht et al. demonstrated that exercise training may provide meaningful benefits in patients with coronary artery disease, including improved symptoms and functional capacity (Hambrecht et al. 2003). Cardiac rehabilitation programmes combine supervised exercise, education, risk factor control and behavioural counselling. The effectiveness of these programmes highlights that physical activity should be integrated into routine cardiovascular care rather than treated as an optional lifestyle addition.

However, exercise prescription in patients with cardiovascular disease must be individualised. Intensity, duration and type of activity should depend on clinical status, comorbidities, baseline fitness, medication use and risk stratification. For many patients, supervised programmes provide safety, motivation and structured progression. In the long term, the challenge is to maintain activity after completion of formal rehabilitation.

Discussion

The reviewed evidence strongly supports physical activity as a cornerstone of cardiovascular disease prevention. The consistency of findings across epidemiological studies, clinical trials, meta-analyses and international guidelines indicates that the relationship is robust. The observed associations are biologically plausible because exercise influences several major cardiovascular risk pathways simultaneously. Improvements in endothelial function, blood pressure, lipid metabolism, glucose regulation, inflammation and body composition together create a broad protective effect that cannot be fully replicated by a single pharmacological intervention (Warburton et al. 2006; Lavie et al. 2015).

One of the most important practical implications is that benefits are not limited to vigorous exercise. Moderate intensity activities such as brisk walking can produce meaningful reductions in cardiovascular risk. This is particularly relevant for older adults, people with obesity, patients with chronic conditions and those who have been inactive for many years. A prevention strategy that communicates achievable goals is more likely to produce sustainable behavioural change than one focused only on high-intensity training.

Despite strong evidence, adherence to physical activity recommendations remains insufficient in many populations. Barriers include lack of time, low motivation, limited access to safe environment, socioeconomic inequalities, chronic pain, fear of injury and insufficient support from healthcare systems. Swift et al. emphasised that exercise is important for weight management and cardiometabolic health, but long-term adherence is often difficult (Swift et al. 2014). Barry et al. also highlighted the interaction between fitness, body composition and health outcomes, suggesting that improving fitness may provide benefits even when weight loss is limited. (Barry et al. 2014).

The role of sedentary behaviour adds complexity to prevention. A person may complete planned exercise but still spend most of the day sitting. Therefore, advice should include both structured physical activity and daily movement strategies. Examples include walking during breaks, using stairs, active commuting, reducing screen time and interrupting sitting every 30 to 60 minutes. These recommendations are simple but may have important cumulative effects.

Another important issue is measurement. Many studies rely on self-reported physical activity, which may be affected by recall bias and social desirability bias. Objective tools such as accelerometers and wearable devices can improve measurement accuracy, but they also present challenges regarding cost, interpretation and long-term compliance. Future research should combine objective monitoring with clinical outcomes to identify the most effective and realistic prevention strategies.

The public health value of physical activity is especially high because it is inexpensive and has benefits beyond cardiovascular disease. It improves mental health, musculoskeletal function, metabolic health and

quality of life. For this reason, physical activity promotion should involve healthcare professionals, schools, workplaces, urban planners and policymakers. Environments that make active choices easy are essential for population-level prevention.

In addition to the physiological mechanisms discussed above, several studies highlight the broader clinical and behavioural importance of physical activity in cardiovascular disease prevention. Swift et al. (2014) and Barry et al. (2014) demonstrated that both physical fitness and body composition independently influence cardiovascular risk, suggesting that maintaining an active lifestyle is essential regardless of weight status.

Furthermore, exercise-based interventions have been shown to significantly improve outcomes in patients with established cardiovascular disease. Gielen et al. (2010) reported improvements in endothelial function and overall cardiovascular performance following structured exercise programs, while Hambrecht et al. (2003) demonstrated that regular physical activity may be as effective as invasive interventions in selected patient populations. From a public health perspective, Powell et al. (2011) emphasized the importance of large scale strategies aimed at increasing physical activity levels across populations. These findings highlight the need for both individual and systemic approaches to reducing the global burden of cardiovascular disease.

Conclusions

Regular physical activity plays a fundamental role in the prevention of cardiovascular diseases. The evidence indicates that physically active individuals have lower cardiovascular morbidity and mortality, and that cardiorespiratory fitness is a powerful predictor of prognosis. The protective effect of exercise is mediated by improvements in endothelial function, blood pressure regulation, lipid metabolism, insulin sensitivity, inflammation and mitochondrial efficiency.

Sedentary behaviour should be recognised as an independent risk factor. Prevention strategies should therefore aim not only to increase structured exercise but also to reduce prolonged sitting and promote movement throughout the day. Physical activity is also important in secondary prevention, particularly through supervised cardiac rehabilitation and long-term lifestyle modification.

Clinical and public health practice should treat physical activity as a central prevention tool. Recommendations must be realistic, individualised and supported by social and environmental conditions that enable long-term adherence. Future research should focus on objective measurement, personalised exercise prescription, strategies for improving adherence and interventions targeting sedentary behaviour.

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