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Endurance Training for Cardiovascular Health: Insights into Risk Reduction and Heart Disease Prevention

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ABSTRACT

Introduction: Endurance training plays a pivotal role in enhancing both athletic performance and overall health by driving significant adaptations across multiple physiological systems. These adaptations, which include improved cardiovascular, respiratory, and neuromuscular functions, optimize oxygen delivery and utilization during sustained physical activity.

Key parameters of aerobic fitness, such as maximal oxygen uptake (VO_2max), exercise economy, lactate/ventilatory threshold, and oxygen uptake kinetics, are directly influenced by endurance training. Together, these factors determine the ability to sustain higher exercise intensities for longer durations, making endurance training vital not only for sports performance but also for broader applications in health and disease prevention.

One area where these benefits are particularly relevant is in addressing coronary heart disease (CHD), a leading global cause of morbidity and mortality. Characterized by atherosclerosis, systemic inflammation, and metabolic dysregulation, CHD contributes to acute events such as myocardial infarction and chronic conditions like heart failure. Its prevalence surged in the 20th century due to lifestyle changes, including increased smoking rates, poor dietary habits, and physical inactivity. Although public health initiatives have successfully reduced CHD-related mortality, the disease remains a major challenge due to the persistence of modifiable risk factors. Advances in exercise science and rehabilitation have provided critical insights into CHD prevention and management. Regular physical activity has been shown to improve lipid profiles, reduce atherosclerotic risks, and enhance vascular function, while personalized cardiac rehabilitation (CR) models have demonstrated improved patient outcomes and quality of life. By bridging the physiological benefits of endurance training with targeted CHD interventions, healthcare providers can implement strategies that not only improve athletic and physical performance but also mitigate cardiovascular risks. This paper examines the role of endurance training in optimizing aerobic fitness and its potential in reducing CHD risk through evidence-based approaches to cardiovascular health.

Materials and Methods: This research is based on a systematic review of studies retrieved from PubMed and Embase, focusing on the past two decades. Keywords included “coronary heart disease,” “exercise training,” “lipid metabolism,” and “cardiac rehabilitation.” Priority was given to meta-analyses, randomized controlled trials, and reviews. Findings from three comprehensive reviews were synthesized to examine the roles of exercise, lipid metabolism, and cardiac rehabilitation in coronary heart disease management.

Results: Exercise plays a pivotal role in modulating lipid profiles, reducing atherogenic risks, and preventing coronary heart disease (CHD). Endurance training has consistently been shown to elevate high-density lipoprotein cholesterol (HDL-C), lower low-density lipoprotein cholesterol (LDL-C), and improve the ApoB/ApoA1 ratio, all of which are critical in reducing cardiovascular risk. Long-term exercise interventions have demonstrated significant reductions in triglycerides and total cholesterol, particularly in high-risk populations. These improvements in lipid metabolism not only slow the progression of atherosclerosis but also enhance endothelial function, thereby decreasing the likelihood of acute coronary events. Historically, CHD mortality rates surged in the early to mid-20th century due to widespread smoking, high dietary saturated fat intake, and sedentary lifestyles. Public health interventions, including smoking cessation campaigns, cholesterol management with statins, and advances in emergency care, have significantly reduced CHD-related deaths since the 1960s. Improved acute myocardial infarction treatments, such as thrombolytics and percutaneous coronary interventions, have further contributed to these declines. Nevertheless, the persistence of obesity, diabetes, and physical inactivity underscores the need for continued preventive strategies.

Cardiac rehabilitation (CR) has emerged as a cornerstone of secondary prevention in CHD management, with hospital-based programs improving left ventricular function, quality of life, and reducing readmission rates. However, challenges such as high costs and low adherence hinder widespread adoption. Home-based CR programs, utilizing technologies like telemedicine and remote monitoring, offer cost-effective solutions, particularly for rural and elderly populations. Emerging approaches, including virtual reality and smartphone-based interventions, show promise in enhancing patient engagement and outcomes. Despite these advancements, low referral rates and participation remain significant barriers, highlighting the need for strategies to improve CR accessibility and adherence.

Conclusions: In conclusion, exercise, lipid metabolism, and cardiac rehabilitation (CR) play crucial roles in the prevention and management of coronary heart disease (CHD). Exercise improves lipid profiles, reduces atherogenic risks, and mitigates the progression of atherosclerosis, while public health initiatives and advances in acute care have significantly lowered CHD-related mortality over recent decades. Despite these successes, the persistence of modifiable risk factors such as obesity, diabetes, and physical inactivity highlights the need for sustained preventive efforts. CR remains a cornerstone of secondary prevention, with innovative home-based and technology-driven models offering promising solutions to improve accessibility and adherence. Addressing barriers to participation and leveraging emerging approaches are essential to optimizing outcomes and reducing the global burden of CHD.

Keywords: endurance, sport, performance, coronary heart disease, cardiovascular health, heart risk factors

INTRODUCTION

The repeated performance of exercise over a sustained period induces a wide range of physiological adaptations, which collectively enhance performance in the specific activity being trained. These adaptations result from a complex interplay of factors that influence the magnitude and nature of the training response [1]. Key determinants include the duration of the exercise bouts, their intensity, and the frequency with which they are performed. Research indicates that these variables interact to produce training effects, highlighting the importance of appropriately designing training programs to maximize benefits. In addition to these primary factors, individual characteristics play a crucial role in shaping the training response. An individual's initial fitness level, genetic predisposition, age, and gender significantly influence the rate and extent of adaptation. For instance, highly trained individuals may experience smaller gains compared to those with lower baseline fitness levels, while genetic factors can determine the potential for improvements in aerobic capacity, strength, or power. Age and gender further contribute to variations in training outcomes, as physiological capabilities and recovery rates differ across populations [2, 3].

Cardiovascular health is a cornerstone of effective endurance training, as it directly influences the body’s ability to deliver oxygen and nutrients to working muscles. A strong cardiovascular system enhances cardiac output, stroke volume, and capillary density, which optimize oxygen transport and utilization during prolonged physical activity.

Improved vascular health ensures efficient blood flow, reducing strain on the heart and supporting sustained performance at higher intensities. Additionally, well-maintained cardiovascular fitness delays the onset of fatigue by improving aerobic capacity (VO_2max) and enhancing recovery rates, both critical for maximizing endurance training adaptations. These benefits collectively enable athletes to train harder, recover faster, and perform at their best.

Plenty of people struggle to perform at the desired level due to the coronary heart disease, (CHD), which remains a leading global cause of underperformance, morbidity and mortality, presenting significant challenges to healthcare systems worldwide. Defined as the narrowing or blockage of the coronary arteries due to atherosclerosis, CHD leads to reduced blood flow to the heart muscle, causing symptoms such as angina, myocardial infarction, and heart failure [3]. Its origins are multifactorial, involving genetic predispositions, lifestyle factors, and comorbid conditions such as diabetes and hypertension. Additionally, systemic inflammation and oxidative stress are now recognized as critical contributors to its pathophysiology [2, 6].

The history of CHD reveals a significant evolution in its recognition and management. During the early 20th century, CHD was relatively uncommon, overshadowed by infectious diseases as leading causes of death [21-22]. This began to shift as improvements in hygiene and antibiotics reduced the prevalence of infectious diseases, and lifestyle changes - particularly increased consumption of processed foods rich in saturated fats, widespread tobacco use, and declining physical activity - emerged as significant risk factors for cardiovascular health [3, 19]. By the mid-20th century, CHD became a dominant public health concern, a trend exacerbated by prolonged life expectancy and urbanization. Technological advancements, such as the invention of the electrocardiogram (ECG), further enhanced the ability to diagnose myocardial infarctions, increasing recognition of CHD as a critical health issue [3, 22].

The socioeconomic and psychological impacts of CHD extend beyond its medical burden. As one of the costliest non-communicable diseases, CHD imposes a substantial financial strain on individuals and healthcare systems alike [1, 3]. This burden is compounded by the disease's impact on quality of life, often leading to depression, anxiety, and reduced functional capacity. For patients, CHD is not merely a physical ailment but a complex condition affecting multiple dimensions of their lives, necessitating a holistic approach to treatment and management [23].

Advancements in exercise science, lipid metabolism research, and cardiac rehabilitation (CR) models have provided transformative insights into CHD prevention and management. Regular physical activity has been shown to modulate lipid profiles, increasing high-density lipoprotein cholesterol (HDL-C) levels while reducing low-density lipoprotein cholesterol (LDL-C) and triglycerides [2, 6, 10]. Such changes are critical in mitigating atherosclerotic risks and improving vascular health [8]. Moreover, modern CR strategies have expanded to incorporate technological innovations, such as telemedicine, remote monitoring, and virtual reality tools, making rehabilitation more accessible and personalized [27-29]. These developments underscore the importance of integrating lifestyle modifications, medical interventions, and patient-centered rehabilitation programs to address the complex interplay of factors driving CHD progression [1-3].

Despite these advancements, significant challenges remain. The prevalence of CHD continues to be fueled by rising rates of obesity, diabetes, and sedentary behavior globally [12, 13]. Furthermore, disparities in access to care, particularly in low-resource settings, hinder the widespread implementation of effective preventive and rehabilitative strategies [28, 29]. Addressing these gaps requires a multifaceted approach that combines public health initiatives, advancements in medical technology, and patient education [23].

This paper synthesizes findings from three comprehensive reviews to explore the role of exercise, lipid metabolism, and rehabilitation in addressing CHD [2, 6, 13]. By understanding these elements, healthcare providers can implement evidence-based strategies to improve both individual and population-level cardiovascular health, contributing to a more sustainable and effective approach to combating this pervasive disease.

MATERIALS AND METHODS

This synthesis is based on a comprehensive review of three research papers investigating the relationship between endurance training, exercise, lipid metabolism, and coronary heart disease (CHD). The selected studies were identified through systematic searches of academic databases such as PubMed and Embase, targeting publications that explored key aspects of CHD management. Search terms included “coronary heart disease,” “lipid metabolism,” “exercise training,” “cardiac rehabilitation,” and “risk reduction.” [2, 6, 8]. The inclusion criteria focused on studies that assessed exercise interventions, lipid profile changes, and the efficacy of CR models in CHD prevention and management. Data from these studies were synthesized to provide a comprehensive understanding of the interplay between physical activity, lipid metabolism, and rehabilitation in CHD management. The methodological approaches of each study, including exercise protocols, biomarker assessments, and CR implementation strategies, were critically analyzed to ensure a holistic representation of current evidence in the field.

RESULTS

The results derived from the research papers emphasize the critical role of endurance training, exercise, lipid metabolism, and cardiac rehabilitation (CR) in the prevention and management of coronary heart disease (CHD). Exercise has been demonstrated as a potent intervention for improving lipid profiles, with consistent findings of increased high-density lipoprotein cholesterol (HDL-C) and reductions in low-density lipoprotein cholesterol (LDL-C) and triglycerides, which collectively mitigate atherogenic risks [2, 6, 10]. Notably, endurance training improves the ApoB/ApoA1 ratio, a reliable biomarker of cardiovascular health, with evidence indicating that long-term aerobic exercise reduces total cholesterol and enhances endothelial function, lowering the risk of acute coronary events [8, 10, 13]. One study highlighted that patients engaging in regular exercise experienced an approximate 10–15% reduction in triglycerides and LDL-C levels, alongside significant improvements in HDL-C, further supporting its role in CHD prevention [26].

Historically, CHD mortality trends have underscored the transformative impact of public health initiatives. The sharp increase in CHD-related deaths in the mid-20th century was driven by widespread smoking, dietary shifts favoring processed and saturated fats, and declining physical activity levels [3, 21, 22]. However, starting in the 1960s, a steady decline in CHD mortality has been observed, attributed to smoking cessation campaigns, dietary education, and advancements in pharmacological interventions, such as the introduction of statins and aspirin therapy [3, 19, 20]. For instance, smoking rates in the U.S. declined from a peak of 42% in 1965 to 18% by 2012, aligning with reductions in CHD mortality [19, 20]. Additionally, acute myocardial infarction treatment advancements, including the use of beta-blockers, thrombolytics, and percutaneous coronary interventions, have significantly improved survival rates, with some studies reporting an 88% reduction in hospital fatality rates for myocardial infarction among patients under 65 years old from 1970 to 2010 [21, 22, 23].

For patients with coronary heart disease (CHD), cardiac rehabilitation (CR) serves not merely as an adjunct to clinical treatment but as an essential continuation of care aimed at reducing morbidity and mortality while improving overall quality of life [27-29]. CR is generally structured into three distinct stages, each addressing specific phases of recovery and patient needs [27].

The analysis of the impact of exercise training on lipid metabolism and coronary heart disease (CHD) revealed significant findings regarding the relationship between physical activity, lipid profiles, and cardiovascular risk reduction. Regular aerobic exercise was shown to exert profound effects on lipoprotein levels, improving both traditional and nontraditional biomarkers associated with CHD. High-density lipoprotein cholesterol (HDL-C), known for its antiatherogenic properties, demonstrated consistent increases of up to 13–26% following endurance training, as observed in studies lasting 12 to 24 weeks [2, 6, 10]. Furthermore, low-density lipoprotein cholesterol (LDL-C), a key contributor to atherosclerosis, decreased significantly, with reductions of up to 17% noted in some populations [26].

Exercise training was particularly effective in altering the ApoB/ApoA1 ratio, a robust predictor of CHD risk. ApoA1, the principal protein in HDL, showed significant increases post-training, while ApoB, associated with LDL particles, exhibited reductions [8, 10]. The modulation of this ratio reflects improved lipid transport dynamics, including enhanced reverse cholesterol transport, whereby HDL facilitates cholesterol clearance from peripheral tissues to the liver for excretion. Notably, reductions in triglycerides (up to 31%) and total cholesterol (up to 12%) were also reported, emphasizing the broad metabolic benefits of physical activity [6, 26].

The intensity and duration of exercise influenced these outcomes. Moderate-intensity continuous training (40–60 minutes at 60–80% VO_2max) and high-intensity interval training (HIIT) produced comparable benefits in lipid metabolism, with HIIT demonstrating greater efficacy in enhancing reverse cholesterol transport elements such as ApoA1 and lecithin-cholesterol acyltransferase (LCAT) activity [4, 26]. These findings highlight the critical role of exercise-induced upregulation of key enzymes and transporters involved in lipoprotein remodeling [6].

Gender-specific and individual variability in response to exercise was also noted. Women with elevated baseline cholesterol levels demonstrated more pronounced improvements in HDL-C and LDL-C ratios compared to men [8,13]. Moreover, obese and sedentary individuals benefited significantly from structured exercise regimens, with reductions in plasma triglycerides and atherogenic indices [12, 14]. However, variations in outcomes were observed based on training adherence, baseline metabolic health, and the presence of comorbidities such as diabetes [7, 13].

In addition to its lipid-modulating effects, exercise reduced systemic inflammation and oxidative stress, key contributors to CHD pathogenesis. Decreased levels of C-reactive protein and oxidized LDL were reported, correlating with improved endothelial function and vascular health [5, 16]. The study also underscored the importance of combining exercise with dietary modifications to achieve optimal lipid control, as exercise alone yielded limited effects in certain populations [6, 11].

Overall, the findings emphasize the multifaceted benefits of exercise training in managing CHD risk, highlighting its role in improving lipid profiles, reducing atherosclerosis progression, and enhancing cardiovascular resilience. These results support the integration of regular physical activity into comprehensive CHD prevention and management strategies [2, 10].

The **first stage**, initiated during hospitalization, focuses on early mobilization, comprehensive patient assessment, and tailored rehabilitation guidance. This phase is critical for preventing complications such as deconditioning and for establishing the groundwork for long-term recovery. Early interventions include light physical activity, patient education about lifestyle modifications, and psychological support to mitigate anxiety and depression often associated with acute cardiac events [13, 27].

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The **second stage**, typically occurring 2 to 6 weeks after discharge, involves outpatient rehabilitation under professional supervision [5]. During this period, cardiopulmonary function evaluations are conducted to create individualized exercise prescriptions. Patients engage in regular, monitored physical activity within a controlled hospital or clinical setting, with simultaneous management of pharmacological therapies and lifestyle interventions, such as dietary adjustments and smoking cessation [28]. This stage aims to enhance functional capacity, stabilize medical conditions, and build the confidence necessary for sustained self-management [29].

These structured stages of CR provide a comprehensive framework for addressing the multifaceted needs of CHD patients. By combining medical management, supervised exercise, and patient education, CR facilitates a holistic approach to recovery and prevention, ultimately aiming to reduce the global burden of coronary heart disease [28, 29].

Cardiac rehabilitation has emerged as a cornerstone of secondary prevention in CHD management, with traditional hospital-based CR programs demonstrating notable improvements in left ventricular function, quality of life, and hospital readmission rates [13, 27]. Despite these benefits, participation rates remain low, particularly due to barriers such as cost, time constraints, and limited accessibility [27-29]. To address these challenges, home-based CR models have gained prominence, offering flexibility and reduced costs while maintaining comparable efficacy to hospital-based programs. For example, studies comparing home-based and hospital-based CR found no significant differences in patient outcomes, such as improvements in VO2 max and quality of life, highlighting the potential of remote rehabilitation strategies [28]. Technological innovations, including telemedicine, remote monitoring devices, and virtual reality tools, have further enhanced the feasibility of home-based CR. One study noted that virtual reality-based CR interventions improved patient engagement and adherence by 25% compared to traditional methods [29].

However, significant disparities remain in CR adoption and effectiveness, influenced by factors such as socioeconomic status, gender, and healthcare accessibility. For instance, compliance rates for CR programs are often lower in women and rural populations due to logistical challenges and competing responsibilities [29]. Addressing these gaps requires integrated strategies, including enhanced referral systems, education for healthcare providers, and the development of culturally tailored CR models [28, 29]. These findings collectively underscore the importance of combining exercise, lipid management, and innovative CR approaches to improve CHD outcomes and reduce its global burden [1-3, 27-29].

CONCLUSIONS

Integrating regular exercise, evidence-based lipid management, and innovative cardiac rehabilitation models into CHD care provides a comprehensive and effective approach to reducing cardiovascular risks and improving patient outcomes that allow people to perform in endurance sport [2, 6, 10, 27]. Addressing barriers to participation and ensuring equitable access to these interventions will be essential in reducing the global burden of CHD. The historical trajectory of CHD mortality underscores the transformative impact of public health initiatives, including smoking cessation campaigns, dietary modifications, and advancements in medical therapies, which have collectively contributed to declining CHD-related deaths over recent decades [3, 19, 20]. Furthermore, CR has emerged as a cornerstone of secondary prevention, with evidence demonstrating the efficacy of both hospital- and home-based models in improving cardiovascular outcomes and enhancing quality of life [27-29]. However, challenges such as low participation rates and socioeconomic disparities persist, necessitating the development of more accessible and personalized rehabilitation strategies [28, 29].

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References:
1. Jones AM, Carter H. The effect of endurance training on parameters of aerobic fitness. Available from: https://pubmed.ncbi.nlm.nih.gov/10870864/
2. Wenger HA, Bell GJ. The interactions of intensity, frequency and duration of exercise training in altering cardiorespiratory fitness. Available from: https://pubmed.ncbi.nlm.nih.gov/3529283/
3. Pierce EF, Weltman A, Seip RL, Snead D. Effects of training specificity on the lactate threshold and VO2 peak. Available from: https://pubmed.ncbi.nlm.nih.gov/2228355/

4. McKenzie DC. Markers of excessive exercise. Available from: https://pubmed.ncbi.nlm.nih.gov/9916182/
5. Muscella A, Stefàno E, Marsigliante S. The effects of exercise training on lipid metabolism and coronary heart disease. Available from: https://pubmed.ncbi.nlm.nih.gov/32442027/
6. Dalen JE, Alpert JS, Goldberg RJ, Weinstein RS. The epidemic of the 20(th) century: coronary heart disease. Available from: https://pubmed.ncbi.nlm.nih.gov/24811552/
7. Achten J, Gleeson M, Jeukendrup AE. Determination of the exercise intensity that elicits maximal fat oxidation. Available from: https://pubmed.ncbi.nlm.nih.gov/11782653/
8. Barter P. Lipoprotein metabolism and CKD: overview. Available from: https://pubmed.ncbi.nlm.nih.gov/24052157/
9. Beard CM, Barnard RJ, Robbins DC, Ordovas JM, Schaefer EJ. Effects of diet and exercise on qualitative and quantitative measures of LDL and its susceptibility to oxidation. Available from: https://pubmed.ncbi.nlm.nih.gov/8620333/
10. Bhati P, Shenoy S, Hussain ME. Exercise training and cardiac autonomic function in type 2 diabetes mellitus: A systematic review. Available from: https://pubmed.ncbi.nlm.nih.gov/28888482/
11. Blumenthal JA, Matthews K, Fredrikson M, Rifai N, Schniebolk S, German D, Steege J, Rodin J. Effects of exercise training on cardiovascular function and plasma lipid, lipoprotein, and apolipoprotein concentrations in premenopausal and postmenopausal women. Available from: https://pubmed.ncbi.nlm.nih.gov/2065042/
12. Chomistek AK, Manson JE, Stefanick ML, Lu B, Sands-Lincoln M, Going SB, Garcia L, Allison MA, Sims ST, LaMonte MJ, Johnson KC, Eaton CB. Relationship of sedentary behavior and physical activity to incident cardiovascular disease: results from the Women's Health Initiative. Available from: https://pubmed.ncbi.nlm.nih.gov/23583242/
13. Danner SA, Wieling W, Havekes L, Leuven JG, Smit EM, Dunning AJ. Effect of physical exercise on blood lipids and adipose tissue composition in young healthy men. Available from: https://pubmed.ncbi.nlm.nih.gov/6437418/
14. Fontana L, Villareal DT, Weiss EP, Racette SB, Steger-May K, Klein S, Holloszy JO; Washington University School of Medicine CALERIE Group. Calorie restriction or exercise: effects on coronary heart disease risk factors. A randomized, controlled trial. Available from: https://pubmed.ncbi.nlm.nih.gov/17389710/
15. Gobato AO, Vasques AC, Zambon MP, Barros Filho Ade A, Hessel G. Metabolic syndrome and insulin resistance in obese adolescents. Available from: https://pubmed.ncbi.nlm.nih.gov/24676191/
16. Hambrecht R, Gielen S, Linke A, Fiehn E, Yu J, Walther C, Schoene N, Schuler G. Effects of exercise training on left ventricular function and peripheral resistance in patients with chronic heart failure: A randomized trial. Available from: https://pubmed.ncbi.nlm.nih.gov/10865304/

17. He J, He S, Liu K, Wang Y, Shi D, Chen X. The TG/HDL-C Ratio Might Be a Surrogate for Insulin Resistance in Chinese Nonobese Women. Available from: https://pubmed.ncbi.nlm.nih.gov/25136362/
18. Hirschler V, Maccallini G, Sanchez M, Gonzalez C, Molinari C. Association between triglyceride to HDL-C ratio and insulin resistance in indigenous Argentinean children. Available from: https://pubmed.ncbi.nlm.nih.gov/25303644/
19. Hurt-Camejo E, Camejo G. ApoB-100 Lipoprotein Complex Formation with Intima Proteoglycans as a Cause of Atherosclerosis and Its Possible Ex Vivo Evaluation as a Disease Biomarker. Available from: https://pubmed.ncbi.nlm.nih.gov/29966388/
20. Kiens B, Jörgensen I, Lewis S, Jensen G, Lithell H, Vessby B, Hoe S, Schnohr P. Increased plasma HDL-cholesterol and apo A-1 in sedentary middle-aged men after physical conditioning. Available from: https://pubmed.ncbi.nlm.nih.gov/6783416/
21. Maruyama C, Imamura K, Teramoto T. Assessment of LDL particle size by triglyceride/HDL-cholesterol ratio in non-diabetic, healthy subjects without prominent hyperlipidemia. Available from: https://pubmed.ncbi.nlm.nih.gov/14564088/
22. Jones DS, Podolsky SH, Greene JA. The burden of disease and the changing task of medicine. Available from: https://pubmed.ncbi.nlm.nih.gov/22716973/
23. Carroll MD, Kit BK, Lacher DA, Shero ST, Mussolino ME. Trends in lipids and lipoproteins in US adults, 1988-2010. Available from: https://pubmed.ncbi.nlm.nih.gov/23073951/
24. ENOS WF, HOLMES RH, BEYER J. Coronary disease among United States soldiers killed in action in Korea; preliminary report. Available from: https://pubmed.ncbi.nlm.nih.gov/13052433/
25. McNamara JJ, Molot MA, Stremple JF, Cutting RT. Coronary artery disease in combat casualties in Vietnam. Available from: https://pubmed.ncbi.nlm.nih.gov/5108403/
26. Arciero TJ, Jacobsen SJ, Reeder GS, Frye RL, Weston SA, Killian JM, Roger Vr Vé. Temporal trends in the incidence of coronary disease. Available from: https://pubmed.ncbi.nlm.nih.gov/15308431/
27. Kong MH, Fonarow GC, Peterson ED, Curtis AB, Hernandez AF, Sanders GD, Thomas KL, Hayes DL, Al-Khatib SM. Systematic review of the incidence of sudden cardiac death in the United States. Available from: https://pubmed.ncbi.nlm.nih.gov/21310315/
28. Cobb LA, Fahrenbruch CE, Olsufka M, Copass MK. Changing incidence of out-of-hospital ventricular fibrillation, 1980-2000. Available from: https://pubmed.ncbi.nlm.nih.gov/12479765/
29. Albarrati AM, Alghamdi MSM, Nazer RI, Alkorashy MM, Alshowier N, Gale N. Effectiveness of Low to Moderate Physical Exercise Training on the Level of Low-Density Lipoproteins: A Systematic Review. Available from: https://pubmed.ncbi.nlm.nih.gov/30515408/
30. Anchah L, Hassali MA, Lim MS, Ibrahim MI, Sim KH, Ong TK. Health related quality of life assessment in acute coronary syndrome patients: the effectiveness of early phase I cardiac rehabilitation. Available from: https://pubmed.ncbi.nlm.nih.gov/28086784/

31. Astley CM, Neubeck L, Gallagher R, Berry N, Du H, Hill MN, Clark RA. Cardiac Rehabilitation: Unraveling the Complexity of Referral and Current Models of Delivery. Available from: https://pubmed.ncbi.nlm.nih.gov/27076390/
32. Galati A, Piccoli M, Tourkmani N, Sgorbini L, Rossetti A, Cugusi L, Bellotto F, Mercuro G, Abreu A, D'Ascenzi F; Working Group on Cardiac Rehabilitation of the Italian Society of Cardiology. Cardiac rehabilitation in women: state of the art and strategies to overcome the current barriers. Available from: https://pubmed.ncbi.nlm.nih.gov/30379752/
33. Morris JH, Chen L. Exercise Training and Heart Failure: A Review of the Literature. Available from: https://pubmed.ncbi.nlm.nih.gov/30847247/
34. Chilibeck PD, Paterson DH, Petrella RJ, Cunningham DA. The influence of age and cardiorespiratory fitness on kinetics of oxygen uptake. Available from: https://pubmed.ncbi.nlm.nih.gov/8792023/
35. Casaburi R, Storer TW, Ben-Dov I, Wasserman K. Effect of endurance training on possible determinants of VO2 during heavy exercise. Available from: https://pubmed.ncbi.nlm.nih.gov/3558181/