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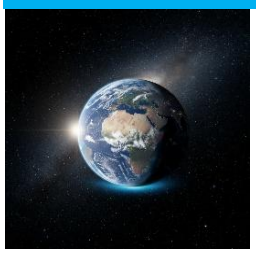

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THE ROLE OF PHYSICAL ACTIVITY IN THE PREVENTION AND TREATMENT OF CARDIOVASCULAR DISEASE , OBESITY AND DIABETES

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ABSTRACT

Introduction: Physical activity is one of the most important elements in the prevention and treatment of cardiovascular diseases, both in people already suffering from heart conditions and in healthy individuals. However, effective exercise recommendations must be based on solid scientific evidence and tailored to the individual needs of the patient. The appropriate amount of exercise and level of cardiorespiratory fitness, as well as the right choice of intensity and training structure, all play an important role here. With age, the risk of cardiovascular disease increases, especially in the presence of metabolic disorders such as obesity and diabetes, which further impair the functioning of the circulatory system. Therefore, understanding the relationship between aging, risk factors, and the body's response to physical activity is crucial for proper prevention. This study presents the most important principles of physical activity planning and the importance of lifestyle changes in reducing the risk of cardiovascular disease in older people and patients with metabolic diseases. The document also emphasizes the role of specialized training programs as an integral part of modern care for people with increased cardiovascular risk.

Aim of the study: The aim of this review is to summarize current evidence on the role of physical activity in the prevention and treatment of cardiovascular disease, obesity, and diabetes, with particular emphasis on underlying mechanisms, clinical outcomes, and practical implications for multidisciplinary care.

Material and methods: Our research method consisted of searching publicly available online databases of scientific articles, such as PubMed, Google Scholar, and others. The research team used the keyword “physical activity” in combination with various terms, including “sports,” “cardiovascular disease,” “prevention,” “metabolic diseases,” and “risk factors.” The collected data were then analyzed manually.

Results and conclusions: Regular, appropriately selected physical activity should be a fundamental element of the prevention and treatment of cardiovascular diseases, especially in older people and patients with metabolic disorders such as obesity and diabetes. The effectiveness of exercise interventions depends on their individual adaptation to the patient's

capabilities and needs, as well as on the consideration of risk factors that increase with age. The available scientific evidence clearly confirms that comprehensive training programs, combined with lifestyle changes, can significantly reduce the health burden resulting from cardiovascular diseases. Therefore, promoting physical activity and its conscious planning should be a priority in modern healthcare, aimed at improving quality of life and reducing cardiovascular risk in an aging population.

KEYWORDS: physical activity, cardiovascular disease, metabolic diseases, risk factors

1. INTRODUCTION

Physical activity can be defined as “any movement of the body generated by skeletal muscles at the expense of energy use”: lifting weights, exercising, playing, traveling, walking, cycling, dancing, gardening, housework [1]. Physical activity is a structured intervention aimed at increasing or maintaining CRF, reducing the incidence of chronic diseases such as hypertension, diabetes, cardiovascular disease, chronic obstructive pulmonary disease (COPD), especially when the patient's BMI is above 30, which indicates obesity [1,2]. Several studies have shown that physical inactivity leads to an increased risk of mortality [1]. Early prevention of chronic complications is of paramount importance and continues to be a challenge for many specialists. Well-known risk factors for cardiovascular disease include excess body weight and the associated atherogenic lipid profile [3]. The problem of overweight and obesity, which also affects children and adolescents with type 1 diabetes, is associated with a global change in eating habits [3]. A minimal increase in physical activity, such as adding an hour of walking per week, can significantly improve overall health and reduce the risk of mortality, but also has a positive effect on overall health [1]. For example, intense aerobic or endurance exercise (such as swimming or brisk running/walking for 150 minutes per week) not only lowers high blood pressure and type 2 diabetes, but also improves the lipid profile and reduces the risk of cardiovascular disease [1]. In addition, endurance and weight-bearing exercises, such as jumping rope, weight lifting, weight training, and using playground equipment, lead to the development of healthy bone mass, bone health, muscle strength, and

musculoskeletal fitness [1]. Furthermore, recent reports indicate that the benefits of physical activity extend beyond its impact on body weight and include a direct effect on the pathophysiological mechanisms of cardiovascular disease. Regular physical activity improves vascular endothelial function, increases tissue sensitivity to insulin, and reduces chronic low-grade inflammation, which plays an important role in the development of atherosclerosis. It has also been shown that even moderate levels of physical activity are associated with a significant reduction in the risk of cardiovascular events and all-cause mortality, regardless of weight loss. For this reason, physical activity should be treated not only as a preventive measure, but also as an integral part of therapeutic management in patients with obesity, diabetes and cardiovascular disease [4]. The aim of this review is to summarize current evidence on the role of physical activity in the prevention and treatment of cardiovascular disease, obesity, and diabetes, with particular emphasis on underlying mechanisms, clinical outcomes, and practical implications for multidisciplinary care.

2. The impact of physical activity on the cardiovascular system

Physical activity throughout different stages of life is an important factor in the primary and secondary prevention of cardiovascular disease. Epidemiological data indicate that both early and sustained physical activity in adulthood is associated with a reduced risk of hypertension, coronary heart disease, heart failure and stroke. Protective mechanisms include improved endothelial function and nitric oxide bioavailability, reduced inflammation, beneficial modification of the lipid profile, and increased tissue sensitivity to insulin [5]. There is evidence to support the effectiveness of interventions involving physical activity and exercise in patients diagnosed with cardiovascular disease [6]. Systematic physical activity and high aerobic capacity are strongly associated with a reduced risk of atherosclerotic cardiovascular disease, and increasing them can lower the relative risk by up to 50% compared to low activity levels [7]. The effect of increased visceral fat mass on natriuresis, activation of the sympathetic nervous system (potentially initiated by leptin activation), activation of renin-aldosterone action, higher secretion of vasoactive substances, and obstructive sleep apnea may causally link obesity to hypertension [8]. Cardiovascular risk in elderly patients with increased BMI

largely depends on blood glucose levels, plasma cholesterol levels, and the presence or absence of hypertension [2]. High concentrations of free fatty acids continue to fuel chronic inflammation [2]. Changing the blood lipid profile by increasing the ratio of protective high-density lipoproteins (HDL) to low-density lipoproteins (LDL) and increasing the use of fat as fuel [1]. This leads to a reduction in risk factors for heart disease and stroke, such as high blood pressure and abnormal blood lipid profiles [1]. Weight loss interventions have been shown to improve or resolve obesity-related hypertension [8]. The beneficial effects of physical activity on blood pressure have been proven, showing that physical activity maintained over a long period of time leads to a reduction in systolic blood pressure of approximately 5 mmHg and a reduction in diastolic blood pressure of approximately 3.5 mmHg [9]. It is known that a reduction in systolic blood pressure of 2–3 mmHg reduces the risk of secondary death from stroke by about 5% and secondary death from acute coronary events by 3–4% [9]. However, the reduction in blood pressure is temporary, so physical activities such as walking must be performed daily [9,10]. Intense exercise appears to be more effective than moderate-intensity exercise in reducing cardiovascular risk [2]. Physical exercise helps control body weight and prevent weight regain after weight loss, but it appears to be most effective for weight loss when combined with a calorie-restricted diet [11]. Men are less prone to serious heart disease than women because they are generally more physically active, researchers found that a one-year lifestyle intervention focusing on moderate dietary changes and regular physical activity was associated with significant improvements in participants' cardiometabolic risk profile [1,12]. Cohort studies indicate that high levels of physical activity are associated with a significant reduction in the risk of developing cardiovascular disease and metabolic disorders at various stages of cardiovascular-renal-metabolic syndrome, compared to individuals with the lowest levels of physical activity (Zhao et al., 2025). Participants with the highest levels of activity had significantly lower rates of heart disease, stroke, diabetes and CVD, as well as a lower risk of progression to more severe stages of CKM syndrome. A dose-response analysis showed a linear relationship between total physical activity and reduced risk of cardiometabolic diseases, with benefits particularly evident in subgroups of older adults, males, and urban residents. These results highlight the important role of intense and regular physical activity as a strategy for preventing cardiovascular disease in populations at high metabolic risk [13].

3. The importance of physical activity in the prevention and treatment of obesity

Obesity, currently defined as a body mass index (BMI) of 30 or more, affects 800 million people worldwide. It is a chronic disease characterized by excessive fatness that has structural and functional consequences, resulting in an increased risk of comorbidities and premature death [14]. Obesity increases the risk of developing primary hypertension by about 70% through several mechanisms [8]. Factors that also contribute to obesity are lifestyle, socioeconomic, and environment [12]. Obesity affects many aspects of health, including physiological, psychological, and sociological aspects. In addition to a higher risk of cardiovascular disease, type 2 diabetes, and mortality, obese individuals are more prone to depression [15]. The growing prevalence of obesity in many countries is associated with an increase in type 2 diabetes, sleep disorders, dyslipidemia, hypertension, and cardiovascular disease, as well as other chronic diseases [16]. Metabolically, obesity induces myocardial cellular mechanisms such as ectopic cardiac fat deposition, accumulation of toxic lipid metabolites, mitochondrial dysfunction, and inflammation, which lead to metabolic adaptations [12]. Obesity is also associated with chronic low-grade inflammation and increased cytokine production, which can lead to further health complications, especially in the case of cardiovascular disease [16]. Any length of physical activity, even 1-2 minutes, spread out over time, can benefit cardiovascular and metabolic health [2]. Weight loss improves glucose, lipids, blood pressure, and obesity-related comorbidities, and physicians can offer many effective treatments for obesity and diabetes [14]. Warm-up exercises facilitate the transition from rest to endurance training by stretching the postural muscles and increasing blood flow. Therefore, it should include calisthenic exercises, followed by activities that increase HR to 20 beats per minute of the minimum target HR range recommended for endurance training [2]. Clinical guidelines recommend that all patients participate in 150 to 300 minutes/week of moderate or 75 to 150 minutes/week of vigorous physical activity, as well as resistance training 2 to 3 times per week [14]. Moderate-intensity aerobic exercise (defined as 50% to 70% of maximum heart rate) is associated with a reduction in visceral obesity and moderate weight loss (average effect of -2 kg to -3 kg) [14]. Physical activity combined with adequate food intake has the opposite effect on weight gain and obesity. High physical activity leads to high energy expenditure and, consequently, a reduction in stored fat (obesity) and a lower BMI [1]. Doctors may encourage physical activity throughout the day, such as walking for 2 minutes every hour or using the

stairs [14]. Stretching involves slow walking or low-intensity exercise and provides gradual recovery after an endurance or conditioning phase [2]. It allows for proper circulation adjustment and a return of heart rate and blood pressure to values close to resting values; it increases venous return, thereby reducing the risk of hypotension and dizziness after exercise; facilitates heat dissipation from the body; promotes faster removal of lactic acid than stationary recovery and counteracts the potential harmful effects of increased plasma catecholamine concentrations after exercise [2]. In the context of cardiovascular disease prevention, it is worth emphasising that partners and family members play an important role in supporting patients in modifying their lifestyle, which is one of the main health recommendations indicated in the work of Kaminsky et al. (2022). The presence of a partner — both as a companion in changing eating habits and physical activity, and as a participant in intervention programmes — is associated with better outcomes in terms of modifying risk factors, such as weight reduction or increased physical activity, which translates into a reduced risk of CVD. Studies have shown that patients with partners involved in lifestyle programmes are more likely to achieve beneficial behavioural changes, and partners participating in preventive activities may also improve their own health behaviours, further supporting a health-promoting environment. Integrating partners into rehabilitation programmes or lifestyle interventions can increase motivation, improve the quality of social support and reinforce the lasting adoption of healthy habits, which has the potential to synergistically reduce the risk of cardiovascular disease on a population scale [17]. Restricting the eating window is one of the modern nutritional strategies aimed at improving metabolic parameters and reducing the risk of cardiovascular disease. A study by Schroder et al. (2021) on time-restricted feeding (TRF) in a group of obese women showed that restricting the eating window to 8 hours a day for 3 months contributed to a significant reduction in body weight, waist circumference and percentage of body fat. TRF was also associated with a reduction in the 30-year risk of cardiovascular events, which correlated with less visceral fat and greater muscle mass, suggesting that anthropometric changes may be an indirect mechanism influencing CVD risk. In the context of cardiovascular disease prevention and treatment, such dietary approaches, combined with regular physical activity, may be an effective risk reduction strategy by improving the metabolic profile and body composition of overweight and obese individuals, who are a population at increased risk of cardiovascular disease [18].

4. Physical activity and diabetes

Diabetes is becoming an epidemic in some countries around the world, and the number of people affected by this disease is expected to double over the next decade as the population ages. It is probably one of the oldest diseases known to mankind and has contributed greatly to mortality and disability [19,20]. Depending on the age of onset, it is divided into type 1 diabetes (T1DM) and type 2 diabetes (T2DM) [19]. Type 2 diabetes was defined as a fasting blood glucose concentration of 7.0 mmol/L (126 mg/dL) or higher, a postprandial blood glucose concentration of 11.1 mmol/L (200 mg/dL) or higher (when fasting samples were not available), or the use of blood glucose-lowering medications [21]. In 2017, there were approximately 425 million adults with diabetes worldwide, and this number is estimated to rise to 642 million by 2040 [20]. Modern technologies now help people do less physical work, and the use of private vehicles reduces the need for physical activity-based transportation such as walking or cycling. The introduction of television and electronic forms of entertainment has gradually made sedentary activities more attractive than exercise, especially for young people [1]. Type 2 diabetes can be prevented by maintaining a healthy body weight, eating a high-quality diet, engaging in moderate to vigorous physical activity, avoiding smoking, and consuming alcohol in moderation in the general population and in high-risk individuals, such as patients with elevated fasting glucose levels [20]. Studies have shown that physical activity improves glycemic control and slows the onset of type 2 diabetes in both men and women [1]. A cohort study involving 18,908 young adults with prediabetes showed that an increasing number of suboptimal cardiovascular health factors, including physical inactivity, was significantly associated with an increased incidence of progression to diabetes — 3.3% after one year and 9.5% after five years. Early lifestyle modification, including weight control and increased physical activity, is important in preventing progression to type 2 diabetes [22]. Weight loss resulting from lifestyle changes can improve metabolic syndrome factors, systemic inflammation, and endothelial dysfunction. Studies indicate that weight loss of approximately 5% to 10% over 6 months can improve blood glucose, blood pressure, and cholesterol levels [16]. Chronic hyperglycemia, combined with other metabolic changes that occur in diabetes, predisposes the body to a range of damage to various organs and systems, causing life-threatening complications in patients [9].

A cohort study of patients with diabetes found that less than half of the participants met the recommendations for physical activity (≥150 minutes per week), and those who exercised regularly had significantly lower blood pressure and a more favourable metabolic profile, highlighting the importance of exercise in the prevention of cardiovascular complications in patients with T2DM [23]. Lifestyle change is one of the most effective strategies for preventing complications in patients already suffering from diabetes. These interventions involve a multi-component approach focusing simultaneously on diet control, physical activity, glycaemia, blood pressure and lipid profile. The authors also point out that although the introduction of SGLT2 inhibitors and GLP-1 receptor agonists has changed the paradigm of cardiovascular and renal complication prevention in diabetes, lifestyle interventions aimed at weight reduction and metabolic risk reduction remain the basis [24]. The principles of recommended physical activity are as follows: aerobic exercise is preferred and must be supplemented with balance, strengthening, and flexibility exercises [9]. To date, the most commonly recommended exercise for beginners is walking, followed by resistance training, which is comparable or superior to endurance training in terms of increasing bone mineral density, muscle mass and strength, insulin sensitivity, and basal metabolic rate, should be recommended as a supplement to any physical fitness program [2,9]. It is important to take into consideration that weight-bearing activity may be limited by the presence of neuropathy or diabetic foot disease, which often leads to a reduction in the number of daily steps and limited mobility. Studies show that patients at risk of foot ulcers take significantly fewer steps per day than those without such complications, and outdoor activity is usually lower than indoor activity, which further affects the total level of movement. These findings suggest that when formulating recommendations for physical activity in the prevention of CVD in people with diabetes, the specific limitations of diabetic foot should be taken into account in order to promote safe forms of lower limb weight-bearing activity without increasing the risk of injury [25]. Studies show that diabetes significantly increases the risk of cardiovascular events, including myocardial infarction, but regular physical activity can significantly reduce this risk. A large cohort study involving 294,528 people with newly diagnosed type 2 diabetes analysed the impact of changes in physical activity levels after diagnosis on the occurrence of cardiovascular events. Patients who became physically active after diagnosis had a significantly lower risk of developing heart failure compared to those who remained inactive, while the lowest risk was observed in those who maintained regular activity. These results indicate that, even after diagnosis of diabetes,

increasing or maintaining physical activity significantly reduces the development of cardiovascular complications, which are the leading cause of death, including events such as heart attack [26]. However, in a cohort study by Kaze et al. (2022), the mechanisms of metabolic adaptation to physical activity were analysed and it was shown that some patients with type 2 diabetes experience a phenomenon known as exercise resistance, which consists of a weakened improvement in glycaemic control despite regular physical activity. This is because patients experience exercise-induced glucose uptake impairment. In addition, chronic inflammation and visceral obesity can inhibit training adaptation, reducing the expected improvement in metabolic parameters. These results indicate that although physical activity is the basis of non-pharmacological management in T2DM, in some patients it is necessary to combine it with weight reduction and pharmacological treatment in order to achieve optimal therapeutic effects [27]. A meta-analysis of randomised controlled trials has shown that regular physical activity leads to a significant improvement in insulin sensitivity, a reduction in HbA1c, a reduction in visceral fat mass and a reduction in blood pressure, which in turn reduces the risk of developing type 2 diabetes and cardiovascular complications. These results confirm that even a moderate increase in physical activity in overweight or prediabetic individuals can significantly improve the metabolic and cardiometabolic profile, which further justifies the inclusion of regular physical activity in the prevention and treatment strategy for T2DM [28].

Conclusions

inflammation. Weight loss resulting from lifestyle changes has a positive effect on metabolic parameters, reducing the risk of developing diabetic and cardiovascular complications. According to current guidelines, the best health benefits come from regular aerobic activity supplemented with resistance training, balance exercises, and stretching. Physical activity should be tailored to the patient's age, health status, and abilities, and its regularity is crucial for maintaining long-term health benefits. Promoting physical activity as a permanent part of everyday life is essential for preventing chronic diseases, improving quality of life, and reducing the negative effects of today's sedentary lifestyle.

Physical activity is one of the key elements in the prevention and treatment of chronic diseases, in particular cardiovascular disease, obesity, and type 2 diabetes. Regular exercise, regardless

of its form, contributes to improved cardiorespiratory fitness, normalization of blood pressure, and beneficial changes in blood lipid profile, which significantly reduces the risk of cardiovascular events and mortality. Lack of physical activity and a sedentary lifestyle are strongly associated with overweight and obesity, which are currently one of the greatest public health challenges in the world. Regular physical activity, especially when combined with a sensible diet, leads to increased energy expenditure, reduced body fat, and improved metabolism, and even a small increase in physical activity brings measurable health benefits. Physical activity also plays an important role in the prevention and treatment of type 2 diabetes by improving tissue sensitivity to insulin, better glycemic control, and reducing

Disclosure

Author's contribution

Conceptualization: [IMW], [NJ]

Methodology: [IMW], [NJ], [AS], [ASz]

Software: [IMW], [AŚ], [AC], [AS]

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Formal analysis:[IMW], [TP], [JS], [MK]

Investigation: [IMW], [AŚ], [MK], [TP],[MC]

Resources: [AC], [JS], [TP], [MK]

Data curation: [AS], [JS]

Writing -rough preparation:[IMW], [AŚ], [NJ]

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