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Research Progress on the Intervention Effects of Different Exercise Forms on Risk Factors for Obesity-Related Cardiovascular Diseases

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Abstract: Obesity has become a major global health issue and is an independent risk factor for several cardiovascular risks. Exercise, as a therapeutic method, is commonly used to improve cardiovascular health in obese populations. This paper reviews and analyzes the effects of five different exercise forms on risk factors for obesity-related cardiovascular diseases: Moderate-Intensity Continuous Training (MICT), High-Intensity Interval Training (HIIT), Sprint Interval Training (SIT), aerobic combined with resistance training, and Blood Flow Restriction Training (BFR). The aim is to explore the similarities and differences in health benefits among these exercise forms for individuals with obesity. The review finds that MICT is notably effective in reducing cardiovascular disease risk factors and promoting cardiovascular health in obese individuals. In contrast, high-intensity interval exercises such as HIIT and SIT show even more significant improvements in cardiovascular health. This difference may be attributed to varying biological effects caused by different intensity levels and intervals, though the specific mechanisms require further clarification. Since increased skeletal muscle can enhance basal metabolic rate and positively impact the cardiovascular system, resistance training is often recommended in combination with aerobic training for better results. Additionally, BFR can achieve similar training effects under lower exercise loads, providing a safer training option for obese individuals. Future research should focus on the mechanisms by which different exercise forms affect specific cardiovascular disease risk factors and how to optimize exercise programs based on individual differences to enhance personalization and scientific validity of interventions.

Keywords: Exercise, Obesity, Cardiovascular Disease Risk Factors, Intervention Effects.

1. Introduction

According to the “China Cardiovascular Health and Disease Report (2022),” statistics show that the rates of overweight and obesity among Chinese residents have been rising continuously. Between 2015 and 2017, the overweight rate and obesity rate among Chinese adults reached 33.3% and 14.1%, respectively. It is projected that by 2030, these rates could reach 65.3% and 31.8%, respectively, making obesity one of the major public health challenges. Obesity significantly impacts health, particularly in relation to cardiovascular and cerebrovascular diseases. It is a major risk factor for coronary atherosclerotic heart disease and stroke (especially ischemic stroke), substantially

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increasing the incidence and mortality rates of these diseases. Compared to traditional risk factors such as smoking and alcohol consumption, the risks associated with obesity are more severe, and it has become one of the top five health risks in developed countries. Research by the World Health Organization (WHO) has indicated that obesity is now among the top ten global health hazards. Additionally, obesity significantly increases the mortality rate of cardiovascular diseases, with relative risks rising by 28% and 89%, respectively. Beyond its impact on individual health, obesity also imposes a severe economic burden on both individuals and society. With the acceleration of global urbanization and changes in lifestyle, obesity is becoming increasingly severe worldwide, especially in low-income and developing countries. Therefore, finding effective interventions and treatments for weight loss and fat reduction is urgent. Currently, the main interventions for obesity include medication, dietary control, and exercise. Compared to medication, exercise as a non-pharmacological intervention avoids the side effects of drug treatments and is more effective in reducing and improving obesity.

Numerous studies have been conducted on obesity, cardiovascular disease risk factors, and exercise interventions, all confirming that scientifically sound exercise can effectively reduce obesity and improve various cardiovascular disease risk factors caused by obesity. Wang Kai and colleagues found that a 12-week combined exercise intervention significantly improved indicators such as fasting plasma glucose (FPG), insulin, and HOMA-IR in obese females aged 14-16 [1]. Meanwhile, Duan Lizhu and others, through aerobic exercise combined with dietary intervention in obese adolescents aged 12-18, observed significant increases in serum CTRP9 and eNOS levels in male participants, and a significant increase in serum nitric oxide (NO) levels in female participants [2]. Therefore, it can be inferred that active exercise has a significant positive effect on regulating cardiovascular risk factors in obese individuals. With the development of the exercise and health promotion field, various exercise forms have emerged, and different types of exercise may have varying effects on weight loss, fat reduction, and cardiovascular disease risk factor intervention. This study reviews the effects and possible mechanisms of different exercise forms on obesity and cardiovascular disease risk factors.

2. The Impact of Obesity on Cardiovascular Disease Risk Factors

Obesity is considered one of the primary independent risk factors for cardiovascular and cerebrovascular diseases. It affects the cardiovascular system through multiple mechanisms, including hypertension, diabetes, and dyslipidemia, all of which are major risk factors for cardiovascular diseases. This section will discuss obesity-related hypertension, glucose metabolism disorders, and dyslipidemia in detail.

2.1. Obesity and Hypertension

Hypertension is defined as a systolic blood pressure $\geqslant$140 mmHg and/or a diastolic blood pressure $\geqslant$90 mmHg. Obesity is an independent risk factor for hypertension. Studies have shown that for every 10 kg increase in body weight, systolic blood pressure rises by 3.0 mmHg and diastolic blood pressure rises by 2.3 mmHg. This increase corresponds to a 12% higher risk of coronary heart disease and a 24% higher risk of stroke. This effect is mainly due to increased peripheral small artery wall smooth muscle tension and heightened reactivity to vasoactive substances, which cause structural changes in the vessels and result in increased peripheral vascular resistance. Research has found that individuals with obesity often have hypertension. The association between obesity and hypertension can be explained through several key pathophysiological mechanisms: 1) Activation of the Sympathetic Nervous System (SNS): Obesity can activate the SNS, leading to an increase in heart rate and vasoconstriction, which in turn causes hypertension. 2) Activation of the Renin-Angiotensin-

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Aldosterone System (RAAS): This is a blood pressure-regulating system produced by the kidneys. When activated, it promotes the conversion of angiotensinogen to angiotensin II, leading to significant aldosterone secretion, vascular smooth muscle contraction, and sodium and water retention, which increases blood pressure. 3) Oxidative Stress Response: Obesity can cause an oxidative stress response due to an imbalance between oxidative and antioxidant systems, leading to the excessive generation of oxidative free radicals and reactive oxygen species (ROS). These oxidants attack cellular proteins, lipids, and nucleic acids, resulting in endothelial dysfunction and ultimately contributing to hypertension. 4) Inflammatory Cytokines and Hormones: Obesity leads to the synthesis and release of numerous hormones and pro-inflammatory cytokines from adipose tissue. These factors alter metabolic processes and affect endothelial function, contributing to the development of hypertension.

2.2. Obesity and Glucose Metabolism Disorders

Glucose metabolism disorders can be categorized into three states: diabetes (fasting blood glucose ⩾126 mg/dl or 2-hour blood glucose ⩾200 mg/dl during a 75g oral glucose tolerance test), impaired fasting glucose (IFG, fasting blood glucose between 110-126 mg/dl and 2-hour blood glucose <200 mg/dl), and impaired glucose tolerance (IGT, 2-hour blood glucose between 140-200 mg/dl). Epidemiological studies have shown that all three states of glucose metabolism disorders are closely associated with an increased risk of cardiovascular diseases. Data indicate that obesity and overweight are significantly related to insulin resistance, type 2 diabetes, metabolic syndrome, and cardiovascular diseases. Insulin resistance is a key factor linking obesity with disturbances in glucose and lipid metabolism. The mechanisms include abnormal fat deposition, increased secretion of inflammatory factors, abnormal secretion of adipose tissue hormones, and mitochondrial dysfunction. In individuals with insulin resistance, there is a significant increase in intracellular fat content in cells such as muscle and liver, leading to chronic inflammatory responses. Inflammatory factors such as TNF-α, IL-6, transforming growth factor-β, C-reactive protein, and MCP-1 are significantly elevated, which inhibits insulin signaling through the activation of JNK/SAPK or IKKβ/NF-κB pathways. Additionally, decreased secretion of adiponectin and increased leptin from adipocytes further reduce insulin sensitivity. Mitochondrial dysfunction is also commonly observed in individuals with insulin resistance. The dysregulation of lipid metabolism caused by obesity may be related to several physiological mechanisms, including insulin resistance, enhanced inflammatory responses, altered adipocyte secretion functions, and mitochondrial abnormalities. These factors interact to disrupt lipid metabolism, thereby increasing the risk of cardiovascular diseases.

2.3. The Impact of Obesity on Lipid Metabolism Disorders

The criteria for dyslipidemia include total cholesterol (TC) ⩾5.72 mmol/L, triglycerides (TG) ⩾ 1.7 mmol/L, low-density lipoprotein cholesterol (LDL-C) ⩾ 3.64 mmol/L, and high-density lipoprotein cholesterol (HDL-C) <0.91 mmol/L. Elevated total cholesterol (TC) levels are positively correlated with high blood pressure, and dyslipidemia is an independent risk factor for coronary heart disease and atherosclerosis. The prevalence of hyperlipidemia in obese patients ranges from 23% to 40%, which is significantly higher than in the general population. There is a positive correlation between BMI and elevated lipid levels, which is related to the dysregulation of lipolytic and anti-lipolytic hormones in obesity, leading to increased lipid synthesis and breakdown activities, and ultimately resulting in lipid metabolism disorders. Additionally, obesity causes a decrease in lipoprotein lipase activity, reducing the breakdown of very low-density lipoprotein (VLDL), impairing its clearance, and accelerating cholesterol synthesis. It also makes LDL-C more prone to oxidation and lowers HDL-C levels, thereby increasing the cardiovascular risk in obese individuals.

Furthermore, dyslipidemia induced by obesity is also thought to be related to visceral fat accumulation. Visceral fat has strong lipogenic and lipolytic effects, with a large amount of free fatty acids from lipolysis entering the liver through the portal system, leading to increased triglyceride synthesis. Thus, the dysregulation of lipid metabolism caused by obesity is likely associated with factors such as visceral fat accumulation, dysregulation of lipolytic and anti-lipolytic hormones, insulin resistance, and decreased lipoprotein lipase activity.

3. The Impact of Exercise on Cardiovascular Disease Risk Factors

Regular exercise has been widely proven to effectively improve various cardiovascular risk factors associated with obesity, such as hypertension, dyslipidemia, impaired glucose tolerance, and insulin resistance. Current exercise interventions for obese populations include moderate-intensity continuous training (MICT), high-intensity interval training (HIIT), sprint interval training (SIT), aerobic combined with resistance training, and blood flow restriction training. These forms of exercise have been shown to have a positive impact on cardiovascular health.

3.1. Moderate-Intensity Continuous Training (MICT)

Moderate-intensity continuous training (MICT) typically involves 30-60 minutes of continuous exercise at an intensity of 60%-75% of maximum heart rate or 50%-60% of maximum oxygen consumption (VO2max), with a duration of ⩾4 weeks. Common forms of MICT include running, cycling, and swimming. MICT has been shown to effectively improve cardiovascular disease (CVD) risk factors in obese individuals and has a significant positive impact on cardiovascular health. A study conducted by Iowa State University in the United States demonstrated that, among 406 overweight or obese adults aged 35-70 with elevated blood pressure, a 12-month aerobic training program on treadmills, stationary bikes, and elliptical machines significantly increased HDL-C levels and improved dyslipidemia compared to the control group, leading to a significant reduction in the overall CVD risk score [3]. Another study by Guo Yin et al. targeted 126 obese children and adolescents aged 8-17 with a body fat percentage >30%, who participated in a moderate-intensity aerobic training program for 4 weeks during a weight-loss summer camp in Shanghai from 2007 to 2009. The results showed that while changes in HDL-C were not significant, the HDL-C/LDL-C ratio significantly increased across all groups [4]. This suggests that MICT has a substantial positive impact on lipid ratio regulation across different age groups, and the effect may be related to the duration of the training.

Bret H. Goodpaster and colleagues conducted a 16-week study on 25 obese volunteers (BMI >30 kg/m²), who engaged in moderate-intensity exercise (60%-75% HRmax) for at least 4 times per week, 30-40 minutes per session, combined with a daily caloric intake reduction of 500-1000 kcal and a low-fat diet (with <30% of calories from fat). The intervention group showed a 49% improvement in insulin sensitivity, with a 159% increase in non-oxidative glucose disposal [5]. This means that glucose was more efficiently utilized under insulin stimulation rather than being consumed solely through oxidative pathways. This indicates that the combined effect of moderate-intensity exercise and dietary control may be superior to MICT alone, suggesting that when designing exercise prescriptions for obese individuals, dietary control should also be reasonably managed to achieve better results.

3.2. High-Intensity Interval Training (HIIT)

HIIT involves exercise performed in intervals of high intensity, alternating between periods of intense activity and active recovery. It often includes all-out sprints or exercises at around 90% of maximum oxygen consumption (VO2max or VO2peak). The duration of each exercise bout and recovery period can vary from a few seconds to several minutes. HIIT is now widely used in weight loss and fitness training for obese individuals. It not only effectively enhances cardiorespiratory fitness and metabolic health but also significantly reduces body fat and improves insulin sensitivity, making it a time-efficient and effective training method. In a study by Inga E et al., it was found that the increase in VO2max in the HIIT group was more than double that of the MICT group, with significant improvements in endothelial function [6]. This suggests that, for equivalent energy expenditure, HIIT is more effective than continuous training (MICT) in improving vascular endothelial function and reducing cardiovascular disease risk factors in obese individuals.

Another study compared a 12-week training regimen where the HIIT group exercised for 25 minutes (3 minutes of moderate running followed by 2 minutes of interval training, for a total of 5 sets), while the MICT group performed continuous moderate-intensity exercise for 50 minutes, 5 times a week. The results showed that the HIIT group had a significantly greater reduction in body fat percentage, BMI, and WHR indices compared to the MICT group. Additionally, lung function indicators such as LVEF, VO2max, VT, and vital capacity were significantly improved in the HIIT group, surpassing the MICT group [7]. These findings suggest that HIIT can achieve better weight loss and promote vascular health more effectively in a shorter time compared to MICT.

3.3. Sprint Interval Training (SIT)

Sprint Interval Training (SIT) is a form of high-intensity anaerobic exercise characterized by extremely short bursts of maximum-intensity activity (8-30 seconds), often reaching or exceeding 100% of VO2max. Compared to HIIT, SIT produces greater average power output but with lower energy expenditure. Compared to moderate-intensity continuous training (MICT), SIT is more intense, consumes less energy, and can achieve similar or better training effects in a shorter time. Research by Matthew Cocks et al. found that SIT and MICT had similar effects on improving cardiopulmonary endurance and cardiovascular disease risk factors. Both SIT and MICT effectively improved VO2peak, insulin sensitivity, eNOS levels, eNOS serine 1177 phosphorylation, capillary density, and central arterial stiffness. Given the shorter duration required for SIT, it may serve as a more efficient alternative .

Furthermore, a study by Granata et al. demonstrated that SIT significantly increased mitochondrial biomarkers [8], indicating that it promotes the enhancement of mitochondrial function and quantity, which contributes to improved metabolic rate and energy utilization efficiency, thereby aiding in fat reduction and promoting cardiovascular function. Research also showed that due to the high intensity of SIT, it rapidly burns a large number of calories and continues to elevate the metabolic rate post-training, significantly reducing skinfold thickness [9]. In summary, SIT can improve physical performance, enhance basal metabolism in obese individuals, and quickly improve body composition and cardiovascular disease risk factors. However, due to the high intensity of SIT, it places considerable stress on the heart, increasing the risk of adverse effects. Therefore, for obese individuals, it is essential to follow a gradual training principle, progressively increasing the intensity to avoid excessive strain on the body.

3.4. Resistance Training

Resistance exercise, also known as resistance training or strength training, generally refers to the process in which the body overcomes resistance to achieve muscle growth and increased strength. Muscle tissue is a crucial organ that influences human metabolism and can directly impact the risk of metabolic diseases. Research has shown that resistance training can also enhance basal metabolic rate, promote energy expenditure, reduce body fat accumulation, and improve cardiovascular disease-related risk factors. According to a follow-up survey by Esmée A. Bakker and colleagues, among

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7,418 participants, those who engaged in resistance training were younger, had lower BMI and waist circumference, better cardiorespiratory fitness, and better lipid profiles (lower triglycerides and higher high-density lipoprotein cholesterol) compared to those who did not engage in resistance exercise. Additionally, the survey found that participating in resistance training can reduce the incidence of metabolic syndrome by 17%. Engaging in resistance training for ≤1 hour per week can reduce the risk of metabolic syndrome by 29%. Moreover, individuals who met both resistance training and aerobic exercise guidelines had a 25% lower risk of metabolic syndrome compared to those who did not meet any guidelines [10].

Combining aerobic exercise with resistance training is more effective in reducing body fat percentage in obese youth. It compensates for the lack of skeletal muscle training in aerobic exercise alone and, by increasing muscle mass and enhancing overall metabolic rate, helps improve endothelial function and reduce cardiovascular disease risk factors. A study by Tang Donghui and colleagues on obese adolescents found that after six weeks of MICT combined with resistance exercise, inflammation and oxidative stress-related markers in obese individuals were significantly reduced, and their vascular endothelial function was effectively improved. The research team further discovered that for obese adolescents with dyslipidemia, angiopoietin-like protein 8 might be involved in the improvement of vascular endothelial function through the combined training of aerobic and resistance exercise [11]. In conclusion, compared to resistance training alone, the combined training of aerobic and resistance exercise can effectively improve cardiovascular disease risk factors in obese individuals. However, resistance training may increase the risk of cardiovascular complications (primarily due to the potential rise in blood pressure during exercise). Some studies have indicated that when performing 15 to 20 repetitions at low intensity (40-60% of maximal voluntary contraction), blood pressure only slightly increases, similar to moderate-intensity endurance training. Therefore, it is recommended that obese individuals perform resistance training or combined aerobic and resistance training at a low intensity (40-60% of maximal voluntary contraction) with 15 to 20 repetitions to avoid sudden spikes in blood pressure.

3.5. Blood Flow Restriction Training (BFR)

Blood flow restriction training is a method that involves applying pressure to occlude blood vessels, thereby restricting blood flow and inducing muscle ischemia in the distal limbs. This type of training can effectively stimulate muscle growth and improve muscle fitness at relatively low exercise intensities. For obese individuals, excessive body weight can put significant stress on the joints, increasing the risk of exercise-related injuries. BFR training, as a low-intensity yet highly effective exercise method, can effectively reduce the stress on the lower limb joints caused by excessive weight in obese individuals, thereby lowering the risk of exercise injuries.

Research has shown that BFR can effectively improve glucose and lipid metabolism disorders, thereby reducing the risk of cardiovascular disease. A study combining low-intensity resistance training (20% of one-repetition maximum) with blood flow restriction of the exercising muscle group significantly reduced body fat percentage, fasting blood glucose, and insulin levels in participants, while increasing serum adiponectin levels, which plays a crucial role in regulating glucose and lipid metabolism [12]. Compared to regular resistance training, BFR is more effective in improving body composition and insulin sensitivity in obese individuals, likely due to its ability to promote muscle mass and strength gains. There is a positive correlation between fat cell volume and insulin resistance index, whereas muscle strength and insulin resistance exhibit a negative correlation. Therefore, increasing muscle mass and strength is crucial for improving body composition and enhancing insulin sensitivity in obese individuals. A study on middle-aged obese women showed significant decreases in insulin levels and HOMA-IR after training. Additionally, serum levels of adiponectin and visfatin showed an increasing trend, possibly due to the exercise-induced improvement in insulin sensitivity, which suppresses the expression and secretion of adiponectin in adipose tissue [13]. Simultaneously, the significant decrease in ghrelin and GLP-1 levels may be associated with the increased energy expenditure and appetite suppression caused by exercise, leading to a negative energy balance. These findings indicate that blood flow restriction training has a positive effect on preventing and treating obesity and the cardiovascular risks associated with it.

4. Mechanisms by Which Exercise Regulates Cardiovascular Disease Risk Factors Related to Obesity

4.1. Exercise Improves Metabolic Disorders

Metabolic syndrome, characterized by obesity, hyperlipidemia, impaired glucose tolerance, and insulin resistance, is a significant risk factor for cardiovascular diseases such as hypertension, atherosclerosis, and coronary heart disease. Exercise improves glucose and lipid metabolism and enhances insulin sensitivity through various mechanisms. Specifically, exercise directly promotes glucose utilization and maintains glucose homeostasis, effectively reducing blood glucose levels and glycated hemoglobin in diabetic patients. Molecular biology evidence suggests that exercise regulates glucose metabolism at multiple levels by activating the Rac1/PAK1/p38 MAPK signaling pathway, influencing insulin secretion and transport, and promoting glucose uptake in skeletal muscles. One study found that after 20 minutes of aerobic exercise at 65% of maximum exercise capacity, the level of Rac1-GTP in the soleus muscle of mice increased threefold. Activation of Rac1 enhances insulin secretion in pancreatic β-cells. PAK1 regulates the activity of the Arp2/3 complex through phosphorylation, thereby influencing insulin-mediated glucose transport mechanisms and improving insulin efficiency [14]. Additionally, the transient activation of the Rac1/PAK1/p38 MAPK signaling pathway can enhance GLUT4 expression, increase PGC-1α activity, and promote mitochondrial biogenesis and oxidative metabolism, thereby helping the body absorb glucose more effectively. Exercise also significantly reduces triglyceride levels, increases circulating high-density lipoprotein (HDL), and promotes the browning of adipose tissue, which increases thermogenesis and improves fatty acid metabolism, resulting in muscle gain and fat loss. Further research has found that the expression level of KLF15 in human and mouse skeletal muscle increases after fasting and exercise. KLF15 plays a key role in regulating the distribution and transport of fatty acids, lipid oxidation in mitochondria, peroxisomal function, and the expression of genes related to intramuscular lipid storage [15].

4.2. Exercise Improves Inflammation and Oxidative Stress

Obesity leads to an increase in inflammatory factors within adipocytes, pushing the body into a state of chronic, systemic, low-grade inflammation. This condition raises cardiovascular risk factors and contributes to the development of diseases such as hyperlipidemia, hypertension, coronary heart disease, and diabetes. Regular aerobic exercise has been shown to significantly reduce fat accumulation in obese adolescents, patients with metabolic syndrome (MS), and diabetic patients, while also lowering levels of inflammatory markers (such as IL-1β, IL-6, TNF-α, CRP) and optimizing the body’s inflammatory state. Studies have demonstrated that combining exercise with dietary control effectively alleviates symptoms related to atherosclerosis in rats by reducing levels of inflammatory factors like IL-1β, TNF-α, and CRP, thereby improving the overall chronic inflammatory condition [16]. Oxidative stress refers to the imbalance between the production of free radicals and the body’s antioxidant defense mechanisms. In adipose tissue, increased oxidative stress is considered a key mechanism in the development of obesity-related cardiovascular diseases. Oxidative stress serves as a common pathological basis for cardiovascular diseases, and long-term exercise can significantly improve cardiovascular health by enhancing antioxidant and anti-

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inflammatory capacities. The reactive oxygen species (ROS) produced during exercise not only promote mitochondrial function and muscle growth but also help regulate inflammatory responses and strengthen the body's antioxidant reactions. Relevant research shows that both continuous and cumulative exercise can reduce oxidative stress levels in the myocardium of obese rats, specifically by decreasing Nox2 and increasing Nrf2. Continuous or cumulative exercise for two weeks has been shown to significantly improve myocardial oxidative stress levels in obese rats, with beneficial changes observed immediately after exercise and continuing for up to 48 hours post-exercise [17]. Moreover, exercise can increase lipolysis, reduce visceral fat, and activate the hypothalamic-pituitary-adrenal axis and sympathetic nervous system, leading to the release of cortisol and other factors that inhibit the production of inflammatory cytokines. Aerobic exercise also reduces mitochondrial fragmentation and free radical generation in hypertensive individuals, preventing excessive oxidative stress. These mechanisms help maintain redox balance, alleviate chronic inflammation, and thus prevent and combat obesity-related cardiovascular diseases.

4.3. Exercise Improves Hypertension

Extensive basic and clinical research has confirmed that exercise has significant effects on the prevention and treatment of hypertension. A 2019 meta-analysis by Naci et al. covered 391 randomized controlled trials with 39,742 participants and found that various exercise interventions, including endurance training, dynamic resistance training, and isometric strength training, effectively reduce systolic blood pressure. In particular, regular aerobic exercise can lower resting blood pressure in hypertensive patients by 5 to 7 mmHg [18]. The development of hypertension is associated with increased oxidative stress and endothelial dysfunction. Aerobic exercise improves vascular endothelial function and promotes the production of nitric oxide (NO). NO, a vasodilator produced by endothelial cells, is primarily synthesized by endothelial nitric oxide synthase (eNOS) acting on L-arginine. It then diffuses to vascular smooth muscle cells, leading to vasodilation. Exercise mainly enhances the shear force of blood flow within vessels, which promotes eNOS expression and subsequently increases NO production. Additionally, exercise can enhance the response of forearm blood flow to acetylcholine, increasing NO release under acetylcholine stimulation. Endothelin-1 (ET-1) triggers a sharp and prolonged vasoconstriction by activating ETA receptors, causing a transient increase in intracellular calcium ion (Ca^+) concentration in smooth muscle cells, which leads to elevated blood pressure. Exercise effectively reduces ET-1 levels and increases the concentrations of nitrites and nitrates, thereby protecting vascular health. High-intensity interval training (HIIT) and continuous aerobic training have similar effects in reducing blood pressure, but HIIT has been shown to be more effective in improving cardiorespiratory endurance, enhancing endothelial function, and increasing insulin sensitivity. Additionally, research indicates that HIIT affects neutrophils, which induce nicotinamide adenine dinucleotide phosphate (NADPH) oxidase activity, influencing the redox state and lowering blood pressure [19].

5. Summary and Outlook

This study reviews and analyzes the effects of five different forms of exercise—moderate-intensity continuous training (MICT), high-intensity interval training (HIIT), sprint interval training (SIT), resistance training, and blood flow restriction training (BFR)—on cardiovascular disease risk factors associated with obesity. The goal is to explore the similarities and differences in health outcomes among obese individuals following various exercise regimens. MICT has demonstrated significant effectiveness in reducing cardiovascular disease risk and improving vascular health in obese individuals, primarily by promoting cardiovascular adaptation and endurance through sustained moderate-intensity exercise. In contrast, high-intensity interval exercises like HIIT and SIT, characterized by their high intensity and intervals, show more pronounced improvements in cardiovascular function. The different biological effects may be attributed to variations in intensity and interval duration, though the specific biological mechanisms remain to be further elucidated. Additionally, compared to the prolonged and monotonous nature of MICT, the diverse and engaging formats of HIIT and SIT are more appealing to obese individuals. Although MICT, HIIT, and SIT are all effective in fat loss and improving body composition, they may lead to muscle loss. Given that increasing skeletal muscle mass can boost basal metabolic rate and positively impact the cardiovascular system, resistance training is often recommended in conjunction with aerobic exercise to achieve better fat loss and muscle gain. However, traditional resistance training might pose risks to the knee or ankle joints of obese individuals due to their excessive body weight, presenting certain safety concerns. BFR, which can achieve similar training effects with a lower exercise load, offers a safer alternative for the obese population. Despite the positive impact of these five different types of exercise on body composition and cardiovascular risk factors in obese individuals, the differences in exercise forms, intensity, and duration may lead to varying mechanical stimuli, potentially resulting in different effects on cardiovascular structure and function. Therefore, future research should focus on the biomechanical mechanisms by which different forms, intensities, and interval durations of exercise influence cardiovascular disease risk factors related to obesity, with the aim of enhancing the personalization and scientific basis of interventions.

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