Effects of different exercise modes on obese children and adolescents

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Abstract: Objective: To explore the intervention effects of different exercise methods on obese children and adolescents, providing theoretical support for personalized weight management plans, optimizing physiological health indicators, improving mental health, and promoting coordinated physical and mental development. Methods: A literature review was conducted by searching CNKI, Baidu Scholar, and Pubmed with keywords "children and adolescents," "obesity," and "exercise intervention" to analyze the impacts of different exercise interventions. Conclusion: Aerobic exercise effectively reduces body fat and improves metabolic indicators; resistance exercise enhances muscle mass and bone density. Combined aerobic-resistance exercise exhibits synergistic effects in optimizing body composition and cardiorespiratory function, outperforming single-mode interventions, and shows positive trends in improving psychological resilience.

keywords:obesity; children and adolescents; physical activity; intervention

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1 Introduction

Adolescents' physical and mental health is crucial for national development, affecting quality of life, future prospects, national health indices, and fitness progress. Obesity, a risk factor for chronic diseases, increases adulthood risks of diabetes, fatty liver, and cardiovascular disorders, potentially impairing cognitive development. Exercise is emphasized as a non-pharmacological intervention for weight management. This paper uses a literature review to analyze effects of different exercise modes on obese children and adolescents, providing references for improving physical function.

2 Definition of obese children and adolescents

The World Health Organization (WHO) defines obesity as abnormal or excessive fat accumulation harmful to health. Fat tissue distribution varies individually, particularly in abdominal visceral-to-subcutaneous fat ratio, leading to distinct metabolic effects. Some scholars recently proposed defining obesity as "obesity-based chronic diseases".

Childhood and adolescent obesity assessment is more complex than in adults, with no unified international criteria. While BMI $\geqslant$30 kg/m^2 is widely used globally, some studies adopt waist-to-height ratio >0.5 for abdominal obesity. In China, age- and gender-specific BMI standard deviations are primary for children under seven.

3 Factors Influencing Childhood and Adolescent Obesity

3.1 Genetic factors

Genetic factors account for 40%-70% of obesity development: offspring have 40% obesity risk with one obese parent, 70% with both. Genetics explain 21% of BMI variation, contributing to familial clustering. Recent studies highlight early-life gut microbiota changes significantly influence childhood obesity; establishment starts prenatally/neonatally, stabilizes by ages 3-4, and disruptions may affect weight gain by 12-14. Maternal gut microbiota is an endogenous factor.

3.2 Environmental Factors

Diet is crucial among environmental factors: Long Lu notes healthy eating habits promote children's well-being, while poor dietary patterns contribute to obesity. Wang Li highlights rapid eating, inadequate chewing, prolonged meals, overeating, high-calorie food preference, excessive dinner portions, and late-night snacking as linked to adolescent obesity. Childhood obesity also stems from reduced physical activity: increased screen time and academic pressure cause prolonged sitting and decreased exercise, reducing energy expenditure and fat accumulation, creating a "fatter-less active" cycle. Sleep deprivation and circadian rhythm disruptions correlate with obesity , with Zhou Fang confirming insufficient sleep as a risk factor for childhood weight gain.

Family environment requires attention: most parents lack obesity knowledge, hold misconceptions due to traditional beliefs, and fail to address the issue properly, contributing to rising obesity rates. Global studies show childhood obesity rates vary significantly across families with different economic conditions, income levels, and educational backgrounds.

In summary, besides dietary imbalance and physical inactivity, caregivers' nutritional misconceptions are hidden risk factors for childhood and adolescent obesity. Current research identifies reducing high-fat foods/sugary drinks and increasing regular exercise as key to obesity prevention, with raising parents' awareness of health risks equally vital.

3.3 Social Factors

Local community environment, including childcare facilities, schools, parks, green spaces, public transportation, and food outlets, is key to childhood and adolescent obesity. Fixed daily activity environments (households, neighborhoods, schools) with inadequate sports facilities, insufficient physical education emphasis, and parents' poor exercise awareness restrict physical activity, increasing obesity risks. Wei Hong et

al. showed health education interventions enhance parents' obesity understanding, improve symptoms, and reduce incidence. Tang Xiuli et al. found community-based educational, dietary, and exercise interventions improved health behaviors, weight control, obesity knowledge, cognitive attitudes, and lipid levels in obese adolescents and families, with clinical significance. Thus, enhancing community obesity awareness is critical.

4 The harm of obesity in children and adolescents

4.1 Physical Hazards

Obesity is not merely a nutritional issue but a metabolic disorder affecting children and adolescents' growth and development. Excessive weight increases lower limb burden, causing skeletal problems like bowlegs and flat feet. It hinders intellectual development, leading to cognitive delays and memory impairment. Zhang Yingxiu et al. show adolescent obesity predisposes to cardiovascular and metabolic diseases, with health risks persisting into adulthood. Chest and abdominal fat accumulation restricts cardiac diastole and pulmonary expansion, reducing exercise tolerance. Premature obesity may trigger precocious puberty in girls or delay sexual characteristic development in boys; without intervention, these severely compromise physical health.

4.2 Psychological harm

Developmentally, childhood and adolescent obesity may damage self-esteem: obese youth may experience low self-esteem and depression due to body shape differences from peers, developing negative appearance evaluations that undermine confidence, motivation, learning, and social interactions. Socially, they face dual exclusion: overt exclusion (bullying rates 3.7×higher than normal-weight groups) and covert avoidance (41.2% marginalized in physical education classes) . Lack of social support intensifies psychological stress and loneliness. Notably, obese adolescents enduring weight-related teasing/bullying show higher self-harm and suicide rates than normal-weight peers; prolonged psychological burdens harm healthy development.

5 Effects of different exercise interventions on obese children and adolescents

Lack of physical activity and long-time sitting are main risk factors for obesity in children and adolescents. Exercise interventions can have positive effects on physiological metabolic indicators and mental health. It is worth noting that Stoner et al.'s randomized controlled trial showed structured programs can improve body composition and help optimize glucose-lipid metabolism in the overweight or obese youth because the metabolic pathway is changed through exercise. In fact, regular activity can reduce depressive and anxiety symptoms. It can also improve self-efficacy based on evidence-based research. Current core interventions include aerobic exercise, resistance training, combined modalities and other programs. We discuss these methods.

5.1 Aerobic exercise intervention

Yu Sumei found that aerobic endurance training can help weight loss. It works through endocrine metabolism regulation. This process can reverse the decline of insulin receptor binding rate on muscle cell membrane and it creates negative energy balance. Liang Laiqiang reported that after 12-week full exercise, body fat is reduced and lean mass is increased in the 20 obese youth, and their cardiorespiratory function can be enhanced. Although there are benefits, training fatigue can cause exercise aversion. It affects adherence. Also, prolonged high-intensity lower-body land-based exercise may increase injury risks. So form and intensity should be controlled carefully. Chen Naitao demonstrated that aquatic training can improve body morphology. It also helps strength and endurance. This training has high acceptance and low injury risks. Fun activities like rope-jumping combined with taekwondo can aid adherence and reduce body fat. They improve cardiovascular function and they can break the "obesity-reluctance to move" cycle. Aerobic exercise also benefits mental health. In fact, studies show it can alleviate depressive symptoms. Also, Wang Zhengzhen et al. conducted a 5-week intervention with 32 overweight/obese youth. Weight and fat mass are reduced. BMI is also reduced and muscle mass remains unchanged. To sum up, aerobic exercise can improve body composition and cardiopulmonary fitness in obese children/adolescents. Mental health is also improved. But muscle strength remains unchanged.

5.2 Resistance Exercise Intervention

Resistance training means using one's own strength to overcome external resistance. The short-term effect on the body composition is limited for obese children and adolescents, but resistance training can enhance strength, and prolonged interventions are expected to yield substantial improvements. Liang Jinyu et al. found that eight-week resistance training reduced BMI and body fat percentage in obese adolescents, and serum leptin was also reduced. At the same time, muscle mass increased and lipid metabolism was improved. Shang Wenjin reported that aquatic resistance training improved lipid metabolism and body composition in obese middle school students after eight weeks. Also, serum Irisin levels were improved. This can be an effective intervention for youth with resource access to manage weight and lipid metabolism. Han Ertao pointed out that resistance training can match the efficacy of other methods. It also has added benefits: it can enhance muscle strength and bone density, reduce injury risk, and improve psychological well-being. Strength improvement can help obese adolescents perform basic physical activities. Also, confidence and mental health can be improved. In fact, based on growth patterns, strength training is not suggested to start too early. Excessive load and frequency, or long duration, can impair lower limb development and accelerate bone formation, and height potential can be suppressed. So, programs should be individualized and we can use resistance or light loads to develop the muscle strength.

5.3 Aerobic exercise combined with resistance training as an intervention

Combined aerobic-resistance training can be a good choice for body composition in the overweight children and adolescents. One 12-week online study on simple obese youth shows combined regimens can enhance physiological functions and fitness indicators, and it can outperform aerobic training alone in boosting muscle strength, which means this method should be considered as a better option for clinical practice when we want to improve the physical condition of obese youth. We can see that aerobic plus resistance training can improve anthropometric measurements and metabolic profiles better than aerobic-only interventions. Kelley GA et al. found both aerobic and combined training can improve obesity outcomes and health metrics. About the mechanism, aerobic exercise reduces plasma insulin and stimulates glucagon, and it affects catecholamines and adrenaline while enhancing fat hydrolysis enzymes. Resistance training reduces body fat via musculoskeletal activation and increased lean mass, and it elevates resting metabolic rate. Their integration can create synergistic effects on energy expenditure and metabolism, and this helps optimize weight loss and BMI reduction, so we can say that combined training is more useful than single mode exercise in principle when the goal is to reduce body weight. But exercise-induced energy balance changes may cause compensatory food intake, so dietary control is essential. In fact, Liu Xiaofang et al. studied 122 simple obese youth and found nutritional therapy combined with exercise can be more effective for weight control than exercise alone. Chen Lingjiao found exercise-diet combination can regulate lipid metabolism, and it controls inflammation while reducing oxidative stress. So aerobic-resistance training can be more efficacious than single-mode interventions. Exercise-nutrition combinations can give the best outcomes.

5.4 The effect of exercise intervention on mental health of obese children and adolescents

We examine how physical activity can improve psychological states through two ways. One way is enhancing body self-esteem and regulating emotional valence, which means positive and negative emotions can be balanced through regular movement and this mechanism is important for mental health in daily life. Also, systematic sports engagement can promote neurotransmitter secretion (e.g., endorphins), alleviating anxiety and depressive symptoms, and it can intervene in depression. The secretion of these chemicals in brain can help reduce negative feelings. This process is expected to be important for patients with mood disorders because it can change the chemical balance without using drugs and this is why exercise is recommended by doctors in many countries. In fact, regular exercise can enhance body image cognition, and this is expected to improve self-acceptance in obese adolescents because they can feel better about their body shape when they see improvements from training and this changes their attitude. Next, sports environment interactions can strengthen social support networks. Team sports and group training create social scenarios, and they can enhance group belonging and adaptability through role division and goal coordination, which means people can learn how to work with others and this is good for mental health. Also, regular exercise can reshape self-perception, and it should alleviate social withdrawal particularly because when people feel better about themselves they are more willing to participate in social activities and communicate with others without feeling nervous. We find that overcoming physical challenges can boost confidence. It also can regulate stress responses and improve emotional management, forming a cycle that includes skill enhancement, emotional stability and social improvement, and this happens because brain social perception function is enhanced through regular training. Also, psychological resilience can transfer to learning and daily stress. Different exercise modalities can activate neuroplasticity mechanisms (e.g., brain-derived neurotrophic factors). This can reduce amygdala negative emotion arousal so that the brain can handle stress better and maintain emotional stability in challenging situations that might otherwise cause anxiety and depression in daily life, and this biological mechanism is important for understanding how exercise works. Structured regimens with regularity and goal orientation can alleviate depressive symptoms. In control group studies, the results show that when exercise has clear structure and goals, the depressive symptoms can be reduced and this finding is supported by both behavioral observations and brain imaging evidence from laboratory experiments.

Exercise intervention can reduce obesity through physiological metabolic pathways. We should note that the psychological mechanisms can play the key role here, including emotional regulation and social support together with cognitive reconstruction, and this combination can form a full effect that is expected to bring positive impacts to mental health of children and adolescents.

6 Conclusion

(1) Aerobic exercise can reduce body fat and improve the metabolic indicators. Resistance exercise can enhance muscle mass and bone density. In fact, when we combine these two methods together as a full training protocol, the combined training can reduce body fat percentage and improve metabolic indicators, and it is expected to boost muscle mass and bone density at the same time, so in principle this approach should provide more full benefits.

(2) Exercise alleviates anxiety, depression, and social avoidance in obese adolescents by regulating neurotransmitter secretion and enhancing social interaction; the team-based combined exercise model shows more obvious psychological improvement effects.

(3) Key intervention limitations include family nutritional cognitive deviations, insufficient community sports resources, and puberty development differences.

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