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An overview of various benefits of exercises other than weight control in obese adolescents

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Abstract. Obesity, with its increasing prevalence in adolescents, needs to be addressed with greater attention. As an effective measure to alleviate metabolic symptoms, physical activity and exercise have been widely studied in various studies, including different kinds of exercises. To study the benefits of exercise in various ways on obese adolescents, this literature review summarizes and discusses a few journals that test the effects of various exercises with the elimination of diet interventions. With the use of search engines like EBSCO, PubMed, Lancent, etc., several related research articles were selected with the key words "adolescent obesity", "physical activity", and "exercise". In conclusion, though there is still uncertainty about the minimum effective amount and specific types of exercise that are most beneficial, as well as the underlying mechanisms, research shows exercise is beneficial for overweight youth, though limitations in sample diversity may limit the validity of some studies. Future research should continue to explore effective exercise training for obese adolescents.

Keywords: adolescent, obesity, exercise, HIIT, physical activity benefits.

1. Introduction

Obesity, being associated with the increasing prevalence of various chronic health problems, manifests as a primary health issue. Over 1 billion individuals are fat worldwide, including 340 million youths. This result is shown in the 2022 report of the World Health Organization [1]. 19.7% of adolescents are affected by obesity in 2017 – 2020, with increasing prevalence among certain populations [2]. 41.9% of US citizens had obesity in 2017 – 2020 [3]. The medical cost of obesity was around $173 billion in 2019, and that for adults with obesity was $1861 more than that for healthily weighted people. Therefore, tackling obesity elicits both clinical and economic implications in the United States [4].

Counteracting such national pandemics, obesity, physical activity, any movement that expenses calories, is considered as an effective method. Sports training is a subcategory of sports activities. It refers to "planned, structured, and repetitive activities". Of course, it aims to improve physical fitness and health [5]." As obesity results from the overbalanced energy intake rather than energy expense, exercise training is widely used to ameliorate metabolic health in people with obesity: a most adjustable factor in behavioral modification that increases caloric output with increasing physical activity.

To treat obesity, effective weight loss continues to be the focus. However, the current obesity rate is still high, and ignoring the various benefits of physical activity leads to insufficient comprehensive control of energy input and output. Thus, it's crucial to investigate the benefits of physical activity

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independent of weight loss, for complementing physical and mental health for obese people. To study exercise would demonstrate what kinds of positive effect on obese adolescents and young adults' health, several academic journals were summarized and discussed.

2. Method

To discuss the various benefits of exercise in treating obesity, the search engine Google Scholar, PubMed, The Lancet, and EBSCO were primarily used to generate relative studies regarding the benefits of exercise for overweight youth (BMI > 25 kg/m^2 or greater than the 85th percentile, 10-20 years of age). The following terms were included when searching databases: obesity, exercise, physical activity, and adolescent obesity.

The criteria included articles that were peer reviewed academic journals, originally in English, published between 2017 and 2022, and that all participants were adults with average BMI > 30 kg/m^2. Since the obese BMI range is classified by the CDC, the selected studies excluded those participants are overweight (with the BMI < 30 kg/m^2) to maintain the consistency of the literature review. The research studies in the past five years are believed to show trends of study interests recently, with more up-to-date analysis technique. Studies that included dietary change or supplements intervention were excluded. For defining terms like physical activities and exercise, past journals before 2017 were taken into consideration. There were 89,234 academic journals in total on NYU Library EBSCO Discovery, and the studies were selected from the first three pages for most relativity. This literature review aims at compiling exercise's multidisciplinary effects on obese adolescents and young adults' comorbidity. Also, the commonalities of study research methods among these research were studied.

3. Results

Bagherniya et al., aiming at studying a school-based physical activity intervention's effectiveness while applying the theory of social cognitive, conducted a seven-month randomized controlled trial that included 172 girl students (from 12 to 16 years of age) categorized as either overweight or obese (BMI values are equal to or greater than 85thpercentile) who completed the study. In this trial, students from central Iran were separated into the intervention group (87 students) and the control group (85 students). The intervention group received school-based interventions. These interventions include sports workshops, regular private consultations, free practical and enjoyable exercise courses, free practical and competitive sports courses, etc. In contrast, the control group students received three physical education classes, while their parents and teachers were given one handout regarding the benefits of physical activities, in addition to 10 tickets to the nearest gym, which aims to provide control group benefits as well, in accordance with the social study ethical standards. Weight, height, and waist circumference were used as primary outcome measures, while psychological factors like self-efficacy, social support, outcome expectations, intention, and perceived barriers were used as secondary outcome measures. These measurements were taken using the valid and reliable SCT questionnaire. At the end, for the intervention group, the average BMI decreases 0.7 kg/m^2 from baseline 29.2 kg/m^2. The hours of sedentary behaviors changed from 3.2 to 2.8. Physical activity self-efficacy average value increased from 13.5 to 20.7. Physical activity intention mean value increased from 1.6 to 2.9. Perceived barriers decreased 6.5 from baseline of 25.1. Physical activity, social support, result expectations, and expectancies did not change significantly, though [4].

This experiment that S. Lee et al. conducted aims to compare the effectiveness of aerobic exercise, resistance training, or a combination of both. The study enrolled 118 overweight or obese adolescents with BMI greater than 85th percentile from 12-17 years old, who have a sedentary lifestyle. All of the participants recruited from the Children's Hospital of Pittsburgh were randomly divided into three groups for a period of 24 weeks: 38 were assigned to aerobic exercise (AE), 40 to resistance exercise (RE), and 40 to a combination of AE and RE. To guarantee the negative energy balance is solely from exercise intervention, nutrition counseling sessions were conducted for participants to choose proper food that meets the baseline calorie target. For the intervention, participants were suggested attending 60-minute sessions in a small group of 1-2 participants 3 times per week for 6 months. Total fat, fat-free

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mass, body weight, waist circumference were measured using appropriate equipment respectively. After the study, 85 of 118 participants accomplished the program. The baseline information for each group did not significantly differ from one another. For the primary outcome, though insulin-stimulated glucose disposal of all groups increased hugely, not different from the combined group, Rd improvement in AE group was greater than in the RE group. All groups had a great reduction in 2-hour glucose test, notwithstanding the fasting glucose level for all groups did not alter. For secondary outcomes, only the AE group showed significant reductions in BMI (-1.4 ± 0.1 kg/m^2) and waist circumference (-3.2 ± 0.2 cm). The weight change in the AE group was greater than that in the combination group [6].

Following their first randomized controlled trial, Lee et.al conducted a secondary study to further explore exercise modality on regional body fat and CVD markers. Posters in Pittsburgh were used to enlist 118 adolescents (12–17 years old) who were overweight (the body mass index (BMI)≥85th percentile and <40 kg/m^2; N = 118). Three times a week for 60 minutes, participants in the aerobic group were required to participate in exercise training sessions. Aerobic exercise, progressive in duration and intensity, includes treadmills and/or ellipticals. There is a 1-2 minute break between the two groups. Resistance training includes two groups. Each group repeats 12-15 times. A total of 8 full body resistance exercises. In the combined group, participants were asked to do a 30-minute treadmill and/or elliptical, and 1 set of resistance exercise. At the end of the study, 118 eligible individuals participated in the intervention, while 30 of 38, 28 of 40, and 27 of 40 participants from aerobic, resistance, and combined groups respectively completed the study. Exercise training and cardiovascular disease risk markers did not differ significantly from one another. Only the aerobic group showed a statistically significant reduction in both local and total subcutaneous adipose tissue (SAT). The results revealed that the changes in the aerobic group were substantially bigger than those in the combination group for the lower body SAT ($p=0.02$). In contrast, significant body weight reductions were observed in all groups ($p < 0.05$) [7].

In order to determine the effects of 12 weeks of high intensity interval training (HIIT) and equal intensity continuous training (MICT) on the decrease of abdominal visceral fat in overweight young women (18-22 years old, BMI 25) (kg/m^2), Zhang H et al. conducted the experiment. The percentage of body fat measured by double X-ray absorption method (DEXA) is greater than 30%. In the study, 52 female university students signed up and 47 enrolled. 15 students served as controls with no training, and 16 each were randomly assigned into HIIT and MICT groups, each receiving identical amounts of training. Every participant's diet was recorded from 3 weeks before the training began and during the 12-week training period. A CT scanner was used to measure the visceral and subcutaneous fat areas of the abdomen. 43 of 47 participants finished the training program, for which 15 of 16 individuals from MICT and HIIT groups, and 13 of 15 from the control group. The reduction in body mass (HIIT Group Before 67.3 ± 6.1, after 64.0 ± 6.0; MICT Group Before 68.5 ± 8.0, after 65.1 ± 7.7 $p < 0.01$) and body fat percentage (HIIT before 38.1 ± 2.3 after 35.6 ± 2.0; MICT before 38.0 ± 2.1, after 35.6 ± 2.3, $p < 0.01$) was observed (Figure 1). Decrease in total and regional body fat was also observed ($p < 0.05$). Overall and local body fat also decreased. This reduction is reflected in the number ($p<0.05$). AVFA showed a decrease in abdominal visceral fat in both groups ($p<0.05$), although compared to the control group. Also, participants in both groups showed an increased aerobic fitness after the 12-week training. Both types of exercise showed effective reduction in body fat mass, regional body fat mass, and abdominal visceral fat. However, the results showed no significant difference between MICT and HIIT in reducing body fat. Such results revealed the efficacy of exercise in reducing whole and regional body fat [8].

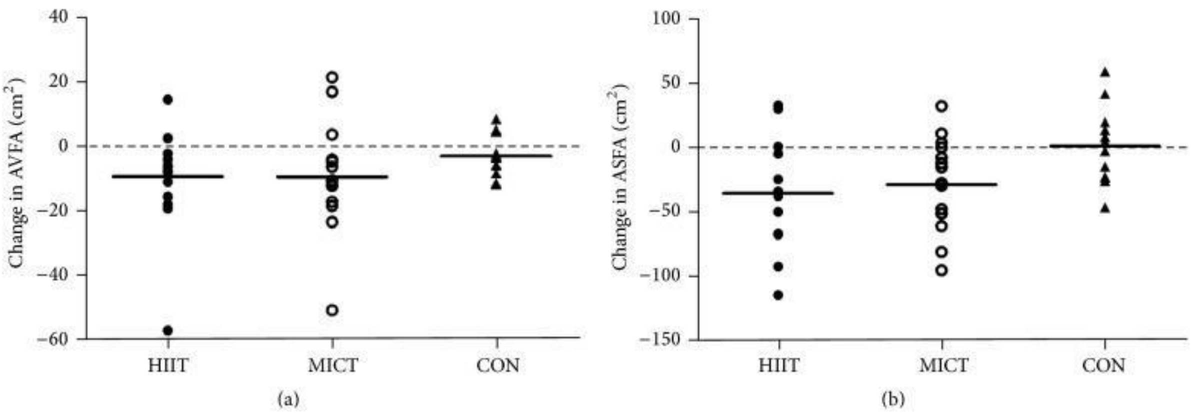

Figure 1. Changes in (a) abdominal visceral fat area (AVFA) and (b) abdominal subcutaneous fat area (ASFA) of participants post intervention in HIIT, MICT, and CON groups [7].

A randomized controlled experiment was carried out by Zhang L et al. The goal of this study is to determine how high-intensity intermittent exercise (HIIE) and high-intensity continuous exercise (HICE) affect inhibitory function in overweight children. The obese children selected here are 10-14 years old, with a BMI equal to or greater than $25kg/m^2$. The level of inhibitory function is measured right before and after the intervention by the Stroop test, a.k.a Color Naming Task, often used to assess not only cognitive function but also inhibit habitual responses. The HIIE group was asked to do a 30-min treadmill session. The HICE group was asked to complete 30-min 80-85% maximal heart rate rope skipping exercise. The control group was asked to watch a designated cartoon for 30 minutes. The results found were compared. The results showed significant differences between the HIIE group (1.69 ± 0.21 seconds) and the CON group (0.43 ± 0.21 seconds) and between the HICE group (1.85 ± 0.21 seconds) and the CON group. In contrast, there was no significant difference between the HIIE and HICE groups (p = 1.00). Strengths include the relatively large sample size with both genders and pathbreaking to test relationship between inhibition function and exercise. Limitations include the single method to test executive cognition and inhibitory function, and lack of documenting heart rate during the intervention. Future studies could research the mechanism between acute HIIE and cognitive functions [9].

As previous studies showed the time-efficient property of circuit resistance training (CRT), and higher metabolic rate than traditional resistance training (or a combined one with aerobic training), Rasooli et al. recruited 40 adolescent boys aged 14-17 years with BMI >= 95%, to study the effect of CRT on levels of improvement in insulin resistance (IR) related metabolites. Control and CRT-intervention groups, each with 20 participants, were randomly assigned to the participants. The intervention group received CRT for 8 weeks, and were asked to avoid exercise outside the study and maintain their usual diet to prevent confounding effects. To be more specific, the CRT program includes briefing sessions, introducing the 1-repetition maximum protocol and various exercise devices. The protocol involves low-moderate intensity activities and warm-up repetitions. After that, participants were asked to perform 10-12 rounds of lifting with an elevated intensity. The results were collected via plasma and urine sample, as well as statistical analysis. In the end, the training group (n=16) showed decreases in post-intervention data of serum profile: glucose, insulin, total testosterone, etc. Also, anthropometric characteristics showed decrease in general, except fat-free mass entailed an increase [10].

4. Discussion

Overall, the studies chosen for this literature review have varied in intervention time from a one-time test up to 30 minutes to a long-term intervention of 10 to 18 weeks. All studies exclusively studied the effect of various exercise training session with control in participants' regular diet. Though varied in actual effects, after intervention, participants from the experimental group manifested positive effects in reducing anthropometric data, metabolites associated with the metabolic syndrome from blood or urine tests, and improving psychological factors like self-esteem and inhibitory functions.

Notwithstanding, advantages and disadvantages entailed by the study designs should also be recognized for more comprehensive study designs in the future. For example, strengths of the study by M. Bagherniya et al. includes special activity programs for students, parents, and teachers at school base. Limitations include: 1. Subjectiveness of self-reported questionnaire; 2. Un-matched randomization between two groups due to the random sampling method used only for selecting eligible schools. Strengths include using gold-standard MRI to measure body composition and fat distribution. Limitations include that the results cannot be generalized to public adolescents due to varied accessibility to exercise trainers and fitness centers. Also, results in other ethnic groups are unknown. Moreover, strengths of the study of S. Lee et al. enclose randomized study design, great adherence to exercise regimen (90%), direct supervision and monitoring. Limitations include the relative lack of certain ethnic group participants like Asian youth, no non-exercising control group, 64% of participants were female, and possibility of non-generalizable results.

5. Conclusion

Presently, research shows benefits of exercise, both aerobic and resistance training, in a myriad of fields, from mental development to body composition and alleviation of comorbidity, including body composition, metabolic syndrome related metabolites level, insulin resistance, and so forth. However, specific limits like the minimal effective amount of exercise and specific types of exercise that are more efficient have yet to be defined, neither the mechanisms between exercise nor benefited organisms. In short, exercise is beneficial to health of overweight youth. For now, some of the research has limited inclusion of sample variety in gender, ethnic group, region, etc., which may hinder their validity for a larger population. Future researchers may continue the path in exploring more effective exercise training that could positively affect obese adolescents. Admittedly, this literature review has its limitations in comprehensiveness with a few number of articles reviewed. However, it would be helpful in setting future research areas by summarizing existing research and their methods.

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