THE EFFECTS OF 12 WEEKS BASIC GYMNASTICS EXERCISES ON BODY COMPOSITION AND LIPID PROFILES IN OBESE CHILDREN

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Abstract

Obesity is a major health concern in the world because it is associated with many diseases. It has been shown that basic gymnastics exercises effectively prevent and treat this problem. Therefore, the present study investigated the effect of 12 weeks of basic gymnastics exercises on body composition and lipid profile in obese girls. In this quasi-experimental study, with a design pre-test-post-test and a control group, 30 obese girls with Body Mass Index (BMI) at or above the 95th percentile and the average age of 9.4 years, were selected purposefully and were divided into 2 groups (Basic gymnastics training, and control) randomly. The training protocol was implemented for 12 weeks, three times a week, and 45 minutes for each session incrementally. Body composition and lipid profile indices were measured in two stages: pre-test and post-test. In order to analyze the data, multivariate covariance tests were used.

The results of the study showed that the exercise intervention significantly reduced the fat percentage and BMI index in obese children ($p \leq 0.001$). In addition, a significant decrease in total cholesterol, triglyceride, and Low Density Lipoprotein Cholesterol (LDL-C) and a significant increase in High Density Lipoprotein Cholesterol (HDL-C) were observed ($p \leq 0.002$). These findings indicate the beneficial effects of basic gymnastics training on body composition and lipid profile in obese children. Therefore, the use of basic gymnastics training is recommended to improve these factors.

Keywords: *Body composition, Basic gymnastics Training, Lipid profile, Obese girls.*

INTRODUCTION

Obesity and overweight in childhood is one of the most important public health problems worldwide. It is estimated that over 330 million children aged 5-19 years suffer from severe malnutrition (Yamamoto, 2021). According to the Center for Disease Control and Prevention (CDC), 4 out of 10 Americans are currently obese. Additionally, the World Obesity Federation predicts that by 2030, one in five women and one in seven men will be obese (Memelink et al., 2023). Specifically, 12.7 % of children aged 2 to 5 years, 20.7 % of those aged 6 to 11 years, and 22.2 % of adolescents aged 12 to 19 years in the United States are obese. Worldwide, more than 340 million children and adolescents between the ages of 5 to 19 years, and 39 million children under 5 years old, are considered obese (Sanyaolu et al., 2019).

In Iran, a meta-analysis conducted from January 2000 to January 2021 examined 2,637,912 children and adolescents aged 2 to 15 years. The overall prevalence of obesity in this group was found to be 11.4% (95% confidence interval: 9.4-13.7%) (Akbari and Mohammadi, 2022). The rising rates of childhood obesity are accompanied by an increase in non-communicable chronic diseases at younger ages, including dyslipidemia, hypertension, nonalcoholic fatty liver disease, obstructive sleep apnea, type 2 diabetes, certain cancers, heart disease, and psychosocial disorders (Leung et al., 2024). According to the World Health Organization (WHO), obesity contributes to four million deaths annually (Jebeile et al., 2022).

Childhood and adolescent obesity have detrimental effects on metabolism that can significantly reduce a person's lifespan. The increase in childhood obesity is driven by various factors, including genetics, hormonal imbalances, metabolic issues, behavioral and nutritional factors, and, ultimately, an imbalance between energy intake and expenditure, coupled with a reduction in physical activity (Walls et al., 2009). The development and persistence of obesity are largely influenced by a biosocial framework, where biological predispositions interact with socioeconomic and environmental factors to promote adipose tissue proliferation and obesity. First-line therapeutic approaches often involve family-based interventions aimed at promoting effective behavioral changes in diet, physical activity, avoidance of sedentary behaviors, and improvement in sleep quality.

However, there is emerging evidence supporting more intensive interventions, such as nutritional supplementation, pharmacotherapy, and metabolic surgery, as adjunctive therapies. Unfortunately, access to these treatments remains limited in many communities (Jebeile et al., 2022).

It is crucial to treat childhood obesity early to manage it before complications arise. Diet modification, exercise therapy, behavior modification, and preventive activities are the foundational principles of treatment. However, children with obesity have limited access to effective treatments compared to adults, as drug therapy and other treatment studies often do not include children.

Moreover, families and medical providers are frequently hesitant to implement these interventions in children due to potential risks or side effects associated with drug and medical treatments (Leung et al., 2024). Given this, it appears that the first line of prevention and treatment for overweight and obesity should be the implementation of physical and sports activities.

Total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), and triglycerides (TG) are among the most critical components of blood lipids related to health. Numerous studies have shown that exercise training interventions reduce body fat and improve lipid profiles, thereby lowering the risk of cardiovascular diseases (Soci et al., 2017). Additionally, aerobic physical activity has been shown to reduce levels of TC and LDL-C (Virani et al., 2021).

One of the dynamic and highly engaging sports that can positively affect body composition and lipid profiles is gymnastics. This sport comprises movements that require cardiorespiratory endurance, flexibility, muscle strength, agility, explosive power, muscular endurance, and body coordination (Lemes et al., 2018). Consequently, gymnastics can be an effective means of improving blood lipoprotein levels. Anwar et al. (2023) reported that gymnastics reduces BMI and increases physical fitness in obese children. Additionally, it has been observed that 6 months of mini-trampoline and treadmill training significantly impact weight loss in obese children (Mashaal et al., 2018). In another study, Shakib et al. (2023) reported a significant decrease in miR-128-1 (a microRNA gene associated with various physiological processes), HDL-C, LDL-C, TG, and cholesterol indices following a combined aerobic and strength training regimen in obese subjects. However, the full extent of this training's effectiveness on physiological indicators remains undetermined. Moreover, most exercise programs aimed at reducing weight and improving body composition and lipid profiles in overweight and obese children have primarily focused on aerobic exercises (Pippi et al., 2022). However, incorporating combined exercises like gymnastics could also prove beneficial. Given the significance of childhood obesity and the limited studies on basic gymnastics training in obese children, this study aims to determine whether basic gymnastics training effectively improves body composition and lipid profiles in obese girls.

METHODS

Participants: The study focused on obese female children aged 7 to 11 years in Isfahan, Iran, with a BMI at or above the 95th percentile. These participants were all in a preadolescent stage and enrolled in primary school, where they participated in a standardized physical education (PE) course (one session per week for 60 minutes). Subjects were carefully selected from those who did not engage in regular sports activities outside of their PE courses at school. A total of 30 participants were purposefully chosen and then randomly divided into two groups: a Training Group (TG, n=15) and a Control Group (CG, n=15).

Based on calculations using G* Power software (version 3.1.9.2), the minimum sample size required was determined to be 24 participants (12 in each group), with an alpha level of 5%, a beta level of 80%, and an effect size of 0.30. However, to account for potential dropout during various stages of the research, 15 participants were assigned to each group.

Procedure: This research is a semi-experimental, applied study conducted using a pre-test-post-test design with a control group. The inclusion criteria were specific to obese female children aged 7 to 11 years, with a BMI at or above the 95th percentile. Participants were required to have no prior engagement in weight loss exercises within the past year, not be taking any drugs or supplements, and to be free of tobacco use. Additionally, they should have no history of illnesses or infections affecting immune factors, no acute lower limb injuries within the last six months, and no pain in the trunk or lower limbs.

The exclusion criteria included missing two consecutive practice sessions, failure to cooperate adequately with the intervention, and the occurrence of injuries. One week prior to the start of the training protocol, all participants were thoroughly informed about the program, its benefits, potential risks, and the correct methods for performing basic gymnastics exercises. They were also instructed to refrain from following any diet plans or engaging in physical activities outside the research exercise program during the study.

Additionally, participants were assured that their personal information would remain confidential with the researchers. They were also given the option to withdraw from the study at any stage if they chose not to continue. All participants received the necessary forms to voluntarily and consciously declare their readiness to participate in the study. Following this, the participants were divided into two groups: Basic Gymnastic Exercises and Control. All research procedures were approved by the University's Ethics Committee, with the ethics ID IR.IAU.KHSH.REC.1402.093.

The training protocol was implemented over 12 weeks, with three sessions per week, in addition to the regular PE course. During this period, the Control group maintained their usual daily routines and continued with the PE course. Body composition and lipid profiles were measured in two phases: pre-test and post-test. All applications and tests were conducted at the Takhti Isfahan Gymnastics Hall.

Measurement method: The method of measuring height, weight and body mass index (BMI): To measure height, a German caliper, SECA model 210, with an accuracy of 3 mm was used. The subject stood barefoot with their back against a height measuring tape that was attached to the wall. The subject's body weight was evenly distributed on both legs, with their head, torso, and legs aligned. The back of the legs, hips, and head touched the wall. A ruler was then placed on the subject's head to measure height, which was recorded in centimeters while the subject exhaled.

A digital scale, KEEP FIT model 6657, made in China, was used to measure weight. Subjects stood on the scale wearing light clothing and no shoes, ensuring their weight was evenly distributed on both feet. Body weight was recorded with an accuracy of 0.1 kg. BMI was then calculated using the formula BMI = weight (kg) / [height (m)]^2 based on the height and weight measurements.

Fat% measurement method: Fat percentage (Fat%) was measured using a 10gms/mm^2 Lafayette caliper (Lafayette Inc., USA) by employing the two-point measurement method and applying Slaughter's (1988) equation [(All F: Fat (%) = 1.33 (triceps + subscapular) – 0.013 (triceps + subscapular)^2 – 2.5)] (Rodríguez et al., 2005).

Blood sampling method: To evaluate the biochemical variables, blood samples from the subjects were collected in two phases: pre-test and post-test. In the pre-test phase, one day before the start of the exercise program and after 12 hours of fasting, a blood sample was drawn from the anticubital vein of the left arm while the subject was seated. The sample, with a volume of 10 ml, was collected between 8 and 10 am by a laboratory technician. In the post-test phase, to prevent the acute effects of exercise on the studied variables, blood was drawn 24 hours after the final exercise session, following the same procedure as in the pre-test. The post-test blood sample was also collected after 12 hours of fasting, between 8 and 10 am.

Lipid profile measurement method: Fasting TC, HDL-C, LDL-C and TG were measured by enzymatic colorimetric method using Roche Diagnostics D2400 kit (Basel, Switzerland) (Paoli et al., 2013).

Exercise protocol: The training protocol was implemented over 12 weeks, consisting of 3 sessions per week, each lasting 45 minutes. Each session began with a warm-up of approximately 15 minutes, which included walking, stretching, rolling, and jogging. The main part of the exercise program was divided into three components: displacement, rotation, and balance. These components were organized according to the difficulty of the equipment and the principle of overload (Garcia et al., 2011) (see Table 1). The program concluded with a 10-minute cool-down that involved stretching and light movements. All exercises were performed under the supervision of a trainer to ensure correct execution of the movements.

The intensity of the exercises was monitored using the Karvonen equation to target 50 to 75% of the heart rate reserve: [Target Heart Rate = [(maxHR − restingHR) × %Intensity] + restingHR]. Exercise intensity was measured with a Polar beat meter (CE 0537, N2965, Polar beat T31, made in Finland). Adjustments to the intensity were made as necessary, with eedback provided to the subjects to ensure they remained within the target range.

To analyze the data, descriptive statistics were employed to calculate central tendencies and dispersion indices, with results reported as mean and standard deviation. The Shapiro-Wilk test was used to assess the normality of the data, and Levene's test was utilized to evaluate the equality of variances ($p \geq 0.05$). To test for significant differences in the means between groups (pre-test and post-test), multivariate analysis of covariance (MANCOVA) was conducted using SPSS version 26, with a significance level set at 0.05.

Table1
Basic gymnastics training program

Practical content	Performance	Time/Repetition	week
Warm-up	walking, stretching, rolling, mild running and jogging	15 minutes	1-12
Front balance	right foot, left foot	10-15 second/3R	1-12
Side balance	right foot, left foot	10-15 second/3R	1-12
Arabesque balance	right foot, left foot	10-15 second/3R	1-12
Walking on the line	walking forward, backward and sideways - walking on the toes	10 minutes	1-6
Walking on the balance beam	walking forward, walking on the toes	5 minutes	6-12
Cradle movement	folded leg cradle, one leg cradle, split cradle, straight leg cradle	10 R	1-6
Form of walking	hop,bear walk, jow walk, crab walk, bunny hopping	10-15 minutes	1-6
Jumping	Jump forward, jump sideways, jump backwards	2-3 time/medium distance	6-12
Forward roll	roll tuck, roll feet apart, roll feet split	10 R	6-12
Cool down	stretching, light movements, sit and reach	10 minutes	1-12

R: Repition

RESULTS

The average and standard deviation of the subjects' age, height, weight, BMI and fat % are presented in Table 2. There are no differences in age, height, weight, BMI, Fat%, Cholesterol, TG, LDL-C and HDL-C between the two groups (p > 0.05).

Table 3 indicates that after applying basic gymnastics exercises, body mass index (BMI) and fat percentage decreased significantly in the training group (P=0.001). Table 4 shows that after the implementation of the intervention in the training group, the amount of CT, TC, and LDL-C decreased and the HDL-C values increased significantly (P=0.001).

Table 2
Characteristics of Research Subject

Variable	Training group (n = 15)	Control group (n = 15)	*p*-Value
Age (year)	9.2 ± 0.52	9.6 ± 0.41	0.682
High (cm)	144.42±5.98	145.13±2.4	0.48
Weight (kg)	63.10±3.82	63.290±5.56	0.669
BMI (kg/m²)	30.34±1.92	30.05±2.34	0.712
Fat %	30.48±9.3	31.2±2.37	0.265
Cholesterol (Mg/dl)	172.45±15.31	174.79±3.56	0.348
TG (Mg/dl)	115.16±2.84	108.99±2.74	0.421
LDL-C (Mg/dl)	105.20±1.73	104.2±3.12	0.282
HDL-C (Mg/dl)	44.3±2.17	43.82±9.5	0.164

Values are reported as mean±SD; BMI: body mass index; **Fat%**: fat percentage; **TG**: Triglycerides; **LDL-C**: low-density lipoprotein cholesterol; **HDL-C**: high-density lipoprotein cholesterol.

Table3
Comparison of of BMI and Fat % for training and control groups between pre and post test in obese children.

Variable	Groups	Pre-Test	Post-Test	*P*-value	F	*P*-value (Beetwen grops)
(Kg/m^2) BMI	Training group	30.34±1.92	28.76 ±1.12	ʎ0.001	26.96	0.001*
	Control group	30.05±2.34	29.54±2.01	0.39		
Fat%	Training group	30.48±9.3	28.16 ±1.17	ʎ0.001	17.99	0.001*
	Control group	31.2±2.37	30.98±2.37	0.27		

ʎ: significant differences from pre-test to post-test; *****: significant difference between two groups. Values are reported as mean±SD; Significant difference at P≤0.05; **F**: statistical value MANCOVA; **BMI**: body mass index; **Fat%**: fat percentage.

Table 4
Comparison of lipid profiles variables for training and control groups between pre- and post-test in obese children.

Variable	Groups	Pre-Test	Post-Test	*P*-value	F	*P*-value (Beetwen groups)
Cholesterol (Mg/dl)	Training group	172.45±15.21	158.25±2.4	ʎ0.001	31.29	0.001*
	Control group	174.79±3.56	172.3±18.6	0.49		
TG (Mg/dl)	Training group	115.16±2.48	106.07±3.1	ʎ0.012	19.39	0.001*
	Control group	108.99±2.74	107.89±19.2	0.61		
LDL-C (Mg/dl)	Training group	105.20±1.73	97.7±3.0	ʎ0.002	32.02	0.001*
	Control group	104.2±3.12	105.01±21.04	0.38		
HDL-C (Mg/dl)	Training group	44.3±2.17	46.9±3.0	ʎ0.001	14.30	0.001*
	Control group	43.82± 9.5	43.01±21.4	0.4		

ʎ: significant differences from pre-test to post-test; *****: significant difference between two groups; Values are reported as mean±SD; Significant difference at P≤0.05; **TG**: Triglycerides; **LDL-C**: low-density lipoprotein cholesterol; **HDL-C**: high-density lipoprotein cholesterol.

DISCUSSION

The present study was conducted with the aim of investigating the effect of 12 weeks of basic gymnastics exercises on body composition and lipid profile in obese children. The results of the study showed that the exercise intervention significantly reduced fat percentage and BMI of obese children (P=0.001). Additionally, a significant decrease in TC, TG and LDL-C, and a significant increase in HDL-C were observed in the basic gymnastics training group (p≤0.002). In line with the results of the present study, Iriyani et al. (2023), in a study investigating the effect of gymnastics on changing the nutritional status and fitness level of overweight and obese adolescents, reported that exercise interventions have an impact on changes in body weight and BMI in this population. Bellicha et al. (2021), in a meta-analysis aimed at summarizing the effects of exercise programs on weight loss, body composition changes, and weight maintenance, showed that exercise leads to significant weight loss, fat reduction, and visceral fat reduction. Similarly, Razavi et al. (2020) observed a significant decrease in BMI in a group focused on physical activity and diet in a study titled "The Effect of Modifying Dietary Habits and Physical Activity (Daily Walk) in the Treatment of Overweight and Obesity in Children." Furthermore, Hajinia et al. (2020), while investigating the effect of a period of interval training (IT) and high-intensity resistance training (HIRT) on lipid profile and body composition in overweight and obese subjects, showed that both weight and body fat percentage decreased significantly in the training groups. These findings were confirmed in a similar study on obese adolescent girls (Hosseini et al., 2014).

To explain these findings, it can be stated that aerobic exercises, such as some basic gymnastics exercises (e.g., walking on the line, walking on the balance beam, cradle movement), increase mitochondrial function, mitochondrial volume, protein turnover, changes in metabolic enzymes of skeletal muscles, the ratio of capillary network to muscle fibers, and insulin sensitivity in obese individuals (Nolan et al., 2009). Additionally, due to the high energy cost and the activation of the AMPK signaling pathway that increases fat oxidation, exercise can reduce body fat percentage (Wedell et al., 2019). Another important mechanism in reducing body fat and BMI following basic gymnastics exercises is the increase in PGC-1α production, which plays a key role in controlling metabolism, increasing fat oxidation, and preventing obesity (Afzalpour et al., 2017). In short, performing basic gymnastics exercises for 12 weeks can, through these mechanisms, impact the utilization of body fat as an energy substrate and ultimately lead to a reduction in body fat, body weight and improve body composition.

Another result of the present study was the reduction of total cholesterol, TG, LDL-C, and the increase in HDL-C levels following the implementation of 12 weeks of basic gymnastics exercises. Previous studies investigating the effect of exercise training on blood lipids have reported conflicting results. Despite this, most published information indicates a close relationship between lipid profile status and physical activity. In agreement with the findings of the present study, Shakib et al. (2023) reported that 12 weeks of simultaneous aerobic and strength training significantly reduced miR-128-1, HDL-C, LDL-C, TG, and cholesterol levels. Similarly, Hajinia et al. (2020) observed weight loss, reductions in body fat percentage, serum TG, and LDL-C levels in overweight and obese subjects following periods of interval training (IT) and high-intensity resistance training (HIRT).

Further supporting these findings, Ramezani et al. (2016) investigated the changes in cardiovascular metabolic risk factors after eight weeks of endurance, resistance, and combination exercises in inactive obese children. Their findings revealed that sports exercises led to decreases in BMI, TC, TG, LDL-C, VLDL, and insulin resistance in the experimental groups. Likewise, Rahmati et al. (2015) examined the changes in serum levels of leptin, insulin, lipid profile, and BMI following a period of speed interval training (SIT) in obese children. The results demonstrated that SIT significantly affected leptin, insulin, and cholesterol levels, improving BMI in these individuals. Souri et al. (2015) also reported that high-intensity training (HIT) exercises likely decrease serum levels of leptin and increase adiponectin in obese children through fat mass reduction.

In this context, Miller et al. (2014) investigated the effect of a short-term, high-intensity circuit training (HICT) program on work capacity, body composition, and blood characteristics in sedentary obese men. Data analysis revealed significant improvements in fat tissue percentage (3.6%), cholesterol (13%), TG (37%), and insulin (18%) levels from before to after the HICT program. Paoli et al. (2013) also showed that high-intensity interval training (HIIT) caused significant decreases in body weight, fat mass, TC, LDL-C, and apolipoprotein B.

Nevertheless, although most studies have reported results consistent with the findings of the present study, there were differences regarding the duration, sample size, population, and exercise interventions used. Various factors, such as differing exercise times, intensities, and durations, can lead to varying results regarding the effect of exercise on lipoprotein levels. However, while the mechanism behind exercise-induced changes in lipoproteins remains unclear, it is likely that exercise increases blood lipid utilization, resulting in decreased lipid levels (Earnest et al., 2013).

The results of numerous studies indicate the beneficial effects of exercise on lipoprotein levels. Physical activity is generally associated with an increase in HDL-C and a decrease in LDL-C and TG. Beyond causing quantitative changes in serum lipids, exercise also positively impacts HDL-C particle growth, composition, and function. It has been reported that regular exercise increases serum HDL-C and apoA-I levels, enhances HDL-C quality and function, and increases total cholesterol content. Furthermore, it boosts antioxidant abilities and reduces TG and oxidized products in LDL-C and HDL-C. As a result, regular exercise with appropriate intensity can endow lipoproteins with more anti-atherogenic properties (Cho et al., 2023).

Aerobic exercise, such as some gymnastic activities, has been proven to affect blood lipid metabolism. By increasing the concentration and activity of lipoprotein lipase (LPL) in skeletal muscles, aerobic exercise boosts HDL-C levels. Moreover, such activities accelerate lipid transport, breakdown, and excretion, reducing fasting or postprandial TG (Shen et al., 2018). In addition to these changes, aerobic physical activity also reduces TC and LDL-C levels (Virani et al., 2021). Similarly, the gymnastics training program in the present study was primarily based on aerobic, strength, and flexibility exercises.

Based on the results of the aforementioned studies, basic gymnastics exercises improve body composition and lipid profile in obese children. Gymnastics is a combination of endurance, flexibility, strength, agility, power and explosive movements. Therefore, this exercise can be an excellent strategy for weight loss and fitness promotion in obese children. It seems that gymnastics exercises promote the oxidation of fats with significant changes in free fatty acids, triglycerides, and lactic acid and can be an important factor in preventing overweight and obesity.

In summary, regular gymnastic training leads to TG consumption by muscle tissue and increases LPL, resulting in more TG hydrolysis. It also improves the efficiency of the PCSK9 enzyme (low-density lipoprotein receptor enzyme), which reduces the absorption of LDL-C and increases its excretion by the liver, and finally, increases the transformation of LXR (liver X receptor) and the expression of ABCA1 (membrane transporter protein) in macrophages and promotes the process of reverse cholesterol transport (RCT) (Wang & Xu, 2017). It is worth mentioning that the subjects studied were obese children who were sitting on the school bench and did not do much physical activity. To create mobility and physical activity for these children, gymnastics is a fun sport that they can follow with interest and enthusiasm and reach an optimal level of physical fitness and fitness.

LIMITATION

This study also had limitations that should be considered when generalizing the results. The research was conducted exclusively on obese female children, so caution is needed when extending the findings to other genders or different populations. Additionally, the sample size was limited to 15 participants per group; a larger sample size and a broader geographical scope would likely enhance the ability to generalize the results to a wider population.

CONCLUSION

The results of the present study showed a significant improvement in body composition and lipid profile after 12 weeks of basic gymnastics training in obese children. Therefore, the implementation of basic gymnastic exercises is recommended to obese children, parents, sports trainers and health centers as a suitable strategy to prevent overweight and obesity.

Disclosure Statement

The authors report no conflict of interest

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