

Effects of a 12-Week Multicomponent Exercise Program on Dyslipidemia and Health-Related Physical Fitness in Children with Obesity

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Article Info	Abstract
Article type: Research Article Article history: Received 31 January 2026 Received in revised form 31 March 2026 Accepted 16 April 2026 Available online 29 June 2026 Keywords: Pediatric Obesity, Exercise, Dyslipidemias, Physical Fitness, Randomized Controlled Trial.	Introduction: Childhood obesity is frequently associated with dyslipidemia and reduced health-related physical fitness (HRPF), increasing cardiometabolic risk early in life. Multicomponent exercise programs may offer a practical and developmentally appropriate strategy to improve lipid profile and HRPF in children. Objective: To investigate the effects of a 12-week supervised multicomponent exercise program on serum lipids and HRPF in children with obesity. Method: In this two-arm parallel-group randomized controlled trial, children with obesity (CDC BMI-for-age ≥ 95th percentile) were randomized to an Exercise Group (12-week multicomponent program; 3 sessions/week; moderate-to-vigorous intensity monitored by heart rate and perceived exertion) or a Control Group (usual activities). Fasting serum lipids (TC, triglycerides, LDL-C, HDL-C) and HRPF (20-m shuttle run/PACER, push-ups, curl-ups, sit-and-reach) were assessed at baseline and post-intervention. Data was analyzed using ANCOVA. Results: Compared with controls, the Exercise Group showed significant improvements in lipid profile, including reductions in LDL-C ($p=0.001$), triglycerides ($p=0.008$), and TC ($p=0.032$), along with an increase in HDL-C ($p=0.004$). HRPF improved significantly in the Exercise Group versus Control, including PACER performance ($p<0.001$), push-ups ($p<0.001$), curl-ups ($p<0.001$), and sit-and-reach flexibility ($p=0.002$). Conclusions: These findings support multicomponent exercise as an effective non-pharmacological approach to reduce cardiometabolic risk and enhance HRPF in this population. Cite this Article: Pouzeh Jadidi, R. (2026). Effects of a 12-Week Multicomponent Exercise Program on Dyslipidemia and Health-Related Physical Fitness in Children with Obesity. <i>Physical Activity in Children</i>, 3(1), 66-72. https://doi.org/10.22034/pach.2026.586912.1093

1. Introduction

Childhood obesity is widely recognized as a major global public health concern and remains one of the most pressing health issues of the twenty-first century (1). Over the past four decades, the prevalence of obesity among children and adolescents has risen dramatically, with recent estimates indicating an approximately tenfold increase worldwide (2). Beyond its increasing prevalence, pediatric obesity represents a multifactorial metabolic disorder with significant short- and long-term health consequences rather than simply an issue of excessive body weight or appearance (3). Among its most common metabolic complications is dyslipidemia, a condition typically characterized by elevated concentrations of total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), and triglycerides, together with reduced levels of high-density lipoprotein cholesterol (HDL-C) (4).

The presence of dyslipidemia during the first decade of life is a significant predictor of premature atherosclerosis and cardiovascular disease (CVD) in adulthood (5). Research indicates that fatty streaks (i.e., the earliest stage of atherosclerosis) can appear in the aorta and coronary arteries of children as young as 10 years old who present with high LDL-C levels (6,7).

Furthermore, children with obesity often exhibit poor health-related physical fitness (HRPF), including diminished cardiorespiratory endurance and muscular strength (8). This “fitness-fatness” relationship creates a vicious cycle: low HRPF levels make physical activity more taxing, leading to further sedentary behavior and worsening metabolic health (9).

Lifestyle modification, specifically regular physical activity, remains the cornerstone of pediatric obesity management (10,11). While the benefits of exercise are well-documented, the optimal “dose” and type of exercise for improving both metabolic markers and HRPF in children remain subjects of ongoing debate. Traditionally, aerobic exercise has been the primary recommendation for lipid management (12). However, recent evidence suggests that multicomponent exercise programs, which integrate aerobic activities, resistance training, and motor skill development, may offer superior benefits (13,14). Such programs are more developmentally appropriate for children, as they mimic the intermittent and varied nature of natural play while targeting multiple physiological systems simultaneously.



From a physiological perspective, regular exercise may improve lipid metabolism through multiple complementary mechanisms, including enhanced skeletal muscle lipoprotein lipase activity, increased utilization of circulating triglycerides as an energy substrate, improved hepatic lipid metabolism, and greater reverse cholesterol transport. Together, these physiological adaptations have the potential to improve lipid metabolism by lowering circulating LDL-C and triglyceride concentrations while increasing HDL-C levels. However, the extent of these beneficial changes is likely to depend on factors such as the mode of exercise, training intensity, and individual participant characteristics (11–14).

Despite the growing interest in multicomponent training, evidence from randomized controlled trials in children with obesity remains limited and somewhat inconsistent, particularly regarding the simultaneous evaluation of blood lipid profile and HRF within a single intervention. Many previous studies have focused primarily on either metabolic outcomes or HRF, have included mixed-weight populations, or have examined isolated exercise modalities rather than comprehensive multicomponent programs (13,15,17). This age range represents a critical “window of opportunity” for intervention before the physiological and hormonal shifts of puberty fully take hold (15,16). Therefore, further randomized studies evaluating supervised multicomponent exercise interventions in children with obesity are warranted to better understand their combined effects on cardiometabolic health indicators and HRF.

Accordingly, this study examined the impact of a 12-week multicomponent exercise intervention on dyslipidemia and HRF among children with obesity. We hypothesized that, relative to the control group, participants receiving the exercise intervention would exhibit more favorable changes in lipid profiles, including lower LDL-C and triglyceride concentrations together with higher HDL-C levels, as well as greater improvements in cardiorespiratory fitness, muscular strength, and flexibility.

2. Methods

2.1. Study Design

This study was conducted as a two-arm, parallel-group randomized controlled trial.

2.2. Participants

Participants were children aged 9–11 years with obesity. Recruitment was conducted through local schools and pediatric clinics. Following initial recruitment, families attended an orientation session to review study procedures. A health screening questionnaire was completed by parents to ensure participants were medically cleared for physical activity. Inclusion criteria were: (1) age 9–11 years; (2) obesity defined as a Body Mass Index (BMI) $\geq$ 95th percentile for age and sex according to the CDC growth charts; (3) medical clearance for exercise; and (4) no participation in structured exercise training ($\geq$ 2 sessions/week) in the preceding 3 months. Exclusion criteria were: (1) chronic medical conditions limiting safe exercise (e.g., severe orthopedic limitations or uncontrolled asthma); (2) endocrine disorders or

medications (e.g., lipid-lowering drugs) known to affect metabolism; (3) acute illness during baseline; and (4) inability to commit to the 12-week schedule.

The required sample size was estimated before participant recruitment using G*Power software (Version 3.1.9.6). The calculation was based on an ANCOVA design with two study groups, assuming a medium effect size ($f = 0.25$), a significance level of .05, and statistical power of 80%. The analysis indicated that a minimum of 30 participants would be sufficient to detect the expected intervention effect. To minimize the potential impact of participant dropout, the planned sample size was increased by approximately 15% during recruitment.

After completion of the baseline assessments, participants were allocated in a 1:1 ratio to either the Exercise Group or the Control Group using a computer-generated randomization schedule. The random sequence was prepared by a researcher who had no role in participant recruitment, intervention delivery, or outcome evaluation. Participant enrollment was undertaken by the principal investigator, while allocation concealment was maintained through the use of sequentially numbered, sealed, opaque envelopes that were opened only after baseline testing had been completed.

Because of the nature of the exercise intervention, participant blinding was not feasible. Nevertheless, laboratory staff responsible for biochemical analyses and investigators conducting the outcome assessments remained unaware of participants' group assignments throughout the study. Dietary intake and nutritional behaviors were not formally monitored during the intervention period. Instead, participants and their parents were instructed to continue their habitual dietary patterns to minimize potential changes in nutritional intake. This methodological consideration was taken into account when interpreting the study findings. Pubertal status was not evaluated, as all participants were primary school children between 9 and 11 years of age; this limitation is addressed in the Discussion section.

2.3. Intervention

2.3.1. Multicomponent Exercise Program

The Exercise Group participated in a 12-week supervised program, meeting three times per week for 50–60 minutes per session. Each session included a 10-min warm-up with light locomotor games and dynamic stretching, a 20-min aerobic component consisting of moderate-to-vigorous activities (running games, relays, and shuttle tasks), a 15-min resistance component featuring age-appropriate bodyweight exercises (squat variations, push-up progressions, and core stabilization) emphasizing proper technique, a 10-min neuromotor/skill segment with agility ladder drills and balance challenges, and a 5-min cool-down of low-intensity movement and static stretching. Exercise intensity was maintained at moderate-to-vigorous levels and monitored using heart rate (target 65–85% HRmax) and the OMNI scale of perceived exertion (target RPE 6–8). Heart rate was monitored throughout each session using Polar H10 heart rate monitors (Polar Electro Oy, Kempele, Finland). Exercise progression was implemented by gradually increasing exercise duration, movement complexity, and task intensity across the 12-week intervention while maintaining the

prescribed target heart-rate zone. Resistance exercises progressed through increases in repetitions, sets, and movement complexity, whereas aerobic activities incorporated progressively more demanding games and shuttle-based tasks. To ensure intervention fidelity, all exercise sessions were supervised by the same certified exercise specialist following a standardized intervention protocol. Session attendance was recorded, and adherence to the planned exercise intensity and session structure was monitored throughout the intervention.

2.3.2. Control Condition

The control arm did not participate in the exercise intervention and was asked to carry on with everyday routines as usual. They received general healthy lifestyle brochures but no supervised training.

2.4. Measurements

2.4.1. Anthropometrics and Lipids

- **Anthropometry:** Height (cm) and weight (kg) were measured using a stadiometer and digital scale. BMI was calculated (kg/m^2) and converted to percentiles.
- **Serum Lipids:** Venous blood was collected after a 10–12 hour overnight fast. Serum was analyzed for TC, triglycerides, LDL-C, and HDL-C using standard enzymatic methods in an accredited laboratory.

The laboratory participated in routine internal quality-control procedures according to the manufacturer's recommendations, and all biochemical analyses were performed by experienced laboratory personnel using standardized protocols.

2.4.2. Health-Related Physical Fitness

The study utilized a standardized fitness assessment battery including cardiorespiratory fitness measured by the 20-m Shuttle Run Test (PACER), muscular fitness assessed using push-ups and curl-ups, and flexibility evaluated with the sit-and-reach test.

2.5. Statistical Analysis

All statistical procedures were carried out using SPSS (Version 27.0.1). The distribution of the data was examined with the Shapiro-Wilk test to confirm the assumption of normality. Independent-samples *t* tests were used to evaluate baseline comparability between groups. Intervention effects were examined using analysis of covariance (ANCOVA). The magnitude of the intervention effects was quantified using partial eta-squared (η^2). To improve the clinical interpretation of the findings, adjusted between-group mean differences and their associated 95% confidence intervals (95% CIs) were also estimated. The primary analyses followed a per-protocol approach and included only participants who completed both the baseline and post-intervention assessments. Statistical significance was defined as $p < 0.05$.

3. Results

3.1. Participant Flow and Baseline Characteristics

Participant recruitment and retention are summarized in the CONSORT flow diagram (Figure 1). Sixty-four children were initially assessed for eligibility, of whom 48 satisfied the inclusion criteria and underwent random allocation to either the Exercise Group ($n = 24$) or the Control Group ($n = 24$). During the intervention, three participants from the Exercise Group discontinued participation because of scheduling conflicts ($n = 2$) or relocation ($n = 1$). In the Control Group, two participants were lost before the final assessment owing to loss to follow-up ($n = 1$) and withdrawal of interest ($n = 1$). Consequently, data from 43 participants (Exercise Group: $n = 21$; Control Group: $n = 22$) were available for the per-protocol analyses. Comparisons between study completers and participants who withdrew revealed no significant differences in baseline characteristics (all $p > 0.05$), indicating that attrition was unlikely to have introduced systematic bias.

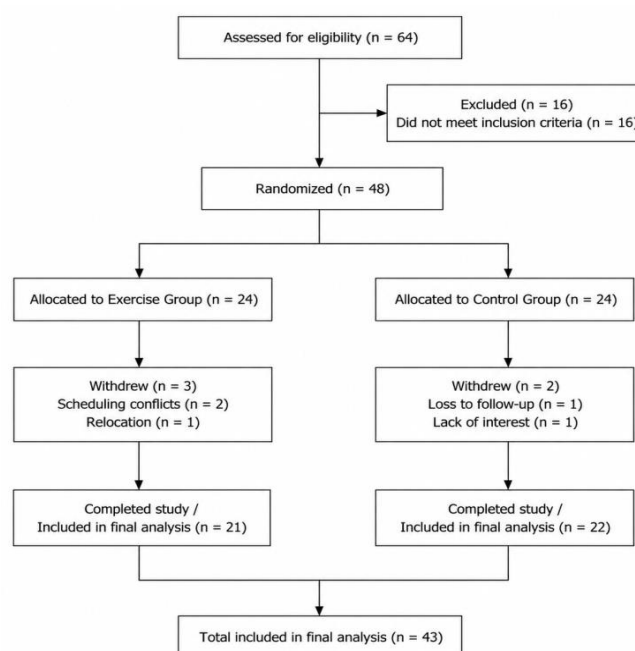


Figure 1. The CONSORT Flow Diagram of the Participants.

No statistically significant between-group differences were identified at baseline for the demographic, anthropometric, biochemical, or health-related physical fitness variables presented in Table 1 (all $p > 0.05$), confirming that the randomization procedure produced comparable groups. Participants in the Exercise Group attended an average of 88.4% of the 36 scheduled training sessions, indicating excellent adherence to the intervention. No serious adverse

events occurred during the study. Two participants experienced mild muscle soreness during the initial two weeks of training; however, the symptoms resolved spontaneously and did not require withdrawal from the program. Although modest reductions in body mass and BMI were observed in the Exercise Group after the intervention, these changes were not significantly different from those of the Control Group (all $p > 0.05$; Table 2).

Table 1. Baseline Characteristics of Participants and Comparison Between Completers and Withdrawn Participants

Variable	Exercise Group	Control Group	Withdrawn	p
Age (years)	10.1 ± 0.8	10.0 ± 0.7	10.2 ± 0.9	0.81
Height (cm)	143.8 ± 6.4	144.5 ± 6.8	143.6 ± 6.1	0.93
Body mass (kg)	54.6 ± 7.9	55.2 ± 8.3	55.8 ± 8.5	0.89
BMI (kg/m ²)	26.4 ± 2.1	26.6 ± 2.3	26.7 ± 2.2	0.95
Total Cholesterol (mg/dL)	191.5 ± 18.7	189.8 ± 19.3	193.1 ± 17.6	0.88
Triglycerides (mg/dL)	146.2 ± 24.1	143.7 ± 22.8	145.9 ± 21.5	0.91
LDL-C (mg/dL)	123.8 ± 15.2	122.6 ± 14.9	124.4 ± 15.7	0.94
HDL-C (mg/dL)	39.6 ± 5.1	40.2 ± 5.4	39.8 ± 5.0	0.96
PACER (laps)	18.4 ± 5.6	18.9 ± 5.9	18.6 ± 5.2	0.97
Push-ups (repetitions)	6.8 ± 2.4	7.1 ± 2.6	6.9 ± 2.3	0.93
Curl-ups (repetitions)	16.7 ± 4.8	17.1 ± 5.0	16.8 ± 4.6	0.95
Sit-and-Reach (cm)	18.9 ± 4.2	19.4 ± 4.5	19.0 ± 4.1	0.91

† Comparison between study completers and withdrawn participants at baseline.

3.2. Effects on Lipid Profile

After 12 weeks, the Exercise Group showed more favorable changes in lipid profile than those in the Control Group (Figure 2). After adjustment for baseline

values, ANCOVA indicated significant between-group differences in post-intervention TC ($F_{1,40}=4.94$, $p=0.032$, $\eta^2=0.11$), triglycerides ($F_{1,40}=7.77$, $p=0.008$, $\eta^2=0.17$), LDL-C ($F_{1,40}=12.63$, $p=0.001$, $\eta^2=0.24$), and HDL-C ($F_{1,40}=9.38$, $p=0.004$, $\eta^2=0.19$) (Table 2).

Table 2. Changes in Anthropometric Variables and Lipid Profile After 12 Weeks.

Variable	Exercise Group Pre	Exercise Group Post	Control Group Pre	Control Group Post	Adjusted Mean Difference (95% CI)	p	Partial η^2
Body mass (kg)	54.6 ± 7.9	53.5 ± 7.4	55.2 ± 8.3	55.4 ± 8.2	-1.28 (-2.61 to 0.05)	0.061	0.08
BMI (kg/m ²)	26.4 ± 2.1	25.9 ± 2.0	26.6 ± 2.3	26.7 ± 2.2	-0.56 (-1.18 to 0.06)	0.074	0.07
Total Cholesterol (mg/dL)	191.5 ± 18.7	181.2 ± 16.9	189.8 ± 19.3	187.9 ± 18.6	-8.5 (-16.2 to -0.8)	0.032	0.11
Triglycerides (mg/dL)	146.2 ± 24.1	128.5 ± 20.7	143.7 ± 22.8	141.9 ± 23.1	-15.8 (-27.1 to -4.5)	0.008	0.17
LDL-C (mg/dL)	123.8 ± 15.2	109.4 ± 13.1	122.6 ± 14.9	121.1 ± 15.3	-12.7 (-19.5 to -5.9)	0.001	0.24
HDL-C (mg/dL)	39.6 ± 5.1	44.8 ± 5.6	40.2 ± 5.4	40.7 ± 5.2	4.4 (1.6 to 7.2)	0.004	0.19

Note: Values are presented as mean ± SD.

3.3. Effects on Health-Related Physical Fitness

After 12 weeks, participants in the Exercise Group demonstrated significantly greater gains across all evaluated components of HRPF than those in the Control Group (Figure 2). After adjustment for baseline

values, ANCOVA demonstrated significant between-group differences in PACER performance ($F_{1,40}=17.97$, $p<0.001$, $\eta^2=0.31$), push-ups ($F_{1,40}=15.56$, $p<0.001$, $\eta^2=0.28$), curl-ups ($F_{1,40}=14.05$, $p<0.001$, $\eta^2=0.26$), and sit-and-reach ($F_{1,40}=8.78$, $p=0.002$, $\eta^2=0.18$) (Table 3).

Table 3. Changes in Health-Related Physical Fitness After 12 Weeks.

Variable	Exercise Group Pre	Exercise Group Post	Control Group Pre	Control Group Post	Adjusted Mean Difference (95% CI)	p	Partial η^2
PACER (laps)	18.4 ± 5.6	28.7 ± 6.3	18.9 ± 5.9	19.8 ± 5.7	8.3 (5.1 to 11.5)	<0.001	0.31
Push-ups (Repetitions)	6.8 ± 2.4	11.6 ± 3.1	7.1 ± 2.6	7.5 ± 2.7	3.9 (2.2 to 5.6)	<0.001	0.28
Curl-ups (repetitions)	16.7 ± 4.8	24.3 ± 5.2	17.1 ± 5.0	17.9 ± 4.8	5.6 (3.2 to 8.0)	<0.001	0.26
Sit-and-Reach (cm)	18.9 ± 4.2	23.6 ± 4.5	19.4 ± 4.5	19.9 ± 4.3	3.2 (1.4 to 5.0)	0.002	0.18

Note: Values are presented as mean ± SD.

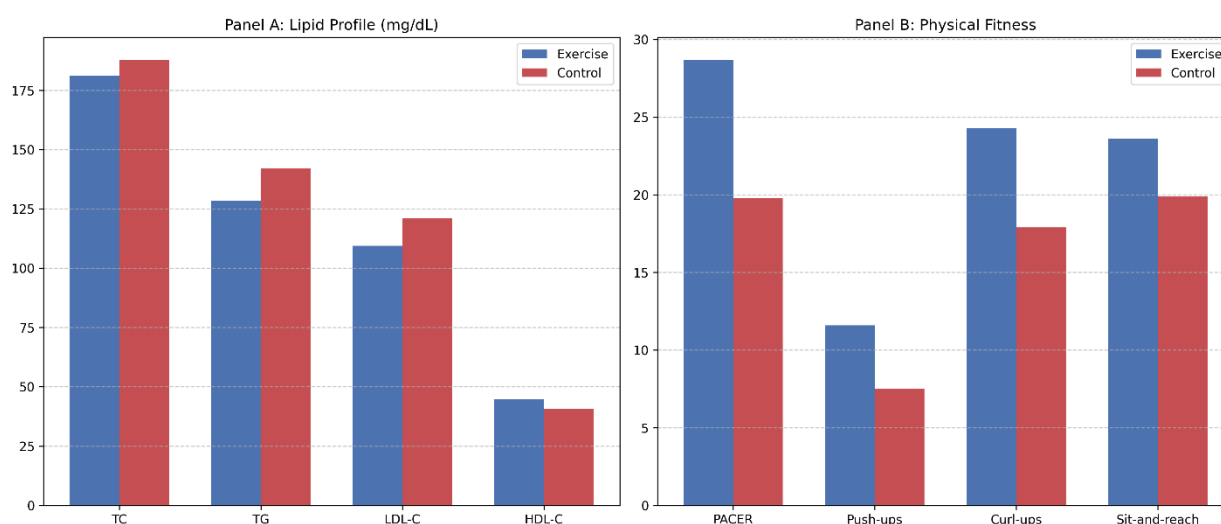


Figure 2. Post-intervention changes in serum lipid profile and health-related physical fitness outcomes in the Exercise and Control groups. Values are expressed as mean $\pm$ SD.

4. Discussion

This study examined the effects of a 12-week multicomponent exercise program on lipid profiles and HRPF in children with obesity. The findings demonstrate that a structured combination of aerobic, resistance, and skill-based activities leads to significant improvements in cardiometabolic health and HRPF. Compared with the control group, children who completed the intervention exhibited lower LDL-C and triglyceride levels, higher HDL-C concentrations, and superior gains in cardiorespiratory fitness, muscular fitness, and flexibility.

One of the most clinically relevant findings was the significant reduction in LDL-C (11.6%) and triglycerides (12.1%) following the intervention. Dyslipidemia in childhood is a strong predictor of adult atherosclerosis, and managing it early is vital (5,18). Our results align with previous meta-analyses suggesting that exercise interventions are effective in modifying the lipid profile of pediatric populations with obesity (19,20). The improvement in HDL-C observed in the exercise group (approx. 13% increase) is particularly noteworthy. In children with obesity, low HDL-C is a common feature of metabolic syndrome (8,21). Although the present study did not directly assess the physiological mechanisms underlying these improvements, previous research suggests that regular exercise may favorably influence lipid metabolism through adaptations such as enhanced lipoprotein lipase activity, improved reverse cholesterol transport, and increased utilization of circulating lipids during exercise (19,20). Therefore, these mechanisms should be considered as plausible rather than confirmed explanations for the observed changes.

Participants in the Exercise Group achieved a marked improvement in cardiorespiratory fitness, with PACER performance increasing by approximately 56% from baseline. In children and adolescents, cardiorespiratory fitness is widely regarded as a key indicator of overall health and has been proposed as a clinical “vital sign” because of its strong association with current and future health status (22-24). The multicomponent program, which integrated aerobic games and relays, likely increased stroke volume and

mitochondrial density in skeletal muscle, leading to better oxygen utilization. Furthermore, the significant gains in muscular fitness and flexibility highlight the versatility of multicomponent training. Unlike purely aerobic programs, our approach targeted multiple physical attributes. Enhancing muscular strength in children with obesity is critical, as it can improve their ability to perform daily locomotor tasks, potentially reducing the “effort barrier” to physical activity and fostering a more active lifestyle. It should also be acknowledged that a small proportion of the observed improvements, particularly in PACER performance, may have resulted from increased familiarity with the testing procedures. Nevertheless, the magnitude of improvement observed in the exercise group compared with the minimal changes in the control group suggests that the intervention itself was the primary contributor to these gains.

The favorable changes in lipid profile and HRPF observed in the present study are likely attributable to multiple physiological adaptations induced by regular exercise. Increased energy expenditure and repeated engagement in physical activity may improve lipid metabolism and promote more efficient utilization of circulating triglycerides (25,26). In addition, previous studies have suggested that resistance exercise may contribute to improved metabolic regulation through enhanced glucose utilization and skeletal muscle adaptations (27,28). However, because body composition, insulin sensitivity, inflammatory markers, and other metabolic biomarkers were not assessed in the present study, these explanations remain speculative and should be interpreted with caution.

For practitioners in school and clinical settings, these results suggest that exercise does not need to consist solely of traditional aerobic activities to be effective. A multicomponent approach that combines games, bodyweight resistance exercises, and agility activities appears to be well suited to children. An additional strength of the intervention was the high attendance rate (88.4%), indicating excellent participant adherence and suggesting that supervised multicomponent exercise programs are both feasible and well accepted by children with obesity. High

adherence likely contributed to the favorable intervention outcomes and supports the practical implementation of similar programs in school and community settings.

Several methodological strengths enhance the credibility of the present findings, including the randomized controlled design, the inclusion of children within a narrow developmental age range (9–11 years), the delivery of a closely supervised exercise program, the high level of participant adherence, and the application of ANCOVA to account for baseline differences between groups. Despite these strengths, the study also has several limitations. First, dietary intake was not monitored throughout the intervention and may have influenced changes in serum lipid concentrations. Second, pubertal status was not assessed. Although participants were between 9 and 11 years of age, individual differences in biological maturation may have influenced lipid metabolism, HRPf, and responsiveness to exercise. Third, the intervention lasted only 12 weeks, precluding conclusions regarding the long-term maintenance of the observed benefits. Finally, because participants were recruited from schools and pediatric clinics within a single geographic region, the generalizability of the findings to other pediatric populations may be limited. Future research should investigate the long-term sustainability of these adaptations, incorporate objective assessments of body composition and metabolic biomarkers, include dietary monitoring, and examine the combined effects of multicomponent exercise and nutritional interventions.

4.1. Conclusion

A 12-week supervised multicomponent exercise program effectively improved lipid profile and HRPf in children with obesity, highlighting its potential as a non-pharmacological approach to improving pediatric health. Nevertheless, the absence of body composition measures and additional cardiometabolic biomarkers limits the extent to which the broader clinical significance of these improvements can be determined. The high attendance rate observed in this study further suggests that supervised multicomponent exercise programs are feasible and acceptable for children with obesity and may represent a practical approach for school- and community-based health promotion initiatives.

Authors' Contribution: The author contributed to the entire research process, including formulation of the research question, study design, organization and delivery of the exercise program, participant assessment, data collection, statistical analysis, interpretation of the results, and preparation and revision of the manuscript.

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originality, integrity, and overall content of the published work.

Ethical Considerations: The study received ethical approval from the relevant institutional ethics committee (Ethics Code: IR.IAU.TABRIZ.REC.1405.146) and was conducted in accordance with the ethical principles of the Declaration of Helsinki. Written informed consent was obtained from the parents or legal guardians before participation. The children were given information appropriate to their age regarding the study procedures, and their voluntary participation was respected.

Data Availability: The datasets generated and analyzed during this study are available from the corresponding author upon reasonable request, subject to relevant ethical, privacy, and confidentiality considerations.

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Conflicts of Interest: The author declares that there are no financial, personal, or professional conflicts of interest related to this research.

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