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ORIGINAL RESEARCH

Application of Combined Dietary and Exercise Intervention in Pediatric Obesity and Its Impact on Anthropometric Measurements and Blood Lipid Parameters

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Objective: To evaluate the effects of a combined dietary and exercise intervention on anthropometric measurements and blood lipid profiles in obese children, and to provide evidence-based support for pediatric obesity management.

Methods: This retrospective study included 130 obese children who underwent routine health examinations and interventions between January 2020 and October 2023. Participants were divided into two groups: the control group received health education only, while the observation group received additional dietary and exercise interventions. Pre- and post-intervention changes in anthropometric indicators, body fat levels, lipid profiles, inflammatory markers, physical activity levels, and parental satisfaction were assessed.

Results: Baseline characteristics were similar between groups ($P > 0.05$). After intervention, the observation group showed significantly lower body weight, BMI, waist-to-hip ratio, body fat percentage, visceral fat area, and lipid levels (TG, TC, LDL-C), along with higher basal metabolic rate ($P < 0.05$). Physical activity increased and sedentary time decreased significantly in the observation group ($P < 0.001$). Additionally, inflammatory markers (IL-6, IL-8, TNF-α) were markedly reduced in the observation group ($P < 0.05$), and parental satisfaction was significantly higher compared to the control group.

Conclusion: A combined dietary and exercise intervention significantly improves body composition, lipid metabolism, physical activity levels, and inflammatory status in obese children. This comprehensive model may be an effective, non-pharmacological strategy for promoting healthy growth and managing childhood obesity.

Keywords: obese children, combined diet and exercise intervention, physical measurements, blood lipid levels

Introduction

Childhood obesity has become a major global public health concern in recent years, posing serious threats to both immediate and long-term physical and psychological health. According to the World Health Organization, the prevalence of overweight and obesity among children and adolescents aged 5–19 has risen dramatically from just 4% in 1975 to over 18% in 2016, with further increases expected in the coming decade.[1] Recent data underscore the growing burden of childhood obesity worldwide. A comprehensive global analysis published in The Lancet (2025) projected a continued rise in pediatric obesity rates across both high- and low-income countries, highlighting the urgent need for early intervention and scalable public health strategies.[2] In addition to genetic and environmental contributors, behavioral factors—especially excessive caloric intake and insufficient physical activity—play a central role in the development of pediatric obesity.[3]

Recent evidence highlights that a sedentary lifestyle is an independent risk factor for childhood obesity. Extended sedentary behavior, particularly screen time, has been associated with increased adiposity and metabolic disturbances in children.[4] In parallel, childhood obesity is now understood to be a chronic low-grade inflammatory condition. Adipose tissue in obese individuals actively secretes pro-inflammatory cytokines, such as interleukin-6 (IL-6), interleukin-8 (IL-8), and tumor necrosis

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factor-α (TNF-α), which not only exacerbate metabolic dysfunction but also increase the risk of future cardiovascular disease and insulin resistance.[5,6]

To address these challenges, various interventions have been explored. Dietary modification remains a cornerstone strategy, aiming to optimize macronutrient composition and reduce overall energy intake. Physical activity interventions are similarly critical, as they promote energy expenditure, improve body composition, and reduce cardiometabolic risk.[7] Increasingly, comprehensive lifestyle interventions that integrate dietary guidance and structured physical activity have been recommended by global health authorities and supported by empirical studies as more effective than single-modality approaches.[8]

However, existing literature often lacks a detailed examination of how combined diet and exercise interventions affect anthropometric and biochemical markers in obese children, particularly in terms of their impact on inflammatory mediators and sedentary behavior. Moreover, relatively few studies have assessed family satisfaction and adherence in such intervention models, which are key to their long-term success and scalability.

Therefore, the present study aims to retrospectively evaluate the effectiveness of a combined dietary and exercise intervention in managing pediatric obesity. We focus on its effects on anthropometric measurements, blood lipid profiles, physical activity levels, inflammatory markers, and parental satisfaction, with the goal of providing a scientific basis for integrated, family-centered obesity management strategies.

Subjects and Methods

Study Subjects

This retrospective study included 130 obese children who underwent health check-ups and interventions at the Department of Child Health Care, West China Second Hospital, Sichuan University, from January 2020 to October 2023. The sample size was estimated using PASS software (version 15.0) with 80% power and a two-sided alpha of 0.05, assuming a moderate effect size of 0.5, yielding a minimum requirement of 128 participants. Participants were assigned to two groups (n=65 per group) based on the chronological order of intervention, rather than randomized allocation. Stratification by gender or baseline weight was not applied, but no significant differences in these characteristics were found between groups ($P > 0.05$), indicating baseline comparability. The study protocol was reviewed and approved by the Ethics Committee of West China Second Hospital of Sichuan University and complied with the ethical standards for medical research involving human subjects as outlined in the Declaration of Helsinki and its subsequent amendments. As this is a retrospective study, the Ethics Committee of West China Second Hospital board waived the need for informed consent. Patient data was held in strict confidentiality and was used only for the purposes of this study.

Inclusion Criteria

The study included children who met the World Health Organization (WHO) criteria for obesity and had an obesity level according to the "China Screening and Classification Standard for Obesity in School-Aged Children and Adolescents" developed by the China Obesity Working Group. The subjects were all from the local district, with favorable family economic conditions, high living standards, and complete clinical data records.

Exclusion Criteria: Children with pathological obesity, endocrine disorders such as thyroid disease, congenital metabolic or genetic disorders, liver or kidney dysfunction, infectious diseases such as HIV or active tuberculosis, or those currently using medications that may affect glucose and lipid metabolism (such as hormones or hypoglycemic drugs) were excluded from the study.

Intervention Methods

The control group received an intervention consisting solely of educational lectures. In contrast, the observation group received a combined diet and exercise intervention based on the control group's intervention, as described below:

Firstly, the primary risk factors in the lifestyles of obese children were identified, and corrective goals were set around specific behaviors such as eating speed, physical activity, and snack intake. The methods included self-monitoring, contract-setting, and reward mechanisms. Children were encouraged to record daily details such as their diet, physical activity, and TV time, with interventions targeting unhealthy habits. The education content emphasized reducing snack and fast food consumption, avoiding eating while watching TV, and not having dessert after dinner, helping children gradually develop healthy eating and lifestyle habits while increasing outdoor activity time and reducing sedentary time. In terms of dietary intervention, the focus was on controlling total energy intake and optimizing the diet structure. Most obese children gain excess weight due to excessive energy intake, so the goal was to gradually reduce daily total energy intake while ensuring the provision of essential nutrients (such as protein, vitamins, and minerals) for the child's health. The proportion of staple foods should be appropriately reduced, while the intake of vegetables and fruits should be increased, ensuring that energy from protein, fat, and carbohydrates accounts for 10–15%, 25–30%, and 60–65% of total energy, respectively. Initially, total energy intake was reduced by 1/4, gradually decreasing to 2/3, ultimately reaching the level needed to maintain the ideal body weight, with the calorie distribution for the three meals being 25%, 40%, and 35%.[9–11] Secondly, for the exercise intervention, fun and easy-to-maintain activities were selected, such as brisk walking, jogging, swimming, shuttlecock kicking, and jump rope. The intensity of exercise should aim to reach 60–75% of the maximum heart rate (220 minus age), with each session lasting for at least 30 minutes, 3–5 days per week. In the early stages of the intervention, exercise could begin with 10-minute sessions, avoiding excessive fatigue, and gradually increasing to the desired duration. Additionally, each exercise session should include 10–15 minutes of warm-up and cool-down activities. Furthermore, psychological intervention should run throughout the process, aiming to stimulate active participation from both children and parents, help children overcome psychological barriers, build self-confidence, eliminate feelings of inferiority, and gradually form a healthy attitude toward life. The successful implementation of the intervention requires guidance from teachers, support from parents, and the child's long-term commitment to ensure significant and sustained results.[12–14] The intervention period in this study was 12 weeks.

Observation Indicators

Physical Measurement Indicators: These include height, weight, BMI, waist-to-hip ratio, and basal metabolic rate (BMR). For height measurement, participants were asked to remove shoes, socks, and hats, and the same measuring equipment was used. Weight, waist circumference, and hip circumference were measured in the morning after the participants emptied their bladders, wearing standardized clothing, and using the same medical scale. BMI and waist-to-hip ratio were calculated from these measurements. BMR was assessed using the InBody 770 bioelectrical impedance analyzer (Biospace Co., Ltd., Korea), which has been validated for pediatric populations in previous studies. The device estimates BMR based on segmental body composition using multi-frequency impedance technology.

Fat Level: Body fat percentage and visceral fat area were measured using a body composition analyzer. Prior to the test, participants were instructed to empty their bladder, refrain from eating and drinking for more than 2 hours, and stand still for 5 minutes before the test.

Blood Lipid Indicators: A 5 mL sample of venous blood was collected from the children in a fasting state in the early morning. The blood was centrifuged at 3000 rpm for 10 minutes, and the supernatant was reserved. Total cholesterol, triglycerides, and low-density lipoprotein (LDL) levels were measured using enzyme-linked immunosorbent assay (ELISA).

Physical Activity: Physical activity was assessed using a 3D triaxial accelerometer (ActiGraph wGT3X-BT, ActiGraph LLC, USA), which was worn on the waist during waking hours for seven consecutive days. The device captures movement data at a 30 hz sampling rate and classifies activity intensity levels using validated cut-points for children. Data were analyzed using ActiLife software (version 6.13.4), with valid data defined as at least 10 hours of wear time on a minimum of 4 weekdays and 1 weekend day.

Inflammatory Factors: A 5 mL sample of fasting venous blood was collected from the children in the early morning. After centrifugation at 3000 rpm for 10 minutes, the supernatant was reserved. The concentrations of interleukin-6 (IL-6), interleukin-8 (IL-8), and tumor necrosis factor-alpha (TNF-α) were measured using enzyme-linked immunosorbent assay (ELISA).

Parental Satisfaction: Parental satisfaction was evaluated using a self-developed questionnaire designed by the research team based on key domains: perceived effectiveness, convenience of implementation, quality of communication with healthcare providers, and child cooperation. To ensure content validity, the draft questionnaire was reviewed by an expert panel consisting of two pediatricians, two pediatric nurses, and two child health educators. Experts were asked to evaluate each item based on relevance, clarity, and comprehensiveness using a 4-point Likert scale (1 = not relevant, 4 = highly relevant). The Content Validity Index (CVI) was calculated at both the item level (I-CVI) and the scale level (S-CVI/Ave). The I-CVI values ranged from 0.83 to 1.00, and the S-CVI/Ave was 0.92, indicating high content validity. Minor modifications were made based on expert suggestions prior to final implementation.

Statistical Data

Images were processed using GraphPad Prism 8, and data were analyzed using SPSS 26.0 software. Measurement data were presented as mean ± standard deviation ($x \pm s$), with comparisons between groups made using the *t*-test. Categorical data were presented as [n (%)], with comparisons between groups made using the chi-square test. A P value < 0.05 was considered statistically significant.

Results

General Information

In the control group, there were 65 children, including 34 males and 31 females, with an average age of 10.28 ± 5.12 years and an average BMI of 27.28 ± 3.11 kg/m². In the observation group, there were 65 children, including 33 males and 32 females, with an average age of 10.54 ± 5.07 years and an average BMI of 27.73 ± 3.22 kg/m². There was no statistically significant difference between the two groups in general information, indicating comparability ($P > 0.05$). See Table 1.

Physical Measurement Indicators

There was no significant difference in height between the two groups ($P > 0.05$). However, body weight, BMI, and waist-to-hip ratio were all lower in the observation group compared to the control group, and the basal metabolic rate was higher in the observation group, with all $P < 0.05$. See Figure 1.

Fat Level

The body fat percentage and visceral fat area in the observation group were lower than those in the control group, with all $P < 0.05$. See Figure 2.

Blood Lipid Indicators

The levels of TG, TC, and LDL-C in the observation group were lower than those in the control group, with all $P < 0.05$. See Figure 3.

Table 1 Comparison of General Information Between the Two Groups

		Control Group	Observation Group	*t*	*P*
Number of Cases	–	65	65	–	–
Gender	Male	34	33	–	–
	Female	31	32	–	–
Age (years)	Mean	10.28±5.12	10.54±5.07	0.291	0.772
BMI (kg/m^2)	Mean	27.28±3.11	27.73±3.22	0.810	0.419

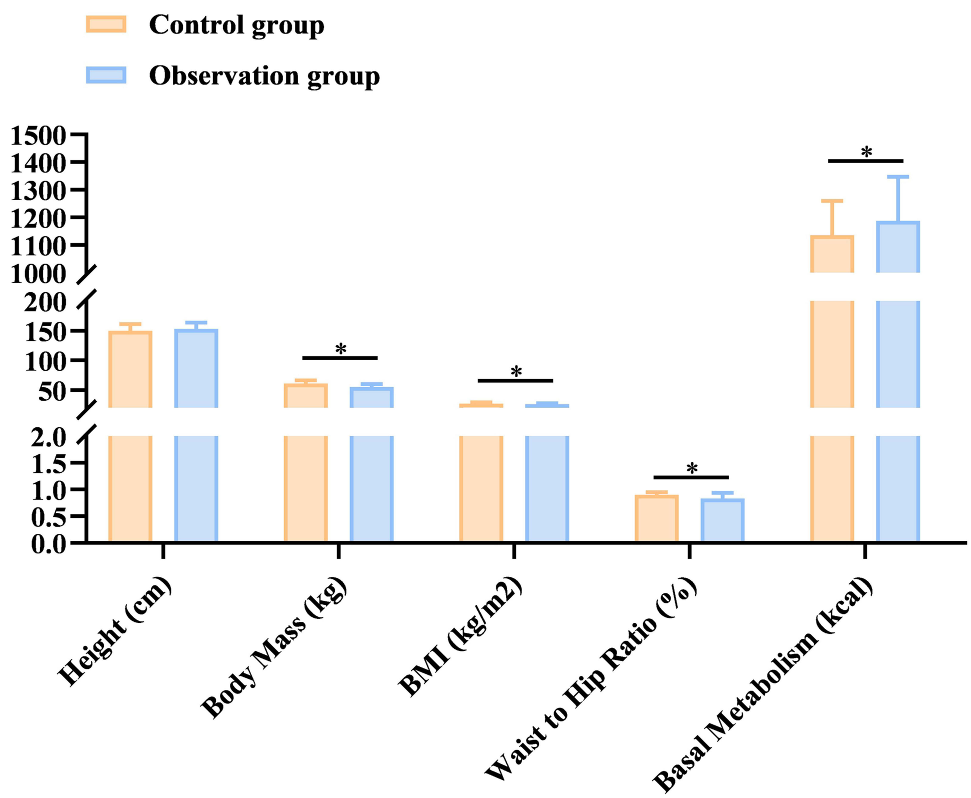

Figure 1 Comparison of Physical Measurement Indicators Between the Two Groups.
Note: *Indicates a significant difference between the two groups, P < 0.05.

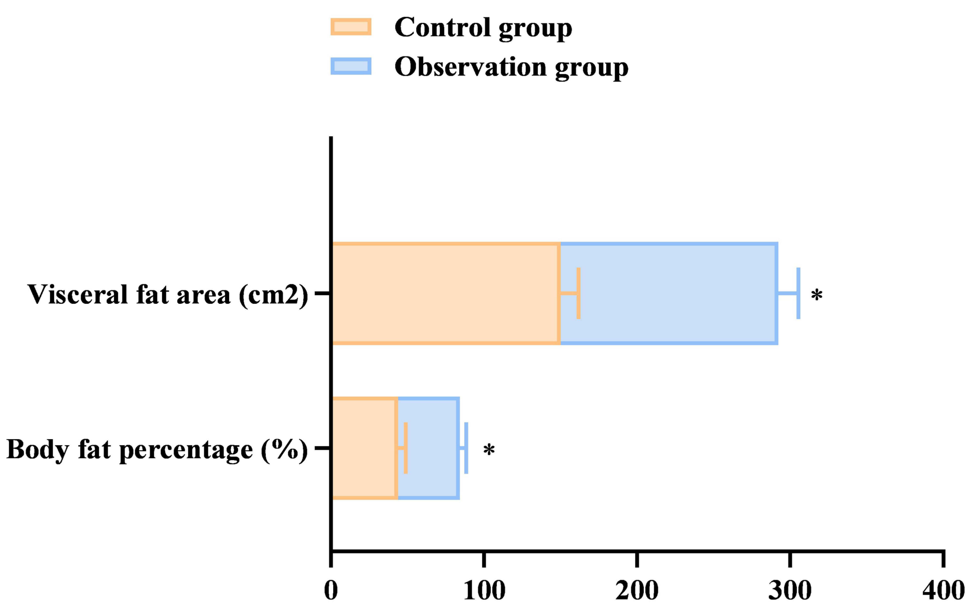

Figure 2 Comparison of Fat Levels Between the Two Groups After Intervention.
Note: *Indicates a significant difference between the two groups, P < 0.05.

Physical Activity

The observation group had less sedentary time than the control group, and the time spent on light, moderate, and high-intensity activities was higher in the observation group, with all $P < 0.05$. See Table 2.

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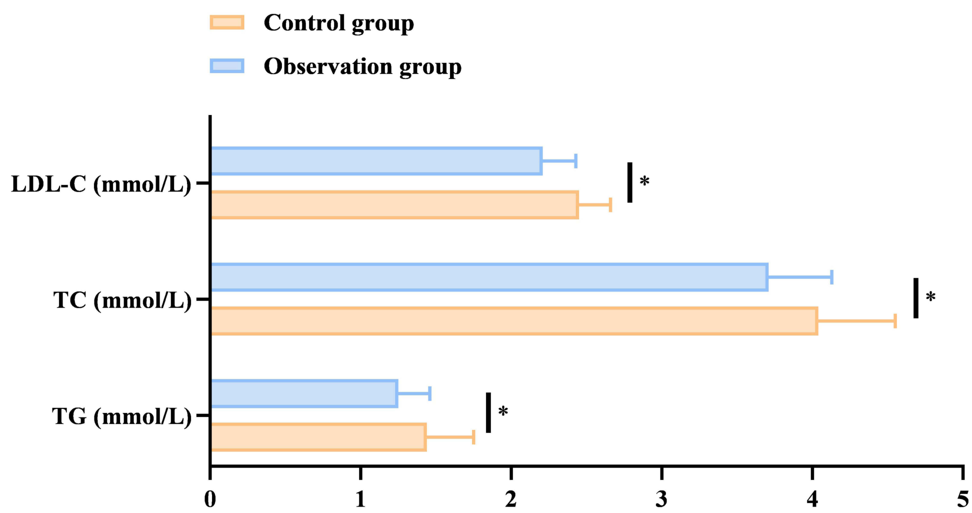

Figure 3 Comparison of Blood Lipid Indicators Between the Two Groups After Intervention.
Note: *Indicates a significant difference between the two groups, P < 0.05.

Inflammatory Factors

The levels of IL-6, IL-8, and TNF-α in the observation group were lower than those in the control group, with all $P < 0.05$. See Figure 4.

Parental Satisfaction

The parental satisfaction rate in the observation group was significantly higher than that in the control group, with $P < 0.05$. See Figure 5.

Discussion

The findings of this study align with international guidelines for the management of pediatric obesity issued by the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), and the American Academy of Pediatrics (AAP). All three organizations advocate for comprehensive lifestyle interventions that include nutritional education, increased physical activity, and behavioral support as the first-line treatment for overweight and obese children. Our intervention model, which integrates structured dietary planning with exercise and parental engagement, reflects these core principles. The observed improvements in body composition, lipid profiles, physical activity levels, and inflammatory markers support the effectiveness of such a multidimensional approach. While our study was retrospective and of limited duration, the results provide real-world evidence consistent with global best practices. Nonetheless, unlike some international guidelines that emphasize the use of motivational interviewing and stage-based behavioral strategies (as per the AAP 2023 guidance), our intervention model did not systematically incorporate formal behavioral counseling. This highlights a potential area for enhancement in future intervention designs.

In terms of body composition, the observation group showed significantly lower BMI, waist-to-hip ratio, body fat percentage, and visceral fat area, along with higher BMR, compared to the control group. These outcomes are consistent with prior research suggesting that multi-component interventions effectively reduce fat mass and increase lean mass

Table 2 Comparison of Physical Activity Time Indicators Between the Two Groups

	Control Group	Observation Group	*t*	*P*
Number of Cases	65	65	–	–
Daily sedentary time (h)	6.22±1.22	4.08±1.18	10.165	<0.001
Light intensity activity (h)	3.11±0.94	5.54±0.88	15.215	<0.001
Medium to high intensity activity (h)	1.11±0.55	2.98±0.48	20.653	<0.001

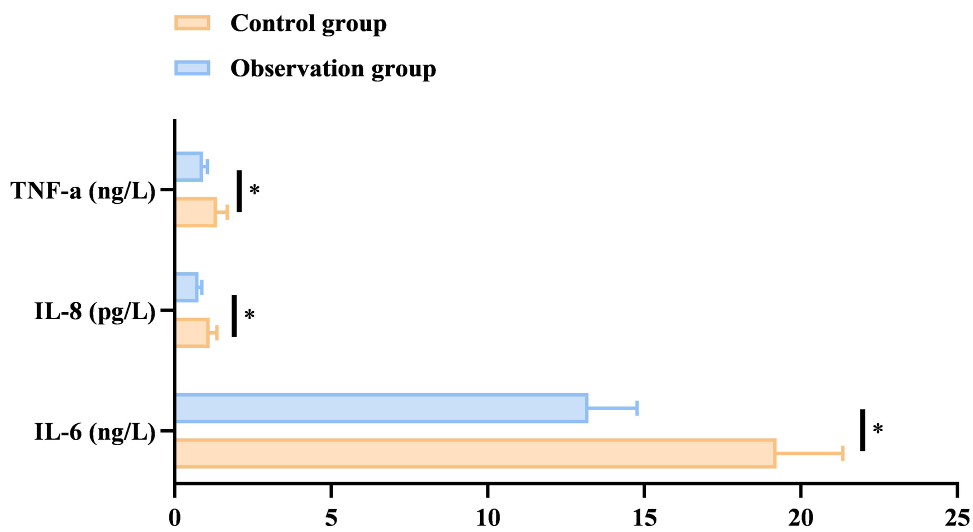

Figure 4 Comparison of Inflammatory Factor Indicators Between the Two Groups After Intervention.
Note: *Indicates a significant difference between the two groups, P < 0.05.

through caloric control and physical training.[15,16] Improvements in basal metabolic rate further suggest enhanced metabolic flexibility and potential benefits for long-term weight maintenance.[8]

Lipid metabolism also improved significantly, as evidenced by reductions in TG, TC, and LDL-C. These changes are of clinical relevance, as dyslipidemia in childhood increases the risk of adult cardiovascular diseases.[17] Similar lipid improvements have been observed in structured pediatric weight management programs combining aerobic and resistance training with nutritional counseling.[18,19] However, it remains unclear whether these observed changes in lipid levels reach clinically meaningful thresholds for cardiovascular risk reduction in pediatric populations. According to existing guidelines from the American Academy of Pediatrics (AAP), elevated LDL-C ≥130 mg/dL, TG ≥100 mg/dL (ages 0–9), or ≥130 mg/dL (ages 10–19), and TC ≥200 mg/dL are considered abnormal in children.[20] While our results show statistically significant improvements, we did not explicitly analyze the proportion of participants who shifted from abnormal to normal lipid levels. Therefore, the clinical significance of these biochemical changes should be interpreted with caution.

Chronic low-grade inflammation is now recognized as a hallmark of obesity. In this study, serum levels of IL-6, IL-8, and TNF-α decreased notably in the intervention group. These findings suggest that integrated lifestyle modification can ameliorate systemic inflammation by reducing visceral fat and modulating cytokine production.[21] This aligns with reports showing that even short-term lifestyle changes can exert anti-inflammatory effects and improve insulin sensitivity.[5,22]

Physical activity assessment using 3D accelerometers revealed that the intervention group had reduced sedentary time and increased time in light, moderate, and vigorous activities. Sedentary behavior has been independently linked to adiposity, insulin resistance, and adverse psychological outcomes in children.[23] Thus, reducing sedentary time is critical, not only for energy balance but also for metabolic and emotional well-being.[4]

Another valuable outcome of this study was the higher level of parental satisfaction in the intervention group. Family engagement has been repeatedly shown to be a key factor in the success of pediatric obesity interventions.[24] The implementation of behavior contracts, self-monitoring, and parental support likely contributed to stronger motivation and adherence.[25]

Despite these positive outcomes, this study has limitations. As a retrospective analysis, the results may be subject to selection bias and uncontrolled confounding. Furthermore, the study did not assess long-term sustainability of the intervention outcomes. Factors such as psychological readiness, socioeconomic background, and dietary environments were not analyzed in depth. Future research should employ randomized controlled designs with longer follow-up periods, and explore adjunctive strategies such as digital health tools and school-based programming.[26–28] Additionally, emerging studies have emphasized the role of behavioral change theories (eg, Social Cognitive Theory, Transtheoretical Model) in

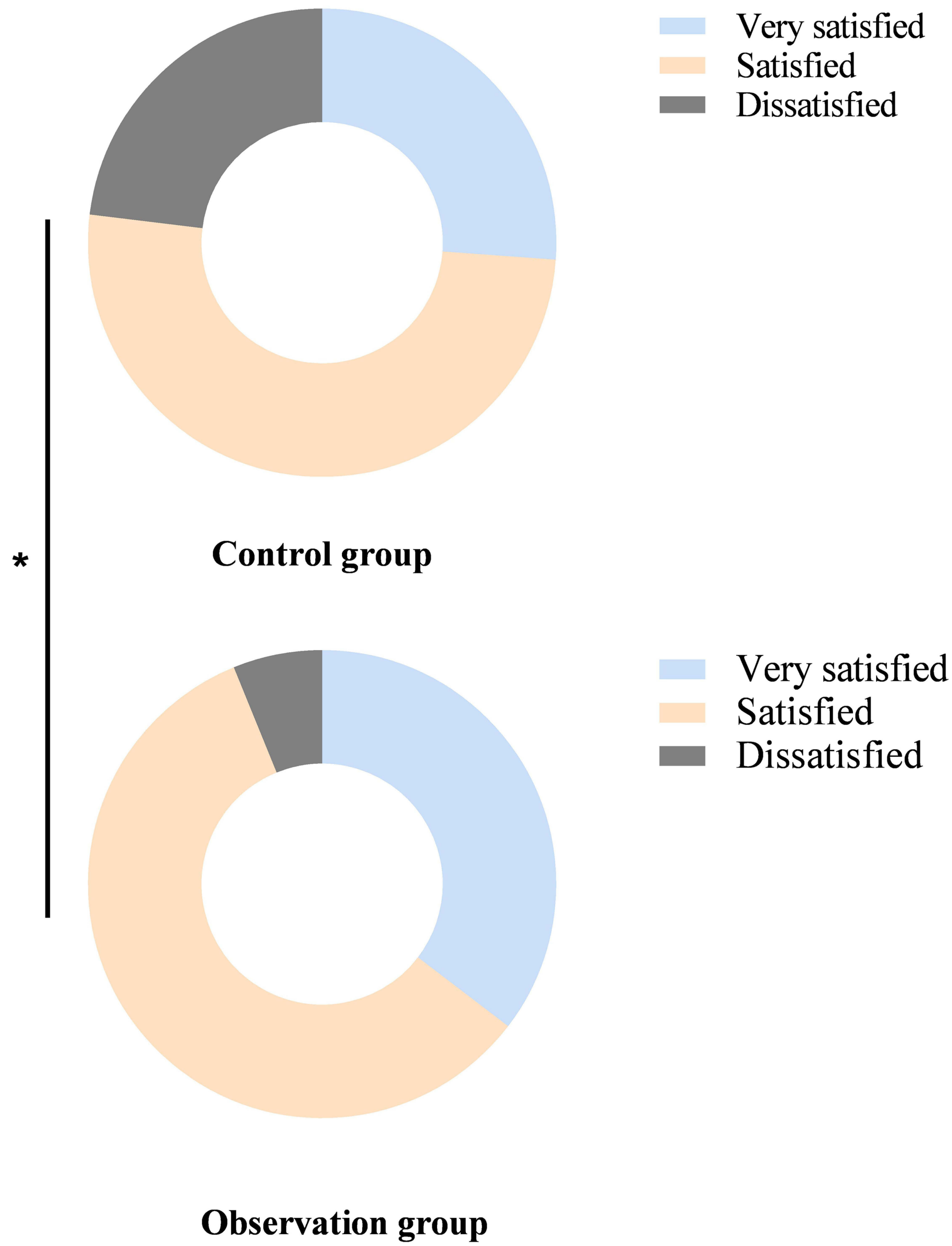

Figure 5 Parental Satisfaction Rate Between the Two Groups.
Note: *Indicates a significant difference between the two groups, P < 0.05.

shaping sustainable interventions.[29] Embedding these frameworks into intervention design may enhance long-term efficacy by addressing motivational and environmental barriers.

In conclusion, this study supports the effectiveness of a combined dietary and exercise intervention in improving physical and metabolic health in obese children. With childhood obesity continuing to rise globally—including in developing regions—low-cost, accessible, and family-oriented interventions are urgently needed.[30] By incorporating behavior change strategies and targeting inflammation and inactivity, such models have the potential to substantially reduce the long-term health burden of pediatric obesity.

Disclosure

The authors report no conflicts of interest in this work.

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