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Original Article

Effectiveness of a School-Based Parental Component Child Obesity Program in Children with Overweight and Obesity: Randomized Controlled Trial

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ABSTRACT

The goal of this study is to evaluate long-term effectiveness of the Child Obesity Program of children with overweight or obesity. Childhood obesity is a major public health concern that requires comprehensive interventions targeting healthy nutrition, physical activity, and behavioral change. School-based programs incorporating parental involvement may play an important role in promoting healthy lifestyle behaviors among children with overweight and obesity. The study used a school-level randomized controlled design with pretest, posttest, and nine-month follow-up assessments. In total 82 children with overweight and obesity aged 8 - 11 years in the program. The data were analyzed by using descriptive statistics, independent samples t-tests, repeated measures of variance and Cohen's d effect size analysis. A significant decrease was found in BMI, weight, subcutaneous adipose tissue thickness of the children who participated in the COP after the intervention. Nutrition behavior, stress management, physical activity, nutrition attitudes, daily drinking water amounts, nutrition self-efficacy, health perceptions were improved in the intervention group. It was also found that the effect of COP continued to support behavioral, cognitive, and physical variables in children's development over the 9-month period.

Keywords: Childhood Obesity; Nutrition; Physical Activity; Stress Management; School Health

Introduction

The dramatic increase in childhood obesity worldwide indicates that health habits in children change over time (1). The World Health Organization (WHO) reports that approximately one out of every three children in Europe is overweight or obese (2). Atlas of Childhood Obesity published by the World Obesity Federation states that obesity in children aged between 5 and 19 will be 206 million in 2025 and 254 million in 2030 (3). Studies show that the rapid increase in childhood obesity is associated with low consumption of vegetables and fruits, insufficient physical activity, excessive screen time, consumption of junk food, and inadequate environments that encourage physical activity and nutrition in schools (1,4,5). Moreover, studies have reported that children with overweight and obesity have higher rates of low self-esteem and anxiety/depressive disorders than children of normal weight (6,7). In this context, it is very important to implement obesity intervention programs in schools, where nutrition, physical activity and stress management are handled together (5,8,9).

Schools play an essential role in obesity interventions because of their long-term and in-depth contact with children (10) Today, school-based obesity studies emphasize the importance of healthy nutrition, physical activity and stress management (5,8,9). In addition, when planning intervention studies in the school community, it is recommended that parents be included in the program with the children (11). Because parental involvement in obesity intervention programs is vital in limiting children's access to unhealthy foods and encouraging physical activity (12).

Background

In the obesity report published by WHO, it has been reported that Turkey is the most obese country in Europe due to its obesity rate of 32.1 percent (2). It is reported that in 2030, the obesity rate in children aged 5-9 will be 22.9% and 17% in children aged 10-19 in Turkey. Further, it is reported that according to the 2025 obesity targets of the World Health Organization, Turkey's chance of meeting the target is 2%, and the childhood obesity risk score in Turkey is 8 out of 11(3). In studies conducted at the regional level in Turkey, it is observed that the prevalence of obesity in children aged between 5 and 15 increased rapidly, with values ranging from 10.18% to 22.0% (4,13). The findings reveal that Turkey's predicted childhood obesity prevalence in 2030 has already been exceeded.

Although it is stated that there is a need for programs that include physical activity, healthy nutrition, and family participation in schools in Turkey to obesity manage and create healthy lifestyle behaviors (4), the lack of school nurses in public creates obstacles for providing school health services and makes it difficult to implement interventions aimed at addressing childhood obesity (5).The Child Obesity Program (COP) is the first school-based child obesity program in Turkey that includes nutrition, physical activity, stress management initiatives and parent involvement. It is thought that the implementation of this program in Turkey will positively affect obesity manage in schools.

Theoretical Framework

The Children Obesity Program is based on the "COPE (Creating Opportunities for Personel Empowerment) Healthy Lifestyles TEEN (Thinking, Emotions, Exercise, Nutrition)" (4,15), program's Turkish culture adapted version ASGE-FABES5 and set up for children between the ages of 8 and 11. It was created by pediatric endocrinologist and nurse researchers who are experts in child obesity.

The program was developed based on Ecological Model and Cognitive Behavioral Theory (CBT). COPE Healthy Lifestyles TEEN aims to transform thoughts, feelings, and behaviors into positives by focusing on the 'present' or the 'moment' (4,15). The program aims to gain cognitive and behavioral skills by increasing nutrition and physical activity knowledge for this transformation. It encourages children to make healthy choices, strengthens their health beliefs, and improves their ability to cope with stress (4,14,15). According to the Ecological Model on which the program is based, food preferences, physical activity, and sedentary lifestyle behaviors may put the child at risk of overweight and obesity (16). According to CBT, emotions and behaviors are affected by how people interpret events (17). Cognitive Behavioral Therapy enhances problem-solving abilities while replacing unhealthy thoughts with positive thinking skills (18,19). The COP is designed to teach children specific cognitive and emotional-control techniques, which can improve their ability to manage their eating habits, exercise routine, and response to stress. These abilities facilitate the maintenance of weight loss and the management of body weight in the long term.

The aim of this study is to determine long-term effectiveness of the Child Obesity Program on the physical (weight, BMI, and subcutaneous adipose tissue thickness), cognitive (nutrition attitude, stress management attitude, physical activity attitude, nutrition self-efficacy and health perception) and behavioral (food behavior, daily water consumption and step counts) variables of children aged 8-11 with overweight or obesity.

Materials and Methods

Research Design

This study employed a school-level randomized controlled design with pretest, posttest, and nine-month follow-up assessments. Two primary schools with similar socioeconomic characteristics were included in the study. One school was randomly assigned to the intervention group and the other to the control group using a random drawing method. Subsequently, eligible children within each school were randomly selected using a random numbers table. This procedure was intended to minimize selection bias, while the use of separate schools aimed to prevent contamination between the intervention and control groups.

Hypotheses

1. The intervention group's post-intervention BMI, weight, and subcutaneous adipose tissue scores will be lower than the control group.

2. The intervention group's post-intervention weekly average number of steps, daily water intake, health perception, days of physical activity per week, nutrition behaviors, nutrition self-efficacy, nutrition attitude, physical activity attitude, and stress management attitude scores will be higher than the control group.

Sampling and Recruitment

The current study population consisted of children with overweight and obesity attending the 2nd, 3rd, and 4th grades in primary schools with a capacity of 400 and above and a sports field in the garden in *****. Two socio-economically similar schools with these characteristics were included in the study. One of the schools was determined as the experimental group and the other as the control group by random drawing method. Thus, it was ensured that the control group was not affected by the intervention group.

Inclusion and exclusion criteria

Inclusion criteria for this study were to be between the ages of 8 and 11, to have a percentile of 85 percent to less than 95 percent (overweight) or 95 percent or more (obese), not have any physical, mental, chronic disease or disability, and the students and their families agreed to participate in the research. Exclusion criteria were not using any medication that could affect weight management.

Sample Size and Power

In the experimental and control group schools, firstly, the students' height and weight were measured and percentile calculations were made. Accordingly, in the experimental school N=72 and in the control school N=70 students with overweight or obesity were identified. Students and families were informed about the research topic and were contacted for their written and verbal consent. Afterwards, 60 students in the experimental group and 54 students in the control group who met the inclusion criteria were determined. In order to avoid bias in children selected in the experimental and control groups, a "random numbers table" was used. The minimum to provide $(1-\beta) = .80$ was calculated as at least 33 people per group in the G-power analysis. Considering the possibility of students dropping out of the research, 42 students in the experimental group and 40 students in the control group were included in the study. The sixth and ninth-month follow-ups of the program were made during the COVID-19 pandemic. Due to the COVID-19 outbreak, school change, and some children's unwillingness to continue, a total of seven children from the intervention and 11 children from the control group withdrew from the study, including the ninth month. To avoid stigma among children during the study, normal-weight children were included in the COP, but their data were not included in the analysis (Figure 1).

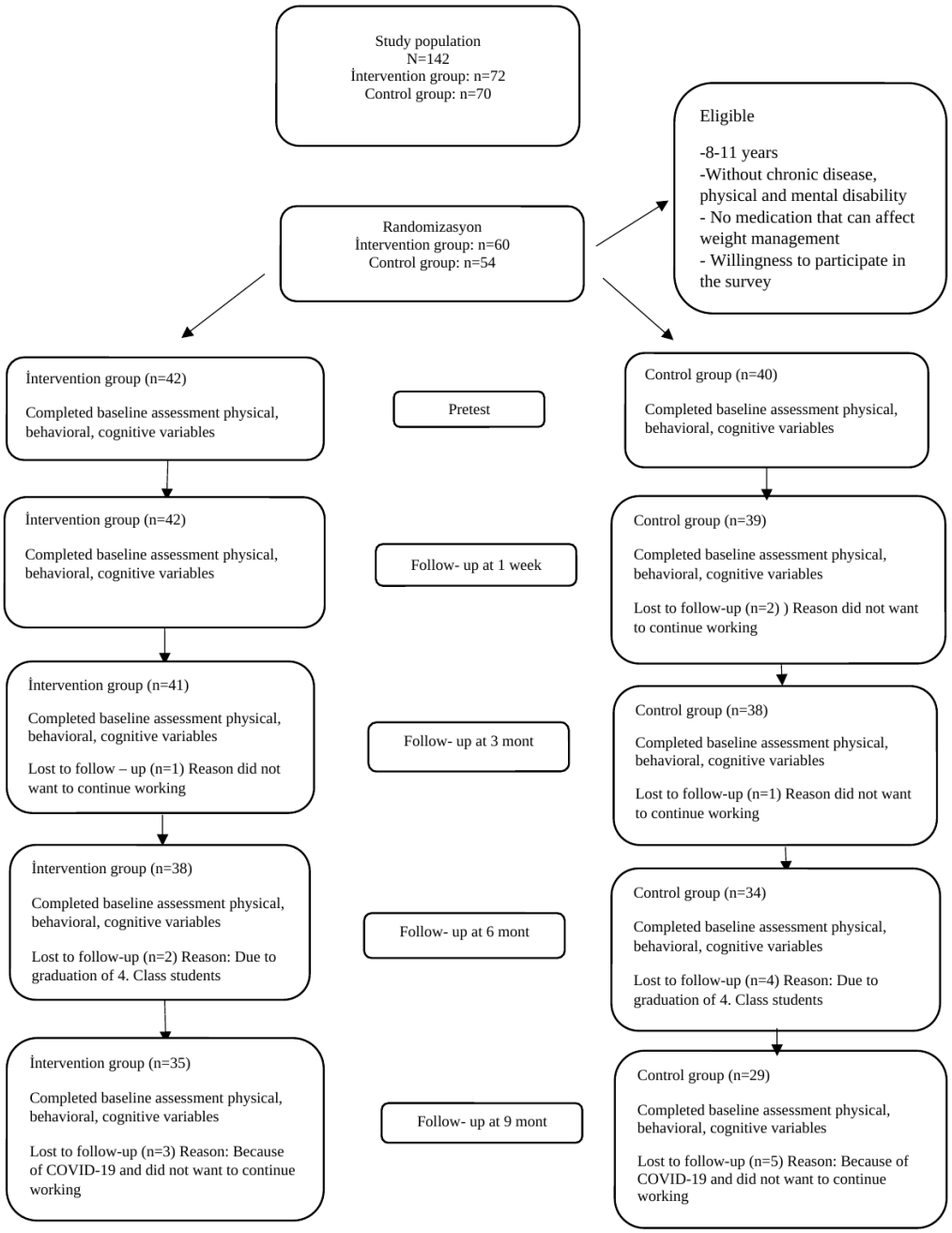

Figure 1. CONSORT followchart of the study

Intervention

The Child Obesity Program consisted of 10 sessions lasting 45 minutes, including physical activity, nutrition, and stress management. Theoretical topics were covered in the first 20 minutes of the sessions, and physical activity in the last 25 minutes. After the theoretical information was shared in the program, short assignments related to the topic of each session were given and these assignments were first discussed in the next week in class. Children were given an COP booklet before the program. Children were asked to share and discuss the information they learned each week with their parents. Session contents were sent to families as a newsletter; children were asked to share and discuss the information they learned each week with their parents. Students who could not attend the session due to an excuse were given the training of the session they could not attend until the next session. Children were also given pedometers and asked to record their step counts every day for ten weeks. Considering the role model effects of parents on children's behaviors, 60 minutes of nutrition and physical activity training was given to parents at the experimental school. All parents of the 42 children in the intervention group attended the educational session, resulting in a parental participation rate of 100%. A WhatsApp group was established with parents to share information about weekly homework assignments, program topics and the program process. The homework assignments and the number of steps

given to the children were checked by the parents, and their questions were answered via the WhatsApp group. In addition, to increase parent-child interaction, an event "We Cook Healthy Foods" was held with parents and children. Thus, it was ensured that children reinforced the theoretical knowledge they learned at school with parental support.

The children in the control group received a total of 50 minutes of physical activity, nutrition and stress management training. Pedometers were distributed to the control group simultaneously as the intervention group. After the end of the study, the COP program was applied to the children in the control group.

Measures

Socio-demographic form: The form includes questions about the child's age, grade, gender, nutrition and physical activity habits, parents' height, weight, educational status, family type, and how they perceive the child's health status. Parents were asked to answer the questions on the form.

Physical Variables

Physical variables were measured by weight, BMI, and subcutaneous adipose tissue thickness. The researcher measured the children's weight using a calibrated scale, removing their shoes and excess clothing. Body Mass Index was calculated using the percentile CDC calculator based on age and sex variables specific to children [20]. Subcutaneous fat tissue measurement was evaluated with "Skinfold Caliper". The tissue was grasped at a depth of approximately 1 cm with the caliper where the measurement was made. The caliper was placed perpendicular to the long axis of the region (1 cm) and paralleled to the ground. Prior to taking the measurement, the region was identified and marked. The measurement itself involved folding the skin, located approximately 3 cm from the belly button. The same pressure was applied on the fingers until the measurement was completed. The researcher made measurements while the child was standing upright. Physical variables were measured by the researchers while protecting the privacy of the children.

Behavioral Variables

The behavioral variables of the study include children's food behavior, daily water consumption and number of steps, days of physical activity per week.

Food Behavior Scale-FBS: Children's nutrition behaviors were measured by means of Food Behavior Scale. The scale was developed as part of the CATCH project to improve the heart health of children and youth in the USA (21,22). and adapted Turkish (23). The scale consists of 14 items and items are -1 for unhealthy food and +1 for healthy food, and the total score is between -14 and +14. A high total score from the scale indicates healthy eating habits. A high total score indicates healthy eating habits. In the present study, the Cronbach's α value of the scale was .55.

Daily Water Consumption Form: How many glasses of water the children drank per day was recorded by asking them in the first part of the form. One glass was rated at 200 ml.

Pedometer: The M4, Power:5V pedometer was used in the study to measure children's average weekly step count. A pedometer step counter was given to each of the children in the intervention and the control groups at the beginning of the study. Step counts were recorded by the children seven days a week for ten weeks. Children were instructed to remove their pedometers while bathing and sleeping. Pedometers are a valid and reliable tool to increase step goals and weight loss in childhood (24).

Days of Physical Activity Per Week: The number of days a week that the children did activities that required 30 minutes or more (cycling, basketball, football, running, swimming, game, and so on) to move quickly was measured using the socio-demographic form.

Cognitive Variables

The cognitive variables of the research were health perception, nutrition self-efficacy, nutrition attitude, physical activity attitude, and stress management attitude.

Children's Cardiovascular Health Promotion Attitude Scale (25,26): Children's nutrition, physical activity and stress management attitudes were measured by Children's Cardiovascular Health Promotion Attitude Scale. The scale has sub-dimensions of stress management, smoking, nutrition and exercise, and the smoking sub-dimension was not used in this study. There are four items in each sub-dimension. The items in the sub-dimensions are between 1 and 4 points (1-strongly disagree, 4-strongly agree). The total score for each sub-dimension is between 4 and 16. A high total score indicates a positive attitude. In the current study, the Cronbach's α value of the scale was .82 in the physical activity sub-dimension and .84 in the nutrition and stress management sub-dimensions.

Child Dietary Self-Efficacy Scale –CDSS (21,22): Nutrition self-efficacy of the children was measured with Child Dietary Self-Efficacy Scale. The scale was developed as part of the CATCH project to improve the heart health of children and youth in the USA (21,22) and adapted Turkish (26). The scale measures children's self-confidence in choosing less fatty and salty foods than fatty and salty foods. There are 15 items in the scale. Scale items are in the range of -1, +1 (-1: not

sure, 0: somewhat sure, +1: very sure), the total score is between -15 and +15. As the total score increases, the self-efficacy value also increases. In the present study, the Cronbach α value of the CDSS was .85.

Health Perception Form: The children were asked to choose one of the answers to the question "I believe my health is……" with a score between 1 and 4 (Excellent 4, good 3, moderate 2, poor 1).

Data Collection

This study was conducted in ****** between November 2019 and January 2021. The data were collected from children by face-to-face survey method. Students filled the scales and forms themselves. The research consisted of two stages. In the first stage, the children's height and weight were measured and overweight and obese children were determined. In the second stage, the experimental design of the research was applied. Anthropometric measurements of the children were made by the researcher with a sports management and nursing license, ensuring privacy and measurement confidentiality. Variables in both groups were measured by the researchers before the intervention (T0), in the first week after the intervention (T1), 3 month (T2), 6 month (T3), 9 month (T4) after the intervention. Figure 1 shows the design of the study.

Statistical Analysis

Data were analyzed with IBM SPSS Statistics 23 program. Categorical variables were calculated with frequency distribution, and numerical variables were calculated with descriptive statistics. Independent samples t-test was used to determine whether there was a difference between the two groups, the relationships between categorical variables were analyzed using chi-square, and the Repeated Measures ANOVA test was used for changes over time. An intention-to-treat (ITT) approach was applied, with missing follow-up measurements imputed using the last observation carried forward (LOCF) method. In statistical analysis, significance was accepted as 0.05 and confidence interval at 95% level [27]. The effect size of the significant difference in the measurements was calculated by Cohen's d effect size analysis. Cohen's d small effect size (≤ 0.49), medium effect size (0.50- 0.79), large effect size (0.80- 1.19), very large effect size (1.20 - 1.99), huge size (≥ 2.00) [28,29].

Ethical Considerations

Before starting the study, approval was obtained from the ethics committee of a Karabuk University (Date:18.6.2019, Number: 2019/11) and children and their parents were informed about the program and "informed consent" was signed. All study participants' parents or legal guardians granted written consent following the principles outlined in the Helsinki Declaration. The study was retrospectively registered at ClinicalTrials.gov (NCT04459130). The study commenced on November 20, 2019, and the registration record was first publicly released on June 26, 2020.

Results

Baseline Characteristics and Comparisons of Intervention and Control Groups

The mean age of the children was 9.21 ± 1.10 years. Of the participants, 45.1% were girls and 54.9% were boys. The baseline sociodemographic characteristics of the intervention and control groups, including age, gender, family type, family financial hardship, and parental education, are presented descriptively in Table 1. Baseline comparisons of physical, behavioral, and cognitive variables are presented in Table 2. The two groups were statistically similar in BMI, weight, subcutaneous adipose tissue thickness, child dietary self-efficacy, health perception, and weekly physical activity days ($p > .05$; Table 2).

Table 1 Characteristics of The Children at Baseline in the İntervention and The Control Groups.

Characteristics	Intervention n=42 M (SD)		Control n=40 M (SD)		Statistics	*p*
Age	9.02 (.95)		9.4 (1.24)		-1.540[a]	.128
	n	**%**	**n**	**%**		
Gender						
Famele	14	33.3	23	57.5	4.832[b]	.028*
Male	28	66.7	17	42.5		
Family type						
Immediate family	34	81	33	82.5		
Extended family	6	14.3	6	15	.422[c]	.100
Broken family	2	4.8	1	2.5		

Family financial hardship						
None	12	28.6	7	17.5		
Very little	11	26.2	10	25	1.853[c]	.600
Medium-level	17	40.5	21	52.5		
Too much	2	4.8	2	5		
Mother's education						
≤ secondary school	22	52.4	12	30	5.476[b]	.140
> secondary school	20	47.6	28	70		
Father's education[b]						
≤ secondary school	13	30.9	11	27.5	.861[b]	.835
> secondary school	29	69.1	29	72.5		

*M: mean, SD: standard deviation, a= t test, b= Chi-square, c= Fisher-Freeman –Halton Exact testi *p<.05,*

Table 2 Comparison of Children's Physical, Behavioral, Cognitive Variables at Baseline

	Intervention n=42	Control n=40	Statistics	
	M (*SD*)	M (*SD*)	*t*	*p*
Physical Variable				
BMI	22.73 (3.49)	22.28 (2.64)	.659	.132
Weigth	39.03 (8.28)	40.25 (8.91)	-.642	.523
Subcutaneous Fat Tissue Thickness	28.48 (7.08)	28.75 (5.00)	-.202	.841
Behavioural Variables				
Daily Water consumption (ml)	776.19 (226.11)	925.00 (281.70)	-2.644	.010*
Days of physical activity per week	3.57 (1.64)	3.25 (1.96)	.804	.424
FBS (min:-14,max:+14)	-1.43 (3.96)	-3.40 (4.69)	2.06	.043
Cognitve Variables				
Health perception	1.73 (0.54)	1.57 (0.63)	1.250	.053
Physical activity attitude	9.55 (2.25)	11.18 (2.73)	-2.952	.004*
Nutrition attitude	9.29 (2.45)	10.85 (2.78)	-2.706	.008*
Stress management attitude	11.76 (1.99)	13.05 (2.28)	-2.735	.008*
CDSS (min:-15,max:+15)	-3.98 (5.18)	-3.15 (7.12)	-0.598	.552

*M: mean, SD: standard deviation, *p<.05, CDSS: Child Dietary Self-Efficacy Scale, FBS: Food Behavior Scale*

Effect Results of Child Obesity Program on Children's Physical, Behavioral and Cognitive Variables

After the child obesity program, the children's BMI, subcutaneous adipose tissue and weight decreased significantly. In addition, the number of steps, daily water intake, health perception, physical activity, nutrition behaviors, nutrition self-efficacy, nutrition attitude, physical activity attitude, and stress management attitude scores of the children in the intervention group increased significantly after the intervention. These results support the research hypotheses.

Physical Variables

In the intervention group over the course of 9 months are as; BMI decreased from 22.73 at baseline to 18.11, weight decreased from 39.03 kg to 33.98 kg, subcutaneous fat tissue thickness decreased from 28.48 cm to 21.95 cm.

According to Repeated Measures ANOVA, BMI (F =39.20, p <.001), weight (F=36.33, p <.001), and subcutaneous adipose tissue (F=20.05, p <.001) changes of the children in the intervention group were significantly decreased in the post-COP measurements compared to the control group. In pairwise comparisons with Bonferroni correction test, significant differences were found T0 > T1(p <.01), T2 (p <.001), T3 (p <.001), T4 (p <.001) in BMI, T2 > T4 (p <.05), T3>T4 (p <.001) in weight and T0 > T1(p <.001), T2 (p <.001), T3 (p

<.001), T4 (p <.001) in subcutaneous adipose tissue. BMI-for-age Z-scores also decreased in the intervention group over the nine-month follow-up period. The mean BMI Z-score decreased from 2.45 ± 0.90 at baseline (T0) to 2.04 ± 0.93 at T1, 1.71 ± 1.00 at T2, 1.20 ± 1.15 at T3, and 0.55 ± 1.16 at T4. In contrast, the mean BMI Z-score in the control group changed from 2.16 ± 0.64 at baseline to 1.95 ± 0.98 at the ninth-month follow-up. Repeated Measures ANOVA indicated a statistically significant group × time interaction in BMI Z-scores (F = 65.72, p < .001), suggesting a greater reduction in age-standardized BMI in the intervention group than in the control group (Table 3).

According to Cohen's d results, the effect size of the program on the change in BMI was 'small' (.30) in 1st week, 'medium' in 3rd (.55) and 'large' 6th (.91) months, and 'very large' in 9th month (1.42), on the change in weight was 'small in 1st week (.06) and 3rd (.16), 6 th (.37) months, 'medium'(.65) in 9 th month. The effect size of the change in subcutaneous adipose tissue thickness was 'small' (.15) in the 1st week and 3rd month (.29), 'medium' in 6 th (.54) month, 'large' 9 th (.97) month (Table 3). According to Cohen's d analysis, the between-group effect size for BMI-for-age Z-scores was negligible at T1 (d = 0.05), small at T2 (d = 0.24), medium at T3 (d = 0.77), and very large at T4 (d = 1.30), indicating an increasing difference between the intervention and control groups over the follow-up period.

Behavioral Variables

According to Repeated Measures ANOVA, number of days of physical activity (F=30.08, p <.001), daily water consumption (F=59.98, p <.001), nutrition behaviors (F= 43.33, p <.001) were significantly higher in the intervention group compared with the control group. In Post hoc pairwise comparisons with Bonferroni correction test, significant differences were found in physical activity behaviors T0 < T1 (p <.001), T2 (p <.001), T3 (p <.001) T4 (p <.001), water amount T0 < T1 (p <.001), T2 (p <.001), T3 (p <.001), T4 (p <.001), nutrition behaviors T0 < T1 (p <.001), T2 (p <.001), T3 (p <.001), T4 (p <.001). The COP's program had a 'large' effect in the 1st week (1.13), 'very large' effect in the 3rd (1.40), 6th (1.80) months, 'huge' effect in the 9th month (2.0) in weekly physical activity days; a huge effect in the 1st week (2.75), in the 3rd (3.90), 6th (3.26), 9th (3.87) months in daily water consumption; a huge effect in the 1st week (2.27), in the 3rd (3.09), 6th (3.74), 9th (3.85) months in nutrition behavior (Table 3).

There was a significant difference between the experimental and control groups in the mean number of steps (F=3.24, p <.05). Children in the control group showed a lower increase in the average number of steps per week compared to the experimental group. Figure 2 shows the weekly step numbers of intervention and control groups with a graphic representation.

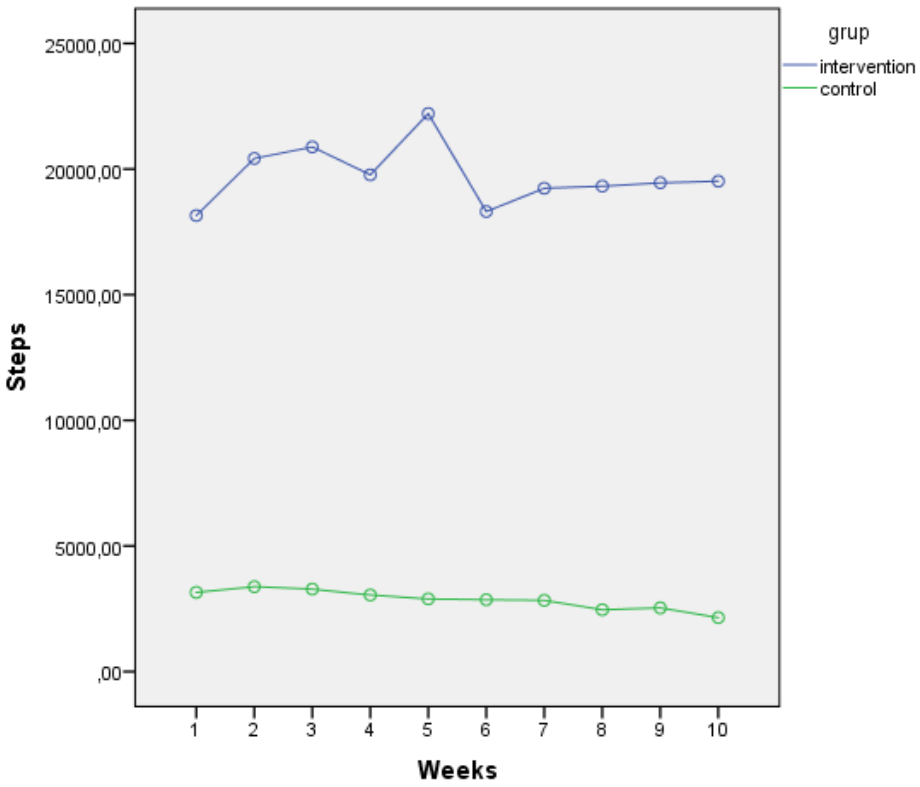

Figure 2. Children's Weekly Step Count Averages

Cognitive Variables

According to the Repeated Measures ANOVA, the children's physical activity (F=29.55, p <.001), nutrition (F=31.82, p <.001), and stress management attitudes (F=18.26, p <.001), nutrition self-efficacy (F=36.95, p <.001), and health perceptions (F=51.90, p <.001) were significantly higher in the intervention group compared with the control group. In pairwise comparisons with Bonferroni correction test, significant differences were found in physical activity attitude T0 < T1 (p <.001), T2 (p <.001), T3 (p <.001), T4 (p <.001), nutrition attitude T0 < T1 (p <.001), T2 (p <.001), T3 (p <.001), T4 (p <.001), stress management attitude T0 < T1 (p <.05), T2 (p <.01)T3 (p <.01), T4 (p <.001), nutrition self-efficacy T0 < T1 (p <.001), T2 (p <.001), T3 (p <.001), T4 (p <.001), and health perception of children T0 < T1 (p <.001), T2 (p <.001), T3 (p <.001). The effect size of COP on physical activity attitude was 'very large' at the 1st week (1.58), 'huge' in the 3rd (2.14), 6th (2.71), 9th (2.79) months; on nutrition attitude was 'very large' in the 1st week (1.47), in the 3rd (1.91), 'huge ' effect in the 6th (2.26), 9th (2.55) months; on nutrition self-efficacy was 'huge' effect in the 1st week (3.59) and in the 3rd (3.87), 6th (4.01), 9th (4.41) months; on health perception was 'huge' in the 1st week (2.93) and in the 3rd (3.24), 6th (3.87), 9th (4.13) months. The effect of COP on stress management attitude was measured as 'medium' in the 1st week (0·55), 'large' in the 3rd (1.09), 'very large' in the 6th (1.35), 9th (1.81) months (Table 3).

Table 3 Effects of Child Obesity Program on Outcome Variables.

Variables	**Groups Intervention (n=42) Control (n=40)**	**Baseline (T0) Mean (SD)**	**Post İntervention 1st Week (T1) M (SD)**	**3th month (T2) M (SD)**	**6th month (T3) M (SD)**	**9 thmonth (T4) M (SD)**	***F* / *p***
Physical Variable							
BMI	Intervention	22.73 (3.49)	21.65 (3.51) †	20.85 (3.28) ††	19.62 (3.29) †††	18.11 (2.97) ††††	**39.20 / <.001*** T0 >T1,T2,T3,T4
	Control	22.28 (2.64)	22.26 (2.82)	22.26 (3.54)	22.80 (3.41)	22.70 (3.29)	
Weigth	Intervention	39.03 (8.28)	38.45 (8.45) †	37.70 (8.19) †	36.00 (7.90) †	33.98 (6.97) ††	**36.33 / <.001*** T2 >T4, T3 >T4
	Control	40.25 (8.91)	40.92 (9.29)	41.66 (10.56)	43.32 (10.44)	43.74 (10.37)	
Subcutaneous fat tissue thickness	Intervention	28.48 (7.08)	27.39 (7.14) †	26.40 (6.99) †	24.74 (6.64) ††	21.95 (6.22) †††	**20.05 / <.001*** T0 >T1,T2,T3,T4
	Control	28.75 (5.00)	28.53 (5.35)	28.68 (6.41)	28.88 (6.70)	28.78 (6.69)	
Behavioural Variables							
Weekly physical activity days	Intervention	3.57 (1.64)	5.12 (1.02) †††	5.36 (.76) ††††	5.81 (.63) ††††	6.05 (.62) †††††	**30.08 / <.001*** T0 <T1,T2,T3,T4
	Control	3.25 (1.96)	3.75 (1.72)	2.80 (1.11)	2.70 (1.04)	2.45 (1.15)	
Daily water consumption (ml)	Intervention	776.19 (226.11)	1366.66 (202.02) †††††	1542.86 (161.00) †††††	1571.43 (259.72) †††††	1676.19 (237.68) †††††	**59.98 / <.001*** T0 <T1,T2,T3,T4
	Control	925.00 (281.70)	1020.00 (263.31)	930.00 (254.40)	900.00 (267.94)	905.00 (267.89)	
Nutrition behaviour	Intervention	-1.43 (3.96)	6.69 (3.14) †††††	8.60 (2.30) †††††	10.05 (1.75) †††††	10.79 (2.10) †††††	**43.33 / <.001*** T0 <T1,T2,T3,T4
	Control	-3.40 (4.69)	0.90 (4.96)	-0.70 (5.54)	-2.65 (3.77)	-3.60 (4.06)	

Cognitve Variables							
Physical activity attitude	Intervention	9.55 (2.25)	13.21 (2.38) †††	14.05 (1.94) †††	14.90 (1.65) †††	15.00 (1.59) †††	**29.55 / <.001***
	Control	11.18 (2.73)	12.80 (2.05)	11.63 (2.50)	10.68 (2.26)	10.63 (2.48)	T0 <T1,T2,T3,T4
Nutrition attitude	Intervention	9.29 (2.45)	12.62 (2.04) †††	13.29 (1.64) †††	14.20 (1.88) †††	14.81 (1.82) †††	**31.82 / <.001***
	Control	10.85 (2.78)	12.23 (2.02)	11.03 (2.37)	10.30 (2.32)	10.30 (2.08)	T0 <T1,T2,T3,T4
Stress management attitude	Intervention	11.76 (1.99)	12.83 (1.83) ††	13.81 (1.76) †††	14.29 (1.74) †††	15.00 (1.55) †††	**18.26 / <.001***
	Control	13.05 (2.28)	13.05 (2.09)	12.60 (1.75)	12.35 (1.75)	12.18 (2.24)	T0 <T1,T2,T3,T4
Nutrition self-efficacy	Intervention	-3.98 (5.18)	11.07 (2.87) †††††	11.67 (2.40) †††††	12.67 (2.76) †††††	13.57 (2.20) †††††	**36.95 / <.001***
	Control	-3.15 (7.12)	5.15 (4.96)	3.48 (4.31)	0.03 (4.32)	-0.45 (4.25)	T0 <T1,T2,T3,T4
Health perception	Intervention	1.73 (.54)	3.23 (.48) †††††	3.50 (0.55) †††††	3.73 (.49) †††††	3.88 (.50) †††††	**51.90 / <.001***
	Control	1.57 (.63)	1.72 (.78)	1.82 (.54)	1.70 (.56)	1.45 (.55)	T0 <T1,T2,T3

*M: mean, SD: standard deviation, *p<.05, F= Repeated Measures ANOVA / Bonferroni post-hoc test, □ small effect size, □□ medium effect size, □□□ large effect size, □□□□ □□□□□ hug effect size*

Discussion

Childhood obesity, which has become a global crisis in public health, is increasing in Turkey and the world [3]. The results of this study revealed that COP is effective in reducing obesity in Turkish children aged 8-11 years.

After ten weeks of COP, there was a decrease in BMI, weight, and subcutaneous adipose tissue thickness of the children in all follow-ups (p <.001). The weight reduction were similar to the COPE Health Teen and ASGE-FABES results (5,30). In different randomized controlled school and family-based studies covering 6 - 12 age groups with at least six months of follow-up, a statistically significant decrease was found in children's mean BMI and weight, similar to the current study (9,31-33). Unlike the current study, no difference was found in the BMI values of children in some the obesity intervention programs (34,35). It was reported that the social isolation experienced during the COVID-19 pandemic in children and adolescents would cause an increase in body fat accumulation (36, 37). In the COP, decreased BMI, weight, and subcutaneous adipose tissue continued in the sixth and ninth months in the intervention group during COVID-19 social restrictions in Turkey (Table 3).

The results showed significant differences in behavioral variables between the intervention and control groups. In the intervention group, there was an increase in the average number of steps per week, the number of physical activity days, daily water consumption, and nutrition behaviors of the children compared to the control group (Table 3). Adequate physical activity levels in children are essential for mental, physical, and social well-being (38). It is also noted that walking is vital as a form of physical activity, and it is helpful to convert it into pedometer-based step goals (24). Similar results were found in different studies using pedometers (24,39). and investigating physical activity (18,34). in the literature. Studies evaluating water intake in obesity interventions in Turkey are insufficient. In this study, the daily water intake of the children in the control group at the baseline was significantly higher than the children in the experimental group. However, after the intervention, the daily water intake of the children in the experimental group was higher than the control group with a huge effect size. Similar to the current study, it was revealed in the program's results conducted on adolescents in Turkey that the amount of water increased (5). Obesity interventions often place a strong emphasis on improving the nutrition behaviors of children (1,31). COP provided positive changes in the short and long-term significant effect size of children's healthy nutritional behaviors (Table 3).

Understanding attitudes in children is essential for promoting child health because attitudes come before behaviors and affect future behaviors (35). Child

Obesity Program supports the notion that "If we think positively, we feel and act positively". This study conducted in Turkey focused on addressing obesity in the age group of 8-11 by simultaneously examining the attitudes towards nutrition, physical activity, and stress management, which had not been done before. At the beginning of the study, the children in the control group had higher attitudes towards nutrition, stress management, and physical activity compared to the children in the intervention group. At the conclusion of the follow-up period, the children in the intervention group exhibited a greater increase of improvement in physical activity, nutrition, stress management attitudes, nutritional self-efficacy, and health perceptions when compared to the control group (Table 3). The moderate and robust effect of COP in children's stress management in unchangeable and unpredictable events can be considered the program's effective success. In the literature, few obesity intervention studies such as COP or similar aimed to reduce psychological problems such as stress, depression and anxiety in children. Similarly, a significant change was found in BMI, depression level and health belief scores in these studies (5-7).

In the current study the importance of increasing nutrition self-efficacy in children is supported by the reduction in BMI in the intervention group. The current research findings align with prior studies that assessed nutrition attitudes in programs designed to reduce obesity (40). How health is perceived is vital in developing healthy lifestyle behaviors (41). The BMI values of the children in the intervention group decreased in the follow-ups after COP, and the health perception scores increased. In a similar study, it was found that children's perception of health increased as BMI decreased (33).

The COP has provided an opportunity for children and families to effectively manage obesity in changing environmental conditions such as the COVID-19 pandemic. Therefore, the success of the COP program in practice is important in the formulation of public health policies. The COP program is expected to fill the gap for obesity manage.

Strength and Limitations

Strengths of this study include a random selected sample, parental involvement, a longer follow-up period, and a clear presentation of intervention methods based on evidence. As the authors, we think that the involvement of the parents in the research increases children's compliance in subjects such as pedometer use and homework tracking. In addition, the current study contributes to the literature by examining physical, behavioral, and cognitive variables related to childhood obesity together. However, the relatively low internal consistency of the Food Behavior Scale (Cronbach's α = 0.55) represents a limitation of the study, as it may have increased measurement error and reduced the precision of nutritional behavior scores. Therefore, findings related to nutritional behavior should be interpreted with caution. The collection of the sixth and ninth month follow-ups of the study during the COVID-19 pandemic was also an important limitation of the study. In these follow-ups, it was difficult to reach children due to the pandemic, and some of the families did not accept the collection of data from children. Gender was not homogeneously distributed in both groups, as participation in the study was based on unchangeable conditions such as volunteerism. Another limitation is behavioral and cognitive variable data were based on children's self-reports. Although the two schools were randomly assigned to the intervention and control groups using a simple random drawing method, and eligible children were randomly selected at the individual level within each school, the inclusion of only one school per study arm represents a methodological limitation. Statistical analyses were conducted at the individual level; however, the potential influence of school-specific characteristics could not be adequately separated from the intervention effect. Furthermore, the limited number of schools prevented reliable estimation of between-school variability and adjustment for clustering. Consequently, the individual-level analyses may have underestimated standard errors and overstated statistical significance. Therefore, the findings should be interpreted with caution, particularly regarding causal inference. Future studies involving a larger number of randomly allocated schools are recommended to confirm these findings. Additionally, BMI-for-age Z-scores were estimated using age recorded in completed years rather than exact age in months. This approach may have introduced some imprecision in age-standardized BMI estimates. Therefore, the BMI Z-score findings should be interpreted with caution.

Recommendations for Further Research

There is a need for parent-oriented programs to be used by professional nurses, including multiple behavioral changes to manage overweight and obesity in children aged 8-11. The results of the study support public health nurses to carry out school-based studies in the intervention of childhood obesity. The COP which focuses on improving child health, can be used in evidence-based studies by school health nurses, which is a sub-branch of public health nursing.

Conclusion

Primary school children participation in the COP gained healthy nutrition and physical activity behaviors, had increased stress management skills and maintain them over a nine month period. It was also seen that this effect continued even under pandemic conditions. These findings suggest that the program may contribute to improvements in children's health-related behaviors and outcomes; however, further studies involving a larger number of schools are needed to confirm its effectiveness.

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