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Keywords

physical activity, primary school, psychology, self-perception, student

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Article

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1. Introduction

In today's world, obesity is an issue not only for adults but also for children [1]. The obesity prevalence in children was found to be around 20%, and the number of obese children has risen dramatically from 11 million to 124 million during the past four decades, and an additional 216 million children have been estimated to be overweight [2]. Although there are multiple reasons for childhood obesity, a sedentary lifestyle seems to be the major reason in the case of otherwise healthy children [3]. Children have great energy metabolism that is metabolically comparable to well-trained elite athletes [4], but today's children spend more than four times less energy than their counterparts of 60 years ago did [5]. As a result, obesity is considered an epidemic that negatively affects health status both in adults and children [6].

Obesity does not only increase individual health risks, such as high blood pressure, type 2 diabetes, risk for cancer, stroke, and arthritis [7], but it also leads to some psychological consequences [8] by affecting the individuals' level of self-esteem and their quality of life [9]. More specifically, childhood obesity significantly affects various psychological parameters of children and adolescents. Obese and overweight children are at a higher

risk of low self-esteem [10] and poor emotional well-being [11]. Obesity during late elementary school and early adolescence may be related to depressive and negative mood states [12, 13], victimization at school [10], psychological stress and anxiety [14], along with lower levels of self-perceptions [9]. This may be coupled with loneliness and body image dissatisfaction [10]. Obese and overweight children have negative perceptions of their physical appearance and lower self-competence [15]. Overweight children received more negative peer reactions when compared to their non-obese counterparts [16]. All of the aforementioned effects can lead to symptoms of psychopathology which, in turn, may lead to reduced life satisfaction as well as negative quality of life [9, 18].

It is well-known that structured intervention programs are useful in preventing obesity-related health problems. Interventions applying effective weight management, motivating children and adolescents to be physically active, and enhancing positive reinforcement strategies may support self-perceptions, which are crucial for children and adolescents' choice of their participation in sports and physical activity [17]. Although physical consequences of childhood obesity were frequently studied, non-physical dimensions, especially self-perception, were less frequently considered, but it is important to keep in mind that obese children are socially, emotionally, and psychologically disadvantageous over their non-obese peers [19]. Obese children frequently experience social stigma [20], social isolation [21], and cruelty [22], which negatively affects their self-perception [20]. Obese children may lack the psychological resources necessary to engage in health-promoting behaviors aimed at lowering obesity and enhancing well-being if they have decreased and/or changed self-perception [23]. Self-perception can be assessed globally or in specific domains, such as physical appearance or athletic competence [24]. These domains were considered as the most important ones for children, and the level of importance gets higher, especially for obese school children. Studies revealed that overweight and obese children scored lower on aspects of self-perception when compared to their non-obese peers [25, 26]. Physical appearance is an important personal characteristic first noticed by others, and the impact of physical appearance on social interactions is very crucial [27]. Children with high BMI scores are prone to be socially isolated by non-obese children, as obese children were thought to be physically incapable, so, obese children are generally excluded from children's games. This social isolation is a challenging obstacle for obese children. They are not included in physical activities as they are obese, and they get fattier because they are not allowed and have less chance to take part in physical activities: it is a vicious circle that must be broken. This circle negatively affects athletic competence as well as physical appearance. It was previously reported and well-known that increased BMI was associated with lower self-perceptions of social acceptance and physical appearance, both of which have previously been reported [23, 26, 28, 29]. Self-perception in children, especially physical appearance, at the age of about 8 through 11 is a good predictor of health-comprising behaviors in adolescence [30, 31]. Preventing excess weight gain in children will promote their life satisfaction and self-perception.

Children spend most of their time at school, and these institutions should be the primary resources to promote regular physical activity [32]. Regrettably, children are not very active during an ordinary school day [33]. Research results suggested that promoting being active in school would help decrease sedentary behavior and tip the obesity "scale" back in the healthy direction [48]. It was previously reported that implementing physical activity interventions in schools caused improvements in children's health-related physical fitness components [35], obesity levels [36, 37], and psychological health [38]. Although different approaches regarding interventions to increase participation in physical activity are found in the literature, the findings of these studies seemed to converge. Though physical activity implementations differed by the researchers, the outcomes were similar to one another. The interventions ranged from 20 mins of aerobic activities for four times a week [37] to basic support for physical activity during breaks and lunch [36] and from home activities for 3 times per week for 20 mins [35] to a series of physical activity homework for 10 mins per day [38]. Along with the overall results, it was proved that

participating in physical activities regularly enhances the health status and reduces the risk of mortality [39]. Moreover, physical activity participation positively affects individuals' self-esteem levels [40].

Regular physical activity classes, namely Game and Physical Activities, allocated in the primary school curriculum in Turkey take place twice per week (only two school classes in total) [41], and the time allocated for physical activity for children is criticized for being inadequate. The general recommendations are known to be "exercise at least 3 times per week" to benefit from physical activity. Although physical activity for children is quite important, it was previously reported that almost half of the school managers cut significant time from physical education classes and dedicate this time to math and science. Such a managers' attitude was cited as a reason for a decline in the "three times per week exercise" recommendation. On the other hand, in the best possible scenario, physical education classes do not provide more than 20 minutes of mild-to-moderate physical activity per session. Even though physical education class is the main source of the weekly recommended exercise in schools, the desired minimum level of weekly exercise time to provide benefits for children's health cannot be reached [42]. When these reasons are summed up, it can be understood that the exercise opportunity for children in school, and consequently the beneficial outcomes of physical activity, are limited.

Keeping in mind the positive effects of obese children's participation in physical activity and its positive contributions to psychological variables, such as self-perceptions, the study aims to assess the effects of implementing 12-week planned exercise sessions in regular school physical education classes on obese elementary school children's fitness and their self-perception levels. By adding a full 60-minute exercise session per week to the children's weekly schedule (two times physical education classes weekly), the minimum weekly exercise recommendation (three times per week) is reached. This paper primarily focused on two facets of the influence of exercise: fitness and self-perception in obese school children. For research purposes, obese children were determined as the experimental group, and their physical and psychological attributes were examined. Then, a 12-week exercise plan was applied. The main hypothesis of the study was that attending a regular exercise program would decrease the level of obesity, increase self-perception levels, promote physical fitness levels, and positively correlate to self-perception and physical performance levels in obese primary schoolchildren. Since the strong association between obesity and psychological health has been shown clearly in adults [43], it was expected that implementation of a 12-week exercise intervention would contribute to obese schoolchildren's psychological health.

2. Materials and methods

2.1. Participants

The study sample consisted of 67 children (27 experimental, 20 obese controls, and 20 non-obese controls) aged 9-11 years, attending primary school in an urban area of the central Anatolian region in Turkey. Obese children were identified by examining school health record files. Children at Obese I or over BMI levels were listed, and an informatory meeting with their parents was arranged to explain the aim of the study. Children, whose parents/legal guardians gave written consent, participated in the study. The obese and non-obese control groups consisted of 20 children in each group. The children in the non-obese control group had BMIs in the healthy range, and their parents also provided written consent for participation. The number of the participants was calculated by using free-to-use G*Power (Version 3.1.9.7, Universität Kiel, Germany) statistical power analysis software. For the level of power for 0.8 (1-β) at the effect size (ϱ) of 0.5 and 0.1 α error probability, the recommended sample size was calculated as 21. Since it was predicted that the subject morbidity might occur during the 12-week program, the groups were set at 30 participants in each category, but it was concluded by losing a total of 23 participants.

The remaining number of subjects was enough to reach the statistical significance at 95% confidence level.

2.2. Permissions

Ethics approval was obtained prior to the study from the local university's Non-Interventional Research Ethics Committee (Protocol No: 2018-09). The institutional permission was also obtained from the local Directorate of Education.

2.3. Experimental exercise protocol

The exercise sessions were limited to once per week as the children participated in regular physical activity classes twice weekly. The experimental group attended 60-minute exercise sessions weekly for 12 weeks and the exercise sessions were held at the local university's sports hall. The workload of the exercise sessions was mild to moderate. Exercise intensity was assessed by using a medical pulse oximeter (Beurer PO 45, Beurer GmbH, Germany) during the exercise sessions. The exercise intensity was aimed to be between 45–75% of the maximum heart rate (MHR). In the first quarter of the experimental period (3 weeks), the exercise intensity was set to be between 45–55% of the MHR. The intensity was increased to 50–65% MHR in the second quarter (4–6 weeks) and then the rest of the exercise sessions (7–12 weeks) were carried out with an intensity of up to 75% MHR. A gradual increase in the intensity was applied to prevent possible health problems due to a harsh increase in exercise intensity for obese students and to let the students have an adaptation period. Obese and non-obese control groups neither attended any planned exercises nor were their nutritional habits interrupted. The nutritional habits of the subjects were not controlled, and their diets were not restricted because the study aimed to focus on the sole effects of exercise on obese children's fitness and self-perception levels. The exercise sessions included children's games, basketball, badminton, coordination-based games, gymnastics, running games, etc. and each session lasted for 60 mins by combining some components shown in Table 1.

Table 1. Physical activity components to be selected for the sessions.

Activities	Loads	Time (mins)
Catch & Run game	The exercise intensity varied as the schedule progressed. Detailed information about the loads was given above (in text).	20
Hopscotch		20
Basketball dribbling game		20
Hops and jumps on the gymnastics mat		20
Rolls on the gymnastics mat		20
Swinging and crossing on the monkey bar		20
Jump rope (individual, team, and group)		20
Teamwork activities (carrying, building, pulling…)		20
Noodle foam activities (catching, throwing, jumping…)		20
Badminton games (carry ball on racket, hit the target…)		20
Imitating animal walks (bear, wounded bear, rabbit…)		20

2.4. Anthropometric measurements

Participants' ages were determined as accurate to one month by extracting the birth year and month from the current year and month. Height was assessed by using a Seca 213 portable stadiometer as 1/10 cm. Weight and body fat percentages were assessed by using the Tanita BC 418 body composition analyzer. The testing protocol suggested by Tanita was strictly followed. The body mass index (BMI) was calculated by dividing weight by squared height in meters (kg/m^2). BMI cut-off points were used as recommended by Cole et al. [44].

2.5. Aerobic fitness assessment

The participants' aerobic performance was assessed by using the 550 meter walk/run test. Children were instructed to cover the 550-meter track as fast as possible by running and/or walking. The time (in secs) to cover the 550-meter track was recorded. A standardized warm-up, consisting of 3 min of light jogging (pace: nearly 7 km/h) and directed stretching of the lower limbs were applied before the test [45].

2.6. Flexibility test

Flexibility was tested by using the sit-and-reach standard test protocol [46]. The participants were guided to warm up, and they were asked to reach as far as possible and stay still there for at least 2 secs. The distance was read on the scale, in 1/100 m.

2.7. Muscular fitness

A digital hand grip dynamometer (Takei Kikki Kogyo, Japan, Model: A5401) was used to test hand grip strength. The participants were encouraged to show their best performance. This test was repeated twice for both hands. Full recovery resting periods were provided between trials, and the best performance was recorded in 1/10 kg. Relative handgrip strength was calculated by dividing the total handgrip performance by the body weight. Muscular endurance was tested by applying a sit-up test [47]. The test was carried out until the children were unable to complete a proper sit-up cycle and the number of correct sit-ups was recorded.

2.8. Self-perception assessment

Self-Perception Profile for Children (SPPC) developed by Harter [48] was used as a pre- and post-test to assess participants' self-perception levels. SPPC is a 36-question measure of self-perception for children aged 8 and/or above and it provides scores in five domains of self-perception: scholastic, social, athletic, physical appearance, and behavioral, as well as a global self-worth subscale. Internal reliability scores are extremely high and quite acceptable ranging from .71 to .91 (Cronbach's alpha) for the different domains, and the tool has a satisfactory test-retest reliability [48].

2.9. Data analysis

Mean and standard deviation ($\bar{X}$ ±SD) values of the variables were presented by groups in Table 2. Differences among groups were analyzed by using analysis of variance (ANOVA). Inter-group analysis was done by using LSD as the post hoc test. Reliability analysis results revealed acceptable levels of internal consistency (α >.76).

3. Results

Percentages and BMI classifications of the subjects at the pre-test were presented in Table 2. Differences among groups were also analyzed and summarized. ANOVA results revealed that there were statistically significant differences between/among groups in height ($F_{2,61}$ = 4.362, p < .05, η^2 = .12), weight ($F_{2,61}$ = 40.808, p < .01, η^2 = .56), BMI ($F_{2,61}$ = 57.540, p < .01, η^2 = .64), PBF ($F_{2,61}$ = 90.011, p < .01, η^2 = .86), 550 m run ($F_{2,61}$ = 3.480, p < .05, η^2=.31), sit-ups ($F_{2,61}$ = 3.458, p < .05, η^2 = .31), and relative handgrip strength ($F_{2,61}$ = 21.456, p < .01, η^2 = .40).

No differences were observed among groups in any subscale of self-perception (p > .05). LSD as post hoc suggested that non-obese controls were significantly better than both experiment and obese controls in BMI, PBF, 550 m run, sit-ups, and relative handgrip strength (p < .05) (Table 2).

Table 2. Characteristics and differences among groups (pre-test).

Variables	(1) Experiment (n = 27)	(2) Non-obese control (n = 20)	(3) Obese control (n = 20)	F	*diff*	η^2	α
	$\bar{X} \pm SD$	$\bar{X} \pm SD$	$\bar{X} \pm SD$				
Age (year)	9.07 ±0.62	8.90 ±0.85	9.15 ±0.81	0.587		.02	
Height (cm)	135.09 ±7.07	131.10 ±7.74	137.58 ±6.09	4.362**	3>2	.12	
Weight (kg)	42.20 ±7.04	27.14 ±4.24	42.91 ±7.15	40.808*	1>2, 3>2	.56	
BMI (kg.m^{-2})	23.04 ±2.81	15.70 ±1.20	22.60 ±2.98	57.540*	1>2, 3>2	.64	
PBF (%)	32.36 ±4.71	17.46 ±2.29	30.89 ±4.29	90.011*	1>2, 3>2	.86	
550 m run (s)	266.63 ±34.29	241.65 ±36.28	266.6 ±36.17	3.480**	1>2, 3>2	.31	
Sit-and-reach (cm)	15.52 ±6.86	16.25 ±4.27	15.35 ±6.03	0.133		.01	
Sit-ups (rep)	22.37 ±20.55	40.9 ±33.85	28.40 ±14.87	3.458**	2>1, 2>3	.31	
Relative strength (kgs)	0.62 ±0.13	0.90 ±0.20	0.68 ±0.12	21.456*	2>1, 2>3	.40	
Scholastic comp. (pts)	19.44 ±4.09	18.30 ±3.40	18.45 ±3.68	0.655		.02	.78
Social comp. (pts)	16.11 ±3.39	17.30 ±3.13	16.80 ±3.12	0.798		.02	.76
Athletic comp. (pts)	16.52 ±3.70	17.85 ±2.32	16.75 ±3.48	1.019		.03	.82
Physical app. (pts)	16.11 ±3.46	17.20 ±2.97	17.60 ±3.12	1.370		.04	.80
Behavioral cond. (pts)	18.93 ±3.72	18.10 ±3.09	19.25 ±2.51	0.689		.02	.77
Global self-worth (pts)	19.96 ±3.50	19.15 ±3.73	21.10 ±2.79	1.682		.05	.76

SD: Standard deviation, α: Cronbach's alpha, * $p < .01$. ** $p < .05$, *diff*: differences between groups, η: eta

Table 3 presents participants' post-test measurements. The results revealed that obese controls' self-perception levels have deteriorated, while the deteriorations in the experimental and the non-obese control groups were limited to scholastic competence and behavioral conduct. Improvements in social competence, athletic competence, physical appearance, and global self-worth subscales were observed. However, statistically significant differences were observed on social and athletic competence subscales. Differences among groups in anthropometric and athletic performance measurements remained almost the same.

Table 3. Post-test values in anthropometry and physical performance.

Variables	(1) Experiment (n = 27)	(2) Non-obese control (n = 20)	(3) Obese control (n = 20)	F	*diff*	η^2
Height (cm)	136.68 ±6.71	132.20 ±7.64	138.73 ±5.96	4.868**	1>2, 3>2	.13
Weight (kg)	43.54 ±7.02	28.42 ±4.56	44.29 ±7.03	40.994*	1>2, 3>2	.56
BMI (kg.m^{-2})	23.23 ±2.84	16.16 ±1.18	22.94 ±2.83	55.957*	1>2, 3>2	.64
PBF (%)	32.91 ±5.04	19.38 ±2.30	32.08 ±4.06	72.929*	1>2, 3>2	.70
550 m run (s)	259.11 ±28.27	241.50 ±36.39	275.25 ±37.28	5.042*	1>2, 3>2	.14
Sit-and-reach (cm)	17.00 ±6.28	17.55 ±4.14	15.90 ±5.88	0.453		.01
Sit-ups (rep)	32.33 ±22.58	47.55 ±37.04	28.40 ±16.89	2.990**	2>3	.09
Relative strength (kgs)	0.60 ±0.12	0.86 ±0.18	0.64 ±0.10	23.480*	2>1, 2>3	.42
Scholastic comp. (pts)	18.96 ±4.17	18.10 ±4.41	18.30 ±3.13	0.310		.01
Social comp. (pts)	17.96 ±2.75	18.25 ±2.34	16.50 ±3.00	2.456*	2>3	.07
Athletic comp. (pts)	18.89 ±3.26	18.70 ±2.89	16.40 ±3.65	3.806*	1>3, 2>3	.11
Physical appearance (pts)	17.56 ±3.12	18.45 ±2.52	16.95 ±3.59	1.181		.04
Behavioral conduct (pts)	18.81 ±3.00	18.00 ±4.17	18.40 ±2.35	0.368		.01
Global self-worth (pts)	20.11 ±3.03	19.65 ±4.44	20.90 ±3.45	0.612		.02

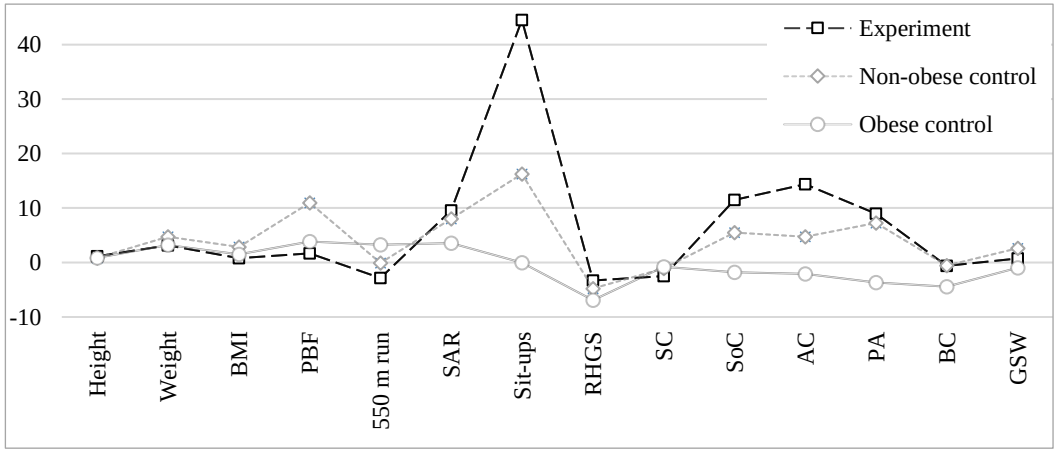
SD: Standard deviation, α: Cronbach's alpha, * $p < .05$, diff: differences between groups, η: eta

Table 4. Analysis of pre- and post-test differences.

Variables	(1) Experiment (n = 27)	(2) Non-obese control (n = 20)	(3) Obese control (n = 20)	F	*diff*	η^2
	$\bar{X} \pm SD$	$\bar{X} \pm SD$	$\bar{X} \pm SD$			
Weight (kg)	1.33 ±1.36	1.28 ±0.78	1.38 ±1.12	0.035		.001
BMI (kg.m^{-2})	0.19 ±0.64	0.45 ±0.43	0.34 ±0.59	1.262		.04
PBF (%)	0.55 ±1.63	1.92 ±1.39	1.19 ±1.81	4.090**	1<2	.11
550 m run (s)	-7.52 ±11.24	-0.15 ±5.22	8.65 ±6.64	20.729*	1<2<3	.39
Sit-and-reach (cm)	1.48 ±2.05	1.30 ±2.34	0.55 ±3.26	0.817		.03
Sit-ups (rep)	9.96 ±5.63	6.65 ±11.82	0.00 ±8.33	7.690*	1>3, 2>3	.19
Relative strength (kgs)	-0.02 ±0.07	-0.04 ±0.12	-0.05 ±0.11	0.525		.02
Scholastic comp. (pts)	-0.48 ±2.28	-0.20 ±3.29	-0.15 ±3.72	0.082		.003
Social comp. (pts)	1.85 ±2.71	0.95 ±2.91	-0.30 ±2.96	3.283**	1>3	.09
Athletic comp. (pts)	2.37 ±2.83	0.85 ±2.18	-0.35 ±2.70	6.356*	1>3	.17
Physical appearance (pts)	1.44 ±3.17	1.25 ±3.35	-0.65 ±2.87	2.902		.08
Behavioral conduct (pts)	-0.11 ±2.64	-0.10 ±3.37	-0.85 ±1.73	0.548		.02
Global self-worth (pts)	0.15 ±2.81	0.50 ±3.56	-0.20 ±3.61	0.226		.01

SD: Standard deviation, α: Cronbach's alpha, * $p < .01$. ** $p < .05$, *diff*: differences between groups, η: eta

Pre- and post-test differences were statistically tested. Results revealed that the 12-week intervention program had significant effects on PBF ($F_{2,61} = 4.090$, $p < .05$, $\eta^2 = .11$), 550 m run ($F_{2,61} = 20.729$, $p < .01$, $\eta^2 = .39$), sit-ups ($F_{2,61} = 7.690$, $p < .01$, $\eta^2 = .19$), social competence ($F_{2,61} = 3.283$, $p < .05$, $\eta^2 = .09$), and athletic competence ($F_{2,61} = 6.356$, $p < .01$, $\eta^2 = .17$). Differences between pre- and post-test measurements demonstrated that the experimental group had the least gain in PBF, while non-obese controls gained the most ($p < .05$). In 550 m run measurement, the experimental group improved its performance better than non-obese controls, and the obese controls' performance worsened. Improvement in sit-up scores of the experimental group was better than in both non-obese and obese controls. Obese controls did not achieve any change in sit-up scores between pre- and post-tests. Social competence and athletic competence scores of the experimental group significantly increased when compared to their obese counterparts ($p < .05$) (Table 4).



SAR: Sit-and-reach, RHGS: Relative handgrip strength, SC: Scholastic competence, SoC: Social competence, AC: Athletic competence, PA: Physical appearance, BC: Behavioral conduct, GSW: General self-worth.

Figure 1. Pre- and post-test difference percentages for variables in each category.

Change rates (calculated as percentages by using the following formula: pre-test subtracted from post-test and divided by pre-test) in participants' measurements were shown in Figure 1 as percentages. Change rates in height were similar in all groups. Change rates in the other anthropometric measures, weight, BMI, and PBF, were found to be in favor of the experimental group. The experimental group had the least gains in these measures. Physical performance changes were also in favor of the experimental group. 550 m run performance times were shortened in the experimental group while the non-obese group had no change and the obese controls' performance time was worsened. Change rates in sit-and-reach, sit-up, and relative handgrip strength performance revealed that the experimental group improved better than the other groups. In self-perception subscales, a satisfactory level of improvement was found in social competence and athletic competence. Obese controls had the lowest change rates in self-perception subscales except for scholastic competence. Non-obese controls had the best improvement in the general self-worth subscale.

Table 5. Multiple regression analysis for significant predictors of change in obese children's self-perception.

Variables		*B*	95% *CI* for *B*		*SE B*	*β*	*R*	R^2
			LL	*UL*				
Social competence	Model						.438	.192
	Constant	4.644	-0.294	9.581	2.359			
	Weight	-2.190	-6,223	1.843	1.927	-1.095		
	BMI	4.788	-3.508	13.084	3.964	1.128		
	PBF	0.046	-0.821	0.913	0.414	0.028		
	550 m run	0.090	-0.041	0.221	0.063	0.373		
	Sit-and-reach	0.254	-0.368	0.876	0.297	0.192		
	Sit-ups	-0.068	-0.283	0.147	0.103	-0.141		
	Relative strength	-8.329	-30.282	13.623	10.488	-0.209		
Athletic competence	Model						.558	.311
	Constant	3.275	-1.482	8.032	2.273			
	Weight	0.334	-3.551	4.219	1.856	0.160		
	BMI	-1.053	-9.045	6.939	3.818	-0.238		
	PBF	0.404	-0.431	1.239	0.399	0.232		
	550 m run	0.040	-0.086	0.167	0.060	0.160		
	Sit-and-reach	0.252	-0.348	0.851	0.286	0.182		
	Sit-ups	-0.173	-0.380	0.035	0.099	-0.343		
	Relative strength	-13.692	-34.840	7.457	10.104	-0.329		

Moreover, stepwise multiple regression analysis results disclosed that weight, BMI, PBF, 550 m run, sit-and-reach, sit-ups, and relative handgrip strength variables entered into the regression for both social competence and athletic competence which significantly differed between pre- and post-tests. For the social competence, these variables together were found to explain about 19.2% of the variance. The same variables explained about 31.1% of the total variance for the athletic competence (Table 5).

4. Discussion

As reported earlier, obesity at the global level (today called globesity) is affecting all individuals, including primary schoolchildren [48]. Along with excess calorie intake, insufficient physical activity and a sedentary lifestyle are accepted as the main factors of obesity [49]. BMI was found to be positively affected by attending physical activities and the experimental group had the least increase in BMI, compared to non-obese and obese

groups. Although the difference between groups was inadequate to reach a significant level, it is clear that the applied intervention had an effect on slowing the increase in BMI. Although BMI does not directly measure body fat, research has shown that BMI is correlated with more direct measures of body fat, such as skinfold thickness measurements, bioelectrical impedance, densitometry (underwater weighing), dual-energy x-ray absorptiometry (DXA), and other methods [44]. PBF measurements were also carried out to inspect the effects of physical activity on body composition, and results revealed that attending physical activities for 60 mins per week was not enough to observe significant differences in obese schoolchildren's body compositions. However, the results of the study demonstrate that PA had effects on the rate of increase in PBF. More specifically, the variations between pre- and post-tests in PBF were in favor of the experimental group. All three groups' PBF values increased during the study, but the experimental group had the least increase in PBF. Previous studies have shown that physical activity lowers the risk of obesity and that being physically active for 60 min/day decreases the risk of obesity by 7% [50]. Children's participation in a physical activity session for ≥60 min/day was recommended to prevent adult obesity [51].

Schools are unlikely to impact childhood obesity unless the physical activity sessions are supported by multiple sectors and environments [52]. This idea was also supported by the qualitative data acquired from the teachers [53]. It was also reported that the effectiveness of interventions to prevent childhood obesity was not supported, and the reason for this was thought to be due to disparities in anthropometric approaches and/or the type of measurement of body fat [54]. Results of the current study suggest that the opportunity for obese children to take part in physical activities in schools should be promoted by the school administration.

Participating in regular physical activity is well-known to have positive effects on obese children's fitness levels [55], but the effects may widely vary, and these are affected by various factors such as the type of the physical activity, obesity level, etc. In the current study, obese subjects' physical fitness levels increased statistically significantly in 550 m run and sit-up performance. Sit-and-reach performance also improved, but it did not reach a level of significance. All groups' relative handgrip strength deteriorated due to the increase in body weight, but the experimental group had the least deterioration. In 550 m run performance, the experimental group had the highest improvement, while their non-obese counterparts had minimal change, and the obese controls' performance highly deteriorated. Handgrip strength is an indicator of sarcopenic obesity in children [56], and the results of the relative handgrip strength test used in the current study revealed that attending physical activities contributed to obese children's strength, and the loss of relative strength was higher in both non-obese and obese controls. Similarly, in muscular endurance (measured by sit-ups), the increase rate in the experimental group was higher than in the obese control group. Although differences in relative handgrip strength and flexibility were not significant, it can be said that participating in physical activity contributed to obese schoolchildren's physical fitness levels. It was previously shown that physical activities enhanced the fitness levels of the obese schoolchildren [57]. The results of the current study were in line with the literature.

Furthermore, the results of the study revealed that non-obese children did better in physical performance tests. One reason for this may be that obese children feel nervous about failing in competitive games, such as running, chasing, and jumping, which children at primary school generally like, and other reasons may include being inactive and having lower levels of physical activity. These factors may also affect obese children's emotional development and have some side effects on self-perceptions because their body images are different than those with normal BMI, as the powerful correlation between body image and fatness was reported earlier [58]. Whenever an obese child feels himself/herself competent enough to efficiently attend physical activity, they will enjoy it and be eager to keep it going [59]. There seems to be a sense of self-confidence and satisfaction with oneself if a person manifests himself/herself with a higher sense of self-sufficiency.

Obese children have been previously shown to have negative body image and lower physical activity scores when compared to other children with normal BMI. Overweight children were found to be more sedentary and spend more hours watching TV and playing computer games [49]. When all these factors are combined, obese children seem to have a great disadvantage over their non-obese counterparts.

Obesity has not only physiological but also psychological and social effects on schoolchildren. Childhood obesity was reported as a detrimental factor for academic performance, and obese children were found to be four times more likely to report having problems at school than their normal-weight peers [18]. Another issue with being obese is that obese children are more likely to miss school more frequently, especially those with chronic health problems, and this can also negatively affect academic performance [60]. Results of the current study revealed that participants' self-perception scores were similar to those reported by Harter [48], and there were no differences in pre-test. However, post-test results revealed that the experimental groups' athletic competence scores were significantly higher than obese controls. Social competence scores were different at post-test, and obese controls scored significantly lower than non-obese controls. The change rate in social competence scores was in favor of the experimental group when compared to the obese controls. No statistical differences were observed in the other aspects of the self-perception scale. Even though the results did not reach a significant level, it is important to mention that participating in physical activities increased global self-worth. This finding concerns the experimental group, while the obese controls scored less in the post-test. It is clear that engaging in physical activity had positive effects on obese schoolchildren's self-perception levels, but in the literature, there is little consensus on the effects of physical activity on self-perception. Although it was suggested that exercise implementation had no effect on self-perception variables in inactive children aged 8–11 [61], some studies suggested that the effects of exercise on self-esteem were evident two years after first participation in physical activity [62, 63]. In addition, other studies documented that self-perception was associated with the level of physical activity [64]. Results of the current study suggested that attending physical activity contributed to the obese primary schoolchildren's general self-worth, athletic, and social competence levels. Athletic competence, which is achieved through participation in physical activity and through experiences of success, is one of the five types of competence, reported by Harter [48], and is crucial to a child's self-esteem. Moreover, social competence determines the sense of value that children have, making them evaluate their appearance favorably. As a result, they seem to be motivated to participate in more physical activity, reaping the benefits of this participation both physiologically and psychologically.

Implementations, limitations, and future research directions

Because of the small sample size of the current study, one should keep in mind that the results of the analysis are to be interpreted as preliminary. Future studies with increased sample size are needed. Furthermore, it can be clearly emphasized that school educators and physical education teachers should motivate schoolchildren to be active by participating in physical activities and group games to protect them from obesity. Being active will help the body image improve and positive psychological benefits will appear [65]. They should also provide opportunities for participation and success to all students, encouraging and praising individual improvement, which comes through personal efforts.

5. Conclusions

The main purpose of the current study was to investigate the effects of a 12-week physical activity intervention program on fitness and self-perception levels of obese primary school students. Results of the study revealed that participation in physical activities contributed to anthropometric, physical, and psychological aspects of obese schoolchildren.

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