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original article

Interdisciplinary intervention on body composition and physical fitness tests in obese children

Intervenção interdisciplinar na composição corporal e em testes de aptidão física de crianças obesas

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Abstract – Lifestyle changes are an important factor in the management and prevention of childhood obesity. The objective of this study was to analyze the effects of an exercise program (based on recreational activities) and nutritional counseling on body composition and physical fitness test performance in obese children. Forty-four children aged 8 to 11 years were divided into two gender- and age-matched groups, intervention (n = 22) and control (n = 22). Several parameters were measured before and after 12 weeks of participation in the program: weight, height, skinfold thickness (biceps, triceps, subscapular, suprailiac, abdominal and medial calf), circumferences (abdominal, arm, hip and calf) and the abdominal flexion and handgrip flexibility tests. The control group did not take part in the intervention. Thirty-two patients completed the study (16 in each group). The intervention group showed significant reductions in body mass index, triceps, subscapular and abdominal skinfold thickness, arm girth and sum of trunk skinfolds. There was a significant increase in right grip strength and abdominal strength. The control group showed a significant increase in body mass, waist circumference, subscapular and calf skinfold thickness, sum of trunk skinfolds, sum of limb skinfolds and arm and calf perimeters, as well as reduction in right hand grip strength. We conclude that the program was effective in reducing body fat and increasing physical fitness in children.

Key words: Body composition; Child; Motor activity; Obesity; Physical fitness.

Resumo – *A mudança no estilo de vida é um importante fator de tratamento e prevenção da obesidade infantil. O objetivo deste estudo foi analisar os efeitos de um programa de exercício físico baseado em atividades lúdicas e orientação nutricional na composição corporal e no desempenho em testes de aptidão física de crianças obesas. Fizeram parte do estudo 44 crianças com idades entre 8 e 11 anos divididas em dois grupos: grupo intervenção (n=22) e grupo controle (n=22) pareados por sexo e idade. Mensuraram-se antes e após 12 semanas do programa: massa corporal, estatura, dobras cutâneas (bíceps, tríceps, subescapular, supra-ilíaca, abdominal e de panturrilha medial), perímetros (abdominal, de braço, de panturrilha e de quadril) e desempenho em testes de flexibilidade, flexão abdominal e preensão manual. O grupo controle não participou da intervenção. Trinta e duas crianças completaram o estudo (16 em cada grupo). O grupo intervenção apresentou redução significativa do índice de massa corporal, das dobras cutâneas do tríceps, subescapular, abdominal, do perímetro do braço e da soma das dobras do tronco. Houve aumento significativo da força de preensão manual direita e abdominal. O grupo controle apresentou aumento significativo da massa corporal, do perímetro abdominal, da dobra cutânea subescapular, da panturrilha, da soma das dobras do tronco, da soma das dobras dos membros e dos perímetros do braço e da panturrilha medial, e redução no desempenho de força de preensão manual direita. Pode-se concluir que o programa foi efetivo em reduzir a quantidade de gordura corporal e aumentar os níveis de aptidão física das crianças.*

Palavras-chave: *Aptidão física; Atividade física; Composição corporal; Criança; Obesidade.*

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INTRODUCTION

Obesity is the object of increasing concern due to its high prevalence and association with a variety of disease conditions[1]. Studies have shown a substantial increase in the prevalence of overweight and obesity in several age ranges, including pediatric populations[2]. In some Brazilian cities, such as Florianópolis, state of Santa Catarina, the prevalence of obesity in children and adolescents is as high as 20%[3].

Genetic predispositions, inadequate dietary habits, and a sedentary lifestyle are some of the factors associated with development of childhood obesity, with sedentary behavior being one of the leading causes of diabetes in this age group worldwide[4]. Although regular physical activity is recommended for the prevention of cardiovascular risk factors[5], studies have shown that obese schoolchildren engage in less moderate-to-vigorous physical activity[6] and are less physically fit than their non-obese peers[7,8]; this provides evidence of an urgent need to increase physical activity levels in these children.

Leading a physically active lifestyle since childhood is associated with a wide range of benefits, not only in physical fitness but also in psychological, cognitive, and social aspects, and may boost prevention of chronic noncommunicable diseases. Moreover, engagement in physical activities during childhood may encourage healthier lifestyle choices in adulthood[9,10]. Conversely, low levels of physical activity may lead to impaired physical and motor performance; a decline in physical performance may in turn lead to frustration and avoidance of physical education (PE) classes or leisure activities[10]. Within this context, introducing physical exercise in the guise of play may ensure greater involvement in and adherence to proposed activities, justifying the use of leisure activities as a method of intervention in the present study.

Prior studies have detected positive effects of recreational physical exercise and nutritional guidance on the components of the metabolic syndrome[11] and reduction of overweight, fat mass, abdominal circumference, and blood pressure in obese children[12]. However, further studies are required on the use of recreational activities as physical exercise in obese children.

In view of the rising rate of child obesity[2], primary efforts should focus on prevention strategies. However, in children already affected by this condition, and particularly by its comorbidities, treatment is indispensable. The objective of this study was to analyze the effects of a recreational-based physical exercise program and dietary guidance on the body composition and physical fitness test performance of obese children.

METHODS

This was a controlled clinical trial. The initial population comprised children between the ages of 8 and 11 years, with a body mass index (BMI) above the 95th percentile according to NCHS criteria[13], recruited from

the outpatient pediatric cardiology and pediatric endocrinology clinics of Hospital Infantil Joana de Gusmão (HIJG) in Florianópolis, Brazil, between January and July 2009.

During the recruitment period, approximately 120 obese children between the ages of 8 and 11 were seen at the study clinics. Of these, 90 met the criteria for inclusion (age 8 to 11, BMI >95th percentile, seen at the aforementioned clinics, living in Florianópolis, and not taking part in any weight control programs other than follow-up at HIJG) and were invited by staff physicians to take part in the program. The parents of 77 children contacted the lead researcher and showed interest in enrolling their children in the study. Of these, 32 had morning classes and 45 had afternoon classes. Due to limited infrastructure at the Universidade Federal de Santa Catarina (UFSC) Sports Center, program sessions took place in the afternoon. Hence, children who attended school in the morning were allocated to the intervention group (n=32), and those who attended afternoon classes were allocated to the control group (n=45).

Several subjects were lost between initial contact and the start of the program: 10 in the intervention group (seven quit prior to the start of the program and three were excluded due to participation in other physical activities) and 23 in the control group (seven due to participation in other physical activities, eight due to failure to attend initial assessment, and eight who could not be matched to subjects in the intervention group). Therefore, each group comprised 22 obese children (11 boys and 11 girls) for a total of 44 gender- and age-matched subjects. Children in the control group did not take part in the intervention. All children (intervention and control groups) were instructed to maintain their usual level of activity and received exercise and dietary guidance from the HIJG staff during initial assessment, as is usually provided at the start of obesity treatment at any age.

This study is part of a larger project[14], in which sample size was calculated on the basis of a clinically significant difference of 15 mmHg in systolic blood pressure and a standard deviation of 15 mmHg in the population of obese children, with type I and II error rates of 5% and 20% respectively (pilot study), due to the nature of hypertension as a major risk factor and early determinant of cardiovascular consequences in childhood and adolescence[15]. Considering these parameters, the minimum sample size would be 16 subjects in each group. This was expanded by 25% to account for potential dropouts and loss to follow-up, and coincided with the number of children who agreed to see the program through[14].

After the start of the program, children who did not attend at least 90% of sessions were excluded from the sample[16], as were those whose parents or caregivers failed to attend dietary guidance sessions and controls whose matched subjects in the intervention group dropped out or were excluded from analysis.

All assessments were carried out at HIJG, between 0730 and 1200 h, up to one week before the start and one week after the end of the program.

A questionnaire was administered to the parent or caregiver of each

child to obtain a characterization of the sample profile. Data on sexual maturity, determined on the basis of the Tanner scale (pubic hair), were also collected[17].

Anthropometric parameters were measured according to the techniques recommended in the Anthropometric Standardization Reference Manual[18], except for abdominal circumference, which was measured after Fernandez et al[19]. Three measurements were obtained and the mean was used as the definitive result. All anthropometric parameters were measured by the same highly experienced examiner.

Body mass was measured with a digital scale (resolution 100 g, capacity 150 kg). Children were weighed while standing, barefoot, and wearing light clothes. Height was measured as the distance between the cranial vertex and plantar aspect of the feet, using a portable stadiometer (accurate to and with a resolution of 0.1 cm) mounted onto a wall with no skirting board. BMI was calculated as the ratio between body mass in kg and the square of the height in meters. Abdominal circumference was determined with a standard tape measure (resolution 0.1 cm), placed above the iliac crest, parallel to the floor, with the subject standing, relaxed abdomen, heels touching, and arms at side of body.

Biceps, triceps, subscapular, supra-iliac, abdominal, and medial calf skinfold thicknesses were measured with skinfold calipers (resolution 0.01 cm). Measures were always obtained from the right side of the body. Abdominal, arm, calf, and hip circumference were determined with a fiberglass tape measure (resolution 0.1 cm). Three nonconsecutive measurements were obtained and the arithmetic mean was used as the definitive result. All measurements were obtained by the same highly experienced examiner.

Flexibility was measured with the standardized "sit and reach" test, performed as recommended by the American Alliance for Health, Physical Education, Recreation and Dance[20], using a wooden box with a 0.5 cm-scale. Abdominal strength was determined using the number of correct sit-ups performed in one minute[20]. Upper body strength was measured as maximum grip strength in kg, as determined with a Jamar hydraulic hand dynamometer, with the best out of three attempts considered to be the definitive result.

The intervention program consisted of 12 consecutive weeks of physical exercise and dietary guidance (the latter provided to parents and children alike). Physical exercises took place at the sports gymnasium and/or soccer field (twice weekly) and swimming pool (once weekly) of the UFSC Sports Center.

Physical exercises were arranged into three 60-minute sessions per week, for a total of 36 sessions. Each session consisted of 5–10 minutes of stretching/warm-up exercises and 40–45 minutes of aerobic exercise, followed by a 5–10 minute cool-down period. Exercises were developed and programmed in advance by two professional coaches and a physical education major, and consisted of recreational activities (including walking, jogging, sprinting, adapted gameplay, trampoline, skipping rope, dancing,

and pool-based activities) of moderate to vigorous intensity[11,16]. In every session, the primary objective was to keep subjects active for the duration of the exercise period.

Exercises were planned so as to make subjects reach 65% to 85% of the target heart rate (HR)[16], as determined by the formula (target HR = 208 – 0.7 × age)[21]. Each subject wore a Polar S610i HR monitor throughout the physical activity period so as to ensure permanence at the target HR level. The first two weeks of the program were scheduled as an adaptation period, with lower-intensity activities. At the end of each session, HR monitor data were analyzed (using the proprietary Polar S620i software) to determine which activities had kept children within the target HR range. Also at the end of each session, children were provided guidance on the importance of keeping the healthy habit of regular physical activity.

Dietary guidance was provided by a UFSC dietitian and a group of undergraduate Dietetics students, and consisted of weekly informative/educational meetings with children and their parents, with the objective of encouraging the switch to healthier dietary habits. These meetings also included lectures on proper, balanced nutrition, using the adapted Brazilian food pyramid[22].

The paired and unpaired *t*-tests were used for within-group and between-group comparisons respectively, as all data were normally distributed. Statistical analyses were conducted in the SPSS 17.0 software environment. The significance level was set at $p<0.05$ for two-tailed tests.

The study was approved by the UFSC Research Ethics Committee with protocol no. 302/08. After conclusion of the study, all subjects continued to receive clinical follow-up at the service from which they had been recruited.

RESULTS

Of the 44 children who began the program, six in the intervention group did not complete it, thus leading to the exclusion of their counterparts in the control group. Therefore, 16 children (eight boys and eight girls) in each group completed the study. There were no significant differences in any study variables between completing participants and dropouts ($p>0.05$).

Mean age was 9.5 years in the intervention group and 9.4 years in the control group ($p=0.89$). All children attended public schools in the city of Florianópolis, Santa Catarina; had PE classes three times a week; were prepubertal or pubertal on the Tanner scale; and most belong to families with a monthly household income of two to five minimum wages.

A comparative analysis of body composition variables and performance on physical fitness tests showed no statistically significant between-group differences at baseline, with the exception of triceps skinfold thickness ($p=0.024$).

Table 1 shows the impact of the intervention program on body composition. Subjects in the intervention group had significant reductions in

BMI, triceps, subscapular, and abdominal skinfold thickness, sum of trunk skinfolds, and arm circumference, and significant increases in height. Conversely, subjects in the control group exhibited significant increases in body mass, height, abdominal circumference, subscapular and medial calf skinfold thickness, arm circumference, sum of extremity skinfolds, and sum of trunk skinfolds.

Four children in the intervention group went from obese at baseline to overweight at the end of the program, as determined by BMI.

Table 1. Body composition of subjects in both groups, pre- and post-intervention.

Variable	Intervention			Control		
	Pre (n=16)	Post (n=16)		Pre (n=16)	Post (n=16)	
	Mean ± SD	Mean ± SD	p	Mean ± SD	Mean ± SD	p
Mass (kg)	53,2±11,6	52,5±11,5	0,090	57,3±15,3	59,3±15,7	0,001*
Height (cm)	141,2±8,5	142,8±8,4	0,001*	141,5±8,1	143,0±8,1	0,001*
BMI (kg/m^2)	26,4±3,7	25,4±3,7	0,001*	28,3±5,1	28,7±5,3	0,060
BC (mm)	14,4±3,5	14,5±4,9	0,972	16,1± 3,5	17,3± 4,0	0,067
TR (mm)	22,4±3,3	20,76±2,6	0,033*	26,6± 6,0	28,1 ±5,2	0,082
SS (mm)	28,4±9,7	25,6±7,4	0,010*	29,8±10,3	33,8±10,8	0,023*
SI (mm)	45,3±11,1	41,4±11,6	0,134	46,8±12,8	47,5±15,9	0,835
AB (mm)	40,3±9,6	34,8±7,5	0,001*	43,2±12,4	46,0±13,1	0,175
MC (mm)	27,8±9,8	27,6±7,4	0,870	29,9±9,5	33,8± 9,1	0,032*
∑T	114,0±28,3	101,9±24,8	0,006*	119,9±30,5	127,3±32,3	0,048*
∑E	64,7±14,3	62,9±13,1	0,444	72,6±16,8	79,3±15,9	0,002*
G (cm)	87,5±9,5	86,4±10,0	0,060	90,7±12,0	94,3±12,0	0,001*
AC (cm)	27,8±2,9	26,9±2,8	0,003*	30,0± 4,8	30,5±4,7	0,047*
CC (cm)	34,5±3,9	35,1±3,8	0,331	35,9±3,7	36,6± 3,6	0,304
HC (cm)	89,2±16,7	86,2±18,6	0,568	89,8±20,3	93,9±14,3	0,450

BC = biceps skinfold thickness; TR = triceps skinfold thickness; SS = subscapular skinfold thickness; SI = supra-iliac skinfold thickness; AB = abdominal skinfold thickness; MC = medial calf skinfold thickness; ∑T = sum of trunk skinfolds (SS+SI+AB); ∑E = sum of extremity skinfolds (BC+TR+MC).
G = abdominal circumference; AC = arm circumference; CC = calf circumference; HC = hip circumference;
*statistically significant difference after 12 weeks.

At the end of the program, subjects in the intervention group had increased right hand grip strength and abdominal muscle strength. Conversely, subjects in the control group had reduced right hand grip strength (Table 2).

Table 2. Performance of subjects on physical fitness tests, pre- and post-intervention.

Variable	Intervention			Control		
	Pre (n=16)	Post (n=16)		Pre (n=16)	Post (n=16)	
	Mean ± SD	Mean ± SD	p	Mean ± SD	Mean ± SD	p
HGS_R (kg)	19.0±2.9	20.8±3.9	0.029*	21.2±5.2	20.0±5.0	0.034*
HGS_L (kg)	18.1±3.3	19.3±4.4	0.155	19.1±5.2	18.5±5.1	0.277
Flexibility (cm)	24.1±7.3	26.0± 7.1	0.146	25.0±7.6	24.8±5.6	0.830
Sit-ups (no.)	16.2±8.8	18.2± 9.4	0.036*	13.6±9.1	11.8±9.0	0.121

HGS_R = right hand grip strength; HGS_L = left hand grip strength;
*statistically significant difference.

DISCUSSION

The study results showed a positive impact of the intervention program on body composition parameters and performance on physical fitness tests, providing evidence of the benefits of recreational activity as a method for tackling childhood and youth obesity.

One of the strengths of this study was the use of a gender- and age-matched sample, minimizing the potential influence of these variables on adiposity and physical fitness indicators[23]. Furthermore, there were no statistically significant between-group differences at baseline, with the exception of triceps skinfold thickness, and no differences in any study variables between subjects who completed the intervention and those who did not.

In another study, an intervention program similar to that reported herein (12 weeks of physical activity and dietary guidance) yielded significant reductions in BMI and lipid parameters in a sample of obese children[11]. Reinehr et al.[12] reported reductions in BMI, waist circumference, triceps and subscapular skinfolds, body fat percentage, and blood pressure after a 6-month program of physical activity, dietary guidance, and behavioral support.

Other intervention programs using methods different from those reported in this study have also yielded similar results, using physical exercise with[24,25] or without[26] dietary guidance. The findings of these investigations were similar to those of the present study, which found that exercise and dietary intervention has a positive impact on measures of adiposity in obese children and thus constitutes an important tool in the battle against obesity. Even if participants remain obese, beneficial body composition changes are worthy of note, in view of the health issues associated with obesity[1,27] and of the fact that obese children are more likely to become obese adults[28]. Furthermore, improvements in physical fitness test performance will have played a major role in improving overall health in these children, as even moderate levels of cardiorespiratory fitness, flexibility, muscle strength and resistance, and adequate body fat percentage are very important to health and to the prevention of chronic and degenerative diseases[29]. A previous study[30] found that overweight and obesity were predictors of failure to perform well on health-related physical fitness tests in children. This should serve as a warning of the repercussions of excess weight to health in this population.

Another important finding of the present study was the significant increase in some indicators of adiposity and reduction in physical fitness test performance detected in the control group. These findings may be indicative of the harms of insufficient physical activity and inadequate dietary habits. The potential benefits of the intervention program on body weight management should be taken into account: the results of this study also show that a short program of monitored, recreational physical exercise and dietary guidance helps prevent increases in body fat percentage. The significant increase in abdominal circumference detected in the control group on reassessment after the intervention period suggests this is a

cardiovascular risk factor in the study population, in view of the positive association between central adiposity and cardiovascular risk[28].

One of the limitations of the present study was the lack of supervised control of the daily dietary habits of participants. This may have contributed to the lack of significant changes in some indicators of adiposity after the intervention. Furthermore, different variables may require different doses of physical exercise for a significant effect to occur. A longer intervention period or higher-intensity exercise might have produced superior effects on abdominal circumference, biceps, supra-iliac, and medial calf skinfold thickness, calf and hip circumference, hand grip strength, and flexibility. Moreover, the specificity of flexibility and strength exercises and the sensitivity of tests for exercise-induced change in these parameters could be called into question.

Sampling loss during the intervention period was higher than expected, even on comparison to a similar Brazilian study conducted on an adolescent population[24]. Some factors may have contributed to this limitation, such as difficulty reaching the study site, as many children required public transport to do so, and the difficulty of ensuring that a parent or guardian chaperone the child to every session, as this often conflicted with the work schedule of adults. The initial sample size was quite small; nevertheless, the study showed a significant difference in trunk skinfold thicknesses, which may indicate a clinically significant impact on the cardiovascular risk associated with central obesity.

It bears stressing that children were very receptive to most proposed activities, particularly to water based-activities. Heart rate monitor data show that subjects remained within target HR range for, on average, 40 minutes per session. Although we did not measure dietary intake, the importance of the dietary guidance meetings held throughout the program with the purpose of encouraging changes in dietary habits should not be underestimated.

CONCLUSIONS

The combined physical activity and dietary guidance program described herein, provided in addition to traditional physician follow-up, proved effective in reducing BMI, skinfold thicknesses (triceps, subscapular, abdominal, and sum of trunk skinfolds), and arm circumference, as well as increasing right hand grip strength and abdominal muscle strength.

The results of this study may suggest that programs designed to intervene on childhood and youth obesity by means of recreational physical activities and dietary guidance should be part of obesity management actions in this population group. There is great potential for implementation of the program described herein in other locations, as it is carried out in physical spaces that are widely available in other realities (soccer field, sports gymnasium) and uses low-cost equipment, usually available at schools and universities, to support recreational activities.

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