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## Original article

# Effects of physical exercises and nutritional guidance on the cardiovascular risk profile of obese children<sup>☆</sup>

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### A B S T R A C T

**Objective:** To analyze the effects of a supervised physical exercise and nutritional guidance program, conducted with a playful basis, on the cardiovascular risk profile of obese children. **Methods:** Forty-four children aged between 8 and 11 years, divided into two groups, were paired by gender and age: intervention group (n = 22) and control group (n = 22). The following parameters were measured before and after the intervention: body mass, height, waist circumference, total cholesterol, HDL cholesterol, LDL cholesterol, triglycerides, fasting glucose, high-sensitive C-reactive protein, blood pressure, and carotid intima-media thickness. Both groups continued their traditional medical treatment. The case group exercised with recreational activities three times a week during 12 weeks, and participated in a weekly nutritional guidance session. The control group did not participate in the intervention described. Descriptive statistics, paired and unpaired Student's t-test, Mann-Whitney's U test, and the Wilcoxon test were used, with a significance level of  $p < 0.05$ . **Results:** 32 children concluded the study (16 in each group). At the end of the study, the case group showed a significant reduction in the body mass index (BMI) ( $p = 0.001$ ), total cholesterol ( $p = 0.001$ ), LDL cholesterol ( $p = 0.001$ ), diastolic blood pressure ( $p = 0.010$ ), and average ( $p = 0.003$ ) and maximum ( $p = 0.002$ ) carotid intima-media thickness. The control group showed a significant increase in waist circumference ( $p = 0.001$ ), blood glucose ( $p = 0.025$ ), C-reactive protein ( $p = 0.016$ ), a reduction of HDL cholesterol ( $p = 0.012$ ) and total cholesterol ( $p = 0.042$ ), and an increase in the average ( $p = 0.012$ ) and maximum ( $p = 0.024$ ) carotid intima-media thickness.

**Conclusion:** The program proved effective in the reduction of obesity indicators and of the intima-media thickness, a direct and early signal of atherosclerosis.

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## Efeitos do exercício físico e da orientação nutricional no perfil de risco cardiovascular de crianças obesas

### R E S U M O

#### Palavras-chave:

Doenças cardiovasculares

Atividade física

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Criança

Recreação

**Objetivo:** Analisar os efeitos de um programa de exercício físico e orientação nutricional supervisionado, de caráter lúdico, no perfil de risco cardiovascular de crianças obesas.

**Métodos:** Quarenta e quatro crianças com idades entre 8 e 11 anos divididas em dois grupos pareados em sexo e idade: grupo intervenção (n = 22) e controle (n = 22). Mensurou-se, antes e após a intervenção, a massa corporal, estatura, perímetro abdominal, colesterol total, HDL-colesterol, LDL-colesterol, triglicérides, glicemia de jejum, proteína C reativa ultrasensível, pressão arterial e espessura médio-intimal carotídea. Ambos os grupos continuaram com acompanhamento médico tradicional. O grupo caso participou de 12 semanas de exercício físico, com atividades recreativas em três sessões semanais e uma sessão semanal de orientação nutricional. O grupo controle não participou da intervenção descrita. Na análise foram utilizados a estatística descritiva, o teste t pareado e o teste não pareado, o teste U de Mann Whitney e o teste do Wilcoxon, adotando-se nível de significância  $p > 0,05$ .

**Resultados:** Trinta e duas crianças completaram o estudo (16 em cada grupo). Ao final, o grupo caso apresentou redução significativa no índice de massa corporal (IMC) ( $p = 0,001$ ), colesterol total ( $p = 0,001$ ) e LDL-colesterol ( $p = 0,001$ ), pressão arterial diastólica ( $p = 0,010$ ) e espessura médio-intimal média ( $p = 0,003$ ) e máxima ( $p = 0,002$ ). O grupo controle apresentou aumento significativo no perímetro abdominal ( $p = 0,001$ ), glicemia ( $p = 0,025$ ), proteína C reativa ( $p = 0,016$ ) e redução do HDL-colesterol ( $p = 0,012$ ) e colesterol total ( $p = 0,042$ ) e aumento na espessura médio-intimal média ( $p = 0,012$ ) e máxima ( $p = 0,024$ ).

**Conclusão:** O programa foi efetivo na redução dos indicadores de obesidade e na diminuição da espessura médio-intimal, um sinal indireto e precoce da aterosclerose.

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## Introduction

Obesity is a chronic and currently epidemic disease whose prevalence increased in the last decades in various countries, including Brazil.<sup>1,2</sup>

In addition to the high prevalence, the relevance of childhood obesity has been increasing due to its association with several morbid conditions, such as diabetes mellitus type 2, systemic arterial hypertension, dyslipidemia, and atherosclerosis complications in adulthood.<sup>3,4</sup> Early endothelial dysfunction in obese children and adolescents, in which the carotid intima-media thickness is significantly greater than those with normal weight, is also described.<sup>5</sup>

The relationship between obesity and metabolic syndrome appears to be especially important in childhood, since excess weight has been considered a predisposing factor for this syndrome even at this age, diagnosed in approximately 40% of obese children.<sup>6</sup> Metabolic syndrome comprises the grouping of cardiovascular risk factors, such as arterial hypertension, central deposition of body fat, dyslipidemia, and insulin resistance.<sup>7</sup> Its importance in children and adolescents is increasing due to the association with early signs of myocardial damage and subclinical atherosclerosis.<sup>8</sup>

As a basic component of prevention and treatment of obesity, the early adoption of a healthy lifestyle should be considered, such as a balanced diet and regular practice of physical activities, preferably from childhood onwards.<sup>9</sup> In addition to the benefits of the prevention and treatment of diabetes associated with obesity and of metabolic syndrome,<sup>10</sup> regular physical exercises may also significantly improve the metabolic profile as an independent effect, even when the patient remains overweight.<sup>11,12</sup>

Physical exercise programs and nutritional guidance have been proved effective in the treatment of obesity and improvement of the lipid profile of obese adolescents.<sup>12</sup> However, when working with children, structured physical exercise programs, although effective, may be less welcoming, receiving lower adherence. Hence, physical exercises with recreational activities, due to being fun, may increase participation and adherence to the proposed activities during childhood, and may be a predictive factor for maintenance of regular physical activities during adolescence and adulthood.

Evidence regarding the efficiency of supervised interdisciplinary programs for obese children appears to still be fairly scarce, especially in Brazil, mainly regarding the effects on the thickness of the carotid artery after

interventions in children. Previous studies found positive effects of physical exercises through recreational activities and nutritional guidance on the components of the metabolic syndrome;<sup>13</sup> and in reducing excess weight, fat body mass, abdominal perimeter, and blood pressure<sup>14</sup> of obese children.

Given the outlined shortcomings, this study aimed to analyze the effects of a supervised physical exercise and nutritional guidance program, conducted with a playful basis, on the cardiovascular risk profile of obese children.

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## Methods

This was a controlled clinical test. The initial population of the study encompassed children aged between 8 and 11 years old and with a body mass index (BMI) above the 95<sup>th</sup> percentile according to criteria of the National Center for Health Statistics (NCHS).<sup>15</sup> Children were recruited consecutively at the cardiology and pediatric endocrinology outpatient clinic of the Hospital Infantil Joana de Gusmão (HIJG) in Florianópolis/SC, Brazil (state reference center for this disease) during the period from January to July, 2009. Inclusion criteria were: obese children aged between 8 and 11 years old, attended to at the clinic, and resident in Florianópolis/SC. Exclusion criteria were: participation in any type of structured interdisciplinary program for weight loss; or having any physical or mental disability that impaired participation in the program. All children who met the inclusion criteria and sought assistance in this period were invited by the institution's physicians to participate in the study. Also, posters about the program were attached to the institution's entrance hall, with a telephone number for contact. During the recruitment period, approximately 120 obese children aged between 8 and 11 years old were attended to at the outpatient clinic; 90 of them met the inclusion criteria.

Seventy-seven parents/guardians demonstrated interest in the participation of their children in the program. Of these children, 32 studied during the morning, and 45 during the afternoon. Due to the infrastructure available in Universidade Federal de Santa Catarina (UFSC) Sports Center, the program was developed during the afternoon. Therefore, children that studied during the morning were allocated to the intervention group ( $n = 32$ ), and those who studied during the afternoon, to the control group ( $n = 45$ ). Losses from the first contact until the beginning of the program amounted to ten in the intervention group, and 23 in the control group. Thus, each group initially comprised 22 children (11 females and 11 males per group), amounting to 44 obese children classified by age and gender. Children from the control group did not participate in the intervention, except for the traditional medical monitoring. All children, from both groups, were instructed to keep their regular activities during the study period, and received guidelines from the HIJG medical team, or from other units that monitored them, regarding the

maintenance of an active life style activities and healthy eating habits during the monitoring, as is usually done in the treatment of obesity at any age.

To calculate the size of the sample, a clinically significant difference of systolic blood pressure of 15 mmHg and standard deviation of 15 mmHg of the population of obese children in Florianópolis,SC (Brazil) were considered, with error type I of 5% and error type II of 20%, as it is the risk factor that first causes cardiovascular repercussions in childhood and adolescence.<sup>8</sup>

Considering these parameters, the minimum size of the sample would be 16 individuals in each group. To this number, 25% were added to account for potential losses and refusals; the resulting number coincides with the number of children that intend to participate.

After the beginning of the program, the following exclusion criteria were adopted: children from the case group that did not attend at least 90% of the sessions<sup>16</sup> and whose caretaker did not participate in the nutritional guideline sessions; and children from the control group whose case group pairs quit the intervention or were excluded from the analysis.

All children were submitted to valuations at HIJG in the morning, from 7:30 a.m. to 12:00 p.m., until one week before and one week after the beginning and termination, respectively, of the intervention program.

In order to characterize the sample, a pre-coded questionnaire with questions regarding socio-demographic and clinical aspects was completed by the child caretaker. Additionally, information regarding sexual maturity was also collected through self-evaluation, pursuant to Tanner's stages of maturity;<sup>17</sup> this study considered information related to pubic hair on both genders.

To measure the body mass, a 150 kg digital scale with an accuracy of 100 grams was used. The scale was calibrated before measuring, and the children were weighed standing, barefoot, wearing only shorts and shirts. A portable stadiometer was used to measure their height; it was mounted on a wall without baseboard and had a scale and resolution of 1 mm, using the vertex and the plantar region as reference points.<sup>18</sup> BMI was determined by the formula body mass (kg) divided by the square of height (m). Waist circumference was measured using a measuring tape with scale of 1 mm. The tape was placed above the iliac crest, parallel to the floor, with the individual standing with a relaxed abdomen, arms along the body, and feet close together. All anthropometric measurements were taken twice, always by the same evaluator, and were repeated in case of disagreement.

While measuring total cholesterol and fractions, triglycerides, blood glucose, and high sensitivity C-reactive protein, venous blood (4 mL) was also collected, observing 12-hour fasting. Total cholesterol and triglycerides were determined using the enzymatic method (SHOD-PAP, Merck®). HDL-cholesterol was determined directly after

precipitation of other lipoproteins.<sup>19</sup> LDL-cholesterol was calculated using the formula proposed by Friedewald et al.<sup>20</sup> Blood glucose levels were determined by the enzymatic method (glucose oxidase). C-reactive protein levels were determined using a highly sensitive immunonephelometry method.<sup>21</sup>

Systemic blood pressure was assessed through the auscultator method, with a mercury sphygmomanometer and cuff adjusted to the mid-upper arm circumference, pursuant to international guidelines. Two right arm measures were taken by an experienced physician: after five minutes of rest in the supine position and again approximately 25 minutes after the first measure, repeating another measure if the results of the previous two measures were above the 90<sup>o</sup> percentile for age, gender, and height.

All measures were taken approximately one hour after blood collection. A snack was served after blood collection and at least one hour before the measurements of blood pressure. For analysis purposes, the average of the two or three measurements was used.

The carotid intima-media thickness was assessed by a cardiologist, using a GE (Connecticut, USA) device, the Vivid i<sup>®</sup> model, with a 12-MHz linear transducer. Six pictures of each individual were taken, with a longitudinal view of the carotid bulb in arterial diastole, with the three clearest images subsequently selected. Each image was digitally read offline to determine the average and maximum carotid intima-media thicknesses. The average of the average values from each image, and the average of the maximum values from each image were calculated.

### ***Intervention Program*** ***Cardiometabolic Intervention Program in Obese Children Applied with a Playful and Interdisciplinary Basis (Programa de Intervenção Cardiometabólica em Crianças Obesas, Lúdico e Interdisciplinar – PICCOLI)***

The intervention program consisted of physical exercises with playful activities and nutritional guidance for 12 consecutive weeks.

Physical exercises took place in a gymnasium and on a field (twice a week) and in a pool (once a week), all located at UFSC Sports Center – CDS (Brazil). The exercises were performed in three weekly sessions, with the duration of 60 minutes each, amounting to 36 sessions. Each session consisted of stretching/warming up (5-10 minutes), a main part – aerobic physical activities (40-45 minutes), and relaxation (5-10 minutes). The exercises were previously prepared and developed by two professional physical educators, and consisted of recreational activities (e.g.: walking, running, circuit training, pre-sporting games, trampoline games, jump rope, dancing, and swimming pool activities) with a moderated to vigorous intensity.<sup>13,16</sup>

Activities were carried out aiming at achieving an intensity of 65% to 85% of the maximum heart rate,<sup>16</sup> indirectly determined by the formula (maximum heart rate = 208 – 0.7 x age).<sup>22</sup> The heart rate was individually monitored, through a Polar (S610i) heart rate monitor, during all activities, to ensure

its maintenance within the recommended range. After the exercises, monitor data were analyzed and transferred to a Polar computer program (S620i). At the end of all sessions, orientations on the importance of regular physical exercises were provided.

The nutritional guidance was provided by a nutritionist and a group of UFSC nutrition students, and consisted of weekly meetings with parents and children, with educational and informative purposes, aiming to encourage them to adopt healthier eating habits. In these meetings, lectures on nutritional guidance were given using the Brazilian food pyramid<sup>23</sup>. After explanations, the participants were encouraged to play games and fun activities related to the theme.

In order to analyze the data obtained, descriptive statistics procedures were initially performed, with the calculation of the average and standard deviation in variables with parametric distribution, and median and interquartile range in those with non-parametric distribution. Paired and unpaired Student's t-test were used for data with regular distribution; Mann-Whitney's U test and the Wilcoxon test were used in variables with non-regular distribution. All statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) 17.0, adopting a significance level  $p < 0.05$ , accepting that all tests were two-tailed.

This study was approved by the Research Ethics Committee of the UFSC (protocol No. 302/08). All persons responsible for the children were previously informed about the objective and design of the study, and those who accepted to participate signed an informed consent. All children were submitted to medical evaluation prior to being accepted in the research. After the end of the study, all children continued to receive medical care from the original service.

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## **Results**

Of the 44 children (22 in each group) that initiated the study, there was a loss of six children in the intervention group, and the study was concluded with 32 children (16 in each group). As the individuals were paired, their respective pairs from the control group were excluded. There was no significant difference between the individuals who concluded or abandoned the study ( $p > 0.05$ ).

The average age in the intervention group was 9.6 years and in the control group was 9.4 years ( $p = 0.625$ ). All children were students from public schools of Florianópolis/SC, had physical education classes three times a week, were at the prepubescent or pubescent stage of maturity, and most belonged to families with a monthly income between two and five minimum wages. In the intervention group, the time spent watching TV or using the computer was  $3.6 \pm 1.8$  hours/day, and in the control group the time was  $3.1 \pm 1.5$  hours/day ( $p = 0.460$ ). In the intervention group, one child was medicated for

dyslipidemia and one for gastroesophageal reflux disease. In the control group, one child was medicated for arterial hypertension, one for depression, and one for bronchial asthma. The other children in the groups did not take medications on a regular basis.

The comparative analysis of initial anthropometric and metabolic parameters demonstrated that there were no statistically significant differences between the groups in the pre-test (unpaired t-test or Mann-Whitney's test). However, the post-test showed that groups differed as to systolic blood pressure ( $p = 0.003$ ), diastolic blood pressure ( $p = 0.025$ ), C-reactive protein ( $p = 0.002$ ), and average intima-media thickness ( $p = 0.018$ ), with lower values in the intervention group, representing more satisfactory results.

Table 1 presents the impact of the intervention program on the anthropometric and metabolic profile. The intervention group showed significant reduction in BMI, total cholesterol, LDL-cholesterol, and diastolic blood pressure after the end of the program. No significant differences were observed regarding the remaining variables. Conversely, the control group presented a significant increase in waist circumference and in fasting glucose, as well as a reduction in HDL-cholesterol and in total cholesterol (Table 1). Data in the table indicate that the reduction in total cholesterol was observed in both groups; however, the reduction was almost twice as high in the intervention group when compared to the control group. Four children in the intervention group changed from the classification "obesity" to "overweight" by the end of the program.

Table 2 presents the results regarding the intima-media thickness, triglycerides, and C-reactive protein before and after the intervention. Significant changes regarding the average and maximum carotid intima-media thickness were found in the intervention group; while in the control group, there was a statistically significant increase in both average and maximum carotid intima-media thickness. No significant improvements were verified in other parameters analyzed after intervention in the case group. The control group showed an increase of the C-reactive protein in the post-test.

## Discussion

The results of this study evidenced the positive effects of the program on the cardiovascular risk profile of obese children, especially in the reduction of the BMI, total cholesterol, LDL cholesterol, diastolic arterial pressure, and carotid intima-media thickness in the intervention group. For the first time, the impact of a playful intervention program on the progress of atherosclerosis was demonstrated.

One of the strengths of this study was the fact that the sample was paired by gender and age, mitigating possible influences of these variables on the anthropometric and metabolic parameters during the study period.

Physical activities in this program had a recreational nature, emphasizing that this type of activity, together with nutritional guidance, also provides positive effects on obese

**Table 1 – Anthropometric and metabolic characteristics of before and after the intervention groups – PICCOLI study, Florianópolis, SC, Brazil, 2010.**

Variables	Intervention group			Control group		
	Before (n = 16)	After (n = 16)		Before (n = 16)	After (n = 16)	
	Average ± SD	Average ± SD	p	Average ± SD	Average ± SD	p
BMI (kg/m <sup>2</sup> )	26.6 ± 3.7	25.5 ± 3.8	0.001*	28.4 ± 5.2	28.7 ± 5.2	0.078
WC (cm)	87.6 ± 9.5	86.4 ± 10.0	0.060	90.7 ± 12.1	94.3 ± 12.0	0.001*
TC (mg/dL)	209.3 ± 49.2	184.8 ± 41.1	0.001*	192.7 ± 34.5	177.4 ± 24.7	0.042*
HDL-C (mg/dL)	58.6 ± 11.6	54.4 ± 14.0	0.375	60.5 ± 16.1	47.8 ± 18.7	0.012*
LDL-C (mg/dL)	130.9 ± 45.3	112.7 ± 40.7	0.001*	113.6 ± 27.1	107.8 ± 19.8	0.458
GL (mg/dL)	85.9 ± 8.8	85.1 ± 8.1	0.747	84.1 ± 8.1	87.9 ± 8.3	0.025*
SBP (mmHg)	111.5 ± 10.9	105.7 ± 6.3	0.053	114.4 ± 14.6	118.1 ± 13.8	0.362
DBP (mmHg)	70.3 ± 8.1	65.3 ± 7.5	0.010*	73.8 ± 14.9	70.7 ± 5.4	0.375

BMI, body mass index; WC, waist circumference; TC, total cholesterol; HDL-C, HDL cholesterol; LDL-C, LDL cholesterol; GL, blood glucose; SBP, systolic blood pressure; DBP, diastolic blood pressure.

\* Statistically significant difference (paired t test).

**Table 2 – Results regarding the measurement of carotid artery, triglycerides, and C-reactive protein before and after the intervention – PICCOLI Study, Florianópolis, SC, Brazil, 2010.**

Variables	Intervention group			Control group		
	Before (n = 16)	After (n = 16)	p	Before (n = 16)	After (n = 16)	p
	Median [IQR]	Median [IQR]		Median [IQR]	Median [IQR]	
Average IMT (mm)	0.43 [0.40-0.45]	0.41 [0.40-0.43]	0.003*	0.43 [0.39-0.47]	0.44 [0.41-0.50]	0.012*
Maximum IMT (mm)	0.56 [0.52-0.64]	0.52 [0.52-0.56]	0.002*	0.54 [0.48-0.60]	0.56 [0.52-0.66]	0.024*
TG (mg/dL)	93.0 [77.5-111.9]	82.5 [68.0-101.0]	0.244	85.5 [64.7-118.0]	94.0 [62.2-134.7]	0.532
CRP (mg/L)	1.8 [1.4-5.0]	0.8 [0.7-2.7]	0.124	2.2 [0.9-6.1]	7.0 [1.6-9.0]	0.016*

IQR, interquartile ranges; IMT, intima-media thickness; TG, triglycerides; CRP, Ultra-sensitive C-reactive protein.

\* Statistically significant difference (Wilcoxon test).

children, in addition to regular treatment (monitoring, treatment, and traditional medical counseling). Such results may suggest that the magnitude of the impact of the program was similar to that of other structured physical exercise programs with<sup>12</sup> or without<sup>24</sup> nutritional guidance.

A study that used intervention with similar characteristics as those of the present study – 12 weeks of physical exercises with recreational activities and nutritional guidance – also showed positive effects on the components of metabolic syndrome and on insulin resistance, with significant reductions in the BMI, leptin levels, systolic blood pressure, total cholesterol, triglycerides, and glucose levels in obese children.<sup>13</sup> Another study involving a low-calorie diet, and aerobic physical activity and recreational games for obese children, showed an increase in HDL-cholesterol, regardless of the baseline value, when compared to low-calorie diet only.<sup>25</sup> This study demonstrated that diet alone or diet combined with aerobic exercises reduces total cholesterol and LDL cholesterol, when these show high levels.<sup>25</sup> Other results suggest that pediatric patients with metabolic syndrome show great improvements with physical exercises and nutritional guidance, demonstrating a significant improvement in the lipid profile after a short intervention period (two weeks, with daily physical exercises).<sup>11,26</sup> In these programs for obese children with metabolic syndrome, gymnastics and games, in addition to nutritional guidance, resulted in significant reductions in the body mass, BMI, total cholesterol, blood pressure, and triglycerides.<sup>11,26</sup> Reductions in waist circumference, HDL cholesterol,<sup>11</sup> and LDL cholesterol<sup>26</sup> were also found.

The results found in the present study demonstrate that, although the intervention period was relatively

short to promote major changes in the BMI, important improvements in the metabolic profile after the intervention were verified. This appears to be especially important to children's health, as the intensity, extent, and prevalence of atherosclerosis appear to be related to the occurrence and severity of cardiovascular risk factors typically described in adults;<sup>8</sup> the most influential factor in the acceleration of this process is dyslipidemia, especially when total cholesterol, LDL-cholesterol, and triglycerides levels are high, and HDL-cholesterol levels are reduced.<sup>27</sup> The benefits in the reduction of anthropometric parameters (BMI and, although not significant, waist circumference), should also be emphasized, given the severity of obesity, by the associated comorbidities.<sup>3,4</sup>

Regression of carotid intima-media thickness was significant in the intervention group, which may suggest reduction in the risk of events related to atherosclerosis in the medium and long terms, if healthy habits are maintained. Such reduction reinforces the findings of a previous study<sup>28</sup> that demonstrated an improvement in intima-media thickness within six months of physical exercises under supervision, suggesting a significant reversibility of atherosclerosis progression in childhood, when following a physical exercise program combined with nutrition counseling. Another study also evidenced that obesity related to vascular dysfunction was partially reversible with diet alone or diet combined with physical exercises during six weeks, with substantial progress in those that maintained diet and physical exercises for 12 months, showing lower carotid artery thickness.<sup>29</sup> However, the results found in this study, although significant, may also be attributed to technical issues, as the device used to evaluate the carotid artery thickness is very sensitive and

capable of detecting subtle changes in less time, as it has a very high resolution. New studies are required to identify the clinical meaning of these changes in the medium and long terms. In any case, ultrasound measurement of carotid intima-media thickness has been emerging as a test with great potential for noninvasive evaluation of atherosclerosis, evidencing the association between carotid artery thickness and incidence of cerebrovascular and coronary diseases.<sup>30</sup>

In this study, no improvements regarding waist circumference, HDL cholesterol, triglycerides levels, fasting glucose, C-reactive protein, and systolic blood pressure were observed at the end of the program. Other studies also did not find effects on triglycerides<sup>25</sup> and glucose<sup>12</sup> levels after the intervention, confirming the present findings. However, there are studies that have found improvements in these variables with a program similar to the present study's.<sup>13</sup> It is possible that these differences may be attributed to the amount and intensity of physical exercises, total duration of the program, caloric restriction, initial body fat distribution, and initial metabolic profile. One of the limitations of this study was the lack of an effective control of the groups' daily eating habits, which may have influenced the non-significant effects, after the program, on levels of triglycerides, blood glucose, and HDL cholesterol. Additionally, different parameters may require different levels of physical exercises, which may also have influenced the variation in the results. Studies with a higher number of children may bring important contributions to the behavior of such variables.

It is important to highlight that the children proved to be very receptive to most of the proposed activities, especially regarding water activities. Although it is a physical exercise program with recreational activities, children remained within the target zone during the sessions, for approximately 40 minutes, with individual variations according to polar data; circuits and trampoline activities were the exercises that maintained the children most of the time within the recommended target zone. The importance of nutrition meetings developed throughout the program in order to encourage changes in the children's eating habits is emphasized.

The use of medications during the program was another limitation, which may have influenced the results obtained. However, initial data about the metabolic and anthropometric profile was similar between the groups, regardless of the drug used, and no child in the group started or ceased medication after the start of the monitoring. Adiposity was determined only through the BMI result, which does not necessarily measure adiposity.

The sample loss (27.3%) during the intervention was not expected. Losses were higher than those of other studies carried out with obese young people.<sup>12,26</sup> Some factors may have contributed to such losses, e.g., difficulty of transportation, since many children depended on public transportation and the project did not have the resources to

control such difficulty; the presence of a person responsible for the child to conduct him/her to the intervention site was required, which conflicted with work duties.

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## Conclusion

The physical exercise and nutritional guidance program, in addition to the regular clinical treatment, was effective in reducing BMI, total cholesterol, LDL cholesterol, diastolic arterial pressure, and carotid intima-media thickness (an indirect and early sign of atherosclerosis). Considering the implications of obesity on children's health, such findings are important, warning of the importance of preventing such cardiovascular risk factors during childhood.

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## Conflict of interest

All authors declare to have no conflict of interest.

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## REFERENCES

1. Wang Y, Monteiro C, Popkin BM. Trends of obesity and underweight in older children and adolescents in the United States, Brazil, China and Russia. *Am J Clin Nutr.* 2002;75:971-7.
2. POF – Pesquisa de Orçamento Familiares: 2008-2009. Antropometria e estado nutricional de crianças, adolescentes e adultos no Brasil. Rio de Janeiro: Ministério do Planejamento, Orçamento e Gestão, Instituto Brasileiro de Geografia e Estatística-IBGE; 2010.
3. World Health Organization (WHO). Preventing and managing the global epidemic.. Geneve: WHO; 2000. [Report of a WHO Consultation].
4. Reinehr T, Wunsch R, Sousa G, Toschke AM. Relationship between metabolic syndrome definitions for children and adolescents and intima-media thickness. *Atherosclerosis.* 2008;199:193-200.
5. Pasquali SK, Cohen MS. The impact of obesity in children with congenital and acquired heart disease. *Prog Pediatr Cardiol.* 2008;25:119-24.
6. Weiss R, Dziura J, Burgert TS, Tamborlane WV, Taksali SE, Yeckel CW, et al. Obesity and the metabolic syndrome in children and adolescents. *N Engl J Med* 2004;350:2362-74.
7. Cook S. The metabolic syndrome: antecedent of adult cardiovascular disease in Pediatrics. *J Pediatr.* 2004;145:427-30.

8. Giuliano IC, Caramelli B. Dislipidemias na infância e na adolescência. *Pediatria (São Paulo)*. 2008;29:275-85.
9. I Diretriz Brasileira de Diagnóstico e Tratamento da Síndrome Metabólica. Sociedade Brasileira de Cardiologia. *Arq Bras Cardiol*. 2005;84(supl 1):1-28.
10. Sato Y, Nagasaki M, Kubota M, Uno T, Nakai N. Clinical aspects of physical exercise for diabetes/metabolic syndrome. *Diabetes Res Clin Pract Suppl*. 2007;77:87-91.
11. Chen AK, Roberts CK, Barnard RJ. Effect of a short-term diet and exercise intervention on metabolic syndrome in overweight children. *Metab Clin Exp*. 2006;55:871-8.
12. Leite N, Milano GE, Cieslak F, Lopes WA, Rodacki A, Radominski RB. Effects of physical exercise and nutritional guidance on metabolic syndrome in obese adolescents. *Rev Bras Fisioter*. 2009;13:73-81.
13. Monzavi R, Dreimane D, Geffner ME, Braun S, Conrad B, Klier M, et al. Improvement in risk factors for metabolic syndrome and insulin resistance in overweight youth who are treated with lifestyle intervention. *Pediatrics*. 2006;117:1111-8.
14. Reinehr T, Shaefer A, Winkel K, Finne E, Toschke AM, Kolip P. An effective lifestyle intervention in overweight children: findings from a randomized controlled trial on "Obeldicks light". *Clin Nutr*. 2010;29:331-6.
15. CDC. Table for calculated body mass index values for selected heights and weights for ages 2 to 20 years. Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion; 2000. [cited 2008 aug 20]. Available from: <http://www.cdc.gov/growthcharts>.
16. Watts K, Beye P, Siafarikas A, O'Driscoll G, Jones TW, Davis EA, et al. Effects of exercise training on vascular function in obese children. *J Pediatr*. 2004;144:620-5.
17. Tanner JM. *Growth at adolescence*. Oxford: Blackwell; 1962.
18. Lohman TG. Applicability of body composition techniques and constants for children and youths. *Exerc Sport Sci Rev*. 1986;14:325-57.
19. Rifai N, Warnick GR, Dominiczack MH, editors. *Handbook of lipoprotein testing*. Washington (DC): AACC Press; 1997.
20. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clin Chem*. 1972;18:499-502.
21. Cazzolato G, Prakasch G, Green S, Kostner GM. The determination of lipoprotein Lp(a) by rate and endpoint nephelometry. *Clin Chim Acta*. 1983;135:203-8.
22. Tanaka H, Monahan KD, Seals DR. Age-predicted maximal heart rate revisited. *J Am Coll Cardiol*. 2001;37:153-6.
23. Philippi ST, Latterza AR, Cruz ATR, Ribeiro LC. Pirâmide alimentar adaptada: guia para escolha dos alimentados. *Rev Nutr*. 1999;12:65-80.
24. Farpour-Lambert NJ, Aggoun Y, Marchand LM, Martin XE, Herrmann FR, Beghetti M. Physical activity reduces systemic blood pressure and improves early markers of atherosclerosis in pre-pubertal obese children. *J Am Coll Cardiol*. 2009;54:2396-406.
25. Parente EB, Guazzelli I, Ribeiro MM, Silva AG, Halpern A, Villares SM. Perfil lipídico em crianças obesas: efeitos de dieta hipocalórica e atividade física aeróbica. *Arq Bras Endocrinol Metab*. 2006;50:499-504.
26. Roberts CK, Chen AK, Barnard J. Effect of a short-term diet and exercise intervention youth on atherosclerotic risk factors. *Atherosclerosis*. 2007;191:98-106.
27. Berenson GS, Srinivasan SR, Bao W, Newman WP 3rd, Tracy RE, Wattigney WA. Association between multiple cardiovascular risk factors and atherosclerosis in children and young adults. The Bogalusa Heart Study. *N Engl J Med*. 1998;338:1650-6.
28. Meyer AA, Kundt G, Lenschow U, Schuff-Werner P, Kienast W. Improvement of early vascular changes and cardiovascular risk factors in obese children after a six-month exercise program. *J Am Coll Cardiol*. 2006;48:1865-70.
29. Woo KS, Chook P, Yu CW, Sung RYT, Qiao M, Leung SSF, et al. Effects of diet and exercise on obesity-related vascular dysfunction in children. *Circulation*. 2004;109:1981-6.
30. Torres FS, Moreira CM, Vianna FF, Gus M. Medida de espessura das camadas íntima e média das artérias carótidas para avaliação do risco cardiovascular. *Rev Bras Hipertens* 2007;14:167-71.