Influence of the aerobic and anaerobic training on the body fat mass in obese adolescents

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ABSTRACT

The aim of this study was to verify the influences of anaerobic and aerobic exercise in the body composition of obese male adolescents. The sample was constituted of 28 adolescents with ages ranging from 15 and 19 years, and severe obesity. The volunteers were divided into three groups and for all groups was provided nutritional orientation. The intervention period was 12 weeks. Group I accomplished interval training in a cycle ergometer that consisted of 12 shots of 30 sec. with maximum power and speed, pedaling with high load (0.8% of the body weight x 25 watts) and 3 min recover. Group II accomplished aerobic training in a cycle ergometer pedaling with relative load to the ventilatory threshold for 50 min. Group III served as control, and was not submitted to physical activity. All volunteers underwent bone densitometry with analysis of the body composition (DEXA) and medical and fitness evaluations. For the variables weight and BMI exercise groups presented reductions when initial and final interventions periods were compared. Regarding to the body composition, there was a decrease in total body and lower limbs fat mass (in grams) and in the fat percentage of the lower limbs in the exercise groups when initial and final periods were compared. There was a significant difference between groups I and II for the percentile deltas of total body fat mass and of lower limbs and in the percentage of fat of lower limbs. The data suggest that anaerobic and aerobic exercise with nutritional orientation promoted a larger weight reduction, when compared with nutritional orientation only. The anaerobic exercise proposed in this study was more efficient to produce reduction of body fat and fat percentage. The aerobic exercise seemed to have been more effective preserving and/or increasing free fat mass.

Key words: Obesity. Adolescents. Body composition. Body fat mass.

INTRODUCTION

Conceptually, obesity may be considered as a growth of fat tissue throughout the body, caused by genetic or endocrine-metabolic diseases or by nutritional alterations[(1)].

The ingestion of an excessive amount of calories may also lead to obesity[(2)], but the appearance and prevalence of the overweight in children and adults is not only due to the ingestion of nutrients, but also due to the decrease on physical activity, leading to an unfavorable energetic balance[(3,4)].

There has been a change on the nutritional state of the Brazilian population that, besides the continuous increase of malnutrition, now presents an excessive increase on the number of obese individuals distributed through all age ranges and social classes. According to data from the first Research of Life Standard (RLS), published by the Brazilian Institute of Geography and Statistics (IBGE), while the index of obesity among Northeasterners is of 8.7%, in the Southeast region this index is of 10.5%. In children, the increase of obesity occurred in all regions of the country, but especially in South and Southeast regions, where prevalence of 9.6% and 9.3%, respectively can be found[(6)].

The coexistence of malnutrition and obesity is also an index of concern in the developing countries[(7,8)]. A study developed in the slums of São Paulo showed high correlation between obesity among adolescents and previous malnutrition. The obesity and overweight associated to previous malnutrition were found in 8.7% of boys and 7.5% of girls, while for children with normal size in relation to the age, 3.7% of boys and 4.7% of girls were obese. In adolescents, the obesity was identified in 35% of girls with low size for the age, while girls with normal size for the age, according to the NCHS[(9)], the obesity prevalence was only verified in 13% of girls.

From data obtained from the Health and Nutrition National Research, Neutzling[(10)] demonstrated that in Brazilian adolescent population, 7.6% presented overweight and Priore[(11)] reported a higher prevalence of obese adolescents in the city of São Paulo, out of the 14.7% classified as overweighted, 14% were female and 15.6% were male.

Obese children and adolescents tend to become obese adults. According to Mossberg[(12)], 80% of the obese adolescents lead to cases of adult obesity; although the childhood obesity does not contribute with over than 1/3 of the adult obesity[(13)], the adult obese individuals who presented obesity in the childhood tend to be classified as having worse obesity than those who became obese when adults[(14)].

Many studies have demonstrated that the exercise may be quite effective in reducing the body fatness in obese children and adolescents, with or without specific diet restrictions. Most of these studies involve programs of increase on the physical activities in schools[(15)]. Ward and Bar-Or[(16)] made a reviewing containing 13 studies based on constant aerobic exercises from nine weeks to 18 months, where the fat percentage dropped from 5 up to 10% in all 13 articles analyzed.

Studies involving adults have shown that high-intensity exercises are associated to low adherence. In programs of physical training with children, better results were reached when the physical activity involved was familiar to the children's life style, like to walk and to go upstairs, instead of running and participating of physical exercises classes[(17)].

The objective of this study was to evaluate the effect of the anaerobic exercise on the body fat mass of obese adolescents, comparing it to the aerobic exercise and to a control group with no prescription of any type of exercise.

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METHODOLOGY

Casuistic

The sample was composed of 28 male adolescents with ages ranging from 15 to 19 years (16.08 ± 1.23). Only volunteers who presented severe obesity were included in this research (with body mass index equal or above 95% of adaptation in relation to the percentile 50 of tables of Must *et al.*[18]). The volunteers were recruited through advertisement published in media (newspaper, radio and television) of São Paulo. All selected volunteers, who presented BMI adequate for the research were examined by a pediatrician and only those who had no contraindication to physical exercises were included in the study.

The consent for the participation on the study was obtained from parents or responsibles for the adolescents included in the study, being informed of all procedures and free to interrupt the participation at any moment of the research.

The volunteers were randomly distributed through allotment into three groups: 1) Anaerobic training group (n = 10; 16.7 ± 1.50 years): three months of anaerobic physical training with nutritional orientation and consultation to nutritionist each month. 2) Aerobic training group (n = 9; 15.83 ± 0.75 years): three months of aerobic physical training with nutritional orientation and consultation to nutritionist each month. 3) Control group (n = 9; 16.00 ± 1.32 years): no prescription of physical exercises during three months with nutritional orientation and consultation to nutritionist each month.

Methods

All selected volunteers were submitted to anthropometric, clinical, body composition and physical fitness evaluations before entering the project. The intervention period was three months, when the volunteers of the exercise groups performed the physical training and nutritional orientation and the volunteers of the control group only had nutritional orientation. After the three-month period, the volunteers were submitted to reevaluation, using the same criteria as the initial evaluation.

1) Anthropometric evaluation: The body mass was obtained through a platform weighter label *Filizola*, with maximal load of 150 kg and accuracy of 100 g. The balance was gauged before each measure and the volunteers were weighted in standing position, barefoot, wearing only trunks or underwear. The size was verified with a standing stadiometer, calibrated with a measure tape in centimeters and accuracy of 1 mm, with a fixed vertical wooden bar, using a mobile square for the positioning over the volunteer's head.

2) Criterion for the obesity diagnosis: the body mass index (BMI) was used, also known as Quetelet index[19], which is considered as the most simple anthropometric method, corresponding to the relation between the body mass in kg and the squared size in meters: body mass (kg)/size^2 (m). For the classification, the table of Must *et al.*[18] was used, according to the percentile 90 (equal or greater).

3) Clinical evaluation: Performed by a pediatrics professional for the detection of eventual cardiovascular diseases or orthopedics disorders that would make the participation on the research impossible and to establish the sexual maturational degree. The individuals who presented contraindications for the physical activity were excluded from the study.

4) Body composition: For the evaluation of the body composition, the double X-ray absorptiometry (DEXA) technique was employed, using the *DPX-Lunar* device from the company Lunar Radiation Corporation, with office in Madison, WI.

5) Cardiopulmonary exercise test (aerobic evaluation): For the evaluation of the aerobic capacity and to determine the training intensity, each selected individual performed a cardiopulmonary exercise test with electrocardiogram, from where the parameters necessary for the individual determination of the training intensity were obtained. In the reevaluation, the electrocardiogram was not necessary. The following variables were determined: maximum oxygen intake ($\dot{V}O_{2max}$), ventilatory threshold, maximal cardiac frequency and training cardiac frequency (cardiac frequency at the intensity of the ventilatory threshold). These variables were used to standardize the physical training of volunteers. The use of the term $\dot{V}O_{2máx}$ was determined to make it uniform as the designation usually found in literature, although some volunteers only presented the $\dot{V}O_2$peak. The ergometry tests were performed in cycle ergometer model *Cybex The Bike* (label Cibex).

Test protocol: The tests started with 25 watts, in other words, the volunteers started the tests pedaling the cycle above described with load corresponding to 25 watts. At the first two minutes, the volunteers pedaled with 25 watts, maintaining 80 rpm; after the two initial minutes, the increase of 25 watts each minute was manually performed until the volunteer's exhaustion.

Equipment: The respiratory and metabolic variables were obtained through the method of measurement of the expired gases a computerized metabolic system (*Vista XT* metabolic system, EUA) (Intel 486, DX2, 66 mhz). A set of masks, caps and turbine with mouth and nose closing was used, taking the exhaled air into the gases analysis equipment. The gases metabolic analyzer used is type System Mini Vista CAX Vacuumed California – USA. For the monitoring of the cardiac frequency, a cardiac frequency meter Polar type – model BEAT was used.

6) Wingate test (anaerobic evaluation): For the determination of the maximal anaerobic power, the Wingate test was used, performed in the cycle ergometer *Cibex The Bike*, from where the standardization values of the anaerobic training were obtained. The cycle Cibex The Bike presents a computerized program for the anaerobic test. The test is performed pedaling as fast as possible for a period of 30 seconds against a established resistance, taking into account the volunteer's gender and body mass.

7) Physical training

Aerobic Training: The program of aerobic training was developed in cycle ergometer, three times a week, during 12 weeks and for an initial period of 40 minutes. At the second month, the activity was performed during 50 minutes and at the third month, during 60 minutes. The increase on the training overload was performed in the variable duration rather than in the variable activity intensity, in other words, during all the three months of training the intensity remained the same and the increase only occurred in the activity time. The aerobic activities were standardized according to the percentage of the maximal oxygen intake ($\dot{V}O_{2max}$). According to the American College of Sports Medicine (ACSM)[20], the physical training programs that aim to lose body mass should be performed with approximately 60 to 70% of the $\dot{V}O_{2max}$.

Anaerobic training: The anaerobic training was performed using the method of "Interspaced Training"[21-24]. The interspaced work was performed with series of cycle ergometer work with a load equivalent to 25 watts X 0.8% of the volunteer' body mass during 30 seconds with an interval for active recovery (walking) of three minutes between series. At the first month, the volunteers performed 11 series in the cycle ergometer at a pedal rotation speed above 80 rpm, the volunteers were instructed to pedal as fast as possible. The total time of each session at the first month was of 40 minutes. At the second month, there was an increase on the working time with load, from 11 series, the volunteers began to perform 14 series with an increment of 10% on the initial load, performing a training time per session of 50 minutes. At the third month, the volunteers began to perform 14 series of 45 minutes with the same load as on the second month and with the same recovery time, performing a training time per session of 60 minutes.

8) Evaluation and nutritional orientation: The nutritional evaluation was performed by a nutritionist indicated to follow the fulfillment of the project. The volunteers performed three consultations

to the nutritionist (initial, at the end of two months and at the end of the third month), where they delivered the alimentary inquiries and received dietary orientation.

9) Alimentary inquiry: The alimentary inquiry was performed through an instrument elaborated to satisfy the objectives of this study. A simple and objective methodology was adopted for the elaboration of the instrument in such way to enable a better adhesion of adolescents. The method of alimentary recording was used during three days in the week, also used by several other authors[25-28], and one more day during the weekend. The weekdays were randomly selected, and some variation may occur between adolescents, based on results published by Chalmers *et al.*[29], that the evaluation of the alimentary ingestion through inquiry methods does not depend on the weekday in which the information will be collected. The inquiries obtained were analyzed with the aid of computer program developed by the Public Health School – USP, Virtual Nutri software, developed by Phillipi, S.T. (1995)[30].

10) Dietary intervention: The dietary intervention was based on the proposal of the multidisciplinary staff of the Adolescent Attending and Support Center of the Pediatrics Specialties subject – Pediatrics department – Unifesp-EPM, which approves the maintenance of the adolescent's body mass by means of modifications on the alimentary behavior, without the prescription of restrictive and preestablished diets. The general orientations are related to the reduction on the amount ingested, avoiding the repetition of meals, to chew food well, not to eat in front of television, to eat at the correct timetables, to control the ingestion of food rich of fat and to increase the number of meals, from three to six daily meals.

11) Statistic method: The statistic orientation was provided by the Bio-statistics subject of the Psychobiology Department – Unifesp-EPM.

Tests employed:

For the evaluation of the body fat mass, the body thin mass, the fatness percentage and the free fat mass, the two-factor ANOVA test was performed (group factor: anaerobic, aerobic and control; time factor: initial and final), as complementary analysis, the Tukey test was performed using the percentile delta[31]. With this type of analysis it was possible to identify some significant differences in the studied variables:

– For the age, not presenting normal distribution: Kruskal-Wallis test followed by the Mann-Whitney test;

– For the other variables:

  – Between initial and final periods: paired *t* test.

  – Between groups: ANOVA followed by Tukey test.

The statistic program used was the SPSS; the significance level was established in at least 5%.

12) Ethic aspects of the work: The entire methodology (tests protocols and exercises) presented in this study was approved by the Medical Ethics Committee of the Universidade Federal de São Paulo (Unifesp) – EPM.

RESULTS

The results are presented as average ± standard deviation. Group I was composed of volunteers who performed the anaerobic training (N = 10), group II was composed of volunteers who performed the aerobic training (N = 9), and group III composed of control volunteers (N = 9).

With regard to the sexual maturation, all subjects included in the study presented pubertal stages 4 or 5 of the Marshal & Tanner[32] scale. The initial values of age, body mass, size and BMI were not different between groups.

The initial and final body mass values of each group are presented on table 1. No differences between groups for values of initial and final body mass, initial and final size and initial and final BMI were verified. However, groups I and II presented differences between values of body mass and BMI between the initial and final periods ($p < 0.05$). The two-factor analysis of variance ANOVA revealed significant differences for the variable body mass ANOVA: factor group [$F_{(2.24)} = 0.03$; $p = 0.96$] and factor time [$F_{(1.57)} = 10.54$; $p = 0.003$]. No interaction between values was observed. For the variable size, no statistical differences were observed ANOVA: factor group [$F_{(2.24)} = 1.26$; $p = 0.30$] and factor time [$F_{(1.24)} = 0.69$, $p = 0.41$]. No interaction between values was observed. For the variable BMI, significant difference in factor time was observed [$F_{(2.24)} = 11.14$; $p = 0.002$] and no difference in factor group [$F_{(2.24)} = 0.89$, $p = 0.42$]. No interaction between values was observed.

TABLE 1
Body mass (kg) and size (cm) at the initial (i) and final (f) periods

	Body mass i	Body mass f	Size i	Size f	BMI i	BMI f
Group I	101 ± 11	98 ± 12*	176 ± 7	177 ± 7	33 ± 3	31 ± 3*
Group II	99 ± 13	96 ± 13*	173 ± 6	173 ± 6	33 ± 3	32 ± 3*
Group III	98 ± 14	96 ± 14	174 ± 7	174 ± 7	33 ± 3	33 ± 4

Legend: Group I: anaerobic training; Group II: aerobic training; Group III: control.
* Differences between initial and final evaluations p < 0.05.

When compared in relation to the values of total body fat mass and lower limbs fat mass, the groups presented differences between the initial and final periods for the values of total body fat mass (in grams) in groups I and II ($p < 0.01$) and between groups I and III ($p < 0.05$); for the values of upper limbs fat mass (in grams), all groups presented significant differences between the initial and final periods and the group I was different from group III ($p < 0.01$) when the values of Δ% are compared. For the analysis of the total body fat mass, significant difference in factor time was observed [$F_{(1.24)} = 28.53$; $p = 0.00001$] and no difference in factor group [$F_{(2.24)} = 1.30$, $p = 0.29$]. No interaction between factors was observed. Now, for the lower limbs fat mass, significant difference in factor time was observed [$F_{(1.24)} = 40.94$; $p = 0.000001$] and no difference in factor group [$F_{(2.24)} = 1.14$, $p = 0.33$]. No interaction between factors was observed. The results are presented on table 2.

TABLE 2
Total body fat mass (MGct) and lower limbs fat mass (Mgmmii) in kilograms, at the initial and final periods and the percentile delta (Δ%)

	Initial MGct	Final MGct	Δ% MGct	Initial MGmmii	Final MGmmii	Δ% MGmmii
Group I	37.1 ± 9.2	33.1 ± 9.2*	–11.3 ± 6.5#	14.6 ± 4.1	12.8 ± 4.1*	–13.3 ± 6.6#
Group II	36.7 ± 7.5	32.8 ± 6.6*	–10.4 ± 6.4	14.6 ± 3.5	13.3 ± 3.5*	–9.5 ± 5.1
Group III	39.3 ± 10.6	37.8 ± 10.6	–3.9 ± 5.2	15.6 ± 4.5	15.0 ± 4.4*	–4.5 ± 4.7

Legend: Group I: anaerobic training; Group II: aerobic training; Group III: control.
* Differences between initial and final evaluations. # difference in relation to group III p < 0.05.

The values of the upper limbs fat mass presented no significant statistical differences for the values of initial arm fat mass (GI = 3559.3 ± 1067.6; GII = 3548.4 ± 1087.6 and GIII = 4420.3 ± 1588.1) and final arm fat mass (GI = 3131.9 ± 1059.3; GII = 3196.6 ± 711.5 and GIII = 4119.2 ± 1503.3), neither between groups. No significant statistical difference between groups when values of Δ% were compared was observed as well.

The values of the trunk fat mass presented no differences between the initial period (GI = 14617.9 ± 4136.9; GII = 14679.1 ± 3575.0 and GIII = 15691.6 ± 4531.1) and final period (GI = 12802.7 ± 4175.8; GII = 13349.6 ± 3519.2 and GIII = 15014.3 ± 4408.0), neither between groups when values of the trunk fat mass were compared. No significant differences were found when values of Δ% were compared.

Table 3 presents the values of the total body fat percentage and lower limbs fat percentage.

TABLE 3
Total body fat percentage (%Gct) and lower limbs fat percentage (%Gmmii) at initial and final periods and the percentile delta (Δ%)

	Initial %Gct	Final %Gct	Δ% of %Gct	Initial %GRmmii	Final %GRmmii	Δ% GRmmii
Group I	36.9 ± 7.0	34.0 ± 7.3*	–8.2 ± 4.5	38.3 ± 7.5	34.4 ± 8.1*	–10.6 ± 5.8#
Group II	37.4 ± 5.8	34.3 ± 5.5*	–8.2 ± 4.9	38.8 ± 6.4	35.6 ± 6.7*	–8.3 ± 5.5
Group III	40.6 ± 7.8	39.1 ± 7.5*	–3.7 ± 3.6	41.8 ± 8.2	40.3 ± 7.8*	–3.6 ± 3.4

Legend: Group I: anaerobic training; Group II: aerobic training; Group III: control.
* Differences between initial and final evaluations. # difference in relation to group III $p < 0.05$.

No differences were verified between groups for values of the total body fat percentage, however, all groups presented differences when the initial and final periods were compared as well as all groups presented differences in the values of the lower limbs fat percentage. The analysis of variance revealed significant difference in relation to the total body fat percentage in factor time [$F_{(1.24)} = 29.58$; $p = 0.00001$] and no differences in factor group [$F_{(2.24)} = 2.41$; $p = 0.11$]. No interaction between factors was observed. For the variable lower limbs fat percentage, significant difference in factor time was observed [$F_{(1.24)} = 28.17$; $p = 0.00001$] and no differences for factor group [$F_{(2.24)} = 2.23$; $p = 0.12$]. No interaction between factors was observed.

For the values of the upper limbs fat percentage, no differences were observed between the initial period (GI = 33.7 ± 7.2; GII = 34.0 ± 6.4 and GIII = 40.2 ± 8.6) and final period (GI = 31.3 ± 7.5; GII = 31.8 ± 5.9 and GIII = 37.8 ± 8.1), or between groups, when the upper limbs fat percentage or the Δ% are compared.

The values of the trunk fat percentage are presented on table 4. Differences were observed between the initial and final periods for groups I and II ($p < 0.01$), however, no differences between groups were observed, neither when the values of Δ% were compared. The analysis of variance revealed significant difference in factor time [$F_{(1.24)} = 18.53$; $p = 0.0002$] and no differences in factor group [$F_{(2.24)} = 2.01$, $p = 0.15$]. No interaction between factors was observed.

TABLE 4
Trunk fat percentage (%GRt) at initial and final periods and the percentile delta (Δ%)

	Initial %GRt	Final %GRt	Δ%
Group I	36.8 ± 6.6	34.4 ± 6.8*	–6.5 ± 5.3
Group II	37.5 ± 5.6	34.3 ± 4.8*	–8.2 ± 6.8
Group III	39.7 ± 7.2	38.4 ± 7.1	–3.3 ± 5.0

Legend: Group I: anaerobic training; Group II: aerobic training; Group III: control.
* Differences between initial and final evaluations $p < 0.05$.

For the total caloric value in kilocalories, group I presented difference ($p < 0.05$) between the initial period (2,328 ± 751) and final period (1,692 ± 260), the other two groups presented no differences between the initial period (GII = 2,316 ± 884; GIII = 1,789 ± 761) and final period (GII = 1,827 ± 629; GIII = 1,593 ± 650). No differences between groups were verified.

DISCUSSION

The use of the physical exercise has been one of the most employed procedures for the obesity treatment. A reduced rate of physical exercises is a risk factor that contributes for the development of the obesity; little physical activity increases the risk of obesity incidence and the obesity, in turn, may also contribute for the low level of physical activity[33]. There is a significant inverse relation between physical activity and fat indexes[34,35].

Studies have verified the effectiveness of the exercise for the increase on the fat burn and decrease on the body mass. People who practice exercises constantly reach better results on the loss of body mass than those who do not practice any type of physical activity at all[36]. Although exercises are not able to protect the organism from the reduction of the resting metabolic rate, caused by the use of a low-calorie diet (usual procedure when one desires to lose body mass), the exercise is quite effective on promoting a higher body fat burn. Two types of physical training were conducted: the aerobic training and the anaerobic training.

In the aerobic training, the cardiac frequency was used as indicative of the training intensity. The cardiac frequency used was the one corresponding to the cardiac frequency determined through the cardiopulmonary exercise test as the cardiac frequency of the ventilatory anaerobic threshold 1 (LV1). The aerobic training occurred within the concept of the utilization of 60% of the $\dot{V}O_{2máx}$, what establishes an activity of average intensity, able to promote the fat mobilization during the activity.

The anaerobic training was performed based on the Wingate test, with shots of 30 seconds (first and second months) and 45 seconds (third month), aiming to each from 90 to 100% of RPM at each shot. Similar methodology was used by Woitge *et al.*[38] and characterized as high-intensity anaerobic activity.

The differences between groups from this work for values of the body composition were observed especially between anaerobic training group and control group, what may have been due to the activity intensity, once the anaerobic training group presented a training load (volume versus work intensity) above the aerobic training group.

Studies comparing aerobic exercises and strength training on their effectiveness to prevent the decrease of the lean body mass or to increase the fat burn in obese adults, children and adolescents are present in literature. With the development of more accessible and cheaper new techniques for the evaluation of the body composition, the changes on the body composition induced by exercise have also been object of many studies.

Grillo[36] emphasizes that the exercise with no dietary modification seems not to be sufficient to produce a significant loss of body mass in obese people, and that the main strategy is to associate the physical exercise to diet; and that although the exercise itself does not promote a reduction of body mass with short interventions, it is essential on the maintenance of the body mass. The main proposal of this study was to verify the differences on the body composition caused by the aerobic and anaerobic exercises without a nutritional intervention composed of restrictive diet; the volunteers had nutritional orientation aimed at the alimentary education by means of habits changes.

One of the limitations of our study was the impossibility for the implementation of a more severe dietary control and daily physical activities. At the beginning of the research, it was requested from the participants to avoid physical exercises out of the training program except for the regular physical education classes in school and the weekend entertainment. With regard to the diet, although we could not interfere directly, it was also requested from the volunteers to try to follow correctly the nutritionist's orientations.

In our study, the differences of body mass and BMI between groups, although statistically not significant, showed that both exercise groups presented a decrease statistically significant on the body mass and therefore on the BMI, when the initial and final values are compared.

This probably indicates that, even without a restrictive diet, the physical exercise is capable to promote a significant mass loss from the biological point of view, once the physical training groups reported satisfaction with the results obtained. Although we did not use parameters to measure "satisfaction", as the groups were small in number of individuals, it was possible to keep a contact more individualized with the volunteers and the reports were made as comments on how the training period influenced their daily lives and how they felt the change on their life styles, unchaining an improvement on their quality of life.

The volunteers of the control group obtained a slight change on the body mass that did not reflect on the BMI and that could be explained by the adequate nutritional orientation. The caloric ingestion of the adolescents who participated on this study is far higher than the required, what explains the obesity condition in which they are found. The nutritional orientation was effective, especially at the beginning of the program. The volunteers of the control group were oriented to reduce the amount of food ingested, what caused the change on the body mass without the use of physical exercises.

Skender *et al.*[39] performed a two-year longitudinal study and concluded that individuals who lost body mass only through diet obtained a higher body mass gain after the end of intervention, while individuals who only performed physical exercises obtained lower losses of body mass, however, got a better maintenance of the acquired body mass. Our study produced a small body mass loss; the highest body mass losses occurred especially in the exercise groups, although no differences between groups were verified.

The physical exercise alone produces a small body mass loss, although studies verify that, when the exercise is performed in high intensities, it may promote high body mass losses; however, obese individuals generally do not present the physical and fitness requirements necessary to perform high intensity physical exercises[36-40]. The exercise intensity affects the elevation magnitude of the post-exercise metabolic rate more than the duration; however, it seems not to be possible that untrained individuals be able to maintain the intensity necessary to produce an extended elevation on the post-exercise energy expenditure[40].

What was mentioned above may be a probable explanation for the little decrease on the body mass occurred in our study, as, although we offered an adequate nutritional orientation, we are not sure if all volunteers have actually followed such orientation. It seems, therefore, that when the reduction of body mass of obese individuals is concerned, the nutritional intervention is vital, regardless if patients are adult, adolescent or children.

Kraemer *et al.*[41] investigated the physiologic effects of a dietary treatment aimed at the loss of body mass with or without physical exercise in men. The results obtained indicate that the diet with aerobic exercise and strength training avoids the normal decline of the free fat mass and increases the muscular power and the maximal oxygen intake when compared with the restrictive diet alone. Treuth *et al.*[42] evaluated the changes on the abdominal fat tissue in pre-pubertal obese girls with the introduction of a strength training without the use of a restrictive diet and concluded that, although the intra-abdominal fat tissue presented no changes after a period of five months, the total body fat and the abdominal subcutaneous fat increased. The volunteers of this study presented no increase on the quantity of body fat, even without the utilization of the restrictive diet (on the contrary) it was possible to verify a decrease on the total body fat of the training groups when the initial and final periods and between aerobic and anaerobic training groups are compared.

Ebbeling & Rodriguez[43], in a study performed with obese children, concluded that the exercise brings metabolic benefits during the loss of body mass induced by the low calorie diet. Sothern *et al.*[44] concluded that a strength training program may be included on the control treatment of body mass for preadolescent children, once it resulted on reduction of the body mass, BMI and body fat percentage.

In the analysis of the alimentary recordings, it was not possible to identify differences between groups, although all groups have reported a low caloric quantity ingested that probably does not suit the dietary reality of the volunteers. The recordings were performed by the volunteers themselves and we believe that, since they could choose the day and in this day they would report all caloric ingestion performed, probably in these days and only at these recording days, the ingestion had been smaller, caused by the need of reporting all that has been ingested. Therefore, it seems not possible that a significant change on the alimentary habits of the volunteers on this study have occurred.

It is well reported in literature that the physical exercise aids on the body fat burn[45,36,46-50]. In the present study, the exercise groups presented reduction on the total body fat and on the lower limbs fat, both in grams, when the initial and final intervention periods are compared. These results are in agreement with literature and once again these results evidenced that the fat burn is facilitated when the individual performs physical exercises aimed at the loss of the body mass. The difference on the total body fat seems to have been influenced by the loss of fat on the lower limbs, may be influenced by the type of the activity, once the physical exercise proposed for both groups was performed by the lower limbs (to pedal in cycle ergometer).

When we compare groups, the anaerobic exercise group presents a reduction on the total fat and on the lower limbs fat evidenced by the percentile delta in relation to the control group. Although the aerobic exercise group presented no statistical differences in relation to the control group, the reduction, both on the total fat and on the lower limbs fat, was significant from the biological point of view. We believe that with a larger number of volunteers and/or with a longer time of intervention, the differences between groups could be statistically significant.

When the body fat is expressed in percentage, it is possible to establish differences between the initial and final periods for the three groups on the total fat percentage and on the lower limbs fat percentage. These data suggest that the fat loss was more effective for the lower limbs, reflecting on the body fat, even when physical exercises were not performed, as the control group, probably due to the effort of moving the extra body mass in the daily activities such as walking and going upstairs.

The difference between groups was significant when the anaerobic training group and the control groups were compared in relation to the percentile delta with regard to the lower limbs fat percentage; the aerobic exercise group, although presented no statistical difference in relation to the control group, reveals a higher tendency to the reduction on the lower limbs fat percentage, suggesting that the physical exercise maximizes the fat loss.

With regard to the trunk fat percentage, only exercise groups presented reduction in relation to the initial and final intervention periods. According to several studies, the body fat distribution may also be an indicative of higher or lower risk of cardiac diseases, abnormalities on the blood pressure, tolerance to glucose and alterations on the cholesterol levels, and individuals who present higher deposits of fat on the upper part of the body (abdomen and flanks) are the ones who have higher probabilities of increased risks by these pathologies[51-54].

Although the control group also presented a reduction on the body fat percentage, this reduction is not related to the trunk fat, emphasizing that the physical exercise may be a modifier factor for the decrease of diseases related to the growth of fat on the upper part of the body.

Considering the data obtained in this study and all bibliographic reviewing performed, it seems correct to affirm that the physical exercise plays an important role for the control and treatment of obesity, and that the use of a well-oriented diet is vital for the attainment of positive results. The physical activity intensity seems to be directly related to the loss of the body mass and the body fat, once physical exercises performed at a higher intensity promote, as consequence, a higher caloric burn, leading to the relevant loss of body mass.

We conclude that the both aerobic and anaerobic physical exercises, in addition to the nutritional orientation, promote a higher weight reduction, when compared with the nutritional orientation alone.

The anaerobic exercise proposed in this study was more effective to promote the decrease on the body fat and on the fat percentage than the aerobic exercise and the isolated alimentary orientation.

Regardless the type of exercise used on the obesity treatment, the activity intensity should be always progressive, once the untrained and/or sedentary individual is not able to perform a high-intensity exercise in the beginning of the treatment.

The physical exercise intensity is a vital factor for a better attainment of results, for both the physical conditioning and aimed at the loss of the body mass.

The low adherence on physical training presented by adolescents may be related to the type of activity proposed. A training program not tiresome and that causes no boredom, with objectives able to be reached, as well as hindrances that can be overcome, probably will have a lower discontinuance rate.

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