Effects of two programs of exercise on body composition of adolescents with Down syndrome

Efeitos de dois programas de exercício na composição corporal de adolescentes com síndrome de Down

Efectos de dos programas de ejercicios en la composición corporal de adolescentes con síndrome de Down

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ABSTRACT

Objective: To investigate the effects of a 12 week aerobic and resistance exercise on body composition of adolescents with Down syndrome.

Methods: A quasi-experimental study with 41 adolescents with Down syndrome, aged 15.5±2.7 years, divided into three groups: Aerobic Training Group (ATG; n=16), Resisted Training Group (RTG; n=15) and Control Group (CG; n=10). There were two types of training: aerobic, with intensity of 50-70% of the heart rate reserve 3 times/week, and resisted, with intensity of 12 maximum repetitions 2 times week. Both trainings were applied during a 12-week period. The percentage of fat evaluation was performed using plethysmography with Bod Pod® equipment. Waist circumference (WC), body weight and height were also measured. Paired t-test was used to compare variables before and after the exercise program.

Results: The percentage of body fat did not change significantly for both groups that participated in the training intervention. However, CG showed a significant increase in this variable (31.3±7.2 *versus* 34.0±7.9). On the other hand, body mass index (BMI) and WC were significantly reduced for ATG (BMI: 27.0±4.4 and 26.5±4.2; WC: 87.3±11.1 and 86.2±9.7), while RTG and GC showed no differences in these variables.

Conclusions: The aerobic and resisted training programs maintained body fat levels. ATG significantly reduced BMI and WC measures. Individuals who did not attend the training intervention increased their percentage of fat.

Key-words: Down syndrome; body composition; exercise; adolescent.

RESUMO

Objetivo: Analisar os efeitos do exercício aeróbio e resistido por 12 semanas na composição corporal de adolescentes com síndrome de Down.

Métodos: Estudo quase experimental com 41 adolescentes com síndrome de Down, com idades de 15,7±2,7 anos, divididos em três grupos: Grupo Treinamento Aeróbio (GTA; n=16), Grupo Treinamento Resistido (GTR; n=15) e Grupo Controle (GC; n=10). Realizaram-se dois tipos de treinamento: o aeróbio, com intensidade de 50 a 70% da frequência cardíaca de reserva 3 vezes/semana, e o resistido, com intensidade de 12 repetições máximas 2 vezes/semana. Ambos os treinamentos foram realizados por 12 semanas. A avaliação da porcentagem de gordura foi realizada por pletismografia com o equimento Bod Pod®. Mensuraram-se ainda as variáveis antropométricas de circunferência abdominal (CA), massa corporal e estatura. Aplicou-se o teste *t* pareado para a comparação das variáveis analisadas antes e após o treinamento.

Resultados: A porcentagem de gordura corporal não se alterou nos grupos que participaram do treinamento; entretanto, o GC apresentou aumento significativo dessa variável

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(31,3±7,2 *versus* 34,0±7,9). Por outro lado, a CA e o índice de massa corpórea (IMC) reduziram-se de forma significante para o GTA (IMC: 27,0±4,4 e 26,5±4,2; CA: 87,3±11,1 e 86,2±9,7), enquanto que o GTR e o GC não apresentaram diferenças nessas variáveis.

Conclusões: Os programas de treinamento aeróbio e resistido mantiveram os níveis de gordura corporal e o GTA reduziu de forma significativa as medidas de IMC e de CA. Os indivíduos que não participaram do treinamento tiveram sua porcentagem de gordura aumentada.

Palavras-chave: síndrome de Down; composição corporal; exercício; adolescente.

RESUMEN

Objetivo: Analizar los efectos del ejercicio aeróbico y resistido en la composición corporal de adolescentes con síndrome de Down.

Métodos: Estudio casi experimental con 41 adolescentes con síndrome de Down, con edades de 15,7±2,7 años, divididos en tres grupos: Grupo Entrenamiento Aeróbico (GEA; n=16), Grupo Entrenamiento Resistido (GER; n=15) y Grupo Control (GC; n=10). Se realizaron dos tipos de entrenamiento: el aeróbico, con intensidad de 50 a 70% de la frecuencia cardiaca de reserva, y el resistido, con intensidad de 12 repeticiones máximas. La evaluación del porcentaje de grasa se realizó por pletismografía con equipo Bod Pod®. Se midieron además las variables antropométricas de circunferencia abdominal (CA), masa corporal y estatura. Los datos fueron inicialmente tratados por estadística descriptiva, utilizando la prueba de *t* pareada para la comparación de las variables analizadas.

Resultados: El porcentaje de grasa corporal no se alteró en los grupos que participaron del entrenamiento; sin embargo, el GC presentó aumento significativo de esa variable (31,3±7,2 *versus* 34,0±7,9). Por otra parte, la CA y el índice de masa corporal (IMC) se redujeron de manera significante para el GEA (IMC: 27,0±4,4 y 26,5±4,2; CA: 87,3±11,1 y 86,2±9,7), mientras que el GER y el GC no presentaron diferencias en esas variables.

Conclusiones: Los programas de entrenamiento aeróbico y resistido mantuvieron los niveles de grasa corporal y el GEA redujo de modo significativo las medidas de IMC y de CA. Los individuos que no participaron del entrenamiento tuvieron su porcentaje de grasa aumentada.

Palabras clave: síndrome de Down; composición corporal; ejercicio; adolescente.

Introduction

Most of the world's population does not exercise regularly, although there is evidence showing an inverse relation between mortality and a healthy lifestyle[1]. Moreover, the prevalence of obesity worldwide, especially in young people, has demonstrated a rapid increase in recent decades, making it a true global epidemic[2].

Obesity is characterized by excessive accumulation of body fat associated with health problems such as cardiovascular disease, type II diabetes mellitus, and dyslipidemia, as well as some disorders such as sleep apnea[3]. Among people with disabilities, obesity is also a serious public health problem, especially due to the few opportunities to access physical exercise programs[4], because young people in this condition still face major barriers to enter and remain in such programs[5].

In individuals with Down syndrome (DS) that have a tendency to some health related disorders, such as heart problems, muscle hypotonia, and increased predisposition to leukemia, the obesity factor may further compromise their quality of life[6]. Despite the similar life expectancy of individuals with DS and the general population, DS is associated with a variety of comorbidities in different stages of life[7].

Individuals with DS have higher rates of obesity compared to those without the syndrome. According to Florentino Neto *et al*[8], obesity is intensified by a characteristic feature in the routine of people with DS, the sedentary lifestyle. According to Harris *et al*[9], 30–50% of children with DS are obese, which provides greater risk for obesity in adulthood[10], indicating the need for physical exercise programs aimed at this population.

The negative consequences of obesity and the contribution for its onset due to the characteristics of DS are facts that show the importance and urgency of creating specific intervention programs for this population. Studies show, in some cases, positive developments in body composition of patients with DS after completion of a training program, with reduced fat percentage[11,12]. On the other hand, other studies did not show improvement in that regard. Thus, there is insufficient evidence to identify which exercise programs are most effective for improving body composition in people with DS[4,13-15].

In this context, the aim of this study was to compare the effects of aerobic and resistance exercise on body composition in adolescents with DS.

Method

The present study is quasi-experimental. We carried out the selection of participants by convenience in institutions assisting people with DS in the municipality of Londrina, state of Paraná. Once informed about the conditions of the research, the parents or guardians of the participants signed an informed consent form. This study was approved by the Research Ethics Committee of Universidade Estadual de Londrina, opinion n. 93680/2012.

The study included 41 adolescents with DS (25 boys and 16 girls) who were authorized for the practice of physical exercise by a physician. The following adolescents were excluded: those with respiratory, cardiac, or orthopedic impairments, and/or intellectual disabilities that could interfere with the performance or understanding of tests and/or physical exercise sessions. The subjects were divided into three groups by convenience, according to the availability of attending the program, being: Control Group (CG – n=10, with six girls); Aerobic Training Group (ATG – n=16, with five girls); and Resistance Training Group (RTG – n=15, with five girls).

The assessment of body composition (percentage of fat mass and lean mass) was made by a plethysmography device (BOD POD® – Life Measurement Inc., Concord, CA). The apparatus was calibrated before evaluations with a cylinder with a volume of 50L. After calibration, the volunteers were assessed using a minimum amount of clothes and a cap on their heads. In this equipment, we analyzed the variations between pressure and volume to determine body density. From these data, we calculated body composition based on the equation of Siri[16].

The following anthropometric variables were also measured: waist circumference (WC), weight, and height. Waist circumference was measured in centimeters, using a flexible 2-meter tape measure. Body mass index (BMI) was calculated by dividing body weight measured in kilograms (by digital scale with precision of 100g) by height in square meters (measured with a stadiometer with accuracy of 0.1cm). All evaluations were performed twice, before and after the 12-week program of training, by the same evaluator.

The training program consisted of 12 weeks, with a frequency of 3 times per week for the ATG and twice a week for the RTG, following the recommendations proposed by the American College of Sports Medicine (ACSM)[17]. Each session lasted approximately 50 minutes, consisting of a 5–10 minute warm-up preceding the exercise and 5–10 minute stretching at the end of the session.

The aerobic training was performed on a treadmill/bike, with heart rate intensity corresponding to 50–70% of the heart rate reserve (controlled by a Polar FT2 frequency counter) during 30 minutes. The maximum heart rate was obtained through a maximal exercise test specific for this population[18], conducted prior to the start of the training period.

Resistance training was composed of nine exercises and consisted of three sets of 12 maximum repetitions (12 MR) for each exercise, with 1-minute interval between sets and 3 minutes between exercises. We proposed the following series of exercises: bench press machine, leg extension, front pull-down, cable biceps curl, standing hip flexion with ankle weights, cable triceps, calf raise with ankle weights, front raises with dumbbell weights, and abs. The two initial sessions were adaption sessions with light loads; thereafter, we estimated the load used observing the ability to perform the exercise in 12 maximum repetitions. The progression of the load was spontaneous, being increased as the individual could perform more than 12 repetitions of that exercise. Thus, the increased load was given as the individual could perform the 13th repetition.

The data were initially treated by means of descriptive statistics, with mean values and variability. After checking the normality of the data, so that the groups were compared in the two time points, we performed analysis of variance (ANOVA to verify possible differences between the groups. As for the comparison of variables before and after the exercise program, the paired *t* test was performed. To test the correlation between BMI, WC, and fat percentage, the Pearson's correlation coefficient was used. In all cases, the significance level was established at $p \leq 0.05$. The data were treated in the Statistical Package for the Social Sciences (SPSS), version 17.

Results

The 41 participants were divided into three groups: 16 in the ATG, 15 in the RTG, and 10 in the CG. The groups ATG, RTG, and CG were homogeneous regarding age (respectively 15.7±2.7; 16±2.8, and 14.4±2.5 years) and body weight (61.5±10.8; 52.7±10.0 and 54.7±11.8kg). As for height in centimeters, the CG (140.0±9.1) values were significantly lower in comparison to values for the ATG (151.0±8.4) and the RTG (150.4±7.0).

Table 1 presents the values of weight, fat percentage, BMI, and WC in the pre- and post-training period in the different groups. It was possible to verify that there were no significant changes in body weight values for any group, and

Table 1 - Measures of body composition before and after training in the three groups, described as mean±standard deviation

	Groups	Before	After	*p*-value (pre- *versus* post-training)
Body weight	ATG	61.5±10.8	60.8±10.1	0.06
	RTG	52.7±10.0	52.6±10.5	0.75
	GC	54.7±11.8	55.2±11.8	0.19
Fat %	ATG	29.6±10.5	29.4±10.5	0.72
	RTG	22.9±10.9	22.4±11.8	0.43
	GC	31.3±7.2	34.0±7.9*	0.04
BMI	ATG	27.0±4.4	26.5±4.2	0.01
	RTG	23.3±4.3*	23.1±4.6*	0.28
	GC	27.6±3.8	27.6±3.7	0.88
WC	ATG	87.3±11.1	86.2±9.7	0.01
	RTG	77.5±9.2	77.4±10.1	0.89
	GC	85.8±10.0	86.3±10.3	0.32

*$p<0.05$ – significant difference between other groups in a single moment, ANOVA. ATG: Aerobic Training Group; RTG: Resistance Training Group; CG: Control Group. BMI: body mass index; WC: waist circumference

Table 2 - Frequency of overweight and obesity according to body mass index

BMI by age	Boys	Girls	Total
Obesity	24.0%	62.5%	39.0%
Overweight	40.0%	6.2%	26.8%

Obesity: ≥95th percentile; overweight: ≥85th percentile (reference values according to the Centers for Disease Control and Prevention – CDC[19])

also that the exercise program did not change significantly the values of fat percentage in the groups that participated in the training. However, it was observed that the group that did not perform exercise (CG) had a significant increase in this variable (p=0.049). In addition, when the second evaluation was performed, values of fat percentage for this group were significantly higher compared to other groups.

When analyzing BMI, the group that performed aerobic training was able to significantly reduce the values of this variable (p=0.010), while those who performed resistance training and those who did not exercise presented no differences between the two moments. Similarly, changes in the WC measurement also showed significant only to the ATG (p=0.017). It is noteworthy that the RTG presented, in the pre-training, significantly lower values for BMI (p=0.022) and WC (p=0.029), when compared to other groups.

Table 2[19], shows that 65.8% of adolescents were overweight or obese. In the analysis by gender, more than 60% of girls and 24% of boys were obese.

Regarding the cardiovascular risk of adolescents according to WC measurements, 25% of girls and 12% of boys presented high cardiovascular risk, because they were above the 90th percentile according to the reference values[20]. Still, 50% of girls and 44% of boys exhibited values between the 75 and 90th percentiles. As for the fat percentage values, 44% of girls and 16% of boys were above the 90th percentile[21].

There were strong, positive, and significant correlations ($p<0.01$) between the variables of weight and BMI (r=0.76; r=0.86; and r=0.78) and WC (r=0.80; r=0.80; and r=0.93) for three groups (aerobic, resistance, and control), respectively. Likewise, the correlations between WC and BMI were also strong and significant ($p<0.01$) for the three groups (r=0.91; r=0.77; and r=0.92). On the other hand, when correlated fat percentage with BMI (r=0.62; r=0.53), moderate correlations were noted for the aerobic and resistance group, and strong correlation for the CG (r=0.73). Regarding the correlation of fat percentage with WC (r=0.68; r=0.61; and r=0.65) it was moderate for the three groups, respectively (aerobic, resistance, and control). All correlations were significant ($p<0.05$). When performed correlations between weight and body fat percentage, these were weak (r<0.40) and not significant ($p>0.05$) for all groups.

Discussion

The results of this study show high rates of overweight and obesity in adolescents with DS. In this sense, the World Health Organization[22] points to the alarming rise in the prevalence of these rates also in young people in general. Murray and Ryan-Krause[23] highlighted that the prevalence of obesity in individuals with DS may be higher than in the general population and, as a justification, the authors describe some physiological and behavioral factors associated with the syndrome that contribute to this fact, such as a reduction of basal metabolism, hypothyroidism, increased leptin, and physical inactivity.

According to Loveday *et al*[24], the best definition for obesity is based in adiposity (body fat percentage), because it is the variable that leads to increased morbidity and mortality. According to Adelekan *et al*[25], the increase in dyslipidemia in individuals with DS is associated with changed levels of leptin, which is secreted by adipocytes and, thus, relates to the percentage of fat. Consequently, children and adolescents with DS represent a population at high risk for obesity, diabetes, and unfavorable lipid profile, which is an additional risk for cardiovascular disease in adult life.

In order to contribute to reducing the deleterious effects of this situation, some studies have been conducted to examine the influence of exercise on body composition in children and adolescents with DS. However, a recent literature review showed that in the few studies found, the results have been contradictory regarding the effects of training on body composition[26].

Varela *et al*[14] conducted a 16-week study with a rowing ergometer in adolescents and young adults with DS, with intensity and volume similar to the aerobic training in this study, and found no changes in weight or body fat. Likewise, González-Agüero *et al*[27], after 21 weeks of training of combined strength exercises in people with DS, also did not observe decreases in body fat percentage or BMI, using the same weekly frequency as the present study (twice a week).

On the other hand, Ordonez *et al*[11] assessed 22 overweight and obese adolescents with DS, having performed an exercise program (in water and land) of 3 sessions a week, with progressive duration for 3 months. The authors observed a significant reduction in fat mass (31.8±3.7 to 26.0±2.3%). It was possible that the specificity of the exercise (water and land) contributed to reduce these values.

In the present study, Table 1 shows that the subjects of the ATG and the RTG did not obtain a significant reduction in fat percentage. However, it is noteworthy that the percentage of body fat of individuals in the CG increased, i.e., the exercise proved beneficial in providing the maintenance of body fat levels of the subjects with DS who participated in the exercise program.

In some recent studies with adults with DS, in which the influence of the exercise was verified, there were no changes in the values of body composition. Mendonca *et al*[28], after aerobic and resistance training, concluded that the exercise program had no significant effect on the body composition of participants. Calders *et al*[29], in turn, analyzed the influence of a combined training (aerobic and strength) and observed that the variables BMI, WC, and percentage of fat mass remained stable after the intervention period. Finally, Rimmer *et al*[4] conducted a 12-week intervention program of combined exercise (aerobic and resistance) with 52 adults with DS, with a frequency of 3 times a week, observing body weight reduction in these individuals; however, no changes were found in BMI.

Besides fat percentage, BMI and WC are also important variables to analyze body composition. The present study showed a prevalence of 65.8% of individuals with BMI above the 85th percentile, which puts them at risk, according to international criteria[19]. As an aggravating factor, about 40% of these were above the 95th percentile, which indicates the presence of obesity. The use of cutoff points of BMI for young people with DS is questioned. However, a recent study [30] determined the validity of this parameter to identify excess fat in young people with DS, using the CDC cutoffs as a basis[19].

Another important measure in the evaluation of the health of children and adolescents is the WC, as this is associated with health problems such as hyperlipidemia, type II diabetes, and cardiovascular risk factors in general. Therefore, early identification of children with high central adiposity is critical[20].

The results of this study indicated that 17% of young people with DS had cardiovascular risk because they presented WC above the 90th percentile. Moreover, almost half of the individuals were between the 75th and 90th percentiles. The average WC found in this study is similar to that found in children and adolescents with DS in Spain[31].

The high prevalence of risk conditions regarding body composition in this population is worrying. Rimmer *et al*[32] pointed out that excess weight aggravates many secondary health conditions in children and adolescents with DS, including chronic pain, social isolation, depression, falls, injury, and extreme fatigue. Taking this fact into account Murray and Ryan-Krause[23] highlighted the need to prioritize prevention and intervention in children and adolescents with DS.

Regarding the effects observed after the intervention program for 12 weeks, this study found a reduction in measures of BMI and WC for individuals who performed the aerobic training. However, although significant changes were not observed in these values for those who performed resistance training, it should be noted that the RTG, in the pre-exercise assessment, already showed results of significantly lower BMI and WC when compared to other groups. This may have contributed to insignificant changes in these variables in the post-training, since the smaller the initial values, probably the smaller the possibility of improvement.

The specificity of training is also an issue to be considered when analyzing the influence of exercise program. In the present study, attendance to exercise sessions has always been above 85% for both experimental groups, all subjects performed the requested exercises properly, always under the supervision of a responsible teacher who controlled intensity, movement technique, the number of repetitions, and resting time.

Despite having shown significant results, some limitations of the study need to be mentioned. One of them refers to the volume of training proposed in the intervention, once the number of weekly sessions and the duration of training may not have been sufficient to generate a significant impact on body composition. The sample selection by convenience and the fact that we did not perform the calculation of the sample size may have reduced the statistical power to detect significant differences in the effects of training. Another possible intervening point is that the diet of the participants was not controlled. Throughout the intervention, some parents reported that their children, after the start of the training period, began to ingest a larger amount of food, especially those rich in carbohydrates. Nevertheless, the results showed a decrease in BMI and WC values in the group that performed aerobic training. Therefore, if the training were combined with a proper and healthy diet, the results could have been different.

Finally, the results showed that the physical exercise was able to keep the body fat levels of young people with DS, and those who remained sedentary suffered losses in this variable. In addition, aerobic training caused a reduction in measures of BMI and WC, contributing to better health. However, a few points are worth mentioning between the two types of exercise. The aerobic training had a larger volume than the resistance training; moreover, the progression of the load in the resistance training was spontaneous and, therefore, more subjective, once it depended a great deal on the individual's motivation. The intensity control of the aerobic training was performed with the heart rate.

Therefore, we reinforce the idea that intervention studies are necessary in order to contribute for the prevention and treatment of obesity in young people with DS, to help reducing cardiovascular risk factors and, consequently, to increase life expectancy in this population.

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