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Original Article

ASSOCIATION OF AEROBIC FITNESS AND BODY COMPOSITION IN PEOPLE WITH DOWN SYNDROME

ASSOCIAÇÃO DE APTIDÃO AERÓBIA E COMPOSIÇÃO CORPORAL EM PESSOAS COM SÍNDROME DE DOWN

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RESUMO

Pessoas com Síndrome de Down (SD) apresentam diferenças metabólicas quando comparadas à população em geral, o que resulta em maior prevalência de sobrepeso e menores índices de aptidão aeróbia. O objetivo deste estudo foi analisar a associação da aptidão aeróbia com a composição corporal em indivíduos com SD. Foram avaliados 30 indivíduos com SD da cidade de Londrina / Brasil com média de idade 18,00±3,66 anos. Foram investigadas as variáveis índice de massa corporal, gordura corporal, e aptidão aeróbia (VO²pico). Os homens foram mais altos que as mulheres, apresentaram maior percentual de massa magra e maior VO²pico, enquanto as mulheres apresentaram maiores médias para gordura andróide, ginóide e total. A aptidão aeróbia associou-se inversamente ao índice de massa corporal, massa magra e gordura corporal.

Palavras-chave: Pessoas com deficiência; Síndrome de Down; Deficiência Intelectual

ABSTRACT

People with Down Syndrome (DS) present metabolic differences when compared to the general population, which ends up at a higher prevalence of overweight and lower rates of aerobic fitness. The aim of this study was analysing the association of aerobic fitness and body composition in individuals with DS. Thirty individuals with DS from the city of Londrina / Brazil with a mean age of 18.00±3.66 years were evaluated. The variables body mass index, body fat, and aerobic fitness (VO²peak) were investigated. Men were taller than women, presented a higher percentage of lean body mass and higher VO²peak, while women showed higher means for android, gynoid and total fat. Aerobic fitness was positively associated with bone mineral density and inversely associated with nutritional status, lean body mass and body fat.

Keywords: Disabled Persons; Down Syndrome; Intellectual Disability

Introduction

Down syndrome (DS) is a chromosomal disorder caused by an exceeding 21 chromosome, which results in intellectual disabilities and physical anomalies[1]. This condition directly influences the physical fitness levels of such population, including the prevalence of obesity, low aerobic fitness and inappropriate strength levels[2,3], mainly due to their low muscle tone, endocrine problems and lack of physical activity[2,4,5].

People with DS have a reduced resting metabolic rate, which directly contributes to a higher prevalence of obesity[5,6]. Mendonça, Pereira and Fernhall[7] point out that people with DS tend to show a reduction in chronotropic activity, leading to a lower heart rate response during extenuating exercise, one of the main causes of lower VO² max in this population[7,8].

Aerobic fitness is an important health marker both for the general population[9,10]. In addition, research also indicates that aerobic fitness is a predictor of basic motor skills, which play a key role in spelling, reading and math performance [11]. Improved aerobic fitness in people with DS, despite lower VO²peak values due to anatomical dysfunctions, ventilatory capacity and metabolic dysfunction when compared to the population without DS[3], in addition to the benefits applied to the general population, it has a positive impact on the metabolic risk profile[2] and better hormonal response[12].

In general population, studies indicate that lower body fat is associated with better aerobic fitness rates[13]. However, in people with DS, literature presents divergent results as for example presented in the cross-sectional study carried out by Beck et al.[14] no relationship between aerobic fitness, body fat and body mass index (BMI) were noted. Izquierdo-gomez et al.[15], when conducting a cross-sectional survey in Spain with 222 adolescents (111 with DS), have noted an inverse association between BMI, body fat and aerobic fitness. Then in follow-up study, in which the adolescents were followed for two years, authors noticed a decrease in aerobic fitness in those individuals with high body fat and BMI (at the baseline)[16]. But, when analysing data at the end of two years, authors report having found no association between aerobic fitness and body composition.

Review studies also show a contradiction between the relationship between aerobic fitness and body composition. The review performed by Sutana et al[17], for example, compared the effect of interval and high-intensity exercises on body composition and aerobic fitness. Authors found that both methods were inefficient for the modulation of body composition, however there was a significant improvement in aerobic fitness in both interventions when compared to the control group. In another review that analyzed the effect of different physical activity programs on body composition in people with DS, the authors came to the conclusion that programs involving aerobic activities (jumping, cycling and swimming) brought about a reduction in fat mass, but it is not yet clear the association between the variables[5].Thus, considering the literature gap on such topic, this research aims to analyse the association of aerobic fitness with body composition variables in individuals with DS.

Methods

Sample

This is a cross-sectional descriptive study, which included a non-probabilistic sample of 30 individuals with DS, 17 boys and 13 girls aged 18 ± 3.66 years-old, who attended institutions specialized with the care of DS people based in the city of Londrina, south of Brazil.

The exclusion criteria were: individuals with orthopaedic, cardiac or respiratory impairments, atlantoaxial instability, people under the use of drugs that may influence their heart rate and people who had severe or profound intellectual disabilities. The study was approved by the Ethics Committee for Research with Human Beings of the State University of Londrina, under the protocol 1.215.776 / 2015.

Procedures

For VO2peak determination, a maximal oxygen uptake test with a validated protocol for DS people was used[16]. The test was carried out on a treadmill, with a start speed of 4 km/h with 0% inclination for two minutes, with increases of 2.5% in the ergometer elevation every two minutes, until reaching an elevation of 12.5 %. From this moment on, the speed was increased by 1.6 km/h every minute until exhaustion. A portable ergo spirometer (Cosmed k4b², Italy) and a heart monitor (Polar model M400) were used to measure HR throughout the test.

The BMI was calculated by the ratio between total body mass (kg), measured with a digital scale of 100g precision, and the square of height (m^2), measured in a wall stadiometer with a precision scale of 0.1cm. A Lunar Prodigy Advance model was used for DEXA evaluation. For body composition data, total body mass, body fat and lean mass were used. For the fat distribution trend analysis, the percentages of android and gynoid fat were used; the android/gynoid rate (A/G) was calculated by the ratio between the android fat mass (kg) and the gynoid fat mass (kg), while the Fat Mass Index (FMI) was calculated by the ratio of the fat mass (kg) by the square of height (m^2).

Skeletal maturation was determined through bone age, using the Greulich-Pyle[18] method. This method compares the radiograph of an individual's left hand and wrist with a set of radiographs that characterize successive stages of maturational development at different chronological ages for each sex. The participant was assigned a bone age equal to that of the pattern to which he resembled. For this, a total of 28 ossification points were examined during the comparison.

Statistical analysis

Normality of the data was tested using the Kolmogorov-Smirnov test, verifying the asymmetry and kurtosis of the histogram and then descriptive analysis was used; inferential analysis using Student's t test was used to verify differences between the sexes in the independent variables.

To verify the association between aerobic fitness and the other variables, the calculation of the adjusted linear regression was adopted, with the models being presented with the regression coefficient and 95% of confidence interval. For the adjusted model, the variables sex and age were included, as they directly influence the levels of aerobic fitness[11]. Bone age was also included as a variable in the adjusted model, as studies also show that people with DS prematurely mature skeletally[19].

Interactions between independent variables were tested, however, these were not verified. For evaluating the final model, it was compared to the null model, with a difference between them. multicollinearity was tested using the variance inflation factor (VIF), and the residuals of the model in all variables showed normal distribution verified by means of histogram and heteroscedasticity by means of scatterplot. With regards to the residual and predicted values, there were no outliers. In the analysis, the Statistical Package for Social Science® v.25 program was used, adopting a significance level of $p < 0.05$.

Results

The descriptive data of the study participants are summarized in Table 1. Regarding sexes, there was a significant difference in height, lean body mass and VO^2peak, with men data being higher than women. Women, on the other hand, showed higher percentages than men for android, gynoid and total fat, along with BMI variables.

Table 1: Mean, standard deviation and independent Student *t* test by sex of the continuum variables

Variables	Mean ± SD	Women (mean±SD)	Men (mean±SD)	p
Age (years)	18,00±3,66	17,85±4,05	18,12±3,46	**0,84**
Bone age (years)	17,40±2,22	17,23±2,48	17,53±2,06	**0,87**
Height (cm)	149,13±10,74	143,09±9,34	153,11±10,23	**0,01**
Total body mass (kg)	59,95±13,49	55,13±14,43	63,64±11,85	**0,08**
BMI (kg/m²)	27,12±5,87	27,90±7,45	26,52±4,46	**0,56**
Total Fat (kg)	28,50±19,19	24,17±10,05	31,80±23,77	**0,28**
Lean body mass (kg)	36,45±8,88	28,76±4,17	42,33±6,71	**<0,01**
Android Fat (%)	39,92±11,78	45,95±8,53	35,31±12,03	**0,01**
Gynoid Fat (%)	43,87±11,20	52,46±5,31	37,30±10,03	**<0,01**
Total fat (%)	36,25±11,43	44,01±7,33	30,03±10,49	**<0,01**
A/G rate	0,91±0,14	0,87±0,10	0,93±0,16	**0,28**
FMI (kg/m²)	9,66±4,73	12,22±5,14	8,21±4,03	**0,02**
VO² peak	33,46±7,00	30,01±5,75	36,26±6,18	**0,01**

Note: cm – centimetres / Kg – Kilograms / m – metres / BMI – Body mass index / SD – Standard deviation / BMD – Bone mineral density / % - Percentage / A/G – Android/ Gynoid / FMI – Fat mass index
Source: Authors

Regarding the association between aerobic fitness and body composition, the crude analysis of the variables total body mass, BMI, percentage of android, gynoid and total fat, and FMI presented an inverse relationship. When the analysis was adjusted by sex, chronological age and skeletal age, the relationships remained the same, and the variables lean body mass and A/G rate showed an inverse relationship with aerobic fitness (Table 2).

Table 2: Crude and Adjusted linear regression analysis for aerobic fitness variables and body composition

Variable	Crude Analysis			Adjusted Analysis¹			
	β	(IC95%)	p	β	(IC95%)	p	R²*
Height (cm)	0,150	(-0,97-0,39)	0,22	0,028	(-0,24 – 0,30)	0,83	0,08
Total body mass (kg)	-0,192	(-0,38 - -0,02)	**0,04**	-0,315	(-0,48 - -0,14)	**<0,01**	0,43
BMI (kg/m²)	-0,739	(-1,12 - -0,35)	**<0,01**	-0,679	(-1,05 - -0,30)	**<0,01**	0,42
Total fat (kg)	0,112	(-0,22 – 0,24)	0,09	0,100	(-0,39 – 0,23)	0,14	0,15
Lean Mass (kg)	0,099	(-0,20 – 0,40)	0,66	-0,729	(-1,21- -0,23)	**<0,01**	0,33
Android fat (%)	-0,407	(-0,58 - -0,23)	**<0,01**	-0,369	(-0,58 - -0,15)	**<0,01**	0,39
Gynoid fat (%)	-0,383	(-0,58 - -0,18)	**<0,01**	-0,432	(-0,75 - -0,10)	**0,01**	0,40
Total Fat (%)	-0, 420	(-0,60 - -0,23)	**<0,01**	-0,437	(-0,70 - -0,17)	**<0,01**	0,37
A/G rate	-15,94	(-33,8 – 1,95)	0,07	-21,103	(-37,29 - -4,92)	**0,01**	0,29
FMI (kg/m²)	-1,01	(-1,43 - -0,58)	**<0,01**	-0,901	(-1,41 - -0,38)	**<0,01**	0,40

Note: cm – centimetres / Kg – Kilograms / m – meters / BMI – Body mass index / SD – Standard deviation / % - Percentage / A/G – Android/ Gynoid / FMI – Fat mass index; 1 - Analysis adjusted for the variables: sex, age and chronological age / Adjusted R² / VIF=1.93
Source: Authors

Discussion

The aim of this study was to analyse the association of aerobic fitness and body composition variables in individuals with DS. With regards to the body composition, women showed higher percentages of android, gynoid and total fat, while men showed better mean values for aerobic fitness. Regarding the association of body composition variables, it was noted that only the variables total body fat and height were not associated with aerobic fitness, while the other variables showed an inverse relationship with VO²max.

Several studies point out the differences in body composition between sexes. As reviewed by Bredella[20], men tend to present more lean body mass while women have greater body fat, especially in the hip and neck regions. Similar characteristics are also observed in the population with DS, as described in a longitudinal study carried out in Spain[21], in which the authors compared people with and without DS during adolescence. It was observed that, despite the body composition variables increase in people with DS, body fat increased significantly only in women, highlighting that sex is a variable that also influences the body composition in such population.

The result found in this study on the difference in body composition between men and women with DS, which is already established in the literature, may be an indication that, especially in this population, there is a need for greater interventions among the female group, since despite physiologically women have more body fat than men[20], there is a lower participation in relation to physical exercise in activities of daily living[22].

With regards to the aerobic fitness, the results showed that the VO^2max of men was higher than of women, fact observed both in the general population[9] and in groups with DS[23]. Such result is expected due to the maturational development, even if delayed in people with DS, as it promotes alterations between sexes, which directly influence aerobic fitness[24]

The results found in this research indicate that the BMI and the body fat are inversely associated with aerobic fitness. These findings contrast with the ones from the study carried out by Beck et al.[14], in which the researchers evaluated nine people with DS, having found no association between anthropometric variables (BMI and body fat) and aerobic fitness. On the other hand, research carried out by Ringenbach et al.[25] with 30 individuals with DS describes an inverse association between BMI and aerobic fitness, although the authors did not find the same relationship when they associated the body fat (assessed by skinfolds) and aerobic fitness.

In a larger study involving 111 adolescents with DS in Spain[15], an inverse correlation between body fat and aerobic fitness is described. In a longitudinal two-years follow-up study with the same sample[16], authors report that adolescents who had a high level of body fat presented lower aerobic fitness (after a period of two years). However, such relationship was not noticed when the change in body composition based on initial aerobic fitness was compared, which denotes that, over time, body fat can influence aerobic fitness and not the other way around. This light up the need to rethink interventions aimed at this population.

An inverse relationship between lean mass and VO^2max was observed in this study, just as in the research carried out by Beck et al.[14], fact which is not usually seen in the population without DS. Such occurrence may be due the fact that oxygen consumption is partially determined by the muscle's ability to perform oxidative phosphorylation, which depends on mitochondrial capacity[26]. Previous studies report that people with DS have problems with the regulation of mitochondrial function[27], that is, this condition could explain not only the relationship found with lean mass, but also a potential explanation for the fact that individuals with SD present lower levels of VO^2max[14].

The main results of this study are consistent with most of the literature on the subject related to obesity and aerobic fitness in people with DS, however few studies seek to investigate the relationship between the variables. Beck et al. [14] suggest that the relationship between anthropometry and cardiorespiratory fitness found in the general population is not the same in adults with DS, since in this population there is autonomic dysfunction (including lower heart rate), impaired blood pressure control, which would lead to insufficient oxygen and nutrients to muscles.

As a limitation of the study, we can mention the fact of the cross-sectional design, not allowing the establishment of causality on the results, which reinforces the need for more research on the effect of aerobic fitness on body composition in individuals with DS. Another limiting point is the small number of participants, which makes it difficult to extrapolate the results. Despite that, as a positive point of this study, the use of direct measures to access aerobic fitness, along with the technique considered as “gold standard” for evaluating body composition in people with DS must be highlighted.

Conclusion

Based on the results of this study, it is concluded that the BMI levels, body fat (android, gynoid and total), A/G rates, IMG and lean body mass are negatively associated with aerobic fitness in people with DS, regardless of sexes, chronological age and bone age.

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