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Case Report

Programa de treinamento físico híbrido sobre a saúde e função física em jovem obeso com síndrome do cromossomo 16: um relato de caso

Hybrid physical training program on health and physical function in an obese adolescent with chromosome 16 syndrome: a case report

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ABSTRACT: Introduction: Chromosome 16 syndrome is a disorder generated by microdeletions of variable sizes in region 11.2 of this chromosome. The phenotype may include cognitive deficit, severe obesity, and neurodevelopmental delay, affecting health-related quality of life. Objective: to report the effects of a physical exercise program on the quality of life and functional capacity of a young person with chromosome 16 syndrome. Method: the study is a case report, which consisted of a 20-week physical exercise program, with aerobic and resistance exercises, in the hybrid model (*Home-Based Exercise* and face-to-face/supervised). Information about the participant was sought and measured: body mass, height, body circumference, and applied the tests *Timed Up and Go* (TUG) and *Five Times Sit-to-Stand Test*, (5TSTS), to assess physical function, pre and post-intervention. The health-related quality of life of the young adolescent and his caregivers was assessed through the *Pediatric Quality Of Life Inventory* (PedsQL™). The data were analyzed using descriptive statistics. Results: the participant was a 14-year-old male adolescent, physically inactive and obese (body mass index ~ 65kg / m2). The evaluations did not demonstrate morphological changes, however, there was an improvement in the performance of the functional tests, being 28.5% in the TUG and 10.9% in the 5TSTS, suggesting progress in functional capacity. Regarding the quality of life, favorable changes were observed to improve the social (absolute variation: 65 points), physical and emotional (absolute variation: 50 points in both) aspects in the perception of the adolescent. In the "Family Impact Module" all domains were modified, with the exception of "activities of daily living", "communication with other people" stands out with greater variation. Conclusion: this study demonstrated that the regular practice of physical exercise, in a hybrid way, provided positive results in the physical function, emotional and social health of the youthful with the syndrome.

KEY WORDS: Case reports; Adolescent; Exercise; Inborn Genetic Diseases; Obesity.

RESUMO: Introdução: A síndrome no cromossomo 16 é uma desordem gerada por microdeleções de tamanhos variáveis, na região 11.2 deste cromossomo. O fenótipo pode incluir déficit cognitivo, obesidade grave e atraso de neurodesenvolvimento, afetando a qualidade de vida relacionada à saúde. Objetivo: relatar os efeitos de um programa de exercício físico na qualidade de vida e capacidade funcional de um jovem com a síndrome do cromossomo 16. Método: o estudo é um relato de caso, que consistiu em um programa de exercício físico de 20 semanas, com exercícios aeróbios e resistidos, no modelo híbrido (*Home-Based Exercise* e presencial/supervisionado). Buscou-se informações sobre o participante e foram mensuradas: massa corporal, estatura, circunferências corporais e aplicados os testes *Timed Up and Go* (TUG) e *Five Times Sit-to-Stand Test*, (5TSTS), para avaliar da função física, pré e pós-intervenção. A qualidade de vida relacionada à saúde, do jovem e seus cuidadores, foi avaliada por meio do *Pediatric Quality of Life Inventory* (PedsQL™). Os dados foram analisados com recursos da estatística descritiva. Resultados: o participante foi um adolescente de 14 anos, sexo masculino, inativo fisicamente e com obesidade (índice de massa corporal ~ 65kg/m²). As avaliações não demonstraram alterações morfológicas, entretanto, houve melhora no desempenho dos testes funcionais, sendo 28,5% no TUG e 10,9% no 5TSTS, sugerindo progresso da capacidade funcional. Referente à qualidade de vida, foram observadas modificações favoráveis à melhora dos aspectos social (variação absoluta: 65 pontos), físico e emocional (variação absoluta: 50 pontos em ambos) na percepção do adolescente. No "Módulo de impacto familiar" todos os domínios foram modificados, com exceção para "atividades de vida diária", destaca-se a "comunicação com outras pessoas" com maior variação. Conclusão: este estudo demonstrou que a prática regular de exercício físico, de forma híbrida, proporcionou resultados positivos na função física, saúde emocional e social do jovem com a síndrome.

PALAVRAS-CHAVE: Relato de casos; Adolescente; Exercício físico; Doenças Genéticas Inatas; Obesidade.

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INTRODUCTION

Chromosome 16 deletion syndrome is a disorder caused by microdeletions of variable sizes in the region 11.2 of the short arm of this chromosome[1]. The phenotype is variable and may include cognitive deficit, dysmorphic facial features, predisposition to severe early-onset obesity, autism spectrum disorder, and neurodevelopmental delays[2,3,4].

Obesity in chromosome 16 syndrome is considered to be of genetic origin, characterized by early onset, which may or may not remain in adulthood[5]. Besides, it may be related to genes involved in the hypothalamic leptin-melanocortin pathway, such as the SH2B1 gene, which acts as a fundamental intermediate in the signaling of leptin, a satiety hormone[6]. With this affected gene, the signaling of these processes is ineffective and the inhibitory action of hunger by the hormone leptin is compromised, which seems to be related to hyperphagia[6].

The presence of obesity can bring risks for the emergence of secondary diseases, such as diabetes mellitus, arterial hypertension and hypercholesterolemia[7]. In addition, people with obesity have a reduced ability to perform activities of daily living (ADL), such as sitting and standing up, lying down, walking, and climbing stairs[8,9].

For the treatment of chromosome 16 syndrome, lifestyle changes are highly recommended, such as physical exercise and modifications in eating behavior, which should be initiated as early as possible to avoid the aforementioned consequences of genetic obesity[10].

Therefore, physical exercise can be an important form of non-pharmacological treatment to improve health-related quality of life (HRQOL)[10]. Exercise is able to promote the increase of functional capacity, motor coordination, reduction of body mass and the breaking of sedentary behavior[11,12].

Physical exercise programs for children and adolescents are traditionally held in schools, gyms and clubs. However, its impact on public health, in general, seems to be associated with sufficient financial conditions, resources and motivations to remain in the long term[13]. Thus, for greater accessibility and adherence to the practice of physical exercise, programs such as *Home-Based Exercise* (HBE; physical exercise performed at home, or home physical exercise)[12,13], are indicated, guaranteeing access for families with lower socioeconomic status, such as those compromised by too much work time and transportation; in addition to offering flexibility and privacy to participants[13,14].

The HBE is a form of presentation of a physical exercise program, performed at home, often found in the literature[13,14] and popularized during the COVID-19 pandemic. This includes the prescription and guidance of exercises through prints and/or communication apps such as Whatsapp®.

Given this, knowing that chromosome 16 deletion syndrome is considered rare, the existing literature on the subject provides relevant data for the characterization of the biological profile of people with this syndrome, however, it is pointed out as a gap in knowledge, data and analysis on HRQOL and experimental studies addressing physical exercise. Therefore, this study aims to report the effects of a physical exercise program on the quality of life and functional capacity of an adolescent with chromosome 16 syndrome.

METHOD

The present study has a longitudinal, quantitative characteristic and is called a case report; a research approach used to generate an in-depth understanding of a complex and little-known issue. This is appropriate in some circumstances, when the case is rare and there are not many similar situations to compare[15].

CASE REPORT

The participant was a 14-year-old boy, enrolled in the 6th grade of elementary school, male, insufficiently active, hypertensive (systemic arterial hypertension), on regular medication, diagnosed with deletion syndrome on chromosome 16 and presents the following phenotypes: congenital malformation; intellectual disability; delay in neurodevelopment; and severe obesity.

The adolescent was referred from the basic healthcare unit (BHU) of reference to the physical education team of the multiprofessional residence acting on site.

The participant is dependent on parental assistance for ADL, uses an ambulation device (i.e. pair of Canadian crutches) and composes a family with socioeconomic standard dependent on government aid and donations. The monthly family income is approximately one minimum wage.

To participate in this study, the adolescent underwent prior medical clinical evaluation and after approval by the Ethics and Research Committee (5.380.938/2022), with the consent of the Municipal Health Department and the Health Workers Education Center of the city of Campinas-SP, the Informed Consent Form (ICF) and the Informed Assent Form (IAF) were signed by the parents and the participant, respectively.

Experimental design

The study was carried out through the participant's BHU of reference in the city of Campinas, São Paulo, by home visits. Data from the electronic medical record were used for clinical description of the case, by the e-SUS system, a resource of Brazil's Unified Health System (SUS, in Portuguese), which contains the Citizen's Electronic Health Record (PEC, in Portuguese), and comprises the individual follow-up history.

A physical exercise program, with 20 weeks of duration, in the hybrid model, with three weekly sessions: twice a week at a distance (HBE) and once a week face-to-face/supervised. The average duration of each session was 30 to 40 minutes of activity.

For anthropometric evaluation were measured: body mass, height, body circumferences and the following tests to assess functional capacity: *Timed Up and Go* (TUG) and *Five Times Sit-to-Stand Test* (5TSTS). For HRQOL parameters, an instrument with proven reliability and validity was used, called *Pediatric Quality Of Life Inventory* (PedsQL™)[16]. It should be noted that all the items mentioned above were performed before and after the intervention.

Anthropometry

Body mass (kg), height (m) and body circumference (abdominal, right leg (RL), right arm (RA) and neck) were measured. For body mass measurement, an electronic scale with a capacity of 500kg of the Welmy ® brand and manufacturer was used, with 100g division. For height, the measurement was performed with a stadiometer fixed on a wall. Then, the collected data were used to calculate the body mass index (BMI = body mass[kg]/height [m^2]). It was adopted for the classification of the participant the growth curves for healthy adolescents, according to sex and age, of the World Health Organization (WHO, 2007)[17].

To measure body circumferences, a measuring tape of the brand Prime med® was used, with a resolution of 0.1cm, inextensible. All measurements were performed using the participant's right side as a reference. The criteria for measurement were: leg – largest leg circumference[18], arm - midpoint between the acromion and olecranon[18], neck - midpoint of neck height[19] and abdominal circumference - umbilical scar[20,21]. The initial and final assessments, respectively, were carried out on the first and last day of intervention, with each measurement being repeated twice.

Physical function

Knowing that ADL performance is determined by the combination of different physical abilities and capabilities, physical function tests are important tools to assess functional mobility and effects of interventions based on exercise programs[21]. The tests were used: *Timed Up and Go* and *Five Times Sit-to-Stand Test*, considered efficient, affordable, low cost and easy clinical application[21].

The test *Timed Up and Go* quantifies, in seconds, dynamic equilibrium through the task of getting up from a chair, walking a three-meter linear path to a demarcation/object (e.g. cone), bypassing it, and then returning to the chair to sit, as the starting position[21]. The participant began the test sitting in a chair with a backrest, with his back supported, arms relaxed on his thighs, and feet on the floor. The test is based on the total runtime, so after the warning from the researcher, the stopwatch starts and the test begins. When returning to the chair to the sitting position, the stopwatch is stopped and the time recorded. The adolescent's pair of daily-use Canadian crutches for ambulation was used in the test, ensuring safety and representing his usual form for the task of walking.

The *Five Times Sit-to-Stand Test* measures the time of the action of getting up and sitting down five times, which may be related to the strength and/or power of the lower limbs and is associated with ADL[22]. The test consisted of standing up and sitting on a chair (i.e., height of 43cm), as fast as possible, with hands resting on the waist, five times. The time that the participant took from the verbal instruction "go" until the end of his last movement was considered for the analysis. There was an attempt to familiarize, each test, pre-intervention, in the week prior to the first data collection.

The two tests were performed on the same day, two attempts each, and the best value was adopted for analysis. The *Timed Up and Go Test* and the *Five Times Sit-to-Stand Test* were carried out in sequence, respectively, with a two-minute rest interval between attempts and a five-minute rest interval between tests.

Health-related quality of life (HRQOL) assessment

To evaluate HRQOL, the PedsQL™ questionnaire was used, with prior approval from the *Mapi Research Institute*. This is an instrument that allows assessing the HRQOL of children and adolescents with and without chronic health disorders, developed and validated in the English language by Varni et al.[23], translated and validated by Klatchoian et al.[16] for the Portuguese language.

In this study, three formats of PedsQL™ were used: one for the adolescent to report their own perception of quality of life: "Self-report - Version 4.0" - for adolescents aged 13 to 18 years, another for parents: "Parents' report - Version 4.0", to evaluate the parents' perception of their child's quality of life and the "Family Impact Module - Version 2.0", which evaluates the quality of life of one of the parents as a result of the child's health conditions[16].

The questionnaires "Self-report" and "Parents' report" have 23 items each and cover the dimensions: physical - eight items, emotional, social and school, five items each[16]. Each item has five answer options on a scale *Likert* (never = zero and almost always = four)[16]. The values are transformed into an inverse linear scale from 0 to 100, and the higher the score, the better the perception of quality of life. This questionnaire can be scored by dimensions (average of the scores of the corresponding items) or by the total[16].

The "Family Impact Module" has 36 items and 8 domains: physical, emotional, social, cognitive and problems with: communication, worries, daily activities and family relationships[16]. A detailed explanation was given to the participant and his parents about the questionnaires used, in order to reduce underestimation or overestimation in the answers.

Physical training

The program was conducted in a hybrid model: one supervised session, in person, and two remote sessions, via Whatsapp®, totaling three weekly sessions (30 to 40 minutes each session). The participant and his parents received an initial face-to-face demonstration and printed instructions on the exercises (e.g. images, number of repetitions, intensity and duration).

The session involved resistance and aerobic exercises of low to medium intensity, monitored by Borg's Scale (Rate of Perceived Exertion, RPE)[24], a scale with numbers from 0 to 20 that represent a level of physical exertion during a given activity. Regarding the intensity variable, the RPE was between 11 and 13, which corresponds to the intensity "light" to "a little difficult"[24]. The participant was previously informed about the use, function of the RPE and familiarization, emphasizing the progression of numbers along with signs of breathing, in a playful way, to facilitate understanding (this was used during and at the end of each exercise).

The training included a sequence of simple exercises, using his own body weight, which act on the main muscle groups: 1) walking for 15 to 30 meters, 2) sitting and standing up, 3) development of upper limbs, holding a rubber ball (i.e. shoulder abduction with elbow extension), 4) plantar flexion sitting with back support, 5) dorsiflexion sitting with back support, 6) trunk stretching with emphasis on the cervical and thoracic region.

The progression of sets, repetitions and intervals between sets and exercises are described in Tables 1 and 2. The training volume was progressively increased through the number of sets.

Table 1 - Walking exercise progression and rest between sets

Exercise	Sets progression		Interval between sets
	1st to 13th week	13th to 20th week	
Walk 15 to 30 meters	3 sets	5 sets	60 seconds

Table 2 - Exercises, sets progressions, repetitions, rest between sets and rest between exercises

Exercises	Sets progression			Repetitions	Interval between sets	Interval between exercises
	1st and 2nd week	3rd to 12th week	12th to 20th week			
Sit-to-stand	2 sets	3 sets	4 sets	8-12 repetitions	60 seconds	120 seconds
Upper limb development with rubber ball*	2 sets	3 sets	4 sets	10 repetitions	60 seconds	120 seconds
Seated plantar flexion with back support	2 sets	3 sets	4 sets	8-12 repetitions	60 seconds	120 seconds
Sitting dorsiflexion with back support	2 sets	3 sets	4 sets	8-12 repetitions	60 seconds	120 seconds
Trunk stretches (emphasis on the cervical and thoracic region)	2 sets	3 sets	4 sets	40 seconds	60 seconds	120 seconds

*shoulder abduction with elbow extension.

RESULTS

Anthropometry

When plotting BMI data, for gender and age of participant on WHO growth curves[17] for healthy adolescents, it is observed that the participant was above the 97th percentile (indicative of obesity). When plotting the height data, these are within the normal range[17] between 50th and 15th percentile.

There was no expressive difference between pre and post-intervention values of body mass and body circumferences. However, there was an increase in height from 160cm to 162cm, resulting in a change in BMI from 65kg/m^2 to 64kg/m^2 (Table 3).

Table 3 - Pre and post-intervention body composition data

Anthropometry	Pre-intervention	Post-intervention	Relative variation (%)
Body mass (kg)	168	168	0
Height (cm)	160	162	1,25
Body mass index (kg/m²)	65	64	-1,53
Abdominal circumference (cm)	152	152	0
Right leg circumference (cm)	57	57	0
Right arm circumference (cm)	48	48	0
Neck circumference (cm)	42	42	0

Functional capacity tests

There was a reduction of 7.4 seconds in TUG time, resulting in a 28.5% performance improvement. While 5TSTS had a reduction of 1.9 seconds and 10.9% performance improvement (Table 4).

Table 4 - Data from pre and post-intervention functional capacity tests

Functional tests	Pre-intervention	Post-intervention	Relative variation (%)
TUG (seconds)	26	18.6	28,5
5TSTST (seconds)	17,4	15,5	10,9

TUG = *Timed Up and Go*; 5TSTST = *Five Times Sit-to-Stand Test*.

Quality of life

When analyzing the adolescent's perceptions of quality of life perceptions through the "Self-report," positive changes were observed across all domains, with greater absolute variations occurring in the social, physical, and emotional domains, and less absolute variation in the school domain (Table 5).

Table 5 – Quality of life data (PedsQL™) of the adolescent pre and post-intervention

Domain	Number of items	Average (points) Pre-intervention	Average (points) Post-intervention	Absolute variation (points)
Physical Functioning	8	9,3	59,3	50
Emotional Functioning	5	10	60	50
Social Functioning	5	0	65	65
School Functioning	5	35	45	10
Total	23	54,3	229,3	175

In the perception of HRQOL through the "Parents' report" there was a reduction, although not expressive, in the average score after the intervention in the physical environment, while in other dimensions no differences were observed (Table 6).

Table 6 - Data on the adolescent's quality of life (PedsQL™), through the parents' report pre and post-intervention

Domain	Number of items	Average (points) Pre-intervention	Average (points) Post-intervention	Absolute variation (points)
Physical Functioning	8	21,8	18,7	-3,1
Emotional Functioning	5	35	35	0
Social Functioning	5	20	20	0
School Functioning	5	25	25	0
Total	23	101, 8	98,7	-3,1

In the "Family Impact Module", all domains showed modifications, with the exception of activities of daily living, there is a greater absolute variation in the "communication with other people" domain, representing possible improvement in this aspect after the intervention (Table 7).

Table 7 - Data from the family impact on quality of life module (PedsQL™) pre and post-intervention

Domain	Number of items	Average (points) Pre-intervention	Average (points) Post-intervention	Absolute variation (points)
Physical Functioning	6	58,6	75	16,40
Emotional Functioning	5	50	40	-10
Social Functioning	4	56,2	75	18,8
Cognitive functioning	5	40	10	-30
Communication with other people	3	50	100	50
Concerns	5	30	50	20
Activities of daily living	3	41,6	41,6	0
Problems in family relationships	5	20	5	-15
Total	36	346,4	396,6	50,2

DISCUSSION

This study aimed to describe the effects of a physical exercise program in the hybrid model on HRQOL and functional capacity of an adolescent with chromosome 16 syndrome and obesity.

No expressive changes were observed in the values of body mass and body circumference of the participant, which can be attributed to the absence of intervention in the nutritional aspect in this study. This limitation arises from the difficulties in monitoring caloric intake and energy expenditure of adolescents, considering that changes in morphological parameters require, in addition to physical exercise, changes in eating behavior, as well as psychological monitoring and, in some cases, specific pharmacological treatment[10]. However, based on the results of the physical tests, expressive changes in the functional capacity of the participant were observed, which allows us to infer that the intervention may have contributed to the improvement of his physical performance. This finding is in line with the questionnaire "Self-report", in which, according to the adolescent's own perception, there was a positive modification in his physical function.

Corroborating the data found, according to the parents of the participant and as noted during the initial home visits, it was observed that before the intervention, the adolescent moved at home through the support of the knees on the ground and, after the program, the participant reduced this form of displacement, starting to use only the Canadian crutches. This observation supports the data from the functional tests and the "Self-report" questionnaire.

With this hybrid model, in addition to improvements in functional capacity, positive changes were obtained in the participant's HRQOL, especially in the social, physical and emotional dimensions, as well as in that of his parents, observed through the "Family Impact Module" questionnaire. This evolution may be associated with a greater bond and proximity of the family with the reference BHU, through home visits and weekly follow-ups.

Poeta et al.[25] compared the HRQOL of children from 8 to 12 years, obese and eutrophic. In their findings, they observed a significant relationship between obesity and low HRQOL, since obese children obtained scores lower than eutrophic in all domains, suggesting that a substantial proportion of children may be living with lower HRQOL due to obesity.

Therefore, the importance of easy-to-apply and low-cost physical exercise programs to improve the quality of life of obese children and adolescents is emphasized, and as evidenced in this case report, a hybrid physical exercise program seems to have satisfactory applicability for this population.

Obesity shares the same logic as muscle strength depletion with aging[26]. There is a consensus that the process of sarcopenia (progressive reduction of muscle mass and physical function with aging) requires greater physical effort to perform ADL and excess fat in young people may represent an anticipation of this situation, as there is less muscle in the total body mass for a greater amount of adiposity, promoting expressive difficulty in basic daily tasks compared to eutrophic individuals[26].

The present study used an alternative method for the application of an exercise program, which is HBE, and has been presented in the literature with positive results. A study by Aoike et al.[14] compared effects of 24 weeks of exercise performed in the gym with home exercise in a hybrid way: face-to-face, supervised and remote in sedentary, overweight/obese patients and in stages 3 and 4 of chronic kidney disease. Both groups showed improvement in cardiopulmonary capacity and functional capacity, peak oxygen consumption, HRQOL and sleep quality.

This study allows a better understanding of the phenotype and the repercussions of chromosome 16 deletion syndrome on the quality of life of the participant and his family. The results of physical function, emotional and social health were positive, although without morphological changes, so it is important to emphasize the importance of regular physical exercise, whether hybrid, remote or face-to-face.

Conflicts of Interest: The authors declare no conflict of interest.

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Authors' contribution: Caroline Fogagnolo: theme definition; conceptualization; research; methodology; data collection, processing and analysis; writing, submission and revision of the manuscript. Marco Carlos Uchida: theme definition; methodology; data collection; data analysis; manuscript review and supervision.

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