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Body composition of patients with autism spectrum disorder through bioelectrical impedance

Composición corporal por medio de la impedancia bioeléctrica de los pacientes con trastorno del espectro autista

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ABSTRACT

Background: Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by deficits in sociability, communication, and limited repertoire of interests and behaviors. We aimed to investigate the nutritional status through bioelectrical impedance analysis (BIA) and antrophometrics variables in 63 ASD children and adolescents (10.5 ± 4.1 years; 81% male).

Materials and methods: Anthropometric variables were weight, height, and waist circumference (WC); body composition (fat mass, fat free mass) and phase angle (PA) were obtained through BIA.

Results: The body mass index showed a prevalence of overweight, obesity and underweight of 38.9, 36.5 and 15.8%, respectively. According to the body fat percentual, obesity prevalence was 49.2%, and 49,2% showed WC > 80th percentile for age. Eleven patients presented lower PA values than references.

Conclusion: According to the these parameters, a large percentual of ASD children and adolescents in this sample had total overweight and obesity and truncal adiposity, which causes concern, as well as the percentage of underweight participants.

Key words: Autism spectrum disorder. Body composition. Nutritional Status. Nutrition.

RESUMEN

Introducción: el trastorno del espectro autista (TEA) es un trastorno neurológico caracterizado por deficiencias en la sociabilidad y la comunicación, y un repertorio limitado de intereses y comportamientos.

Objetivos: investigar el estado nutricional por medio del análisis de impedancia bioeléctrica (BIA) y variables antropométricas en 63 niños y adolescentes con TEA (10,5 ± 4,1 años, 81% hombres).

Métodos: las variables antropométricas fueron el peso, la altura y la circunferencia de la cintura (CC); la composición corporal (masa grasa, masa magra) y el ángulo de fase (PA) se obtuvieron por medio de BIA.

Resultados: el índice de masa corporal mostró una prevalencia del sobrepeso, la obesidad y el bajo peso de 38,9, 36,5 y 15,8%, respectivamente. De acuerdo con el porcentaje de grasa

corporal, la prevalencia de obesidad fue del 49,2%, y el 49,2% mostró CC > percentil 80 para la edad. Once pacientes presentaron valores de PA inferiores a las referencias.

Conclusión: de acuerdo con estos parámetros, un gran porcentaje de niños y adolescentes ASD en esta muestra presentaba adiposidad total de sobrepeso y obesidad y del tronco, lo que causa preocupación, así como el porcentaje de participantes con bajo peso.

Palabras clave: Trastorno del espectro autista. Composición corporal. Estado nutricional. Nutrición.

INTRODUCTION

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by social communication deficits and repetitive behaviors and/or restricted interests (1). A recent epidemiological study indicates that one in 68 children are diagnosed with ASD in the US (2) and it is estimated that 1% of the global population is affected by this disorder (3). ASD is evident in early childhood and patients often present a series of co-occurring symptoms and disorders including seizures, sleep disturbances, gastrointestinal complaints, anxiety and behavioral rigidity (4). More specifically, the behavioral rigidity displayed by these individuals can lead to unhealthy eating habits. There are reports of food selectivity presented by these individuals, like consume of a limited range of food items, resistance to try different foods and behavioral problems at mealtime (5). Thus, impaired nutritional status is not unusual in patients with ASD (6,7).

The reports about the nutritional status in patients with ASD show high prevalence of overweight (8). Attlee et al. (2015) (9) indicated that 52% of the studied subjects were obese and 22% were overweight. The increasing prevalence of child obesity has represented a significant change in the profile of health and disease worldwide in recent years. In preschool ages, the early occurrence of increased body adiposity and fast weight gain represent a risk factor for the development of obesity in later life (10). Although there are different methods to evaluate overweight and obesity in children and adolescents (11), body composition methods demonstrate accuracy in assessing adiposity (12,13).

Bioelectrical impedance analysis (BIA) is a practical method and non-invasive bedside technique, and it evaluates specific body composition parameters (14). In addition, it is

possible to obtain the phase angle (PA) value through BIA, a variable that indicates cell membrane integrity and can be used as a prognostic indicator and a predictor of survival under certain clinical conditions (15). Besides some studies evaluating the nutritional status of ASD individuals (16), there is a lack of information regarding their body composition; therefore, it would be reasonable to assess this information through BIA. Thus, we aimed to investigate the nutritional status (anthropometrics measures and body composition variables obtained from BIA) in children and adolescents diagnosed with ASD.

METHODS

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and the national research committee, and with the Declaration of Helsinki of 1964 and its later amendments or comparable ethical standards. The study was approved by the local Ethics Committee (protocol number 13-0321).

Participants

The participants between four and 16 years old were recruited from the Child Neurology Unit at [removed for blind peer review], and the ASD diagnosis was performed by pediatric neurologists. Exclusion criteria were the diagnosis of a genetic syndrome known to be associated with ASD (e.g., Fragile X syndrome) or the other conditions that preclude the patient to perform the BIA (e.g., edema, generalized seizures and fail to prepare or perform the exam).

From the consecutive sample, a total of 73/132 children and adolescents met the criteria for the study. The parents/caregivers of these 73 patients were invited, but only 63 (final study sample size) signed the informed consent form and finished the questionnaires.

Data collection

Parents/caregivers were interviewed to elicit information about the patients. The socioeconomic status of the participants was defined based on their responses to a questionnaire, named [removed for blind peer review], designed and validated by the [removed for blind peer review] (17).

Patients' medical records were reviewed for clinic-demographic data. In addition, the scores for the Autism Screening Questionnaire (ASQ) (18) and Childhood Autism Rating Scale (CARS) (19) were obtained.

Height and weight of each participant were measured by a qualified investigator. Height was measured with a wall-mounted stadiometer (Harpenden, Holtain®, Crymych, UK) to the nearest 0.1 cm, and weight was obtained using a digital platform scale with a resolution of 0.1 kg (Toledo®, Model 2096PP/2, São Paulo, Brazil), while subjects were barefoot and wearing lightweight clothing. Waist circumference (WC) was measured using a Cescorf® inelastic measuring tape, accurated to 1 mm. WC was classified according to the criteria suggested by Taylor et al. (2000) (20).

The BIA analyses (Biodynamics 450® version 5.1, Biodynamics Corporation, Seattle, WA, USA) were performed using Resting ECG tab electrodes (Conmed Corporation, Utica, NY, USA). Evaluation of body composition parameters throughout BIA, fat mass (FM), fat free mass (FFM), body mass index (BMI), and the PA were performed according to previous studies (21). Briefly, the measurements were done with the patients lying down with their legs and arms parallel to their bodies and positioned far from the chest. The electrodes were placed on standard locations (the dorsal surface of the right wrist, the third metacarpal bone, the anterior surface of the right ankle between the bone prominences, and the dorsal surface of the third metatarsal bone). Instructions were given to the patients to be followed before BIA tests: overnight fasting, exercise restriction 24 hours before examination and bladder voiding. Test-retest procedures were performed with a minute interval. Body fat percentage data were used for obesity classification, defining obese as greater than the 95th centile on percentual of body fat reference curves (22). BMI was used to classify children into one of the following categories (23): underweight (≤ 5th percentile), healthy (> 5th to < 85th percentiles), overweight (≥ 85th to < 95th percentiles), or obese (≥ 95th percentile).

Statistical analysis

For the statistical analyses, the Statistical Package for Social Sciences 22.0 (SPSS® Inc., Chicago, IL) was used. Data were described using absolute and relative frequencies. Shapiro-Wilk statistical test was performed to verify the normality of the variables. Continuous

variables were expressed as mean ± standard deviation and compared through the Student t-test; non-parametric values were expressed as median and interquartile range. In addition, the Spearman's rank correlation coefficient was performed to test for correlations between body composition variables, and PA was performed. The level of significance was set at 0.05.

RESULTS

The total study sample included 63 patients with ASD and their general and clinical characteristics are presented in table I. There was predominance of boys (81%). The mean age was 10.5 ± 4.1 years and the average age of symptoms onset was 1.7 ± 1.2 years. The ASQ mean score was 21.1 ± 5.1 and by gender 22.8 ± 4.8 and 20.5 ± 5.4, for boys and girls, respectively. The ASQ classification was 50.7% with mild-moderate and 36.5% with severe symptoms. The average CARS score was 36.3 ± 8.43 and, when stratified by gender, 36.78 ± 7.85 for boys and 34.27 ± 10.91 for girls (all participants had a CARS score above 30, classified as mild-severe ASD).

The majority of patients (87.3%) were using some type of medication at the time of the study; the most common groups of drugs were antidepressants and antipsychotics (data not shown). From the 63 participants, 12.6% (n = 8) were using anticonvulsant drugs; however, 33.3% (n = 21) had at least one seizure episode in their lives.

Table II presents the average values for anthropometric data and body composition stratified by gender (no statistical differences were detected). The BMI showed that 38.9% (n = 24) of the patients presented overweight and 36.5% (n = 23) were obese. Only 9.5% (n = 6) of the sample was within the healthy weight values, and 15.8% (n =10) were classified as underweight. According to body fat percentual centiles (22), these values increased to 49.2% of obese children and adolescents. For WC values, a total of 49,2% showed values above the 80th percentile of that age, 27 boys and four girls, indicating high trunk fat mass, according to Taylor et al. (2000) (20).

Regarding the PA values, only eleven patients had values that are lower than what is established for healthy individuals (21,24). Despite this, there was a weak negative correlation between BMI and PA (r = -0.072, p = 0.05, Spearman correlation). When other anthropometric parameters and body composition variables were analyzed, PA was significantly correlated with the FM in kg (r = -0.295, p = 0.019, Spearman correlation), with

the FFM in kg and % (r = 0.311, p = 0.013; r = 0.295, p = 0.019, respectively, Spearman correlation).

DISCUSSION

In the present study, we investigated the nutritional status of children and adolescents with ASD, using anthropometric measures and body composition. Our main findings were: high prevalence of obesity in patients with ASD according to BMI and body fat percentage centiles, a high prevalence of truncal adiposity according to WC.

The symptoms of ASD are evident either early in the first year of life or late in the second year, when abnormal behaviors are observed and the child loses previously acquired skills (25). In our study, the average age of onset of symptoms was 1.7 ± 1.2 years. The majority of participants from this study were male, similar to what is found in most of ASD epidemiological studies (2). Approximately 12-30% of children with ASD develop seizures or EEG changes (26). The prevalence of epilepsy in our study (30%) was in this range (27,28). It is important to highlight that epilepsy is reported in the literature as a disease associated to overweight and obesity (29).

The percentage of overweight and obesity in our study was higher than the percentage of overweight and obesity in typically developing children (26.9%) and adolescents (7.6%) from the same region in Brazil (30). Other report with ASD patients showed even higher prevalence of obesity (52%) (9). It is noteworthy that in this report, 74% of the individuals present excess of weight (obesity percentage + overweight percentage) (9), similar to what was found in the present study (75.4%). In another study with a larger sample of ASD patients (n = 111), overweight and obesity considering z-score were around 31.5% (31). However, a report with ASD and attention deficit hyperactivity disorder children age-matched with reference population (NHANES 1999-2002) showed similar prevalence of overweight to both groups (32). On the other hand, a recent study presented higher prevalence of healthy weight (70%) and underweight (20%) children with ASD (5). Data regarding underweight, however, were in accordance with our study.

According to Taylor et al. (2000) (20), WC is a simple and effective method to evaluate truncal adiposity in children and adolescents. Our study showed nearly 50% of ASD children and adolescents with high trunk fat mass. The WC values in our study were also higher,

when compared to values obtained from typically developing girls (278) and boys (302) aged 3-19 years from New Zealand (20). The same conclusion was obtained when this comparison was made with typically developing Brazilian children (33). In addition, the WC values of our ASD patients were higher than the values presented by healthy youths from different countries (Denmark, Portugal, Estonia, Norway, Switzerland and USA) participating in a study that used the WC to define diagnosis for cardio metabolic diseases (34). It is interesting to note that both methods used in our study, WC and body fat mass centiles, showed similar percentages of adiposity, describing nearly 50% of children and adolescents with high central and total adiposity.

A recent study using anthropometric variables showed a significant increased subcutaneous fat thickness in children with ASD, which, according to the authors, could be resulting from the food selectivity and sedentary life style of these patients (35). However, FM and FFM values of ASD patients from our study are similar to the data obtained from healthy individuals that were also evaluated by BIA (36-39). In addition, this similarity is sustained when we compare our results to data from a cohort study that assessed these parameters by bone densitometry in a population from the same region as our patients (39).

Another recent study concluded that, besides body composition, the PA measurements are valuable to assess nutritional status and growth in children (40). In the present study, correlations between BMI and body composition were observed. Higher FFM values correlated positively with PA, while higher FM values have an inverse correlation with this parameter, indicating that altered body composition may be a worsening factor to the overall health of the patient. It is necessary for these patients to be nutritionally monitored, aiming healthy eating habits and, consequently, healthy living. Additionally, these parameters may be useful to determine baseline measurements at hospital admission, and to monitor progress of nutrition treatment or change in nutritional status during hospitalization (40). Considering that some patients with ASD have behavioral rigidity, are hyperactive and present self-injurious behavior, it should be highlighted that BIA protocol was strictly followed in our study. Parents and caregivers followed the instructions given by the researchers regarding pre-examination. No major intercurrences involving patients were reported during BIA. Taking these aspects into account, this could be a promising approach in collecting data on the nutritional status of these children and adolescents in view of

intervention or monitoring of nutritional status.

In conclusion, according to WC and body fat percentage obtained by BIA, a large percentual of ASD children and adolescents in this sample had total overweight and obesity and truncal adiposity, which causes concern, as well as the percentage of underweight participants. The various health concerns associated with nutrition need more attention, especially with this population. The results about truncal adiposity can also be associated with risk of cardiac diseases besides inadequate nutritional status. It is important to highlight the needs for attention by clinicians for this population concerning body composition, nutritional status and other issues linked to nutrition (quality of food, food selectivity, and feeding problems). Nutritional aspects must be considered by parents, caregivers and all professionals involved in the treatment of these patients. Further studies are necessary to describe and investigate the body composition variables among other groups of patients with ASD, the impact on their overall health and also determinants of nutritional status of these individuals in order to improve treatment strategies.

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Table I. General characteristics of the sample

Variable (n = 63)	*n (%)*
Gender	
Female	12 (19.0)
Male	51 (81.0)
Epilepsy	
Yes	13 (20.6)
No	50 (79.4)
ABEP*	
A	2 (3.2)
B	28 (44.4)
C	32 (50.7)
D	1 (1.6)

ABEP: Economics Classification Criteria - Brazil. *This questionnaire is used to estimate the purchasing power of individuals and families and categorizes Brazilian population into five socioeconomic levels: A to E, with A being the highest and E the lowest level.

Table II. Anthropometric data and body composition (BMI, FM, FFM and PA) according to the bioelectrical impedance analysis*

Variable	*Total sample* *n = 63*	*Male* *n = 51*	*Female* *n = 12*	*p value*
Weight (kg)	44.40 ± 22.26	44.22 ± 23.73	45.15 ± 15.24	0.998
Score-z W/A	0.79 (1.40-1.93)	0.53 (1.40-1.78)	0.58 (1.32-2.01)	0.297
Height (cm)	140.73 ± 20.54	140.26 ± 2.77	142.69 ± 14.79	0.827
Score-z H/A	0.31 (-1.07-1.43)	0.56 (-0.95-1.53)	-0.37 (-2.14-1.05)	0.323
BMI (kg/m^2)	21.11 ± 6.04	20.99 ± 6.42	21.65 ± 4.24	0.899
Score- z BMI/A	1.20 (0.04-2.38)	1.1 (0.07-2.61)	1.36 (-0.53-1.59)	0.976
FM (%)	23.20 (13.8-35.6)	20.30 (15.7-32.8)	26.30 (13.8-35.6)	0.619
FFM (%)	76.7(64.6-86.2)	79.7 (67.2-84.3)	73.7 (64.6-86.2)	0.780
PA (°)	5.91 ± 1.46	5.84 ± 1.44	6.16 ± 1.59	0.512
WC (cm)	72.36 ± 19.51	71.82 ± 19.10	74.57 ± 21.85	0.696

*Values expressed as mean ± standard deviation or median (P25-P75); score-z was calculated according to reference values for the same sex and age (WHO, 2007). W/A: Weight/age; H/A: Height/age; BMI: Body mass index; BMI/A: Body mass index/ age; FM: Fat mass; FFM: Fat free mass; PA: Phase angle; WC: Waist circumference.