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Anthropometric profile and body composition of children and adolescents with cerebral palsy on enteral diet

Perfil antropométrico e composição corporal de crianças e adolescentes com paralisia cerebral em uso de dieta enteral

Érica Patrícia Cunha Rosa Schmitz[1], Margarida Maria de Castro Antunes[1], Kátia Galeão Brandt[1]

[1] Universidade Federal de Pernambuco, Centro de Ciências Médicas, Programa de Pós-Graduação em Saúde da Criança e do Adolescente. Recife, PE, Brasil. Correspondence to: KG BRANDT. E-mail: <katiagaleaobrandt@gmail.com>.

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ABSTRACT

Objective
To investigate the anthropometric variables and body composition of children and adolescents with cerebral palsy based on the type of enteral diet received.

Methods
A case-series study involving 38 individuals with spastic quadriparetic cerebral palsy, aged four to 18 years, fed only by the enteral route, followed up at a Reference Hospital in the city of Recife (PE), Brazil. One group received an exclusively industrialized enteral diet, while the other received a mixed diet (industrialized and homemade). Weight, stature, arm circumference, and arm muscle area were measured. Body composition was assessed using bioelectrical impedance analysis.

Results
There was no significant difference between the groups receiving industrialized and mixed diets, with a high stature deficit frequency (63.6% versus 68.7%; p=0.743), excess fat mass (93.3% versus 58.3%; p=0.060), and fat free mass deficit (73.3% versus 66.7%; p=1.000) observed in both groups. Regarding the nutritional composition of the enteral diet, 54.5% and 53.8% of the individuals in the industrialized and mixed diet groups, respectively, received an industrialized enteral diet with a hypercaloric, hyperlipidic, and hypoproteic nutritional composition.

Conclusion
It was concluded that there was no difference in anthropometric parameters and body composition based on the type of diet received. It should be considered that the nutritional composition of the most commonly used industrialized diet among the individuals in this study

may have influenced the unfavorable outcomes, such as the high frequency of low muscle mass and excess fat mass. This highlights the need for the formulation and availability of an enteral diet that meets the nutritional needs of this population.

Keywords: Body composition. Cerebral palsy. Eating. Enteral nutrition. Nutritional status.

RESUMO

Objetivo

Investigar os parâmetros antropométricos e a composição corporal de crianças e adolescentes com paralisia cerebral em função do tipo de dieta enteral recebida.

Métodos

Estudo tipo série de casos, envolvendo 38 indivíduos com paralisia cerebral tetraparética espástica entre 4 e 18 anos, alimentados apenas por via alternativa, acompanhados em um Hospital de Referência em Recife, Pernambuco, Brasil. Um grupo recebia dieta enteral industrializada exclusiva e outro, dieta mista (industrializada e artesanal). Foram aferidos, peso, estatura, circunferência e área muscular do braço. A composição corporal se deu por meio da utilização de bioimpedância elétrica.

Resultados

Não houve diferença significante entre os grupos dieta industrializada e dieta mista, sendo constatada elevada frequência de déficit estatural (63,6% versus 68,7%; p=0,743), excesso de massa gorda (93,3% versus 58,3%; p=0,060) e déficit de massa livre de gordura (73,3% versus 66,7%; p=1,000), em ambos os grupos. Quanto à composição nutricional da dieta enteral ofertada, 54,5% e 53,8% dos indivíduos nos grupos dieta industrializada e dieta mista, respectivamente, recebiam dieta enteral industrializada de composição nutricional hipercalórica, hiperlipídica e hipoproteica.

Conclusão

Conclui-se que não houve diferença nos parâmetros antropométricos e na composição corporal em função do tipo de dieta recebida. Deve-se considerar que a composição nutricional da dieta industrializada mais utilizada pelos indivíduos dessa pesquisa pode ter influenciado os resultados desfavoráveis, como a elevada frequência de baixa massa muscular e excesso de massa gorda. Surgindo por sua vez, a necessidade da formulação e disponibilização de uma dieta enteral que atenda às necessidades nutricionais dessa população.

Palavras-chave: *Composição corporal. Paralisia cerebral. Ingestão de alimentos. Nutrição enteral. Estado nutricional.*

INTRODUCTION

The greater the severity of Cerebral Palsy (CP), the higher the prevalence of malnutrition, low weight and stature, lower muscle mass, and excess body fat [1-3]. As oral feeding is commonly impossible, the use of alternative feeding methods must be considered through the provision of industrialized, homemade, or mixed enteral diets [4].

Industrialized diets are preferably recommended for enteral nutrition in individuals with Spastic Quadriparetic Cerebral Palsy (SQCP) [5,6]. However, the increased availability of enteral diets with high energy density, not formulated to meet the nutritional needs of these individuals, may result in excess body fat due to excess eating [7]. Additionally, they may contain high levels of sugars, artificial flavors, and additives in comparison to homemade diets [8,9].

There is currently a trend toward increased use of homemade enteral diets in higher-income countries [9,10]. Reasons for their use include lower cost, natural ingredients, allowing free food selection, greater physical and emotional connection with caregivers, a wider variety of foods, and improved gastrointestinal symptoms [8,11]. However, the use of homemade diets is not recommended by major international nutrition and clinical guidelines due to concerns about nutritional adequacy and safety [12,13].

On the other hand, mixed enteral therapy can also be considered to meet nutritional needs, where the use of homemade diets is interspersed with industrialized diets or the use of industrialized modules, provided that specific criteria are assessed and constant monitoring is conducted by a multidisciplinary team [14,15].

Knowledge about the type and adequacy of the nutritional composition of enteral diets is crucial for monitoring children and adolescents with SQCP, as continued provision of inadequate diets will compromise their nutritional status and body composition, already affected due to the severity of CP. Thus, the aim of this study was to investigate the anthropometric parameters and body composition of children and adolescents with cerebral palsy based on the type of enteral diet received.

METHODS

A case series study was conducted from January 2020 to March 2021 at a reference outpatient center for children and adolescents with severe forms of CP. Participants included children and adolescents aged 4 to 18 years diagnosed with SQCP, with severe motor impairment (Gross Motor Function Classification System [GMFCS] levels IV and V), exclusively using enteral diets. Exclusions comprised those with congenital malformations unrelated to CP, chromosomal disorders, and those receiving botulinum toxin application in the six months prior to assessment due to its impact on muscle mass.

Weight was measured following the recommendations of the Brazilian Ministry of Health [16]. Direct stature measurement was not feasible; thus, estimated stature was used, calculated using specific formulas for children and adolescents with physical limitations [17,18]. Frisancho's reference values were employed for the classification of arm muscle circumference (AMC) and arm muscle area [19].

Anthropometric indices, stature-for-age, and Body Mass Index (BMI)-for-age were classified into z-scores according to the World Health Organization growth charts [20,21] for the general population, using the Who AnthroPlus® program, version 3.2.2. Although there are specific growth charts for individuals with CP, their use is not recommended by the European Society for Paediatric Gastroenterology Hepatology and Nutrition [13], as they describe growth that is not necessarily ideal, including other health conditions affecting growth and underestimating malnutrition.

Bioelectrical impedance was performed using the Maltron BF-906 device (Maltron, UK), with a frequency of 50Hz in alternating current. Total body water was estimated from impedance and stature measurements using validated equations for patients with CP [22]. Fat Free Mass (FFM) was determined by dividing total body water by hydration factors specific to sex and age groups [23].

The FFM and fat mass were adjusted for stature by dividing these values by stature squared, determining the Fat Free Body Mass Index (FFMI) and Fat Mass Index (FMI). Lohman's criteria were used for the diagnosis of excess fat mass [24].

Participants were classified into the mixed diet group if they received two or more homemade meals. The remaining participants were classified into the industrialized diet group. Industrialized diets used by participants were self-purchased or provided by the municipality through a bidding process. Diets were categorized as hypercaloric (energy density above 1.2 kcal/ml), hypoproteic (protein quantity below 10% of total energy value), and hyperlipidic when lipid quantity exceeded 35% of total energy value [25].

Dietary intake was recorded through 24-hour recall. The nutritional compositions of industrialized enteral diets were obtained from information available on the product labeling. The prevalence of inadequate intake corresponded to the proportion of individuals whose consumption was below the estimated energy requirement and estimated average requirement, calculated individually. As lipids do not yet have an estimated average requirement, only adequate intake was considered, and the estimation of the proportion of inadequacy was not possible. Macronutrients were assessed based on the Acceptable Macronutrient Distribution Range (AMDR) for carbohydrates (45 to 65%), proteins (10 to 30%), and lipids (25 to 35%) according to the age range of 4 to 18 years [26].

Statistical analysis was performed using the IBM®SPSS® for Windows version 21.0 (Inc., Chicago, IL, USA). Variables were tested for normality using the Kolmogorov-Smirnov test. In those with normal distribution, Student's t-test was used for comparison of continuous variables. The Chi-square or Fisher's Exact test was used to analyze the relationship between categorical variables. A $p<0.05$ was considered statistically significant.

This study was approved by the Ethics Committee for Research Involving Human Subjects of the Universidade Federal de Pernambuco, under number 22875019.7.0000.8807.

RESULS

The study included 38 children and adolescents with a mean age of 9.5±3.5 years. The sample consisted mostly of children (68.4%), with 60.5% being males. Exclusively industrialized diets were the most utilized (57.9%), while exclusively homemade diets were the least used (7.9%). Regarding the nutritional composition of the offered enteral diet, 54.5% and 53.8% of individuals in the industrialized diet and mixed diet groups, respectively, received industrialized enteral diets with a hypercaloric, hyperlipidic, and hypoproteic nutritional composition. The mean age at the initiation of alternative feeding was 5.5±3.6 years, with a mean duration of 3.7±2.6 years (results not presented in the table).

Concerning the association between the type of diet and anthropometric and body composition parameters, no statistically significant difference was observed between the groups. However, there was a statistically significant trend of excess fat mass in the group with an industrialized enteral diet (Table 1).

Table 1 – Anthropometric parameters and body composition according to the type of enteral diet received by children and adolescents with cerebral palsy. Recife (PE), Brazil, 2021.

Variables	Type of diet				Total		p*
	Exclusively industrialized		Mixed				
	n	%	n	%	n	%	
Stature for Age							
Short Stature (< Z Score -2)14	63.6	11	68.7	25			0.743
Adequate Stature (≥ Z Score -28	36.4	5	31.3	13			
BMI for Age							
Thinness (< Z Score -2)	5	22.7	6	37.5	11	28.9	0.471**
Eutrophic and excess weight (≥ Z Score -2)	17	77.3	10	62.5	27	71.1	
Arm Muscle Circumference							
Low Muscle Reserve (< p5)	9	40.9	7	43.7	16	42.1	0.861
Adequate Muscle Reserve (≥ p5)	13	59.1	9	56.3	22	57.9	
Arm Muscle Area							
Low Muscle Reserve (<p5)	11	50	8	50	19	50	1.000
Adequate Muscle Reserve (≥p5)	11	50	8	50	19	50	
Fat Free Mass Index							
Deficit (< Z Score -2)	11	73.3	8	66.7	19	70.4	1.000**
No deficit (≥ Z Score -2)	4	26.7	4	33.3	8	29.6	
Fat Mass Index (%) °°†							
No excess	1	6.7	5	41.7	6	22.2	0.060**
Excess	14	93.3	7	58.3	21	77.8	

Note: *Chi-square test, **Fisher's test, °°n=27 participants. †excess >18% in boys and >25% in girls.

When comparing groups regarding calorie and macronutrient consumption, insufficient calorie intake was found in 40.1% of participants in the industrialized enteral diet group (Table 2). Individuals in this group also exhibited higher lipid consumption (p=0.017). Protein consumption was higher in the mixed diet group (p=0.000) (Table 3).

Table 2 – Daily intake recommendation and percentage of inadequacy (% Inadeq) of energy and macronutrients by type of enteral diet in children and adolescents with cerebral palsy. Recife (PE), Brazil, 2021.

Nutrients	Exclusively industrialized diet			Mixed diet	
	Recommendation	Offer		Offer	
	X±SD	X±SD	%Inadeq*	X±SD	%Inadeq*
Calories (Kcal)	1270.21±226.31	1305.66±333.05	40.13	1419.71±315.99	25.78
Proteins (g/day)	17.04±4.90	35.47±11.80	4.9	62.91±22.37	–
Carbohydrates (g/day)	100	165.07±44.50	6	171.46± 53.90	6

Note: %Inadeq*: Refers to insufficient intake, SD: Standard deviation.

Table 3 – Analysis of macronutrients (AMDR) according to the acceptable distribution range by type of enteral diet in children and adolescents with cerebral palsy. Recife (PE), Brazil, 2021.

Macronutrients	Exclusively industrialized diet	Mixed diet	p*
Proteins			
Intake (% EI)	10.94±2.57	17.65±5.31	0.000◊
Protein needs – AMDR (%)	10-30	10-30	
Below AMDR (%)	43.3	16	0.029
Above AMDR (%)	16	–	0.037**
Carbohydrates			
Intake (% EI)	50.20±3.20	48.59±10.20	0.415◊
Carbohydrate needs – AMDR (%)	45-65	45-65	
Below AMDR (%)	26.7	28	0.912
Above AMDR (%)	30	20	0.397
Lipids			
Intake (% EI)	38.85±5.03	33.76±9.87	0.017◊
Lipid needs – AMDR (%)	25-35	25-35	
Below AMDR (%)	10	16	0.689**
Above AMDR (%)	60	56	0.765

Note: *Chi-square test, ** Fisher's test. ◊Student's t-test, % EI: percentage of energy intake.

DISCUSSION

In this study, there was no difference in anthropometric parameters and body composition based on the type of diet received. This demonstrates that the introduction of a mixed enteral diet would not be detrimental to the nutritional condition and body composition of these participants followed on an outpatient basis by a multidisciplinary team. Both groups showed a higher frequency of fat free mass deficit and excess fat mass. Half of the sample received an industrialized diet with hypoproteic and hyperlipidic nutritional composition, which may have been a contributing factor to these negative results.

Regarding anthropometric parameters, a high prevalence of low stature for age was observed in both groups. Individuals with CP tend to show a greater stature deficit compared to those with less motor severity, and this would occur regardless of the quality of care and nutritional support offered [27]. Alternatively, the low stature for age in this population may result from previous malnutrition, due to the fact that they arrive late at health services, commonly already in a state of chronic malnutrition [28]. This fact may have influenced this finding in this study, as there was a late start of enteral nutrition.

The low prevalence of thinness found by BMI for age, similar between groups, confirmed findings from previous studies with percentages ranging from 25% to 33% of the sample [29,30]. The results may be related to multidisciplinary follow-up and the use of an alternative feeding route, regardless of the type of enteral diet received [31]. However, in this study, we cannot rule out the possibility that the lower percentage of individuals with low body weight may be attributed to an overestimation of BMI, which is due to the lower linear growth of these individuals, suggesting a misdiagnosis of normal nutritional status by the BMI for age parameter. It is worth noting that BMI overestimation could, in turn, lead to a reduction in caloric offer, especially in children dependent on enteral nutrition.

Regarding the assessment of body composition, in this study, a high deficit of fat free mass was observed in both groups. The higher frequency of this condition is mainly reported in association with higher levels of GMFCS [2,3,32]. This is explained by the fact that muscles have a reduced growth potential due to the neuromuscular injury that leads to increased sarcomere length (the fundamental unit of muscle force production and contraction) and muscle fibers [33]. Additionally, the occurrence of malnutrition is also associated with muscle mass depletion [34].

In terms of measuring fat mass, a high percentage of excess was observed in both groups, with a higher frequency noted in individuals from the industrialized enteral diet group. This may be related to the low level of physical activity, lower fat free mass, and energy expenditure, leading to greater infiltration of adipose tissue in skeletal muscle [33,35].

Furthermore, the nutritional composition of the enteral diet used must be considered, as it is known that energy requirements decrease as the severity of cerebral palsy increases [36]. When a child is being fed enterally, nutritional needs should be calculated individually, based on physical activity level and CP severity, to avoid overweight and/or increased body fat [37]. Thus, the continued use of a hyperlipidic, hypoproteic industrialized diet may have influenced the negative results presented in this study, such as low fat free mass and excess fat mass. This could be harmful to these individuals who receive this diet exclusively.

Regarding dietary intake assessment, there was a higher percentage of caloric adequacy in the mixed diet, which could be justified by individualized monitoring by an experienced dietitian. Additionally, the versatility of this diet allows for adjustments through the addition of foods or nutrient modules [38].

In terms of macronutrients, a higher percentage of protein needs was observed in the industrialized diet group compared to the AMDR. This could be a consequence of the insufficient caloric intake observed, which may have occurred due to adjustments made by the care team in response to excessive weight gain or intolerance to increased diet volume [39]. Additionally, it can be justified by the fact that half of the participants received a hypoproteic industrialized enteral diet.

The higher protein intake in the mixed diet group, also observed in previous studies [40,41], indicates that it is possible to ensure adequate supply of this macronutrient through mixed diets, justified by the possibility of offering high-quality protein (meat, milk, and derivatives) at some times and nutritionally complete industrialized enteral diet at others.

A higher lipid consumption was observed in the industrialized diet group, which may be related to the fact that half of the study participants received a hyperlipidic industrialized enteral diet. A study found that 77.78% of closed system pediatric enteral nutrition diets currently offered in the Brazilian market were classified as hyperlipidic [42]. Similar results were also observed in the adult population, although to a lesser extent [43,44]. This is concerning, especially for the pediatric population with CP, and could be directly related to the development of cardiovascular and metabolic diseases (obesity, diabetes, dyslipidemia) in the long term [7].

To avoid excessive caloric and lipid intake, the guidelines of the European Society for Pediatric Gastroenterology Hepatology and Nutrition recommend the use of low-fat, low-calorie industrialized enteral diet for children with severe neurological impairment after nutritional status rehabilitation [13].

CONCLUSION

It is concluded that there was no difference in anthropometric parameters and body composition based on the type of diet received. It should be considered that the nutritional composition of the most common industrialized diet by the individuals in this study may have influenced the unfavorable results, such as the high frequency of low muscle mass and excess fat mass. Consequently, there arises the need for the formulation and availability of an enteral diet that meets the nutritional needs of this population.

Furthermore, investigations are suggested through longitudinal studies, comparing the nutritional composition and the influence of exclusively homemade and industrialized enteral diets on the assessment of anthropometric and body composition parameters in children and adolescents with SQCP.

At last, the importance of early and continuous nutritional monitoring is emphasized to adjust the composition of the offered diet, aiming to reduce adverse effects on the body composition and nutritional status of these individuals, which is already compromised due to the severity of CP.

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CONTRIBUTORS

Conceptualization, data curation, writing – original draft, writing – review and editing: EPCR SCHMITZ. Conceptualization and writing – review and editing: KG BRANDT and MMC ANTUNES.