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Assessment of nutritional status of children and adolescents with Spastic Quadriplegic Cerebral Palsy

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ABSTRACT – Background – Due to several factors, such as gastrointestinal's diseases and difficulty in feeding, children with Spastic Quadriplegic Cerebral Palsy tend to present nutritional deficits. **Objective** – To assess the nutritional status of pediatric patients with Spastic Quadriplegic Cerebral Palsy according to reference curves for this population and with the measures of folds and circumferences, obtained by the upper arm circumference and triceps skin fold. **Methods** – The data were obtained from: knee-height, estimated height, weight, upper arm circumference, and triceps skin fold. Values of folds and circumferences were compared with Frisancho, and specific curves for these patients were used as reference. The relationship between the values in the growth curve for healthy children, Z-Score, and comparison with the reference curve were verified by Fisher's exact test. We adopted the significance level of 5%. **Results** – We evaluated 54 patients. The mean age was 10.2 years, and 34 were male, 25 fed by gastrostomy and 29, orally. The frequency of low weight by the reference curve was 22.22%. More than half of the patients presented the parameters indicating lean mass below the 5th percentile. The height of all patients was classified as adequate for the age by the reference curve. **Conclusion** – Low weight was found in 22% of patients, and there is a greater tendency to present reduced muscle mass and increased fat mass, showing the need for evaluation and appropriate interventions for patients with Spastic Quadriplegic Cerebral Palsy.

HEADINGS – Cerebral palsy. Quadriplegia. Nutrition assessment.

INTRODUCTION

Spastic Quadriplegic Cerebral Palsy (SQCP) designates a type of not progressive or evolutionary chronic encephalopathy (NECE), associated with serious motor abnormalities, usually poor dietary intake, impairment of body composition, and malnutrition. It is a permanent, severe, and irreversible neurological condition[6,9,23].

Many children with SQCP present swallowing disorders and other diseases of the gastrointestinal tract (GIT), as gastroesophageal reflux and constipation[6,9,23,26]. In general, they are unable to communicate hunger and satiety, which makes it necessary to caregivers to regulate the supply and intake randomly[13]. As the task of feeding these patients is time-consuming, laborious, and with risk of tracheal suction, the quantity of food supplied may be insufficient to meet individual demands[13,14]. These factors contribute for many children with cerebral palsy to present impairment of the nutritional status.

Fung et al. (2002), in their study with 230 children with moderate/severe CP, observed that the feeding difficulty is common and often associated with the nutritional status. Even those who presented moderate dysfunction tend to require cropped and smashed food, which may be a risk to the maintenance of an adequate nutritional status[9].

The anthropometric assessment in children with SQCP requires differentiated procedures, and the ideal anthropometric goals are different from those expected in healthy children[1,2,3,5,17,18,20].

Brooks et al. built, in 2011, specific growth curves for children with CP based on the curves of the *Centers for Disease Control and Prevention* (CDC), considering degree of motor impairment and feeding way[2]. These curves represent the most current reference available, in addition of coming from a study with representative sample. Araújo and Silva (2013) analyzed patients with CP and found that 51% were below the 10th percentile of weight for age when placed in the CDC curves, while only 10% remained on this range when the data were plotted in the specific growth curves for cerebral palsy, indicating that references commonly used in pediatrics tend to overestimate the malnutrition in patients with SQCP[1].

Several studies present data compatible with a high percentage of malnutrition in patients with SQCP[3,16,21,22,23]. Stevenson (2006) verified that up to 19% of patients may be below the 10th percentile of weight for age[22]. Samson-Fang and Stevenson (2000) found values of weight/height below the 10th percentile in 45% of the studied children[21]. Caram et al. (2010) identified 50.9% of malnutrition in the weight for age parameter[3]. However, the studies mentioned above have as limitation the fact that they examined patients with various types of CP.

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Spastic quadriplegia is the more severe type of cerebral palsy[6], because, in addition to global paralysis, convulsive syndrome, and respiratory complications, it is often associated with dysfunctional feeding[11,25], an aggravating factor for malnutrition[6,9,23]. This study was designed to describe the values relating to the nutritional assessment of children with Spastic Quadriplegic Cerebral Palsy (SQCP), followed on a tertiary care service, using specific references to this condition.

METHODS

This study was carried out in a university hospital, from April 2013 to March 2014. It was approved by the Ethics Committee on Institutional Research of *Faculdade de Ciências Médicas* of UNICAMP under the protocol number 331,270 in July 10, 2013.

The informed consent form was presented for agreement and signed by the guardians who agreed to participate.

Inclusion criteria were: age between two and nineteen years old and definitive diagnosis of Spastic Quadriplegic Cerebral Palsy. We excluded patients with genetic diseases.

Data on gender, age, etiology of CP, and comorbidities related to gastrointestinal tract were obtained from medical records. The measurement of anthropometric parameters was performed on the patients' appointment date, according to the hospital's agenda. We used the following techniques and measures:

Estimated height: method used for patients unable to keep standing posture for direct height measure. To do so, we use the value of knee-height, measured with a Cescorf® bone caliper and the child's leg at an angle of 90°. The measurement of the length of the anterior surface of the leg until the sole was measured and applied to the formulas of Stevenson (1995)[23] and Chumlea (1994)[4]. Stevenson's equation was used for ages under 12 and Chumlea's equation, for ages over 12, as described in the Figure 1.

Group	Age (years)	Equation
Children*	2 – 12 years old	EH (cm) = 24.2 + (2.69 × KH) ± 1.1 (SD)
White boy**	6 – 18 years old	EH (cm) = 40.54 + (2.22 × KH)
Black boy**	6 – 18 years old	EH (cm) = 39.6 + (2.18 × KH)
White girl**	6 – 18 years old	EH (cm) = 43.21 + (2.15 × KH)
Black girl**	6 – 18 years old	EH (cm) = 46.59 + (2.02 × KH)
White man**	> 18 years old	EH (cm) = 71.85 + (1.88 × KH)
Black man**	> 18 years old	EH (cm) = 73.42 + (1.79 × KH)
White woman**	> 18 years old	EH (cm) = 70.25 + (1.87 × KH) – (0.06 × age)
Black woman**	> 18 years old	EH (cm) = 68.10 + (1.86 × KH) – (0.06 × age)

FIGURE 1. Mathematical equations for calculation of estimated height (EH), from values obtained from knee-height (KH), according to references of *Chumlea et al. (1994)[4] and **Stevenson (1995)[23]. SD: Standard Deviation.

Weight: the Filizola® digital scale was calibrated to zero. Due to the impossibility of the patients to stand up, we first weighed the caregivers barefoot, with light clothes, and in standing position. Then, the children were weighted on their guardians' lap, and their weights were calculated by the difference.

Upper arm circumference (UAC): the children's arm was placed in flexion position. Using an inelastic tape measure, the midpoint between the acromial process of the scapula and the olecranon (elbow) was marked with felt-tip pen. Thus, the arm perimeter was measured with the pending member at the marked point.

Triceps skin fold (TSF): Lange® adipometer was applied on the back of the arm, in the same point used to obtain the UAC. The measurement was carried out following the longitudinal axis of the member.

The anthropometric measurements were measured on the right side of the child, and we considered the mean of three consecutive measurements. Later, we calculated values of Body Mass Index (BMI), Upper Arm Muscle Circumference (UAMC), Upper Arm Muscle Area (UAMA), and Upper Arm Fat Area (UAFA), using mathematical equations for these purposes (Figure 2). The values of folds and circumferences were compared with the reference of Frisancho (1993)[7].

Parameter	Equation
BMI, (Kg/m²)	$\text{BMI, (Kg/m}^2\text{)} = \frac{\text{Weight}}{\text{Height}^2}$
UAMC (cm)	$\text{UAMC (cm)} = \text{UAC (cm)} - \pi \times [\text{SQCP (mm)} \div 10]$
UAMA (cm²)	Female $\text{UAMA (cm}^2\text{)} = \frac{[\text{UAC (cm)} - \pi \times \text{SQCP (mm)} \div 10]^2 - 10}{4\pi}$ Male $\text{UAMA (cm}^2\text{)} = \frac{[\text{UAC (cm)} - \pi \times \text{SQCP (mm)} \div 10]^2 - 6.5}{4\pi}$
UAFA (cm²)	$\text{UAFA (cm}^2\text{)} = \frac{\text{UAC (cm)} \times [\text{SQCP (mm)} \div 10]}{2} - \pi \times \frac{[\text{SQCP (mm)} \div 10]^2}{4}$

FIGURE 2. Mathematical equations for body mass index (BMI) calculation, Upper Arm Muscle Circumference (UAMC), Upper Arm Muscle Area (UAMA), and Upper Arm Fat Area (UAFA), based on data of Upper Arm Circumference (UAC) and Triceps Skin Fold (TSF).

The curves of Brooks et al. (2011)[2] were used as reference standard. We defined as malnourished patients with index of weight for age below the 25th percentile, as well as established in the original study. We considered the degree of motor impairment according to the division of the curves in the original study, in which all children belonged to level V by being patients with extremely committed self-mobility, being carried by manual wheelchair. We also considered the feeding way, since the study was composed of patients fed orally and by gastrostomy. We also used the reference curves of the World Health Organization (WHO)[27] to calculate the Z-Score and compare the curves. We defined as eutrophic those that presented Z-Score ≥ 2SD and ≤1SD, as thin those with Z-Score < −2SD, and obese those with Z-Score > +2SD.

For tabulation and data analysis, we used the Statistical Package for the Social Sciences® software (SPSS), version 17.0. Exploratory data analysis was performed by descriptive statistics and summary measures (frequency, percentage, mean, standard deviation, minimum, median, and maximum). The relation between growth curve for healthy children (represented by the calculated Z-Score) and curve adopted as a reference was verified by Fisher's exact test. We adopted the significance level of 5%.

RESULTS

We evaluated 54 pediatric patients with definitive diagnosis of SQCP, established by the team of Pediatric Neurology, 34 of them being male and 20, female. The age ranged from 2 to 18 years old, with a mean of 10.2 years ±4.45, and median of 10.3 years. Twenty five patients were fed by gastrostomy (SGT) and 29 orally (O), and, for each group, the specific growth curves for the corresponding cerebral palsy were used[2]. All the children performed the estimated height and were able to undergo the knee-height measurement correctly.

Table 1 shows the analysis of the assessed anthropometric parameters. A total of 72.22% of the patients were classified as eutrophic for BMI and 100% presented adequate height for age, using Brooks et al. reference. We also found 22.22% below the 25th percentile for weight. In the parameters indicating lean body mass, such as upper arm circumference, upper arm muscle circumference, and upper arm muscle area, more than half of the children presented depletion and preserved fat mass according to the parameters indicating body fat mass, such as triceps skin fold and upper arm fat area.

TABLE 1. Frequency and percentage of anthropometric variables of weight/age, height/age, BMI/age, skin folds, and upper arm circumferences in patients with Cerebral Palsy classified according to the reference curve of Brooks et al.[2] and Frisancho[7].

Variables	Individuals (n=54)	
	n	%
Weight for age		
<p5	5	9.26
p10 - p90	45	83.33
>p90	4	7.41
Height for age		
p10 - p90	51	94.44
>p90	3	5.56
BMI for age		
<p5	12	22.22
p10 - p90	39	72.22
>p90	3	5.56
Upper arm circumference		
<p5	28	51.85
p5 - p10	4	7.41
p10 - p95	21	38.89
>p95	1	1.85
Triceps skin fold		
<p5	16	29.63
p5 - p10	5	9.26
p10 - p95	31	57.41
>p95	2	3.70
Upper arm muscle circumference		
<p5	30	55.56
p5 - p10	3	5.55
p10 - p95	18	33.33
>p95	3	5.56
Upper arm muscle area		
<p5	33	61.11
p5 - p10	3	5.55
p10 - p95	17	31.49
>p95	1	1.85
Upper arm fat area		
<p5	19	35.19
p10 - p95	32	59.26
>p95	3	5.55

n: number of patients.

Table 2 shows the association between the specific growth curves for CP and the Z-Score calculation for weight that was performed using the growth patterns of the World Health Organization (WHO). There was significant difference, with $P<0.0001$ (Fisher's exact test); kappa=0.8276 (CI95%:0.5983-1.0000).

TABLE 2. Association between the reference curve (Brooks et al., 2011) and the Z-Score calculation for weight, according to parameters of the WHO.

	Classification of weight percentile in Brooks curve *					
	Low weight for age		Adequate weight for age		High weight for age	
Z-Score Classification for Weight	n	%	n	%	n	%
Thinness	3	100	2	14.3	0	0
Eutrophy	0	0	12	85.7	0	0
Obesity	0	0	0	0	3	100

n: number of patients. Thinness = Z-Score < −2SD. Eutrophy = Z-Score ≥ −2SD and ≤ +1SD. Obesity = Z-Score > + 2SD. $P<0.0001$ (There was significant difference $P<0.05$ – Fisher's exact test); kappa=0.8276 ($CI_{95\%}$:0.5983-1.0000). * Values calculated only for children under 10 years, as proposed by the WHO, 2006.

Table 3 shows the values of association between the specific growth curves for cerebral palsy and the Z-Score calculation for BMI. There was significant difference, with $P<0.0001$ (Fisher's exact test); kappa=0.5689 (CI95%:0.3509-0.7868).

TABLE 3. Association between the reference curve (Brooks et al., 2011) and the Z-Score calculation for BMI, according to parameters of the WHO.

	Classification of percentile of Brooks curve					
	Low weight		Eutrophy		Overweight and obesity	
Z-Score Classification for BMI	n	%	n	%	n	%
Thinness	12	100	4	10	0	0
Eutrophy	0	0	29	74	0	0
Obesity	0	0	6	15	3	100

n = number of patients. Thinness = Z-Score < −2SD. Eutrophy = Z-Score ≥ −2SD and ≤ +1SD. Obesity = Z-Score > + 2SD. $P<0.0001$ (There was significant difference $P<0.05$ – Fisher's exact test); kappa=0.5689 ($CI_{95\%}$:0.3509-0.7868).

Table 4 shows the data on the association between the specific growth curves for cerebral palsy and the Z-Score calculation for height. We observed that, for weight and BMI, the kappa index (close to 1) and the value of P (<0.05) indicate a good agreement and association between the curves, a fact that was not verified in height, which showed low correlation between the curves.

TABLE 4. Association between the reference curve (Brooks et al., 2011) and the Z-Score calculation for height, according to parameters of the WHO.

	Classification of percentile of Brooks curve	
	Adequate height for age	
Z-Score Classification for Height	n	%
Very low height for age	18	33.33
Low height for age	16	29.63
Adequate height for age	20	37.04

n: number of patients. Very low height for age = Z-Score < −3SD. Low height for age = Z-Score ≥ −3SD and < −2SD. Adequate height for age = Z-Score ≥ 2SD.

DISCUSSION

We found low weight in 22% of the studied patients, using the specific growth curves for patients with SQCP. As they are patients with SQCP, this rate was higher than that described by Araújo and Silva (2013)[1], of 10%, which covers various degrees of severity of CP. More than half of the patients presented the parameters indicating lean mass below the 5th percentile. The height of all patients was classified as adequate for the age by the reference curve.

Krick et al. (1996)[12] and Day et al. (2007)[5], in their studies, built specific curves for children with CP and classified fewer individuals as bearers of nutritional deficit, compared to NCHS classifications[5,12]. These results were also found in this study. Another point of disagreement was the classification of height as adequate for age in 100% of patients, defined by the specific growth curves for cerebral palsy, while the Z-Score indicate low or very low height for age. Weight and BMI indexes show a good agreement between the curves, but the height index showed a bad agreement, which can be related to the fact that the height was estimated by knee-height, a measurement of difficult assessment and that may not match accurately the height when measured in standing position.

Brooks et al. (2011)[2] conducted a study to classify the nutritional status according to the patient's motor performance by the evaluation of individuals with CP, which were used in this study. Other authors have shown the need for the use of specific curves for SQCP, since these children present a different growth from healthy children, being smaller, but do not present nutritional deficit related to losses, consumption, or low nutrient intake[2,15,22]. In this study, we found 22.22% below the 25th percentile for weight, however, it is important to note that, even when properly nurtured, children with CP present muscle atrophy, possibly due to physical inactivity, mechanical forces exerted on bones, joints, and muscles, endocrine factors, in addition to higher prevalence of prematurity and low birth weight than the general population, which also makes them be usually smaller than healthy children[10].

The measurement of skin folds is an important instrument in the nutritional assessment of patients with Spastic Quadriplegic CP. The triceps or subscapular skin folds provide useful information of fat mass, and the TSF is the best tool for evaluation of malnutrition in children with SQCP[21].

Muscle mass can be estimated using mathematical equations to this end[8]. Although most patients were classified as eutrophic according to weight and BMI, more than half presented the parameters indicative of lean mass below the 5th percentile, showing depletion (UAC=51.85%; UAMC=55.56%; UAMA=61.11%), while the parameters indicative of fat mass were between the 10th and 95th percentiles, showing conservation (TSF=57.41% and UAFA=59.26%). These findings may be related to the limited mobility and lack of physical activity of these patients, generating little stimulus for muscle forming. Thus, it is clear that children with SQCP have greater tendency to show reduced muscle mass and increased fat mass when compared to healthy children[24].

Low food intake in these patients seems to be associated with a number of factors, highlighting predominantly the swallowing disorders and higher incidence of gastrointestinal disorders. In addition, there are factors associated with the difficulties of caregivers to feed them properly. Caring for a chronically disabled child and with feeding difficulties requires efforts of social, emotional, financial, and familiar nature, not always available[19].

Recognizing that the anthropometric aspects of children with SQCP differ from those of healthy children is essential to the good clinical practice in the care of these cases. All children with this diagnosis need individualized nutritional assessment and prescription, a task that must recognize any deficits and identify plausible goals. We recommend the use of specific curves, including measurements of triceps skin fold and upper arm circumference in the clinical evaluation, since they are easy, low-cost methods, and additives for the appropriate nutritional diagnosis.

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Authors' contributions

Caselli TB: lead researcher and article author. Lomazi EA: contribution with correction. Montenegro MAS: help in obtaining data. Bellomo-Brandão MA: project supervisor.

Caselli TB, Lomazi EA, Montenegro MAS, Bellomo-Brandão MA. Métodos de avaliação do estado nutricional de crianças e adolescentes com Paralisia Cerebral Tetraespástica. Arq Gastroenterol. 2017;54(3):201-5.

RESUMO – Contexto – Devido a diversos fatores, como doenças do trato gastrointestinal e dificuldade de alimentação, frequentemente crianças com Paralisia Cerebral Tetraespástica apresentam prejuízo no estado nutricional. **Objetivo –** Avaliar o estado nutricional de pacientes pediátricos com Paralisia Cerebral Tetraespástica de acordo com curvas de referência para essa população e comparar com as curvas de referência utilizadas para a população pediátrica em geral. **Métodos –** Foram obtidos os dados de: altura do joelho, estatura estimada, peso, circunferência braquial e dobra cutânea triciptal. Valores de dobras e circunferências foram comparados com Frisancho e curvas específicas para esses pacientes foram utilizadas como referência. A relação entre os valores plotados na curva de crescimento para crianças saudáveis, Escore-Z e comparação com a curva referencial foram verificados através do teste exato de Fisher. O nível de significância adotado foi de 5%. **Resultados –** Foram avaliados 54 pacientes. A média de idade foi de 10,2 anos, 34 eram do sexo masculino. Vinte cinco se alimentavam via gastrostomia e 29 via oral. A frequência de baixo peso pela curva referencial foi de 22,22%. Mais da metade dos pacientes apresentaram os parâmetros indicativos de massa magra abaixo do percentil 5. A estatura de todos os pacientes foi classificada como adequada para idade pela curva referencial. **Conclusão** – O baixo peso foi encontrado em 22% dos pacientes, e há maior tendência para que esses pacientes apresentem massa muscular reduzida e aumento da massa gorda, mostrando a necessidade de avaliação e intervenções apropriadas para pacientes com Paralisia Cerebral Tetraespástica.

DESCRITORES – Paralisia cerebral. Quadriplegia. Avaliação nutricional.

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