Original Research Article

ASSESSMENT OF BODY FAT IN CHILDREN WITH NEUROPATHY BY DEUTERIUM OXIDE DILUTION

Abstract :

Purpose: Evaluate nutritional status by anthropometry and body fat by isotopic dilution with deuterium oxide in children with chronic neuropathies. **Method:** Study of a series of cases of children and adolescents hospitalized with a diagnosis of severe chronic neuropathy due to cerebral asphyxia, cerebral palsy and spinal muscular atrophy. Weight, height, age and gender data were obtained and analyzed according to the recommendations of the World Health Organization (2006, 2007) and anthropometric indices were obtained using the Anthro and AnthroPlus software. To analyze body fat, 4mL of saliva was collected at baseline and three hours after the administration of a dose of deuterium oxide (0.5g/kg/weight). The samples were analyzed using the SHIMATZU FTIR IRAfinit-1 ® equipment and IRsolution software. The study was approved by the Research Ethics Committee of Hospital InfantilNossaSenhora da Glória (CAAE 18593013.7.0000.5069). **Results:** eight mixed race patients included, half male, mean age 36.25±32.39 years, height 85.75±19.95 cm, weight 17.60±9.50kg, BMI-for-age 17.35±4.40kg/m^2, body fat 5.89±5.04 kg and body fat percentage 35.76±16.10%. Half of the patients were malnourished, and of these, some had a fat percentage higher than expected. The height was adequate in 5/8. **Conclusion**: Low weight is common among patients with spastic paralysis, while in those with type I progressive spinal muscular atrophy type I, there is a predominance of obesity. Height/length is preserved in most patients, regardless of the type of neuropathy. A body fat percentage of over 30% was found, even among those who were underweight.

INTRODUCTION

It is now known that patients with chronic neuropathies such as cerebral palsy are at risk of malnutrition, either because of their oromotor difficulties or because of factors that are not fully understood. Of these, those living in underdeveloped countries are at even greater risk and deserve special attention when it comes to their nutritional profile[1].

Cerebral palsy is characterized by motor and cognitive impairments resulting from insults to the developing brain. The etiology is multifactorial and includes intrauterine fetal stroke, prematurity, neonatal infection, trauma and hypoxia, as well as genetic causes. Its occurrence may be present in the prenatal, perinatal or postnatal period[2].

Impaired autoregulation of cerebral blood flow in children who have suffered traumatic brain injury, for example, is an important cause of hypoxic-ischemic brain damage[3]. One of the complications observed in this group is the presence of epilepsy[4], which contributes to increased caloric-metabolic demands and, consequently, leads to worse nutritional outcomes in these patients.
Children with cerebral palsy present a lifelong condition of heterogeneous and debilitating motor disorders[5] associated with multiple motor alterations and dysfunctions, characterized by abnormal movements or posture, beginning early in development[6]. Although attributed to perinatal asphyxia, this condition can represent a clinical spectrum of disorders, many of which are due to genetic causes[7].

Werdnig-Hoffmann disease, in turn, is a rare autosomal recessive hereditary disease[8], that presents with spinal muscular atrophy, being the most serious motor neuron disease that affects voluntary muscle control, which affects about 80% of those affected. Babies with this disease have severe muscle weakness, which starts before the age of six months and shows symptoms such as severe motor weakness,poor muscle tone and lack of motor development[9].

Although it is known that the nutritional care of these patients is fundamental for their development and quality of life, there are no cohesive and specific nutritional parameters[10]. In this sense, the isotope dilution technique with deuterium oxide, considered the gold standard for assessing body composition[11], combined with the difficulty in handling these patients using other assessment methods[12], the team that conducted this research opted to use the stable isotope technique in order to better understand the metabolic demands of these patients. Furthermore,anthropometryis a useful tool for nutritional assessment in children with CP, but it is weak in accurately measuring weight and height[13], and may underestimate levels of body fat[14].

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To that end, the purpose of this study was to assess the nutritional status and body fat of children with chronic neuropathies using anthropometry and isotopic dilution with deuterium oxide by Fourier transform.

METHOD

A series of eight cases are described here of children with neuropathies due to asphyxia or cerebral palsy and spinal muscular atrophy (Werdnig-Hoffmann disease), with an emphasis on the evolution of nutritional status. Children hospitalized due to severe, spastic or atonic neuropathies often have nutritional disorders associated with malnutrition or obesity[15] and need to be monitored by the Multidisciplinary Nutritional Therapy Team, considering that the lack of nutritional monitoring and the offer of inadequate diets can contribute to unfavorable nutritional evolution with serious results in nutritional status and body composition[16].

This is an exploratory-descriptive case series study of eight children with severe chronic neuropathy who were admitted to Hospital InfantílNossaSenhora da Glória in Vitória, ES, Brazil, in 2015.

Based on weight and height/length measurements, the body mass index (BMI) was calculated using the equation: BMI = Weight (Kg)/Height (m)². To classify nutritional status, BMI for age (BMI-for-age) z-scores were used, considering the following cut-off points: marked thinness (<escore z -3); magreza (≥ escore z -3 e <escore z -2); eutrofia (≥ escore z -2 e ≤ escore z +1); sobrepeso (> z score +1 and ≤ z score +2); obesity (> z score +2 and ≤ z score +3); serious obesity (> z score +3). The height-for-age index was defined as very short stature for age (< z score -3); short stature for age (≥ z score -3 and < z score -2); and adequate stature for age (≥ z score -2), as recommended in the WHO curves (2006,2007)[17]. To identify the BMI-for-age and height-to-age z scores, the WHO Anthro and AnthroPlus software was used[18]. Due to the impossibility of standing up for assessment, as recommended for obtaining height, we opted to take the measurement lying down, corresponding to length.

Deuterium oxide (D_2O) was used to measure body fat using the FTIR technique by Fourier transform, following the methodology described by Slater el al[19] and consisted of collecting a 5mL sample of basal saliva, after fasting for at least 30 minutes for solids and liquids. A dose of Deuterium Oxide (D_2O) at 99.99% from Sigma Aldrich® (0.5g/kg/dose, maximum 30g) was then administered orally and a new saliva sample (5mL) was taken three hours later. The samples were stored at -40^{o}C. All the analyses were conducted on the SHIMATZU FTIR IRAfinit-1® equipment and using IRsolution software.

Descriptive statistics were used to analyze the data, including frequencies (%), mean, standard deviation and median. SPSS software version 25.1 was used.

The study was approved by the Research Ethics Committee of Hospital InfantilNossaSenhora da Glória (CAAE 18593013.7.0000.5069).

RESULTS

Eight children with a diagnosis of severe chronic neuropathy were assessed, all of whom were mixed race and equally distributed between males and females. One participant was excluded from the body fat assessment due to a missed dose of D_2O during its administration.

The demographic, anthropometric and body composition variables are shown in Table 1. The frequency (%), mean and median of anthropometric and body composition data are shown in Table 2.

Table 1 – Demographic, anthropometric and body fat data of children with neuropathies admitted to HINSG in 2015 (n=8).

Case	Age (month)	Sex	Height (cm)	Weight (kg)	BMI (kg/m^2)	Z-BMI-by-age	Nutritional Diagnosis	Z-Height-to-Age	Height	fat (kg)	Fat (%)
01	43	M	100	17.1	17.3	1.43	RSP	-0.31	A	9.15	53.53
02	22	F	88	16.0	20.7	3.12	O	1.04	A	5.6	34.99
03	30	M	91	14.0	17.2	1.05	RSP	-0.54	A	4.25	30.35
04*	2	F	48	3.58	15.5	-0.29	M	-4.79	MBE	*	*
05	20	F	82	8.18	12.2	-3.05	MA	-0.39	A	2.47	30.17
06	7	M	67	7.64	17.0	-0.21	M	-1.15	A	2.52	32.99
07	69	F	102	27.0	26.0	4.45	OG	-2.33	BE	15.74	58.3

08	97	M	108	15.0	12.9	-2.49	M	-3.52	MBE	1.5	10.02

*Missed dose of D_2O
Nutritional diagnosis: RSP (Risk of overweight); O (Obese); OG (Severely obese); M (Thinness); ME (Marked thinness)
Stature= A (Adequate); MBE (Very short stature); and BE (Short stature)

Table 2 – Mean and median anthropometric and body fat data of children with neuropathies admitted to HINSG in 2015 (n=8).

Variable	Mean±Standard deviation	Median
Age (Years)	36.25±32.39	26.00
Height (cm)	85.75±19.95	89.50
Weight (kg)	17.60±9.50	15.50
BMI-for-age (Kg/m^2)	17.35±4.40	17.10
Body fat (kg)	5.89±5.04	4.25
Body fat (%)	35.76±16.10	32.99

*Missed does of D_2O administered in one case

DISCUSSION

All patients had a long hospital stay and those with complete muscle paralysis, including the tone of the main and accessory muscles of breathing, required mechanical lung ventilation and feeding via gastrostomy catheters. This paralysis implies a marked reduction in energy expenditure and excessive calorie supply leads to an increase in weight, body mass index and body fat[20].

It should be noted that in this study the weight control of a patient with total muscle paralysis (case 07) was only achieved 30 days after offering a total caloric rate corresponding to 70.0% of the basal metabolic rate. Adequate replacement of vitamins, minerals and trace elements and control of hemoglobin and serum albumin levels were performed to avoid acute malnutrition.

A study with anthropometric evaluation in 15 children with type I and II spinal muscular atrophy indicated that the impairment of nutritional status seems to be more linked to the magnitude of neurofunctional impairment than nutritional impairment, due to the different energy needs in relation to their specific body composition and hypermetabolism of fat-free mass[2].

It is important to note that these patients generally have vitamin deficiencies, especially vitamin D, minerals and other micronutrients such as selenium, copper, zinc, iron, chromium, cobalt, boron, magnesium, iodine and others, which can lead to imbalances in glucose homeostasis, insulin resistance and anemia, influencing the loss or gain of body weight, especially the increase in body fat[22,23].

The four patients diagnosed with thinness and marked thinness had spastic cerebral palsy. Malnutrition in this group can be justified by alterations in the swallowing reflex, pulmonary microaspiration, dysphagia, increased oral transit time, directly associated with global motor impairment[24], in addition to food *deficits* associated with socioeconomic and care factors in the food supply[12,16,25], observed in patients facing poverty and social vulnerability.

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Contrary to expectations, two patients with short stature had a body fat percentage of over 30%, indicating that malnourished children preserve body fat to the detriment of lean mass[26]. This situation has been observed in other studies[26-29]. In patients with muscle paralysis, there is lower energy expenditure, which may justify excess body fat[30], even with adequate calorie supply for the age.

There is evidence indicating that fat restoration is disproportionately rapid compared to muscle gain in hospitalized malnourished children[27]. However, a study assessed 850 malnourished children, aged six to 59 months, using anthropometry, and after 4 months of treatment, no excess adiposity was observed[31].

CONCLUSION

Low weight is common among patients with spastic paralysis, while in those with type I progressive spinal muscular atrophy type I, there is a predominance of obesity. Height/length is preserved in most patients, regardless of the type of neuropathy. A body fat percentage of over 30% was found, even among those who were underweight.

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