Nutritional State and Gross Motor Function of Children with Cerebral Palsy

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Abstract

Background: Nutritional abnormalities are common across the spectrum of severity of CP. Children with all levels of motor impairment are at risk for malnutrition. Impaired growth of children with CP is commonly reported. CP children are tend to be smaller and to grow more slowly than typically developing children. Growth disorders and nutritional deficits are present in approximately one third of paediatric patients with CP. The aim of this study is to assess the nutritional status of children with cerebral palsy according to their functional abilities.**Methods:** 105 children with hemiplegic and diaplegic CP of both sexes were selected, their age ranged from 6 months to 12 years, they were classified according to GMFCS in to level II, III, IV, their degree of spasticity are 1, 1+ and 2 and parents accepting to participate in the study referred from Nour- EL Hayah rehabilitation center and EL-Rahma rehabilitation center in Alexandria to assess their dietary intake and to investigate the relation between GMFCS and their nutritional status. Dietary intake was assessed by a 3- day food diary filled by the caregivers report all food and beverages that will be consumed. Finding of dietary intake was analyzed using the Egyptian Food Composition Tables by National Nutrition Institute to determine energy and macronutrient intake. **Results:** MANOVA revealed that there was a significant difference between GMFM levels in nutritional status ($p = 0.001$). There was a significant increase in energy, iron, water, fat, protein and carbohydrate of level II compared with that of level III ($p < 0.01$). However, there was no significant difference in calcium between level II and level III ($p > 0.05$). There was a significant increase in calcium of level IV compared with that of level II ($p < 0.05$). There was a significant increase in iron and water of level II compared with that of level IV ($p < 0.001$).However, there was no significant difference in energy, fat, protein and carbohydrate between level II and level IV ($p > 0.05$). There was no significant difference between level III and level IV in all parameters ($p > 0.05$).**Discussion:** Our finding showed that there was an increase in energy, iron, water, fat, protein and carbohydrate of level II compared with that of level III and also, there was no significant difference in calcium between level II and level III. **Conclusion:** It could be concluded that, the nutritional state for level II is better than level III and IV.

Key words: cerebral palsy, nutritional status, functional abilities, Dietary intake and gross motor function.

INTRODUCTION

Cerebral palsy (CP) is a group of non-progressive disorders of movement and posture **(1)**. This disorder is the result of damage to the immature brain that occur before, during, or after child birth. The most common causes are congenital or metabolic, prematurity, perinatal asphyxia or trauma, or meningitis, traffic accident or near drowning accidents when the disorder is acquired during maturation**(2).**Due to the severity, of their disabilities, most of these children are dependent and need care from specialized day-care centres, specialized

schools. Cognitive impairment may be associated with inability to communicate hunger or satiety, inability to request food and drink, and to communicate symptoms. There is a strong evidence that the prevalence of malnutrition increases with lower intelligence quotients (IQ) **(3).**Nutritional abnormalities are common across the spectrum of severity of CP, Children with all levels of motor impairment are at risk for malnutrition, and impaired growth of children with CP is commonly detected **(4).**CP children have higher risk to be smaller and to grow more slowly than normal children, Growth disorders and nutritional deficits are present in approximately one third of paediatric patients with CP **(5).**On the other hand there is some evidence that CP children with less sever motor impairments may be at increased risk of being overweight **(6).**Poor growth in this population may result from poor nutrition, both in utero as well as during infancy. Infant, fetal growth restriction is common on this population **(7).**But it may be a consequence of antenatal brain injury unrelated to fetal nutrition **(8).**Poor nutrition during infancy may also play a role in poor growth, since early feeding problems (i.e. poor oral motor function) are common symptoms in CP children **(9).**Nutritional status has a significant effect on overall health and quality of life in CP children. Both under and over nutrition generally lead to increased health care use and reduced participation in educational and social activities. Malnutrition has been observed in CP children in 46%-90% of cases **(10).**Nutritional support is a critical part of the care of CP children as it will improve overall health and quality of life, that what can be achieved by anadequate nutritional assessment and a successful nutritional intervention. The key to success are collaboration with families, use of multiple methodologies for example; feeding history, anthropometry, serum nutritional markers, and longitudinal repeated assessments. The first step in nutritional assessment is to collect an accurate medical history including the underlying neurological disease, level of motor impairment, the type and duration of antiepileptic treatment, and the number of hospitalizations **(11).**Physiotherapy (PT) for CP children is a physio-medical intervention for a healthy growth and development, including building strong bones and muscles, improving balance, and acquiring and developing motor skill. In paediatric PT the Gross Motor Function Classification System (GMFCS) is the international language to classify gross motor function of CP children **(12).**It has enhanced communication between families and professionals by providing standardized descriptions of gross motor function for each level and age band **(13).**The five levels of GMFCS

describe children typical performance at home and at the community, rather than their optimal capacity observed during motor testing in clinic setting, Evidence of construct validity of GMFCS was provided by the motor development curves for children and young people with CP**(14).**The aim of this studyis to assess the nutritional status of children with cerebral palsy according to their functional abilities.

Methods

Participants

The inclusion criteria for the study were children with hemiplegic and diaplegic CP of both sexes were selected, their age ranged from 6 months to 12 years, they were classified according to GMFCS in to level II, III, IV, their degree of spasticity are 1, 1+ and 2 and parents accepting to participate in the study. The exclusion criteria for the study were children younger than 6 months of age, and parents not accepting to participate in the study. Informed consent was obtained from the families after they were informed about the study. The study received Ethics Committee Approval from the High Institute of Public Health.

Procedures

This Cross section study was performed on 105 children with CP age ranged from 6 months to 12 years according to one proportion Power Analysis in NCSS & PASS program referred from Nour- EL Hayah rehabilitation center and EL- Rahma rehabilitation center in Alexandria to assess dietary intake of cerebral palsy children and to investigate the relation between GMFCS- E&R and nutritional status of cerebral palsy children. Activity limitations were studied with the GMFCS for gross motor function **(15).** Children were classified according to GMFCS which was evauated through observation, assessment, and questions asked to the parents and caregivers about the children.

Assessment tools

Gross Motor Function Classification System (GMFCS) is a common classification system and an evidence-based classification tool of five levels ranging from level I, which includes children with minimal or

no disability with respect to community mobility, to level V which includes children who are totally dependent on external assistance for mobility **(15).**

Data collection methods and tools:

The following tools were used to collect the required data from parents / caregivers of the study sample:

1. Interviewing:

Predesigned interview questionnaire was used to collect data about:

1.1 Parental/ caregiver characteristics:

Consanguinity of parents, age of mother at child's birth, caregiver's marital status, caregiver's educational status.

1.2 Child characteristics:

Age, sex, place of birth, gestational age of birth, the CP child subtyped according to Surveillance of Cerebral Palsy in Europe (SCPE) **(16).**

1.3 Medical history:

Child admission to hospital after birth, epilepsy, surgical intervention, presence of cognitive impairment, taking anti-epileptic drugs (AEDs), and dietary supplements.

1.4 Level of gross motor function:

By applying the gross motor function classification system expanded and revised (GMFCS-E&R) to determine level of gross motor function according to CP child age through five level of motor function **(15).**

1.5 History of feeding difficulties:

By categorizing feeding difficulties reported into five main groups: (1) difficulties with the breast feeding (weak suckling, problems in latching); (2) slow rate of feeding and prolonged feeding times; (3) vomiting or excessive spit up; (4) poor oral motor function (problems in swallowing or chewing, excessive drooling); and (5) use of naso-gastric tube or percutaneous endoscopic gastrostomy to maintain nutritional needs **(17).**

2. Assessment of dietary intake:

This is was done by a 3- day food diary filled by the caregivers report all food and beverages that will be consumed **(18).** Dietary intake was calculated by using ESHA Food Processor modified by the Egyptian Food composition tables and the USDA Food composition tables**(19).**

Statistical analysis:

Descriptive statistics and ANOVA-test were conducted for comparison of subject characteristics between groups. Chi- squared test was used for comparison of sex distribution between groups Normal distribution of data was checked using the Shapiro-Wilk test for all variables. Levene's test for homogeneity of variances was conducted to test the homogeneity between groups. MANOVA-test was conducted for comparison of nutritional status between level II, III and IV GMFM. Post-hoc tests using the tukey test were carried out for subsequent multiple comparison. The level of significance for all statistical tests was set at $p < 0.05$. All statistical measures were performed through the statistical package for social studies (SPSS) version 22 for windows.

Results:

Subject characteristics

Table 1 showed the mean ± SD age of level II, III and IV GMFM groups. There was no significant difference between the three groups in the mean age ($p = 0.95$).

Table 1: ***Descriptive statistics and ANOVA test for the mean ageof group A, B, and C:***

	Level II $\overline{X}$ **±SD**	**Level III** $\overline{X}$ **±SD**	**Level IV** $\overline{X}$ **±SD**	**F- value**	**p-value**
Age (years)	5.06 ± 2.57	4.32± 2.36	5 ± 2.48	0.95	0.39
Boys/girls	20/15	19/16	16/19	(χ^2=0.99)	0.6

$\bar{X}$**, Mean; SD, standard deviation; χ2, Chi squared value; p-value, level of significance.**

Comparison of energy, calcium, iron, water, fat, protein and carbohydrate between level II, III and IV:

MANOVA revealed that there was a significant difference between GMFM levels in nutritional status (Wilks' Lambda = 0.43; $F_{(14,192)} = 7.01$, p = 0.001). Table 2 showed descriptive statistics of energy, calcium, iron, water, fat, protein and carbohydrate of level II, III and IV as well as the significant level of comparison between GMFM levels. There was a significant increase in energy, iron, water, fat, protein and carbohydrate of level II compared with that of level III ($p < 0.01$). However, there was no significant difference in calcium between level II and level III ($p > 0.05$). There was a significant increase in calcium of level IV compared with that of level II ($p < 0.05$). There was a significant increase in iron and water of level II compared with that of level IV ($p < 0.001$).However, there was no significant difference in energy, fat, protein and carbohydrate between level II and level IV ($p > 0.05$). There was no significant difference between level III and level IV in all parameters ($p > 0.05$).

Table 2:*Mean energy, calcium, iron, water, fat, protein and carbohydrate of level II, III and IV GMFM:*

	Level II	Level III	Level IV	p-value		
	$\bar{X}$ ±SD	$\bar{X}$ ±SD	$\bar{X}$ ±SD	II vs III	II vs IV	III vs IV
Energy (kcal)	1111 ± 470.25	823.29 ± 354.08	948.59 ± 390.31	0.01*	0.22*	0.4
Calcium (mg)	335.75± 197.84	420 ± 257.18	510.5 ± 389.12	0.45	0.03*	0.4
Iron (mg)	8.92± 4.07	3.89 ± 2.14	3.9 ± 2.05	0.001*	0.001*	1
Water (L)	1605.05± 792.1	1088.01 ± 511.07	1001.7 ± 481.84	0.002*	0.001*	0.82
Fat (g)	33.88± 15.45	24.27 ± 10.73	27.34 ± 12.7	0.008*	0.09	0.59
Protein (g)	39.37± 15.98	28.34 ± 13.76	31.4 ± 15.06	0.007*	0.07	0.67
Carbohydrate (g)	172.27± 72.31	121.51 ± 62.91	144.05 ± 66.44	0.006*	0.19	0.34

$\bar{X}$**, Mean; SD, standard deviation; p-value, level of significance; * Significant.**

Discussion

Poor growth and malnutrition can be conceptualized as important secondary health conditions that impact the global health and well-being of children with CP and their families.Dietary intake analysis using

ESHA showed that non-ambulatory children with CP had significantly lower minerals, carbohydrates and protein with CP. Our finding showed that there was an increase in energy, iron, water, fat, protein and carbohydrate of level II compared with that of level III and also, there was no significant difference in calcium between level II and level III. However, there was no significant difference in energy, fat, protein and carbohydrate between level II and level IV. The total energy requirements and intakes of cerebral palsied children level III and IV were less than those cerebral palsied children level II of the same age. Because their dietary intakes tend to be small, the quality of these children's diet demands close attention if the recommended allowances of nutrients are to be attained.Oral-motor dysfunction increases feeding difficulty for many individuals with **CP (20)**Poor nutrition and low calcium intake are common in this population **(4)** and may contribute to poor mineralization. Many children with CP take or have taken anticonvulsant medications, which some authors suggest may adversely affect bone mineralization **(21).**Since nutrition is an important area of the management of children with CP, it is imperative to clarify the role of nutrition in maintaining health and well-being. Evidence documenting the effects of poor growth and malnutrition on the health of children with CP is limited, although much of the research done on adults and children without disabilities is applicable to this population.The ill effects of malnutrition on physiology, motor function, neurological and psychological function are wide ranging and may be particularly devastating during early development.Diminished muscle strength leads to impairment in motor function as well as weakness of respiratory musculature, with resultant impaired cough and predisposition to pneumonia **(22).**Malnutrition results in increased circulation times and diminished cardiac work capacity, and a predisposition to congestive heart failure when under cardio-respiratory stress **(23, 24).**Malnutrition leads to diminished immune function **(25),** causing increased susceptibility to infection. Neurological consequences include diminished cerebral growth, delayed cognitive development, and abnormal behavior **(26).**Undernourished children show lower levels of exploratory activity and attachment behavior that may affect social emotional development **(27).** Irritability and decreased activity have been described clinically in undernourished children **(28)**. Malnutrition decreases the energy available for discretionary activity, which decreases social interaction, increases apathy, and negatively affects learning and

quality of life. These characteristics may affect a child's ability to participate in play, school, or rehabilitation. In children with CP, malnutrition has been shown to increase the severity of gastroesophageal reflux, and nutritional rehabilitation has been shown to lessen the symptoms associated with gastroesophageal reflux**(29).**Malnutrition impairs wound healing and immunity, which increases the risk of postoperative complications following surgery for fundoplication [Weber, 1995] and scoliosis repair **(30).**Malnutrition is a frequent complication in CP children impacting on overall health and quality of life. Severity of feeding issues generally increases with reduction of general motor function and cognitive ability. Nutritional assessment and support should be an integral part of the care of CP children aiming at early identification of children at risk of nutrition-related comorbidities. To ensure success of interventions, close monitoring of nutritional status should be performed by a multidisciplinary team.These findings suggest that children with cerebral palsy (level III and IV) are at risk for a variety of abnormalities of nutritional status, and that a growth and nutritional assessment should be conducted periodically so that under- or over nutrition can be corrected when identified.

Conclusion

It was concluded that the nutritional state for cerebral palsy children should be assessed periodically to prevent causing malnutrition for them and also, it is important to add suitable amount of calcium, iron, water, fat, protein and carbohydrate in food for cerebral palsy children (level III and IV) to provide energy to enhance their motor abilities.

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