

A Survey on Growth and Nutritional Status of Children with Cerebral Palsy in the Northwest Iran

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Abstract

Background: Cerebral palsy (CP) is the leading cause of childhood disability. Children with CP are at risk for growth and nutritional disorders. The current study aimed at evaluating the growth and nutritional status of children with CP and assessing the relationship between the studied variables, clinical presentation, disease severity, and functional level in these patients in Northwest Iran.

Methods: In the current cross sectional, descriptive study, 99 outpatient children with CP referring to the rehabilitation clinic of children's Medical center in Tabriz, Iran, were studied for a 12-month period from June 2015 to June 2016. Demographic variables, CP type, anthropometric measures, and GMFCS (gross motor function classification system) were recorded. The patients' weight and height were measured, and then, weight-for-age and height-for-age percentiles were calculated based on the percentile charts for all patients. Dietary intake of the children was determined by the 24-hour dietary recalls of 3 nonconsecutive days (2 weekdays and 1 weekend day) by asking their parents as reliable reporters.

Results: Sixty-four patients had inadequate calorie intake, while 47 and 42 patients had abnormal weight and height percentiles. Quadriplegic and diplegic types CP, compared with the hemiplegic type ($P = 0.003$ and $P = 0.043$), and GMFCS III to V, compared with the classes I and II ($P = 0.001$), had significantly less normal weight percentiles, but there were no significant differences between normal and abnormal height percentiles, based on CP type and GMFCS level.

Conclusions: Abnormal growth was significantly common in children with quadriplegic and diplegic CP and high GMFCS level. About 64% of the children had inadequate calorie intake. Nutritional management should be arranged for the undernourished children to promote their nutritional status and improve their growth and functional capacities.

Keywords: Growth Failure, Children, Cerebral Palsy, Calorie Intake

1. Background

Cerebral palsy (CP), a common cause of disability in children, persists throughout life and is characterized by persistent disorders in posture and motor control that result from non-progressive brain lesions (1). Furthermore, children with CP experience several problems related to sensation, cognition, communication, and behavioral disturbances, epilepsy, and secondary musculoskeletal complications (2). Children with CP experience limitations in their daily activities (e.g., feeding, dressing, bathing, and mobility) due to abnormal motor control, gait problems, imbalance, and poor social functioning (3, 4). They also experience difficulty in swallowing. Feeding difficulties and malnutrition are the 2 problems associated with CP (5).

Growth and nutritional disorders are common in children with CP. As previously described (6-8), due to oral motor dysfunction, gastroesophageal reflux, and food refusal, the total caloric intake of children with CP is inadequate, which results in undernourishment and growth im-

pairment. Neurological impairment along with malnutrition and low caloric intake may lead to slow linear growth and weight gain, which accompanies the lower height and weight in children with CP, compared with their healthy counterparts (9, 10).

Although nutritional and growth disorders may occur in all children with CP, according to the reports, it is more common among the patients with greater degrees of motor impairments (10-12). Abnormal growth manifestations, such as malnutrition and obesity, are controversial while taking care of children with CP. To design a better program to improve the health status of children with CP, it is important to assess the growth and nutritional status of such patients in each geographical region. The current study aimed at evaluating the growth and nutritional status of children with CP in Northwest Iran.

2. Methods

The current cross sectional study recruited 99 outpatient children with CP referring to the Rehabilitation clinic of the children's Medical center in Tabriz, Iran. The Tabriz Children's Medical center is the largest medical center for pediatrics in Northwest Iran. The children were randomly selected over a 12-month period from June 2015 to June 2016. Patients within the age range of 3 to 12 years and confirmed diagnosis of CP were included, regardless of gender. Exclusion criteria were the history of genetic, metabolic, or neurodegenerative disease, and other medical conditions that affect growth. The study was approved by the research ethics committee of Tabriz University of Medical Sciences. Written informed consent was obtained from the parents or legal guardians of the children.

Demographic variables, CP type, anthropometric measures, and gross motor function classification system (GMFCS) were evaluated. Patients were classified as spastic, dyskinetic or extrapyramidal, cerebellar or ataxic, hypotonic or mixed type, based on the motor impairment (1).

2.1. Weight Measurement

A zero-calibrated digital scale, in kilograms, was used to measure the weight of the children without cloths. Alternatively, weight was calculated as the difference between the caregiver's weight with and without the child.

2.2. Height Measurement

A stadiometer was used to measure the height of children in centimeters in an upright or standing position and was performed on those individuals who had no major skeletal deformities (e.g., scoliosis, kyphosis, or structural deformities in lower limb flexion).

The knee height equation was used to estimate the height for those with deformities, where: $\text{height} = (2.69 \times \text{knee height}) + 24.2$ (13). The formula utilizes the height from the knee to the heel to estimate the overall height. It is the most frequently used height estimation system as it exhibits the smallest error rate relative to the exact height (14). The measured values were evaluated in the growth charts and their weight-for-age and height-for-age percentiles were calculated.

The children below the 5th percentile were categorized as malnourished cases, those between the 5th and 95th percentiles as normal weight, and those > 95th percentile as overweight (15, 16).

2.3. Calorie Intake

Dietary intake of children was determined based on the 24-hour dietary recalls of 3 nonconsecutive days (2

weekdays and 1 weekend day) by asking their parents as the most reliable reporters (17). The data were analyzed by the mean values collected from 3 questionnaires.

In all cases, the feeding route was oral. The type and amount of foodstuff consumed within a 24-hour (midnight to midnight) by the children for the day preceding the interview were recorded using the automated multiple-pass method. N4 (Nutritionist IV) software was used to compare the daily calorie intake with the recommended rates, based on height and weight (18).

2.4. GMFCS

GMFCS is a standard observational tool used to assess children with CP; it evaluates the ability to perform movements such as walking, climbing stairs, running, and sitting. According to this scale, children were stratified into 5 grades from I to V according to their gross motor skills, with lower levels representing better gross motor skills (i.e., I refers to the lightest level of impairment and V is the most severe level of impairment) (18).

2.5. Sample Size Determination

According to the results of similar studies, the current study was powered to detect an effect size of $d = 0.1$ as statistically significant in a 2-tailed test with $\alpha = 0.05$ and an expected proportion of 0.50 with $N = 90$. By the estimation of 10% dropouts in the study subjects from the last follow-up appointment, 99 children were included in the study.

2.6. Statistical Analysis

Data were analyzed with SPSS software (version 21.0, SPSS Inc., Chicago, IL, USA). Quantitative data were expressed as mean \pm standard deviation (SD), while qualitative data were reported as the frequency and percentage. Categorical variables were analyzed using the chi-square test, or the Fisher exact test, if needed. Simple logistic regression was used to explore the association between dichotomous outcomes and predictor variables. $P < 0.05$ was considered as the level of significance.

3. Results

The current descriptive study evaluated 99 outpatient children with CP, aged 2 to 13 years, from March 2014 to May 2015. Table 1 demonstrates the baseline findings in the study population. Most cases were male, with spastic and quadriplegic types of CP and GMFCS levels of II or III. More than half of the patients had normal weight and height, but two-thirds of them had an inadequate level of daily calorie intake.

Table 1. Baseline Findings of the Study Population

Variable	Category	Frequency	Percent
Age, y, mean \pm SD		7.49 \pm 2.51	
Gender	Female	44	44.4
	Male	55	55.6
Physiotherapy history	Regular	43	43.4
	None	1	1.0
	Irregular	55	55.6
Walking ability	Yes	46	46.5
	No	53	53.5
Anticonvulsant drugs usage	Yes	25	25.3
	No	74	74.7
Orthopedic surgery	Yes	6	6.1
	No	93	93.9
Palsy type	Quadriplegic	44	44.4
	Diplegic	37	37.4
	Hemiplegic	18	18.2
CP type	Mixed	7	7.1
	Dyskinetic	4	4.0
	Spastic	72	72.7
	Hypotonic	16	16.2
GMFC level			
I-II	I	7	7.1
	II	42	42.4
III-V	III	36	36.4
	IV	9	9.1
	V	5	5.1
Serum calcium level, mean \pm SD		9.82 \pm .59	
Serum 25-OH vitamin D3 level, mean \pm SD		29.23 \pm 24.20	
Weight		16.30 \pm 7.35	
	Normal (5th - 95th percentile)	52	52.5
	Abnormal (< 5th percentile)	45	45.5
Height		105.27 \pm 17.90	
	Normal (5th - 95th percentile)	57	57.6
	Abnormal (< 5th percentile)	34	34.3
	Abnormal (> 95th percentile)	8	8.1
Calorie intake		1374.65 \pm 465.69	
	Sufficient	35	35.4
	Insufficient	64	64.6
Calcium intake		703.09 \pm 359.85	
	Sufficient	43	43.4
	Insufficient	56	56.6
Protein intake		835.94 \pm 454.84	
	Sufficient	99	100.0
	Insufficient	0	0.0

There were few patients in the > 95th percentile for weight and height. In order to evaluate differences between the growth markers and related factors, patients were divided into 2 groups of normal and abnormal weight and height. To evaluate the nutritional status

of children with CP more accurately, patients were categorized based on GMFCS levels into either I-II or GMFCS III-V (Table 2). The prevalence of abnormal weight was statistically higher in children with severe forms of CP such as quadriplegic and diplegic, compared with the children with hemiplegic CP. Children with quadriplegic and diplegic CP were 7.94- and 4.25-times more likely to predispose abnormal weight than the ones with hemiplegic CP, respectively ($P = 0.003$ and $P = 0.043$).

Although there was no significant association between the CP type and weight percentile, the children with mixed CP were 10-times more likely to develop abnormal weight, compared with the ones with hypotonic CP (85.7% vs. 37.5%). The results also indicated that, by increasing GMFCS level, the rate of abnormal weight percentile significantly increased (30.6% vs. 64.0% for level I-II, compared with level IV-V, respectively; OR: 0.25, 95%CI: 0.11 - 0.57, $P = 0.001$). Increase of serum calcium levels was associated with a decreased likelihood of abnormal weight (OR 0.37, 95%CI: 0.14 - 0.94, $P = 0.036$).

Children with walking abnormalities were significantly 5.49-times more likely to predispose abnormal height. The results also demonstrated that children with mixed CP were more likely to predispose abnormal height, compared with the ones with hypotonic CP, although the relationship was not statistically significant (OR: 7.71, 95%CI: 0.75 - 79.77, $P = 0.087$).

The last section of Table 2 compares the nutritional status (calorie intake) among the categories of related factors. Although inadequate calorie intake was higher in quadriplegic and spastic types of CP and increased based on the GMFCS level, there was no significant differences in the nutritional status.

A comparison of serum 25-OH vitamin D levels and physiotherapy history with the categories of weight percentile, height percentile, and nutritional status did not show any significant differences.

4. Discussion

The current study evaluated the growth and nutritional status among 99 children with CP within the age range of 3 to 12 years, living in the Northwest Iran, and found inadequate calorie intake in 64.6% below the 5th percentile and over the 95th percentile of weight-for-age and height-for-age in 45.4%, 2%, 34.3%, and 8.1%, respectively. In the current study, most patients had low body-weight.

The results were inconsistent with those of the studies showed that lower weight was more frequent among children with CP, although obesity and overweight showed increase in such children (19-22). These differences could be due to poor or inadequate nutrition. The current study

Table 2. Factors Related to Weight Percentiles, Height Percentiles, and Nutritional Status in the Subjects with CP

Variable	Abnormal, No. (%)	P value	Odds Ratio (95% CI)
Weight			
Walking ability		0.051 ^a	
Yes	17 (37.0)		0.45 (0.20 - 1.00)
No	30 (56.6)		Reference group
Palsy type		0.006 ^a	
Quadriplegic	27 (61.4)		7.94 (1.99 - 31.57)
Diplegic	17 (45.9)		4.25 (1.05 - 17.20)
Hemiplegic	3 (16.7)		Reference group
CP type		0.091 ^b	
Mixed	6 (85.7)		10.00 (0.95 - 104.49)
Dyskinetic	3 (75.0)		5.00 (0.42 - 59.66)
Spastic	32 (44.4)		1.33 (0.44 - 4.06)
Hypotonic	6 (37.5)		Reference group
GMFC level		0.001 ^a	
I and II	15 (30.6)		0.25 (0.11 - 0.57)
III-V	32 (64.0)		Reference group
Height			
Walking ability		< 0.001 ^a	
Yes	10 (21.7)		Reference group
No	32 (60.4)		5.49 (2.25 - 13.37)
Palsy type		0.260 ^a	
Quadriplegic	22 (50.0)		2.60 (0.79 - 8.53)
Diplegic	15 (40.5)		1.77 (0.52 - 6.02)
Hemiplegic	5 (27.8)		Reference group
CP type		0.106 ^b	
Mixed	6 (85.7)		7.71 (0.75 - 79.77)
Dyskinetic	2 (50.0)		1.29 (0.14 - 11.54)
Spastic	27 (37.5)		0.77 (0.26 - 2.31)
Hypotonic	7 (43.8)		Reference group
GMFC level		0.123 ^a	
I and II	17 (34.7)		0.53 (0.24 - 1.19)
III-V	25 (50.0)		Reference group
Nutritional Status (Calorie Intake)			
Walking ability		0.340 ^a	
Yes	32 (69.6)		1.50 (0.65 - 3.46)
No	32 (60.4)		Reference group
Palsy type		0.803 ^a	
Quadriplegic	30 (68.2)		1.36 (0.44 - 4.26)
Diplegic	23 (62.2)		1.04 (0.33 - 3.32)
Hemiplegic	11 (61.1)		Reference group
CP type		0.120 ^b	
Mixed	4 (57.1)		1.33 (0.22 - 7.98)
Dyskinetic	1 (25.0)		0.33 (0.03 - 3.93)
Spastic	51 (70.8)		2.43 (0.80 - 7.32)
Hypotonic	8 (50.0)		Reference group
GMFC level		0.122 ^a	
I and II	28 (57.1)		0.52 (0.22 - 1.20)
III-V	36 (72.0)		Reference group

Abbreviations: CP, Cerebral Palsy; GMFCS, Gross Motor Function Classification System.

^aPearson chi-square test.^bExact test.

also observed that most children with CP had inadequate calorie intake. Similarly, it was reported that the calorie intake of children with CP was lower than that of the age-matched controls (23, 24).

When a child cannot take essential nutrients due to difficulty in feeding, the scarcity of foodstuff, or when the needs of the child exceeds food intake due to an increase in the metabolic rate, the malnutrition occurs. It was suggested that feeding difficulties can interfere with the calorie intake required for the energy needs of children; thereby, it probably results in a decrease of the linear growth and a serious risk of malnutrition (9, 19). Multiple etiologies such as motor disability, inadequate nutritional intake, and motor dysfunction were suggested as the factors causing malnutrition in children with CP (6-8). Inadequate nutrition may increase healthcare costs and limit functional mobility, particularly in children with severe motor impairments (21, 25, 26). Nutrition is an important factor to manage children with CP; therefore, appropriate and early nutritional support and follow-up are necessary to ensure adequate growth, improved quality of life, and optimized functional status.

Previous results indicated that children with CP were at risk of malnutrition. Studies also reported that the severity of malnutrition and growth problems differed regarding the CP type (27). Stallings et al., (28) reported that children with hemiplegia or diplegia experienced a reduced linear growth and 30% of such children were also undernourished. In another study on children with spastic quadriplegia, the researchers also noted a reduction in linear growth and body weight (29, 30). In addition, the calorie requirements were different for the various types of CP. For example, children with hypotonic and non-ambulatory CP did not require calories more than that to sustain the resting energy expenditure (31); while children with athetoid CP had an increased demand for calories (32, 33). Similarly, children with diplegic or hemiplegic CP required more calories to sustain their daily activities than the normal children (33, 34).

The current study showed that the rate of inadequate calorie intake was higher in patients with quadriplegic and spastic CP, but the difference was not significant. The need for energy showed increase in the patients with spastic CP, compared with the ones with hypotonic type; since they had a significantly higher rate of inadequate calorie intake. Patients with the quadriplegic CP, compared with diplegic and hemiplegic types, had significantly lower normal weight percentiles, but no significant difference was observed between spastic and hypotonic CP types regarding weight or height percentiles.

According to the results of the current study, with increase in the plegic limbs, the lower weight and height in-

creases; In another study, (34) also reported low values of height-to-age percentile in the individuals with tetraplegia. Other reports were also inconsistent with these findings (19, 35, 36).

Studies also showed that decreased nutritional status in children with CP was related to decreased mobility (GM-FCS) (26). Brooks et al., (16) reported that children in GMFCS levels I and II had significantly better weight than the ones in GMFCS levels III, IV, and V. Similarly, with the increased GMFCS levels, the rate of normal weight percentile significantly reduced. Although not significant, patients with GMFCS levels III, IV, and V more frequently take inadequate calories than the children with GMFCS levels I and II.

The study had some limitations; first, the large sample of patients for GMFCS II and II, which may affect the interpretation of the results regarding the GMFCS levels. The sample size was rather small; as the patients were just recruited from a tertiary care hospital. Evaluation of children with CP from different centers could increase the sample size and allow the generalization of results. It is also possible that family income affected the nutritional status of children; however, the study did not evaluate this variable in the population.

In conclusion, inadequate calorie intake and growth problems are common in children with CP and nutritional management should be arranged for undernourished children to improve their nutritional status, growth, and functional capacity.

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Footnotes

Authors' Contribution: Vahideh Toopchizadeh, study design, writing the manuscript, and contributing the research conduction and reporting; Mohammad Barzegar, protocol development; Navid Madinei, drafting the protocol and data collection; Fatemeh Jahanjoo, abstracting, analyzing, and interpreting the data, and contributing in writing and preparing the manuscript.

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