Original Article

DOI: 103126/JNPS.V4113

Relationship Between Gross Motor Function and Nutritional Status in Children with Cerebral Palsy attending a Tertiary Children's Hospital of Nepal

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Article History
Received On : Apr 28, 2021
Accepted On : Jun 05, 2022

Funding sources: None

Conflict of Interest: None

Keywords: GMFCS; stunting; under-weight; wasting

Online Access

DOI: https://doi.org/10.3126/jnps.v42i1.38130

Abstract

Introduction: Malnutrition is a common problem in children with cerebral palsy and their management outcome is not satisfactory unless we address their nutritional aspect. The present study aims to find the relationship between gross motor function and nutritional status in these children by comparing the proportion of stunting, wasting and under-weight between the various levels of gross motor function.

Methods: Our study was across- sectional study conducted on 82 cases of cerebral palsy between one to five years of age visiting Kanti Children's Hospital, Kathmandu, Nepal from May 2017 to September 2018. Their level of gross motor function was ascertained by applying the Gross Motor Function Classification System (GMFCS) and anthropometry was done using standard methods. On the basis of their motor function, the children were divided into two categories: those with poorer motor function who had poor self-mobility even with assistance (GMFCS level 4 and 5) and those with better motor function who had self-mobility with various degrees of assistance (GMFCS level 1, 2 and 3). Wasting, stunting and under-weight were compared between the two categories and odds ratio with 95% confidence interval was estimated for malnutrition.

Results: The children belonging to poorer motor function were more likely to be underweight (Odds ratio 3.41; CI 1.36-8.52; p-value 0.008) and stunted (Odds ratio 3.9; CI 1.47-10.53; p-value 0.048) than those with better motor function.

Conclusions: Children with poorer motor function are more likely to develop malnutrition (Specially stunting) than those with better motor function indicating that chronic form of malnutrition is more common in these children.

Introduction

Disorders of growth and nutrition are common in children with cerebral palsy (CP). These nutritional deficiencies can add losses to motor and cognitive development, socialization and increased need for hospitalization.[1] Etiology of malnutrition in children with CP is multi-factorial, including both nutritional and non-nutritional factors. The main factor responsible is inadequate dietary intake as a consequence of gastrointestinal disorders including oral motor dysfunction, gastro- esophageal reflux and constipation; along with negative neurotropic effects and endocrine abnormalities.[2,3]

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The effects of poor nutrition negatively impacts on their quality of life and the effects on their health are devastating during early stages of development leading to compromised immunity, cognitive problems, increased severity of gastro-esophageal reflux and stunted growth.[4-7] In high-income countries, growth and nutrition disorders are seen in one- third of the pediatric CP patients.[8] This figure can be even worse in developing countries like ours. Despite extensive research in this area, studies evaluating nutrition related problems in children with CP have mainly been done in developed countries and there is scarcity of such studies in developing countries including Nepal.

Different standards have been used in past studies leading to diverse findings and interpretations, thus making it difficult to compare data across different studies. The development of the 2006 World Health Organization (WHO) child growth standards and the WHO Reference 2007 growth charts has provided gold standards for assessing and monitoring the growth of children and adolescents making it possible to compare data between different age groups. A recent study on children with cerebral palsy has confirmed that use of the WHO standard deviation scores (Z-scores) provides accurate parameters for assessing malnutrition in patients with Cerebral Palsy.[9]

Nutritional support is an essential part of the care of children with CP who have extremely complex and challenging needs. The relationship between nutritional status and gross motor function if proven can be a good help to detect malnutrition in all children with CP at the earliest level of motor dysfunction by routine nutritional assessment. It allows for timely nutritional intervention by a multidisciplinary team leading to restoration of normal growth and development, decrease in spasticity, improvement in wound healing, reduction in frequency of hospitalization and increase in social activities, hence improving overall health and quality of life. The objective of present study was to find the relationship between gross motor function and nutritional status in children with CP by comparing the weight - for - age, height - for - age and weight - for - height z-scores between the levels of gross motor function.

Methods

Our study was a hospital based cross- sectional study conducted in Kanti Children's Hospital, Maharajgunj, Kathmandu, Nepal over a period of 18 months from May 2017 to September 2018 in children with CP from one to five years of age attending the Department of Neurology within the study period. In this study, we have mainly focused on the children with CP between one to five years of age as this was the commonest age group visiting our neurology OPD and also the most vulnerable ones. Among 98 children of above age group with CP, total 82 children were enrolled in the study after excluding two with dysmorphic features, three with chromosomal abnormalities and one with neurodegenerative disorder that might affect their growth other than CP. Similarly, ten children whose parents did not accept to participate in the study were also excluded.

A comprehensive history with a thorough physical examination was performed to determine gross motor function by applying the Gross Motor Function Classification System (GMFCS) based on which the children were allocated to five different levels of motor function starting from level 1 (Best motor function) to level 5 (Worst motor function).[10] Next, anthropometry of all the selected cases was done. Height was measured to the nearest 0.5 cm by using a wall- mounted stadiometer by UNICEF for children above two years of age, and length was measured by using standardized infantometer for children below two years of age. For those children who had difficulty standing fully erect, knee height was measured and was used to predict height by using equation that was developed for children with CP {Height in cm = (2.69 × Knee Height) + 24.2 ±1.1}.[11]

Body weight was measured with the child unclothed using standardized portable electronic scale named SECA, Model No. 8741021659 with d = 0.1 kg manufactured in Hamburg, Germany. For children below two years, electronic scale named Kinlee, EBSA-20 with d = 5 gm and maximum capacity 20 kg was used. In children with difficulty in measuring weight alone, it was calculated by measuring the difference in the weight of the guardian with and without child. All anthropometric measures were conducted twice, and their average was used in the analyses.

Nutritional status and growth parameters were evaluated according to the WHO sex- specific weight- for- age, height - for - age, and weight - for - height growth charts using the ANTHRO and ANTHRO - PLUS software packages and prevalence of malnutrition was calculated in each level of GMFCS.[12,13] Malnutrition was defined according to WHO as moderate if the nutritional status and growth parameters fell below - 2 Z score and severe if they fell below - 3 Z score. Similarly, the cut-off point of > + 2 SD classified high weight- for- age and weight - for - height as overweight.[12,13] On the basis of their motor function, the children were divided into further two categories. Those with poorer motor function who had poor self- mobility even with assistance (GMFCS level 4 and 5) and those with better motor function who had self-mobility with various degrees of assistance (GMFCS level 1, 2 and 3).[14]

Data entry and analysis was done using SPSS version 20. All the continuous variables were presented as means and standard deviations. The dependent variables of weight for-age, height-for-age and weight - for - height were compared between these two categories and odds ratio with confidence interval 95% was estimated for malnutrition in these categories on the basis of above variables using Fisher's Exact Test. A p value of < 0.05 was considered indicative of statistical significance.

Results:

Among the 82 cases, 54 (65.9%) were male and the mean age of the children enrolled was 2.45 years ± 1.2 years. Most of the children presented with spastic quadriplegia (n = 28, 34.1%) followed by spastic diplegia (n = 16, 19.5%) and spastic hemiplegia (n = 12, 14.6%).

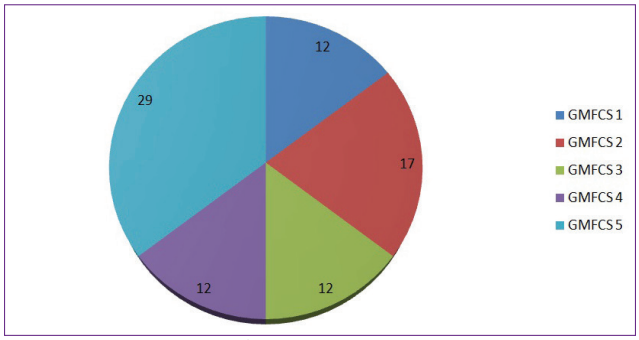

Figure 1. Distribution of children according to GMFCS levels

When the children under study were divided into various levels of motor function using GMFCS from level 1 to 5, 12 children (14.6%) fell under level 1, 3 and 4 each while 17 (20.7%) under level 2 and 29 (35.4%) under level 5.

On the basis of weight for age (WFA), malnutrition (under-weight) was found in 43.9% of the cases. Moderate malnutrition was found highest in level 3 and 4 of GMFCS (25% each), and severe malnutrition was found highest in level 4 (41.7%).

Table 1. Distribution of children on the basis of weight for age and GMFCS.

Weight for Age (WFA) Z-score	GMFCS Class					Total n (%)	p-value
	1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)		
1 to 2 z-score	n (%)	2	0	0	1	2	
	n (%)	3	(0.0%)	(0.0%)	(3.4%)	(2.4%)	
0 to 1 z-score	n (%)	4	0	1	1	7	
	n (%)	5	(0.0%)	(8.3%)	(3.4%)	(8.5%)	
-1 to 0 z-score	n (%)	2	3	0	3	11	
	(25.0%)	(11.8%)	(25.0%)	(0.0%)	(10.3%)	(13.4%)	
-1 to -2 z-score	6	6	3	3	8	26	0.252
	(50.0%)	(35.3%)	(25.0%)	(25.0%)	(27.6%)	(31.7%)	
-2 to -3 z-score	2	3	3	3	5	16	
	(16.7%)	(17.6%)	(25.0%)	(25.0%)	(17.2%)	(19.5%)	
<-3 z-score	0	1	3	5	11	20	
		(5.9%)	(25.0%)	(41.7%)	(37.9%)	(24.4%)	
Total n (%)	12	17	12	12	29	82	
	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	

On the basis of length / height for age, stunting was found in 65.9% of the cases. Moderate stunting was found highest in children of level 3 GMFCS (n = 5, 27.8%) while severe stunting was found highest in children of level 5 of GMFCS (n = 19, 52.8%).

Table 2. Distribution of children on the basis of length / height for age and GMFCS.

Length/ Height for Age (LFA/HFA) Z-score	GMFCS Class					Total n (%)	p-value
	1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)		
1 to 2 z-score	0	0	0	0	1	1	
	(0.0%)	(0.0%)	(0.0%)	(0.0%)	(3.4%)	(1.2%)	
0 to 1 z-score	2	0	0	0	0	2	
	(16.7%)	(0.0%)	(0.0%)	(0.0%)	(0.0%)	(2.4%)	
- 1 to 0 z-score	2	6	1	1	4	14	
	(16.7%)	(35.3%)	(8.3%)	(8.3%)	(13.8%)	(17.1%)	
- 1 to - 2 z-score	5	1	3	0	2	11	0.001
	(41.7%)	(5.9%)	(25.0%)	(0.0%)	(6.9%)	(13.4%)	

-2 to - 3 z-score	3 (25.0%)	4 (23.5%)	5 (41.7%)	3 (25.0%)	3 (10.3%)	18 (22.0%)
< - 3 z-score	0 (0.0%)	6 (35.3%)	3 (25.0%)	8 (66.7%)	19 (65.5%)	36 (43.9%)
Total n (%)	12 (100%)	17 (100%)	12 (100%)	12 (100%)	29 (100%)	82

Similarly, on the basis of weight for length / height, wasting was found in 12 cases (14.7%). Among them, moderate wasting was found in nine cases (11%), most of them in level 5 and severe wasting in only three cases (3.7%), among which two were in level 3 and one in level 5. Obesity was found in total six cases (7.3%) most of which belonged to level 2 (11.8%) followed by level 5 (10.3%).

Table 3. Distribution of children on the basis of weight for length / height and GMFCS.

Weight for Length / Height (WFL/WFH) Z-scores	GMFCS Class					Total n (%)	p-Value
	1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)		
> 2 z –score	0 (0.0%)	2 (11.8%)	1 (8.3%)	0 (0.0%)	3 (10.3%)	6 (7.3%)	
1 to 2 z-score	1 (8.3%)	4 (23.5%)	1 (8.3%)	0 (0.0%)	4 (13.8%)	10 (12.2%)	
0 to 1 z-score	1 (8.3%)	5 (29.4%)	0 (0.0%)	2 (16.7%)	3 (10.3%)	11 (13.4%)	0.350
-1 to 0 z-score	4 (33.3%)	2 (11.8%)	3 (25.0%)	4 (33.3%)	5 (17.2%)	18 (22.0%)	
-1 to - 2 z-score	5 (41.7%)	4 (23.5%)	3 (25.0%)	5 (41.7%)	8 (27.6%)	25 (30.5%)	
-2 to -3 z-score	1 (8.3%)	0 (0.0%)	2 (16.7%)	1 (8.3%)	5 (17.2%)	9 (11.0%)	
<-3 z-score	0 (0.0%)	0 (0.0%)	2 (16.7%)	0 (0.0%)	1 (3.4%)	3 (3.7%)	
Total n (%)	12 (100%)	17 (100%)	12 (100%)	12 (100%)	29 (100%)	82 (100%)	

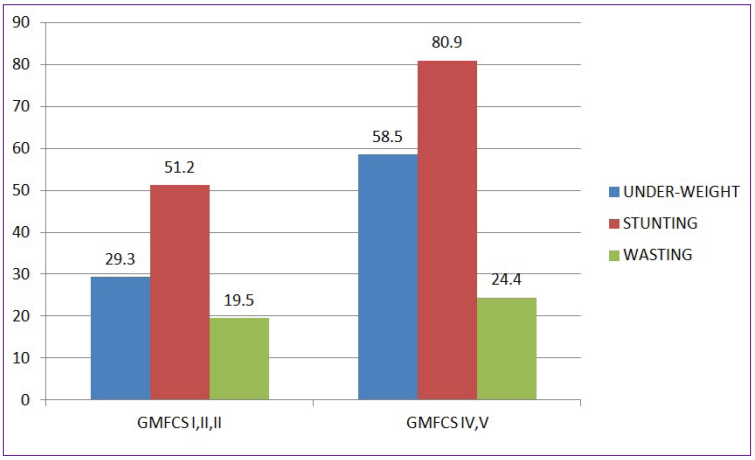

Figure 2. Bar diagram depicting the frequency (percentage) of malnutrition according to various parameters in two GMFCS groups of children.

As stated earlier, the children were further divided into two groups on the basis of their motor function, with each group comprising of 41 children each. On the basis of weight for age, the children belonging to poorer motor function (GMFCS level 4 and 5) were 3.4 times more likely to be underweight than those with better motor function (GMFCS level 1, 2 and 3).

Table 4. Malnutrition on the basis of weight for age in two groups of children

GMFCS Class	Malnutrition on the basis of Weight for Age (WFA)		Total n (%)	p-Value	Odds Ratio (95% CI)
	Yes n (%)	No n (%)			
Poor Motor Function (IV, V)	24 (58.5%)	17 (41.5%)	41 (100%)	0.008	3.41 (1.36 - 8.52)
Better Motor Function (I, II, III)	12 (29.3%)	29 (70.7%)	41 (100%)		
Total n (%)	36 (43.9%)	46 (56.1%)	82 (100%)		

Similarly, children with poorer motor function (GMFCS level 4 and 5) were 3.9 times more likely to develop stunting than those with better motor function (GMFCS level 1, 2 and 3).

Table 5. Stunting on the basis of length / height for age in two groups of children

GMFCS Class	Stunting		Total n (%)	p-Value	Odds Ratio (95% CI)
	Yes n(%)	No n (%)			
Poor Motor Function (IV, V)	33 (80.5%)	8 (19.5%)	41 (100%)	0.048	3.9 (1.47 - 10.53)
Better Motor Function (I, II, III)	21 (51.2%)	20 (48.8%)	41 (100%)		
Total n (%)	54 (65.9%)	28 (34.1%)	82 (100%)		

However, in case of wasting, the odds ratio was 1.33; CI 0.46-3.8 (p-value 0.594).

Table 6. Wasting on the basis of weight for length / height in two groups of children

GMFCS Class	Wasting		Total n (%)	p-Value	Odds Ratio (95% CI)
	Yes n (%)	No n (%)			
Poor Motor Function (IV, V)	10 (24.4%)	31 (75.6%)	41 (100%)	0.594	1.33 (0.46-3.8)
Better Motor Function (I, II, III)	8 (19.5%)	33 (80.5%)	41 (100%)		
Total n (%)	18 (22.0%)	64 (78.0%)	82 (100)%		

Discussion

In our study, 58.5% of children with poorer motor function were under-weight, so were 29.3% of those with better motor function with odds ratio of 3.412 (95% CI 1.36-8.52; p-value 0.008). In 2012, Dahlseng MO[16] published a study conducted in Norway where 20% of patients with severe motor dysfunction were malnourished, which was lower than in our patients. But a study conducted by Melunovic M et al[17] in 2017 showed the results similar to our study as follows:

Malnutrition in	Our study	Melunovic M et al [17]
Better motor function	29.3%	26.5%
Poorer motor function	58.5%	63%

Similarly, 80.5% of those with poorer motor function were stunted as compared to 51.2% of those with better motor function with greater odds ratio of 3.929 (95% CI 1.47-10.53, p-value 0.048). In a study done in Colombia by Herrera-Anaya E et al,[14] 66.4% of children with CP were stunted which was similar to our findings. However, the odds ratio of being underweight and stunted among those with poorer motor function was lower in our study as shown below:

Wasting was found in 24.4% of children with poorer motor function as compared to 19.5% with better motor function with odds ratio of 1.33; 95% CI 0.46-3.8 which was not statistically significant (p-value 0.594).

As showed by above results, stunting was found more in the children than wasting which is a marker of chronic malnourishment and subsequent growth retardation. Despite stunting being

multi-factorial in its etiology, it reflects inadequate nutrition in relation to the body's needs over a long period, and more severe the level of motor dysfunction more is the degree of stunting. Wasting, measured by weight for height, reflects a recent episode of weight loss, often due to an acute stress factor, including illness.

An interesting finding was that of obesity which was found in total six cases (7.3%) most of which belonged to most severe level of motor dysfunction. Rogozinski et al[18] in 2007 reported an increase of 8.8% in the prevalence of obesity among ambulatory children with CP from 1994 –1997 to 2003 – 2004 in the US. This double burden of obesity might be explained by similar factors as those observed in children with no disabilities, including urbanization, which creates barriers for physical activity, and the nutritional transition related to the growing adoption of processed foods and increased sugar consumption.

Conclusions

It can be concluded from our study that gross motor function and nutritional status in children with CP are interrelated, and those with poorer motor function are more likely to develop malnutrition than those with better motor function. Most of the nutritional parameters especially stunting showed decreasing trend with increasing motor dysfunction indicating that chronic form of malnutrition is more common in these children. Another important finding of our study was the presence of double burden of obesity mostly in those with poorer motor function. So, routine nutritional assessment and management should be integral while attending such cases to lessen the burden of malnutrition among them.

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