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Association of Functional Ability with Nutritional Status Among Children with Cerebral Palsy

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Abstract: Cerebral palsy (CP) is the most common physical disability in childhood. Children with CP are particularly vulnerable to malnutrition. There is a paucity of studies among these individuals to find the association between functional ability with nutritional status. In this study our objective was to find out the association between functional ability (functional level measured by four functional classification systems) and nutritional status in children with cerebral palsy (CP) attending in a tertiary care hospital in Bangladesh. We performed a cross-sectional study on 127 children (aged 18 months to 12 years) with a diagnosis of CP who were attending outpatient and inpatient department of National Institute of Neurosciences & Hospital, Dhaka, Bangladesh (January 2020–December 2020). Functional ability was assessed by standard CP classification systems (GMFCS, MACS, CFCS, EDACS, Level I through level V). Nutritional status was evaluated and classified according to the WHO growth charts. To find out the association, Spearmann-rho correlation analysis were applied. Sixty five patients (51%) were found underweight, 86 (67.7%) were stunted and 40 (31.5%) were wasted. Among them, severe underweight, severe stunting and severe wasting were found in 21.3%, 41.7% and 11.8% cases respectively. Severe thinness measured by BMI was found in 81.1% cases. Forty one percent (41.1%), 40.2%, 11%, 7.9% patients were functionally leveled as severe in GMFCS, MACS, CFCS and EDACS, although CFCS and EDACS were not applicable for all ages (36.2%, 37.8%). A significant negative association was found between weight for height, weight for age, BMI and functional level measured by GMFCS, MACS, CFCS and EDACS (P value <0.05 to<0.001) but no significant negative association was found between height for age and functional level measured by GMFCS, MACS. Stunting and wasting are more common among pediatric patients with CP. In our study stunting was more prevalent. We found significant negative association between functional level and nutritional status as measured by scales applied in this study.

Keywords: Cerebral Palsy, Nutritional Status, Functional Ability

1. Introduction

Cerebral palsy (CP) is one of the common physical disabilities in childhood [1]. Cerebral palsy is defined as non progressive and changing disorders of movement and posture. Problems in brain function that occurred during fetal brain development or within the first two to three years of life are the causes of these movement disorders [2, 3]. It can result in spasticity, dystonia, muscle contractures, weakness and difficulty in coordination that ultimately affects the ability to control movements [4].

The occurrence of cerebral palsy is approximately 2.11 per 1000 live births [5]. Globally, there is an estimated 17 million people living with CP [6]. Prevalence of cerebral palsy (CP) is 3.4 per 1000 children in rural Bangladesh. There are an estimated 2, 33, 514 children with CP in Bangladesh [7, 8].

CP can be classified in various ways. Traditionally, CP

has been classified using a combination of the motor type and the topographical distribution, as well as subjective severity level. Motor types include terms like spastic, ataxic, dyskinetic or mixed. The topographic classifications include the limbs that are affected, namely diplegia (or diparesis), triplegia, tetraplegia, quadriplegia or hemiplegia. CP severity is classified subjectively in terms of mild, moderate or severe [1, 9].

Topographic and anatomic classifications do not tell us what the child's current functional level is. More recently, a simple ordinal grading system of functional performance have been employed. These systems allow a more precise discussion between providers, as well as better subject stratification for research. CP is classified by four common functional systems: the Gross Motor Function Classification System (GMFCS), the Manual Ability Classification System (MACS), the Communication Function Classification System (CFCS), and the Eating and Drinking Ability Classification System (EDACS). All these measures are standardized, reliable and complementary to one another [10].

Clinicians, academicians and researchers have created classification systems using a simple ordinal grading system of functional capacity over the last twenty years. These classification systems use a common language to describe child's function. They do not describe potential improvements or assess underlying etiology. Classification system provides a framework for a common language to better describe and communicate about the vastly heterogeneous functional abilities of individuals with CP. For quick and accurate transmission of information from one care provider to the next or from care provider to caregiver, such common language is very important. Descriptions of patients are more accurate and meaningful under the above mentioned functional systems compared to traditional topographic descriptions. These classifications can change the quality of care for children with cerebral palsy [10-17].

Growth pattern in children with cerebral palsy (CP) differs significantly from children without CP [18, 19]. Children with CP have the linear growth, weight, muscle mass, fat stores and bone mass density below average as compared to the children without CP. Besides under nutrition, overweight and obesity have also been reported among these children. [19] Growth of these children is very slow throughout their lives. They have significantly lower mean height, weight, skin fold thickness and mid upper arm circumference (MUAC) as compared to general population [18, 19].

Children with CP are particularly vulnerable to malnutrition. Reasons for this include physiological factors such as dysregulation of growth hormone secretion, serum leptin level and extra energy expenditure due to muscle spasticity. Feeding difficulties, including oral-motor impairments affecting chewing, food ingestion, gastro-oesophageal reflux disorder and lack of self feeding skills and nutrient loss are common and often severe. These difficulties may negatively impact the responsiveness of caregiver feeding practices, further reducing nutritional intake [19-24].

Socioeconomic factors also play an important role in nutritional status [25].

Recently, Khondoker et al, conducted an epidemiological survey in Shahajadpur but they did not address any association between functional abilities with nutritional status of children with cerebral palsy [7].

Present study focuses on finding out any association between four functional abilities with nutritional status of children with cerebral palsy in specialized hospital of Bangladesh.

2. Methods

This is a cross-sectional study on 127 children (aged 18 months to 12 years) with a diagnosis of CP who were attending outpatient and inpatient department of National Institute of Neurosciences & Hospital, Dhaka, Bangladesh (January 2020–December 2020) with the objective of finding the association of functional ability with nutritional status in children with cerebral palsy. Functional ability was assessed by standard CP classification systems (GMFCS, MACS, CFCS, EDACS, Level I through level V). Nutritional status was evaluated and classified according to the WHO growth charts. To find out the association, Spearmann-rho correlation analysis were done.

2.1. Selection of Cases

2.1.1. Inclusion Criteria

1) Patient of cerebral palsy diagnosed by history and clinical examination with fulfillment of all three following criteria:
   i. Presence of disorder of posture and movement as manifested by disturbances in the motor function, any movement disorder or imbalance.
   ii. Signs of pyramidal, extra pyramidal or cerebellar sign correlating with above clinical features.
   iii. Developmental milestones are static or improving over time.
2) Age between 18 month to 12 years.

2.1.2. Exclusion Criteria

CP mimics excluded clinically, especially.

i. Nonspecific motor delay.
ii. Diagnosed cases of NMD.
iii. Diagnosed case of neurodegenerative disorder.

2.2. Statistical Analysis

Data were collected using a pre-designed data collection sheet.

All the data were collected and recorded systematically in a questionnaire and analyzed by using SPSS (version 22.0) and all the qualitative data were presented in terms of proportion or percentage at 95% CI (confidence interval). A value of $p < 0.05$ was considered statistically significant for all tests.

Z score for three standard indices was used to measure the overall nutritional status of children with CP. These includes:

(i) Weight for Age Z score to measure overall nutritional status.
(ii) Height for Age Z score to measure chronic malnutrition.
(iii) Weight for Height Z score to measure acute malnutrition.

Z scores were calculated using WHO growth charts. Further descriptive analysis (mean, median, proportion) was done by SPSS Statistics software version 22 (IBM Corporation, Chicago, IL). To find out the association Spearmann-rho correlation analysis was done.

2.3. Ethical Aspect

Oral and written informed consent was obtained from all families prior to initiation of the study. This study was approved by ethical committee of National Institute of Neurosciences and Hospital (NINS&H).

2.4. Research Instruments

A pre-tested questionnaire (Appendix I).

2.5. Study Procedures

In outpatient and inpatient department of NINS, diagnosed cases of cerebral palsy was selected as per inclusion and exclusion criteria. Informed written consent (both Bengali and English) were obtained from parents or attendants after full explanation of the details of the research process. Anthropometric measurements (weight in kilogram and height in centimeter, MUAC in centimeter) were measured by using Tanita weighing scale, Knee height caliper and Sakir's tape. All measurements were obtained twice, and the average was used for analysis. Weight was recorded to the nearest 0.1 kg on a digital scale, with the child dressed in a thin set of clothes and without hats or shoes. If the child was unable to stand independently, we weighed the child with a caregiver. The child's weight was determined by subtracting the weight of the caregiver from the combined weight. Knee height (in centimeter) was measured in all children, because some children with cerebral palsy could not stand properly due to severe physical impairments.

Estimated height (EH) was determined by using the knee height equation, EH= [(2.69Xknee height) + 24.2]. Z score for three standard indices was used to measure the overall nutritional status of children with CP. These included –

(i) Weight for Age Z score to measure overall nutritional status.
(ii) Height for Age Z score to measure chronic malnutrition.
(iii) Weight for Height Z score to measure acute malnutrition.

Z scores were calculated using WHO growth charts. The calculated Z scores for each of the indices were classified into three categories based on WHO cutoff points (over nutrition: >+2SD, normal: <+2SD to >-2SD; moderate under nutrition: <-2SD to >-3SD and severe under nutrition: <-3SD) to measure the severity of malnutrition among children. Body mass index was measured by using BMI calculator. The BMI was graded as normal weight (between the 18.5 and <25 cut offs) and overweight (25 to <30) and obesity (≥30) as +1 and +2 respectively, while thinness grades 1 (mild), 2 (moderate), and 3 (severe) were coded as −1 (17 to <18.5), −2 (16 to <17), and −3 (<16).

This study was a cross sectional observational study. All study participants were diagnosed by history and clinical examination. Topographic classification was done and assessed the nutritional status, GMFCS, MACS, Mini-MACS, CFCS and EDACS level (Appendix II).

Finding of observation was recorded in a prescribed data collection form.

Collected data was compiled and subjected to statistical analysis with the help of SPSS software (version 22).

3. Results

The objective of this study is to investigate the association between nutritional and functional status of children with cerebral palsy. We focus mainly on the nature of relationship between growth parameters (weight, height, weight for age, weight for height, height for age, OFC, BMI, MUAC) and functional parameters of children with cerebral palsy (GMFCS, MACS, CFCS, EDACS) in Bangladesh. Estimated results will be presented in this chapter in 2 parts in light of the methodology presented in the previous chapter.

Part 1 presents descriptive statistics of demographic characteristics, topographic and functional classification of cerebral palsy, associated comorbidities, prenatal and postnatal risk factors predisposing CP.

Part 2 deals with statistical tests, like Spearmann correlation test and their graphical representation.

Table 1. *Baseline characteristics of the children with CP (n=127).*

Characteristics	Number of patients	Percentage (%)
Sex		
Male	74	58.3
Female	53	41.7
Age bands (years)		
<2	33	26
2-<4	52	40
4-<6	25	19.7
6-12	17	13.4
Socioeconomic status (Taka)		
<10000		
10000-30000	31	24.4
>30000	80	63
	16	12.6
Mother's education		
Illiterate	6	4.8
Below SSC	66	52.4
SSC	26	20.6
HSC	11	8.7
Graduate	17	13.5
Father's education		
Illiterate	6	4.7
Below SSC	65	51.2
SSC	14	11
HSC	20	15.7
Graduate	22	17.3
Mother's occupation		
House wife	120	94.5

Characteristics	Number of patients	Percentage (%)
Employed	7	5.5
Father's occupation		
No service	17	13.4
Employed	110	86.6

Table 1 shows the baseline characteristics of children with CP. The study enrolled 127 patients, among them 74 patients (58.3%) were male and 53 patients (41.7%) were female. Children aged between 18 months to 12 years were included. Fifty two patients (40%) were in the age range between 2 to <4 years.

Socio economic status is represented on the basis of parent's monthly income, mother's and father's level of education. Most of the patients (63%) belonged to middle class, 24.4% were from lower socioeconomic background.

Mother's educational level consisted of illiterate (4.8%), below SSC (52.4%), SSC (20.6%), HSC (15.7%) and graduate (17.3%). So more than 77% patients mother's educational level were SSC or below.

Father's educational level consisted of illiterate (4.7%), below SSC (51.2%), SSC (11%), HSC (8.7%) and graduate (13.5%). So more than two third (67%) of the patients father's educational level were SSC or below. It is obvious that father of the patient's are relatively higher educated compared to mother.

Last part of the table shows the occupation of parent's of the patients. While 86.6% patient's father were employed (in services, agriculture or businesses), only 5.5% patient's mother were employed (in services, agriculture or businesses). So unemployment rate is much higher among mother (94.5%) compared to father (13.4%) of the patients.

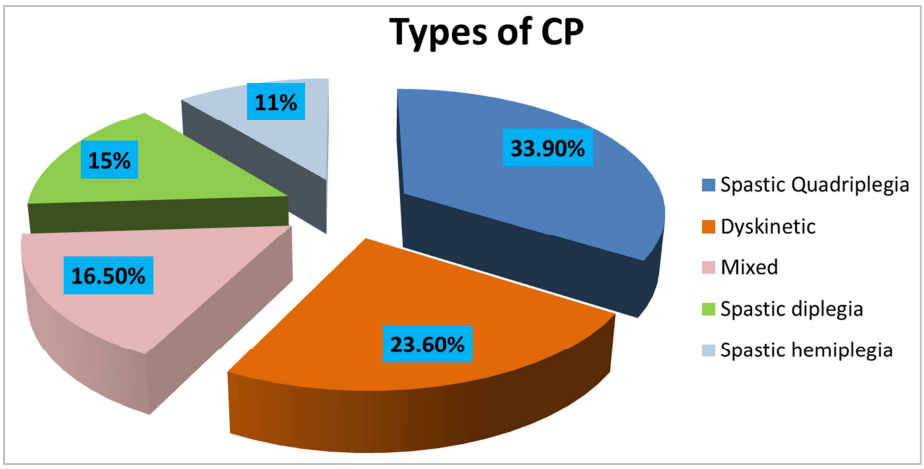

Figure 1. *Pie chart showing types of CP (n-127).*

Figure 1 depict the distribution of the study patients by types of CP. It was observed that 43 patients (33.9%) were spastic quadriplegic, 30 (23.6%) were dyskinetic and 21 (16.5%) mixed type, 19 (15%) spastic diplegic, 14 (11%) spastic hemiplegic.

Table 2. *Comorbidities of the patients with CP (n-119).*

Comorbidities	Number of patients	Percentage (%)
Cognitive delay	116	97.47
Speech problems	113	94.95
Feeding problems	94	78.91
Epilepsy	71	59.9
GI problems	57	47.89
Behavioural problems	28	23.52
Vision impairments	24	20.16
Respiratory problems	24	20.16
Hearing impairments	5	4.20
Sleep problems	5	4.20

Table 2 shows comorbidities of CP. Out of 127 patients, 119 (93.7%) were suffering from comorbidities. Nature of comorbidities included: cognitive delay in 116 (97.47%), speech problems in 113 (94.95%), feeding problem in 94 (78.91%), epilepsy in 71 (59.9%), visual impairments in 24 (20.16%), hearing impairments in 5 (4.2%) patients. Gastrointestinal, behavioural, respiratory and sleep problems were found in 47.89%, 23.52%, 20.16% and 4.20% patients respectively.

Table 3. *Classification of CP by functional level (n-127).*

Characteristics	Number of patients	Percentage (%)
GMFCS		
Level I	19	15
Level II	2	2.4
Level III	15	11.8
Level IV	37	29.1
Level V	53	41.7
MACS		
Level I	18	14.2
Level II	11	8.7
Level III	21	16.5
Level IV	26	20.5
Level V	51	40.2
CFCS		
Level I	26	20.5
Level II	5	3.9
Level III	18	14.2
Level IV	18	14.2
Level V	14	11
Not applicable for age	46	36.2
EDACS		
Level I	22	17.3
Level II	10	7.9

Characteristics	Number of patients	Percentage (%)
Level III	22	17.3
Level IV	15	11.8
Level V	10	7.9
Not applicable for age	48	37.8

Table 3 presents statistics on functional parameters of the patients. As per GMFCS, 53 patients (41.7%) were found at level V, 37 (29.1%) at level IV, 15 (11.8%) at level III, 2 (2.4%) at level II, and 19 (15%) at level I. As per MACS, 51 patients (40.2%) were found at level V, 26 (20.5%) at level IV, 21 (16.5%) at level III, 11 (8.7%) at level II and 18 (14.2%) at level I. Forty six patients (36.2%) were not classified by CFCS level, as CFCS is not applicable below 3 years of age. Forty eight patients (37.8%) were not classified by EDACS level, as EDACS is not applicable below 4 years of age.

Table 4. *Distribution of patients by prenatal events, gestational age, place of delivery, mode of delivery and post natal complications (n-127).*

Characteristics	No of patients	Percentage (%)
Prenatal events		
None	109	85.8
HTN	11	8.7
DM	2	1.6
Fever with rash	2	1.6
others	3	2.4
Gestational age		
Term	108	85
Preterm	19	15
Place of delivery		
Home	81	63.8
Government hospital	41	32.3
Clinic	5	3.9
Mode of delivery		
NVD	99	78
C/S	28	22
Birth weight		
NBW	97	76.4
LBW	21	16.5
VLBW	9	7.1
09 Complication during delivery		
Prolonged labour	22	17.3
Obstructed labour	9	7.1
PNA		
Present	74	58.3
Absent	53	41.7
Post natal complication		
Uneventful	18	14.2
Seizure	65	51.2
Neonatal hyperbilirubinemia	14	11.1
Sepsis	8	6.3
Others	22	17.2

Table 4 shows distribution of patients by prenatal events, gestational age, places of delivery, mode of delivery, complication of delivery, PNA and post natal complications.

More than three fourth (85.8%) patient's mother had no history of prenatal events, 11 patient's mother (8.7%) had hypertension, 7 (5.6%) had DM, fever with rash and other types of prenatal events. Most of the patients, 81 (63.8%) were delivered at home by normal vaginal delivery. According to gestational age, 108 patients (85%) were term and the rest were pre term. Prolonged labour was found in 17.3% cases. PNA (as evidenced by history of delayed cry) was present in 74 (58.3%) cases. Neonatal seizure, neonatal hyperbilirubinaemia and neonatal sepsis were found in 51.2%, 11.1% and 6.3% cases respectively.

Table 5. *Nutritional status of CP patients (n-127).*

Characteristics	Number of patients	Percentage (%)
Weight for age (Under nutrition)		
Normal	62	48.8
Moderate	38	29.9
Severe	27	21.3
Height for age (Stunting)		
Normal	41	32.3
Moderate	33	26
Severe	53	41.7
Weight for height (Wasting)		
Normal	87	68.5
Moderate	25	19.7
Severe	15	11.8
BMI		
Normal	4	3.1
Mild	10	7.9
Moderate	10	7.9
Severe	103	81.1

Table 5 shows nutritional status of the patients measured by weight for age, height for age, weight for height and BMI. This table shows 29.9% patients were moderately underweight, 21.3% were severely underweight with a total of 51.2% underweight. Moderate stunting was found in 26% and severe stunting in 41.7% patients with a total of 67.7% stunted. Moderate wasting were found in 19.7%, severe wasting in 11.8% patients with a total of 31.5% wasted. Among them, severe under weight, severe stunting and severe wasting were found in 21.3%, 41.7% and 11.8% cases respectively. Severe thinness measured by BMI was found in 81.1% of the cases.

Figure 2 reveals seventy one patients (55.9%) were suffering from epilepsy. Types of epilepsy were: Focal epilepsy in 45 patients (63.38%), GTCS in 11 (15.49%), IS (Infantile spasm) in 8 (11.26%), myoclonic in 3 (4.23%) multiple seizure type in 2 (2.82%) and unclassified in 2 (2.82%).

Table 6. *Correlation between nutritional and functional status among the study cases (N-127).*

	Spearman's rho	*P value
Height for age (stunting) Vs GMFCS	-0.012	0.892
Weight for Height (wasting) Vs GMFCS	-0.278	0.002
Weight for age Vs GMFCS	-0.228	0.010
BMI Vs GMFCS	-0.205	0.021
Height for age (stunting) Vs MACS	0.052	0.564
Weight for Height (wasting) Vs MACS	-0.304	0.001
Weight for age Vs MACS	-0.212	0.017
BMI Vs MACS	-0.136	0.127
Height for age (stunting) Vs CFCS	0.000	0.998
Weight for Height (wasting) Vs CFCS	-0.268	0.002
Weight for age Vs CFCS	-0.070	0.436
BMI Vs CFCS	-0.050	0.578
Height for age (stunting) Vs EDACS	0.002	0.880
Weight for Height (wasting) Vs EDACS	-0.255	0.004
Weight for age Vs EDACS	-0.071	0.426
BMI Vs EDACS	-0.051	0.579

* Spearman's rho correlation tests.

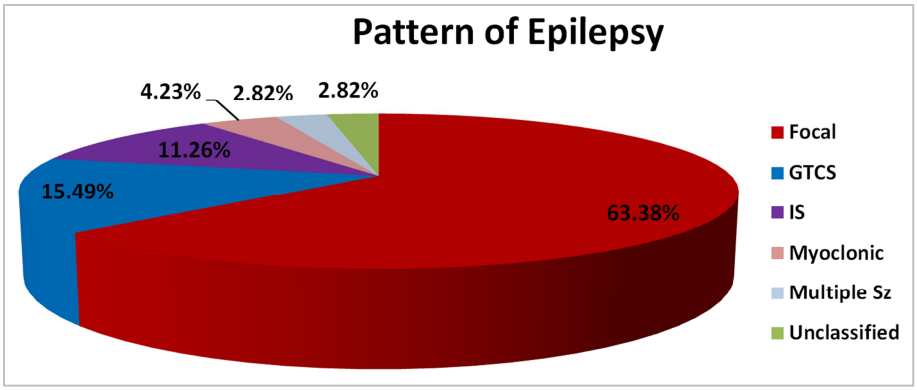

Figure 2. *Showing the distribution of the study patients by types of epilepsy (N-71).*

Table 6 shows a series of correlation tests using Spearman rank analysis. A significant negative association was found between weight for height, weight for age, BMI and GMFCS level (r=-0.278, p= 0.002; r= -0.228, p= 0.010; r= - 0.205, p = 0.021) but no association was found between height for age and GMFCS level.

A significant negative association was found between weight for height, weight for age, and MACS level (r=-0.304, p= 0.001; r= -0.212, p= 0.017) but no association was found between height for age and MACS level and between BMI and MACS level.

Significant negative association was found between weight for height and CFCS level and between weight for height and EDACS level (r =-0.268, p = 0.002; r= -0.255, p = 0.004).

4. Discussion

This study was conducted on 127 children with CP in National Institute of Neurosciences& Hospital, Dhaka, Bangladesh. It observed an association between nutritional status and functional classification system of CP. Nutritional status was evaluated by weight, height, OFC, MUAC, weight for age, height for age, weight for height and functional level was evaluated by the GMFCS, MACS, CFCS &EDACS level. In this study most of the children were male (58.3%), this fact is consistent with BCPR (Bangladesh Cerebral Palsy Register) study done in Shahajdpur, Bangladesh (61.8% were male) [7].

Children aged between 18 months to 12 years were included in our study and found 52 patients (40%) in the age range between two to less than four years. In BCPR cohort, they excluded children under the age of 5 years [7], though it is necessary to diagnose at an earlier age for rehabilitative and nutritional intervention.

In this study 87.4% patients belonged to lower and middle socioeconomic background. A study done by Israt Jahan et al, 2018 found that 73.9% were from low income families [29].

Around 52% of parents of CP children were below SSC level, out of this 4.8% were illiterate. This finding is consistent with that of Israt Jahan et al [29].

As per analysis of perinatal events, we found 108 patients (85%) were term and rests (15%) were preterm. Most of the patients (63.8%) were delivered at home. Normal vaginal deliveries were 78%. It was observed that almost three fourth (85.8%) patient's mother had no history of any prenatal events. Prolonged labour was found in 17.3% cases. Perinatal asphyxia (as evidenced by history of delayed cry) was present in 58.3% cases. Neonatal seizure, neonatal hyperbilirubinaemia and neonatal sepsis were found in 51.2%, 11.1% and 6.3% cases respectively. BCPR study also supports our findings, they found 16.3% children were preterm, 72.7% were delivered at home. Perinatal risk factors were reported in 61.6% (neonatal respiratory depression, neonatal encephalopathy, neonatal infections etc) [7].

In Nigeria, a hospital based study was done where they reported birth asphyxia, bilirubin encephalopathy, and post infectious brain damage as the main causes of CP [26].

Another study done in China among 377 children, where they found 43.8% children were born with a low birth weight and 54.1% were premature [19]. Our study found that only 15% were preterm and 23.6% were low birth weight.

In this study, spastic quadriplegic, dyskinetic, mixed, spastic diplegic and hemiplegic type of CP were found 33.9%, 23.6%, 16.5%, 15% and 11% cases respectively. Khondoker et al found, majority of the children (79.6%) had a spastic motor type (27.3% had monoplegia/hemiplegia, 17.1% had diplegia, 9.6% had triplegia and 25.6% had quadriplegia). If we add all type of spastic CP, we get 59.9% which slightly differs from that of Khondoker study [5].

Out of 127 patients, 119 (93.7%) were suffering from comorbidities. Nature of comorbidities included: cognitive delay 116 (97.47%), speech problems 113 (94.95%), feeding problems 94 (78.91%), epilepsy 71 (55.9%), visual impairments 24 (20.16%), hearing impairments 5 (4.2%). Khondoker et al found associated impairment in 79.6% patient of CP. Among them speech impairments were 67.1%, intellectual impairment 28.5%, epilepsy 23.4%, hearing impairment 10.2%, visual impairment 10.1% [7].

The incidence of epilepsy among CP patients has wide range of variation (15%-60%). Epilepsy most commonly affect children with spastic tetraplegia and those associated with intellectual disability [1-3]. In our study, more epilepsy (55.9%) were found compared to Khondokers findings (23.4%). This may be due to the fact that more patient of

neurological disease come to National Institute of Neurosciences & Hospital, as it is a specialized hospital for neurological patient. Among the epilepsy cases, focal epilepsy was found in 45 patients (63.38%), GTCS in 11 patients (15.49%), IS in 8 patients (11.26%), myoclonic in 3 patients (4.23%) multiple seizure type in 2 (2.82%) and unclassified in 2 (2.82%) patients.

Functional level was assessed by applying GMFCS, MACS, mini MACS in all of our study patients (n-127) and CFCS, EDACS in 81 and 79 patients respectively. By GMFCS, we found level V in 53 (41.7%), level IV in 37 (29.1%), level III in 21 (16.5%), level II in 2 (2.4%), level I in 19 (15%) patients. By MACS, we found level V in 51 (40.2%), level IV in 26 (20.5%), level III in 21 (16.5%), level II in 11 (8.7%), level I in 18 (14.2%) patients.

Level IV and V CFCS level were found in 25.2% cases. Forty six (36.2%) patients were not classified by CFCS level, as CFCS were not applicable below 3 years of age. Level IV& V EDACS level were found in 19.7% study cases. Forty eight (37.8%) CP patients were not classified by EDACS level, as EDACS are not applicable below 4 years of age. We assessed functional level by applying all four functional classification systems in this study but no such study applied all four classification system. Functional level IV and V were observed in more than half of CP child assessed by GMFCS, MACS in a study done in Columbia [32] which is consistent with findings of ours (GMFCS IV & V- 70.8%, MACS IV & V-61.1%). After extensive literature search, I found no study that look for association between nutritional status & CFCS level, as well as EDACS level. That's why I could not make any comparison with other study.

Under nutrition are common in children with cerebral palsy but over nutrition can also coexist in this group of patient [32]. Nutritional status was assessed by weight for age, weight for height, height for age and body mass index. In our study, around half of the patient's (51%) were found underweight, 86 (67.7%) were stunted and 40 (31.5%) were wasted. According to BMI 103 (81.1%) patients were found severely thin. No overweight and obesity were found. But overweight was observed in similar studies done in Columbia (16.0%) [32] and China (11.1%) [19]. This may be due to the fact that, nutritional supply, feeding process and rehabilitative facilities are better in China and Columbia.

Columbia study, found approximately two out of every three children with CP had either malnutrition or stunting (63.1% under nourished and 66.4% stunted) [32].

There was a cross sectional survey carried out in Ghana found approximately two thirds of study population were malnourished and over a third were severely malnourished. The proportion of children who were underweight was almost six times than that of the Ghana national average [31].

A review done by Andrew et al found, more than two-third of these children (70.0%) were moderate to severely underweight. More than half (52.4%) of the children were severely stunted and 20.7% were moderately stunted [21].

Pearson's and Spearmann-rho correlation tests had done to find out association between nutritional status and functional status of CP. Those who had better nutritional status (higher weight, height, OFC, MUAC), their level in different functional classification systems (GMFCS, MACS, CFCS, EDACS) were low. On the other hand, those who had lower nutritional status had higher level in different functional classification systems which were found statistically significant ($P<0.000$).

These findings are consistent with the findings of the study done in China by Yaung et al. They found significant negative correlation between nutritional status and functional level in GMFCS, MACS, indicating that children with less severe motor function impairments tends to be taller and heavier, while those with severe motor impairments appeared to be shorter, lighter and thinner [19].

Correlation test cannot detect the direction of causality. I am not sure whether lower growth parameters are causing deterioration of functional parameters or higher functional parameters are causing lower growth parameters. Third factor problems may arise. Instead of height, weight, OFC, MUAC& BMI, third factors like inadequate energy intake resulting from poor oral motor and swallowing function, gastrointestinal disorder like GERD, lack of self-feeding skills, extra energy expenditure due to spasticity or constant movements, nutrient losses from vomiting may responsible for poor functions [28]. Growth hormone, serum leptin level also play important role in nutritional aspect [21, 23].

Primary neurological insult influences not only physical and mental capabilities but also enteric neural pathways leading to dysphagia, vomiting, swallowing deficits, gastroesophageal reflux, aspiration and constipation, compromising the adequate nutrient intake in children with CP [29-32].

5. Recommendation

As this study was done at a single point of time, we didn't not follow up these children due to time constraint. So further prospective longitudinal study is required to see the improvement of nutritional and functional level after giving proper nutritional advice.

6. Conclusion

Nutritional challanges are common in children with cerebral palsy. Malnutrition and over nutrition can occur. But in our study, no over nutrition was found. This study reflects that malnutrition problems were very high among Bangladeshi children with CP and stunting was more prevalent. Poor nutritional status was associated with higher level of functional impairments.

7. Limitations

1. Purposive/judgment sampling was applied to children who were attending National Institute of Neurosciences & Hospital. Although they came from different strata of the society and district of Bangladesh, they were not the representative of all children with CP in this country.
2. WHO growth standards were used in this study, as there

is no reference parameter for Bangladeshi children with cerebral palsy.

3. This study does not give impression on direction of causality. I am not sure whether lower growth parameters are causing deterioration of functional parameters or higher functional parameters are causing lower growth parameters.

Appendix

Appendix 1: Data Collection Sheet

Title: Association of functional ability with nutritional status among children with cerebral palsy.
Sl no. ……. Reg no. …….. Date……..
Name of the investigator: Dr. Razia Sultana
Place of study: National institute of Neuroscience and Hospital, Outdoor/indoor
Particulars of the patient:
Name: Sex: Male-1/Female-2
DOB:
Age: < 2 years-1, 2-<4 years-2, 4-<6 years-3, 6-12 years-4
Father's name: Age: Ph:
Mother's name: Age: Ph:
Informant: Relation with patient:
Address: Urban-1, Rural-2
Father's occupation: Unemployed-1, Employed-1
Education: Illeterate-0, Below SSC-1, SSC-2, HSC-3, Graduate-4
Mother's occupation: House wife-1, Employed-2
Education: Illeterate-0, BelowSSC-1, SSC-2, HSC-3, Graduate-4
Socioeconomic status: <10000 (LI)-1, 10000-30000 (MI)-2, >30000 (UI)-3
History of current illness: (Chief complaints)
Past medical illness: Meningitis-1, Encephatitis-2, others-3
Birth history:
ANC: DM-1, HTN-2, fever with rash-3, Abortificient use-4
Natal: FT-1, PT-2 (---WKS), Prolongedlabour-1, Obstructed labour-2, NVD -1, C/S-2, Birth weight: NBW-1, LBW-2, VLBW-3,
Postnatal: Uneventful-1, PNA-2, N. Jaundice-3, N. Convulsion-4, N. Sepsis-5
Dev. history: Age appropriate -1, Delayed- 2
Feeding history: BF-1, Formula-2, mixed-3 timely weaning-4, delayed weaning-5,
Feeding method: Orally-1, NG tube-2, Gastrostomy tube-3
Consistency: Normal-1, semisolid-2, smashed-3, puriee-4, liquid-4
Position: Upright-1, Recumbent-2, lying-3
Feeding difficulty: Inadequate intake-1, fear of chocking-2, chewing difficulty-3, swallowing difficulty-4, nasal regurgitation-5, Prolonged feeding time (>30min)-6, parents lack of knowledge-7, lack of attention to diet-8
GI problem: Vomiting-1, Diarrhoea-2, Constipation-3, Difficulty in chewing-4, swallowing difficulty-5, lack of appetite-6
Family history:
Consanguinity: Yes-1, No-2 No of sib: One-1, two-2, three-3, >three-4
Sib death: Yes-1, No-2 Other sib: affected -1, no-2
Examination:
Vitals: N-1, Abnormal-2
Anthropmetry:
OFC: …….cm, Normal-1, Microcephaly-2, Macrocephaly-3
Weight……kg, N-1, Low weight-2 Height: ……cm, N-1, Low-2
Wasting (weight for height): Normal-1, Moderate-2, Severe-3
Stunting (Height for age): Normal -1, Moderate-2, Severe-3
Body Mass index: Normal-0, Mild-1, Moderate-2, Severe-3
MUAC: Normal-0, Mild-1, Moderate-2, Severe-3
Fontanel: open-1, closed-2, bulged-2 Head size: Normal-1, abnormal-2
Neurological examination: Cranial nerve examination: Intact -1, not intact -2
Tone of muscles: normal-1, hypotonia -2, hypertonia-3 Dystonic-4, Mixed-5
Deep tendon reflexes: normal -1, decreased-2, increased -3

Developmental assessment:
GM: Normal-1, Impaired-Mild-2, Mod-3, Severe-4
FM: Normal-1, Impaired-Mild-2, Mod-3, Severe-4
Hearing: Normal-1, Impaired-Mild-2, Mod-3, Severe-4
Vision: Normal-1, Impaired-Mild-2, Mod-3, Severe-4
Speech: Normal-1, Impaired-Mild-2, Mod-3, Severe-4
Cognition: Normal-1, Impaired-Mild-2, Mod-3, Severe-4
Seizure: Absent-1, Mild-2, Mod-3, Severe-4
Behaviour: Normal-1, Impaired-Mild-2, Mod-3, Severe-4
CP classification system:
GMFCS: Level-I-1, Level II-2, Level III-3, Level -IV-4, Level V-5
MACS: Level-I-1, Level II-2, Level III-3, Level -IV-4, Level V-5
EDACS: Level-I-1, Level II-2, Level III-3, Level -IV-4, Level V-5
CFCS: Level-I-1, Level II-2, Level III-3, Level -IV-4, Level V-5
Other systemic Examination:
Alimentary system:
Liver: Enlarged-1, no-2
Spleen: Enlarged-1 /no-2
Respiratory system: Normal-1, abnormal-2
Investigations:
Hb: Normal -1, Decrease, mild -2, moderate-3, severe-4
PBF: Normal-1, Microcytic-2, Macrocytic-3
Urine R/E: N-1, Abnormal-2
TORCH screening: Normal -1, Abnormal -2
EEG: Normal-1, Abnormal-2
CT scan of brain: Normal-1, cerebral atrophy-2, Encephalomalacia-3, structural abnormality-4, calcification-5, Others-6
MRI of brain: Normal-1, cerebral atrophy-2, Encephalomalacia -3, structural abnormality-4, calcification-5, Others-6
Hearing assessment: Normal -1, mild -2, moderate-3, severe-4
Visual assessment: Normal-1, Impaired-2
Diagnosis: Quadriplegic cp-1, Diplegic-2, hemiplegic-2, Dyskinetic-4, Mixed-5, hypotonic-6, ataxic-7
Comorbidity: Epilepsy-1, Cognitive delay-2, Speech delay-3 Hearing impairment-4, Visual impairment-5, Sleep problem-6, Behavioural problem-7 Others-8

Appendix II: CP Classification Forms

1. Before 2nd Birthday

GMFCS	Level	Child current status
1. Infants move in and out of sitting and floor sit with both hands free to manipulate objects. 2. Infants crawl on hands and knees, pull to stand and take steps holding on to furniture. 3. Infants walk between 18 months and 2 years of age without the need for any assistive mobility device	I	
1. Infants maintain floor sitting but may need to use their hands for support to maintain balance. 2. Infants creep on their stomach or crawl on hands and knees. 3. Infants may pull to stand and take steps holding on to furniture	II	
Infants maintain floor sitting when the low back is supported. Infants roll and creep forward on their stomachs	III	
Infants have head control but trunk support is required for floor sitting. Infants can roll to supine and may roll to prone	IV	
Physical impairments limit voluntary control of movement. Infants are unable to maintain antigravity head and trunk postures in prone and sitting. Infants require adult assistance to roll	V	

2. Between 2nd and 4th Birthday

GMFCS	Level	Child current status
1. Children floor sit with both hands free to manipulate objects. Movements in and out of floor sitting and standing are performed without adult assistance. 2. Children walk as the preferred method of mobility without the need for any assistive mobility device	I	
1. Children floor sit but may have difficulty with balance when both hands are free to manipulate objects. 2. Movements in and out of sitting are performed without adult assistance. 3. Children pull to stand on a stable surface. 4. Children crawl on hands and knees with a reciprocal pattern, cruise holding onto furniture and walk using an assistive mobility device as preferred methods of mobility	II	
1. Children maintain floor sitting often by "W-sitting" (sitting between flexed and internally rotated hips and knees) and may require adult assistance to assume sitting.	III	

GMFCS	Level	Child current status
2. Children creep on their stomach or crawl on hands and knees (often without reciprocal leg movements) as their primary methods of self-mobility. 3. Children may pull to stand on a stable surface and cruise short distances. 4. Children may walk short distances indoors using a hand-held mobility device (walker) and adult assistance for steering and turning.		
1. Children floor sit when placed, but are unable to maintain alignment and balance without use of their hands for support. 2. Children frequently require adaptive equipment for sitting and standing. Self-mobility for short distances (within a room) is achieved through rolling, creeping on stomach, or crawling on hands and knees without reciprocal leg movement.	IV	
1. Physical impairments restrict voluntary control of movement and the ability to maintain antigravity head and trunk postures. 2. All areas of motor function are limited. Functional limitations in sitting and standing are not fully compensated for through the use of adaptive equipment and assistive technology. 3. At Level V, children have no means of independent movement and are transported. Some children achieve self-mobility using a powered wheelchair with extensive adaptations	V	

3. Between 4th and 6th Birthday

GMFCS	Level	Current status
1. Children get into and out of, and sit in, a chair without the need for hand support. Children move from the floor and from chair sitting to standing without the need for objects for support. Children walk indoors and outdoors, and climb stairs. 2. Emerging ability to run and jump.	I	
1. Children sit in a chair with both hands free to manipulate objects. 2. Children move from the floor to standing and from chair sitting to standing but often require a stable surface to push or pull up on with their arms. 3. Children walk without the need for a handheld mobility device indoors and for short distances on level surfaces outdoors. 4. Children climb stairs holding onto a railing but are unable to run or jump.	II	
1. Children sit on a regular chair but may require pelvic or trunk support to maximize hand function. Children move in and out of chair sitting using a stable surface to push on or pull up with their arms. 2. Children walk with a hand-held mobility device on level surfaces and climb stairs with assistance from an adult. 3. Children frequently are transported when traveling for long distances or outdoors on uneven terrain.	III	
1. Children sit on a chair but need adaptive seating for trunk control and to maximize hand function. 2. Children move in and out of chair sitting with assistance from an adult or a stable surface to push or pull up on with their arms. 3. Children may at best walk short distances with a walker and adult supervision but have difficulty turning and maintaining balance on uneven surfaces. 4. Children are transported in the community. Children may achieve self-mobility using a powered wheelchair	IV	
1. Physical impairments restrict voluntary control of movement and the ability to maintain antigravity head and trunk postures. 2. All areas of motor function are limited. Functional limitations in sitting and standing are not fully compensated for through the use of adaptive equipment and assistive technology. At Level V, children have no means of independent movement and are transported. 3. Some children achieve self-mobility using a powered wheelchair with extensive adaptations.	V	

4. Between 6th and 12th Birthday

GMFCS	Level	Child current status
1. Children walk at home, school, outdoors, and in the community. Children are able to walk up and down curbs without physical assistance and stairs without the use of a railing. 2. Children perform gross motor skills such as running and jumping but speed, balance, and coordination are limited. Children may participate in physical activities and sports depending on personal choices and environmental factors	I	
1. Children walk in most settings. Children may experience difficulty walking long distances and balancing on uneven terrain, inclines, in crowded areas, confined spaces or when carrying objects. 2. Children walk up and down stairs holding onto a railing or with physical assistance if there is no railing. Outdoors and in the community, children may walk with physical assistance, a hand-held mobility device, or use wheeled mobility when traveling long distances. 3. Children have at best only minimal ability to perform gross motor skills such as running and jumping. Limitations in performance of gross motor skills may necessitate adaptations to enable participation in physical activities and sports.	II	
1. Children walk using a hand-held mobility device in most indoor settings. When seated, children may require a seat belt for pelvic alignment and balance. 2. Sit-to-stand and floor-to-stand transfers require physical assistance of a person or support surface. 3. When traveling long distances, children use some form of wheeled mobility. 4. Children may walk up and down stairs holding onto a railing with supervision or physical assistance. 5. Limitations in walking may necessitate adaptations to enable participation in physical activities and sports including self-propelling a manual wheelchair or powered mobility.	III	
1. Children use methods of mobility that require physical assistance or powered mobility in most settings.	IV	

GMFCS	Level	Child current status
2. Children require adaptive seating for trunk and pelvic control and physical assistance for most transfers. 3. At home, children use floor mobility (roll, creep, or crawl), walk short distances with physical assistance, or use powered mobility. 4. When positioned, children may use a body support walker at home or school. At school, outdoors, and in the community, children are transported in a manual wheelchair or use powered mobility. 5. Limitations in mobility necessitate adaptations to enable participation in physical activities and sports, including physical assistance and/or powered mobility.		
1. Children are transported in a manual wheelchair in all settings. 2. Children are limited in their ability to maintain antigravity head and trunk postures and control arm and leg movements. 3. Assistive technology is used to improve head alignment, seating, standing, and and/or mobility but limitations are not fully compensated by equipment. 4. Transfers require complete physical assistance of an adult. 5. At home, children may move short distances on the floor or may be carried by an adult. Children may achieve self mobility using powered mobility with extensive adaptations for seating and control access. 6. Limitations in mobility necessitate adaptations to enable participation in physical activities and sports including physical assistance and using powered mobility.	V	

5. MACS

MACS	Level	Child current status
Handles objects easily and successfully.	I	
Handles most objects but with somewhat reduced quality and/or speed of achievement. Certain activities may be avoided or be achieved with some difficulty.	II	
Handles objects with difficulty; needs help toprepare and/or modify activities	III	
Handles a limited selection of easily managed objects in adapted situations.	IV	
Does not handle objects and has severely limited ability to perform even simple actions. Requires total assistance.	V	

6. Mini MACS

Mini MACS	Level	Child current status
1. Handles objects easily and successfully. The child may have a slight limitation in performing actions that require precision and coordination between the hands but they can still perform them. 2. The child may need somewhat more adult assistance when handling objects compared to other children of the same age.	I	
1. Handles most objects, but with somewhat reduced quality and/or speed of achievement. Some actions can only be performed and accomplished with some difficulty and after practice. 2. The child may try an alternative approach, such as using only one hand. 3. The child need adult assistance to handle objects more frequently compared to children at the same age.	II	
1. Handles objects with difficulty. Performance is slow, with limited variation and quality. 2. Easily managed objects are handled independently for short periods. 3. The child often needs adult help and support to handle objects.	III	
1. Handles a limited selection of easily managed objects in simple actions. The actions are performed slowly, with exertion and/or random precision. 2. The child needs constant adult help and support to handle objects.	IV	
Does not handle objects and has severely limited ability to perform even simple actions. At best, the child can push, touch, press, or hold on to a few items, in constant interaction with an adult.	V	

7. CFCS

CFCS	Level	Child current status
Effective Sender and Receiver with unfamiliar and familiar partners.	I	
Effective but slower paced Sender and/or Receiver with unfamiliar and/or familiar partners	II	
Effective Sender and Receiver with familiar partners.	III	
Inconsistent Sender and/or Receiver with familiar partners	IV	
Seldom Effective Sender and Receiver even with familiar partners	V	

8. EDACS

EDACS	Level	Child current status
Eats and drinks safely and efficiently	I	
Eats and drinks safely but with some limitations to efficiency.	II	
Eats and drinks with some limitations to safety maybe limitations to efficiency.	III	
Eats and drinks with significant limitations to safety.	IV	
Unable to eat or drink safely – tube feeding may be considered to provide nutrition	V	

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