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Nutritional profile of preschool children with cerebral palsy attending a tertiary care medical rehabilitation centre in a low-and-middle-income country

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ABSTRACT

Purpose: Optimal nutrition during the early years of life is essential for maintaining optimal health across the lifespan and in children with cerebral palsy (CCP) it might enhance the motor function. Hence, we aimed to assess the status of malnutrition and the underlying risk factors among children with CP.

Methods: After screening, out of 483 CCP, 120 CCP aged between 2 and 4 years of age were recruited from tertiary care medical rehabilitation centre through simple random sampling technique. Demographic dimensions include, age, gender, weight, height, arm circumference, head circumference, body temperature, and other indicators like, neurological signs, and socio-economic status were collected. Nutritional profile was reported using WHO Z score charts. Chi-square statistics was used to derive the association between.

Results: After screening out of 483 CCP, 120 CCP [75 (62.50%) male and 45 (37.50%) female] aged 2-4 years participated. 40.8% and 41.6% were identified to be underweight and stunted growth. Statistical significance association using Chi-square was reported only in age between 2 to 3 and 3 to 4 years in underweight (p=0.027) and stunning (p=0.0028).

Conclusion: A high prevalence of under nutrition was identified among preschool children with cerebral palsy, with significant age-related differences in weight and height outcomes. While other factors such as sex, aetiology, topographical distribution, and motor function severity showed no significant association with nutritional status, the findings emphasize the need for age-focused nutritional monitoring and intervention strategies. These results contribute valuable preliminary evidence from a low-and-middle-income country setting, supporting the development of targeted nutritional and rehabilitative care models for children with cerebral palsy.

KEYWORDS

Dietary assessment, developmental delay, food therapy, child growth.

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INTRODUCTION

Low-and middle-income countries (LMICs) encompass 85% of the global population and are burdened with 90% of the world's health issues[1]. Physical growth is a fundamental aspect of health and an indicator of physical well-being in children[2,3]. In 2018, 149.0 million children were reported with stunted growth[4]. Impaired growth is often seen in children with cerebral palsy (CCP) due to feeding difficulties[3,5,6]. They have significantly lower mean height, weight, and mid-upper arm circumference than their healthy peers[3,7–9]. Although growth depends on the nutritional status, other factors related to feeding difficulties like dysphagia, gastro-oesophagal reflux, immobility, endocrine dysfunction, intellectual disability, cognitive impairment, anti-epileptics drugs, stress, communication disorders, physical disabilities were cannot be ignored[6–11]. Globally 46%–90% of CCP were suffering from malnutrition and the prevalence of being underweight is higher than the overweight[11,12].

In Most CCP were born as small for gestational age (SGA) as their healthy peer, negatively impacting postnatal growth[5]. However, overweight and obesity may also become an increasing problem among CCP following the secular trend among children and adolescents in the general population[13,14]. Early nutrition deficit can cause stunning, impaired intellectual growth, deceased cellular immunity, endocrine dysfunction, decreased strength and endurance, poor bone mineralization and decreased cerebral maturation[3,15–17]. It also affects mood, muscle tone, wound healing, peripheral circulation and general well-being in children[3,17]. Moreover, feeding difficulties has a close relationship with lesser life-expectancy and increased morbidity and mortality rate (six-time more)[6]. Optimal nutrition during the early years is essential for maintaining optimal health across the lifespan and in CCP it might enhance the motor function[2,3]. Therefore, we aimed to assess malnutrition and the underlying risk factors among children with CP in Odisha.

METHODS

The study protocol was approved by the scientific review board (SRB), and then ethical approval was obtained from the institutional ethics committee (IEC) of Swami Vivekanand National Institute of Rehabilitation Training and Research, Olatpur, Bairoi, Cuttack. The sample size for the prevalence study was calculated using the prevalence formulae, $n = Z\alpha^2 P (1 - P)/d^2$, where $Z\alpha = 1.96$; P = 72% as the hypothesized prevalence of CCP with malnutrition from previous systematic review (pooled prevalence)[18], and d = 8%, resulted in the minimum number of participants required for this study was estimated to be, n = 120. The study was performed according to the principles laid by, declaration of Helsinki (Revised 2013), Council for International Organizations of Medical Sciences (CIOMS) guidelines, International ethical guidelines for health-related research involving humans (2016) and National guidelines for biomedical and health research involving human participants (2017). The study was conducted between June 2021 to May 2023 and consent was obtained from the parents of CCP before obtaining their enrollment. Children were included age between 2 and 4 years old having history of CP associated clinical conditions and acute diseases or tube feeding were considered as exclusion criteria.

After screening, total 483 CCP attending outpatient department of tertiary care rehabilitation centre, only 120 CCP, aged between 2 and 4 years, were recruited from tertiary care rehabilitation centre (Swami Vivekanand National Institute of Rehabilitation Training and Research, Olatpur, Bairoi, Cuttack). Demographic details of each CCP were collected along with anthropometric measurements including Age, gender, weight, height, arm circumference, head circumference (HC), body temperature, and neurological signs. Weight (kg) and height (cm) were measured as previously reported. The weight was marked on the standard calibrated scale. In children who could stand easily and upright, height was measured using a fixed stadiometric scale. If measurement of standing height was not possible or complicated by congenital contractures or scoliosis, height above knee height was estimated using available validated equation, height = [2.69 x knee height (cm) + 24.2][19,20]. The patient was lying down in a supine position when the knee-height measurement procedure was carried out. A stretchable measuring tape of standard quality was employed for the measurement process. Each measurement was taken three times, and the average was taken into account. All measurements were carried out in the morning by the same skilled examiner. The socio-economic status was estimated by using the Kuppuswamy scale ranging the score from 5 to 29. Then Communicated with each parent in the local (Oriya) language and their responses were recorded in English by the primary investigator. All the clinical anthropometric indicators (e.g. GMFCS, were collected.

Data analysis

Data entry and analysis were carried out using Microsoft MS Excel 2019 in Windows 11 Home edition. All the data were entered into the database. Descriptive analysis which includes reporting in frequency and percentage was done for Socio-demographic characteristics, clinical factors, and nutritional status of the children with Cerebral Palsy. Three indices were used to describe the nutritional status in children with CP – weight-for-age (WA), height-for-age (HA), weight-for-height (WH), and head circumference-for-age (HCA). The Z score for the four indices (i.e. WA, HA, WH, HCA) was calculated manually using WHO Z score charts for boys and girls separately. Each CCP's nutritional status was evaluated using z-scores. For interpretating the results, being below a WA Z-score of < −2 SD was categorized as underweight; while having a HA Z-score < −2 SD was classified as 'stunting', WH Z-score < −2 SD indicated 'wasting', and HCA Z-score < − 2 indicated 'microcephaly' as documented previously[19]. Furthermore, the nutritional status of children with CP was sub-categorized using the WHO cutoffs for the Z scores (i.e. -2 SD to +2SD Normal, <-2SD to -3SD Moderately undernourished, <-3 SD Severely undernourished). The WA Z-score and WH Z-score was calculated for CCP. Bivariate analysis was done to identify potential risk factors for malnutrition among the children with Cerebral palsy. Chi-square tests were used to examine the statistical differences in nutritional status between groups of children according to their socio-demographic characteristics and clinical factors.

RESULTS

A total of 120 children [75 (62.50%) male and 45 (37.50%) female] with CP aged 2- 4 years participated in the prevalence study. The classification of CCP was according to aetiology (pre-term or post-term), topographical distribution, motor functioning and gross motor function classification system (GMFCS) were mentioned in Table 1. GMFCS was considered as a clinical factor only associated with nutritional status. Characteristics of CCP according to their nutritional status (mild, moderate and severe) according to weight, stunning, wasting and microcephaly were displayed in Table 2. While their profile classification of children with cerebral palsy based on weight and height for age Z scores in sex, age, modified Ashworth scale, aetiology, GMFCS, timing, and neurological classification were tabulated in Table 3. Statistical significance association using Chi-square was reported only in age between 2 to 3 and 3 to 4 years in underweight (p=0.027) and stunning (p=0.0028).

Table 1 presents the classification of 120 children with cerebral palsy based on four criteria: Aetiology, Topographical distribution, Gross Motor Function Classification System (GMFCS), and Neurologic classification. In terms of Aetiology, a majority of the children were born post-term (63.3%), while 36.7% were pre-term. This finding highlights that cerebral palsy can affect children irrespective of gestational age, with a larger proportion occurring in post-term births within this sample. The Topographical distribution of motor impairment revealed that 59.2% of children had Quadriplegia, affecting all four limbs. Diplegia was present in 30.8%, primarily involving the lower limbs, while Hemiplegia, affecting one side of the body, accounted for 10% of cases.

Table 1. Aetiology, topographical distribution, motor functioning and gross motor function classification system (GMFCS) of children with cerebral palsy (n=120)

Classification of children with cerebral palsy		Frequency (n)	Percentage (%)
Aetiology	Pre-term	44	36.7
	Post-term	76	63.3
Topographical distribution	Quadriplegia	71	59.2
	Diplegia	37	30.8
	Hemiplegia	12	10
Gross motor function classification system (GMFCS)	Level-5	32	26.7
	Level-4	15	12.5
	Level-3	29	24.2
	Level-2	44	36.7
Neurologic classification	Spastic Quadriplegia	66	55
	Spastic Diplegia	36	30
	Spastic Hemiplegia	12	10
	Athetoid Quadriplegia	05	4.2
	Ataxic Quadriplegia	01	0.8

Classification based on the Gross Motor Function Classification System (GMFCS) showed a varied distribution of motor function abilities. The highest proportion of children, 36.7%, were categorized in Level-2, indicating mild functional limitations. Conversely, 26.7% were in Level-5, reflecting severe functional impairments with minimal voluntary movement. Level-3 and Level-4 represented 24.2% and 12.5% of the children, respectively. Under Neurologic classification, the most common type identified was Spastic Quadriplegia (55%), followed by Spastic Diplegia (30%), and Spastic Hemiplegia (10%). Less common types included Athetoid Quadriplegia (4.2%) and Ataxic Quadriplegia (0.8%). These findings reinforce that spastic forms of cerebral palsy are predominant among affected children, with spastic quadriplegia being the most severe and prevalent. The data reveals a predominance of post-term births, widespread distribution of quadriplegic cerebral palsy, and a majority of spastic forms, with significant variation in motor function abilities. These insights emphasize the heterogeneity of cerebral palsy and underline the importance of tailored medical and rehabilitation strategies for different clinical presentations.

Table 2 presents the nutritional profile of 120 children with cerebral palsy, examining four key indicators: weight status, stunting, wasting, and microcephaly. The findings reveal significant nutritional challenges within this population. In terms of weight status, the majority of children (66.7%) were not underweight. However, 23.3% were mildly underweight, 9.2% moderately underweight, and 0.8% severely underweight. When assessing stunting (low height-for-age), 52.5% of the children showed no signs of stunting. Nevertheless, 25% exhibited moderate stunting, and 21.7% were severely stunted, indicating a considerable burden of growth retardation. Regarding wasting (low weight-for-height), 31.7% had no wasting. The rest were distributed as 22.5% mildly wasted, 20.8% moderately wasted, and 25% severely wasted. This highlights a concerning prevalence of acute under nutrition.

The data on microcephaly (small head circumference) revealed that only 16.7% of children had normal head size for age. The majority were affected, with 20.8% displaying mild microcephaly and 29.2% experiencing moderate microcephaly. More than half of the children maintained normal weight and height-for-age, a substantial proportion suffered

Table 2. Nutritional profile of children with cerebral palsy according to weight, stunning, wasting and microcephaly (n=120)

Nutritional profile of children with cerebral palsy		Frequency (n)	Percentage (%)
Weight	Not underweight	80	66.7
	Mildly underweight	28	23.3
	Moderately underweight	11	9.2
	Severely underweight	1	0.8
Stunting	No stunting	63	52.5
	Mild stunting	1	0.8
	Moderate stunting	30	25
	Severe stunting	26	21.7
Wasting	No wasting	38	31.7
	Mild wasting	27	22.5
	Moderate wasting	25	20.8
	Severe wasting	30	25
Microcephaly	No microcephaly	20	16.7
	Mild microcephaly	25	20.8
	Moderate microcephaly	35	29.2

from moderate to severe levels of stunting, wasting, and microcephaly. These findings emphasize the importance of comprehensive nutritional assessments and interventions for children with cerebral palsy.

Table 3 presents a detailed classification of the nutritional profile of 120 children with cerebral palsy, assessed through weight-for-age and height-for-age Z-scores. The analysis was stratified by key demographic, clinical, and functional indicators, including sex, age, spasticity level (Modified Ashworth Scale), aetiology, and Gross Motor Function Classification System (GMFCS) levels. Statistical significance was determined using p-values for each category.

Out of 120 children, 62.5% were male and 37.5% were female. Among male participants, 25.8% were underweight, while 26.7% were stunted based on height-for-age Z-scores. In comparison, 18% of females were underweight, and 15% were stunted. Despite these variations, no statistically significant association was found between sex and either weight-for-age (p=0.412) or height-for-age (p=0.261) Z-scores.

The age distribution included 52.5% of children aged 2–3 years and 47.5% aged 3–4 years. Notably, underweight prevalence was higher in the 3–4 years group (35%) compared to the 2–3 years group (33.3%). Similarly, stunting was observed in 35% of 3–4-year-olds and 36.7% of 2–3-year-olds. A statistically significant association was identified between age and both weight-for-age (p=0.027) and height-for-age (p=0.028) Z-scores, suggesting that nutritional challenges increase with age in this population.

When classified by spasticity severity, most children were categorized under Upper Moderate (UM) spasticity (57.5%), followed by Lower Moderate (LM), Upper Low (UL), Lower Low (L), and Unclassified (UC). Underweight and stunting were more prevalent in the UM group (35.8% underweight, 23% stunted). However, the association between spasticity level and nutritional status was not statistically significant for either weight-for-age (p=0.590) or height-for-age (p=0.710).

Half of the children in this study had cerebral palsy caused by Hypoxic Ischemic Encephalopathy (HIE) (50%), with other causes including Premature birth (36.7%), Meningitis (3.3%), Jaundice (7.5%), and Seizure (2.5%). The prevalence of underweight and stunting was highest among children with HIE (35.8% underweight, 17.5% stunted). Despite these trends, no significant association was identified between the aetiology of cerebral palsy and nutritional status, with p-values of 0.391 for weight-for-age and 0.657 for height-for-age.

Functional ability, classified through the GMFCS, showed that the largest group of children belonged to Level-2 (36.7%), followed by Level-3 (24.2%). The prevalence of underweight was 25% in Level-2 and 14.2% in Level-3, while stunting affected 13.3% in Level-2 and 13.3% in Level-3. As with other indicators, the association between GMFCS levels and nutritional status was not statistically significant, with p-values of 0.550 for weight-for-age and 0.890 for height-for-age.

DISCUSSION

This exploratory prevalence study was conducted at one of the tertiary care rehabilitation centre in a LMICs with 120 CCP to assess the status of malnutrition and the underlying risk factors. Based on the findings, the factors like sex, age, aetiology (Prenatal and Postnatal), topographic distribution (Quadriplegia Diplegia, Hemiplegia), or Socio-Economic condition, does not have any association except age with the nutritional profile in CCP. The growth patterns of CCP are unique[21]. A statistically significant association of age between 2 to 3 and 3 to 4 years in weight and height.. The age-specific growth measures were closer to normal during 1 to 2 years[2,10]. The better nutritional status, higher levels of body fat, and improvements in oral motor functioning as feeding milestones may assist the growth at a younger age[6]. In contrast, a study

Table 3. Nutritional profile classification of children with cerebral palsy based on weight and height for age Z scores

Indicator		Total	Weight for age Z Scores		p-value	Height for age Z Scores		p-value
			Normal	Underweight		Normal	Stunning	
Sex	Male	75 (62.5)	44 (36.7)	31 (25.8)	0.412	43 (35.8)	32 (26.7)	0.261
	Female	45 (37.5)	27 (22.5)	18 (15)		25 (20.8)	18 (15)	
Age	2-3 years	63 (52.5)	23 (19.2)	40 (33.3)	0.027	19 (15.8)	44 (36.7)	0.028
	3-4 years	57 (47.5)	15 (12.5)	42 (35)		22 (18.3)	25 (20.8)	
Modified Ashworth scale	LM	35 (29.2)	12 (10)	22 (18.3)	0.590	17 (14.2)	18 (15)	0.710
	UM	69 (57.5)	26 (21.7)	43 (35.8)		46 (38.3)	23 ()	
	UL	7 (5.8)	2 (1.7)	5 (4.2)		2 (1.7)	5 (4.2)	
	L	1 (0.8)	1 (0.8)	0 (0)		0 (0)	1 (0.8)	
	UC	8 (6.7)	6 (5)	2 (1.7)		4 (3.3)	4 (3.3)	
Aetiology	Premature	44 (36.7)	16 (13.3)	22 (18.3)	0.391	22 (18.3)	22 (18.3)	0.657
	HIE	60 (50)	17 (14.2)	43 (35.8)		39 (32.5)	21 (17.5)	
	Meningitis	4 (3.3)	1 (0.8)	3 (2.5)		1 (0.8)	03 (2.5)	
	Jaundice	9 (7.5)	4 (3.3)	5 (4.2)		5 (4.2)	4 (3.3)	
	Seizure	3 (2.5)	1 (0.8)	2 (1.7)		3 (2.5)	0 (0)	
GMFCS	II	44 (36.7)	30 (25)	13 (10.8)	0.550	27 (22.5)	16 (13.3)	0.890
	III	29 (24.2)	17 (14.2)	12 (10)		16 (13.3)	13 (10.8)	

showed that those below 6 years of age had slightly greater growth deficiency than older children[22]. According to Samson-Fang and Stevenson's report boys (below the age of 10) grew more slowly than girls[21].

Only a handful of studies have reported anecdotal comments about the neglect and poor nutritional status of children with disabilities[18,19]. They are fed inadequately as their parents/caregivers often consider them sick and fear worsening the illness by extra feeding[23]. Few researches highlight the feeding problems in a resource-poor community[17,24]. However, the socioeconomic factors were not responsible for poor linear growth among CCP.

Children with severe motor impairment (GMFCS level IV-V) often face difficulties with oromotor function[13,25]. They frequently reported feeding difficulties like choking, drooling, biting and gastroesophageal reflux[26]. However, these findings were not consistent with our result, and they did not reveal any significant association between the nutritional status of CCP and motor severity and associated impairments. The proportion of underweight children was not significant but was found to be higher in GMFCS level II. Similarly, the proportion of stunting was also higher among CCP with GMGCS II.

The results also reveal the proportion of underweight and stunting in CCP with postnatal aetiology was higher but non-significant. Improved perinatal care and delineating operational definitions to record birth asphyxia are now available even in poor resource settings. Also, the potential post-natal causes of CP like CNS infections, septicemia, hypoglycemia, hyperbilirubinemia and vitamin-K deficiency-associated intracranial bleeds can be managed effectively by advanced diagnostic and treatment. We found that the majority of spastic quadriplegic and spastic diplegic types of CCP were underweight but statistically non-significant whereas Stunting was significantly higher among them. Spastic CP is the commonest type of CP and Severe form of malnutrition was evident in CCP with spastic quadriplegia[6,12]. Incidentally, a greater number of spastic quadriplegic types of CCP took part in our study.

The growth and maturation of CCP do not depend only on nutrition, the sedentary lifestyle was also the major contributor. Hence, there is a need for physical activities to build strong bones and muscles, improve balance, and acquire and mature motor skills[27]. Unfortunately, there is a shortage of literature investigating the link between a sedentary lifestyle and growth and development among the mobility-restricted CCP which will permit ascertainment of the importance of inactivity prevention activity promotion strategies for the effective management of CP and to identify the high-need groups within the CP population.

The study has few limitations. Small sample size and study population were recruited from single centre. Nevertheless, this was the first study to report the nutritional profile of CCP attending tertiary care rehabilitation centre in a LMICs. Though the study had small sample size, the sample size is sufficient to limit type-I error. However, the sample being represented from single centre, they have wider sample representation as recruited from the National level rehabilitation centre established directly by the Ministry of Health. Moreover, these results can be considered as the preliminary findings in exploring similar further research.

CONCLUSION

The findings revealed a substantial prevalence of malnutrition, with 40.8% of children underweight and 41.6% stunted. Among the demographic and clinical variables assessed, age showed a statistically significant association with both weight-for-age and height-for-age Z-scores, indicating that nutritional risks intensify as children with cerebral palsy grow older.

No significant association was identified between nutritional status and other factors, including sex, aetiology and topographical distribution, gross motor function severity, or spasticity level. Although a higher proportion of under nutrition was observed in children with spastic quadriplegia and severe motor impairment, these differences were not statistically significant. The study underscores the necessity for early, age-specific nutritional interventions and consistent growth monitoring in children with cerebral palsy, particularly beyond infancy into the preschool years.

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