Original Article

The Prevalence of Malnutrition, Nutrient Intakes and Deficiencies of Thai Children with Cerebral Palsy, at QSNICH

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Objective: To evaluate the prevalence of malnutrition, nutrient intakes, and deficiencies of Thai children with cerebral palsy (CP), at QSNICH.

Materials and Methods: A cross-sectional study was performed in Thai children diagnosed CP at Neuro-clinic, QSNICH. Collecting demographic, previous 3-day food record, feeding, anthropometric data, physical examinations, and laboratory investigations. Nutritional status was assessed using WHO growth references (2007). Nutrient intakes were analyzed by program IMMUCAL.

Results: Twenty-three children diagnosed CP were included. Sixty-one percent were boys and 39% were girls. The mean age was 63±31 months. Sixty-one percent had feeding problems. Twenty cases (87%) were oral feeding. Energy distribution of carbohydrate, fat, and protein was 46, 38, and 16, respectively. Daily intakes of nutrients were inadequate, such as calcium at 78%, iron at 35%, vitamin C at 26%, vitamin A and B1 at 22%, energy at 13%, and protein vitamin B2 and B3 at 9%. Malnutrition revealed that 52% were underweight and 35% were stunting. Glossitis, dental caries, and gingivitis were found in 65%, 56%, and 26%, respectively. Laboratory investigations revealed anemia in 13%, iron deficiency in 9%, and vitamin C deficiency in 22%. Malnutrition was not statistically significantly related to energy intake, feeding problems, and route. Energy intake above 100% DRI was related to normal length ($p=0.019$).

Conclusion: Children with CP commonly had malnutrition and nutrient deficiencies due to inadequate intakes. Proper nutritional support with balanced diet will prevent malnutrition and promote health of these children.

Keywords: Cerebral palsy; Malnutrition, nutrient intakes; Nutrient deficiencies; Thai children

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Cerebral palsy (CP) is the most common motor disability in childhood. In Thailand, CP prevalence was 1 in 1,000 live birth(1). Multiple factors are associated with the risk for CP including prematurity(2,3), traumatic brain injury, and meningitis(2). Children with CP suffer from multiple problems such as developmental delay, motor deficits, intellectual impairment, epilepsy, growth, and nutritional problems(2-5). Children with CP often have feeding difficulties that play a key role in the main cause of malnutrition and increase the risk of growth failure(3-7). Malnutrition is associated with significant morbidity, and the consequences include decreased cerebral function, impaired immune function, reduced peripheral circulation, poor wound healing, decreases social interaction, and diminished motor function(3-6). The prognosis for CP depends on associated conditions and appropriate interventions including nutritional support(2,5,6). The prevalence of malnutrition in Thai children with CP at Siriraj Hospital was 34.6%(8). There was no previous report of nutrient intake and deficiency in Thai children with CP. The objective of the present study was to evaluate the nutritional status, nutrient intakes, and deficiencies of Thai children with CP, at Queen Sirikit National Institute of Child Health (QSNICH).

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Materials and Methods

A cross-sectional study was performed in Thai children diagnosed CP at Neuro-clinic, QSNICH, in May 2010. Approval of the Institution's Ethics Committee (EC135/2564) and written informed consents from the parents of these children were obtained prior to enrollment. All participating parents were requested to provide the previous 3-day food record and were interviewed about feeding problems included difficult or prolonged feeding, method of feeding, nutrient supplementation, and medications of their children with CP. Cases without 3-day food record were excluded from the present study. Demographic and anthropometric data were collected from their out-patient records. Physical examinations for diagnoses of glossitis, gingivitis, and dental caries were performed. Laboratory investigations included hemoglobin, albumin, blood urea nitrogen (BUN), red blood cell (RBC) folate, serum ferritin, and serum vitamin C were done. Nutrient intakes from 3-day food record, included energy (E), macronutrients as carbohydrate (CHO), protein, fat, calcium, iron, vitamin A, thiamine, riboflavin, niacin, and vitamin C were analyzed using program IMMUCAL. Intake of each nutrient was analyzed in percentage of daily recommended intake (% DRI) for Thai children[9], and adequate nutrient intake was defined as intake of nutrient's estimated average requirement, at 67% DRI[10]. By the World Health Organization (WHO) guidelines, the normal Hb value is 11 and 11.5 g/dL in the age groups of 6 months to 5 years and 5 to 11 years, respectively. Low Hb level is classified as anemia[11]. RBC folate is a sensitive indicator of long-term folate status, and the concentrations of less than 160 ng/mL indicated folate depletion[12]. Serum ferritin is the most and early sensitive index of iron storage. The cut-off for iron deficiency is defined as serum ferritin less than 12 and 15 ng/mL in children under and beyond 5 years of age, respectively[12]. Case with anemia and iron deficiency was defined as iron deficiency anemia. Vitamin C deficiency was defined as serum vitamin C less than 0.3 mg/dL[13]. Nutritional status was determined as Z-score or standard deviation (SD) score of weight and length for age (WAZ and LAZ), by using WHO growth references (2007). The WHO standard proposed the following cut-offs, overweight at WAZ over +1SD, underweight at WAZ less than –2SD, and stunting at LAZ less than –2SD[14]. The categorical data were analyzed in number and percentage. The continuous data, included nutrient intake and laboratory data were expressed in range, mean, SD, and median. The relationships among feeding problems, nutritional status, and nutrient deficiencies were assessed using Fisher's exact test. A p-value of less than 0.05 was considered statistically significant.

Results

Twenty-five children diagnosed CP were enrolled in the present study. Two cases without 3-day food record were excluded. Therefore, twenty-three children participated and included 61% boys and 39% girls. The age ranged between 21 months and 9 years 10 months. Mean (SD) and median age were 63 (31) and 60 months, respectively. Risk factors for CP included 35% prematurity, 26% asphyxia, 26% epilepsy, 17% brain anomalies, 4% head accident, 4% sepsis, and 17% had no risk factor. Seventeen cases (77%) received anti-epileptic drugs. Four cases (17%) had previously multivitamin supplement, but none had recent vitamin supplement. Feeding problems revealed that 61%, included nasopharyngeal incoordination. Twenty cases (87%) were orally fed. There were three cases (13%) of tube feeding, via gastrostomy in two cases, and nasogastric tube in one case. From the 3-day food record, the average daily intake of nutrients is shown in Table 1, and as follow, E 1,095 kilocalories (kcal), protein 3 g/kg, calcium 387 mg, iron 7.7 mg, vitamin A 845 RE, thiamin 1.1 mg, riboflavin 1.1 mg, niacin 9.1 mg, and vitamin C 47 mg. Median intakes of energy, iron, and calcium were 94%, 85%, and 35% DRI, respectively (Table 2). The inadequate daily intakes of nutrients were found in 78% with calcium, 35% with iron, 26% with vitamin C, 22% with vitamin A and B1, 13% with E protein, and 9% with vitamin B2 and B3. All cases had Ca intake less than 100% DRI. Five cases (22%) had protein intake of less than 100% DRI. Eighteen cases (78%) had protein intake DRI of more than 100% DRI. Five cases (22%) had excessive protein intake over 200% or more than 4 g/kg/day (Table 3). Mean E distribution as CHO:fat:protein ratio was 46:38:16 (Table 4).

Table 1. Daily intake of energy and nutrients

Nutrients	Range	Mean (SD)	Median
Energy (kcal)	537 to 1,520	1,095 (300)	1,081
Protein (g/kg)	1.2 to 6.5	3 (1.3)	3
Calcium (mg)	90 to 814	387 (192)	341
Iron (mg)	4.4 to 21.9	7.7 (3.5)	6.8
Vitamin A (RE)	5.5 to 152.2	845 (1,103)	451
Thiamin (mg)	137 to 4,641	1.1 (0.9)	1.0
Riboflavin (mg)	0.2 to 4.4	1.1 (0.4)	1.2
Niacin (mg)	0.3 to 1.8	9.1 (3.5)	8.9
Vitamin C (mg)	3 to 17	47.3 (42)	33

SD=standard deviation

The nutritional status was underweight in 52%, stunting in 35%, and normal in 43%. Overall malnutrition as underweight and stunting was 57%. Mean (SD) ages of children with stunting

Table 2. % DRI of energy and nutrients, and number of cases with low and adequate intake

Nutrients	% DRI			Number of cases with % DRI; n (%)		
	Range	Mean (SD)	Median	Less than 67%	Less than 80%	100% plus
Energy (kcal)	45 to 113	84 (19)	94	3 (13)	6 (26)	6 (26)
Protein (g/kg)	58 to 327	150 (66)	150	2 (9)	3 (13)	18 (78)
Calcium (mg)	9 to 92	45 (26)	35	18 (78)	18 (78)	-
Iron (mg)	51 to 313	93 (54)	85	8 (35)	10 (43)	6 (26)
Vitamin A (RE)	30 to 1,547	228 (324)	116	5 (22)	5 (22)	16 (70)
Thiamin (mg)	34 to 728	188 (151)	190	5 (22)	7 (30)	16 (70)
Riboflavin (mg)	45 to 358	192 (72)	200	2 (9)	2 (9)	21 (91)
Niacin (mg)	37 to 284	124 (60)	111	2 (9)	4 (17)	14 (61)
Vitamin C (mg)	22 to 1,014	267 (295)	141	6 (26)	8 (35)	14 (61)

DRI=daily recommended intake; SD=standard deviation

Table 3. Daily intake, % DRI of macronutrients

Nutrients	Daily intake (g)	% DRI		
	Range	Range	Mean (SD)	Median
CHO	45 to 191	18 to 66	46 (13)	47
Protein	18 to 72	7 to 24	16 (4)	15
Fat	15 to 123	13 to 75	38 (15)	37

DRI=daily recommended intake; SD=standard deviation; CHO=carbohydrate

Table 4. Laboratory data, cases of deficiency

Laboratory data	Range	Mean (SD)	Cases of deficiency; n (%)
Hemoglobin (g/dL)	10.7 to 13.9	12.3 (0.84)	3 (13)
BUN (mg/dL)	4.6 to 16.2	10.5 (3)	1 (4)
Albumin (g/dL)	3.5 to 4.9	4.3 (0.3)	-
Ferritin (ng/mL)	6.9 to 70.3	31.5 (17.6)	3 (13)
RBC folate (ng/mL)	422 to 3,001	897 (553)	-
Vitamin C (ng/mL)	0.15 to 0.91	0.51 (0.22)	5 (22)

SD=standard deviation; BUN=blood urea nitrogen; RBC=red blood cell

Table 5. Average level of BUN and protein intake

Protein intake	Inadequate (2 cases); mean (SD)	Adequate (16 cases); mean (SD)	Excessive (5 cases); mean (SD)
BUN (mg/dL)	7.9 (4.7)	10.4 (2.7)	11.6 (3.4)

SD=standard deviation; BUN=blood urea nitrogen

and normal length were 68.5 (31) and 59.6 (31) months, respectively. Physical examinations revealed glossitis in 65%, dental caries in 56%, and gingivitis in 26%. All cases with gingivitis also had glossitis. Laboratory investigations (Table 5) revealed anemia in three cases (13%), low BUN level at 4.6 mg/dL in one case, and protein intake at 1.2 g/kg/day (58% DRI), iron deficiency in three cases (13%) including iron deficiency anemia in one case, and vitamin C deficiency in five cases (22%). All cases had normal level of RBC folate and serum albumin.

Serum levels of nutrients, nutrient deficiencies, feeding problems, and malnutrition were related to nutrient intakes. Mean of BUN was related to level of protein intake, as follow 11.6 (3.4), 10.4 (2.7), and 7.9 (4.7) mg/dL in excessive, adequate, and inadequate intakes, respectively (Table 6). Fifteen children with glossitis also had gingivitis in 40%, vitamin C deficiency in 13%, and inadequate intake of micronutrients, including iron in 33%, vitamin C and A in 27%, vitamin B1 in 20%, vitamin B2 in 13%, and vitamin B3 in 7%. Children with glossitis had average (SD) daily vitamin B2 intake of 1.1 (0.5) mg, lower than 1.3 (0.3) mg of those without glossitis. Serum ferritin and vitamin C were correlated to % DRI of iron (p=0.6) and vitamin C (p=0.5), respectively (Table 7 and 8). All children with iron deficiency had iron intake less than 100% DRI. Only 60% of children with vitamin C deficiency had vitamin C intake less than 100% DRI (Table 7, 8). Children with intake of E at more than 100% DRI, no feeding problem, and tube feedings, were underweight in 38%, 44%, and 33%, respectively. The prevalence of underweight was increased to 60%, 57%, and 55% in children with E intake less than 100% DRI (p=0.28), feeding problems (p=0.43), and oral feeding (p=0.46), respectively (Table 9). Children with E intake more than 100% DRI and tube feeding had normal length (p=0.019 and 0.26, respectively). Children with stunting had feeding problems in 36% and 33% with no feeding problems. Three children were normal length but only one case fed via gastrostomy tube was underweighted. E intake less than 100% DRI was statistically significantly related to stunting, with prevalence of 53%.

Table 6. % DRI of iron, serum ferritin and cases of iron deficiency

% DRI of iron	Less than 67% (8 cases)	67% to 99% (9 cases)	100% plus (6 cases)
Serum ferritin (ng/mL); mean (SD)	23.5 (14.7)	30.7 (15.1)	43.2 (20.5)
Number of cases with iron deficiency*	2	1	-

DRI=daily recommended intake; SD=standard deviation

* Fisher's exact test (p=0.6)

Table 7. % DRI of vitamin C, serum vitamin C and cases of vitamin C deficiency

% DRI of vitamin C intake	Below 67% (6 cases)	67% to 99% (3 cases)	100% plus (14 cases)
Serum vitamin C (ng/mL); mean (SD)	0.31 (0.11)	0.47 (0.21)	0.61 (0.21)
Number of cases with vitamin C deficiency*	2	1	2

DRI=daily recommended intake; SD=standard deviation

* Fisher's exact test (p=0.5)

Table 8. Underweight and related factors: energy intake, feeding problems, and route

Related factors	Underweight (12 cases)	Normal weight (11 cases)	p-value*
Energy intake			0.59
Inadequate (3 cases)	1	2	
Adequate (20 cases)	11	9	
Energy intake			0.28
Less than 100% DRI (15 cases)	9	6	
100% DRI plus (8 cases)	3	5	
Feeding problems			0.43
Yes (14 cases)	8	6	
No (9 cases)	4	5	
Feeding			0.46
Via tube (3 cases)	1	2	
Oral (20 cases)	11	9	

DRI=daily recommended intake

* Fisher's exact test

Table 9. Stunting and related factors: energy intake, feeding problems, and route

Related factors	Stunting (8 cases)	Normal length (15 cases)	p-value*
Energy intake			0.1
Inadequate (3 cases)	1	2	
Adequate (20 cases)	7	13	
Energy intake			0.01
Less than 100% DRI (15 cases)	8	7	
100% DRI plus (8 cases)	-	8	
Feeding problems			0.6
Yes (14 cases)	5	9	
No (9 cases)	3	6	
Feeding			0.26
Via tube (3 cases)	-	3	
Oral (20 cases)	8	12	

DRI=daily recommended intake

* Fisher's exact test

Discussion

The present study revealed the risk factors for CP such as prematurity, asphyxia, and epilepsy were consistent with the previous reviews[2,3]. Seventy-seven percent of children with CP received anti-epileptic drugs, which was slightly higher than 51.7% of the Turkish study[15]. Sixty-one percent had feeding problem including oropharyngeal dysphagia in the present study, which was consistent with 58.4% of the Turkish study[15], and 60% of the severely disabled Swedish children[16]. However, less than 90% of Italian infants with CP had feeding problem[6]. Because of the prevalence of oropharyngeal dysphagia in ambulatory CP reduced with increasing age and resolved by 60 months[17], the prevalence of feeding problems in older children with CP should be lower than in infants. In the present study, inadequate intakes of E, calcium, and iron were commonly found in children with CP as in the previous Danish and Finnish reports[18,19]. In the present study, the median E intake was 86% of DRI and intake less than 80% DRI revealed 26%, compared to 76% and 57% of the Finnish study, respectively[18]. So, E intake in the present study was higher than in the Finnish study[18]. CHO:fat:protein ratio was 46:38:16, in the present study and was similar to 46:37:17 from the previous review[6], and 50:32:17 in the Finnish study[18]. There was no difference in macronutrient intake of Australian children between normal and CP[20]. A low micronutrient intake was common in children with CP similar to the previous review[6]. In the present study, inadequate intake of calcium was 78%, and the median intake was 35% DRI. Compared to the previous reports, low calcium intake was only 35%[6], and the median intake was 142% in Finnish study[18]. The insufficient daily intake of niacin was found at 26% in the present study was lower than 65% in the previous review[6]. Low iron intake in the present study was found in 74%, which is higher than 60% of the previous review[6]. Because of distinct cultures between European and Asian countries, that milk consumption in children was higher in European countries than Asian countries. In addition, there was different in food consumption and DRI.

The prevalence of underweight in children with CP was 52% in the present study was higher than 34.6% in Thai children with CP[8], and the others at 43%, 44%, and 47.5%, in the Swedish[16], Italian[21], and Bosnian[7] studies, respectively. In the present study, the prevalence of stunting was 35%. Prevalence of underweight and stunting in Indian children with CP was high as 82.9% and 85.4%, respectively[22]. Because of higher prevalence of underweight and stunting in under-5- year Indian children was 33.4% and 34.7% in 2017, respectively, compared to prevalence of 6.7% and 10.5%, respectively, in under-5-year Thai children (2016)[23]. The prevalence of malnutrition was different between studies because the different growth references were used. There was no overnutrition in the present study, compared to 9% and 11.3%, in the Swedish[16] and Bosnian studies[7], respectively. The E intake in the present study was slightly above 100% DRI, with the maximum of 113% DRI. The previous findings supported individuals with CP had low resting E expenditure[4]. Overall malnutrition rate in the present study was 57%, lower than 76.6% in the Turkish study[15]. According to E intake of below and above 100% DRI in the present study, the prevalence of underweight was 60% and 38%, respectively. The prevalence of stunting was found only in 53% of the children with E intake less than 100% DRI. This was similar to the Finnish study, which children with low E intake were shorter and lighter than children with sufficient E intake[18]. In the present study, children with feeding problems had prevalence of underweight in 57% and stunting in 36%. This is because feeding problems led to reduce daily E intake[21] and had a significant impact on malnutrition, as in the Bosnian study[7]. In the present study, the prevalence of underweight was 55% and 33% in oral-fed and tube-fed children, respectively. Stunting was only found in 40% of the children with oral feeding. This is because tube feeding was superior to oral feeding in terms of increasing body weight[24], which is similar to the Brazilian patients with gastrostomy feeding[25], and children with low E intake in oral feeding were shorter than children with sufficient E intake from tube feeding[18]. In the present study, underweight was not statistically significantly related with E intake, feeding problems, and route because of the small number of enrolled cases, the younger age, and short time effect on weight. Effect of inadequate E intake on stunting is a long-term effect. Therefore, in the present study, the mean (SD) age of children with stunting was higher than children with normal length. The % DRI of nutrient intake was analyzed by age groups, so the age of children had no effect on the results.

In the present study, physical examinations revealed glossitis in 65% and gingivitis in 26%, suggestive of micronutrient deficiencies[6]. This is due to the insufficient intakes of protein, iron, vitamin C, A, B1, B2, and B3. There were similar evidence indicating the inadequate intakes of vitamins and minerals from the previous reports, as the majority of Indian children with CP had vitamin B complex deficiency in 90.2%[22]. That review study confirmed that a low micronutrient intake was common in children with CP, which included niacin 65%, iron 60%, and folate 40%[6]. Overall, the previous study found low dietary intakes and micronutrient deficiencies in children with CP, especially in those not receiving nutritional supplements[4,6]. In the present study, dental caries presented in 56%, due to difficulties in oral hygiene and dependence on their caregiver, as reported from literature review[6,26].

With regards to laboratory analysis, the present study revealed anemia in 13%, iron deficiency in 13%, iron deficiency anemia in 4%, vitamin C deficiency in 22%, no folate deficiency, and no hypoalbuminemia. Iron deficiency in the present study was similar to the Danish study at 14%[19] and 13.8% of the previous review[6]. The previous reports revealed the different prevalence of nutrient deficiencies, including 75.6% anemia in Indian children[22], 13% iron deficiency anemia in the Italian study[21], 22% with low serum folate in the Danish study[6,19], and 30% with low serum albumin in Italian children[21]. In the present study, children with vitamin C deficiency had vitamin C intake less than 100% DRI with only 60% and 40% that had intake above 100% DRI. Vitamin C is heat-labile, and Thailand is hot. Therefore, loss of vitamin C from foods could be from improper handling, processing, and storage.

Nutritional status can influence brain plasticity and function via a mediator. Brain-derived neurotrophic factor is significantly reduced in underweighted children, severe CP, and suboptimal dietary intake[24]. Daily dietary intake and feeding problems of children with CP should be evaluated and advised. An initiation of enteral nutrition and pediatric formulas should be used to prevent malnutrition and avoid micronutrient deficiencies[5]. The previous study suggested that protein intake of 2 g/kg/day and an additional 15 to 20% increase of calorie intake may be sufficient to guarantee "catch up growth"[6]. In addition, oral health should be considered a vital component for CP patients[26].

Conclusion

Children with CP commonly had nutritional problems due to feeding difficulties and inadequate nutrient intakes. Stunting is statistically significantly related with E intake less than 100% DRI. Nutritional support with proper and adequate balanced diet should be done to prevent malnutrition and promote health of Thai children.

What is already known on this topic?

Children with CP often have feeding difficulties leading to inadequate intakes and malnutrition in Thailand.

What this study adds?

While the majority of cases in the present study had feeding difficulties, only 13% were tube feeding. It is difficult for the parents to accept tube feeding for their children.

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Conflicts of interest

The authors declare no conflict of interest.

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