JOURNAL OF
EXERCISE THERAPY
AND REHABILITATION

Journal of Exercise Therapy and Rehabilitation. 2026;13(1):67-77. DOI: 10.15437/jetr.1756019

ORIGINAL ARTICLE

Cerebral palsy and nutrition: effects of gross motor function on eating behaviour

Serebral palsi ve beslenme: kaba motor fonksiyonun yeme davranışına etkileri

Hakan TOĞUÇ[1], Osman SÖYLER[2], Hakan AYDIN[3], Zehra FİDAN[4]

Abstract

Purpose: Cerebral palsy (CP) is a movement disorder that develops due to brain damage and is usually seen in childhood. Common feeding problems in individuals with CP can negatively affect health and quality of life. This study aims to investigate the effects of gross motor function on eating behaviour and nutritional status in children with CP.

Methods: This study is a cross-sectional study conducted with 50 children diagnosed with CP at a rehabilitation centre. Participants were administered socio-demographic information, The Children's Eating Behavior Inventory (CEBI), the Gross Motor Function Classification System (GMFCS), and the Paediatric Functional Independence Measure (WeeFIM); their nutritional status was measured using 24-hour food consumption records, and anthropometric measurements and muscle strength were assessed. Independent t-test, Mann-Whitney-U test, Pearson and Spearman correlations, and multiple regression analyses were used in the analysis of the data.

Results: The average age of the participants was 8.32±3.60 years, 52% were male and 48% were female. It was found that children with CP met 70.61% of their energy requirements and 53.17% of their fibre requirements. As the GMFCS level increased, WeeFIM ($p<0.001$) and CEBI-skill ($p<0.001$) decreased and underweight increased ($p=0.015$). In addition, a significant positive correlation was found between right and left quadriceps, right and left biceps, and right and left triceps muscle strength and CEBI-skill ($p<0.05$).

Conclusion: These findings demonstrate an increase in GMFCS and malnutrition in children with CP. A proper feeding strategy can positively influence motor function and general health.

Keywords: Cerebral palsy, Nutritional status, Functional status, Eating.

Öz

Amaç: *Serebral palsi (SP), beyin hasarı nedeniyle gelişen ve genellikle çocukluk çağında görülen bir hareket bozukluğudur. SP'li bireylerde sık görülen beslenme sorunları, sağlık ve yaşam kalitesini olumsuz etkileyemektedir. Bu çalışmanın amacı serebral palsili çocuklarda kaba motor fonksiyonların yeme davranışı ve beslenme durumu üzerindeki etkilerini araştırmayı amaçlamaktı.*

Yöntem: *Bu çalışma, bir rehabilitasyon merkezinde SP tanısı konmuş 50 çocukla yapılan kesitsel bir çalışmadır. Katılımcılara sosyo-demografik bilgiler, Çocukların Yeme Davranışı Envanteri (CEBI), Kaba Motor Fonksiyon Sınıflandırma Sistemi (GMFCS) ve Pediatrik Fonksiyonel Bağımsızlık Ölçeği (WeeFIM) uygulandı. Beslenme durumları 24 saatlik gıda tüketim kayıtları kullanılarak ölçüldü ve antropometrik ölçümler ile kas gücü değerlendirildi. Verilerin analizinde bağımsız t-testi, Mann-Whitney-U testi, Pearson ve Spearman korelasyonları ve çoklu regresyon analizleri kullanıldı.*

Bulgular: *Katılımcıların yaş ortalaması 8,32±3,60 yıl, %52'si erkek ve %48'i kadındır. SP'li çocukların enerji ihtiyaçlarının %70,61'ini ve lif ihtiyaçlarının %53,17'sini karşıladıkları tespit edildi. GMFCS seviyesi arttıkça, WeeFIM (p<0,001) ve CEBI-beceri (p<0,001) azaldığı ve yetersiz beslenmenin arttığı (p=0,015) tespit edildi. Ayrıca, sağ ve sol kuadriseps, sağ ve sol biseps ve sağ ve sol triseps kas gücü ile CEBI-beceri arasında anlamlı pozitif korelasyon bulundu (p<0,05).*

Sonuç: *Bu sonuçlar, SP'li çocuklarda yetersiz ve dengesiz beslenmenin yaygın olduğunu göstermektedir. SP'li çocuklarda uygun bir beslenme stratejisi, motor fonksiyonları ve genel sağlığı olumlu yönde etkileyebilir.*

Anahtar Kelimeler: *Serebral palsi, Beslenme durumu, Fonksiyonel durum, Yeme.*

1: Department of Nutrition and Dietetics, İnönü University, Malatya, Türkiye
2: Department of Orthopaedic Prosthetics and Orthotics, Lefke European University, Lefke, Turkish Republic of Northern Cyprus
3: Department of Physiotherapy and Rehabilitation, Lokman Hekim University, Ankara, Türkiye
4: Department of Physiotherapy and Rehabilitation, İstanbul Aydın University, Istanbul, Türkiye
Corresponding Author: Hakan Toğuç : hakan.toguc@inonu.edu.tr
ORCID IDs (order of authors): 0000-0002-8134-1151; 0000-0002-2798-0649; 0000-0003-2761-7935; 0009-0009-3977-9713
Received: August 1, 2025. Accepted: February 14, 2026.

INTRODUCTION

Cerebral Palsy (CP) is a movement disorder caused by prenatal, intrapartum or postnatal brain damage and represents the most common childhood disability globally, affecting 2-3 per 1000 births.[1] While the exact origins of CP remain unclear, factors such as prenatal and intrapartum oxygen deficiency, infections and cerebral haemorrhage are known risks.[2] CP impairs muscle coordination and body movements, typically manifested by impaired motor functions, spasticity, involuntary movements and imbalance, making feeding and eating behaviours difficult.[3] Nutritional problems, inadequate food intake, swallowing difficulties (dysphagia) and gastrointestinal complications are frequently observed in individuals with CP. These problems may lead to serious consequences including growth retardation, malnutrition and decreased quality of life.[4]

Nutrition includes the intake, digestion, absorption and metabolism of nutrients necessary for growth, development and maintenance of body health. Assessment of nutritional status is critical for improving overall health and quality of life in individuals with CP. Feeding difficulties in these individuals may result from dysphagia, anorexia, inadequate chewing and gastrointestinal problems.[5] Oral-motor dysfunction is common in children with SP, characterised by irregularities in orofacial muscle tone and coordination due to central motor control impairment, impaired bolus formation/transfer, and reduced safety–efficiency of swallowing.[6] These pathomechanisms can exacerbate feeding difficulties through prolonged meal duration, inadequate intake, choking/coughing, and aspiration risk, and the severity of oral phase disorders tends to increase as the Gross Motor Function Classification System (GMFCS) level worsens.[7] As a result of this situation, nutritional problems can be observed in a significant proportion of children with CP and thus growth and development are negatively affected.[8] In a study by Donkor et al.[9] malnutrition was found in 90% of children with CP. Similarly, in a study conducted by Sullivan et al.[8] growth retardation and malnutrition were found in a significant proportion of children with CP. This shows that these individuals cannot meet their daily calorie, protein and other nutritional needs.

As the gross motor function level worsens in children with CP, postural control and selective motor control limitations increase; this negatively affects oral phase skills (chewing, bolus control) and the safety/efficiency of swallowing, leading to more frequent and severe feeding-swallowing difficulties. This relationship is supported by clinical assessment-based findings showing that oropharyngeal dysphagia increases in a graded manner with GMFCS in preschool children with CP.[7] Similarly, parent-reported studies have indicated that as gross motor function deteriorates, children's ability to consume/eat different food textures decreases; consequently, inadequate intake, prolonged meal times, and increased feeding risks are reported.[10] In this context, it is important to assess anthropometric measurements and muscle strength in the study to reveal not only the eating-swallowing function but also the physical outcome of this functional loss; as feeding difficulties can have measurable effects on dietary intake and growth, and deterioration in growth/nutrition status can further compromise functional capacity.[6] Therefore, studies addressing gross motor function level, nutritional-anthropometric measurements and nutritional status within the same framework are required for the early diagnosis of high-risk subgroups and the targeting of rehabilitation-dietetics-nutrition management according to motor severity. This study aims to examine the effects of gross motor function on eating behaviours and nutritional status in children with CP.

METHODS

This cross-sectional study was conducted at a rehabilitation centre in eastern Turkey. The study was conducted between July 2024 and December 2024. The study was approved by the İnönü University Health Sciences Non-Interventional Clinical Research Ethics Committee on 16 April 2024 in accordance with the Helsinki Declaration (Ref. No: 2024/5871). The parents responsible for the care of the participants were informed about the study and written informed consent was obtained.

The inclusion criteria for the study were: having a diagnosis of CP, being between 3 and 18 years of age, and voluntary participation in the study as confirmed by the primary caregiver. At the start of the study, 58 participants were reached, but 5 of them were excluded from the study because they were over 18 years of age, and 3 withdrew from the study, so the study was completed with 50 participants. The data collected included socio-demographic information, The Children's Eating Behavior Inventory (CEBI), GMFCS, Paediatric Functional Independence Measurement (WeeFIM), 24-hour food records, anthropometric and muscle strength measurements.

The Children's Eating Behavior Inventory (CEBI)

This scale was developed to determine the eating behaviours of children with disabilities who require medical treatment by Archer, Rosenbaum and Streiner[11] and adapted into Turkish by Kürtüncü and Arslan.[12] It consists of 19 items on a five-point Likert scale. The scale consists of five subscales: family, skills, negativity, emotions, and permission.

The Gross Motor Function Classification System (GMFCS)

GMFCS is a standardised tool developed by Palisano et al.[13] to classify gross motor function in children with CP based on their ability to move independently, with a particular focus on sitting, transfer and mobility skills. The system consists of five levels (I–V) that reflect differences in functional limitations and the need for assistive devices. GMFCS ensures consistent and reliable classification of motor function in clinical and research settings. The Turkish adaptation and validity of GMFCS were conducted by El et al.[14] Because the distribution of GMFCS levels was markedly imbalanced in our sample, GMFCS was collapsed into two clinically meaningful categories to improve the stability of statistical comparisons: levels I–III (ambulatory/more mobile) and levels IV–V (limited mobility/non-ambulatory).

The Paediatric Functional Independence Measure (WeeFIM)

The scale is a standardised assessment tool developed to evaluate functional abilities and functional independence in children. Adapted from the Functional Independence Measure (FIM) for adults, the WeeFIM assesses 18 items across three domains: self-care, mobility, and cognition. Each item is scored on a 7-point scale indicating the level of assistance required to perform the task. This scale provides a comprehensive understanding of a child's functional abilities in daily life and is widely used in clinical and research settings related to paediatric rehabilitation. WeeFIM was developed by Kim et al.[15] and its Turkish adaptation and validity were conducted by Tur et al.[16]

Food Consumption Record

Information on children's food consumption over the past 24 hours was collected through questions asked to mothers; the amounts of food consumed were recorded in a way that mothers could express more accurately, with examples of measurement units provided.[17]

Anthropometric Measurements

Height was calculated as estimated height using validated equations appropriate for age and gender, based on stature measured with a stadiometer in children who could stand safely for measurement, or based on tibia length measured in a sitting/supine position when standing measurement was not possible. Height (cm) = 32.3 + 3.14 × Tibia length (cm) has been calculated.[18] Knee lengths and upper mid-arm circumferences (MUAC) were taken using an inflexible tape measure. Body weights were obtained with a weighing scale.[17] MUAC z-score, body mass index (BMI) z-score and height-for-age (HFA) z-score were calculated according to World Health Organisation standards.[19]

Handgrip And Muscle Strength Assessment

Handgrip strength was assessed bilaterally using a hand dynamometer (Lafayette Manual Muscle Tester, Model 01163, USA) in a standardized seated position (shoulder adducted and neutrally rotated, elbow at 90° flexion, forearm neutral, wrist in 0–30° extension and 0–15° ulnar deviation). After a standardized instruction, three trials were performed for each hand with ≥30 s rest intervals, and the mean of the three trials was used for analyses. Quadriceps, biceps, and triceps strength were evaluated bilaterally by an experienced physiotherapist using manual muscle testing (MMT; 0–5 scale). Quadriceps was tested in sitting with hip and knee at 90° flexion against resisted knee extension (resistance applied to the distal tibia), whereas biceps and triceps were tested in sitting against resisted elbow flexion (forearm supinated) and elbow extension, respectively (resistance applied to the distal forearm).[20] All MMT procedures were performed with standardized verbal cues and stabilization to minimize compensations.

Statistical analysis

The sample size was calculated using G*Power under the assumption of an independent samples t-test to test the difference in eating behaviour scale scores according to GMFCS level (I–III vs IV–V). Based on Toğuç et al.'s[21] report of significant differences in clinical outcomes according to GMFCS levels in children with CP and the large effect size (Cohen's d≈0.80) derived from the reported group mean±SD values, a minimum total sample size of N=42 was found for α=0.05 and power=0.80. At the end of the study, data was collected from 50 participants and the study was completed accordingly.

Data analysis was performed using the IBM SPSS 22.0 software package, and food consumption records were analysed using the BeBIS 8.2 software package. To increase the stability and interpretability of comparisons between groups within the GMFCS and to reduce the risk of unreliable estimates arising from sparse groups, the GMFCS was clinically divided into two meaningful categories: Grades I-III (able to walk or more mobile) and Grades IV-V (limited mobility/unable to walk). Descriptive statistics include means, standard deviations, and percentages. Normality was assessed using histograms, the Shapiro-Wilk Test, Q-Q plots, and skewness and kurtosis within ±1.00. Intergroup comparisons were performed using the independent samples t-test for variables showing a normal distribution and the Mann-Whitney U test for variables showing a non-normal distribution. For relationship analyses, Pearson correlation was used for continuous variables showing a normal distribution, and Spearman rank correlation was used for non-normal and/or ordinal variables. The effect of demographic information and GMFCS level on eating behaviour was analysed using multiple regression analyses. Statistical significance was set at $p<0.05$.

RESULTS

The general information of the participants is shown in Table 1. The average age of the participants was 8.32±3.60 years, 52% were male and 48% were female. The father's education level of 40% and the mother's education level of 52% of the participants was primary school or below. Family income of 48% of children with CP was less than their expenses. Children's energy intake was 1237.26±391.56 kcal, carbohydrate intake 132.26±58.91 g, protein intake 47.04±16.27 g, fat intake 55.97±17.56 g, saturated fat intake 22.56±7.16 g and fibre intake 13.44±7.91 g.

Table 2 summarises the comparative analyses of WeeFIM, CEBI, anthropometric indices, and muscle strength according to participants' GMFCS levels. For analytical purposes, participants were grouped as GMFCS I–III versus GMFCS IV–V. With respect to functional independence, the GMFCS IV–V group exhibited significantly lower performance than the GMFCS I–III group across multiple WeeFIM domains. Specifically, scores were reduced for self-care ($p<0.001$), sphincter control ($p=0.009$), transfers ($p=0.004$), locomotion ($p<0.001$), communication ($p=0.003$), and social cognition ($p<0.001$). Consistent with these domain-level findings, the WeeFIM total score was also significantly lower in participants classified as GMFCS IV–V ($p<0.001$). Collectively, these results indicate that greater motor impairment is associated with broader limitations in activities of daily living, mobility, and communication-related functioning. Turning to eating behaviour outcomes, participants in the GMFCS IV–V group demonstrated significantly lower scores on the Skill subscale ($p<0.001$) and on the CEBI total score ($p=0.012$) compared with those in the GMFCS I–III group. This pattern suggests that increasing severity of motor limitation may be accompanied by less favourable eating behaviour profiles, particularly with respect to eating-related skills. In parallel, group comparisons of anthropometric measures revealed significant differences in indicators related to nutritional status. The GMFCS IV–V group had lower BMI ($p=0.028$), MUAC ($p=0.012$), and MUAC z-score ($p=0.022$) than the GMFCS I–III group. These findings imply that

Table 1. Demographic data for participants (N=50).

	n (%)
Type of birth	
Normal	22 (44)
C-section	28 (56)
Gender	
Male	26 (52)
Female	24 (48)
Seizure presence	
Yes	15 (30)
None	35 (70)
Father's education	
Illiterate	1 (2)
Primary	19 (38)
High school	19 (38)
University	11 (22)
Mother's education	
Illiterate	4 (8)
Primary	22 (44)
High school	19 (38)
University	5 (10)
Family income status	
Income exceeds expenses	2 (4)
Income and expenditure equal	24 (48)
Income less than expenditure	24 (48)
	Mean±SD
Age (years)	8.3±3.6
Birth weight (g)	2393.4±1045.5
Food consumption	
Energy (kcal)	1237.3±391.6
Carbohydrate (g)	132.3±58.9
Protein (g)	47.0±16.3
Fat (g)	56.0±17.6
Saturated fat (g)	22.6±7.2
Fiber (g)	13.4±7.9

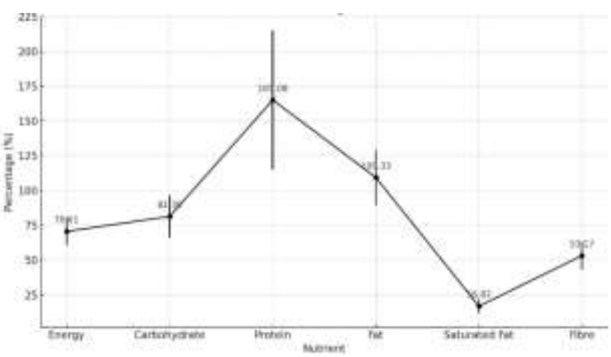

Figure 1. Comparison of participants' food consumption according to recommended daily intake.

participants with more severe functional impairment may be at greater risk of suboptimal anthropometric status. Finally, muscle strength assessments showed a consistent and marked reduction in the GMFCS IV–V group relative to the GMFCS I–III group. Strength values for the right and left quadriceps, biceps, and triceps, as well as right and left handgrip force, were all significantly lower among participants classified as GMFCS IV–V (all $p<0.001$). This uniform decrement across both upper and lower limb measures underscores the close association between higher GMFCS levels and diminished muscular strength.

The graph comparing the food consumption of the participants according to the recommended daily intake is given in Figure 1. According to the recommended daily intake, the participants met 70.61% of their energy needs, 81.39% of their carbohydrate needs, 165.08% of their protein needs, 109.33% of their fat needs and 53.17% of their fibre needs. It was also found that saturated fat intake constituted 16.82% of total energy.

Information about the relationship between participants' eating behaviour scores (CEBI) and muscle strength is given in Table 3.

Accordingly, a positive and moderately significant relationship was found between skill-related eating behaviour and right and left quadriceps, biceps and biceps (p=0.001; p=0.002; p=0.001; p=0.001; p=0.001; p=0.001; p=0.001; p=0.001; p=0.001; p=0.001; p=0.002, respectively). In addition, a moderately significant relationship was found between permissive eating behaviour and right triceps and between total eating behaviour scores and right biceps (p=0.002) and triceps and left triceps (p=0.015; p=0.020; p=0.016, respectively).

CEBI total score showed weak-to-moderate positive associations with muscle strength and handgrip strength (Spearman’s rho=0.29–0.45, all $p<0.05$), with the strongest correlation observed for right handgrip (p=0.45). No significant associations were found with left quadriceps and left triceps strength ($p>0.05$). In contrast, the skill-related CEBI subscale was moderately correlated with bilateral quadriceps, biceps, triceps strength and bilateral handgrip strength (p=0.40-0.55, all $p\leq0.004$).

Table 2. Comparison of WeeFIM, The Children's Eating Behavior Inventory (CEBI), anthropometric measurements and muscle strength according to GMFCS levels.

	GMFCS Grade I–III (n=33) (Mean±SD)	GMFCS Grade IV–V (n=17) (Mean±SD)	p
Anthropometric measurements			
Height (cm)	121.52±22.54	112.88±16.73	0.134
Bodt weight (kg)	25.80±14.10	18.18±7.79	0.038*
Body mass index (kg/m^2)	16.31±3.75	13.87±2.94	0.028*
Mid-arm circumferences	19.09±4.31	16.47±2.92	0.015*
WeeFIM			
Self-Care	15.88±13.18	1.71±3.79	<0.001*
Sphincter control	6.79±7.23	2.35±6.52	0.009*
Transfer	9.85±10.59	3.24±10.89	0.004*
Locomotion	11.82±6.84	2.06±2.49	<0.001*
Comminication	15.97±11.20	6.24±6.08	0.003*
Social cognition	13.30±6.55	5.65±7.06	<0.001*
WeeFIM total scores	21.18±11.24	8.94±11.15	<0.001*
The Children's Eating Behavior Inventory (CEBI)			
Family	7.15±5.16	6.29±3.65	0.668
Skill	13.85±5.24	8.18±3.15	<0.001*
Negativity	6.18±3.16	5.88±3.22	0.554
Emotion	11.30±3.07	11.47±3.71	0.694
Permission	9.76±3.82	7.71±3.55	0.073
CEBI total score	48.24±12.06	39.53±9.55	0.012*
Quadriceps muscle strength			
Right	2.21±1.17	0.65±0.70	<0.001*
Left	2.15±1.09	0.59±0.71	<0.001*
Biceps muscle strength			
Right	2.18±1.16	0.35±0.70	<0.001*
Left	2.15±1.06	0.35±0.70	<0.001*
Triceps muscle strength			
Right	2.15±1.06	0.59±0.80	<0.001*
Left	2.06±1.00	0.53±0.72	<0.001*
Grip force			
Right	5.99±7.44	0.85±0.90	<0.001*
Left	5.08±4.84	0.79±0.86	<0.001*
Malnutrition scores (Z-Score)			
Body mass index (Z-Score)	2.73±1.57	2.00±1.41	0.083
Mid-arm circumferences (Z-Score)	3.48±1.30	2.59±1.23	0.022*
Height-For-Age (Z-Score)	2.36±1.27	1.65±0.86	0.054

* p<0.05. GMFCS: Gross Motor Function Classification System. WeeFIM: Paediatric Functional Independence Measurement.

Table 3. The relationship between participants' The Children's Eating Behavior Inventory (CEBI) scores and muscle strength.

		The Children's Eating Behavior Inventory (CEBI)					
		Family	Skill	Negativity	Emotion	Permission	CEBI Total
Right quadriceps	r	-0.018	0.481**	0.042	0.009	0.164	0.274
	p	0.901	0.001	0.771	0.952	0.255	0.054
Left quadriceps	r	-0.009	0.422**	0.003	-0.031	0.123	0.217
	p	0.948	0.002	0.985	0.829	0.397	0.131
Right biceps	r	-0.081	0.510**	0.028	0.200	0.264	0.343*
	p	0.574	0.001	0.848	0.164	0.064	0.015
Left biceps	r	-0.052	0.484**	-0.041	0.216	0.260	0.328*
	p	0.721	0.001	0.776	0.132	0.068	0.020
Right triceps	r	-0.020	0.459**	0.008	0.122	0.327*	0.338*
	p	0.890	0.001	0.956	0.400	0.020	0.016
Left triceps	r	-0.094	0.427**	-0.018	0.130	0.273	0.273
	p	0.514	0.002	0.903	0.367	0.056	0.055
Right grip force	rho	0.128	0.276	0.095	0.092	0.114	0.261
	p	0.375	0.052	0.511	0.524	0.429	0.067
Left grip force	rho	0.118	0.208	0.016	0.117	0.150	0.224
	p	0.414	0.147	0.913	0.417	0.298	0.118

* p<0.05. p: Pearson Correlation test. rho: Spearman Correlation test. CEBI: The Children's Eating Behavior Inventory.

Table 4. Relationship between demographic variables and the Gross Motor Function Classification System (GMFCS) group and eating behaviour (The Children's Eating Behavior Inventory, CEBI).

Predictor	B	SE	%95 CI (Lower–Upper)	p
Age	0.678	0.416	(−0.136) – (1.493)	0.103
Gender	−0.821	3.717	(−8.106) – (6.463)	0.825
Parental educational level	−3.322	2.343	(−7.914) – (1.269)	0.156
GMFCS (IV–V vs I–III)	−7.989	3.350	(−14.556) – (−1.422)	0.017

Model: F:3.61, R^2=0.243, p=0.012, multiple regression analysis model, GMFCS: Gross Motor Function Classification System, p<0.05.

The multivariate linear regression model examining the relationship between demographic variables and the GMFCS group and eating behaviour (CEBI) is presented in Table 4. In the model, when age, gender, and parental education level were controlled for, being in the GMFCS IV–V group was associated with a significant and independent decrease in the CEBI total score (B = −7.99, 95% CI: −14.56 to −1.42; p = 0.017). In contrast, age, gender, and parental education level were not found to be significant independent predictors of the CEBI total score (all p>0.05). The model showed that the variables (age, gender, parental education level, and GMFCS group) explained approximately 24.3% of the total variance in the CEBI score.

DISCUSSION

In this cross-sectional study, children with GMFCS IV–V levels demonstrated significantly lower functional independence in multiple domains and total scores of the WeeFIM compared to the GMFCS I–III group. Furthermore, as GMFCS severity increased, a more negative profile characterised by lower scores, particularly in the 'Skill' subdomain of eating behaviour and the CEBI total score, was observed. Finally, the insufficient fulfilment of energy (70.61%) and fibre (53.17%) requirements, accompanied by lower MUAC Z-scores and marked muscle weakness in the GMFCS IV–V group, suggested that nutritional status and physical capacity may be simultaneously adversely affected in severe motor impairment.

In this study, the relationship between children's gross motor skills and feeding/eating behaviours was assessed in 50 participants diagnosed with CP. The participants' parents had a low level of education (40% of fathers and 52% of mothers had primary school education or below) and low socioeconomic status (48% of families had income below expenditure); similar findings have been reported in studies by Sel et al.[22] and Piştav Akmeşe et al.[23] These data suggest that having a child with CP may be more frequently associated with low parental educational attainment and low economic status.

As GMFCS levels increased, children's scores for self-care, transfers, communication, social cognition, and overall independence were found to decrease significantly. A study by Bakkaloğlu et al.[24] also observed similar results and found that functional independence decreased as GMFCS levels increased. Similarly, a study by Günel et al.[25] reported that WeeFIM scores decreased as the GMFCS level increased. These results demonstrated that the study findings were consistent with the literature and predicted that an increase in GMFCS scores would reduce functional independence in children.

In this study, when examining eating behaviour outcomes, participants in the GMFCS IV–V group demonstrated significantly lower scores on the skill subscale and CEBI total score compared to those in the GMFCS I–III group. This pattern suggests that increasing severity of motor impairment may be associated with less favourable eating behaviour profiles, particularly in terms of eating-related skills. One study reported that feeding difficulties and oral-motor dysfunction are highly prevalent in children with CP and that a significant proportion of clinically meaningful problems are affected.[26] Specifically, the 'motor severity–eating skill' link is reinforced by findings from a large cohort showing that the ability to eat different consistencies/textures decreases as the GMFCS level increases.[10] Furthermore, it has been demonstrated that swallowing difficulties with critical safety implications, such as oropharyngeal dysphagia, are prevalent in preschool children with CP and correlate with more severe gross motor levels; this indicates that the decline in 'eating ability' intersects not only with skill/independence but also with the dimension of safe swallowing.[7]

Methods such as age-specific MUAC z-score, BMI score, and age-specific height z-score are used to measure nutritional deficiencies in children with CP. This study found that age-specific MUAC z-scores decreased significantly as the GMFCS level increased. This indicates that the risk of malnutrition is higher in groups I-III than in groups IV-V. Similarly, another study found that the rates of thinness/underweight were very high in GMFCS V.[27] The difficulty in interpreting anthropometry in CP stems from systematic problems such as the inability to accurately measure height (contracture, spasticity, scoliosis, positioning difficulties), which leads to errors in BMI. At this point, MUAC is a practical alternative/complementary indicator as it is less dependent on height measurement. Indeed, recent evidence shows that the MUAC z-score can demonstrate good discriminatory power in screening for wasting in children with CP; although its sensitivity is limited on its own, diagnostic performance increases when combined with clinical factors.[28] Furthermore, it is emphasised that MUAC may be useful in screening the pre-school CP population; however, World Health Organisation cut-off points may need to be adapted specifically for CP.[29]

Providing adequate and balanced nutrition for children with CP is very difficult. In this study, it was found that participants met 70.61% of their energy requirements. Another study found that children with CP met 78.6% of their energy requirements.[30] Similarly, another study found that 72.4% of energy requirements were met.[31] This is thought to be due to difficulties in chewing and swallowing food and gastrointestinal complaints in children with CP. Furthermore, this study found that children's daily fibre requirements were met by 53.17%. Ecertaştan[31] found that 72.1% of children with CP consumed insufficient fibre, and Özder et al.[30] determined that children with CP met

15.8% of their daily fibre requirements. These data suggest that individuals with CP have low fibre intake, which may increase the incidence of constipation, a common complaint in CP.

A significant positive correlation was found between participants' eating skills and their right and left quadriceps, biceps, and triceps muscles. The eating behaviour and skill component (grasping the spoon/fork during eating, bringing it to the mouth, carrying it without spilling, managing the mouthful, etc.) inherently requires proximal stability of the upper extremity and distal force transmission. Biceps-triceps strength provides critical 'work capacity' for elbow flexion/extension control, smoothness of movement, and the repetitive cycle of bringing food to the mouth. Muscle rigidity and decreased muscle strength in CP can significantly affect hand/arm function and manual performance, which is reflected in bimanual/single-manual self-care tasks such as eating.[32] Weakness of the lower extremity anti-gravity muscles (including the quadriceps) may limit the 'freedom' of the upper extremity through sitting stability, pelvic control, postural adjustments, and balance strategies.[33] The moderate to high level of association between trunk control and upper extremity function reinforces this chain. In this context, quadriceps strength may be related not because it is directly the 'eating muscle' with CEBI–Skill, but because it contributes to the postural stability infrastructure that supports eating performance.[34] Along with these, Merino-Andrés et al.[35] state that strengthening these muscle groups improves motor functions and activities of daily living. In this context, skill-based eating behaviours are seen to be effective on these muscle groups, and the results of this study are consistent with the literature.

In this study, after controlling for age, gender, and parental education, the persistence of a decline in the CEBI total score at GMFCS IV–V level ($B \approx -7.99$; $p=0.017$) persists, suggesting that gross motor severity is not merely a reflection of demographic/familial factors; it is a clinical predictor that can independently predict difficulties in eating behaviour/mealtime processes.[36] This interpretation is consistent with cohort findings showing that children's likelihood of acquiring the ability to eat different textures decreases as GMFCS level increases, and with studies reporting that swallowing/feeding problems (including dysphagia) are more frequent and severe at more severe gross motor levels.[10] Therefore, GMFCS IV–V should be considered a high-risk phenotype not only for mobility but also for feeding behaviour problems; systematic feeding–swallowing screening and caregiver support strategies should be incorporated into clinical follow-up for this group at an early stage.[7]

Limitations

The single-centre structure and cross-sectional design of this study limit the generalisability of the findings and complicate causal interpretations. The assessment of food intake based solely on 24-hour dietary records and entirely on parental reports, coupled with the absence of the Eating and Drinking Ability Classification System measurement, increases the risk of measurement bias.

Conclusion

This study showed that gross motor function significantly affects eating behaviours and nutritional status in children with cerebral palsy. As GMFCS levels increased, significant decreases in independence and eating skills were observed, leading to inadequate fulfilment of energy and nutritional needs. Furthermore, a positive correlation was found between eating skills and muscle strength. These findings highlight the need for well-planned nutritional strategies and programmes for children with CP that can improve motor function and overall health. Future research should aim to develop more comprehensive nutrition and health programmes to improve the quality of life of these children.

Acknowledgement: The authors would like to thank all candidates who participated in this study.

Authors' Contributions: **HT:** Concept/idea development, study design, project management, data analysis/interpretation, literature review, writing, critical review; **OS:** Concept/idea development, study design, project management, writing, critical review; **HA:** Concept/idea development, study design, data collection/processing, data analysis/interpretation, provision of cases, provision of facilities/equipment; **ZF**:Data collection/processing, data analysis/ interpretation, provision of cases, provision of facilities/equipment.

Funding: *None*

Conflicts of Interest: *None*

Ethical Approval: The study was approved by the İnönü University Health Sciences Non-Interventional Clinical Research Ethics Committee on 16 April 2024 in accordance with the Helsinki Declaration (Ref. No: 2024/5871).

REFERENCES

1. Sellier E, Platt MJ, Andersen GL, et al. Decreasing prevalence in cerebral palsy: a multi-site European population-based study, 1980 to 2003. Dev Med Child Neurol. 2016;58:85–92.
2. Sadowska M, Sarecka-Hujar B, Kopyta I. Cerebral palsy: Current opinions on definition, epidemiology, risk factors, classification and treatment options. Neuropsychiatr Dis Treat. 2020;16:1505-1518.
3. Christensen D, Van Naarden Braun K, Doernberg NS, et al. Prevalence of cerebral palsy, co-occurring autism spectrum disorders, and motor functioning - Autism and Developmental Disabilities Monitoring Network, USA, 2008. Dev Med Child Neurol. 2014;56:59-65.
4. Jahan I, Sultana R, Muhit M, et al. Nutrition ınterventions for children with cerebral palsy in Low- and Middle-Income Countries: A scoping review. Nutrients. 2022;14:1211.
5. Lopes PA, Amancio OM, Araújo RF, et al. Food pattern and nutritional status of children with cerebral palsy. Rev Paul Pediatr. 2013;31:344-349.
6. Sullivan PB, Juszczak E, Lambert BR, et al. Impact of feeding problems on nutritional intake and growth: Oxford Feeding Study II. Dev Med Child Neurol. 2002;44:461-467.
7. Benfer KA, Weir KA, Bell KL, et al. Oropharyngeal dysphagia in preschool children with cerebral palsy: oral phase impairments. Res Dev Disabil. 2014;35:3469-3481.
8. Sullivan PB, Lambert B, Rose M, et al. Prevalence and severity of feeding and nutritional problems in children with neurological impairment: Oxford Feeding Study. Dev Med Child Neurol. 2000;42:674-680.
9. Donkor CM, Lee J, Lelijveld N, et al. Improving nutritional status of children with Cerebral palsy: a qualitative study of caregiver experiences and community-based training in Ghana. Food Sci Nutr. 2019;7:35-43.
10. Weir KA, Bell KL, Caristo F, et al. Reported eating ability of young children with cerebral palsy: is there an association with gross motor function?. Arch Phys Med Rehabil. 2013;94:495-502.
11. Archer LA, Rosenbaum PL, Streiner DL. The children's eating behavior inventory: reliability and validity results. J Pediatr Psychol. 1991;16:629-642.
12. Kürtüncü M, Arslan, N. Validity and reliability of the turkish form of the eating behavior scale for children. DEUHFED. 2020;13:267-274.
13. Palisano RJ, Rosenbaum P, Bartlett D, et al. Content validity of the expanded and revised Gross Motor Function Classification System. Dev Med Child Neurol. 2008;50:744-750.
14. El O, Baydar M, Berk H, et al. Interobserver reliability of the Turkish version of the expanded and revised gross motor function classification system. Disabil Rehabil. 2012;34:1030-1033.
15. Kim GW, Kim H, Jeon JY, et al. Validity and Reliability of Functional Independence Measure for Children (WeeFIM) for Children With Cerebral Palsy. Inquiry. 2022;59: 469580211072454.
16. Tur BS, Küçükdeveci AA, Kutlay S, et al. Psychometric Properties Of The Weefim in Children With Cerebral Palsy in Turkey. Dev Med Child Neurol. 2009;51:732-738.
17. Baysal A, Aksoy M, Bozkurt N, et al. Diyet El Kitabı. 12. Ed, Ankara: Hatiboglu Publications; 2020.
18. Mokhy MS, Jamaluddin R, Ismail AR, et al. Validated predictive equations based on tibial length in estimating height for children with cerebral palsy for 2-18 years, across all GMFCS levels. J Nutr Sci. 2021;10:e108.
19. World Health Organization (WHO), Child Growth Standards. Access Date: 17.07.2024. https://www.who.int/tools/child-growth-standards/standards/
20. Núñez-Cortés R, Cruz BDP, Gallardo-Gómez D, et al. Handgrip strength measurement protocols for all-cause and cause-specific mortality outcomes in more than 3 million participants: A systematic review and meta-regression analysis. Clin Nutr. 2022;41:2473-2489.
21. Toğuç H, Aydın H, Fidan Z. Multifactorial influences on constipation in children with cerebral palsy: a cross-sectional study of diet, motor function, and spasticity. Turk J Pediatr Dis. 2025;19:227-233.
22. Sel SA, Günel M, Şengelen M, et al. An examination of the factors affecting compliance of parents of children with cerebral palsy to home program: a scale development study. Turk J Physiother Rehabil. 2020;31:103-114.
23. Piştav Akmeşe P, Kayhan N, Mutlu A. Levels of perception of family environment in mothers of children with cerebral palsy. Toplum ve Sosyal Hizmet Dergisi. 2011;22:105-114

24. Bakkaloğlu ZT, Umut GU, Saka S. The relationship between trunk control, functional capacity and functional independence in children with cerebral palsy. Haliç Üniv Sağ Bil Der. 2023;6:23-32.
25. Gunel MK, Mutlu A, Tarsuslu T, et al. Relationship among the Manual Ability Classification System (MACS), the Gross Motor Function Classification System (GMFCS), and the functional status (WeeFIM) in children with spastic cerebral palsy. Eur J Pediatr. 2009;168:477-485.
26. Reilly S, Skuse D, Poblete X. Prevalence of feeding problems and oral motor dysfunction in children with cerebral palsy: a community survey. J Pediatr. 1996;129:877-882.
27. Huysentruyt K, Geeraert F, Allemon H, et al. Nutritional red flags in children with cerebral palsy. Clin Nutr. 2020;39:548-553.
28. Topçu U, Lazoğlu Ç, Aslan C, et al. Use of mid-upper arm circumference band in wasting detection in children with cerebral palsy in Türkiye. Children (Basel). 2025;12:1002.
29. Zhou H, Peng T, Wei M, et al. Validity and predictability of mid-upper arm circumference for nutrition screening in outpatient preschoolers with cerebral palsy. Front Nutr. 2025;12:1609032.
30. Özder F, Ilgaz F, Arslan SS. Clinical and nutritional evaluation of chewing dysfunction in children with cerebral palsy: a case report. Bes Diy Derg. 2021;49:106-115.
31. Ecertaştan AS. Assesment of growth, development and nutritional status in children with cerebral palsy. Haliç University, Master thesis. İstanbul, 2014.
32. Vaz DV, Cotta Mancini M, Fonseca ST, et al. Muscle stiffness and strength and their relation to hand function in children with hemiplegic cerebral palsy. Dev Med Child Neurol. 2006;48:728-733.
33. Kim DH, An DH, Yoo WG. The relationship between trunk control and upper limb function in children with cerebral palsy. Technol Health Care. 2018;26:421-427.
34. Pavão SL, Nunes GS, Santos AN, et al. Relationship between static postural control and the level of functional abilities in children with cerebral palsy. Braz J Phys Ther. 2014;18:300-307.
35. Merino-Andrés J, García de Mateos-López A, Damiano DL, et al. Effect of muscle strength training in children and adolescents with spastic cerebral palsy: A systematic review and meta-analysis. Clin Rehabil. 2022;36:4-14.
36. Palisano R, Rosenbaum P, Walter S, et al. Development and reliability of a system to classify gross motor function in children with cerebral palsy. Dev Med Child Neurol. 1997;39:214-223.