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ORIGINAL ARTICLE

Feeding ability, dietary intake, and gastrostomy satisfaction in children with cerebral palsy: An observational study

Víctor Manuel Navas-López[a,*], Marta Herrador-López[a], Ramón Cancho Candela[b,c], José Luis Peña Segura[d], Ruth García Romero[e], Juan José Díaz Martín[f], miembros del Grupo de Trabajo Multidisciplinar de Parálisis Cerebral Pediátrica[1]

[a] *Sección de Gastroenterología y Nutrición Infantil, Hospital Regional Universitario de Málaga, Málaga, Spain*
[b] *Neuropediatría, Hospital Universitario Río Hortega, Valladolid, Spain*
[c] *Facultad de Medicina, Universidad de Valladolid, Valladolid, Spain*
[d] *Neuropediatría, Hospital Infantil Miguel Servet, Zaragoza, Spain*
[e] *Gastroenterología Pediátrica, Hospital Infantil Miguel Servet, Zaragoza, Spain*
[f] *Gastroenterología Pediátrica, Hospital Universitario Central de Asturias, Oviedo, Asturias, Spain*

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KEYWORDS
Cerebral palsy;
Nutritional assessment;
Feeding behavior;
Gastrostomy;
Motor skills disorders

Abstract
Objectives: Cerebral palsy (CP) often causes motor impairment and comorbidities, including gastrointestinal problems that contribute to undernutrition. This study characterizes feeding capabilities and nutritional needs in Spanish children with CP.
Methods: We conducted a multicenter observational study in 10 Spanish hospitals in pediatric patients (4–14 years) with CP classified according to Gross Motor Function Classification System (GMFCS) level. We collected data on sociodemographic, anthropometric, and nutritional variables. We used the Eating and Drinking Ability Classification System (EDACS) to assess feeding and drinking dysfunction, and the Structured Satisfaction with Gastrostomy Feeding (SAGA-8) questionnaire to assess caregiver satisfaction.
Results: A total of 112 patients (median age, 9 years; IQR, 7—11 years) were included; 70.5% had GMFCS levels IV–V. Most patients (77.7%) received oral feeding, and oral nutritional supplementation increased with GMFCS severity. The EDACS distribution differed significantly in relation to the GMFCS level, as did the total energy intake, energy expenditure, and daily protein and fat intakes. The dietary intake of vitamin D and selenium and the serum vitamin B12 concentration also differed significantly by GMFCS level. Approximately 80% of caregivers reported high satisfaction with gastrostomy feeding (SAGA-8).

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* Corresponding author.
E-mail address: victor.navas@gmail.com (V.M. Navas-López).
[1] Appendix A lists the members of the Pediatric Cerebral Palsy Multidisciplinary Working Group that collaborated in this study.

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Conclusion: Children with CP differ in feeding ability, energy expenditure, and macronutrient and micronutrient intake in relation to the GMFCS level. Caregivers perceive gastrostomy as a helpful and satisfactory nutritional support strategy.
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PALABRAS CLAVE
Parálisis cerebral;
Evaluación nutricional;
Comportamiento alimentario;
Gastrostomía;
Trastorno de las habilidades motoras

Estado nutricional y habilidades de alimentación en niños españoles con parálisis cerebral: estudio observacional

Resumen
Objetivos: La parálisis cerebral (PC) suele causar deterioro motor y comorbilidades, incluidas alteraciones gastrointestinales que contribuyen a la desnutrición. Este estudio caracteriza las capacidades de alimentación y las necesidades nutricionales de niños españoles con PC.
Métodos: Se realizó un estudio observacional multicéntrico en 10 hospitales españoles en pacientes pediátricos (4–14 años) con PC, clasificados según el Gross Motor Function Classification System (GMFCS). Se recogieron variables sociodemográficas, antropométricas y nutricionales. El Eating and Drinking Ability Classification System (EDACS) evaluó la disfunción para comer y beber, y el cuestionario SAGA-8 valoró la satisfacción de los cuidadores.
Resultados: Se incluyeron 112 pacientes (mediana de edad 9 años [7—11]); el 70,5% presentaba niveles IV-V del GMFCS. La mayoría (77,7%) recibía alimentación oral, y el uso de suplementos orales aumentaba con la gravedad. La distribución EDACS difirió significativamente según el GMFCS, al igual que la ingesta calórica total, el gasto energético y la ingesta diaria de proteínas y lípidos. La ingesta dietética de vitamina D y selenio, y las concentraciones séricas de vitamina B12, también difirieron significativamente. Aproximadamente el 80% de los cuidadores refirió alta satisfacción con la gastrostomía.
Conclusión: Los niños con PC presentan diferencias en la capacidad de alimentación, el gasto energético y la ingesta de macro y micronutrientes según la gravedad del GMFCS. Los cuidadores perciben la gastrostomía como una estrategia nutricional útil y satisfactoria.
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Introduction

Cerebral palsy (CP) is the most common cause of physical disability in children, with a global incidence of approximately 2–2.5 cases per 1000 live births.[1] It comprises a heterogeneous group of permanent movement and posture disorders attributable to nonprogressive disturbances in the developing brain of the fetus or infant.[2] Beyond motor impairment, CP is frequently associated with comorbidities that influence the clinical course and quality of life, among which feeding disorders and malnutrition are particularly relevant.[3]

Feeding disorders are highly prevalent in children with CP and represent a major pathway to undernutrition, with downstream consequences for growth, neurodevelopment, and functional outcomes.[2] Feeding dysfunction is generally multifactorial, reflecting impaired oral-motor control, altered neuromotor maturation, and inadequate postural stability, which reduce feeding efficiency and safety.[1] Associated conditions such as dysphagia, gastrointestinal dysmotility, and non-ambulation are common and contribute to complications including aspiration pneumonia, constipation, and gastroesophageal reflux.[2–4]

Children with neurological impairment often exhibit reduced adiposity, lean mass, and protein reserves.[3] Energy requirements are closely linked to mobility and habitual activity, and abnormal growth trajectories are strongly associated with poor nutritional status,[2] supporting guideline recommendations for structured longitudinal monitoring, including anthropometric assessment at least every 6 months and micronutrient evaluation at least every 12 months.[3]

Oral feeding should be preserved whenever feasible and safe. However, in the presence of dysphagia or significant feeding difficulties, individualized dietary adaptations and, in selected cases, enteral feeding via gastrostomy may be required to prevent malnutrition and dehydration.[5,6] Nutritional supplements or energy-dense homemade preparations have been associated with improvements in body weight and motor performance.[4,7]

Optimizing nutritional support in children with CP promotes weight gain and linear growth, improves quality of life, and may reduce hospitalization rates.[2] However, evidence on the benefits and best implementation of nutritional management strategies in pediatric CP remains limited, with the literature historically focused predominantly on adult populations.

Building on prior work describing the clinical and nutritional profile of Spanish children with CP,[8] we conducted a study with the aim of characterizing the feeding capabilities and nutritional needs in this population in order to support clinical decision-making and inform care strategies.

Methods

Study design and participants

We conducted a multicenter observational study in pediatric patients (aged 4–14 years) with CP in 10 public hospitals in Spain with referral pediatric neurology and pediatric nutrition units. All centers followed a common protocol that predefined eligibility criteria, study variables, questionnaires, and procedures. The recruitment period lasted 12 months. Patients with a confirmed CP diagnosis meeting eligibility criteria were invited to participate on a consecutive basis, irrespective of GMFCS level, and were recruited from both neurology and nutrition clinics to reduce selection bias. We obtained written informed consent from legal guardians and assent from patients aged 13–14 years with normal cognition; all the data were collected during a single study visit.

The study adhered to the principles of the Declaration of Helsinki and was approved by the Malaga Provincial Research Ethics Committee of the Hospital Regional Universitario de Málaga (study code 0114-N-19).[8] The sample size (103 patients) was estimated based on the previous literature[9] for a 95% confidence level and a 10% margin of error, with an expected prevalence of malnutrition in children with CP of 45%.

Study variables

We collected data on sociodemographic, clinical (gestational age, multiple gestation, age at diagnosis, time since diagnosis), and anthropometric (birth weight, body weight, height) variables using standard techniques available at each center; specific anatomical segments, height-estimation equations, and scale types were not centrally defined. Malnutrition was evaluated using the Waterlow weight-for-height index, comparing the weight of the patient to the median weight-for-height of the reference population,[6] and weight status was categorized as obesity, normal weight or mild, moderate, or severe underweight. The body mass index (BMI) and *z* scores for malnutrition indicators were also recorded and reported previously.[5]

Motor function was classified using the GMFCS (level I, highest independence, to level V, most severe limitation) and feeding/drinking ability using the EDACS (level I, safe and efficient, to level V, unable to eat or drink safely). Data on oral medication and gastrointestinal comorbidities (dysphagia, constipation, gastroesophageal reflux) were retrieved from the health records and from routine clinical assessments applying standard criteria at each center.

A 3-day food record (2 working days, 1 non-working day) was used to collect data on dietary intake, feeding strategy, and oral supplementation. Nutritional calculations were made with the *Organizador Dietético Metabólico* (Odimet[10]) using Spanish reference tables. Energy adequacy was calculated as energy intake/estimated total energy expenditure (TEE) $\times$ 100; the TEE was estimated using the Schofield equation and the Nutritional Application of the Spanish Society of Pediatric Gastroenterology, Hepatology and Nutrition (SEGHNP)[11] using the age, sex, weight, and height of the patient, without adjustments for GMFCS level or physical activity. Macronutrient and micronutrient adequacy was expressed as percentage of the corresponding recommended dietary allowance (RDA)/reference daily intake (RDI). Laboratory results (complete blood count, hematocrit, iron, ferritin, calcium, albumin, prealbumin, 25-hydroxyvitamin D [25(OH)D], folic acid, and vitamin B12) were collected from the health records within the 3 months preceding the study visit; dietary intake of zinc, selenium, and vitamin D was estimated from the 3-day food record rather than serum concentrations.

Caregiver satisfaction, gastrostomy ease of use, support received, perceived nutritional improvement, and impact on family routines were assessed by means of the Satisfaction with Gastrostomy Feeding Questionnaire (SAGA-8), whose total score ranges between 8 and 31, with higher scores indicating greater satisfaction.

Statistical analysis

Quantitative variables are expressed as mean and SD or median and IQR, and categorical variables as absolute and relative frequencies. Patients were classified according to CP severity (GMFCS level I-III vs level IV-V), EDACS, and Waterlow classification. We used the Shapiro-Wilk test to assess normality; the Student *t*-test or ANOVA for normally distributed continuous variables and the Mann-Whitney test for non-normal distributions, as well as the χ^2 or Fisher exact test for categorical variables. The analyses used only the available data, reporting the missing data for each; *P* values of less than .05 were considered statistically significant. The statistical analysis was performed with the software SAS version 9.4.

Results

Patient characteristics

A total of 112 patients participated, with a median age of 9 years (IQR, 7—11), and 51.8% were male. The median birth weight was 2600 g (IQR, 1240—3150), and the median duration of disease was 7.3 years (IQR, 5.3—10.1). Perinatal CP was present in 73.2% of children, and 45.5% were classified as GMFCS level V. More than half of the sample (52.2%) had some degree of malnutrition by Waterlow classification. Table 1 presents the baseline characteristics of the sample.

Feeding management

Most patients were exclusively orally fed (77.7%), 15.2% received nutrition via gastrostomy, and 7.1% followed a mixed approach (Supplementary Table 1); gastrostomy use increased with GMFCS severity, peaking at level V (Supplementary Fig. 1).

Table 1 Baseline patient and disease characteristics.

Characteristics (*)	
Current age (years)	
Median (IQR)	9 (7—11)
Mean (SD)	9.2 (2.9)
Sex, n (%)	
Male	58 (51.8)
Female	54 (48.2)
Gestational age (weeks)	
Median (IQR)	38 (30—40)
Gestational age group, n (%)	
<28 weeks	17 (15.2)
28–<32 weeks	15 (13.4)
32–<37 weeks	18 (16.1)
≥37 weeks	62 (55.4)
Birth weight (g)	
Median (IQR)	2600 (1240—3150)
Multiple gestation, n (%)	15 (13.4)
Age at diagnosis (years)	
Median (IQR)	1 (0—2.5)
Time since diagnosis (years)	
Median (IQR)	7.3 (5.3—10.1)
Etiology of CP, n (%)	
Prenatal‡	24 (21.4)
Perinatal‡	82 (73.2)
Postnatal	7 (6.3)
Characteristics (*)	
Semiological classification of CP, n (%)	
Spasticity	70 (62.5)
Dyskinesia/Dystonia	3 (2.7)
Mixed (Spasticity- Dyskinesia)	39 (34.8)
Topographic classification of CP, n (%)	
Monoparesis	1 (0.9)
Hemiparesis	16 (14.3)
Diparesis	13 (11.6)
Triparesis	6 (5.4)
Tetraparesis	76 (67.9)
GMFCS level, n (%)	
I	10 (8.9)
II	16 (14.3)
III	7 (6.3)
IV	28 (25.0)
V	51 (45.5)

Waterlow weight-for-height index	n (%)	n (%) excluding missing data
Obesity (>110)	12 (10.71%)	12 (19.7)
Normal weight (90—110)	17 (15.18%)	17 (27.9)
Mild undernutrition (80—90)	15 (13.39%)	15 (24.6)
Moderate undernutrition (70—80)	12 (10.71%)	12 (19.7)
Severe undernutrition (<70)	5 (4.46%)	5 (8.2)
Total Waterlow weight	61 (100.0%)	
Missing data*	51 (45.54%)	

Abbreviations: CP, cerebral palsy; GMFCS, Gross Motor Function Classification System; IQR, interquartile range; SD, standard deviation.

‡ Both causes recorded in one patient.

* Data missing from 51 patients (6 in GMFCS I-III group and 45 in GMFCS IV—V group).

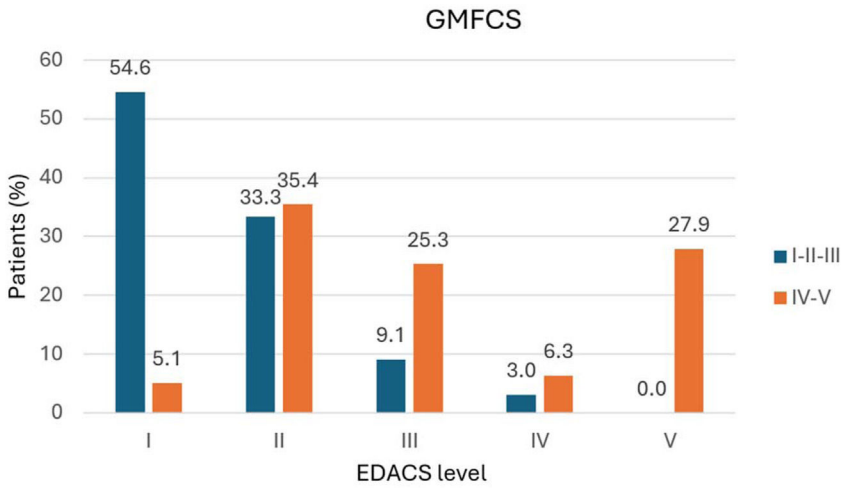

Figure 1 Patient distribution according to EDACS and GMFCS levels.
Abbreviations: EDACS, Eating and Drinking Ability Classification System; GMFCS, Gross Motor Function Classification System.

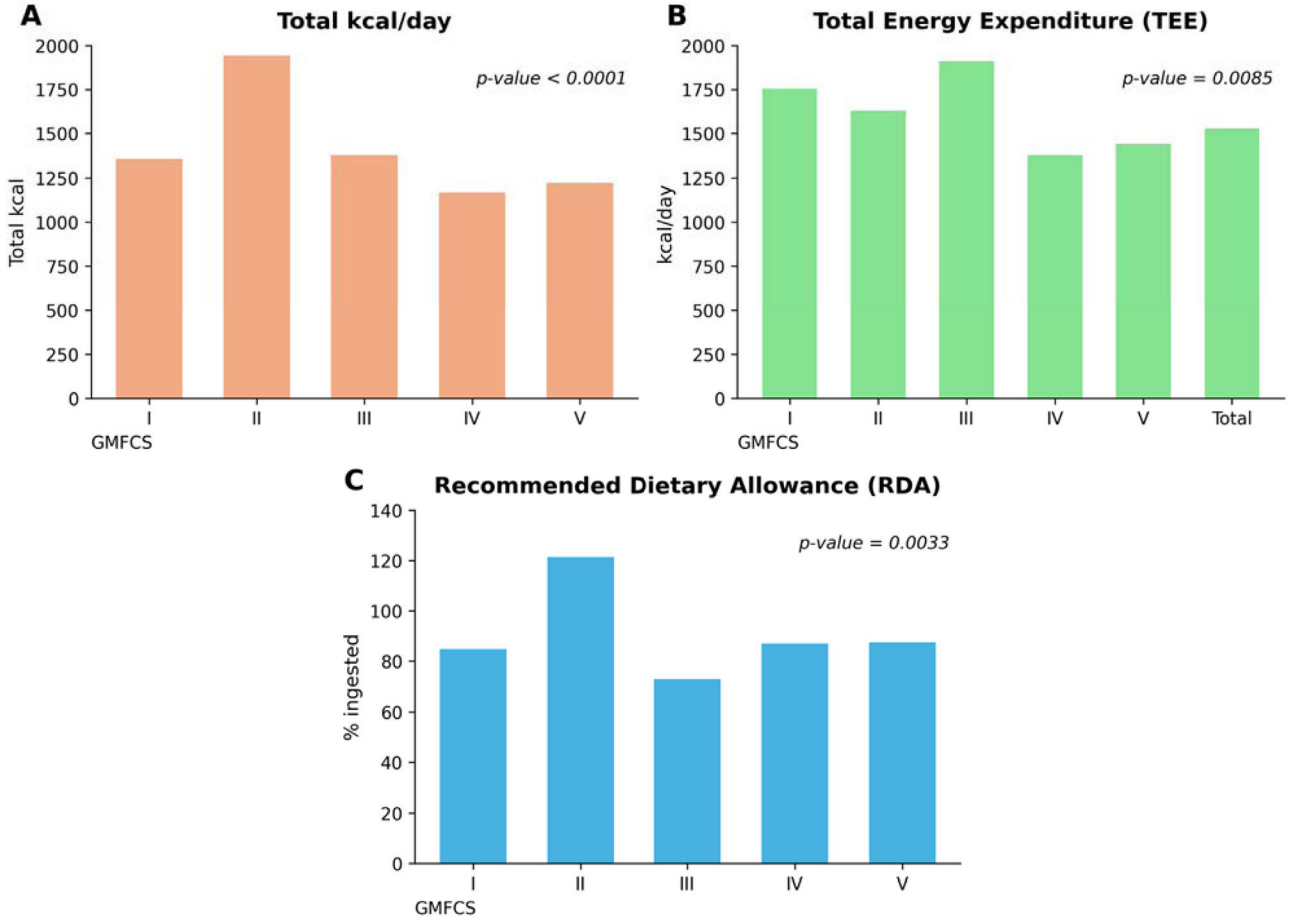

Figure 2 Quantitative analysis of the diet according to GMFCS: (a) Total kcal/day, (b) total energy expenditure, and (c) recommended daily allowance.
Abbreviation: GMFCS, Gross Motor Function Classification System.

Patients were also classified according to the EDACS, and there was a statistically significant difference in the EDACS distribution according to GMFCS level ($P < .0001$) (Fig. 1). Patients with milder motor dysfunction showed minimal eating/drinking impairment (EDACS I-II), while those with more severe motor dysfunction showed greater heterogeneity across EDACS levels.

Regarding GI complications, there were significant differences between patients in GMFCS groups I-III compared to patients in groups IV—V (Supplementary Table 2).

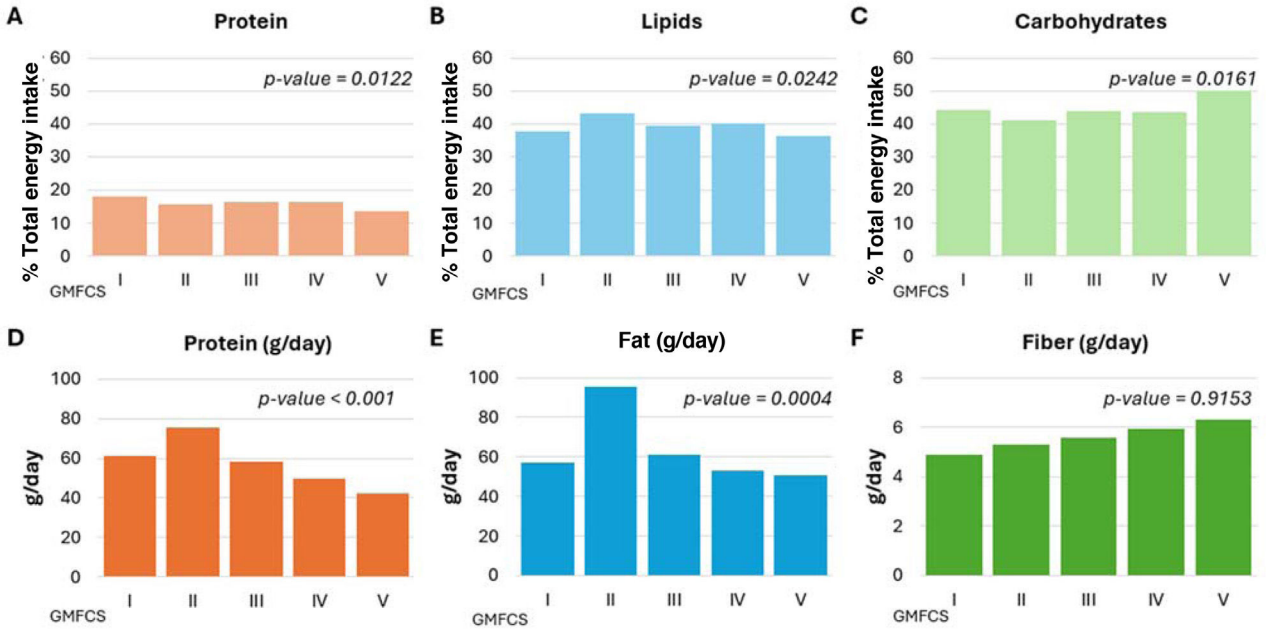

Figure 3 Macronutrient analysis by GMFCS group. Percentage of total energy intake: (a) protein, (b) fat, and (c) carbohydrate. Distribution of daily intake (g/day): (d) protein, (e) fat, and (f) fiber.
Abbreviation: GMFCS, Gross Motor Function Classification System.

Quantitative analysis of diet

The 3-day food record was completed by 68 patients across all GMFCS levels. Significant between-group differences were found for total kcal/day ($P < .0001$), TEE ($P = .0085$), and RDA ($P = .0033$) (Fig. 2).

Patients from groups GMFCS I-II-III covered almost 100% (99.1%) of their TEE through diet, compared to 87% for groups GMFCS IV—V.

Macronutrient analysis

Regarding macronutrients, protein intake was lower and carbohydrate intake higher in the GMFCS-V group (Fig. 3), with significant differences in the percent of the total energy intake for protein ($P = .0122$), carbohydrate ($P = .0161$), and fats ($P = .0242$); fiber intake was numerically higher in higher GMFCS levels but not significant ($P = .9153$).

Laboratory tests

Among laboratory parameters, vitamin B12 differed significantly by GMFCS group ($P = .0381$), with higher values in GMFCS II, IV, and V; no significant differences were found for iron, ferritin, 25(OH)D, albumin, or folic acid (Fig. 4a–e).

Dietary micronutrient intake

Regarding micronutrients, the dietary intake of vitamin D ($P = .0082$), vitamin C ($P = .0025$), and selenium ($P = .0201$) differed significantly by GMFCS level, with a higher vitamin D and C intake and lower selenium intake in GMFCS V and IV–V, respectively (Fig. 5).

Table 2 presents the micronutrients for which at least one GMFCS group did not meet 100% of the RDI/RDA[12]; we identified deficiencies in 25(OH)D, vitamin E, and iron in all groups, as well as deficiency in every evaluated nutrient in the GMFCS III group.

Satisfaction with gastrostomy feeding questionnaire (SAGA-8)

Out of the total group with a gastrostomy (23.2% of the total), we obtained SAGA-8 responses from parents of 26 patients (7.7% GMFCS II, 7.7% GMFCS IV, 84.6% GMFCS V) (Fig. 6).

The level of satisfaction was high (mean score, 29; SD, 2.5; range, 8–31): most respondents reported the highest levels of satisfaction with the gastrostomy (80.8%), ease of use (84.6%), hospital support (76.9%), nutritional improvement (76.9%), and family wellbeing (80.8%).

When it came to the dichotomous items, 92% reported a reduction in meal duration and 88.5% a reduction in infections; all 26 parents were very satisfied, and 85% would have implemented gastrostomy earlier had they known its benefits.

Discussion

Achieving and maintaining adequate nutritional status in children with CP remains a major clinical challenge,[13] as this population frequently struggles to meet recommended energy, macronutrient, and micronutrient intakes, with potentially severe consequences.[14] Motor dysfunction is often accompanied by feeding difficulties that impair growth and overall health,[15] and enteral nutrition via gastrostomy is commonly implemented to improve outcomes.[4] This study

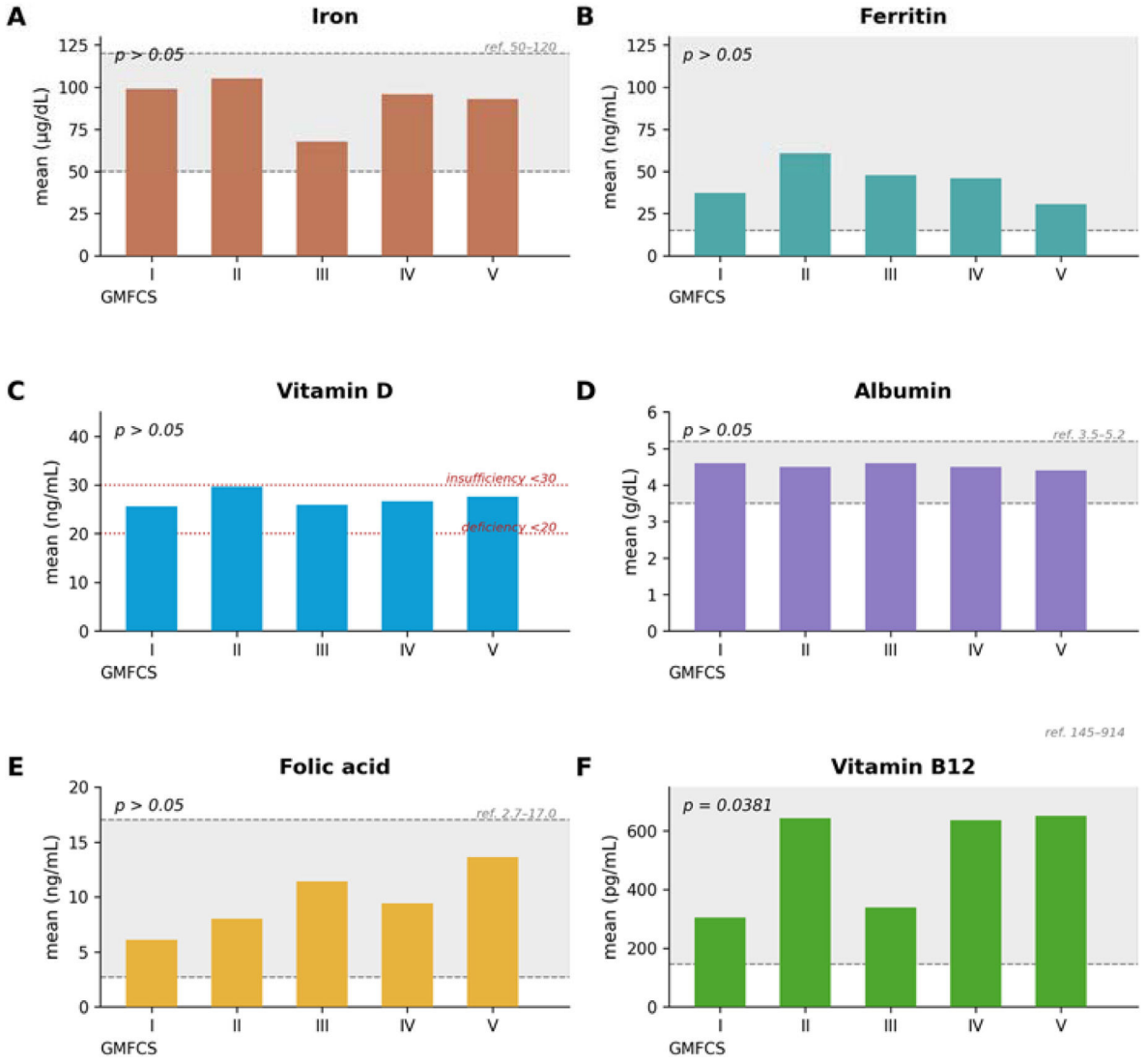

Figure 4 Laboratory parameters of nutritional relevance by GMFCS group: (a) iron (mean µg/dL), (b) ferritin (mean ng/mL), (c) 25-hydroxivitamin D (mean ng/mL), (d) albumin (mean g/dL), (e) folic acid (mean ng/mL), and (f) vitamin B12 (mean pg/mL). Shaded bands indicate the laboratory reference range for each parameter; red dotted lines in panel (c) indicate the thresholds for vitamin D insufficiency (<30 ng/mL) and deficiency (<20 ng/mL).
Abbreviation: GMFCS, Gross Motor Function Classification System.

Table 2 Nutrients for which 100% of the RDI was not met by GMFCS group.

	Vit A	Vit D	Vit E	Vit C	Vit B12	Iron	Calcium	Zinc
I		X	X			X		
II		X	X			X		
III	X	X	X	X	X	X	X	X
IV		X	X	X		X	X	X
V		X	X	X	X	X	X	X

aimed to characterize the clinical profile of Spanish children with CP at the national level, exploring relationships between motor impairment, feeding strategies, and nutritional status.

Approximately half of our cohort was born before 37 weeks, consistent with the association between decreasing gestational age and CP risk.[16–19] The etiology was prenatal or perinatal in most patients, in line with evidence that postnatal causes are uncommon.[20,21] Using the GMFCS, a recognized predictor of motor outcomes,[22,23] 70% of participants were classified as levels IV or V, a higher proportion than reported by Ron et al.[24] but consistent with previous

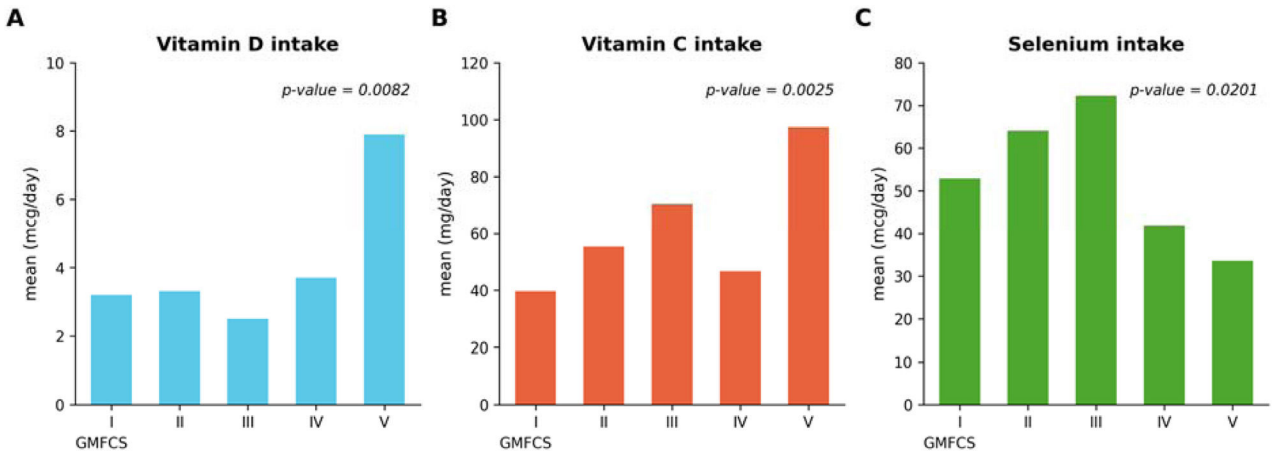

Figure 5 Dietary micronutrient intake by GMFCS group: (a) vitamin D intake (mean μg/day), (b) vitamin C intake (mean mg/day), and (c) selenium intake (mean μg/day).
Abbreviation: GMFCS, Gross Motor Function Classification System.

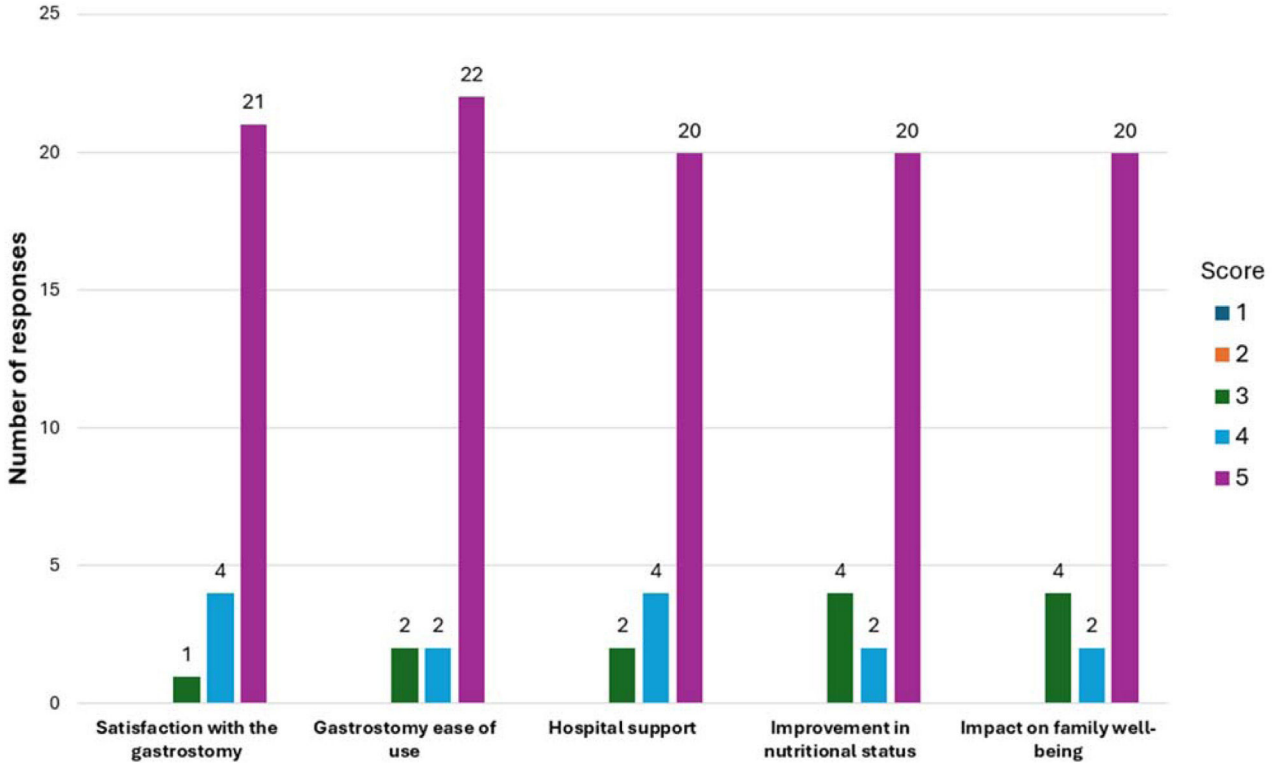

Figure 6 Distribution of answers to SAGA-8 questionnaire items.

Spanish studies[25,26]; the sample in the study by Costa et al.[25] was broader, with patients with CP amounting to only 58% of the total.

The use of nutritional supplementation differed significantly across GMFCS groups, consistent with the known high malnutrition risk in CP[1,27,28] and with recommendations favoring supplementation[29] and enteral feeding[4] as primary strategies. We also observed discrepancies between EDACS and GMFCS classifications, consistent with previous studies reporting a variable correlation between feeding ability and motor impairment.[30,31]

The total energy intake (TEI), TEE, and RDA differed significantly across GMFCS levels, with a lower TEI and TEE in children with more severe disease. Although abnormal muscle tone has been linked to increased energy expenditure in some studies,[1] our findings align with others that suggest that energy requirements decrease with functional capacity,[32,33] potentially reflecting an adaptation to poorer nutritional conditions as feeding difficulties worsen.[33,34]

Children with higher GMFCS levels also showed lower protein and fat intake, in agreement with Cieri et al.[35] Dietary vitamin D intake was higher in GMFCS V, likely reflecting

a greater use of fortified supplements and enteral formulas rather than true differences in vitamin D status, since serum 25(OH)D did not differ significantly between groups ($P > .05$), in contrast with reports linking vitamin D deficiency to CP severity.[36] Conversely, dietary selenium intake was lower in patients with GMFCS IV-V, consistent with an overall reduction in dietary quality in more severely impaired patients; the literature on micronutrient status in CP remains limited,[37] and measurement of selenium levels would be needed to confirm clinical relevance. Vitamin B12 was also significantly higher in the GMFCS II, IV, and V groups, possibly reflecting routine supplementation with enteral/fortified formulas; given the small subgroup sizes (n = 3–16), this finding should be considered exploratory.

The SAGA-8 results indicated that gastrostomy use has a positive impact on nutrition and family wellbeing, with high caregiver satisfaction, consistent with previous reports.[38–40] Notably, 27.9% of patients were classified as EDACS V but only 23.2% had a gastrostomy, a discrepancy whose causes (such as preserved oral intake, referral timing, clinical decision-making, family preference) could not be determined from our data but merit prospective investigation, particularly given how many caregivers reported they would have opted for earlier placement.

Overall, our findings reinforce the need for a holistic, multidisciplinary approach integrating motor and nutritional assessment to identify care gaps and guide personalized interventions.

Limitations

Several limitations should be noted. The methods used to obtain anthropometric measurements were not standardized across centers, and a substantial proportion of patients lacked complete anthropometric data, likely reflecting the practical challenges of these measurements in children with severe motor impairment; therefore, nutritional indices derived from weight and height should be interpreted with caution. The TEE was estimated using the Schofield equation without adjusting for GMFCS level, physical activity, or spasticity, and relied on anthropometric measurements that were themselves subject to uncertainty. Data on gastrointestinal comorbidities were obtained from routine clinical assessments, without central adjudication. Caregiver-reported responses may not accurately capture the experience of the child, and we cannot exclude the possibility of nonresponse bias. Finally, as analyses were largely based on unadjusted subgroup comparisons, there may be residual confounding from unmeasured factors.

Conclusions

Nutrient deficiencies are common among children with CP, with a higher prevalence in those with greater functional impairment (GMFCS IV-V). Despite the high nutritional risk in these patients, gastrostomy is not consistently implemented, even though caregivers generally perceive it as highly beneficial, underscoring the need for proactive dietary support in this population.

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Declaration of competing interest

José Luis Peña Segura has received honoraria for talks and for collaborating in the development of this multicenter study.

Marta Herrador-López has received honoraria for talks, and for the dietary analysis of the patients included in this study.

Alejandro Rodriguez Martínez has received honoraria for talks, attending meetings, research grants, and for advisory boards for Danone Nutricia.

Ruth García Romero received honoraria for talks and for collaborating in the development of this multicenter study.

Juan José Díaz Martin has received honoraria for talks, congress attendance, and participation in advisory boards.

The remaining authors did not declare any conflicts of interest.

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Appendix A. Members of the Pediatric Cerebral Palsy Multidisciplinary Working Group that collaborated in this study

Xenia Alonso Curco; Pediatric Neurology, Hospital Sant Joan de Déu, Barcelona, Spain.

Gema Arriola; Pediatrics, Hospital Universitario de Guadalajara, Guadalajara, Spain.

Estibaliz Barredo Valderrama; Pediatric Gastroenterology, Hospital General Universitario Gregorio Marañón, Madrid, Spain.

Barbara Blanco Martínez; Pediatric Neurology, Hospital Universitario Virgen del Rocío, Seville, Spain.

Andrés Bodas Pinedo; Pediatric Gastroenterology, Hospital Clínico San Carlos, Madrid, Spain.

Gonzalo Galicia Poblet; Pediatric Gastroenterology, Hospital Universitario de Guadalajara, Guadalajara, Spain.

Ainhoa García Ribes; Pediatric Neurology, Hospital Universitario de Cruces, Bizkaia, Spain.

Adrián García Ron; Pediatric Neurology, Hospital Clínico San Carlos, Madrid, Spain.

Ignacio Málaga Dieguez; Pediatric Neurology, Hospital Universitario Central de Asturias, Oviedo, Spain.

Alejandro Rodríguez Martínez; Pediatric Gastroenterology, Hospital Universitario Virgen del Rocío, Seville, Spain.

Cesar Ruiz García; Pediatric Neurology, Hospital Regional Universitario de Málaga, Malaga, Spain.

Mariela de los Santos; Pediatric Gastroenterology, Hospital Sant Joan de Déu, Barcelona, Spain.

Mar Tolín Hernani; Pediatric Gastroenterology, Hospital General Universitario Gregorio Marañón, Madrid, Spain.

Carlos Tutau Gomez; Pediatric Gastroenterology, Hospital Universitario de Cruces, Bizkaia, Spain.

Ana María Vegas Álvarez; Gastroenterology, Hospital Universitario Río Hortega, Valladolid, Spain.

Appendix B. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.anpedi.2026.504368.

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