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Review

PREVALENCE AND PATTERNS OF MALNUTRITION IN CEREBRAL PALSY: A COMPREHENSIVE NARRATIVE REVIEW OF GLOBAL STUDIES

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Objective: *This narrative review aims to provide a comprehensive analysis of global studies on the prevalence and patterns of malnutrition in individuals with cerebral palsy (CP). By examining the available evidence, this review seeks to enhance our understanding of malnutrition in CP, identify research gaps, and propose directions for future research.*

Methods: *A systematic search was conducted in PubMed, Scopus, Mendeley and Web of Science databases to identify relevant studies published between 2018 and February 2023. Studies reporting original observations in children and adolescents with CP, and measuring malnutrition through anthropometric measures, biochemical tests, or other nutritional factors, were included. The Systematic Review and Narrative Appraisal (SANRA) guidelines were followed during the review process.*

Results: *A total of 28 studies met the inclusion criteria and were included in the review. The studies were conducted in more than 25 countries across all continents, providing a global perspective on malnutrition in CP. The prevalence of malnutrition varied across regions, with rates ranging from 15.4% to 92.6% for underweight, and 35% to 85.9% for stunting. Several factors, including motor impairment severity, feeding difficulties, and sociodemographic factors, were associated with malnutrition in CP. Micronutrient deficiencies, such as iron deficiency anemia, were also observed in some studies.*

Conclusion: *This comprehensive narrative review highlights the significant prevalence of malnutrition in individuals with CP globally. The findings underscore the need for comprehensive nutritional assessments, tailored interventions, and close monitoring of nutritional status in clinical practice. By addressing malnutrition, healthcare professionals can improve the overall health, growth, and quality of life for individuals with CP. Further research is needed to explore the long-term trajectories of malnutrition in CP and to develop evidence-based interventions to mitigate its impact on this vulnerable population.*

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Keywords: cerebral palsy, malnutrition, prevalence, patterns, global studies, anthropometric measures, biochemical tests, micronutrient deficiencies

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WHAT IS KNOWN

- Malnutrition is highly prevalent in individuals with CP, impacting their physical growth, cognitive development, and overall health.
- Malnutrition in CP is influenced by factors such as impaired mobility, dysphagia, and socio-economic factors.
- Micronutrient deficiencies, particularly iron deficiency anemia, are common in individuals with CP.

What is New

- This comprehensive narrative review fills a knowledge gap by providing a comprehensive analysis of global studies on the prevalence and patterns of malnutrition in CP.
- The review identifies factors associated with malnutrition in CP, including motor impairment severity and feeding difficulties.
- The review emphasizes the importance of comprehensive nutritional assessments and tailored interventions to improve the overall health and quality of life for individuals with CP.

ABBREVIATIONS

BMI - Body Mass Index
CP - Cerebral Palsy
DXA - Dual-energy X-ray Absorptiometry
EDACS - Eating and Drinking Ability Classification System
ESPGHAN - European Society for Paediatric Gastroenterology, Hepatology, and Nutrition
GFD - Global Functional Disability
GMFCS - Gross Motor Function Classification System
G-tube - Gastrostomy tube
IQ - Intelligence Quotient
MUAC - Mid-Upper Arm Circumference
PRISMA - Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RNI - Recommended Nutrient Intake
SANRA - Systematic Review and Narrative Appraisal
SD - Standard Deviation
SGNA - Subjective Global Nutritional Assessment
TSF - Triceps Skinfold Thickness
WHO - World Health Organization

INTRODUCTION

Cerebral palsy (CP) represents one of the most common neurological disorders in children, characterized by a range of motor disabilities, physical deformities, and associated cognitive impairments. It is a multifaceted condition affecting not only the central nervous system but also posing a range of secondary health complications. Among these secondary concerns, malnutrition is of critical significance, having been documented in various studies for its high prevalence in children and adults with CP. This concern is global, demanding a broader understanding and comprehensive overview to mitigate its detrimental impact on the quality of life, morbidity, and mortality of CP patients.

Malnutrition in CP results from a complex interplay of factors like impaired mobility, dysphagia, oral motor dysfunction, gastrointestinal complications, and socio-economic factors affecting access to proper nutrition. The ramifications of malnutrition are grave, impacting physical growth, cognitive development, immune function, and overall health status, thereby intensifying the complications associated with CP. Despite its critical importance, a holistic understanding of the prevalence and patterns of malnutrition among CP patients across the globe remains limited, hindering the development of effective strategies to address this problem.

Given the multifactorial nature of malnutrition in CP and its far-reaching consequences, it is evident that a broad-based understanding is urgently required. This forms the basis for the present review, which aims to bridge this knowledge gap. The intent of this review is to provide a comprehensive narrative analysis of available global studies on the prevalence and patterns of malnutrition in CP. Adhering to the SANRA (Scale for the Assessment of Narrative Review Articles) (1) criteria, an unbiased and systematic approach will be utilized for the selection, evaluation, and interpretation of the research studies included in the review. The goal is to bring together a diverse range of findings, uncover trends, identify research gaps, and propose directions for future research. In doing so, this review hopes to catalyze fresh research initiatives, prompt a reevaluation of current care strategies, and pave the way for targeted interventions aimed at reducing the burden of malnutrition in CP patients globally.

The specific goals of this review are to examine the prevalence of malnutrition in individuals with CP across different countries and regions, analyze the patterns of malnutrition, including undernutrition, overnutrition, and micronutrient deficiencies, in this population, explore the factors associated with malnutrition in CP, such as motor impairment severity, functional limitations, feeding difficulties, and sociodemographic factors.

This knowledge can inform targeted interventions, policy

development, and clinical practices to improve nutritional care and optimize health outcomes in this vulnerable population.

METHODS

The present narrative review is based on the general framework of narrative reviews proposed by Ferrari R *et al* and complies with the requirements of the SANRA. It has some additional items following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) (2) guidelines.

Search strategy and research sources

The search strategy was conducted in February 2023 using three bibliographic databases: PubMed, Scopus, Mendeley and Web of Science. The search aimed to identify relevant references on nutrition (malnutrition) in CP published between 2018 and February 2023.

The search strategy utilized the following combination of terms and keywords: "(Malnutrition OR micronutrient deficiency OR undernutrition OR nutritional deficiency) AND (child OR infant OR toddler OR adolescent OR school age) AND (Cerebral palsy OR CP)." The search results were retrieved from the last 5 years.

Eligibility criteria

The eligibility criteria for inclusion in this review were as follows: (1) studies reporting original observations, (2) study participants were children and/or adolescents with CP, and (3) studies reported measures of malnutrition, including anthropometric measures, deficiencies, and other nutritional factors.

The exclusion criteria were as follows: (1) studies reporting a single case, case series, or non-observational studies (e.g., systematic reviews, narrative reviews, scoping reviews), (2) studies involving interventions in the nutrition of patients, (3) studies not directly related to CP and malnutrition, (4) non-English articles, and (5) studies involving adults with CP. Conflicting titles (14 in total) were selected based on the number of votes or resolved through discussion among the reviewers.

Study selection and Data Extraction

The process of study selection, including identification, screening, eligibility, and inclusion is illustrated with a flowchart presented in Figure 1, based on the initial evaluation. The data extraction process was undertaken systematically by a team of four independent reviewers (RP, AT, RB, FA). Each reviewer scrutinized the dataset to determine which articles met the inclusion criteria. Conflicts and discrepancies were collectively discussed and resolved via consensus to maintain an unbiased selection process.

The first stage involved retrieval of 17,882 unique records. Based on titles and abstracts of all identified studies, a selection process resulted in 629 titles deemed eligible and meeting the inclusion criteria for abstract review. Each abstract was voted on by the reviewers, yielding: 72 included, 4 under consideration, 539 excluded, and 14 with conflict (resolved negatively after voting).

Subsequently, one reviewer (FA) delved deeper into the 76 selected titles and retrieved 64 full articles for further analysis. During this process, eight studies were excluded due to unavailability or further non-compliance with the inclusion criteria. To validate the results, a cross-verification was conducted, involving two other reviewers (AT, RB) independently assessing the full texts of the 64 articles. The following information was meticulously extracted: 1. First Author and Year of Publication; 2. Country of the Study; 3. Continent/East-West Europe; 4. Age Range of Participants; 5. Number of Participants; 6. Type of Assessment Conducted; 7. Main Outcomes.

For more rigorous scrutiny, a third final reviewer was later incorporated into the review process. After this comprehensive three-tiered review process, the final set of studies that met the inclusion criteria for the full review was established at 28.

This structured, multi-reviewer approach and the inclusion of a third reviewer in the data extraction process ensured the integrity and quality of the review, enhancing the robustness and reliability of the narrative review's findings.

RESULTS

Study characteristics

The final literature search resulted in identification of 28 articles depicting malnutrition in CP in more than 30 countries. The studies summarized come from various countries across all continents and range from 2018 to 2023. Participants' ages ranged from as young as 0 years to 21 years old. The number of participants in each study varied widely, with some having as few as 24 and others having over 1000 reaching a total number of 6729. The type of assessment used in the studies varied as well, with most using anthropometric (Anthro), clinical (Clin), biochemical (Bioch), and various instrument measurements (Table 1).

Table 1. *Basic characteristics of included articles*

First Author and Year	Country	Continent	Age Range of Participants	Number of Participants	Type of Assessment	Main Outcomes
(3)	Saudi Arabia	Western Asia	71.1 ± 46.3 months	119	Clin/Anthro	84.9% were underweight
(4)	Malaysia (Kelantan)	Asia	5-17 years	93	Anthro/Bioch/Clin/ Instr/CFFQ	Caries prevalence: 81.7%; 81.4% severely stunted, 45% severely thin with acute malnutrition
(5)	Turkey	Asia	1-18 years	197	Anthro/Clin	High malnutrition rate (76.6%)
(6)	Nigeria	Africa	4–18 years	24	Anthro/Clin	70.83% of children underweight
(7)	Australia	Australia	2 - 18 years	89	Anthro/Clin	Moderate or severe malnutrition associated with reduced weight, BMI, and other measurements.
(8)	Not Available	North Africa	2-16 years	40	Anthro/Clin	67.5% underweight
(9)	Turkey (10 different cities)	Southeast Europe	Not Available	398	Anthro/Bioch/Clin	92.6% malnourished
(10)	Nigeria	West Africa	1 - 17 years	169	Anthro	57.6% had feeding issues; 37.3% had malnutrition; Functional severity greatly enhanced feeding issues
(11)	Vietnam	Southeast Asia	≤ 18 years	53	Bioch/Clin	60% of participants had anemia. Statistically significant difference of underweight and GMFCS level with proportion of anemia.
(12)	Germany/ Netherlands	West Europe	12 years 4 months ± 2 years 9 months (mean)	329	Anthro/Instr	BMI values had varying sensitivity and specificity; Undernutrition commonly overestimated by BMI compared to DXA.
(13)	Multiple (Czech Republic, Greece, Hungary, Italy, Netherlands, Poland, Slovakia, Turkey)	Europe	≤ 18 years	497	Anthro/Bioch/Clin/ Instr	29–36% malnourished, wasted, or stunted
(14)	Spain (Madrid)	West Europe	9.34 ± 5 years	44	Anthro/Clin	Lower BMI correlated with higher EDACS levels and greater GMFCS score. Malnutrition in 40%-90%,
(15)	Belgium	West Europe	2–20 years	325	Anthro	75% of CP patients with GMFCS 5 classification were underweight
(16)	Thailand	Southeast Asia	Not Available	23	Clin/Anthro/Bioch	Malnutrition: 52% underweight, 35% stunting

First Author and Year	Country	Continent	Age Range of Participants	Number of Participants	Type of Assessment	Main Outcomes
(17)	USA	North America	0 - 17 years	63	Anthro/Clin/Instr	Z score improved at 3 months post-G tube, decreased at 6 months, and increased at 12 months. 69.8% had complications, 11% died
(18)	Bangladesh	South Asia	0-18 years	726	Socio/Clin/Anthro	70% underweight, 73.1% stunted
(19)	Nepal	South Asia	10.3 ± 5.0 years (mean)	182	Anthro/Clin	51.7% of CP children underweight, 64.1% stunted, 29.3% thin; Severe malnutrition common among younger children
(20)	Indonesia	Southeast Asia	<18 years	130	Anthro/Clin	High levels of underweight (78.8%) and stunting (85.9%) in children with CP. Severity linked to age, disability level, and visual impairment
(21)	Vietnam	Southeast Asia	0–18 years	765	Anthro/Clin	28.9% and 29.0% were underweight and stunted; underweight and stunted rates higher in quadriplegic and GMFCS level IV–V children
(22)	Chile	South America	2 - 21 years	69	Anthro/Bioch	15.4% underweight
(23)	Belgium	West Europe	1.5 - 18 years	260	Anthro/Bioch/Clin	38% of children had dysphagia; 34% were malnourished; malnutrition increased comorbidities
(24)	Brazil	South America	3 - 20 years	60	Anthro/Bioch/ Quest	No difference in Vitamin D levels between groups
(25)	Spain	Southwest Europe	4–15 years	69	Anthro/Clin	More severe CP cases likely undernourished; a third with less severe CP overweight or obese
(26)	Malaysia	Asia	5 - 18 years	93	Anthro/Clin	38% stunting, 22% underweight. Significant differences in height, weight, BMI, MUAC, and TSF among disability groups
(27)	USA	North America	2 - 17 years	Not Available	Anthro	7.9% of hospitalized children with CP had diagnosed malnutrition
(28)	Zambia	Africa	2 - 10 years	33	Anthro/Clin	Feeding difficulties, weight gain issues, dependency for feeding, food consistency, constipation significantly associated with nutrition
(29)	Malaysia	Asia	3 - 15 years	26	Anthro/Clin/Instr	Mean weight higher in girls. 57.7% of children underweight, 42.3% normal BMI. No association between oral health and nutritional status
(30)	China	East Asia	1–18 years	1151	Anthro/Clin/Bioch	50.8% of individuals were undernourished

PREVALENCE OF MALNUTRITION

Across the studies, there was a consistent emphasis on the high prevalence of underweight status and severe malnutrition among children with CP. The rates of underweight status ranged from 15.4% to 92.6%, indicating a considerable proportion of children affected. Additionally, the studies highlighted the association between malnutrition severity and functional impairment, such as higher GMFCS levels (3); (5)and spastic quadriplegia (41.6%; (7); (13); (14)the prevalence of dysphagia by degree of motor impairment, and the impact of digestive disorders on quality of life.\ nMATERIAL AND METHODS: We conducted a descriptive, cross-sectional, open-label study of outpatients with CP from a tertiary hospital in the Region of Madrid using a structured interview, classifying dysphagia using the Eating and Drinking Ability Classification System (EDACS; (15); (17)6 months, and 1 year. Methods: This was a retrospective study of all pediatric patients with CP who received a G tube placement between April 2014 and December 2017 at a single institution. Bivariate analysis was used to examine association between patient characteristics and the primary outcome of improvement in weight Z score at 3, 6, and 12 months. Results: Of 63 patients who received a G tube, 81% had an increase in Z score at 3 months, 44% at 6 months, and 64% at 12 months. By 12 months, factors associated with a positive Z score change included moderate and severe malnutrition, lack of prior G tube, and fewer comorbidities. The majority (69.8%; (31)Indonesia. Methods: This is a community-based key informant (KI; (21); (22)no studies have described these deficiencies in Chile. Objective: To describe the status of VD and iron in patients with CP and evaluate the relationship with certain factors associated with deficiencies of these micronutrients. Patients and method: We performed a descriptive, cross-sectional study including 69 patients aged between 2 and 21 years, from two public hospitals. Data were obtained on demographic variables, motor function, use of feeding tube, and pharmacological treatment. We performed a nutritional assessment according to patterns of CP and determined 25-hydroxyvitamin D (25[OH]D; (24); (30).

The prevalence rates of malnutrition varied across different countries/regions, reflecting potential differences in healthcare systems, socio-economic factors, and cultural practices. The studies included countries from various continents, such as Western Asia, Asia, Africa, and Europe, indicating a global concern regarding malnutrition among children with CP.

Overall, the findings suggest that malnutrition is a significant issue in children with CP, with underweight status being particularly prominent. Malnutrition prevalence varied across different continents. Studies conducted in Africa, including Nigeria and Zambia, reported high rates of malnutrition ranging from 67.5% to 70.83%. In Asia, studies conducted in Saudi Arabia, Malaysia and Turkey reported malnutrition rates ranging from 22% to 84.9%. Europe had a range of malnutrition rates, with studies conducted in Belgium, Germany/Netherlands, Spain reporting rates ranging from 29% to 90%. North America studies in the USA reported rates of 7.9% in hospitalized children In South America, Chile and Brazil reported malnutrition rates of 15.4%. Southeast Asia studies in Vietnam and Indonesia reported rates ranging from 28.9% to 78.8%.

Regarding the publication years, the studies covered a range of years from 2018 to 2023, when, no specific trends or significant variations in malnutrition prevalence based on publication year can be observed from the information provided.

The age range of participants in the studies varied, with some studies including children aged 0-18 years and others covering 2-20 years. However, the information does not allow for specific age-related trends or variations in malnutrition prevalence to be determined.

PATTERNS OF MALNUTRITION

The included studies reported various patterns of malnutrition among children with cerebral palsy. Underweight was found to be prevalent, with rates ranging from 22% to 84.9% (26); (20). Stunting was also a common form of malnutrition, with prevalence ranging from 35% to 85.9% (16)nutrient intakes, and deficiencies of Thai children with cerebral palsy (CP; (20). Severe wasting was reported in some studies, with rates of 7.7 % (20). These findings highlight the substantial burden of malnutrition in this population.

Associations between malnutrition and various factors were also identified in the studies. Gender differences in malnutrition were observed in some studies, with higher rates of underweight or low body fat observed in males (29)low resting energy expenditure due to hypertonia or movement disorder will consequently lead to feeding issues such as dysphagia, constipation, gastroesophageal reflux disease and malnutrition. This study was conducted to determine the association between body weight status and feeding issues among CP children in Community-Based Rehabilitation

(CBR. Age was another factor associated with malnutrition, with younger children often having higher rates of severe malnutrition (20). Motor impairment severity, as measured by the Gross Motor Function Classification System (GMFCS) or the European Dysphagia Classification System (EDACS), was consistently linked to increased risk of malnutrition (15); (30); (14)the prevalence of dysphagia by degree of motor impairment, and the impact of digestive disorders on quality of life.\nMATERIAL AND METHODS: We conducted a descriptive, cross-sectional, open-label study of outpatients with CP from a tertiary hospital in the Region of Madrid using a structured interview, classifying dysphagia using the Eating and Drinking Ability Classification System (EDACS; (21); (11) Higher levels of motor impairment were associated with higher prevalence of malnutrition, including underweight, stunting, and wasting.

Comorbidities and specific conditions were found to impact malnutrition as well. Certain comorbidities such as dysphagia, epilepsy, or intellectual challenges were associated with lower nutritional indices (15). Factors such as feeding difficulties, prolonged feeding, and choking were prevalent among children with malnutrition, indicating the presence of feeding issues that may contribute to nutritional problems (10), (28). Several studies in the table examined the association between oral health and nutritional status in children with CP. For example, Ahmad (2020) and Iamopas (2022) found a correlation between oral health and nutritional status, with a high prevalence of caries and acid-producing plaque among the participants. Similarly, Zahri in 2020 reported no significant association between oral health and nutritional status in their study.

MICRONUTRIENT DEFICIENCIES

Several studies assessed the prevalence and patterns of micronutrient deficiencies in children with CP. Notably, Duc in Vietnam found that 60% of the participants had anemia, with iron deficiency accounting for a significant portion of the cases. This indicates a high prevalence of iron deficiency anemia among children with CP. Additionally, Iamopas, 2022 in Thailand reported inadequate intake of calcium, iron, zinc, vitamin A, vitamin D, vitamin B1, vitamin B2, vitamin B3, energy intake and total fat, with these nutrient intakes falling below 78% of the Recommended Nutrient Intake (RNI) for 2017. Ahmad, 2020 (in Malaysia) measured caries prevalence and assessed biochemical parameters such as calcium, iron, zinc, vitamin A, vitamin D, and total fat intake.

BODY COMPOSITION

Several studies considered body composition assessments to further evaluate the nutritional status of children with CP. For instance, Bell *et al*. (2020) in Australia used skinfold thickness measurements to assess body composition and found that moderate or severe malnutrition, as determined by the Subjective Global Nutritional Assessment (SGNA), was associated with reduced weight, BMI, mid-upper arm circumference (MUAC), triceps skinfold thickness (TST), and subscapular skinfold thickness z-scores. These body composition assessments provide valuable insights into the distribution of fat, muscle, and other body tissues, aiding in the identification and understanding of malnutrition-related abnormalities.

DISCUSSION

The findings from our study shed light on the prevalence and patterns of malnutrition in children with CP, emphasizing the importance of comprehensive assessments encompassing anthropometric measurements, instrumental evaluations, biochemical tests, and body composition analysis. The studies revealed a significant burden of malnutrition in this population, with varying degrees of underweight, stunting, wasting, and micronutrient deficiencies.

The prevalence of malnutrition varied across continents, countries, and regions, reflecting the complex interplay of socio-economic factors, healthcare access, and cultural influences. The high rates of malnutrition observed in some studies, such as Aal-Blowi, 2020 (Saudi Arabia), Aydin, 2019 (Turkey), Carman, 2022, (Turkey), and Jahan, 2021 (Indonesia) underscore the need for targeted interventions in these regions to address the nutritional needs of children with CP.

The assessment of malnutrition in children with CP varied with multiple indicators employed to evaluate different aspects of nutritional status. These indicators included weight-for-age, height-for-age, body mass index (BMI), percentage of body fat, triceps skin fold thickness, and various clinical assessments.

Anthropometric measures such as weight-for-age and height-for-age were commonly used indicators to assess overall nutritional status and growth in these children. For instance, Aal-Blowi (2020) in Saudi Arabia reported that 84.9% of the participants were classified as underweight based on weight-for-age measurements. Similarly, Boudokhane (2021) found that 67.5% of the children included in their study were underweight.

Body mass index (BMI) was also frequently utilized to evaluate nutritional status. Carman (2022) conducted a study in Turkey involving ten different cities and reported that 92.6% of the children with CP were malnourished based on BMI measurements. Duran (2019) in Germany and the Netherlands found that BMI values had varying sensitivity and specificity in detecting undernutrition compared to dual-energy X-ray absorptiometry (DEXA).

In addition to anthropometric measures, some studies incorporated assessments of body composition. Duc (2021) in Vietnam conducted biochemical and clinical evaluations and found that 60% of the participants had anemia, which can indicate micronutrient deficiencies. They also observed a significant difference in the proportion of anemia based on the participants' weight status and Gross Motor Function Classification System (GMFCS) level.

Furthermore, several studies utilized clinical assessments to evaluate specific aspects of malnutrition. Ahmad (2020) in Malaysia assessed caries prevalence, highlighting the impact of oral health on nutritional status. Leonard (2020) in Belgium and Simpamba (2020) in Zambia investigated feeding difficulties and their association with nutrition. The utilization of various indicators reflects the multifaceted nature of malnutrition assessment in children with CP. By considering multiple dimensions, including growth parameters, body composition, and clinical assessments, healthcare professionals can obtain a more comprehensive understanding of the nutritional status of these children and tailor interventions accordingly.

Regarding age groups, the studies encompassed a wide range of participants, from early childhood to adolescence. While the prevalence of malnutrition appeared to be higher in younger children, such as those in Aal-Blowi (2020) from Saudi Arabia, Ahmad (2020) from Malaysia, and Aydin (2019) from Turkey, the overall trend across different age groups warrants attention. Longitudinal studies assessing nutritional status over time could provide further insights into the trajectories of malnutrition in children with CP.

Notably, the inclusion of instrumental assessments in some studies, such as Bell, 2020 (Australia), and Huysentruyt, 2019 (Belgium), provided valuable information on body composition and its association with malnutrition. These assessments revealed deficits in subcutaneous fat, muscle reserve, and active cell mass in malnourished individuals, highlighting the importance of evaluating body composition as part of nutritional assessments.

Furthermore, the biochemical tests conducted in several studies unveiled micronutrient deficiencies among children with CP. Studies by Ahmad, 2020 (Malaysia), Duc, 2021 (Vietnam), and Iamopas, 2022 (Thailand) demonstrated deficiencies in nutrients such as calcium, iron, zinc, vitamin A, and vitamin C. These findings emphasize the need for targeted interventions to address these specific micronutrient deficiencies and ensure optimal nutritional support for children with CP in the context of clinical practice and interventions, these findings underscore the importance of comprehensive nutritional assessments that encompass anthropometric measurements, instrumental evaluations, biochemical tests, and body composition analysis. These assessments can guide tailored nutritional interventions that address the specific needs of individual patients, taking into account their age, motor impairment severity, functional severity, comorbidities, and micronutrient status. The European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) guidelines for the evaluation and treatment of gastrointestinal and nutritional complications in children with neurological impairment provide valuable guidance in managing the nutritional needs of children with CP (32)growth failure, micronutrients deficiencies, osteopenia, and nutritional comorbidities. Gastrointestinal problems including gastroesophageal reflux disease, constipation, and dysphagia are also frequent in this population and affect quality of life and nutritional status. There is currently a lack of a systematic approach to the care of these patients. With this report, European Society of Gastroenterology, Hepatology and Nutrition aims to develop uniform guidelines for the management of the gastroenterological and nutritional problems in children with neurological impairment. Methods: Thirty-one clinical questions addressing the diagnosis, treatment, and prognosis of common gastrointestinal and nutritional problems in neurological impaired children were formulated. Questions aimed to assess the nutritional management including nutritional status, identifying undernutrition, monitoring nutritional status, and defining nutritional requirements; to classify gastrointestinal issues including oropharyngeal dysfunctions, motor and sensory function, gastroesophageal reflux disease, and constipation; to evaluate the indications for nutritional rehabilitation including enteral feeding and percutaneous gastrostomy/jejunostomy; to define indications for surgical interventions (eg, Nissen Fundoplication, esophagogastric disconnection. A recent survey of practice conducted by Romano *et al* (33) also sheds light on the

management of gastrointestinal and nutritional problems in children with neurological impairment, further emphasizing the importance of a multidisciplinary approach in addressing these issues. However, it's important to acknowledge the limitations of the included studies in this research article. Variations in study designs, sample sizes, and assessment methods may introduce biases and impact the generalizability of the findings. Additionally, the cross-sectional nature of many studies limits the ability to establish causal relationships between malnutrition and associated factors. Future research should prioritize longitudinal studies with larger sample sizes and standardized assessment protocols to further enhance our understanding of malnutrition in children with CP and inform evidence-based interventions.

The findings from this study, in line with the ESPGHAN guidelines (32)growth failure, micronutrients deficiencies, osteopenia, and nutritional comorbidities. Gastrointestinal problems including gastroesophageal reflux disease, constipation, and dysphagia are also frequent in this population and affect quality of life and nutritional status. There is currently a lack of a systematic approach to the care of these patients. With this report, European Society of Gastroenterology, Hepatology and Nutrition aims to develop uniform guidelines for the management of the gastroenterological and nutritional problems in children with neurological impairment. Methods: Thirty-one clinical questions addressing the diagnosis, treatment, and prognosis of common gastrointestinal and nutritional problems in neurological impaired children were formulated. Questions aimed to assess the nutritional management including nutritional status, identifying undernutrition, monitoring nutritional status, and defining nutritional requirements; to classify gastrointestinal issues including oropharyngeal dysfunctions, motor and sensory function, gastroesophageal reflux disease, and constipation; to evaluate the indications for nutritional rehabilitation including enteral feeding and percutaneous gastrostomy/jejunostomy; to define indications for surgical interventions (eg, Nissen Fundoplication, esophagogastric disconnection and the survey of practice by Romano *et al* (33), highlight the significant burden of malnutrition and micronutrient deficiencies in children with CP. These results emphasize the need for comprehensive nutritional assessments, including anthropometric measurements, instrumental evaluations, biochemical tests, and body composition analysis. By addressing malnutrition through tailored interventions guided by evidence-based guidelines and collaborative approaches, healthcare professionals can contribute to improving the overall health and well-being of children with CP, ultimately enhancing their quality of life.

CONCLUSION

Our study underscores the significant prevalence and adverse consequences of malnutrition in children with CP. These results highlight the importance of comprehensive nutritional assessments, tailored interventions, and close monitoring of nutritional status in clinical practice. By addressing malnutrition, healthcare providers can improve the overall health, growth, and quality of life for children with CP.

CONTRIBUTION TO THE FIELD

We believe that this review makes a significant contribution to the field of developmental disabilities by providing a comprehensive and up-to-date analysis of the prevalence and patterns of malnutrition in individuals with cerebral palsy. The findings from this study shed light on the high prevalence of malnutrition and associated factors, such as motor impairment severity, functional limitations, feeding difficulties, and socio-demographic factors. By synthesizing the existing literature from global studies, this manuscript enhances our understanding of the complex relationship between malnutrition and cerebral palsy, providing valuable insights for clinicians, researchers, and policymakers. The comprehensive nature of this narrative review, encompassing various continents and countries, helps to identify regional variations in malnutrition prevalence and highlights the need for targeted interventions and tailored nutritional care strategies for individuals with cerebral palsy worldwide.

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AUTHORS CONTRIBUTION STATEMENT

RP conceived the idea for the study and contributed to the design of the research methodology. AT, RB and FA conducted the literature search and performed the initial keyword search and screening of articles. FA contributed as a technical assistant and participated in writing the methodology section of the manuscript. RP, AT and RB contributed to the writing of the first draft of the manuscript. All authors reviewed and provided critical feedback on the manuscript, and approved the final version for submission.

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