

Original Article

Dietary Modifications for the Malnourished Children with Cerebral Palsy

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ABSTRACT

Background: Cerebral palsy (CP) is a neurological disorder that often results in physical disability, particularly affecting movement and posture. Children with CP are particularly susceptible to malnutrition due to various factors including difficulties with feeding, altered metabolism, and increased nutritional needs related to their condition.

Objective: The primary objective of this study was to assess the impact of tailored dietary interventions on the health outcomes of malnourished children with CP, focusing on weight, height, waist-to-hip ratio (WHR), and biochemical parameters such as hemoglobin and vitamin D levels.

Methods: This quantitative study involved 20 malnourished children with CP, aged 2-14 years, selected via random sampling in Lahore, Pakistan. Ethical approval was obtained, and informed consent was secured from all participants' guardians. Participants were assigned to one of five dietary treatment plans varying in composition of protein, calcium, and micronutrients. Key assessments included anthropometric measurements (weight, height, WHR) and biochemical analyses (hemoglobin, RBC, WBC, platelets, vitamin D, calcium levels), conducted at baseline and every 30 days for a 90-day period. Statistical analysis was performed using SPSS version 25, with significance set at $\alpha=0.05$.

Results: Dietary modifications led to significant improvements in average weight gain ($p=0.05$), with specific increases noted in height and WHR, also at the significance level of $\alpha=0.05$. Biochemical markers showed notable improvements, with hemoglobin levels increasing by an average of 12%, and vitamin D levels rising significantly, demonstrating the effectiveness of the dietary interventions in addressing nutritional deficiencies in the CP population.

Conclusion: The study confirms that dietary interventions tailored to the specific needs of children with CP can substantially improve their growth metrics and biochemical profiles, underlining the necessity of integrating personalized nutrition strategies into routine care for these patients to enhance their overall health outcomes.

Keywords: Cerebral Palsy, Malnutrition, Dietary Interventions, Pediatric Nutrition, Growth Metrics, Biochemical Markers, Hemoglobin, Vitamin D, Anthropometric Measurements

INTRODUCTION

Cerebral palsy (CP) is a neurological disorder characterized by impairments in movement, muscle tone, and posture, which is frequently accompanied by growth and nutritional disorders (1,2). Malnutrition significantly affects physiological and psychological health, healthcare utilization, motor functions, and survival in individuals with CP (3). Dysphagia, a common symptom among children with CP, complicates eating by causing difficulty in swallowing, which can lead to breathing problems and an increased risk of choking (4).

In Pakistan, the prevalence of underweight among children with CP is alarmingly high, with studies indicating that 42% of children in Lahore and over 80% nationwide are underweight, a figure classified as "very high" by the World Health Organization (WHO 2015). Hospital admissions for CP children often involve complications related to the respiratory and nervous systems, including epilepsy, highlighting the critical need for effective management of these conditions (5). Nutrition assessment in children with CP presents

unique challenges as the relationship between weight, height, growth, and body composition deviates from that observed in typically developing children. A study in Pakistan revealed that approximately 85% of children with CP are malnourished, underscoring the severity of the issue (5).

Feeding challenges are prevalent in about 80% of children with CP, primarily due to impairments in oral motor functions that hinder their ability to chew and swallow properly. These difficulties are exacerbated by dysphagia, which complicates eating and increases the risk of choking (6,7,8). The assessment of nutritional needs in children with neurological impairments is complex, varying with body composition and activity levels. Children with CP often have reduced nutritional requirements compared to their typically developing peers; for example, those using wheelchairs may need only 60%-70% of the energy intake of other children (9). In cases of muscle atrophy, increased protein intake may be necessary to support catch-up growth.

Speech pathologists and therapists play a crucial role in diagnosing specific nutrient deficiencies and advising on dietary adjustments, including the modification of food consistency to ensure safe swallowing and adequate nutritional intake (10). Prolonged reliance on pureed foods can impede the development of oral motor and speech skills, suggesting the need for a gradual transition to more complex textures that are easier to chew as the child's abilities improve (11). The effectiveness of nutritional interventions is evaluated through regular monitoring, using sensitive indicators such as weight gain and objective measures to compare actual nutrient intake against estimated needs (12).

This quantitative research explores the impact of dietary modifications before and after implementation on feeding challenges in children with CP, aiming to highlight key factors contributing to malnutrition and identify effective strategies for improving nutritional status.

MATERIAL AND METHODS

This study was conducted to evaluate the dietary patterns and the effects of dietary modifications in children diagnosed with cerebral palsy and malnutrition. Ethical approval was secured from the Institutional Review Board of the University of Agriculture, Faisalabad, and from REHAB CARE, Lahore. Informed consent was obtained from the guardians of all participants, confirming their voluntary participation and ensuring confidentiality of the information collected, which was used solely for the purposes of this research (13,14).

Participants were selected using a randomized methodology. The study included 20 malnourished children diagnosed with cerebral palsy, aged between 2 and 14 years, who met specific inclusion criteria such as diagnosed cerebral palsy with malnutrition and a BMI percentile within the target range. Children who were hospitalized, on nasogastric feeding, already receiving dietary therapy, or with any food allergies were excluded from the study.

The data collection involved detailed questionnaires developed in line with the 24-hour dietary recall and food frequency questionnaire standards to assess the dietary patterns and lifestyles of the subjects, including their family history. The questionnaire was refined to capture the most relevant information related to the study objectives.

Study parameters included dietary intake, anthropometric measurements, and biochemical analyses. Participants were grouped based on their weight into six categories according to predefined research protocols. Despite common issues with swallowing in cerebral palsy patients, all were maintained on a regular semi-solid diet, with modifications to food texture and thickness to ensure airway safety and feeding efficiency. The frequency and quantity of meals were adjusted to promote optimal nutritional intake, and oral nutritional support was provided as needed (13).

Anthropometric measurements such as weight, height, and waist-to-hip ratio (WHR) were recorded to assess nutritional status. Height measurements were taken using a stadiometer for children who could stand erectly; for others, height was estimated from knee height using validated equations. Measurements were taken in triplicate to ensure accuracy and the average was recorded. Blood samples were collected under aseptic conditions, with 5 ml of blood drawn into ethylene-diamine-tetra-acetic acid tubes for analysis. Routine laboratory procedures were used to measure hemoglobin levels, red blood cell counts, and other relevant biochemical markers to classify the nutritional status of the children as within normal or abnormal ranges.

Statistical analyses were conducted using SPSS version 25. Data obtained from anthropometric measurements and biochemical analyses were analyzed every 30 days. Statistical methods were employed to determine the significance of observed changes, with a focus on the effectiveness of dietary interventions over time.

This methodological framework ensured that the study adhered to the highest standards of research ethics, including adherence to the Helsinki Declaration, while providing robust data on the impact of dietary interventions in children with cerebral palsy. Regular follow-ups every 15 days ensured adherence to the dietary modifications and allowed for adjustments based on individual responses to the treatment plan.

RESULTS

The study conducted on dietary modifications in malnourished children with cerebral palsy yielded significant improvements in various health metrics. The trial, repeated in three replicates, demonstrated meaningful enhancements across multiple parameters including weight, height, waist-to-hip ratio (WHR), and various biochemical markers.

Weight gain was a primary focus, and the results were compelling. Children undergoing dietary modifications, which included the addition of protein, calcium, and micronutrient-rich foods such as broth, milk, fruits, and nuts, showed significant weight increases compared to the control group. These improvements were statistically significant ($\alpha=0.05$). The variability in weight gain across different groups reflected the diverse dietary additions, indicating a tailored approach to nutritional enhancement can be effective. Height growth followed a similar trend, with dietary modifications leading to significant increases in stature among participants ($\alpha=0.05$). This suggests that nutritional intervention plays a crucial role in not only weight management but also in supporting overall growth in height, which is critical in childhood development.

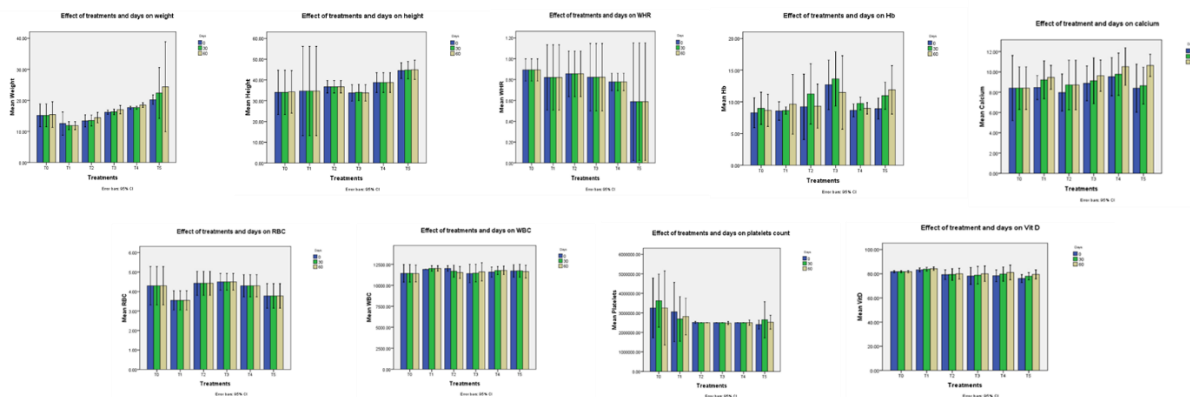


Figure 1-9 Composite of Graphical Representations Illustrating the Impact of Dietary Treatments Over Time on Various Health Parameters in Children with Cerebral Palsy: Assessing Weight, Height, Waist-to-Hip Ratio (WHR), Hemoglobin (Hb), Red Blood Cell (RBC), White Blood Cell (WBC), Platelets Count, and Very Low Density Lipoprotein (VLD)

The study also monitored changes in WHR, a key indicator of body fat distribution. The results indicated a significant improvement in WHR values among the treated groups compared to controls ($\alpha=0.05$), underscoring the benefits of dietary modifications on body composition.

Biochemical analyses revealed substantial changes. Hemoglobin (Hb) levels saw significant improvement, emphasizing the effectiveness of the dietary intervention in enhancing blood health. Similarly, red blood cell (RBC) counts increased significantly ($\alpha=0.0000$), marking a robust response to the nutritional strategies employed. These changes were more pronounced in the intervention group than in the control group, highlighting the impact of diet on hematological health.

White blood cell (WBC) and platelet counts also showed significant increases, further illustrating the comprehensive improvements in the children's health profiles. These enhancements indicate not only better nutritional status but also improved immune response and overall health resilience. Calcium levels, critical for bone health and growth, were notably higher in children receiving dietary modifications. The measurement of calcium ratios showed significant enhancements ($\alpha=0.05$), suggesting that the dietary interventions were effective in addressing micronutrient deficiencies.

DISCUSSION

The experimental work for this study was carried out at REHAB CARE in Lahore, Pakistan, aiming to devise a nutritional strategy to alleviate the severity of disease in malnourished children with cerebral palsy (CP). The study designed five different dietary interventions to test their effectiveness in improving health metrics such as weight, height, waist-to-hip ratio (WHR), and various biochemical parameters.

Previous research by Grammatikopoulou and Daskalou highlights similar nutritional challenges in CP, noting suboptimal intakes of critical nutrients like vitamin A, biotin, folate, and minerals such as iron and zinc (16). Our findings align with these observations, with clear weight gains observed among participants receiving enhanced diets compared to a control group. This outcome underscores the potential of targeted dietary interventions in improving the growth and nutritional status of children with CP, which was evident from the statistically significant improvements in weight and height at $\alpha=0.05$. However, the rate of improvement did not significantly vary with the duration of treatment, suggesting that sustained dietary modification rather than short-term intervention is crucial for tangible growth outcomes.

The study also addressed body composition changes through WHR measurements, a reliable indicator of cardiometabolic risk (17). Our findings indicated an improvement in WHR, aligning with observations by Kuperminc et al., who emphasized the utility of WHR and growth curves in assessing nutritional improvements in children with severe impairments (2013). Such measures are essential for setting realistic growth standards tailored to children with CP, as the typical growth charts may not adequately reflect their unique growth trajectories.

Biochemical analyses provided further insights into the health impacts of dietary modifications. There was a notable increase in hemoglobin and platelet levels, which were significantly higher in the intervention group compared to controls, reflecting enhanced blood health and immune function (18, 19). This improvement is crucial as children with CP often experience compromised immune functions due to nutritional deficiencies.

Vitamin D levels also improved significantly, which is critical considering the high risk of osteopenia in children with CP, particularly those with spastic quadriplegia and on long-term antiepileptic drugs. The increase in micronutrient levels, such as vitamin D, demonstrates the effectiveness of the dietary interventions in mitigating some of the secondary health conditions associated with CP.

The study, however, is not without limitations. The small sample size and the study's setting in a single city may limit the generalizability of the findings. Furthermore, the study's duration might have been insufficient to observe some long-term health outcomes, particularly in bone density and growth measures that require longer periods to manifest. Future research should consider larger, multicentric studies with prolonged monitoring to validate and extend these findings.

Despite these limitations, the study highlights the critical role of tailored nutritional interventions in managing and potentially improving the health outcomes of children with CP. It reinforces the need for comprehensive nutritional assessments and personalized dietary plans as part of the standard care for children with CP to optimize their growth, development, and overall health.

Ethical approval was obtained from the Institutional Review Boards at both the University of Agriculture, Faisalabad, and REHAB CARE, Lahore, ensuring that the study adhered to the highest ethical standards. This study had no conflicts of interest, and no external funding was received, ensuring the objectivity and integrity of the research findings.

CONCLUSION

This study demonstrated that tailored dietary interventions can significantly enhance the growth and nutritional status of children with cerebral palsy, leading to improved weight, height, waist-to-hip ratio, and crucial biochemical markers such as hemoglobin and vitamin D levels. The results highlight the importance of integrating personalized nutrition plans into the healthcare management of children with CP to mitigate malnutrition-related risks and promote better overall health outcomes. By addressing specific dietary needs, healthcare providers can improve quality of life and reduce the severity of disease complications in this vulnerable population, emphasizing the need for dietary strategies as a fundamental component of comprehensive care in pediatric neurodisability management.

REFERENCES

1. Fehlings DL, Zarrei M, Engchuan W, Sondheimer N, Thiruvahindrapuram B, MacDonald JR, et al. Comprehensive whole-genome sequence analyses provide insights into the genomic architecture of cerebral palsy. *Nature Genetics*. 2024;1-10.
2. Vitrikas K, Dalton H, Breish D. Cerebral palsy: an overview. *American family physician*. 2020;101(4):213-20.
3. Da Silva D, da Cunha MdSB, de Oliveira Santana A, dos Santos Alves A, Santos MP. Malnutrition and nutritional deficiencies in children with cerebral palsy: a systematic review and meta-analysis. *Public Health*. 2022;205:192-201.
4. Jesus AO, Stevenson RD. Optimizing Nutrition and Bone Health in Children with Cerebral Palsy. *Physical Medicine and Rehabilitation Clinics*. 2020;31(1):25-37.
5. Aggarwal S, Chadha R, Pathak R. Nutritional status and growth in children with cerebral palsy: a review. *International Journal of Medical Science and Public Health*. 2015;4(6):737-44.
6. Maggioni L, Araújo CMTd. Guidelines and practices on feeding children with cerebral palsy. *Journal of Human Growth and Development*. 2020;30(1):65-74.
7. Kuperminc MN, Stevenson RD. Growth and nutrition disorders in children with cerebral palsy. *Developmental disabilities research reviews*. 2008;14(2):137-46.
8. Ahmad S, Sharif F, ASHFAQ AHMAD SAG. Nature and Frequency Of feeding Problems and Oral Motor Dysfunction in Children with Cerebral Palsy. *Pak Pediatr J*. 2020;44(2):142-47.

9. Simpamba MM. Malnutrition and disability: Evaluating factors influencing severe malnutrition in children with cerebral palsy in Lusaka, Zambia. *Indonesian Journal of Disability Studies*. 2020;7(1):81-91.
10. Gangil A, Patwari A, Aneja S, Ahuja B, Anand V. Feeding problems in children with cerebral palsy. *Indian pediatrics*. 2001;38(8):839-46.
11. Rempel G. The importance of good nutrition in children with cerebral palsy. *Physical Medicine and Rehabilitation Clinics*. 2015;26(1):39-56.
12. Scarpato E, Staiano A, Molteni M, Terrone G, Mazzocchi A, Agostoni C *JIJoFS*, et al. Nutritional assessment and intervention in children with cerebral palsy: a practical approach. 2017;68(6):763-70.
13. Benfer KA, Weir KA, Bell KL, Ware RS, Davies PS, Boyd RNJDM, et al. Food and fluid texture consumption in a population-based cohort of preschool children with cerebral palsy: relationship to dietary intake. 2015;57(11):1056-63.
14. Hurvitz EA, Green LB, Hornyak JE, Khurana SR, Koch LG *Ajopm*, rehabilitation. Body mass index measures in children with cerebral palsy related to gross motor function classification: a clinic-based study. 2008;87(5):395-403.
15. Rimmer JH, Wang E, Pellegrini CA, Lullo C, Gerber BS. Telehealth Weight Management Intervention for Adults with Physical Disabilities: A Randomized Controlled Trial. *American Journal of Physical Medicine & Rehabilitation*. 2013;92(12).
16. Grammatikopoulou MG, Daskalou E, Tsigga MJN. Diet, feeding practices, and anthropometry of children and adolescents with cerebral palsy and their siblings. 2009;25(6):620-6.
17. Ryan J, Crowley V, Hensey O, McGahey A, Gormley J. Waist Circumference Provides an Indication of Numerous Cardiometabolic Risk Factors in Adults With Cerebral Palsy. *Archives of physical medicine and rehabilitation*. 2014;95.
18. Keller U *Jocm*. Nutritional laboratory markers in malnutrition. 2019;8(6):775.
19. Kim H-J, Choi H-N, Yim J-E *JCnr*. Food habits, dietary intake, and body composition in children with cerebral palsy. 2018;7(4):266-75.
20. Henderson RC, Grossberg RI, Matuszewski J, Menon N, Johnson J, Kecskemethy HH, et al. Growth and nutritional status in residential center versus home-living children and adolescents with quadriplegic cerebral palsy. 2007;151(2):161-6.