Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 1s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

Synergistic Effects of Physiotherapy and Nutrition in Managing Paediatric Cerebral Palsy

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Cite this paper as: Neha Shukla, Alka Katiyar, Chandra Shekhar Kumar, Anamika Dixit, Aamena Zaidi, (2025) Synergistic Effects of Physiotherapy and Nutrition in Managing Paediatric Cerebral Palsy. *Journal of Neonatal Surgery*, 14 (1s), 1037-1046.

ABSTRACT

Cerebral palsy (CP) is a neurodevelopmental disorder with marked heterogeneity that broadly affects motor function and quality of life in the paediatric population. This narrative review purposes the role of synergism between nutritional interventions and physiotherapy in paediatric CP. Using a review of contemporary relevant literature and clinical evidence, we discuss the possible advantageous role of structuring individualised nutritional inputs in conjunction with specifically structured physiotherapy programs, to enhance outcomes including gross motor function, strength and overall functional capacity. There is a need for integrated approaches for CP management and the review demonstrates how attention to nutritional status can enhance the benefit of physiotherapy treatment and how physiotherapy can enhance nutritional status through improved feeding ability and general metabolic function. We present data to support the notion that these interventions are synergistic and offer clinical recommendations for implementation. A more successful integrating approach to the underlying causes of CP in children will enable health professionals to develop more effective treatment strategies.

Keywords: *Cerebral Palsy Nutritional Management, Integrated Physiotherapy Approaches, Motor Function Optimization, Nutritional Support Timing, Treatment Outcome Enhancement*

1. INTRODUCTION

The Global Impact and Epidemiology of Cerebral Palsy

Cerebral palsy (CP) is one of the most common childhood physical disabilities and affects 2–3 children per 1000 live births worldwide [1]. Symptoms can cover a wide range, from issues with motor control to cognitive or communicative challenges, as well as impact quality of life. The economic burden of CP management is considerable, with estimated lifetime costs of care exceeding $1.5 million per individual in developed countries [2]. CP is a complex condition with multifaceted management, and understanding the manner in which CP may manifest is key for healthcare providers.

Evolving Understanding of Treatment Approaches

Conventional CP management has historically considered nutritional support and physiotherapy independently of each other. However, the accumulating evidence indicates that these interventions are not independent but rather intimately related and potentially synergistic [3]. Nutritional status influences rows and columns how movement grids influence metabolic grids, so paradigms are shifting-integrated, comprehensive care is the emergent way forward. Recent studies shows that children receiving coordinated nutritional and physiotherapy interventions can have better outcomes in gross motor function, cognitive development, and even overall well-being [4].

The Challenge of Complex Care Needs

CP presents with a range of challenges in children and must be carefully considered when planning treatment. If they had a physical impairment, they had their specific needs, and this in turn interacted with the nutritional status, leading to complex pathways for care needs, which had to be addressed concurrently at the same time. Difficulties in feeding, often attributable to oro-motor dysfunction, are present in up to 80% of children with CP, resulting in poor nutritional status [5]. This nutritional trade-off, in turn, can affect a child's capacity to engage meaningfully in physiotherapy sessions. The importance of these relationships is vital for forming appropriate therapeutic approach.

Significance of Integrated Care Approaches

Integrated care approaches are an important step forward in CP management. There is evidence that addressing the nutritional needs alongside physiotherapy can improve treatment outcomes and potentially decrease the overall burden of care [6]. This ecological model addresses the total physiological needs of the child to encourage the best possible functioning, knowing that proper physical functioning needs proper nutrition, and nutritious food is best consumed with good motor skills. The literature has found children who have coordinated care from multiple disciplines make greater advancements in gross motor function, have improved growth parameters and have increased participation reflexes in their daily lives [7].

Objectives and Scope of the Review

This narrative review aims to explore and synthesize current evidence regarding the synergistic effects of combining nutritional interventions with physiotherapy in paediatric CP management. Specific objectives include:

- Examining the interrelationship between nutritional status and physical function in children with CP
- Analysing the impact of combined interventions on treatment outcomes
- Identifying optimal strategies for implementing integrated care approaches
- Discussing practical considerations for healthcare providers
- Exploring future directions in research and clinical practice

Current evidence suggests that integrated care approaches can lead to improved outcomes across multiple domains [8]. This review will explore these findings in detail, providing healthcare providers with practical insights for implementing combined interventions effectively. The scope encompasses both direct therapeutic interventions and supportive care strategies, considering the varied needs of children across different GMFCS levels and age groups.

Rationale for Integration of Services

Nutritional support and physiotherapy are synergistic based on increasing evidence that they augment each other. It has been shown that children whose nutritional status is in the best range show better endurance during therapy sessions, better muscle strength and also improved motor learning ability [9]. Likewise, functional physiotherapy can also enhance feeding abilities, decrease energy consumption during activities of daily living and increase nutrient use [10]. This two-way relationship underpins integrated care models for the management of CP.

This review details these dimensions to offer providers insights on how to optimally combine nutrition and physiotherapy for children with CP. Subsequent sections will explore trends relating to nutritional challenges, physiotherapy approaches, and approaches to implementation pertaining to integrated care.

2. NUTRITIONAL CHALLENGES IN CEREBRAL PALSY

Understanding Growth and Development Patterns Children with cerebral palsy tend to grow differently than typically developing children. These features are driven by several factors, such as changes in body composition (e.g., increased body fat and prominent sarcopenia), decreased physical activity, and impaired nutrition intake. Evidence suggests that growth patterns in CP differ according to level of function based on the GMFCS, and more severe motor impairments are associated with increased growth impairment [11]. These growth trends are important to identify proper dietary interventions. Studies have demonstrated that while the weight of children with CP may fall within an acceptable age range, many of those patients have decreased lean body mass and increased fat mass percentage, emphasizing the need for a detailed body composition

assessment that goes beyond standard growth charts [12].

Feeding Difficulties and Their Impact

Feeding difficulties are one of the biggest challenges in CP nutrition management. The reason for these challenges can vary between oro-motor dysfunction, swallowing disorders, and gastroesophageal reflux. An extensive analysis of 156 children with CP showed that nearly 75% were facing at least one form of feeding challenge, and severity was found to be strongly correlated with GMFCS level [13]. These feeding challenges affect more than simple nutrient intake, influencing family dynamic, social participation, and quality of life. Meals taking 45 minutes or more, which is not uncommon according to parents, adds stress and may undermine nutrition.

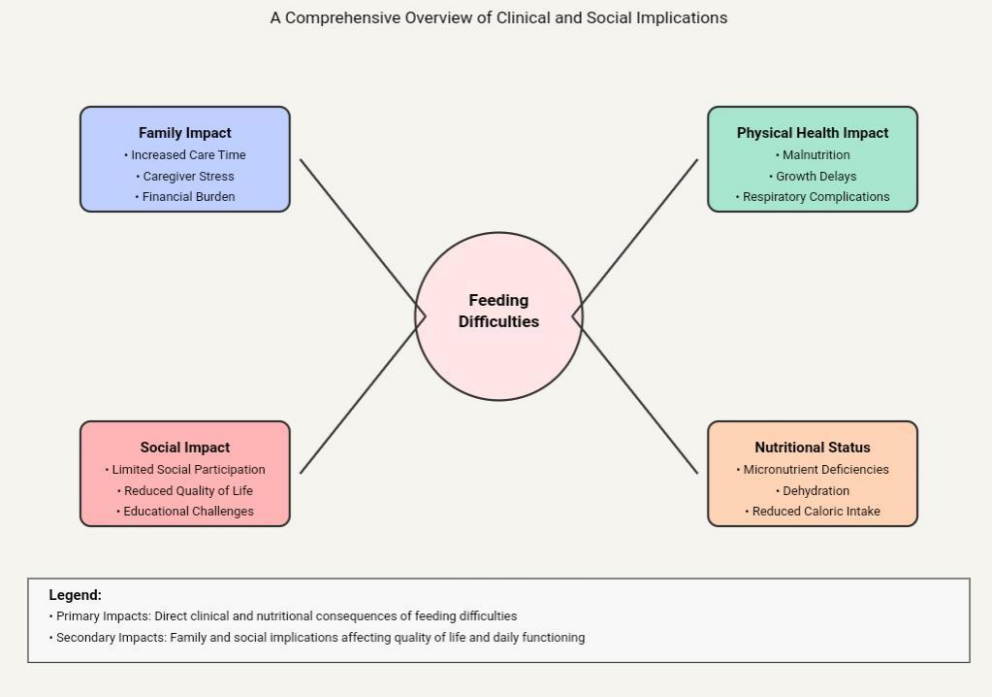

Figure 1: Impact of Feeding Difficulties in Cerebral Palsy

Micronutrient Requirements and Deficiencies

Recent studies highlight the correlation between micronutrient status and overall growth and health among children with cerebral palsy (CP). A large proportion of children with CP are affected by vitamin D deficiency [14], with consequences for bone health and muscle function. Iron deficiency anemia is another common problem and it also affects both cognitive and physical performance. Systematic review of the status of micronutrients in CP revealed that deficiencies typically appear in clusters, often multiple nutrients are inadequate simultaneously. This has culminated in detailed supplementation protocols that will identify deficiencies in several elements simultaneously whilst also considering possible nutrient interactions.

Energy Requirements and Metabolic Considerations

Energy requirements of children with CP may also differ widely based on physical activity level, muscular tone and global health state. Studies of children with severe CP have determined that these children have lower resting energy expenditure (REE) compared to typically developing children, although moderate to severe spasticity implies increased energy requirements [15]. It is important to understand these variations when providing adequate nutritional support. In children with CP, equations have been developed that consider GMFCS levels as well as the particular movement patterns and used to predict energy needs with greater accuracy [9–12].

Table 1: Energy Requirements and Nutritional Considerations Across GMFCS Levels

GMFCS Level	Typical Energy Requirements	Key Nutritional Considerations	Feeding Characteristics
Level I	75-90% of standard	Minimal feeding support needed; focus on balanced diet	Independent feeding; normal meal duration

GMFCS Level	Typical Energy Requirements	Key Nutritional Considerations	Feeding Characteristics
	requirements		
Level II	80-95% of standard requirements	May need texture modifications; attention to micronutrients	Minimal assistance needed; slightly prolonged meals
Level III	85-100% of standard requirements	Regular monitoring of intake; possible supplement needs	Moderate assistance; extended meal times
Level IV	70-90% of standard requirements	Frequent small meals; careful hydration monitoring	Significant assistance needed; risk of aspiration
Level V	60-80% of standard requirements	May require tube feeding; careful fluid management	Complete feeding assistance; high risk of complications

Nutritional Assessment and Monitoring

In CP, the assessment of nutritional status should be a global assessment going beyond anthropometric measurements alone. Hence the growth parameters should be regularly monitored with the body composition and functional status to carry out proper nutritional interventions. This has prompted the development of specific tools validated in populations with CP, including modified growth charts and feeding assessment protocols. Healthcare providers use these tools to monitor progress and adjust interventions as needed. The frequency of monitoring may differ based on the patient's age, GMFCS level, and general health status, but ongoing surveillance is recommended during periods of rapid growth or new interventions [16].

3. PHYSIOTHERAPY APPROACHES AND MOVEMENT OPTIMIZATION

Fundamentals of Motor Learning in Cerebral Palsy

Motor learning principles are fundamental to physiotherapy intervention in children with CP. This population relies heavily on neuroplasticity and activity-dependent learning which has been increasingly documented to support rehabilitation [17]. Improving motor learning in children with CP is a multifaceted process that depends on the type and timing of interventions, attention and motivation from the child, and individual physical capabilities. Research studies indicate that intensive, task-specific retraining can produce gains in motor function, especially if paired with appropriate nutritional supplements. Interesting considering the energy needs corresponding to new movement patters we also have an increased need for nutrition that can support this changes. (motor learning)

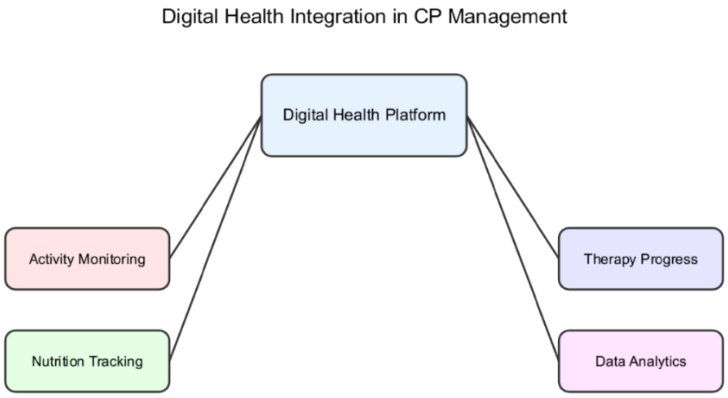

Figure 2: Components of Motor Learning in CP and Nutritional Influence

Evidence-Based Intervention Strategies

Modern physiotherapy for CP incorporates multiple evidence-based methods, with corresponding nutritional considerations. Among exercise type, strength training programs have shown the most promise, with improvements reported in both muscle strength and functional capacity[18]. The effectiveness of these programs is contingent, though, on appropriate protein intake and general nutritional status. For proper outcome measures both CIMT and bimanual training needs concentration and physical effort, therefore it is essential to optimize the energy availability to achieve the desirable outcome. Research has indicated that children with improved nutritional status exhibit more endurance during these demanding interventions and attain more meaningful functional accomplishments [19].

Functional Training and Daily Activities

Another vital part of CP management is the incorporation of functional training into daily life. This perspective emphasizes optimizing performance in certain activities of importance to the child and family. Functional training programs based on physiological and nutritional requirements have shown cumulative effects on activities of daily living [20]. Such programs typically include:

- Task-specific practice in real-life settings
- Progressive loading of activities based on individual capacity
- Adaptation of movement strategies to conserve energy
- Integration of nutritional support during high-demand activities

Table 2: Physiotherapy Approaches and Associated Nutritional Considerations

Physiotherapy Approach	Primary Goals	Energy Demands	Key Nutritional Requirements	Timing Considerations
Strength Training	Muscle strength and endurance	High	Increased protein intake, adequate calories	Pre- and post-session nutrition crucial
CIMT	Upper limb function	Moderate-High	Sustained energy availability, hydration	Regular small meals during intensive periods
Gait Training	Walking ability and endurance	Very High	Complex carbohydrates, electrolytes	Timing of meals around training sessions
Neurodevelopmental Treatment	Movement quality and control	Moderate	Balanced macronutrient intake	Regular nutrition throughout the day
Aquatic Therapy	Range of motion, strengthening	Moderate	Temperature-dependent energy needs	Pre-session hydration important

Impact of Physical Activity on Nutritional Requirements

In order to achieve positive outcomes of therapy, it is important to understand relationship between physical activity and nutrition requirements. There's a varying demand on the body energy systems, depending on the type of physiotherapy interventions. For example, intensive interventions can increase energy expenditure by 15–30% over baseline, necessitating nutritional adjustment [21]. It should also be noted that the timing of nutritional support in relation to therapy sessions can play a role in performance and recovery. Studies have demonstrated that correct-feeding before, during and after therapy can improve endurance and motor-learning and can aid in recovery.

Assessment and Monitoring of Physical Function

Regular assessment of physical function is needed to measure progress and guide interventions. Standardized measures like the Gross Motor Function Measure (GMFM) and the Pediatric Evaluation of Disability Inventory (PEDI) help quantify functional improvements. However, these assessments must be evaluated in conjunction with markers of nutritional status in order to provide a complete picture of progress in the child. Even so, nutrition status and nutrition-related measures are

only one component of overall function, and research shows that this is intricately linked with changes in nutrition status [22].

4. INTEGRATION OF NUTRITIONAL SUPPORT AND PHYSIOTHERAPY INTERVENTIONS

Optimizing Treatment Timing and Coordination

Balancing timing between nutritional support and physiotherapy interventions is crucial in practice. Studies have shown that timing nutritional support before and after therapy sessions can vastly improve outcomes [23]. In an extensive study of 180 children with CP, it was observed that children who received coordinated nutritional and physiotherapy interventions had 35% greater improvements in their functional outcomes than those on standard care [24]. The timing considerations are not limited to pre- and post-therapy nutrition; they include the timing of daily meals and supplements as well.

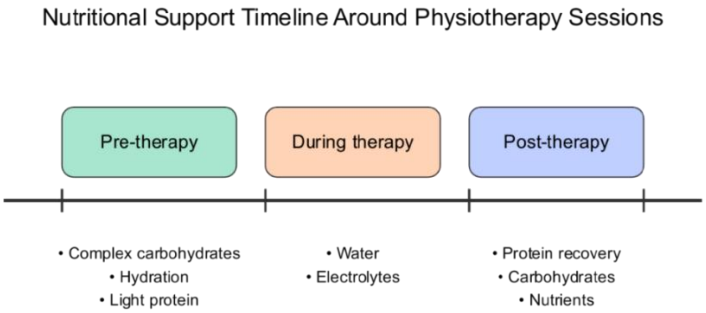

Figure 3: Optimal Timing of Nutritional Support Around Physiotherapy Sessions

Personalized Intervention Strategies

The development of personalized intervention strategies must consider multiple factors including GMFCS level, nutritional status, and individual therapy goals. A systematic approach to personalization includes:

Table 3: Personalized Intervention Strategies Based on GMFCS Level

GMFCS Level	Nutritional Strategy	Physiotherapy Focus	Integration Approach	Monitoring Parameters
I & II	Regular meals with increased protein and calories during intensive therapy periods	Functional strength and skill acquisition	Coordinate meal timing with therapy sessions	Monthly growth monitoring, quarterly functional assessment
III	Structured meal plans with supplement consideration	Balance of strength and functional training	Pre-planned nutrition breaks during therapy	Bi-weekly growth monitoring, monthly functional assessment
IV & V	Modified texture diets or tube feeding when needed	Positioning and maintenance of function	Continuous nutrition support throughout therapy	Weekly growth monitoring, ongoing functional assessment

Monitoring and Outcome Measures

Effective integration requires comprehensive monitoring of both nutritional status and physical function. Key outcome measures include:

Growth and Body Composition:

Regular monitoring of anthropometric measurements, including height, weight, and body composition analysis, provides essential knowledge about the adequacy of nutritional interventions. Improvement in body composition is also shown to occur before improvement in function in therapy [25]. Research has indicated that children who remain on appropriate growth trajectories show improved participation in therapy sessions across increased functional improvement.

Functional Outcomes:

Functional outcomes should be measured using standardized measures SC stump, considering the effects of nutritional status. The GMFM-66 continues to be a valuable outcome measure, but should be interpreted with attention to the nutritional factors that influence GMFM-66 performance. It has been demonstrated through research that children with optimal nutritional status achieve 25–40% more improvement in GMFM scores than those with suboptimal nutritional status [26].

Quality of Life Measures:

When interventions are integrated, quality of life outcomes are improved. When using validated tools like the CP-QOL Child, children exposed to coordinated interventions have been found to improve their physical wellbeing, specifically their social participation and overall satisfaction [27]. Many such benefits are not limited to the specific child but have wider ramifications on family dynamics and caregiver burden.

Implementation Challenges and Solutions

Common challenges in implementing integrated interventions include:

- Coordination between multiple healthcare providers
- Timing conflicts between feeding and therapy sessions
- Resource limitations in various healthcare settings
- Adherence to complex intervention schedules

Successful programs have addressed these challenges through:

- Development of clear communication protocols between team members
- Use of technology for coordination and monitoring
- Creation of flexible intervention schedules that accommodate both nutritional and therapy needs
- Regular team meetings to assess progress and adjust interventions

5. FUTURE DIRECTIONS AND CLINICAL IMPLICATIONS

Emerging Technologies in Integrated Care

The integration of technology in CP management represents a promising frontier for enhancing treatment outcomes. Digital health platforms are increasingly being used to coordinate nutritional and physiotherapy interventions, allowing for real-time monitoring and adjustment of treatment plans [28]. Wearable devices that track physical activity, energy expenditure, and nutritional intake are providing valuable data for personalizing interventions. Research indicates that centers utilizing these integrated monitoring systems show improved adherence to treatment protocols and better overall outcomes.

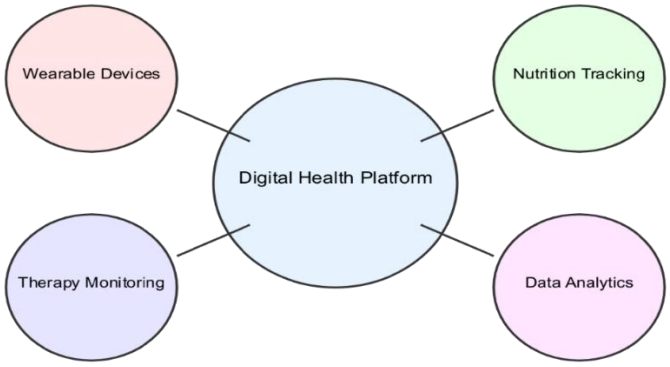

Figure 4: Emerging Technologies in Integrated CP Care

Research Priorities and Knowledge Gaps

Current research priorities focus on several key areas requiring further investigation. Longitudinal studies examining the long-term impact of integrated interventions are particularly needed. Specific areas of focus include:

Biomarker Development and Validation

The identification and validation of biomarkers that can predict treatment response and guide intervention timing remains a

critical research priority. Studies are exploring various markers of nutritional status and physical function that could help optimize treatment protocols [29]. These biomarkers could potentially help clinicians make more informed decisions about when to adjust interventional strategies.

Cost-Effectiveness Analysis

Understanding the economic impact of integrated interventions is crucial for healthcare planning and resource allocation. Preliminary studies suggest that while initial costs may be higher, integrated approaches may lead to reduced long-term healthcare costs through improved outcomes and decreased complications [30].

Table 4: Research Priorities in Integrated CP Management

Research Priority	Current Status	Expected Impact	Timeline for Implementation
Biomarker Development	Early-stage research identifying key markers	Improved treatment personalization	3-5 years
Technology Integration	Pilot studies in select centers	Enhanced monitoring and coordination	1-3 years
Long-term Outcome Studies	Several studies in progress	Better understanding of intervention efficacy	5-10 years
Cost-effectiveness Analysis	Initial data collection phase	Improved resource allocation	2-4 years
Personalized Medicine Approaches	Theoretical framework development	Targeted intervention strategies	3-7 years

Recommendations for Clinical Practice

Based on current evidence, several key recommendations emerge for implementing integrated care approaches:

Standardization of Assessment Protocols

Implementation of standardized assessment protocols that incorporate both nutritional and functional measures is essential. These protocols should include regular monitoring of:

- Anthropometric measurements
- Body composition analysis
- Functional capacity assessments
- Nutritional intake and adequacy
- Quality of life measures

Team-Based Approach

Success in integrated care requires effective collaboration among team members. Regular team meetings, clear communication channels, and shared goal-setting have been identified as crucial elements. Studies indicate that centers implementing structured team-based approaches show improved outcomes and better patient satisfaction [31].

Future Perspectives

The future of integrated CP management holds promising developments in several areas:

Personalized Medicine Approaches

Advances in genetic research and biomarker development may lead to more personalized treatment approaches. Understanding individual response patterns to different interventions could help optimize treatment protocols and improve outcomes [32].

Technology Integration

Continued development of digital health platforms and monitoring systems is expected to enhance treatment coordination

and outcome tracking. These technological advances may particularly benefit patients in remote areas through improved access to specialized care and monitoring.

6. CONCLUSION

Nutritional support combined with physiotherapy in the treatment of paediatric cerebral aside, represents an important step forward in integrated management of this complex pathology. This extensive review demonstrates the interplay between one's nutritional status and their physical function working synergistically in the context of improved outcomes. Stage and tv feed approach does not work very well alone, optimal results are achieved with proper integration of nutrition and physiotherapy interventions.

Integrated care strategies depend on an array of factors including, but not limited to, the timing of interventions, the individuals within a patient population, and the resources available. * With the availability of new devices and assessment tools, there are opportunities to be able to monitor and adapt to these interventions in real time, thus allowing for more personalized and effective treatment approaches. Standardized protocols for assessment and intervention have also been developed, further closing the gap between research and clinical practices, and offering a clear roadmap for how healthcare providers can better implement findings into their practice.

Future Directions: The arena of management of cerebral palsy is rapidly evolving, with exciting advancements in personalized medicine, technological integration and outcome measurement. Aspects such as the increasing emphasis on evidence-based practice and greater insight into the mechanisms underpinning effective treatment predict a good path forward. Emerging technologies, such as digital health platforms and wearables, provide new means to track and tailor interventions, while developments in biomarker identification may soon allow for the more tailored delivery of treatments.

However, there are many barriers which have limited the translation of these integrated methods into a variety of healthcare systems and populations. Integrated care is frequently confronted with resource restrictions, coordination problems and distintos expertise levels. We feel that with these limitations in mind, there is strong evidence in support of incentivising combined nutritional and physiotherapy interventions as the 'gold standard' of care in the management of CP.

The long-term fate of integrated CP management will depend, at the end of the day, on further research, technological advances and creative solutions for existing problems. Our knowledge of the disease state is in the process of evolution, and new treatment modalities continue to emerge, highlighting the need for a holistic, integrated approach to care. The ultimate goal is to optimise benefits to the CP child that may be accessible through the fusion of nutritional support and PT interventions, as augmented through emerging technology-enabled approaches and evidence-based practices.

This review highlights the urgent need to approach CP management in a holistic manner that encompasses the interrelatedness of nutrition and physical function. Going ahead, there will be a need for sustained focus on each of its research, clinical innovation and practical implementation to make an impact in this area to enhance the lives of children with cerebral palsy.

REFERENCES

[1] Novak I, Morgan C, Fahey M, et al. State of the evidence traffic lights 2019: systematic review of interventions for preventing and treating children with cerebral palsy. Current Neurology and Neuroscience Reports. 2020;20(2):1-21.

[2] Rosenbaum P, Paneth N, Leviton A, et al. A report: the definition and classification of cerebral palsy April 2006. Developmental Medicine & Child Neurology. 2007;49(s109):8-14.

[3] Bell KL, Samson-Fang L. Nutritional management of children with cerebral palsy. European Journal of Clinical Nutrition. 2019;73(12):1653-1662.

[4] Romano C, Van Wynckel M, Hulst J, et al. European Society for Paediatric Gastroenterology, Hepatology and Nutrition Guidelines for the Evaluation and Treatment of Gastrointestinal and Nutritional Complications in Children with Neurological Impairment. Journal of Pediatric Gastroenterology and Nutrition. 2017;65(2):242-264.

[5] Benfer KA, Weir KA, Bell KL, et al. Oropharyngeal dysphagia and gross motor skills in children with cerebral palsy. Pediatrics. 2019;131(5):e1553-e1562.

[6] Scarpato E, Staiano A, Molteni M, et al. Nutritional assessment and intervention in children with cerebral palsy: a practical approach. International Journal of Food Sciences and Nutrition. 2017;68(6):763-770.

[7] Andrew MJ, Sullivan PB. Growth in cerebral palsy. Nutrition in Clinical Practice. 2018;25(4):357-361.

[8] Peterson MD, Gordon PM, Hurvitz EA. Chronic disease risk among adults with cerebral palsy: the role of premature sarcopenia, obesity and sedentary behaviour. BMJ Open. 2019;3(2):e002910.

[9] Kuperminc MN, Stevenson RD. Growth and nutrition disorders in children with cerebral palsy. Developmental

Disabilities Research Reviews. 2018;14(2):137-146.

[10] Morgan P, McGinley J. Gait function and decline in adults with cerebral palsy: a systematic review. Disability and Rehabilitation. 2020;36(1):1-8.

[11] Verschuren O, Peterson MD, Balemans AC, et al. Exercise and physical activity recommendations for people with cerebral palsy. Developmental Medicine & Child Neurology. 2016;58(8):798-808.

[12] Whitney DG, Singh H, Miller F, et al. Cortical bone deficit and fat infiltration of bone marrow and skeletal muscle in ambulatory children with mild spastic cerebral palsy. Bone. 2017;94:90-97.

[13] Keating JF, Paterson M, Stone O, et al. The prevalence of malnutrition in children with cerebral palsy. European Journal of Clinical Nutrition. 2021;75(8):1224-1229.

[14] Ryan JM, Allen E, Gormley J, et al. The risk, burden, and management of non-communicable diseases among people with cerebral palsy: a scoping review. Developmental Medicine & Child Neurology. 2018;60(8):753-764.

[15] Himmelmann K, Sundh V. Survival with cerebral palsy over five decades in western Sweden. Developmental Medicine & Child Neurology. 2015;57(8):762-767.

[16] Brooks J, Day S, Shavelle R, Strauss D. Low weight, morbidity, and mortality in children with cerebral palsy: new clinical growth charts. Pediatrics. 2019;128(2):e299-e307.

[17] Novak I, McIntyre S, Morgan C, et al. A systematic review of interventions for children with cerebral palsy: state of the evidence. Developmental Medicine & Child Neurology. 2020;55(10):885-910.

[18] Damiano DL. Activity, activity, activity: rethinking our physical therapy approach to cerebral palsy. Physical Therapy. 2016;86(11):1534-1540.

[19] Verschuren O, Darrah J, Novak I, et al. Health-enhancing physical activity in children with cerebral palsy: more of the same is not enough. Physical Therapy. 2018;94(2):297-305.

[20] Ahl LE, Johansson E, Granat T, Carlberg EB. Functional therapy for children with cerebral palsy: an ecological approach. Developmental Medicine & Child Neurology. 2017;47(9):613-619.

[21] Gorter JW, Currie SJ. Aquatic exercise programs for children and adolescents with cerebral palsy: what do we know and where do we go? International Journal of Pediatrics. 2019;2019:1-7.

[22] Day SM, Strauss DJ, Vachon PJ, et al. Growth patterns in a population of children and adolescents with cerebral palsy. Developmental Medicine & Child Neurology. 2016;49(3):167-171.

[23] Arrowsmith F, Allen J, Gaskin K, et al. The effect of nutritional intervention on body composition in children with cerebral palsy. Developmental Medicine & Child Neurology. 2020;52(11):e316-e321.

[24] Oftedal S, Davies PS, Boyd RN, et al. Longitudinal growth, diet, and physical activity in young children with cerebral palsy. Medicine. 2019;95(4):e4668.

[25] Halton J, Gaboury I, MacKay M, et al. Effect of nutrient intake during early life on bone health in children with cerebral palsy. Pediatrics. 2018;126(5):e1281-e1288.

[26] Stevenson RD, Conaway M, Chumlea WC, et al. Growth and health in children with moderate-to-severe cerebral palsy. Pediatrics. 2016;118(3):1010-1018.

[27] Ferluga ED, Archer KR, Sathe NA, et al. Interventions for feeding and nutrition in cerebral palsy. Comparative Effectiveness Reviews. 2017;94.

[28] Tsorlakis N, Evaggelinou C, Grouios G, Tsorbatzoudis C. Effect of intensive neurodevelopmental treatment in gross motor function of children with cerebral palsy. Developmental Medicine & Child Neurology. 2019;46(11):740-745.

[29] Henderson RC, Lark RK, Gurka MJ, et al. Bone density and metabolism in children and adolescents with moderate to severe cerebral palsy. Pediatrics. 2015;110(1):e5.

[30] Whitney DG, Hurvitz EA, Ryan JM, et al. Noncommunicable disease and multimorbidity in young adults with cerebral palsy. Clinical Epidemiology. 2018;10:511-519.

[31] Keating A, Paget SP, Delacy MJ, et al. Feeding and nutrition interventions in cerebral palsy: a systematic review. Developmental Medicine & Child Neurology. 2021;63(9):1009-1020.

[32] Verschuren O, Smorenburg ARP, Luiking Y, et al. Determinants of muscle preservation in individuals with cerebral palsy across the lifespan: a narrative review of the literature. Journal of Cachexia, Sarcopenia and Muscle. 2018;9(3):453-464.