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## Cerebral palsy and nutrition: A brief review

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### Abstract

Cerebral Palsy (CP) denotes a cluster of neurological disorders manifesting in infancy or early childhood, causing lasting effects on body movement and muscle coordination. It has an impact on the neurological system, particularly on the regions that regulate movement and coordination. People with cerebral palsy usually have difficulty with walking, feeding, or speaking, and may require physical and occupational therapy for management and rehabilitation. The extent of symptoms can vary, and severity can change over time. Cerebral Palsy has been long acknowledged to be associated with various challenges and difficulties in digesting and absorbing nutritional inputs, leading to malnutrition and poor nutritional health. However, little is known about the exact mechanisms behind it and the solutions available to address it. The role of nutrition in cerebral palsy is significant as it can impact multiple factors, including the physical and cognitive development of children. Children with cerebral palsy often have difficulty with chewing and swallowing, leading to poor digestion and nutrient absorption. This can further impact their nutritional status and cause various deficiencies. A proper and customized evidence based nutritional plan is essential to ensure adequate nutritional intake and adequate development, both physically and mentally ensuring quality of life.

**Keywords:** Cerebral palsy (CP), Feeding difficulties, Nutrition, Phytochemicals

### Introduction

Cerebral palsy (CP) encompasses a set of neurological conditions emerging during infancy or early childhood, leading to enduring impacts on body movement and muscle coordination. CP occurs due to injury or abnormalities within the developing brain, which interfere with its capacity to regulate movement and uphold posture and balance. This could be due to brain injury before, during, or after birth or the regions of the brain responsible for muscle movement may not develop as anticipated during fetal development <sup>[1]</sup>. Cerebral palsy (CP) presents challenges in mastication and swallowing, consequently impacting the nutritional status of affected individuals. Thus, there exists a considerable opportunity in the Indian context to investigate and address the research gap pertaining to nutritional considerations in CP. This review attempts to compile existing literature on the significance of nutrition in the management of CP.

### Aetiology and Prevalence

In a study involving regions from various countries, it was found that there is limited data from low and middle-income countries (LMICs) however meta-analysis data from these countries showed a higher prevalence of pre-/perinatal CP compared to high-income countries (HICs). In HICs, the birth prevalence of pre-/perinatal CP was 1.5 per 1000 live births, and 1.6 per 1000 live births when post neonatal CP was included <sup>[2]</sup>.

A meta-analysis by Indian research group found that the overall prevalence of cerebral palsy per 1000 children surveyed was about 2.95, with a confidence interval (CI) ranging from 2.03 to 3.88. When they looked at different types of areas-rural, urban, and mixed rural-urban the prevalence was rates were about 1.83 in rural areas, 2.29 in urban areas, and 4.37 in areas that were a mix of rural and urban respectively <sup>[3]</sup>. The causes of abnormal brain development or damage to the developing brain in cerebral palsy can vary.

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**Prenatal factors**

Congenital brain abnormalities, including defects in cortical development, are among the major recognised causes of cerebral palsy. Cerebral vascular events (e.g., middle cerebral artery occlusion) seen by brain imaging and maternal infections in the first and second trimesters of pregnancy (e.g., rubella, CMV, toxoplasmosis) are other known prenatal causes of cerebral palsy. Cerebral palsy is less frequently caused by metabolic problems, toxic exposure in the mother, and rare genetic abnormalities [4].

**Perinatal factors**

Obstetric situations that threaten the foetus and cause hypoxia include antepartum haemorrhage, cord prolapse, and obstructed labour. The essential criteria that must be met before cerebral palsy can be attributed to an acute intrapartum episode are, metabolic acidosis in foetal scalp, umbilical cord arterial, untreated jaundice, severe hypoglycemia, or a serious newborn infection [4].

**Postnatal factors**

Post-neonatal acquired cerebral palsy can result from infections and traumas. Non-accidental injuries and accidents, such as car crashes, near-drowning incidents, cerebrovascular accidents, surgeries for congenital deformities, conditions like septicemia, meningitis, and diseases like malaria can also lead to cerebral palsy [4].

**Types of cerebral palsy**

Based on severity of symptoms, the body parts and kind of movement affected, CP is classified as follows.

**Spastic cerebral palsy**

Eighty percent of instances of cerebral palsy fall under the most prevalent type, known as spastic CP, characterized by spasticity, a form of hypertonia. There is a decreased physical activity resulting in subsequent structural and morphological alterations in the spastic muscle, which can lead to musculotendinous shortening, or fixed contractures. Depending on the body parts affected spastic cerebral palsy, can be further classified as i) Spastic hemiplegia or hemiparesis; in this condition only an arm, hand, or leg on one side of the body is affected and usually intelligence is normal, but there can be delay in speech. ii) Spastic diplegia/diparesis; this condition results in muscle stiffness in the legs and is less severe in arms and face, with usually normal intelligence and language skills and iii) Spastic quadriplegia/quadruparesis; this is the most severe form of CP characterized by stiff limbs, floppy neck, moderate-to-severe intellectual disability and usually patients are not able to walk [5].

**Athetoid/dyskinetic cerebral palsy**

After spastic forms, dyskinetic cerebral palsy (DCP) is the second most prevalent kind of cerebral palsy. DCP is marked by aberrant postures or movements linked to inadequate tone regulation or movement coordination in hands, feet, arms, or legs. Face and tongue can also be affected leading to hardship in sucking, swallowing, and talking as well. A person with dyskinetic CP has muscle tone that can change not only from day to day, but even during a single day (varying from too tight to too loose) [6].

**Ataxic cerebral palsy**

Five to ten percent of all cases of CP are ataxic CP. This

condition is characterized poor balance, coordination and unsteady walk and gait.

It can be further subdivided based on whether there is stiffness in the lower limbs, into ataxic diplegia and simple ataxia. Up to 50% of cases of ataxic cerebral palsy are thought to result from a single gene defect. Most cases are inherited as autosomal recessive disorders, however, there have been reports of families with X-linked and autosomal dominant inheritance patterns [7].

**Mixed cerebral palsy**

Mixed CP is characterized by occurrence of more than one type of CP.

**Symptoms and Manifestations****Motor impairments**

Motor impairments may range from muscle stiffness (spasticity) to muscle weakness resulting in difficulty to move their limbs or perform coordinated movements, generate muscle force or maintain posture, involuntary movements or tremors thus further complicating motor function. 88% of children may have the spastic form of cerebral palsy, according to registry statistics. Loss of muscular excursion decreased joint mobility, subsequent contractures, bone deformities, joint dislocations, and persistent discomfort are all linked to spasticity [8].

**Speech and communication, vision, and hearing difficulties**

Impaired hearing, strabismus (cross eye), speech and language disorders, such as difficulty in forming words and speaking clearly is more frequent among those with CP than in the general population [8].

**Cognitive challenges**

According to registry data gathered from multicentre collaborative studies, 30% of children diagnosed with cerebral palsy also have severe intellectual disability. Those with bilateral involvement had the highest incidence. Well-conducted, international cross-sectional research revealed a negative relationship between intellectual impairment and autonomy, moods, and other aspects of quality of life [8].

**Feeding difficulties**

Studies conducted using cross-sectional data indicate that difficulties swallowing (38%), chewing (69%), and sucking (57%), are prevalent. The highest risk group is represented by children with more severe motor impairment (Gross Motor Function Classification System (GMFCS) levels 4 or 5), with 91-99% of them experiencing clinically significant oromotor dysfunction. This may result in severe eating impairment, protracted, upsetting mealtimes, stunted growth, and malnourishment [8].

**Other associated conditions**

Thirty to forty percent of children with cerebral palsy have epilepsy, which is frequently underdiagnosed because many seizures are focal (partial) and may or may not result in secondary generalisation. Constipation is rather frequent and can be caused by a variety of things, such as immobility, inadequate eating, and primary tone abnormalities. Scoliosis, kyphosis, and lordosis are often associated with CP. Children with cerebral palsy frequently feel pain thus affecting their quality of life [8]. In a study 95.0% of the CP patients had at least one documented comorbidity, and 36.4% of the patients

had at least one disease falling into one of the three primary categories: neurological, mental / Behavioral, and medical illnesses. Musculoskeletal system and connective tissue diseases were the most common disorders among individuals with CP, accounting for 49.8% of cases. These were followed by digestive system diseases (39.1%), congenital malformations (non-nervous system; 33.6%), and respiratory diseases and infections (29.7% and 27.2%, respectively). Furthermore, compared to the general population's risk, people with CP had an increased risk of practically all medical conditions. This was particularly noteworthy for the eating disorders and malnourishment described above [9].

### **Diagnosis, Assessment, Treatment and Management**

Cerebral palsy is diagnosed through developmental evaluation involving assessment like movement and motor skills, muscle tone, reflexes, posture, and potential cognitive or sensory impairments. Additionally, healthcare providers consider symptoms like seizures and any vision, hearing, or speech difficulties that may be present. Depending on the findings and clinical indications, further diagnostic tests may be recommended. These tests could include brain imaging techniques such as X-ray computed tomography (CT scan) or magnetic resonance imaging (MRI) to examine the brain's structure for any abnormalities. Furthermore, an electroencephalogram (EEG), genetic testing, or metabolic testing may be performed to identify underlying neurological or genetic factors contributing to the condition [10].

The treatment and management of cerebral palsy typically begin with early diagnosis, which is crucial for addressing the unique challenges faced by individuals with CP. This often involves a multidisciplinary approach, with key components including physical therapy and occupational therapy. Physical Therapy aims to improve mobility, muscle strength, flexibility, and coordination, while occupational therapy focuses on enhancing the individual's ability to perform daily activities like self-care tasks, fine motor skills, and school or work-related activities thus providing more independence in performing day to day activities. The inclusion of speech therapists is crucial in tackling communication difficulties, while orthotic devices like braces, splints, and orthopaedic shoes are employed to improve balance and motor-related issues. Additionally, the utilization of assistive devices such as wheelchairs, communication aids, adaptive computer tools, and modifications to the environment can significantly enhance quality of life [11].

Medications are vital for managing symptoms such as muscle spasticity, seizures, pain, and gastrointestinal issues, while Surgical Interventions are necessary to tackle musculoskeletal issues. Psychological Support is also crucial for both individuals with cerebral palsy and their families to navigate emotional challenges effectively [12].

### **Role of nutrition and phytochemicals in CP**

Nutrition is the process of providing the body with the necessary nutrients to maintain normal functioning. Its importance lies in the ability to support overall growth and development as well as providing energy and building blocks for various bodily processes. It plays a vital role in maintaining a healthy weight and supporting physical and cognitive development. It is critical to understand the function that diet plays in preserving health and wellbeing because it is a significant aspect of the management of children with cerebral palsy. Malnutrition has a wide range of detrimental consequences on physiology, motor function, neurological

function, and psychological function. These effects can be more severe during early development. In children with cerebral palsy (CP), growth and nutrition difficulties are prevalent secondary health concerns. Due to their effects on health, including psychological and physiological function, healthcare utilisation, societal involvement, motor function, and survival, poor growth and malnutrition in CP deserve more research. It has been demonstrated that malnutrition increases the severity of gastric reflux in children with CP, and nutritional rehabilitation reduces the symptoms of the condition. Growth problems are common in children with CP [13].

Any child's growth, development, immune system, muscle strength, and wound healing can all be adversely impacted by inadequate nutrition. Since inadequate nutrition is linked to weakened muscles, undernourished children with Cerebral Palsy (CP) may experience weakness in their respiratory muscles and a reduction in their coughing force, which increases their risk of lower respiratory tract infections. In addition, due to weakened immune systems, malnutrition may impede the healing of these illnesses. Furthermore, children with cerebral palsy who are undergoing surgical treatments are particularly vulnerable to the poor wound healing that typically accompanies malnutrition. Delayed wound healing may worsen surgical outcomes and increase length of stay in the hospital for these children. For kids with CP, a healthy diet is a critical survival predictor. Children with cerebral palsy who receive inadequate nutrition are more likely to die, regardless of their level of motor engagement [14].

One of the primary factors influencing the prognosis of malnutrition and stunted growth in children with cerebral palsy is inadequate food intake. According to what is currently known, malnutrition and severe motor impairment are prevalent in children attending rehabilitation centres in Argentina, with a prevalence reaching 50%. An imbalance may arise from a diet deficient in the nutrients required for tissue synthesis, which could lead to nutrient depletion and a higher degree of malnutrition. Furthermore, kids with constipation, dysphagia, and gastroesophageal reflux (GER) may make matters worse by limiting their food intake. Kids with cerebral palsy typically consume inadequate amounts of iron and fiber-containing foods, as well as low levels of calcium, vitamin D, and phosphorus. Growth and development are impacted as a result, which may show up as immune system dysfunction or malnutrition. This raises the risk of infections and recurrent hospital stays. Children with CP who exhibit greater motor impairment experience changes in their calorie and nutritional intake, which impacts their growth [15].

Poor nutritional status is a risk factor for children with severe cerebral palsy, especially for those with oropharyngeal dysfunction. A variety of approaches are needed to determine the necessity and form of nutritional intervention, as it is a multifaceted process. The child's nutritional state, their ability to swallow enough food and liquids, and their risk of pulmonary aspiration will all influence how nutritional support is administered. First-line treatment, where feasible, will consist of oral nutritional support, which includes appropriate positioning and physical assistance at mealtimes. Many children with cerebral palsy have their own specially designed seats, but extra head and body support may be needed to keep them steady and comfortable as well as to make sure they swallow safely [16].

Food apart from being vehicle for nutrients also contain chemical components termed phytochemicals that have health

protective functions in human system. Polyphenols, flavonoids, is flavonoids, anthocyanidins, phytoestrogens, terpenoids, carotenoids, limonoids, phytosterols, glucosinolates, and fibres are all considered phytochemicals. They may offer medical health benefits, such as the prevention and/or treatment of diseases and physiological abnormalities, and they have a significant influence on the healthcare system. Their pharmacological effects on human health include those of antioxidants, antibacterial, antifungal, anti-inflammatory, antispasmodic, chemopreventive, hepatoprotective, hypolipidemic, neuroprotective, hypotensive, induce apoptosis, diuretic, CNS stimulant, analgesic, protects from UVB-induced carcinogenesis, prevent, immunomodulator, and carminative<sup>[17]</sup>.

By altering the receptor activity of inhibitory neurotransmitters, phytochemicals are essential for preserving the chemical equilibrium of the brain and in conditions like CP this may play an important role. Natural substances called phytochemicals have been demonstrated to protect against oxidative stress and neuroinflammation, two main features of neurological diseases. And, immune system is stimulated, platelet aggregation is reduced, and hormone metabolism is regulated by phytochemicals<sup>[18]</sup>.

A study aimed to assess the consumer acceptability of infant food containing oregano essential oil among children diagnosed with CP showed favourable results on organoleptic parameters used i.e., assess odor, flavor, color, and texture acceptability. Thus, incorporation of oregano essential oil presents a viable option for the development of infant food tailored for children with CP which also acts helps in food preservation and flavour enhancement in addition to being antibacterial and an antioxidant. This could also help lower the number of artificial additives in foods meant for children with special needs<sup>[19]</sup>.

### Conclusion

The secondary health concerns of growth and nutrition are common in children with cerebral palsy (CP). Poor growth and malnutrition in CP deserve further research because of their impact on health, which includes psychological and physiological function, healthcare utilisation, societal involvement, motor function, and survival<sup>[13]</sup>.

There are several aetiologies for cerebral palsy, which affects two to three out of every 1,000 live births and is characterised by brain damage that impairs balance, posture, and mobility. Cerebral palsy patients may also have non-movement-related issues that require ongoing care well into adulthood. These issues include cognitive impairment, seizures, pressure ulcers, osteoporosis, emotional or behavioural issues, and difficulties with speech and hearing<sup>[20]</sup>.

Early detection of cerebral palsy (CP) facilitates the investigation of therapy alternatives and early intervention aimed at improving intrinsic brain plasticity for better functional outcome<sup>[21]</sup>.

The few randomised clinical trials on the application of nutritional therapies in children with cerebral palsy and the encouraging findings indicate a neglected field that could enhance the health and well-being of millions of families worldwide<sup>[22]</sup>.

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