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Review Article

Nutrition in Cerebral Palsy Children

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Abstract

Despite its high prevalence in the Kingdom, cerebral palsy (CP) in children in Saudi Arabia has not been given much of the research attention, particularly aspects related to nutrition. Nutrition is usually overlooked for many reasons, but mostly because the medical physicians are usually not skilled in nutritional care. This gap needs to be filled. There are numerous approaches and nutrition awareness is the primary one. In this explanatory review, we present a brief overview on nutrition and CP; how is nutritional status and growth assessed in CP children? What are their common feeding problems? What is the status of CP in Saudi Arabia? These are important questions since the overall health of CP children depends mainly depends on how they are nutritionally cared.

Keywords: Cerebral Palsy; Nutrition; Growth; Nutritional Status; Saud Arabia

Introduction

Cerebral palsy (CP) is considered one of the major causes of motor disability in child age and has been reported to be the main reason for severe physical disability [1]. It is a disorder that appears in early childhood and persists throughout the life [2]. Cerebral palsy is defined as chronic disability of the CNS involving posture and tone, occurring early in life not the result of progressive neurological disease associated with visual, hearing, dental, behavioral with or without seizures. Incidence of CP in multiple births is 7.5/1000 live births and in Singletons births and in Singletons it is 2.1/1000 live births and, more in 1500 grams or less is 80/1000. 10% of the global population has some form of disability [3]. The disorder is associated with a number of other disorders, including nutritional deficiencies and growth deviations [4].

There is commonly observed severe growth deviations and impairment of nutritional status in CP patients. The body composition of patients with CP is characterized by tremendous drop in the muscle mass as well as a decrease in essential fat mass and bone density [5]. The optimal nutritional status is one of the most important factors for a healthy growth and well-being in individuals with CP [4,6]; it is necessary to avoid these losses in muscles mass and fat tissues and also essential to maintain the functions of the respiratory muscles and myocardial, immune system, nervous system, movement, cognitive state of healing and tissue repair in wound and bedsores [7].

While nutrition holds great promise in health of CP patients [8,9], nutritional care is not a priority area in the medical care process of CP patients. This negligence on the part of health care system is mainly responsible for the growth and nutritional problems associated with the disease. There is a lack of global consensus on which growth charts curves to be used for the assessment of these patients [10-12]. It is rational to assume that the caloric requirements of CP children must be different from those of the normal children. The nutritional requirements of CP children vary according to the degree of their motor disability, level of physical activity. However, it is essential that children with PC should, at least, cover the recommended nutrient requirements according to their age and sex. However, reportedly the caloric and macronutrient intakes are always insufficient to cover the minimum recommended requirements in CP children. The contributing factors to lower nutrients intake include, but not limited to, gastrointestinal disorders (dysphagia, constipation, drooling, or excessive salivation and

gastro-esophageal reflux (GER), patient's mandatory dependence on the caregivers at the time of feeding, and socio-economic characteristics of the family and the family environment [12].

In Saudi Arabia, despite a huge volume of work done describing mainly the medical aspects of CP children or reporting the incidence and prevalence of the disease [13-15], little if any, is known regarding their growth patterns, growth deviations and nutritional status. There have been some small studies [e.g. Ref. 4], that described but only a minor part of the whole picture of nutritional disparities in this group of population. In addition, this country has little evidence about the nutritional and clinical interventions carried out in CP and essentially lacks a system for reliable monitoring of prevalence and incidence of this disease. While there are data on nutrition and health of the CP patients in this country, most of the available and updated information derived from publications from countries with excellent systems of registration [16], that may be partly responsible for overestimating or underestimating the disease burden.

The care of children and adolescents with PC is very important since they are complex patients, with a high mortality and morbidity and thus require intensive and prolonged treatments and need physical and social rehabilitation during their lifetime. Making visible the power-related problems could motivate health professionals to strengthen care networks that generate interventions to improve the life-quality of children and adolescents. Nutrition, in this connection, no doubt, has a strong role to play. In this review, we try to appraise the nutritional care of CP children with a focus of the disease in the context of Saudi Arabia.

Brief History and Definition of Cerebral Palsy

William Little reported CP for the first time in 1861; that is why the disease was initially called "Little 's disease" [17]. Cerebral palsy is defined as Cerebral palsy (CP) describes a group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain. The motor disorder of cerebral palsy are often accompanied by disturbances of sensation, perception, cognition, communication, and behavior; by epilepsy, and by secondary musculoskeletal problems.

Disability refers to and results from the interaction between persons with impairments and barriers to the attitude and the environment that prevent their full and effective participation in society on equal terms with others. If it defines disability as an interaction, this means that 'disability' is not an attribute of the person. Progress can be achieved to improve the social participation by addressing the barriers that prevent persons with disabilities to engage in their daily lives.

Situation of CP in Saudi Arabia – incidence, prevalence and nutrition

Several studies have been performed on CP children in Saudi Arabia; mostly focusing on its prevalence and incidence [13-15], some on the associated risk factors [13-15,18-20], a few in relation to other diseases [20, 21], and only a small fraction of studies on nutritional status and growth deviations [13]. Studies done on the prevalence rate of CP in Saudi Arabia are lacking agreement and a consensus on incidence and prevalence levels in Saudi Arabia has yet to be established. Al Salloum., *et al.* (2011), in one of the most recent studies, identified 2.34% per 1000 live birth of CP prevalence rate and described it as the "most common neurologic disorder among Saudi children" [14]. These figures on prevalence are almost the same as reported for the developed world, the UK, for example [22]. Some studies have reported the associated risk factors that are usually found in CP children in Saudi Arabia [13-15,18,23]; and more important risk factors include CP history in sibling and parental consanguinity [15], certain natal, prenatal and postnatal factors [23], twins' birth, low birth weight, and pre-term delivery [4]. Studies conducted on the nutritional health and dietary intake of CP children reported growth deviations, nutritional status and nutrient intake of CP children [14]. Whatever, we know from these few studies on nutrition that the CP children have a poor growth pattern, impaired nutritional status and suboptimal energy intake.

The most frequent cause of disability in children is the CP [24], also called non-progressive static encephalopathy describing posture and movement disorders which are caused by non-progressive brain disorders throughout fetal development or in childhood, causing a limitation of activity. PC motor alterations are frequently accompanied by sensory, cognitive, communication and perception alterations [25]. The CP affects gross motor skills to variable extents; that needs to be observed in the first 12 to 18 months of life, when the child fails to achieve his/her normal motor functions and manifests qualitative differences in motor development [26].

CP is a multifactorial syndrome and offers three types of etiologic factors: (1): prenatal factors, such as maternal factors, alterations of coagulation, autoimmune diseases, hypertension, intrauterine infection, trauma, toxic substances, dysfunction thyroid, abnormalities of the placenta; (2): perinatal factors such as

prematurity, low weight, maternal fever during labor, systemic or infection of the Central nervous system, maintained hypoglycemia, hyperbilirubinemia, intracranial hemorrhage, hypoxic-ischemic encephalopathy, trauma, cardiac surgery or extracorporeal membrane oxygenation; and finally (3): postnatal factors, as infections (meningitis, encephalitis), head injury, convulsive status, cardiac arrest, poisoning or severe dehydration [25-27].

Classification of the Cerebral Palsy

The nutritional approaches in CP patients' needs an accurate and precise state of the disease. As CP is not a homogenous condition and as there are higher variability in the disease conditions from patient to patient, there must be systemic tools to classify the patients. There are different classification systems to determine the type of PC [28]. The CP patients can be classified in (1) accordance to failure of their spastic motor, ataxic, hypotonic, dystonic or mixed; and (2) according to the location of the motor fault or extremities committed as quadriplegia, hemiplegia, diplegia, and monoparesia [27]. PC can also be classified into mild, moderate and severe, according to the gross motor function, aimed at the organization or structuring of voluntary movements [29]. In relation to this classification, [28] developed the system of classification for gross-motor function ("Gross-Motor Function Classification System" (GMFCS) based more on functional achievements in its limitations, emphasizing the performance of activities of daily life at home or in the community [25-27]. The four systems of CP classification commonly used are based on;

A. Level of severity of disease

B. Topographical Distribution of the disease

C. Motor Function

D. GMFCS or 'Gross-Motor Function Classification System'

GMFCS is the most common system of classification [24]. GMFCS categorizes the patients according to their gross motor function [30]. All the children with at any level of the disease are at risk [31,32] but children who are severely impaired in their motor abilities may be more susceptible and are at higher risk [33,34]. Beside its wider application and use, GMFCS is the most reliable and validated system. Table 1 summarizes the GMFCS that is extended and revised for children (6-12 years of age) [30].

GMFCS Levels	Gross Motor Performance
I	○ The patient can walk easily without restrictions but has limited ability of advanced motor skills (e.g., running, jumping).
II	○ The patient van walks in most settings but outdoor walking (in community) is limited.
	○ May need physical assistance, mobility devices that assist in walking, or even wheel chair.
	○ Has little/minimal abilities of running/jumping.
III	○ Can only walks with mobility devices; in outdoors walking faces limitations
	○ For long distances, mobility is on wheel chair mobility
	○ Physical assistance in required for transfer.
IV	○ Self-mobility is with limitations; in most of the setting, the patient needs powered or physical assistance
	○ Adaptive seating is needed for pelvis and trunk controlling
	○ Physical assistance is needed for most of the transfers.
V	○ Wheel chair mobility is required in all settings.
	○ For controlling head and trunk positions, the patient needs assistive technology
	○ The patient is totally dependent on others for transfers.

Table 1: Summarized GMFCS (Children 6 - 12 years of age) [30].

Growth deviations and Nutritional status and the Cerebral Palsy

Background

Nutritional status is one of the most important factors for a healthy growth and well-being in individuals with CP. The nutritional status of the patient with PC will depend on the severity of the disease, the time period during which the disease has developed, care and nutritional surveillance by the multidisciplinary team [35]. Greater degree of motor disability, worse state nutritional, and longer evolution there will be greater involvement of linear growth and weight [36].

Physical examination and Nutritional History

Physical examination and Nutritional/dietary history are the foundational tools that help in identification of factors that affect the growth and nutritional status in CP children. Nutritional/dietary history focuses on (a) feeding difficulties of the patients and finding out any difficulties in positioning. Nutritional history also helps in finding out whether the patient needs any increased caloric needs acquiescent to intervention. In most of the cases, nutritional/dietary history is helpful in identifying the qualitative data on dietary or nutritional intake rather than quantitative data, a fact that is investigated extensively. As an example, Stallings and colleagues (1996) indicated that quantitative oral intake assessment in children CP (quadriplegic) overestimate the amount as much as 44 - 54% of the actual requirements [37]. Data on types and even

causes of growth abnormalities can be assessed by a complete physical examination. The skin and nail examination may reveal some preliminary information on deficiencies of micronutrient [38] and further preventive measures can be implemented.

Anthropometry

In carrying out the anthropometric assessment on the PC to assess growth and nutritional status, difficulties arise mainly in obtaining reliable measurements of stature. This is due to the presence of contractures joint, muscle weakness, scoliosis, involuntary movements and little cooperation from the child or adolescent, that make inaccurate, unreliable, and sometimes impossible to obtain the direct measurement of the size. Postural deformity, which is common in CP children, may be challenging while taking height of the patient. Stadio-meter is one of the preferred techniques for height measurement of CP children who can stand straight without support. Supine length is measured only in those patients who can lie in a position which is straight enough and the limbs align in an appropriate way. Measures of some body segments are used to estimate the size, mainly of long bones: the length of the tibia, knee height, ulnar length and segmental limb lengths. To be easy and reliable measurements, it is recommended to measure them routinely [40,41].

In some situations, weight of the child patient can be measured by taking the combined weight of the child and the caregiver. The caregiver holds the child in the circuit of his/her lap. Weight of the caregiver is deducted from the total weight (weight of the child plus weight of the care-giver). This gives weight of the care giver. Certain children may want sitting, or even hoist scale or wheelchair during weighing. Nevertheless, method consistency is crucially important for getting accurate weight profile of the patients. For accurate weight measurement, the following guidelines have been recommended by Dietitian of Canada (2013) [42]:

1. "Children who weigh less than 20 kg and are unable to stand on their own should be weighed on an infant scale".
2. "Children who weigh greater than 20kg and are unable to stand on their own may need to be weighed held by someone, with the weight of the person holding the child subtracted from their combined weight".
3. "A larger child unable to stand on their own or too heavy to be held, may need to be weighed on a sit-down or wheel chair scale" [42].

Measurements of weight and height should be plotted against the standards. Age and gender-specific growth charts are used for this purpose. Growth charts specifically developed for CP children are existing; however, due care be taken while using these charts as most of these are 'descriptive' and rarely proposed for normative data production [36]. Numerous techniques exist for the prediction of body fat, however, body mass index (BMI) is rarely considered as the method of choice for CP children. Skinfold thickness measurements may prove a good alternative for these are cheaper and easy to do. But be informed these are proxy body fat estimates. Triceps skinfold thickness (TST) measurement is feasible and easy. Value < 10^{th} percentile of TTS showing lower body fat indicating possible under-nutrition in CP children. Linear growth, pubertal development and patterns of bone age of children and adolescents with CP may differ with respect to those neurologically healthy. The children with CP are characterized by bone density, lean mass and decreased fat mass [37]. The results of the investigation of Day., *et al.* (2007) showed that individuals with PC had different weight and height for neurologically healthy children of the same age and sex, except in the group of mild PC where the growth was similar between the two; the major anthropometric differences were found in the group with greater motor integrity [37].

Even though there are specific growth curves for CP children developed, they are still to be standardized worldwide for use in the evaluation of the nutritional status. This is because the data are extracted from a database of a particular health system and, therefore, hardly represent the world's population [37]. So that the WHO growth patterns for normal children and adolescents without disabilities, have been used for the assessment of the nutritional status of children and adolescents with CP in some research studies [38-41]. Although these growth charts developed by the WHO for neurologically healthy children may overestimate low weight and low nutritional stature in children with severe CP, still these charts hold greater value and scientific validity and are very useful to assess the nutritional status in children with PC with a mild and moderate engine commitment and to detect situations of malnutrition due to excess.

Body Composition

Body composition assessment separately measures components of body weight, for example, protein or lean body mass (LBM), body fat, bone content and water. Body composition is greatly changed in CP children and there is a vast decrease in the body cell mass. The extracellular fluid shows an expansion in its volume. As CP children faces relative lower mobility due to their weak motor function, they exhibit reduced fat-free mass. Correct and accurate body composition assessment is always useful as it helps in calculation of the nutrient requirement. There are many methods for measuring body composition; some very precise but expensive and not very feasible (doubly labeled water and DXA),

some easy and more practical (bio-electric impedance (BIA), underwater weighing, skinfold thickness measurements). The DXA technique has been validated for children who have different body posture [42], may be for CP children. BIA can be used for body composition assessment [43], but it yet to be established whether this method is appropriate for CP children [44]. Ultrasound has shown to be promising for the assessment of body composition in CP children in some of its early trials [45].

Biochemical Assessment

In some situations, the laboratory assessment is helpful in evaluating the nutritional status of CP children [46]. There may be some limitation, for example, serum albumin and pre-albumin were found to be not of much help in the nutritional status assessment in CP children [47]. Micronutrient deficiencies may be common in CP children and it is recommended that micronutrient evaluation of CP children should be done when needed [48]. Biochemical evaluation is usually followed by clinical judgment and physical findings. Periodical abnormality screening is warranted, particularly for children who with severe impairment and chronic illness. Children who are at risk for vitamin D deficiency and present with signs, for example, limited exposure to sunlight, skin darkness, and use of anti-epileptic agents on chronic basis should be considered on annual visits. For monitoring of iron status anemia and screening of iron deficiencies, iron lab tests and complete blood count are advised. Identify the primary irregularities likely occurring in liver, kidney, and bone by appropriate tests of these organs [46].

Assessment of Nutrients Requirements

Nutrient requirements of CP children be established before any advice on food and dietary nutritional supplements. Energy requirements should be established using certain easy tools and mathematical expressions. Table 2 shows some equations that can be used for energy requirements of the CP children.

It should be remembered that these formulas provide a 'starting point' only. To note how much effective these equations are, the effects hence-after their application on nutritional status must be monitored carefully ensuring that proper growth is being achieved. Nutritional intervention becomes and essential step when their poor nutrition or growth deviations are evident. In such situations, dietary supplementation may become necessary and some supplements, primarily, glucose and long-chain triglycerides are recommended for increasing energy intake. Alternatively, some other foods with high energy contents may also be recommended. Reassessment is recommended as a necessary step to gadget the response to nutritional intervention. Reassessment frequency depends upon how old a child is; Infants/younger children may need assessment/reassessment more frequently monthly, maybe); Older children require assessment/reassessment less frequently (may be yearly) [30].

Method	Equation
Indirect calorimetry	Energy intake [kcal/d) = BMR*activity*muscle tone] + growth: where ○ Muscle tone = 0.9 (if decreased); 1.0 (if normal); and 1.1 (if increased) ○ Activity = 1.1 (bedridden); 1.2 (wheelchair/crawling); 1.3 (ambulatory). ○ Growth = 5 kCal/g of desired weight gain (normal and catch-up growth)
Dietary reference intake standards for BEE	Energy intake (kcal/d) = BEE × 1.1, where BEE is ○ Male: 66.5 + (13.75*weight in kg) + (5.003*height in cm)– (6.775*age) ○ Female: 65.1+(9.56*weight in kg) + (1.850*height in cm)– (4.676*age)
Height	15 kcal/cm in children without motor dysfunction ○ 14 kcal/cm (for children having motor dysfunction/ ambulatory ○ 11 kcal/cm (for children non-ambulatory)

Table 2: Energy requirements determination for CP children (Andrew and Sullivan, 2010).

BMR: 'Basal Metabolic Rate'; BEE: 'Basal Energy Expenditure'

Food in children and adolescents with Cerebral Palsy

Feeding Problems

Feeding problems in CP children are common [41,49]. These include a wide range of symptoms. We recently studied feeding problems in CP children and found some common feeding problems including: 'inability to self-feed', 'inadequate/absent tongue lateralization', 'chewing problem', 'swallowing problem', 'cough/choking during feed', 'drooling', 'hypertonic tongue', 'inability to take solid

food', 'constipation', 'cucking problem', 'vomiting/regurgitation', 'no closure of lips around spoon', 'inappropriate wide mouth opening' and 'cry/extensor dystonia during feeding'. Some feeding and diet associated problems were more common, e.g. more than half of the children had 'inability of self-feeding' and 'constipation' The underlying pathology of these problems is predominantly neurological and motor, but its implications include the majority of tissues and organ systems, which requires an integrated approach from different disciplines. Any defect in the cortical and subcortical regions, mainly responsible for the harmonious functioning of the digestive system (Araújo., *et al.* 2012), will result in alterations of the nutritional status and therefore, affects the overall health and the psycho-emotional development of CP children and adolescents.

Constipation is a common problem in this condition with little response to the usual treatments. Del Giudice., *et al.* (1992). They estimated that the prevalence of chronic constipation in children PC is 74% and it is defined as less than 3 bowel movements per week (Del Giudice., *et al.* 1992). Intestinal motility is altered in all of the colon due to neurological disorders, resulting in an abnormally high pressure in the sphincter, failure of relaxation of the internal anal sphincter after rectal distention, impaired rectal sensation and reduction of the propulsion colonic [41].

The factors influencing the constipation include prolonged immobility, the absence of erect posture for defecation, bone alterations as scoliosis, hypotonia, dietary factors such as insufficient intake of fiber or liquids and the use of drugs as anticonvulsants, opioids, and antihistamines [49]. In addition to the above factors, children and adolescents with PC have a decrease in the feeling of filling the rectum and the need for larger volumes to trigger the anorectal reflection. In addition, emotional stress and pain factors influence on bowel movement [41]. Dependence on caregivers for food care is intense and spreads throughout the day. It can be assumed that the quality of life of these caregivers will inevitably affect the quality of care they provide to these CP children.

Neurogenic dysphagia (ND)

ND is a disorder that causes difficulty in any of the stages of swallowing (oral, pharyngeal or esophageal) [51]. In children and adolescents with PC, it can be secondary to the innervation and motor control neurological changes that trigger changes in oral sensation and dysmotility esophageal [41]. This disorder leads to eating more slowly compared with children and adolescents neurologically healthy. In addition, can cause aspiration of food and liquids in the respiratory tract, which is a major cause of morbidity and mortality in PC [41].

Gastrointestinal Reflux (GER)

The presence of GER is attributed to an alteration of the motility that affects the esophagus and the mechanism of the lower esophageal sphincter, causing retrograde and involuntary regurgitation of gastric contents into the esophagus [50]. There are several reasons that cause RGE on PC, including dysfunction of neural control of esophageal peristalsis, modification in the innervation of the lower esophageal sphincter with subsequent episodes of transitory relaxations of the supine position prolonged, secondary scoliosis, increased intra-abdominal pressure, spasticity, constipation, convulsions, drugs, obesity and change the consistency of the diet [41]. It is now widely recognized that GER is cause of malnutrition in CP children since it produces symptoms such as vomiting, pain and epigastric burning.

One of the first research studies in an attempt to assess the oral motor skills in children with CP was held by Reilly and colleagues (1996) [52], who found 60% of children were totally dependent on their mother for all aspects of food; 57% had episodes of breathlessness requiring medical care at least once in their childhood; and 71% presented frequent cough and suffocation. Fear and anxiety generated by the process of feeding and the perception of the child or adolescent as more vulnerable may greatly hinder the feeding routine process. In addition, communication problems prevent or distort the application of food, the difficulty of expressing hunger or food preferences, the inability to search for it and the lack of skills of self-feeding and increased dependency [52].

Modified Barium Swallow Study (MBSS) is a reliable test used to investigate the chewing and swallowing difficulties in CP children. The test is carried out by by a Pediatric Radiologist and a Speech Language Pathologist (SLP) only for those patients who have partial feeding difficulties [53]. Briefly, patient's mouth, throat, and esophagus are checked. While doing the test, the patient is in sitting position and upright or semi-upright (approximately 75°, in case of infants). To maintain the midline position, the lateral headsupports are adjusted. Patients having partial feeding difficulties after initial assessment are taken to an x-ray room and asked to swallow small amounts of pureed foods and liquid mixed with barium. Barium is in liquid-paste form, allowing capturing the x-ray images of the patient's mouth, throat and esophagus. At first, the food textures that the patient can easily tolerate are presented and then followed by foods with decreasing order of tolerance by the patients. For each food tested, 2-3 swallows are recommended. The x-ray kept on capturing the moving images of the food while the patient swallowed as it travels from patient mouth through his throat and finally into his esophagus. This test is helpful in identifying whether any food particle or liquid was entering into the patient's

lungs (aspiration) while swallowing the food. The test is also used to ensure which part of the patient's upper gastro-intestinal tract lacked coordination or required strength to push down the food in the right direction towards the stomach [53].

Autonomous Feeding requires an appropriate neurological development

Coordination of movements of sucking, chewing and swallowing with respiratory movements, control of the axial skeleton, voluntary movement of the arms and hands – these actions have an overall cumulative effect on the nutritional status of CP children. In children with CP, these movements are limited although not manifested in the first months of life in which suction is dependent on reflexes, but they are more evident with the introduction of semi-solid and solid foods when the management of mouth needs complex motor patterns of cerebral origin [54]. The final result of these feeding difficulties might be malnutrition, resulting from a decrease in muscle strength that affects the ability to cough up to the deterioration of brain functions. That is why in situations such as severe alteration of swallowing, frequent aspirations or inability to meet the needs of energy and macronutrients with oral feeding an enteral feeding may be necessary [55].

Safety and efficiency are the two main features of eating and drinking. Safety discusses the risks of aspiration and choking while eating. Aspiration and choking may occur as a result when food is held in the airway and may likely get entry into the lungs. Furthermore, efficiency denotes how much time and effort are required to eat or drink, as well as also the ability to keep the food inside the mouth. Sellers., *et al*. (2013) [56] of the National Institute of Health Research (NIHR) developed a system of classification for the capacity of eating and drinking ("Eating and Drinking Ability Classification System" or shortly "EDACS") which describes in a systematic way the power of the individual with PC from the three years of life. It is classified into five levels based on functional capacity, the need to adapt the consistency of foods and beverages, the techniques used and other factors of the environment [56].

In PC children, caloric requirements may be different from those recommended for neurologically and otherwise healthy children and adolescents due to various factors that alter their energy expenditure at rest (EER) as out-patient, the characteristics of the impaired motor (type, distribution and gravity) and muscle tone (hypertonia, hypotonia) [57]. Investigator propose specific formulas to estimate the energy needs of this population [58]. However, there is still no global consensus on these methods but to be on the safe side, the PC child should cover at least what is recommended for their age- and sex-matched children and teenagers [37,59]. In 2004, FAO/who/UNU established energy recommendations for children according to sex, age and body weight to maintain growth and satisfactory development [60].

Various investigations have determined that children and adolescents with CP have a lower energy and macronutrient intake, compared to children without this disease. A study on children with motor disability (59% CP) showed that insufficient nutrient and energy intake were common in these patients and this may have adverse effects, particularly regarding vit D status. The study recommended energy and vitamin D supplements be considered for children with motor disability (Kilpinen-Loisa., *et al.* 2009). Although there are not sufficiently enough research studies on food intake in CP, Kilpinen-Loisa., *et al*. (2009) conducted an investigation with 54 children with motor disabilities (59% with diagnosis of CP) and showed that 57% received less than 80% of the recommended daily caloric intake, with an average consumption of 76% of the recommended [61]. On the other hand, a low caloric intake correlated with children of lower height and weight and drive more serious limitations than those with an adequate intake of energy. In 2004, FAO/WHO/UNU established recommendations for each macronutrient for neurologically healthy children and adolescents: 10-15% protein; 30% fat and 55-60% carbohydrates [60].

Future Outlook

There is need of further investigations to comprehensively study the nutritional problems of CP children in Saudi Arabia. There must be specific food frequency questionnaire (FFQ) developed like those developed for children with other nutritional disorders [62]. Obesity as a chronic inflammation [63] and inflammatory potential of the diet [64] are issues gaining worldwide attention and these must be studied in CP children. CP children may also need to be studied for their nutritional immunity as a special focus group like those investigations focusing specifically on elderly individuals [65-67]. Finally, there is a need of both cross-sectional as well as longitudinal studies.

Conclusion

A healthy nutritional status is essential for the physical and psychological integrity of children and adolescents with PC and contributes to rehabilitation therapy to be effective. Most of the research in this population has shown that malnutrition is a frequent problem that primarily affects those who have problems with their motor functions and cannot achieve the growth expected for their age and sex compared with normal children. Food intake fails to cover most of the caloric requirements. Due to the absence of a national consensus on nutritional guidelines for this pathology, children and adolescents with PC should be particularly assessed to identify what disorders present and thus to prevent it before

it develops into a much irreversible state of malnutrition affairs. The nutrition area which deals with aspects related to food and the nutritional status of children with CP is too complex but utmost necessary as the rest of the areas involved in the treatment of this pathology. Therefore, the inclusion of nutrition in interdisciplinary teams is essential to provide comprehensive care to enhance health and development of children, in particular, and their families, in general. However, the insertion of the degree in nutrition in this area is presented as a difficulty since it does not belong to health care providers covered in disability. The inclusion of the profession in the area of disabilities to be full, it should work since the University education of undergraduate and graduate to the inclusion of issues that respond to the needs of this group, since the providers of health services for development of comprehensive care programs and from the State for the design and implementation of public policies effective that improve the quality of life of persons with disabilities. Research in the area is essential to begin to build the path of nutritional care in disability.

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Volume 2 Issue 1 January 2019