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Malnutrition in Children with Neurodevelopmental Disorders and Disabilities in North-eastern Bulgaria

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Abstract

Background: Malnutrition in children with neurodevelopmental disorders and disabilities (NDD/D) is an issue of a growing attention in academic community. Until recently, it was commonly considered that almost every neurological disability was accompanied by a problem of malnutrition.
Objective: The aim is to assess the nutritional status of children with NDD/D in North-eastern Bulgaria through various anthropometric measurements.
Methods: A survey conducted in the period of April 2017 to April 2018 included 109 children with NDD/D from North-eastern Bulgaria. Questionnaires on socio-demographic data, gross motor skills, nutrition specifics and quality of life were applied, along with an anthropometric measurement of the children. Assessment of nutritional status was made by standards and criteria of World Health Organization (WHO) and American Society for Parenteral and Enteral Nutrition (ASPEN).
Results: The results manifests a high relative share of malnutrition, with underweight cases of 44.9% (weight-for-age ≤ 2Z), stunted–43.3% (length/height-for-age ≤ 2Z), wasted– 48.9% (body mass index-for-age ≤ 2Z) and with a high percentage of likely protein deficiency – 33.8%, measured by mid-upper arm circumference (MUAC-for-age ≤ 1Z) index.
Conclusion: Children with NDD/D need to be assessed and managed by multidisciplinary teams including physicians, nutritionist, and special educators and psychologists. Early diagnosis of neurological disorders in children with NDD/D and early rehabilitation should include a mandatory nutritional support in order to achieve optimal improvement in the development of children despite their inborn genetic and epigenetic factors.
Keywords: Nutritional status, assessment, indexes.

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1. Introduction

Malnutrition in children with NDD/D is of growing interest in the academic community [1, 2]. Until recently, malnutrition was considered an insurmountable part of the major neurological disorder, as well as an inevitable and insuperable consequence of it [3]. It may lead to an increased need for medical assistance, reduced rehabilitation ability, diminished educational and social activities and deterioration of the underlying disease prognosis [4].

Assessment of the overall incidence of malnutrition in children with NDD/D is difficult due to the heterogeneity of neurological disorders. Scientific research on nutrition in children with NDD/D is mostly focused on cerebral palsy (CP) in childhood, where malnutrition is commonly

observed in 46%–90% of the cases, according to 20 years old data[5]. Current studies depict improved care in this area. In 2013, Hollenweg *et al* [6] account for 34.7% malnutrition, assessed as such by anthropometric data.

Nutritional care of children with NDD/D appears to be an essential part of their medical care around the world; their optimal nutritional status is a functional criterion for proper rehabilitation.

In Bulgaria, this is an understudied area and nutritionists are not mandatory members of the teams taking care of this vulnerable group of children.

The aim of this study is to assess the nutritional status of children with NDD/Din North-eastern Bulgaria by interpreting different anthropometric indicators.

2. Material and methods

The survey included 109 children with NDD/D such as:cerebral palsy (CP), hydrocephalus, micro- and macrocephaly, encephalopathy, epilepsy, different levels of mental retardation, pervasive developmental disorders (PDD), trisomy 21.

Parents and caregivers of NDD/D children were part of the survey as well.

It was conducted in North-eastern Bulgaria in the time period of April 2017 to April 2018.

Questionnaires on socio-demographic data, gross motor skills, nutrition specifics and quality of life were applied.

Anthropometric measurements of the studied children were conducted as well. The assessment of nutritional status was made by standards and criteria of World Health Organization (WHO) and American Society for Parenteral and Enteral Nutrition (ASPEN).

3. Statistical Methods

The processing of data was performed using the statistical package IBM SPSSv.23.0. The methods applied were: frequency analysis of qualitative variables, quantitative aspects of variation analysis, chi-square tests.

4. Results

4.1 Socio-demographic characteristics

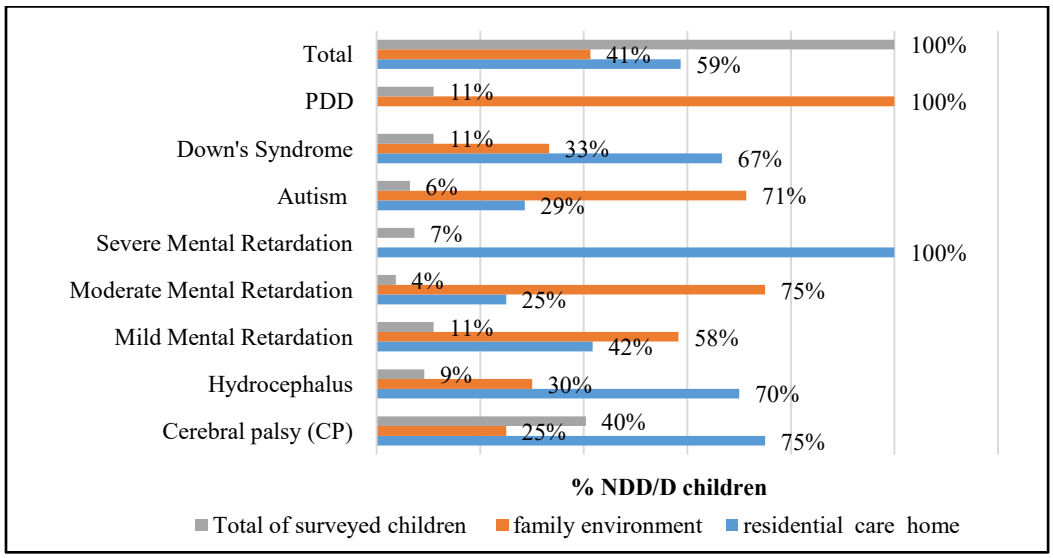
A total sample of 109 children with NDD/D, with an average age of 5.3 ±3.8 years, participated in this study. The girls represented 45.9% of the sample, whereas boys – 54.1%.

Percentage distribution of the surveyed NDD/D children from the rearing environment: 58.7%are raised in residential care homes, compared to 41.3% raised in a family environment.

The mean age of children in residential care homes is 6.2 [± 5.2] years; mean age of children raised in a family environment is 4.5 [± 2.4] years. The male NDD/D children from residential care homes are28 % but the NDD/D males raised in a family environment are 27%. Female children with NDD/D in residential care homes were 32%, compared to 15% female children cared for in a family rearing.

Children with severe neurological impairment and intellectual disability are cared mostly in residential care family-type facilities, whereas children with mild impairments are raised in families. (Figure 1)

Figure 1: Relative share (%) of surveyed NDD/D children, differentiated by types of disorders and rearing environment



4.2. Gross motor skills

The gross motor function of children is assessed by the GMFCS scale (Gross Motor Function Classification System) – a 5-level classification system that describes the gross motor function of children on the basis of their self-initiated movement with particular emphasis on sitting, walking, and wheeled mobility [7]. Distinctions between levels are based on functional abilities, the need for assistive technology, including hand-held mobility devices (walkers, crutches, or canes) or wheeled mobility, and to a much lesser extent, quality of movement.

Our observations encounter statistically significant differences of the motor activity of children depending on the type of rearing environment – family or non-family rearing environment ($X^2 = 19.7$ $p = 0.001$). Twice as many children without mobility restrictions and 66.7% of children with the least motor disability are raised in a family environment.

The prevailing number of children who are classified within the rest four mobility levels and are generally limited in their ability to move themselves around due to severe motor disabilities are raised in resident-type centres.

4.3. Nutritional status of children with NDD/D

The assessment of nutritional status of children with NDD/D included in this study is based on the World Health Organization anthropometric standards and indexes: weight-for-age, length/height-for-age, weight-for-length/weight-for-height and body mass index-for-age, according to WHO growth standards and identification criteria for healthy children [8, 9].

In addition, the nutritional status of NDD/D children is evaluated through the diagnostic indicators and scores of the American Society for Parenteral and Enteral Nutrition (ASPEN), which differentiates severe acute malnutrition from mild and moderate malnutrition. The recommended indexes include weight-for-height/length, body mass index-for-age and mid–upper arm circumference [10].

The Z-score method (the individual deviation rate compared to the average population's mean rate for the reference age and gender population) is used to evaluate individual anthropometric indexes. Interpretation of Z-score anthropometric indicators is based on the international WHO child growth standard, WHO growth reference 5-19 years and the ASPEN standard, derived for healthy individuals (Table 1).

Negative scores in the anthropometric weight-to-age indexes occur mainly due to periods of acute malnutrition, whereas chronic malnutrition typically manifests in a negative length/height-for-age or stunting. Prolonged protein deficiency is reflected in reduced measurements of the mid-upper arm circumference.

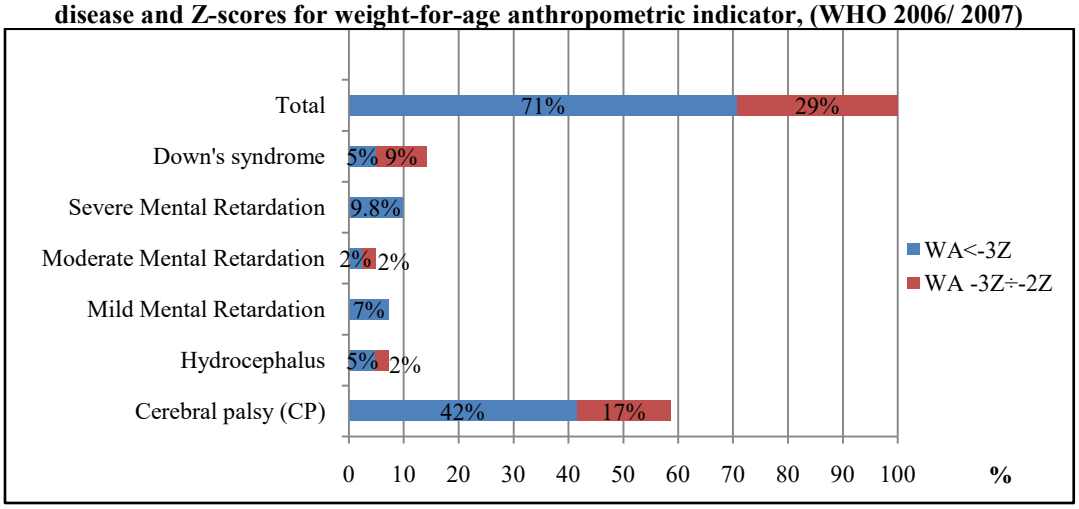
Table 1: Joined malnutrition indicators – WHO child growth standard, 2006 /WHO growth reference 5-19 years, 2007 (WHO 2006/2007) and American Society for Parenteral and Enteral Nutrition (ASPEN, 2015)

<table>
<tr><th></th><th colspan="5">Anthropometric indicators</th></tr>
<tr><th>Z score</th><th>Length/height-for-age</th><th>Weight-for-age</th><th>Weight-for-length/height</th><th>BMI-for-age</th><th>Mid–upper arm circumference-for-age</th></tr>
<tr><td>0</td><td>Height in norm (WHO)</td><td>Weight in norm (WHO)</td><td>Weight-for-length/height in norm (WHO)</td><td>BMI in norm (WHO)</td><td></td></tr>
<tr><td><-1</td><td>Height in norm (WHO)
Data n/a (ASPEN)</td><td>Weight in norm (WHO)</td><td>Weight-for-length/height in norm (WHO)
Mild malnutrition (ASPEN)</td><td>BMI in norm (WHO)
Mild malnutrition (ASPEN)</td><td>Mild malnutrition (ASPEN)</td></tr>
<tr><td rowspan="2"><-2</td><td rowspan="2">Stunted (WHO)
Data n/a (ASPEN)</td><td rowspan="2">Underweight (WHO)</td><td>Wasted (WHO)</td><td>Wasted (WHO)</td><td rowspan="2">Moderate malnutrition (ASPEN)</td></tr>
<tr><td>Moderate malnutrition (ASPEN)</td><td>Moderate malnutrition (ASPEN)</td></tr>
<tr><td rowspan="2"><-3</td><td rowspan="2">Severely stunted (WHO)
Severe malnutrition (ASPEN)</td><td rowspan="2">Severely underweight (WHO)</td><td>Severely wasted (WHO)</td><td>Severely wasted (WHO)</td><td rowspan="2">Severe malnutrition (ASPEN)</td></tr>
<tr><td>Severe malnutrition (ASPEN)</td><td>Severe malnutrition (ASPEN)</td></tr>
</table>

The analysis of the results manifests high relative share of underweight and severely underweight children in the all studied groups– 42.3%, with the prevalence of severely underweight cases –of which 71%with weight-for-age < –3Z versus 29% with weight-for-age –3Z ÷ –2Z. Nearly half of the underweight children are diagnosed with CP.

Child malnutrition data is presented in details in Figure 2.

Figure 2: Relative share (%) of NDD/D studied children with underweight, differentiated by type of neurological disease and Z-scores for weight-for-age anthropometric indicator, (WHO 2006/ 2007)



The prevalence of malnutrition in NDD/D children reflects the significant degree of adverse effects of neurological impairment on the nutritional status of these children. Malnutrition is often associated with impaired linear growth, reduced peripheral circulation, difficult wound healing, increased spasticity and sensitivity of limbs [5].

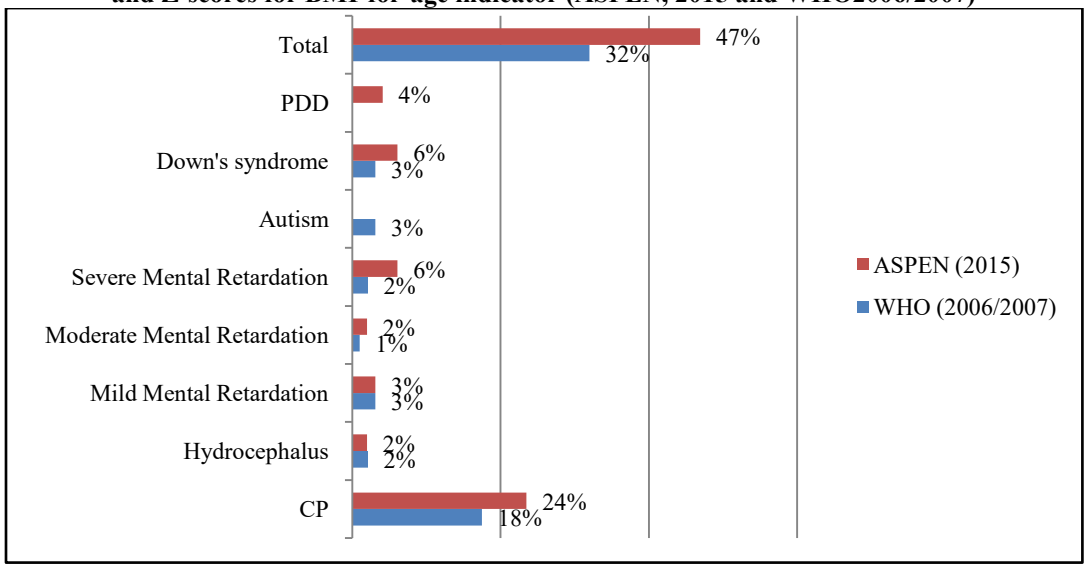
The high relative share of children with height stagnation is due to a sustained shortage of essential nutrients, energy and micronutrients necessary for their growth.

Our results showed that there is no statistically significant difference between the diagnosis and the length/height-for-age anthropometric indicator (X^2=17, p=0.25). However, there is a high relative share of low and very low height-for-age rates – 43.3%, with prevalence of the very low height-for-age rates – 36.1% (length/height-for-age< –3Z), compared to 7.2% low height-for-age (length/height-for-age –3Z ÷ –2Z) (WHO 2006/2007).

Body mass index can also be used to assess malnutrition [8, 9]. However, according to some researchers, it is not always sensitive as an indicator to measure specific changes, as long-term malnutrition is reflected both in a lagging behind in weight gain or underweight, and in height. Thus, weight-for-height ratio reflected in BMI can appear to be normal [11].

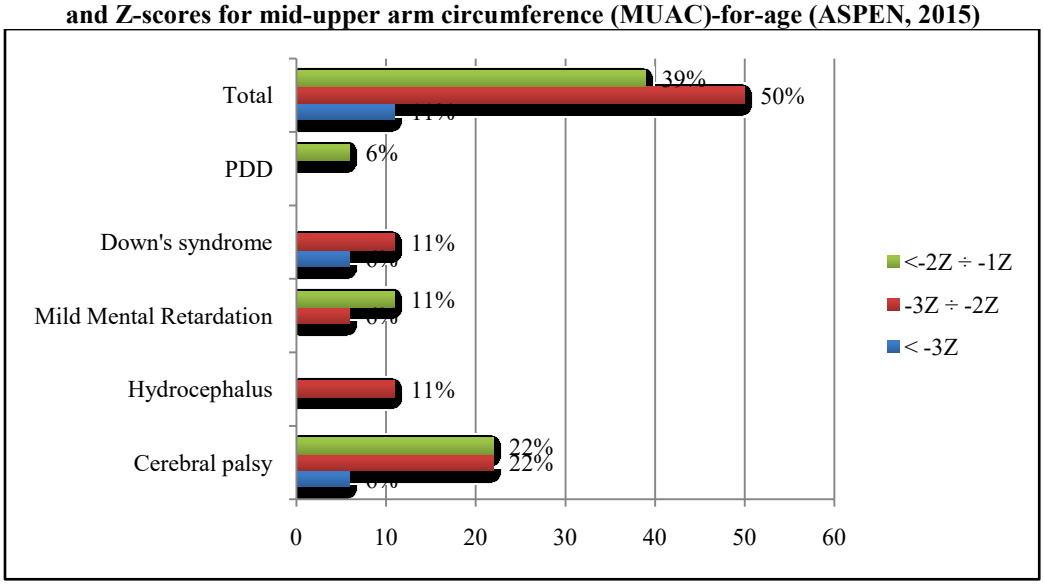
Our study established a statistically significant difference between the type of diagnosis of NDD/D children and the body mass index (X^2=34.35, p=0.002). The relative share of NDD/D children with BMI-for-age<–1Z (mild, moderate and severe malnutrition) is 47%, with prevalence of children with CP (24%), hydrocephalus, mild mental retardation, Down syndrome and other genetic disorders (Figure3).

Figure 3: Relative share (%) of NDD/D children with malnutrition differentiated by type of neurological disorder and Z-scores for BMI-for-age indicator (ASPEN, 2015 and WHO2006/2007)



MUAC measurement is used as an anthropometric assessment tool in determining malnutrition in children 6–60 months of age. MUAC measurements results in our study (n=53) established that 39% of the NDD/D children included in the survey refer to the Z-score group < –1Z, with the highest relative share of children with CP –22% (X^2=7.7, p=0.8) (Figure 4).

Figure 4: Relative share (%) of NDD/D children included in the study differentiated by type of neurological disorder and Z-scores for mid-upper arm circumference (MUAC)-for-age (ASPEN, 2015)



5. Discussion

The etiology of malnutrition in NDD/D children involves different factors. Although the main problems in NDD/D patients are different physical and mental impairments, many observations suggest that brain damage can lead to a significant gastrointestinal dysfunction [12,13,14]. Gastrointestinal disorders are a major chronic manifestation in 80–90% of children with cerebral palsy and in children with other neurodevelopmental disabilities [15,16]. Disorders of the developing central nervous system in children may induce significant dysfunction in the gastrointestinal tract, along with oral-motor dysfunction, rumination, gastroesophageal reflux (GER) with or without aspiration, delayed gastric emptying and constipation. These gastrointestinal difficulties potentially contribute to feeding problems of the impaired children [11].

Assessment of NDD/D children's nutritional status based on WHO (2006, 2007) anthropometric growth standards for healthy individuals implies the risk of underestimating malnutrition in neurologically impaired children. Applying only WHO criteria and standards such as weight-for-height and BMI-for-age indicators to identify malnutrition in children, fails to indicate the cases falling within the Z-score –2Z ÷ –1Z, recommended by ASPEN (2015) for establishing mild malnutrition. Almost half of the study group children identified as malnourished –48.9%, were assessed as such using ASPEN body mass index-for-age indicator. About one third (14.9%) are mildly undernourished and they are not counted by WHO standards. Mid-upper arm circumference (MUAC) indicator is recommended by ASPEN when assessing the nutritional status in children 6–60 months. It showcases 33.8% of the children in this age group as malnourished. Almost one third of them (13.2%) pertain to the Z-score group ≤ 2Z ÷ –1Z, i.e. children with mild malnutrition.

Our observations indicate that ASPEN indicators recommended for the identification of paediatric malnutrition provide a more accurate assessment of underweight and prolonged protein deficiency when compared to WHO standards. Assessing the nutritional status by WHO criteria may fail to indicate early detection of inadequate dietary intake – mild malnutrition.

Future directions

Early identification of neurological impairment in new-borns is critical for the treatment of NDD/D children, as dietary intervention, among other things, might be at risk.

A multidisciplinary approach involving neurologists, gastroenterologists, nurses, professional therapists, psychologists and nutritionists can make a significant contribution to the medical well-being and the quality of life of these children. A detailed assessment of the nature of nutrition difficulties will benefit future dietary needs and advance the involvement of different professionals (speech therapists, nutritionists, gastroenterologists). Targeted medical approach and specific therapy is best performed

only when all pieces of the information are carefully assembled [11]. Psychologists recommend that parents should be involved in these multidisciplinary teams and it is also advisable that the process of evaluation and sharing the results with them is performed by a special algorithm [17].

GI tract disorders are accompanied by other factors contributing to the deterioration of NDD/D children's nutritional status, such as: type and severity of the underlying disease, immobilization with subsequent physical impairment, use of antiepileptic medication, etc.

In Bulgaria, dietary guidelines for children with neurological impairments and mental disability are based on the physiological needs and requirements for optimum nutrition of the respective age groups of healthy children [18,19].

However, both nutritional and non-nutritional factors related to the main neurological disorder hamper adequate food/nutrient intake [3]. This, in turn, aggravates the nutritional status and the level of severity of neurodevelopmental disorder in NDD/D children.

6. Conclusion

Nutritional problems in NDD/D children are critical to achieving optimal growth and development. However, they are often underestimated on account of the primary concern for the main disease.

Overcoming nutritional deficits would reduce children's neurological deficits and would increase their potential for achieving the best possible development, lifespan and quality of life.

Assessment and management of the nutritional and oral status of NDD/D children, performed in a standardised approach and practiced efficiently in many European countries are key aspects of the successful treatment of these children.

References

[1]. Marchand V, Motil KJ. NASPGHAN Committee on Nutrition. Nutrition support for neurologically impaired children: a clinical report of the North American Society for Pediatric Gastroenterology, Hepatology, and Nutrition *J Pediatr Gastroenterol Nutr* 2006; 43: 123–35.

[2]. Rieken R, van Goudoever JB, Schierbeek H, Willemsen SP, Calis EA, Tibboel D *et al*. Measuring body composition and energy expenditure in children with severe neurological impairment and intellectual disability. *Am J Clin Nutr*2011; 94: 759–66.

[3]. Quitadamo P, Thapar N, Staiano A, Borrelli O. Gastrointestinal and nutritional problems in neurologically impaired children. *Eur J Paediatr Neurol* 2016; 20: 810-5.

[4]. Samson-Fang L, Bell KL. Assessment of growth and nutrition in children with cerebral palsy. *Eur J Clin Nutr* 2013; 67: S5–S8.

[5]. Dahl M, Thommessen M, Rasmussen M, Selberg T. Feeding and nutritional characteristics in children with moderate or severe cerebral palsy. *Acta Pediatr*1996; 85 (6): 697–701.

[6]. Holenweg-Gross C, Newman CJ, Faouzi M, Poirot-Hodgkinson I, Bérard C, Roulet-Perez E. Undernutrition in children with profound intellectual and multiple disabilities (PIMD): its prevalence and influence on quality of life. *Child Care Health Dev* 2014; 40: 525-32.

[7]. Palisano RJ, Rosenbaum P, Bartlett D, Livingston MH. Content validity of the expanded and revised gross motor function classification system. *Dev Med Child Neurol*2008; 50 (10): 744–50.

[8]. World Health Organization (WHO). Training Course on Child Growth Assessment: WHO Child Growth Standards. Geneva, Switzerland: World Health Organization; 2008. http://www.who.int/nutrition.

[9]. de Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. Development of a WHO Growth Reference for school-aged children and adolescents. *Bull World Health Organ* 2007; 85: 660-7.

[10]. Becker P, Carney LN, Corkins MR, Monczka J, Smith E, Smith SE *et al*. Consensus statement of the Academy of Nutrition and Dietetics/American Society for Parenteral and Enteral Nutrition: indicators recommended for the identification and documentation of pediatric malnutrition (undernutrition). *Nutr Clin Pract*2015; 30 (1): 147-61.

[11]. Romano C, Van Wynckel M, Hulst J, Broekaert I, Bronsky J, Dall'Oglio L *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. *JPGN* 2017; 65: 242-64.

[12]. Ravelli AM, Milla PJ. Vomiting and gastroesophageal motor activity in children with disorders of the central nervous system. *JPGN* 1998; 26: 56–63.

[13]. Reilly C, Skuse D, Poblete X. Prevalence of feeding problems and oral motor dysfunction in children with cerebral palsy: a community survey. *JPediatr* 1996; 129: 877–82.

[14]. Staiano A, Del Giudice E. Colonic transit and anorectal manometry in children with severe brain damage *Pediatrics*1994; 94: 169–73.

[15]. Erkin G, Culha C, Ozel S, Kirbiyik EG. Feeding and

gastrointestinal problems in children with cerebral palsy. *Int J Rehabil Res* 2010; 33: 218–24.

[16]. Takeda Y, Kubota M, Sato H, Nagai A, Higashiyama Y, Kin H *et al*. Carnitine in severely disabled patients: relation to anthropometric, biochemical variables, and nutritional intake. *Brain Dev* 2015; 37 (1): 94–100.

[17]. Eubova S. Algorythm for assessment of child development. In: Compilation of scientific work from a travelling seminar Istanbul-Kusadasi-Izmir "Innovation in education" – Ep. K. Preslavski Shumen University 2019: 347-354, ISBN: 978-619-00-0996-2

[18]. DulevaV, PetrovaS, Rangelova L, Chikova-Ischener E, Vatralova K. [Main aspects and guidelines for nutrition of children with neurological disorders and mental retardation.] *Bulgarian Journal of Public Health* 2012; 4: 59-70. Bulgarian.

[19]. Ministry of Health.[Ordinance №1 Recommended dietary intakes for Bulgarian population.] State Gazette №11/2018. Bulgarian.