

DOI: 10.5455/msm.2017.29.68-72

Received: 13 February 2017; Accepted: 10 March 2017

© 2017 Melika Melunovic, Feriha Hadzagic-Catibusic, Vildan Bilalovic, Samra Rahmanovic, Selma Dizdar

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ORIGINAL PAPER

Mater Sociomed. 2017 Mar; 29(1): 68-72

# Anthropometric Parameters of Nutritional Status in Children with Cerebral Palsy

Melika Melunovic<sup>1</sup>, Feriha Hadzagic-Catibusic<sup>2</sup>, Vildan Bilalovic<sup>3</sup>, Samra Rahmanovic<sup>1</sup>, Selma Dizdar<sup>4</sup>

## ABSTRACT

**Introduction:** Patients with cerebral palsy (CP), besides the basic neurological damage, are also often undernourished. Adequate nutrition for children is very important during the period of intensive growth and development, which is of particular importance in patients with CP. **Goal:** To evaluate the nutritional status of patients with CP who are treated at the Pediatric Clinic, Clinical Centre of Sarajevo University and causes of malnutrition in these patients. **Materials and Methods:** Eighty patients with CP underwent anthropometric assessment (body weight, body height, body mass index, head circumference, subscapular skinfold thickness, triceps skinfold thickness and mid upper arm muscle circumference). Severity of CP was classified based on the Gross Motor Function Classification System (GMFCS). We compared the anthropometric parameters of our patients with normal values of healthy children, as well as with degree of motor impairment, oromotor dysfunction, feeding assistance, length of meals and daily feeding time. **Results:** There were significant differences in all monitored parameters in relation to normal values, with 38 (47.5%) malnourished patients in the total group, out of which 29 (63.0%) with severe motor impairment and with 9 (11.3%) obese patients in the total group. The presence of oromotor dysfunction and other monitored parameters had a significant impact on the nutritional status of these patients. **Conclusion:** In severely disabled patients with CP there is a risk of profound malnutrition. Early identification and treatment of these patients is very important for their growth, development and health.

**Keywords:** cerebral palsy, nutritional status, anthropometric parameters, oromotor dysfunction.

## 1. INTRODUCTION

Nutritional problems are often present in children with cerebral palsy (CP), especially in

those with severe motor impairment (1). Reasons for nutritional disorders in these patients are multifactorial, so malnutrition can be caused by motor impairment, digestive problems, medications which patient uses, endocrine disorders and social environment.

Calorie intake in children with CP is lower compared to the control group of children of the same age. The analysis of the three-day menu demonstrated significantly lower energy intake in children with moderate and severe developmental disorders, that suggests there is a feeding problem as a cause of malnutrition of these children (2). The reason for that may be modified food texture, as well as food inappropriate for patient's age. Some patients are dependent on the parents/careers' feeding due to inability to express hunger and thirst and the inadequate hand-mouth coordination (3).

Energy needs of children with CP are different compared to healthy children, as well as depending on the type of CP. Many children with CP have reduced energy requirements. Children who are physically active, those involved in an intensive rehabilitation, children with seizures or frequent infections have increased energy needs (4).

Oromotor dysfunction (OMD) affects up to 90% of patients with CP and is major determinant of malnutrition in children with a neurodevelopmental disorder (5, 6). Inadequate sucking, dysfunctional swallowing, increased pharyngeal reflex, sialorrhea due to inadequate mouth closure and decreased ability to chew make oral feeding difficult.

Neurological disease may have an impact on growth. For example, patients with unilateral spastic CP whose body height and triceps skinfold thickness is within the normal range, have significantly lower limb length and circumference of the affected side compared to unaffected side (7). Another study also found that the affected limb had delayed skeletal maturation and reduced

<sup>1</sup>Pediatric Gastroenterology and Hepatology Department, Pediatric Clinic 1, Discipline for the child's health, Clinical Centre of Sarajevo University, Bosnia and Herzegovina

<sup>2</sup>Pediatric Neurology Department, Pediatric Clinic 2, Discipline for the child's health Clinical Centre of Sarajevo University, Bosnia and Herzegovina

<sup>3</sup>Department of Pediatric Medicine, Primary Health Care Center Sarajevo, Bosnia and Herzegovina

<sup>4</sup>Pediatric Gastroenterology and Hepatology Department, Pediatric Clinic 1, Discipline for the child's health, Clinical Centre of Sarajevo University, Bosnia and Herzegovina

### Corresponding

author: Melika Melunovic, Pediatric Gastroenterology and Hepatology Department, Pediatric Clinic, Clinical Centre of Sarajevo University, Sarajevo, Bosnia and Herzegovina. ORCID ID: <http://www.orcid.org/orcid.org/0000-0003-1344-9221>

bone density compared to the unaffected side (8). It looks like that muscle atrophy in the affected side interferes with the growth, independent of poor nutritional intake.

## 2. GOAL

The aim of this study was to assess nutritional status of children with CP, treated at the Pediatric Clinic, Clinical Centre of Sarajevo University and to evaluate causes of malnutrition in these patients.

## 3. MATERIAL AND METHODS

We studied 80 patients who were diagnosed with CP aged 2-18 years. Patients were divided into two groups according to motor disorder severity, the Gross Motor Function Classification System (GMFCS) among which testing was performed. The group of patients with minor motor impairment (MMI) consisted of patients with GMFCS I-III, and the group of patients with severe motor impairment (SMI) consisted of patients with GMFCS IV-V.

Exclusion criteria were: patients with progressive neurodegenerative and central nervous system lesions, other neurological disorders which are not CP, CP patients with associated chronic diseases that may affect nutritional status.

Detailed anthropometry was performed and included measurement of body weight (BW), body height (BH), body mass index ( $BMI = BW/BH^2$ ), head circumference (HC), subscapular skinfold thickness (SST), triceps skinfold thickness (TST), mid upper arm muscle circumference (MUAMC). Mid upper arm muscle circumference was determined according to the formula:  $MUAMC = UAC - (\pi \times TST / 10)$  where UAC is upper arm circumference. Standardized methods of measuring were used for all the measurements, and thereafter Z scores were calculated to enable more accurate comparisons regardless of patient age and sex. For comparison we used following growth charts: body weight, body height, body mass index—the CDC (Centers for Disease Control and Prevention) growth curves, 2000 (9); head circumference—a reference growth curve for children birth-18 years; Roche AF (10); subscapular skinfold thickness and triceps skinfold thickness—a reference curve for triceps and subscapular skinfold thickness in US children and adolescents; Addo and Himes, (11); mid upper arm muscle

circumference—a reference curve for muscle mass and body fat of the upper extremities; Frisancho (12).

Those who met one or more of the following criteria were indicated as malnourished subjects:  $BW < -2$  Z scores,  $BH < -2$  Z scores,  $TST < -2$  Z scores,  $SST < -2$  Z scores. Those who met one or more of the following criteria were indicated as obese respondents:  $BW > 2$  Z score,  $BMI > 2$  Z score,  $TST > 2$  Z score,  $SST > 2$  Z score.

We used a form that was made for the purpose of the study, modified according to forms used in similar published studies of relevant centers (13, 14, 15). The form includes information related to eating habits and problems during feeding, which may affect nutritional status.

OMD has been confirmed in our study based on the presence of one or more of the following features: dysarthria, sialorrhea, asymmetry of oral tissues when resting or during speech or feeding as well as presence of eating and swallowing difficulties.

The level of OMD was estimated according to eating and swallowing problems:

- No eating problems, eats normal food;
- Mild problems, eats chopped or mashed food;
- Moderate problems, requires very mushy, chopped or liquid food;
- Severe problems, requires a dense liquid, puree or needs feeding through a tube.

The patients were divided according to the independence in feeding (fully independent, partially independent, totally dependent on the parent/career), according to the meal length (<15 min, 15-30 min, > 30 min) and according to the length of daily feeding time ( $\leq 3h$ ,  $> 3h$ ).

Results were statistically analyzed using SPSS version 14.0. Statistical methods used in data processing included percentages and rates, median, minimum, maximum,  $\chi^2$  test, Mann-Whitney U test.

## 4. RESULTS

We evaluated nutritional status of 80 patients with CP aged 2 to 18 years. They were classified according to the severity of neurologic dysfunction into two groups between which the analysis was done. MMI group consisted of 34 (42.5%) and

The degree of motor impairment	Entire group	MMI	SMI	P	Boys	Girls	P
BW	-1.69 (-15.64; 2.91)	-0.54 (-5.35; 2.91)	-2.93 (-15.64; 2.38)	$p < 0.01$	-2.15	-0.97	$p > 0.05$
BH	-1.57 (-7.36; 2.31)	-0.68 (-4.35; 2.31)	-2.58 (-7.36; 2.09)	$p < 0.01$	-2.45	-1.06	$p < 0.01$
BMI	-0.68 (-13.41; 3.01)	-0.45 (-4.64; 2.74)	-0.96 (-13.41; 3.01)	$p > 0.05$	-1.16	-0.55	$p > 0.05$
HC	-1.96 (-13.13; 8.41)	-0.93 (-8.78; 4.27)	-3.02 (-13.13; 8.41)	$p < 0.01$	-2.65	-1.56	$p > 0.05$
SST	0.15 (-4.83; 2.54)	0.29 (-2.26; 2.54)	-0.31 (-4.83; 2.36)	$p < 0.05$	0.15	-0.15	$p > 0.05$
TST	-0.42 (-6.87; 2.33)	0.03 (-2.43; 2.33)	-1.02 (-6.87; 2.15)	$p < 0.01$	-0.09	-0.47	$p > 0.05$
MUAMC	-0.74 (-7.22; 3.67)	-0.40 (-3.63; 3.67)	-0.99 (-7.22; 2.79)	$p > 0.05$	-1.33	-0.31	$P = 0.05$

Table. 1. Anthropometric parameters.. Legend: MMI—minor motor impairment, SMI—severe motor impairment, BW—body weight, BH—body height, BMI—body mass index, HC—head circumference, SST—subscapular skinfold thickness, TST – triceps skinfold thickness, MUAMC – mid upper arm muscle circumference.

	MMI		SMI		All
OMD – no	13 (38.2%)		5 (10.9%)		18 (22.5%)
	Undernourished 1 (7.7%)	Not undernourished 12 (92.3%)	Undernourished 3 (60.0%)	Not undernourished 2 (40.0%)	
OMD – yes	21 (61.8%)		41 (89.1%)		62 (77.5%)
	Undernourished 8 (38.1%)	Not undernourished 13 (61.9%)	Undernourished 26 (63.4%)	Not undernourished 15 (36.6%)	
OMD – 1. degree	15 (71.4%)		6 (14.6%)		21 (33.8%)
OMD – 2. degree	6 (28.6%)		9 (22.0%)		15 (24.2%)
OMD – 3. degree	0 (0.0%)		13 (31.7%)		13 (21.0%)
OMD – 4. degree	0 (0.0%)		13 (31.7%)		13 (21.0%)
Independent in feeding	18 (52.9%)		0 (0%)		18 (22.5%)
Partially independent in feeding	11 (32.4%)		15 (32.6%)		26 (32.5%)
Not independent in feeding	5 (14.7%)		31 (67.4%)		36 (45.0%)
Meal time up to 15 min.	17 (50.0%)		12 (26.1%)		29 (36.3%)
Meal time from 15-30 min.	12 (35.3%)		22 (47.8%)		34 (42.5%)
Meal time over 30 min.	5 (14.7%)		12 (26.1%)		17 (21.3%)
Daily feeding time ≤ 3 hours	32 (94.1%)		42 (91.3%)		74 (92.5%)
Daily feeding time > 3 hours	2 (5.9%)		4 (8.7%)		6 (7.5%)

Table 2. Oromotor dysfunction, independence in feeding, length of meals and length of daily feeding in patients with varying degrees of motor impairment. Legend: MMI–minor motor impairment, SMI–severe motor impairment, OMD–oromotor dysfunction,

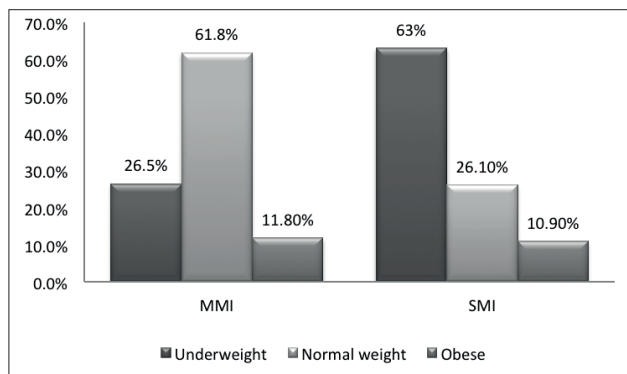


Chart 1. The frequency of patients with different degrees of nutritional status in the group with mild or severe motor impairment. Legend: MMI–minor motor impairment, SMI–severe motor impairment.

SMI group of 46 (57.5%) patients. There were 47 girls and 33 boys in the total group. There were 18 (52.9%) boys and 16 (47.1%) girls in the group of MMI, while there were 29 (63.0%) boys and 17 (37.0%) girls in the group of SMI. There was no statistically significant difference in the representation of gender among various groups.

Table 1. shows the median, minimum and maximum of monitored anthropometric parameters in all patients, in the group of patients with minor and group with severe motor impairment and the median of same parameters in boys and girls. We noted discrepancies in all anthropometric parameters of patients with CP compared to healthy children. These deviations were noted in both groups, but are much more pronounced in patients with SMI. The median Z scores of BW, BH, HC, SST and TST were significantly lower in the SMI group compared to the MMI group. Girls had significantly higher median values of BH than boys, and the difference between the median values of MUAMC in groups of boys and girls is on the borderlines of statistical significance.

Classifying subjects in three groups of malnourished, normal weight and obese we obtained the following results (graph 1.). 38 (47.5%) of respondents were underweight in the

total group, out of which 9 (26.5%) in the MMI group, while there were 29 (63.0%) in the SMI group, thus significantly higher ( $\chi^2 = 11.55$ ;  $df = 2$ ,  $p < 0.01$ ). In our study, there were 9 (11.3%) obese patients in the total group with no statistically significant difference in the incidence of obesity ( $\chi^2 = 0.107$ ,  $df = 2 > 0.05$ ) between the two groups, there were 4 (11.8%) in the MMI group and 5 (10.9%) obese patients in the SMI group.

Table 2. shows the frequency of OMD, independence in feeding, length of meals and daily feeding time in patients. The frequency of OMD is significantly higher in the SMI group ( $p < 0.01$ ), where 41 (89.1%) patient had OMD, while 21 patients (61.8%) had OMD in the MMI group. There are also significant differences in the severity of OMD between these two groups ( $p < 0.01$ ), 13 (31.7%) patients had the third degree of OMD in the SMI group and the same number of them had the fourth degree of OMD and not a single patient had the third and fourth degree of OMD in the MMI group, respectively, all the patients had the first and second degree of OMD. By monitoring the impact of the presence of OMD on malnutrition we showed that patients who had OMD were more often malnourished ( $p < 0.05$ ). Evaluation of the impact of degree of OMD on the occurrence of malnutrition was done by comparing the degree of OMD and TST and we received the result which was on the borderline of statistical significance ( $p = 0.0286$ ).

Complete dependence on the parents/careers' feeding was significantly more frequent in the group of patients with SMI compared to the group with MMI ( $p < 0.01$ ). The probability of occurrence of malnutrition significantly increases with decreasing independence in feeding ( $p < 0.01$ ). There were found no statistically significant differences among the groups of subjects with SMI or MMI in the frequency of meals of varying duration of meal (up to 15 minutes, 15-30 minutes, over 30 minutes) ( $p > 0.05$ ), nor the duration of the daily feeding (under or up to 3 hours or over 3 hours) ( $p > 0.05$ ). The probability of occurrence of malnutrition significantly increases with increasing length of meal ( $p < 0.05$ ) and length of daily feeding ( $p < 0.05$ ).

## 5. DISCUSSION

Our study, like many other studies before, indicates that children with CP significantly differ from the general population in their growth (16, 17). However, it is still unclear to what extent deviant growth represents 'standard' growth for this population or whether it is the result of suboptimal nutrition, resulting in stunting.

Normal growth in children is generally accepted as a marker of health, while abnormal growth may be considered as a sign of disruption in child's nutrition, environment or health. Children with CP, as noted above, have poor growth. Growth that would be considered normal for children with CP has not been established, so it is often difficult to distinguish between children with CP, who are "healthy" from those who are "sick". Abnormalities in growth and body build in children with cerebral palsy are the result of various causes, some of which may be affected to enhance growth.

There are evidences of a significant deviation of all seven anthropometric parameters in relation to the reference values of healthy children in our research. BW, BH, HC, SST and TST were markedly lower in patients with SMI, indicating a small amount of fat tissue in these patients, and a reduced growth in height and growth of bone structures. BMI was not significantly different among the groups, because reduced BW follows reduced BH. MUAMC is lower in patients with SMI, but does not significantly differ from that of patients with MMI.

There was a high incidence of malnutrition in both monitored groups of patients. It was observed, in the total group, in 47.5% of subjects, in the MMI group in 26.5%, and in the SMI group in 63.0%. Malnutrition is slightly lower in other countries: 2016 Karagiozoglou LT recorded a 38.1% undernourished patients (18) in Greece in the total group of respondents, 2006 Bertoli S found 41.2% (19) in Italy, and 2001 Troughton KER 2001 41.2% patients (20) in Ireland. In 2012, Dahlseng MO published a study conducted in Norway where 20% of patients with SMI were malnourished, which is significantly lower than in our patients (21). These differences can be explained by possible late involvement of patients in treatment, as well as by parents/careers' refusal of adequate treatment, because they minimize this problem in regard to other difficulties these patients have. During the research period, no one of the surveyed patients had gastrostomy.

There is also increased frequency of obesity among patients with CP, besides very frequent malnutrition. Obesity in patients with CP, which may have a negative impact on overall health and increased incidence of cardiovascular diseases in adulthood, negatively affects the mobility and functionality of children with CP and has a negative effect on the implementation of the rehabilitation of these patients after orthopedic surgery. Ragozinski et al. (22) showed that obesity among ambulatory children with CP had increased over the last years, and the same trend may be present among more severely impaired children.

Compared to other studies done in recent years, the incidence of obesity in our patients is much lower. In a study published in 2010. in Norway, the prevalence of obesity in children with CP, aged 6-11 years, was 17% (23). Another study in the United States announced that the prevalence of obesity among children with mild CP increased from 7.7% to 16.5% (22) over the last decade. The differences in the values

obtained in our study are possible primarily due to lower use of gastrostomy.

Malnutrition of children with CP is often caused by OMD, which prevents the child to safely consume calories and nutrients needed for growth (6). By using different diagnostic methods, such as assessments of a history provided by parents, the presence of characteristic signs with clinical examination various studies obtained data on the presence of OMD in 58-90% of children with CP (5, 6, 15).

We have proved the existence of OMD in 62 (77.5%) patients in the total group, and in 21 (61.8%) patients with the MMI, and in 41 (89.1%) patients with SMI. OMD is significantly more common among patients with SMI, and also higher degrees of OMD are more common in patients with SMI.

OMD significantly affects the onset of malnutrition. By monitoring malnutrition in relation to the OMD we noted that in MMI group there are more underweight patients among those who have OMD (38.1%) compared to those who do not have OMD (7.7%). In the group of patients with SMI this difference is not very notable. This indicates that the existence of OMD in patients with MMI has a significant effect on the occurrence of malnutrition. On the other side, the occurrence of malnutrition in patients with SMI, besides OMD, is influenced by other factors such as neurological damage, and numerous other factors such as frequent morbidity, various infections, epilepsy, hormonal problems.

According to some authors, the measuring of TST is the best and the simplest way of assessing the nutritional status of children with CP (24). We compared the degree of OMD and TST and received the result which is on the borderline of statistical significance (Spearman 's rho = -0.245, P = 0.0286) which indicates the possible impact of the degree of OMD on nutritional status.

Patients with CP are often partially or totally dependent on the career's feeding. The cause for this may, besides OMD, which is very common, also be immobility, inadequate function of the upper extremities, impaired hearing, vision, inability to communicate, poor cognitive abilities. The number of patients dependent on the parent/career's feeding, in our group of patients, is significant, where 31 (67.4%) of them in the SMI group is totally dependent. Parents try to compensate problems with feeding of these patients with CP in various ways, among others by prolonging the duration of the meal, which prolongs the total time of daily feeding. PB Sullivan believes that the length of daily feeding can be a reliable measure of the severity of feeding impairment and if the parent/career spends 3 or more hours per day feeding his child with CP, then serious thought should be given to the introduction of tube feeding (14).

## 6. CONCLUSION

Our patients with cerebral palsy, namely those with severe motor impairment, are significantly underweight compared to healthy peers. One of the causes is oromotor dysfunction, which has a negative impact on the nutritional status not only in children with more severe motor impairment, but also in those with minor motor impairment. Dependence on the parent/career during feeding and length of mealtime are also important. Regular monitoring of the nutritional status of these children is necessary, as well as adequate and timely



treatment to improve their health status, thus the quality of life for them and their families.

## REFERENCES

- Sangermano M, D'Aniello R, Massa G, Albano R, Pisano P, Budetta M, et al. Nutritional problems in children with neuromotor disabilities: an Italian case series. *Ital J Pediatr*. 2014; 40: 61. doi: 10.1186/1824-7288-40-61
- Schwarz SM, Corredor J, Fisher-Medina J, Cohen J, Rabinowitz S. Diagnosis and Treatment of Feeding Disorders in Children with Developmental Disabilities. *Pediatrics*. 2001, 108(3), 671-6. doi: 10.1542/peds.108.3.671
- Sullivan PB. Feeding and Nutrition in Children with Neurodevelopmental Disability. London. Mec Keith Pres, 2009.
- 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 neurologic impairment and intellectual disability. *Am J Clin Nutr*. 2011 Sep; 94(3): 759-66. doi: 10.3945/ajcn.110.003798
- Sullivan PB, Juszczak E, Lambert BR, Rose M, Ford-Adams ME, Johnson A. Impact of feeding on nutritional intake and growth: Oxford Feeding Study II. *Developmental Medicine and Child Neurology* 2002; 44: 461-7. doi: 10.1111/j.1469-8749.2002.tb00307.x
- Fung EB, Samson-Fang L, Stallings VA, Conaway M, Liptak G, Henderson RC, et al. Feeding dysfunction is associated with poor growth and health status in children with cerebral palsy. *J Am Diet Assoc*. 2002; 102: 361-73. doi: 10.1016/S0002-8223(02)90084-2
- Stevenson RD, Roberts CD, Vogtle L. The effects of non-nutritional factors on growth in cerebral palsy. *Dev Med Child Neurol*. 1995. 37: 124-30. doi: 10.1111/j.1469-8749.1995.tb11981.x
- Lin PP, Henderson RC. Bone mineralization in the affected extremities of children with spastic hemiplegia. *Dev Med Child Neurol*. 1996. 38: 782-6. doi: 10.1111/j.1469-8749.1996.tb15112.x
- Centers for Disease Control and Prevention, National Center for Health Statistics. CDC growth charts United States.
- Roche AF, Mukherjee D, Guo S, Moore WM. Head circumference reference data: Birth to 18 years. *Pediatrics*. 1987; 79: 706-12.
- Addo OY, Himes H. Reference curves for triceps and subscapular skinfold thicknesses in US children and adolescents. *Am J Clin Nutr*. 2010; 91: 635-42. doi: 10.3945/ajcn.2009.28385
- Frisancho AR. New norms of upper limb fat and muscle areas for assessment of nutritional status. *The American Journal of Clinical Nutrition*. 1981; 34: 2540-45.
- Rogers B, Arvedson J. Assessment of Infant Oral Sensorimotor and Swallowing Function. *Mental Retardation and Developmental Disabilities Research Reviews*. 2005. 11: 74-82. doi: 10.1002/mrdd.20055
- Sullivan PB, Lambert B, Rose M, Ford-Adams M, Johnson A, Griffiths P. Prevalence and severity of feeding and nutritional problems in children with neurological impairment: Oxford Feeding Study. *Developmental Medicine and Child Neurology*. 2000; 42: 674-80. doi: 10.1111/j.1469-8749.2000.tb00678.x
- Wilson EM, Hustah KC. Early Feeding Abilities in Children with Cerebral palsy: A Parental Report Study. *J Med Speech Lang Pathol*. 2009, March: nihpa57357. doi: 10.1.1.664.7833
- Stevenson RD, Conaway M, Chumlea WC, Rosenbaum P, Fung EB, Henderson RC, et al.; Growth and Health in Children With Moderate-to-Severe Cerebral Palsy. *Pediatrics*. 2006; 118(39): 1010-18. doi: 10.1542/peds.2006-0298
- Day SM, Strauss DJ, Vachon PJ, Rosenbloom L, Shavelle RM, Wu YW. Growth patterns in a population of children and adolescents with cerebral palsy. *Dev Med Child Neurol*. 2007, 49: 167-71. doi: 10.1111/j.1469-8749.2007.00167.x
- Karagiozoglou-Lampoudi T, Daskalou E, variami E, Zafeiriou D. Identification of feeding risk factors for impaired nutrition status in paediatric patients with cerebral palsy. *Acta Paediatr*. 2012; 101(6): 649-54. doi: 10.1111/j.1651-2227.2012.02641.x
- Bertoli S, Cardinali S, Veggiotti P, Trentani C, Testolin G, Tagliabue A. Evaluation of nutritional status in children with refractory epileps. *Nutrition journal*. 2006; 5: 14. doi: 10.1186/1475-2891-5-14
- Troughton KEV, Hill AE. Relation between objectively measured feeding competence and nutrition in children with cerebral palsy. *Developmental Medicine and Child Neurology* 2001; 43: 187-90. doi: 10.1111/j.1469-8749.2001.tb00185.x
- Dahlseng MO, Finbråten AK, Júlíusson PB, Skranes J, Andersen G, Vik T.. Feeding problems, growth and nutritional status in children with cerebral palsy. *Acta Paediatr*. 2012 Jan; 101(1): 92-8. doi: 10.1111/j.1651-2227.2011.02412.x
- Rogozinski BM, Davids JR, Davis RB, Christopher LM, Anderson JP, Jameson GG, et al. Prevalence of obesity in ambulatory children with cerebral palsy. *J Bone Joint Surg Am*. 2007; 89: 2421-6. doi: 10.2106/JBJS.F.01080
- Julusson PB, Eide GE; Roelants M. et al. Overweight and obesity in Norwegian children: prevalence and socio-demographic risk factor. *Acta Paediatr*. 2010; 99: 900-5. doi: 10.1111/j.1651-2227.2010.01730.x
- Stallings VA, Zemel BS, Davies JC, Cronk CE, Charney EB. Energy expenditure of children and adolescents with severe disabilities: A cerebral palsy model. *Am J Clin Nutr*. 1996; 64: 627-34. doi: 10.1111/j.1469-8749.2000.tb00064.x