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Research article

BODY COMPOSITION AND NUTRITIONAL STATUS OF PRESCHOOL CHILDREN

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Abstract. *The main goal of this research was to determine gender-related differences in some parameters of body composition caused by the nutritional status of preschool children, and group differences within subsamples caused by the nutritional status of both genders. The total sample consisted of 188 participants, boys (n=107) and girls (n=81) from Belgrade, with average values of body height BH=124.59cm±5.76 and body mass BM=24.32kg±3.11, average age 6.39±0.44 years. Body composition was assessed using the InBody 230 device. The main parameters of descriptive statistics were calculated. The MANOVA method was used to determine gender differences in the entire sample, and the ANOVA method was used to determine individual differences. A series of Post-Hoc Bonferroni tests were performed to determine between which groups significant statistical differences existed. This study provides encouraging findings when it comes to a satisfactory percentage of normally nourished children of both genders, but it should also point to a certain trend in the rise of obese and overweight children who make up almost 17% of the total sample. The differences observed in the girls' subsample may indicate girls enter the pre-pubertal phase earlier than boys, based on the differences in the amount of body fat tissue, but also always greater muscle mass in the boys' subsample, and lower average values of body mass and the Body Mass Index in the girls' subsample. Constant monitoring of children's nutritional status and physical abilities every six months or once a year is recommended.*

Key words: *Body Mass Index, Body Composition, Gender and Group Differences, Preschool Age*

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INTRODUCTION

The fact that the body structure is a clear characteristic and that in the case of people it represents human behaviour, disease, and that during the preschool age it is studied from the aspect of growth and development, and not from the aspect of defining body constitution. This is because the level of development of preschool-age children is uneven and therefore constant monitoring of the anthropological dimensions of preschool children, from the youngest age to school age, is very important.

Morphological characteristics provide findings on the psychosomatic status of man, which is defined by anthropometric measurements of the body as a whole or its parts, on the basis of which an objective picture of man's physical development can be obtained (Bala & Popović, 2007). In our region, for the first time, a hierarchical structure of morphological dimensions has been established for school children (Momirović, Medved, Horvat, & Pavišić-Medved, 1968), and since then, studies have mostly been based on their reduced models (Bala, 2007; Pelemiš, Prskalo, & Madić, 2019). Four decades ago, other methods for estimating body composition and determining the structure of morphological space began to be used worldwide, not based on the factor model but rather based on the estimation of body parameters by using methods such as plethysmography, hydrodensitometry, bioelectric impedance (BIA) (Karaba-Jakovljević, 2016). By comparing some of these methods, differences also emerge in attitudes about their use among different authors. An even earlier belief indicates that the BIA method is more useful than others because it provides results at the level of the whole body (Heinonen, Oja, Sievanen, Pasanen, & Vuori, 1998), but the assessment in the sample of older participants must be taken into account as well. Contrary to this fact, a group of authors including Eisenmann, Heelan, & Welk, (2004) indicate that the BIA method has limited application in children aged between 3 and 8. However, it can be said that basic anthropometric measure for designating constitution kind are still more present than the BIA method (Pelemiš, Ujsasi, Srdić, Džinović, & Pavlović, 2019), which could not be assumed given the ease of estimating body composition parameters. This fact probably indicates the deficiencies of the BIA method compared to others, although there are no significant papers that indicate the validity of the parameters obtained by using the BIA method. Today, we also come across terms such as *morphological condition*, which includes indicators of obesity, which include: the Body Mass Index (BMI), visceral and subcutaneous abdominal fat and waist size (Malina & Katzmarzyk, 2006). The authors point out the weaknesses of BMI parameters, which can be explained by the fact that morphological indicators and elements of body composition are not observed separately and individually, but rather together. There is also study by Musalek and associates (2017) that denies this, but also points out that indices such as BMI are not able to identify the amount of adipose tissue that is crucial in assessing motor skills, but only the nutritional status of the population.

After the review of the findings of previous research, the deficiency in the studies of a similar nature conducted so far is reflected in the insufficient number of findings that are supposed to indicate whether and to what extent nutritional status affects possible differences in body composition. Therefore, this research can help us to know something new and additional regarding questions of whether the nutritional status of preschool children of both genders can cause group differences in their body composition, and which of the body composition parameters is the most prominent from the aspect of these group differences. In the preschool age, this could indicate which gender and which nutritional

status group enters the pre-pubertal phase earlier, especially if a subsample of normally nourished children is observed.

The aim of this study was to determine if there are gender-related differences in preschool children in body composition when their nutritional status is neglected, and group differences within subsamples caused by the nutritional status of both genders.

METHOD

The research was of a transversal nature. Was used an ex post facto draft in the research. From the aspect of the scientific research type, the empirical research method was used, while the confirmatory analytical method was used to analyse the problem. The total sample included 188 participants, on average 6.39±0.44 years of age. Of these, 107 were boys or 56.91% of the total sample who were on average 6.44±0.50 years of age, with average body height, body mass and BMI (BH=124.42±5.66 cm; BM=24.77±2.82 kg, BMI=16.03±1.72 kg/m^2), and 81 were girls or 43.09% of the total sample, mean age 6.34±0.35 and mean values of height, body mass and BMI (BH=124.77±5.87cm; BM=23.88±3.35 kg; BMI=15.35±1.93 kg/m^2), who attended the preschool institution "PU Čukarica" in Belgrade (Republic of Serbia). Before the start of the study (October 2019), the children's parents/guardians provided written permission for their children to take part in the research (World Medical Association Declaration of Helsinki, 2013).

Anthropometric measurements were chosen as the sample of measurement instruments: 1. For Longitudinal Skeletal Dimensionality: 1) *Body height* (0.1 cm); 2. For body volume and mass: 2) *Body mass* (0.1 kg). Based on these two dimensions measured, 3) *BMI* (kg/m^2) was calculated too, according to the classification prescribed by the World Health Organization (2008):

$$\text{Body Mass Index}=\text{Body Mass}/\text{Body Height}^2$$

The participants were further grouped based on their BMI by the Centres for Disease Control and Prevention (2000) into the following subsamples: 1) ≤5 percentile- malnourished; 2) between 5 and 85 normally nourished; 3) between 85.01 and 95 overweight and 4) over 95.01 obese.

Body composition was assessed using three body composition measures, as follows: 4) *Muscle mass percentage* (0.1 kg); 5) *Body fat percentage* (0.1 kg) and 6) *Body Water Percentage* (0.1 kg).

The Martin anthropometer was used to measure body height. The participants had no shoes on. They stood on a flat surface, heels together, head in the "Frankfurt horizontal" position. The result is expressed in values of 0.1 cm. Body mass was measured with InBody 230 (Biospace Co., Ltd, Seoul, Korea). The participants stood on the device dressed only in their underwear. The result is expressed in values of 0.1 kg. Body composition measurement was also done by using the Inbody 230 device, which operates based on the BIA methodology.

SPSS software version 20 was used for data analysis. Descriptive statistics were calculated: the measures of central tendency AM-arithmetic mean; and variability measures of S-standard deviation. The normality of data distribution was calculated using the Kolmogorov-Smirnov KS-normality test. Furthermore, four categories of participants according to percentiles were obtained: malnourished; normally nourished; overweight and obese. The MANOVA method was used to determine gender differences in the entire

sample, and a One-Way analysis of variance method was used to determine individual differences. After significant differences were determined between groups of participants obtained on the basis of nutritional status, a series of Post-Hoc Bonferroni tests were performed to determine between which groups significant statistical differences existed.

RESULTS

As shown in table 1, the sample was further grouped based on BMI reference values, and according to the percentile values into the following subsamples (as mentioned above): 1) ≤5 percentile- malnourished; 2) between 5 and 85 normally nourished, 3) between 85.01 and 95 overweight and 4) over 95.01 obese.

It can be seen from Table 1 that the malnourished part of the sample is represented by 10.64%; normally nourished 72.34%; overweight 9.57% and obese 7.44%. Furthermore, a somewhat clearer picture was obtained after dividing the total sample by gender. The values shown in table 1 indicated that the percentage of malnourished boys was 9.35%, normally nourished boys 71.03%, overweight 12.15%, and obese only 7.47%. When looking at the values for girls, we can see that malnourished girls is slightly higher than boys and amounted to 12.35%, normally nourished also slightly higher with some 74.07%, overweight 6.17% and obese almost the same 7.41%. This indicates that there are differences in the nutritional status between boys and girls, which will be further, more precisely determined by statistical analyses.

Table 1 Nutritional status for the sample

Nutritional status	Percentile BMI	Boys (kg/m^2)	Girls (kg/m^2)
Malnourished	<5	≤13.78 (N=10 – 9.35%)	≤13.50 (N=10 -12.35%)
Normally nourished	5-85	from 13.79 to 17.20 (N=76 – 71.03%)	from 13.51 to 17.40 (N=60 – 74.07%)
Overweight	85.01-95	from 17.21 to 18.80 (N=13 – 12.15%)	from 17.41 to 19.40 (N=5 – 6.17%)
Obese	≥95.01	≥18.81 (N=8 – 7.47%)	≥19.41 (N=6 – 7.41%)

By taking into account the values of the multivariate Wilks' F-distribution and its statistical significance in table 2, it can be concluded that the subsamples of boys and girls differ from each other in terms of average values in the entire sample of tested body composition variables. If the significant differences are analysed individually, it can be concluded on the basis of the univariate F-test and its significance that these differences

Table 2 Gender differences in body composition

Variable	Gender	AM	S	pKS	f	p
Muscle mass percentage (0.1 kg)	Boys	11.51	2.09	0.09	13.23	**0.00**
	Girls	10.38	2.09	0.06		
Body fat percentage (0.1 kg)	Boys	5.43	3.55	**0.00**	3.37	0.07
	Girls	6.47	4.17	**0.00**		
Body water percentage (0.1 kg)	Boys	15.95	2.69	**0.01**	4.08	**0.05**
	Girls	15.12	2.60	0.20		
F=10.02; p=**0.00**						

Legend: AM-Arithmetic Mean; S-Standard Deviation; pKS-The Kolmogorov-Smirnov Test Level of Statistical Significance; f-Univariate F-Test; p-Univariate F-Test Level of Statistical Significance; F-Multivariate Wilks' F-Test; P-Statistical Significance of the Multivariate Wilks' F-Test.

were observed in favour of boys in the variables *Muscle mass percentage*, and in the variable *Body water percentage*. By analysing the variable *Body fat percentage*, it can be said that girls have slightly higher values, but they were not significant.

By taking into consideration the significance of the Kolmogorov-Smirnov coefficient, it is possible to determine the deviation in the normal distribution of the following variables: *Body fat percentage* for both genders, and *Body Water Percentage* variable among the boys. The identified deviation of the distribution was expected considering age and body fat distribution, which differs by gender.

Table 3 Group differences in body composition

Variable	Gender	f	p	PT	P
Muscle mass percentage	Boys	0.11	0.95		
	Girls	0.55	0.65	0.66	0.75
Body fat percentage	Boys	1.18	0.32		
	Girls	**11.68**	**0.00**		
Body Water Percentage	Boys	0.22	0.88	**4.56**	**0.00**
	Girls	0.37	0.77		

Legend: f-Univariate f Test; p-Univariate F-Test Level of Statistical Significance; PT-Multivariate Pillai's Trace Test; P-Statistical Significance of the Multivariate Pillai's Trace Test.

From table 3, taking into account the values of the multivariate Pillai's Trace test, it can be concluded that there is no significant difference in levels of nutrition among the boys. There are also no significant differences within the subsample of boys. When looking at the girls' subsample, it can be concluded at the level of the multivariate Pillai's Trace test that there is a difference from the aspect of body composition. If the subsample is observed individually through variables, it can be noticed from the univariate F-test and its significance that the groups differ significantly in the variable *Body fat percentage*.

Table 4 Group differences in body composition for the girls' subsample

Variable	(I) Groups based on nutritional status	(J) Groups based on nutritional status	AM (I-J)	pBonf
Muscle mass percentage	Malnourished	Normally nourished	-0.63	1.000
		Overweight	0.31	1.000
		Obese	-0.76	1.000
	Normally nourished	Overweight	0.94	1.000
		Obese	-0.12	1.000
	Overweight	Obese	-1.07	1.000
Body fat percentage	Malnourished	Normally nourished	-0.51	1.000
		Overweight	-6.79	**0.00**
		Obese	-7.58	**0.00**
	Normally nourished	Overweight	-6.27	**0.00**
		Obese	-7.07	**0.00**
	Overweight	Obese	-0.79	1.000
Body Water Percentage	Malnourished	Normally nourished	-0.71	1.000
		Overweight	0.04	1.000
		Obese	-1.07	1.000
	Normally nourished	Overweight	0.75	1.000
		Obese	-0.36	1.000
	Overweight	Obese	-1.11	1.000

Legend: Group (I)-Groups Based on BMI; Group (J)-Groups Based on BMI; Differences in AM (I-J)-Differences in Arithmetic Mean Values; pBonf-Statistical Significance of the Bonferroni's Test at the Level of $p<0.0125$.

Furthermore, to find out where the groups differ in the above-mentioned variable, a series of Bonferroni Post-Hoc tests for the girls' subsample were performed.

Based on the results shown in table 4, the following difference was concluded between the pairs of groups: malnourished and high-risk overweight in favour of higher average values for high-risk overweight, and pairs of malnourished and obese groups in favour of higher average values for the obese group. Significant differences were also observed between the pairs of groups normally nourished and high-risk overweight, and the groups normally fed and obese in favour of higher average values for obese and high-risk obese. No significant differences are observed between the following pairs of groups: malnourished and normally nourished, nor between the groups obese and high-risk overweight when it comes to the subsample of girls.

DISCUSSION

Based on the research aim, this study first analysed the nutritional status of preschool children, followed by gender differences in body composition when their nutritional status was disregarded, and finally group differences within subsamples caused by the nutritional status for both genders. The total number of malnourished children is 10.64%, normally nourished 72.34%, high - risk overweight 9.57% and obese 7.44%. This fact indicates a relative distribution when it comes to this phenomenon, because the percentile values of normally nourished children in the total sample are at a satisfactory level. This can be compared first with the percentage of malnourished children, which is not so high due to the fact that one group of children in the sample is probably with higher average values of adipose tissue, and higher longitudinal skeletal dimensionality that will take dominance in this period of growth and development in order to produce an intense growth phase. Moreover, the data could not be fully associated with poor nutrition in the previous period of life, but this fact may be somewhat related to some seasonal variations and changes in food availability. Namely, today's children and their nutrition in this part of Europe do not deviate from the findings obtained in other developed countries, whereby at this age the developmental characteristics of children and very uneven periods of growth and development must be taken into consideration. The results fully correspond to the study that was done in Serbia in the Vojvodina region, which analysed the 10-year old age group and indicated a trend of increased body height and decreased body mass and BMI parameters (Pavlica, Rakić, & Sironjic, 2017), which may on the one hand be a consequence of migration in this region, but also of diet, lifestyle and certainly the amount of movement. It is well-known that this part of Serbia has always been in the lead in higher average BMI values for both genders (Radić, 2016), and therefore the population was classified as endomorphs from the aspect of the morphological type, which cannot be stated with certainty anymore, as new studies are required. On the other hand, around 17% of the total sample falls into two categories: high-risk overweight and obese. These findings can be considered a serious threat, because it should be borne in mind that the increase in childhood obesity worldwide and in Serbia is on the rise (Padez, Mourao, Moreira, & Rosado, 2005). Namely, a report (NCD Risk Factor Collaboration, 2016) indicates that 11 million young people aged 5 to 19 were obese, and in 2016, as many as 124 million young people were obese. Obesity is most prevalent on the islands of Polynesia, in the Pacific Ocean, where more than 30% of young people are obese. More than 20% of the children in the United States, the Middle East and

some countries in North Africa are obese. The same study conducted a year later showed that every third child in Serbia is obese, and the report states that the obesity rate in Serbia has increased by 60% in the last 20 years (NCD Risk Factor Collaboration, 2017). Hence, it is no wonder that physical inactivity was declared a risk factor by the World Health Organization (2000), in addition to hypertension and obesity (Pelemiš et al., 2015). After dividing the sample by gender, a somewhat clearer picture was obtained, which indicated that there were more malnourished girls compared to the subsample of males, normally nourished also slightly higher. There were fifty percent less high-risk overweight participants and the percentage of obese participants was almost the same. Such findings may indicate possible differences in nutritional status, or even better, a non-equivalent number classified by the degree of nutritional status, which is indicated by the percentage of high-risk overweight boys that is twice as high. The increased number of female children that are malnourished and a smaller number of high-risk overweight participants indicates that girls probably have lower average muscle mass percentage and uneven levels of adipose tissue. These differences may also indicate exogenous factors, i.e., physical activity of children within organizations (preschools, sports clubs), and endogenous factors, such as higher hormonal activity.

Furthermore, after analysing the gender differences of preschool children in terms of body composition when their values of nutritional status are disregarded, some significant differences can be noticed within the subsamples. It should be noted that it is very important, in an effort to explain the body constitution of children, the focus should be on age-related instability, as well as large differences in the process of child maturation (Longkumer, 2014). The life habits of preschool children can determine the quality of their lives at this age, which will be reflected in the further overall personality development. This relationship can also be a consequence of various socio-economic factors (Pelemiš, Branković, & Banović, 2016). The increase in muscle mass in boys compared to girls may be associated with the behavioural component. This is due to the fact that the girls engage in less physical activity, that is, they engage in those types of physical activities that do not require very dynamic movements. Preschool boys engage in more physical activity, spend more energy and have less subcutaneous adipose tissue, i.e., more muscle tissue (Bailey, 2006), which is confirmed by this research. The resulting gender differences may also be influenced by factors that were not controlled, such as hereditary factors, diet, socioeconomic status, etc. Even some much earlier studies have shown that boys and girls differ in body height when they are three and a half, five and six and a half years old, where boys are slightly taller and with a higher muscle mass percentage (Bala, Jakšić & Popović, 2009). Similar findings were presented by a group of authors (Božić-Krstić, Rakić, & Pavlica, 2003; Veselinović, Milenković, & Jorgić, 2009) who state that preschool boys, in addition to being taller, also have higher upper arm and forearm measurements, and body weight, which in some cases is reflected as a higher body volume (Pelemiš, Macura, & Branković, 2017). Girls had a higher total body fat percentage during this period of development, although there was no significant difference between the genders (5.43 kg boys compared to 6.47 kg girls). Body fat percentage in girls increases during adolescence, when it doubles compared to boys, and boys gain much more muscle tissue. At that moment girls are in the lead in regard to the increase of fat-free body mass (Malina, Bouchard, & Bar-Or, 2004). Differences in body weight between boys and girls are also obvious, although they are not significant, as confirmed by the much earlier research results of Boot, Bouquet, Krenning, & de Muinck Keizer-Schram (1998).

Therefore, there are no significant changes in the subsamples when it comes to growth and development. It can be stated that growth and development occur at an even pace for

both boys and girls in this period, and that girls are slightly lighter, but with higher average values of total body fat percentage, which indicates instability in terms of adipose tissue. Upon further analysis of the research results, the subsample of girls differs in body composition at different levels of nutrition. Namely, girls who are classified as high-risk overweight and obese based on their nutritional status had more body fat than malnourished and normally nourished, which could have been expected. This phenomenon is a direct consequence of instability in the total amount of body fat percentage in girls. This can be explained by the fact that adipose tissue, which otherwise acts as a ballast when it comes to mobility, cannot always be considered useless. Namely, adipose tissue in this developmental period indicates earlier entry into the pre-pubertal phase. This is explained by the fact that the cells are filled with fat, which in this case serves as fuel so that bone growth in length would be fast and efficient. It should be noted that the structure of fat cells in children of this age consists of multinucleated smaller cells until growth and development stops, so it is natural that they break-up easier and faster, while with the cessation of growth and development this structure changes into mononuclear fat cells which are larger, and much more difficult to break down, and grow much faster (Stamatović, Šekeljić, Martinović, & Pelemiš, 2019). Therefore, adipose tissue cells are the only ones that continue to grow even after the end of human growth and development.

CONCLUSION

The value of this study is reflected in the initial evaluation of the nutritional status of preschool children, which provided a starting point for tracking their growth and development. These results obtained by the transverse cross-section of the research will change significantly in the next six months to a year. Namely, it is clear that due to the instability of the total amount of body fat percentage in girls, and reduced values of body weight and BMI compared to boys, and almost the same values of body height, girls enter the pre-pubertal phase characterized by longitudinal bone growth in length and an increase in average values of longitudinal skeletal dimensionality. That developmental period for boys can be expected in some six months to a year. The findings obtained by this research indicate that almost 17% of the total sample of high-risk overweight and obese participants can be considered alarming given the fact that this trend is on the rise world-wide and in our country. Such occurrences could be regulated by moderate motor activities, which from the aspect of biotic motor knowledge could now be upgraded to more intense forms of sports training. National strategy and activities aimed to raise awareness of the impact of physical inactivity would be crucial. The authors recommend constant monitoring of the nutritional status and physical abilities of children for six months to a year, and planning of various forms of kinesiology treatments that would be in accordance with the obtained research findings.

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TELESNA KOMPOZICIJA I STATUS UHRANJENOSTI PREDŠKOLSKE DECE

Cilj istraživanja bio je da se utvrdi postojanje polnih razlika u određenim parametrima telesne kompozicije koje su uzrokovane stanjem uhranjenosti dece predškolskog uzrasta, te grupne razlike unutar subuzoraka prouzrokavane njihovim stanjem uhranjenosti za oba pola. Ukupan uzorak sačinjavalo je 188 ispitanika sa prosečnim vrednostima telesne visine TV=124.59cm±5.76 i telesne mase TM=24.32kg±3.11, prosečnog uzrasta 6.39±0.44 godina, podeljenih po polu na dva subuzorka i to: dečaka (n=107) i devojčica (n=81) iz Beograda. Telesna kompozicija procenjena je pomoću bioelektrične impendance, uređajem InBody 230. Izračunati su glavni parametri deskriptivne statistike. Metoda MANOVA korišćena je za utvrđivanje razlika po polu u celom uzorku, dok je metoda ANOVA korišćena za utvrđivanje individualnih razlika. Izvršena je serija Post-Hoc Bonferroni testova kako bi se utvrdilo između kojih grupa postoje značajne statističke razlike. Ova studija daje ohrabrujuće rezultate tj., zadovoljavajući postotak normalno uhranjene dece oba pola, ali isto tako ukazuje na izvesni trend u rastu rizično gojazne i gojazne dece od skoro 17% ukupnog uzorka. Grupne razlike za subuzorak devojčica ukazuju na mogućnost bržeg ulaska u predpubertetsku fazu, utvrđenu na osnovu različitosti količine masnog tkiva u organizmu, ali i veće količine mišićne mase u subuzorku dečaka, te manjih prosečnih vrednosti telesne mase i indeksa telesne mase u subuzorku devojčica. Preporučuje se stalni monitoring stanja uhranjenosti i fizičkih sposobnosti dece na periode od šest meseci do godinu dana.

Ključne reči: *indeks telesne mase, kompozicija tela, polne i grupne razlike, predškolski uzrast*