

THE IMPACT OF NUTRITIONAL STATUS ON GROWTH AND ANTHROPOMETRIC PARAMETERS IN CHILDREN

Biljana Trpkovska¹, Biljana Zafirova¹, Niki Matveeva¹, Elizabeta Cadikovska¹,
Biljana Bojadzieva¹, Jovana Kordovska¹, Violeta Klisarova², Emilija Antova³,
Anita Hristova Dimceva⁴, Toni Krstev⁵

¹Institute of Anatomy, Faculty of Medicine, Ss. Cyril and Methodius University in Skopje, North Macedonia,

²Clinic for Oncology and Radiotherapy, Faculty of Medicine, Ss. Cyril and Methodius University in Skopje, North Macedonia,

³Clinic for Cardiovascular Diseases, Faculty of Medicine, Ss. Cyril and Methodius University in Skopje, North Macedonia,

⁴Institute for Transfusional Medicine, Faculty of Medicine, Ss. Cyril and Methodius University in Skopje, North Macedonia,

⁵Clinical Hospital 8th Septemvri, Skopje, North Macedonia

Abstract

Evaluation of sex-specific differences of anthropometric parameters as impact of growth and nutritional status in preschool children from Macedonian nationality.

The study included a total of 200 healthy 5-5.99 years-old preschool children from Macedonian nationality. Twelve anthropometric parameters were measured, defining longitudinal, circular and transversal dimensionality of the skeleton using standard technique and instruments for measurement. The following indices were selected and calculated: weight-for-age; height-for-age and BMI. Skin folds (triceps, scapula and thigh) were also measured.

Sex-specific differences for almost all anthropometric parameters were detected, but they were not significant. Boys showed higher values than girls regarding height, weight but for BMI were not significant. Values at the 50th percentile in boys were 20 kg for BW, 113.2 cm for BH and 15.94 kg/m². The values of these parameters in girls were 20 kg for BW, 115.4 cm for BH and 15.64 for kg/m² for BMI.

The values for skin fold for biceps were higher in boys (10.6. ± 3.9) instead of girls (9.7 ± 3.3).

The results obtained can be used for criteria for assessment and detecting deviations in growth and nutritional status in preschool children.

Key words: anthropometry, growth, nutritional status, preschool children.

Introduction

Growth is a critical indicator of a child's overall health and development. It is often assessed using anthropometric parameters such as height, weight, and body mass index (BMI), which provide valuable insights into the child's nutritional status. Adequate nutrition during childhood plays a pivotal role in supporting optimal growth, ensuring proper physical and cognitive development [1].

Poor nutritional status, whether due to under nutrition or over nutrition, can lead to deviations in these anthropometric parameters. For instance, under nutrition may result in stunted growth or low weight-for-age, while over nutrition can lead to overweight or obesity.

Monitoring these parameters regularly helps identify potential health risks early and informs interventions aimed at improving the nutritional status of children.

Obesity in preschool children has become a growing public health concern worldwide. Proper nutrition during these early years is crucial, as it lays the foundation for healthy growth and lifelong habits. Preschool children who are obese face an increased risk of developing chronic conditions such as diabetes, cardiovascular diseases, and joint problems later in life. [2].

Therefore, it is necessary to determine the nutritional status of the populations groups and individuals which is a result of their dietary patterns and utilization nutrients in the metabolic processes. That is why childhood is a very sensitive period of growth, development and maturation when numerous changes happen in the organism. Monitoring and evaluation of growth and development in this period is very important [3]

Current knowledge points out to an increasing rate of risk factors for onset of non-communicable diseases in the developed and underdeveloped countries, where it is necessary to undertake preventive measurements in early preschool age.

The estimation of the child's growth, detection of underweight and/or overweight and obesity is possible according to the standards of the WHO, which show the directions on the children normal growth. They show that children born in different regions have potential to grow and develop in equal span for height and weight for that age [4].

These directions on children growth offer a new prospective period, and not only a descriptive one. Anthropologic examinations, being non-invasive, simple, easy adaptable to children's age, enable monitoring of the dynamics of child's growth and also indicate disorders in the nutritional status during this preschool period. Longitudinal, circular and transversal dimensionality of the skeleton might be defined by measuring the adequate anthropometric parameters [5].

Evaluation of sex-specific differences in anthropometric parameters as indicators of growth and nutritional status in preschool children of Macedonian nationality.

Subjects and methods

Healthy preschool children of both sexes of Macedonian nationality were included in the study. The total number of subjects (n=200) was divided into two groups based on sex criterion, boys (n=100) and girls (n=100).

Twelve anthropometric parameters were measured according to the guidelines of the International Biological Programme (IBP), such as body weight, longitudinal dimensions: body height, length of the arm, length of the leg; circular dimensions of the skeleton: head circumference, chest circumference, mid-upper arm circumference, forearm circumference, thigh circumference and calf circumference; transversal dimensions of the elbow and knee and skin-folds of biceps, scapula and thigh). Standard anthropometric instruments were used (anthropometer by Martin, calliper square, elastic plastic band and medical decimal scales).

The following indices were selected and calculated: weight-for-age, height-for-age and BMI (body mass index). Data obtained were analyzed with descriptive statistics presented with measures of central tendency and its deviations (arithmetic standard values and standard deviation) as well as with ranges (percentiles).

Results

Mean values and standard deviations of the examined anthropometric parameters in preschool children aged 5-5.99 of Macedonian nationality are presented in Table 1 and Table 2.

Table 1 lists mean values and standard deviations of the following parameters: weight, height, BMI, length of the extremities (arms and legs) and circumferences of the head, chest, upper arm and forearm. Body weight of the boys was 21.53 ± 3.49 , height 114.76 ± 6.27 and BMI $16.30 \pm 1.97 \text{ kg/m}^2$.

Girls had the following values for the same parameters: weight $21.96 \pm 3.63 \text{ kg}$, height $114.7 \pm 6.21 \text{ cm}$ and $16.61 \pm 2.0 \text{ kg/m}^2$ for BMI.

Girls showed slightly higher values for weight and height instead of boys. There was no significant difference between the examined parameters except for circular parameters (mid-upper arm $16.35 \text{ cm} \pm 1.69$ and thigh circumference $28.19 \text{ cm} \pm 3.75$) where the significant difference was in favor of girls.

There was also a difference in the skin folds. The skin-fold of biceps was higher in boys ($10.56 \text{ mm} \pm 3.74$); and skin fold of scapula showed higher values in girls ($9.42 \text{ mm} \pm 2.76$). Table 2.

Sex-specific percentiles for the indices weight-for-age, height-for-age and BMI for preschool children from Macedonian nationality are shown in Table 3.

Table 1. Body weight, body height, BMI, lengths and circumferences of the extremities in pre-school children of 5-59 years (mean and standard deviation).

Sex	n	Body weight (kg)	Body height (cm)	BMI (kg/m ²)	Lengths (cm)			Circumferences (cm)		
					Arm	Leg	Chest	Head	Upper arm	Upper leg
B	100	21.53 ± 3.49	114.76 ± 6.27	16.30 ± 1.97	45.40 ± 3.25	58.78 ± 5.62	55.14 ± 5.08	49.51 ± 2.21	15.91 ± 1.68	27.98 ± 3.68
G	100	21.96 ± 3.63	114.7 ± 6.21	16.61 ± 2.0	44.43 ± 3.03	58.82 ± 5.72	54.79 ± 5.78	49.73 ± 2.49	16.35 ± 1.69	28.19 ± 3.75

Table 2. Values of skin-folds in pre-school children of macedonian nationality

	<i>biceps</i>	<i>scapula</i>	<i>thigh</i>
Boys	10.56 ± 3.74	9.18 ± 2.81	13.31 ± 3.10
X ± SD			
Girls	10.48 ± 3.80	9.42 ± 2.76	13.57 ± 3.08
X ± SD			

Table 3. Sex-specific percentiles of the indexes: weight-for-age, height-for-age and BMI in children

	PERCENTILES								
BOYS	5	10	15	25	50	75	85	90	95
Weight-for-age	14	15.9	16	17	20	21	24	24	25
Height-for-age	94.91	96.7	98.97	101	107.1	111.15	112.5	113	114.63
BMI	13.72	14.68	15.11	15.91	16.68	18.63	19.55	21.57	22.46
GIRLS									
Weight-for-age	14.95	15	16	17.75	20	24	26	27	28
Height-for-age	95.9	98.45	100.43	105.75	110	115	117.2	120.05	122.62
BMI	14.12	14.37	14.57	15.26	16.28	17.82	19.34	20.67	20.84

Borderline values for (5th and 90th percentile) in girls were 95.9 cm (5th percentile) and 120.05cm (90th percentile) for height-for-age, 14.95 and 27 kg for weight-for-age and 14.12 and 20.67 kg/m² for BMI. Boys had the following values for the same parameters: 94.91 cm (5th percentile) and 113 cm (90th percentile) for height-for-age; 14 and 24 kg for weight-for-age and 13.72 and 21.57 kg/m² for BMI.

In Table 4 values for thigh circumference, and skin-folds for triceps and scapula are shown.

Table 4. Percentile values for thigh circumference and skin-folds in preschool children aged 5-5.99.

	PERCENTILES								
BOYS	5	10	15	25	50	75	85	90	95
Thigh circumf	22	23.9	24	25	27	28.5	30	30	31
Scapula	5.5	6.0	6.0	6.0	8.0	10	11	12	14
Triceps	7.0	7.2	8.0	9.2	12	14.0	16.0	17.10	18.0
GIRLS									
Thigh circumf	21	23	24	24.5	26.25	30.25	32.5	34.08	35.43
Scapula	5.77	6.95	7.0	8.0	9.0	11.0	12.0	12.20	14.0
Triceps	8.52	9.0	10.0	10.0	12.0	16.0	17.0	18.0	18.0

Discussion

The examined anthropometric parameters in our study define longitudinal and circular dimensionality of the skeleton and are used for assessment of growth and nutritional status in preschool children. It was discovered that mean values of almost all examined anthropometric parameters were higher in girls.

More significant differences were observed in circumferences of the extremities, particularly the mid-upper arm circumference and the thigh circumference that were higher in girls. Some percentile ranges of the anthropometric parameters were calculated in preschool children aged 5 from Albanian nationality.

Data obtained were compared with similar anthropometric studies conducted in children from other populations that were insignificantly higher than the values obtained in NCHS, WHO and CDC [5-6].

Longitudinal parameters are considered to be the most reliable indices of the physical growth in children, and circular parameters along with body weight indicate the body volume, that is its mass. Body weight as parameter of its own is a very weak indicator for assessment of overweight and does not correspond with the reference curve for assessment of weight-for-height indices. BMI (body mass index)

or index for weight/height² is very popular for assessment of obesity or overweight in adults for many years, but it has been recently used in preschool population.

The importance of the most stable anthropometric parameters, the basic being body weight and body height, has been used in very different forms such as indices for presenting the growth and nutritional status in preschool children.[7].

The height-for-age children shows the linear growth and the deviation in its values, which is being detected at the 5th percentile as a borderline value is aimed at discovering children with obstacles in the linear growth as a result of misbalanced nutrition. [8].

Our values for 50th percentile for indices weight-for-age and height-for-age were in girls 20 kg and 110 cm, and 20 kg and 107.1 cm in boys. The values of body weight and height in children aged 5 from Macedonian nationality were higher than children at the same aged from other nationality. These values were slightly higher than those found in the NCHS reference population as well as those reported by the WHO for the same age.

Values above the 85th and 95th percentile are useful in detecting children at risk of obesity [9]. The index of body mass, is a good indicator that monitors the degree of body mass, it is easily calculated and the result obtained is use their long term health outcomes for assessment of children who are obese, overweight underweight or with normal weight. [10,11].

Values above 50th percentile in our children were slightly lower, than those found in children from Canada, and slightly higher in children from Great Britain and Brazil [14,15,17].

The obtained differences between the children from Macedonian nationality in our study and other studies and with reference to the standard values have shown the existence of population differences in anthropometric parameters that depend on many factors (external and internal).

It is necessary to comply with the WHO recommendations that stress the necessity for each country to prepare its own anthropometric standards that are indispensable for classification and detection of growth and development disorders as well as nutritional status in children population [12-13,16,18].

Conclusion

Girls have shown slightly higher values for body weight and height than boys, particularly in circular parameters such as the mid-upper arm circumference and the thigh circumference.

There were no other significant statistical differences. Combining proper nutrition with regular physical activity is key to maintaining a healthy weight and promoting overall well-being in preschool children.

Early intervention and guidance can significantly impact Overweight and obesity have become a matter of growing concern. Monitoring their trends can help in creating criteria for normal growth and development, as well as assessment for nutritional status in preschool children aged 5 from Macedonian nationality.

References:

1. Martorell R, ML Hughes and Grummer-Strawn LM. Overweight and obesity in preschool children from developing countries. *International Journal of Obesity* 2000; 24: 959-967.
2. Fomon SJ, Haschke F, Ziegler EE. Body composition of reference children from birth to age 10 years. *Am J Clin Nutr* 1982; 35:1169-75.
3. Dimitrovska Z, Kendrovski V, Ristovska G at el. *Nutritional Antropometry* 2nd ed. Skopje: Republic Institute of Health Protection; 2006.
4. Mercedes de Onis, Habicht JP. Anthropometric reference data for international use: recommendation from a WHO Expert Committee. *Am J Clin Nutr* 1996; 64(4): 650-8.
5. Zafirova B, Todorovska L. Anthropometric parameters of growth and nutritional status in children aged 6 to 7 years in R. Macedonia. *Advances in Medical Science* 2009; Vol.54 (2):289-295.

6. Peinado Doris Maritza, Bedrinana Jorge Isaac. Comparison of NCHS -1977, CDC-2000 and WHO-2006 Nutritional Classification in 32 to 60 month-old children in the central highlands of Peru (1992-2007). *Universal J of Public Health* 2013; 3:143-149.
7. M Flegal Katherine, Carrol D Margaret, Ogden L Cynthia. Effects of trimming weight-for-height data on growth chart percentiles. *Am J Clin Nutr* 2012; 96: 1051-5.
8. Rong Wei, Katherine Flegal and Cynthia Ogden. Weight-for-stature compared with body mass index-for-age growth charts for the USA from CDC and prevention. *Am J Clin Nutr* 2002; 75:761-766.
9. Cole TJ, JV Freeman, Preece MA. Body mass index reference curves for the UK, 1990. *Archives of Disease in Childhood* 1995; 73: 25-29.
10. De Onis M, Blossner M. Prevalence and overweight among preschool children in developing countries. *Am J Clin Nutr*. 2000; 72(4): 1032-9.
11. Guiliche CastaÑeda RB, Turpo-Chaparro J, Torres JH, Saintila J, Ruiz Mamani PG. Overweight and Obesity, Body Fat, Waist Circumference, and Anemia in Peruvian University Students: A Cross-Sectional Study. *J Nutr Metab*. 2021 Dec 8;2021:5049037.
12. Marcelle M.M. Maia, Maria A Fausto, Erica L. M. Vieira et al. The prevalence of malnutrition and risk factors in children attending outpatient clinics in the city of Manaus, Amazonas, Brazil. *Archivos Latinoamericanos De Nutricion* 2008; (58): 1-8.
13. Child Growth Charts in the Northern Territory, Discussion Paper, Consideration of the 2006 WHO growth standards. www.nt.gov.au/health.
14. Trpkovska B. Criteria for detection and classification of growth and nutritional status in children 2-5 years old in R. Macedonia; 2015.
15. Onur Cirak, Haci Omer Yilmaz et al. Nutritional factors in etiology of childhood obesity. *Gen. Med. Open* 2018, vol 2 (4);1-5.
16. Qazi Iqbal Ahmad et al. Childhood obesity. *IJEM* 2010;14(1);19:25.
17. Bussiek PV, De Poli C et al. A scoping review protocol to map the evidence on interventions to prevent overweight and obesity in children. *BMJ Open* 2018, 293:311.
18. Trpkovska. B.et al. Childhood obesity in macedonian preschool children, prevalence and prevention. *journal of morphological sciences*, Vol 5(2):79-90.