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Characteristics of the basic anthropometric features in children of preschool age (3-6 years) from Smolyan region, Bulgaria

Silviya Mladenova

University at Plovdiv "Paisii Hilendarski", Branch – Smolyan

*Corresponding author e-mail: silviamladenova.sm@uni-plovdiv.bg

The aim of the present study is to make characteristic of the basic anthropometric features for evaluation of the physical development of contemporary generation preschool children from Smolyan region, Bulgaria in age and gender aspects. A transversal anthropometric study of 330 children from both sexes aged between 3 to 6 years from state kindergartens of Smolyan district, Bulgaria was performed in the period 2017-2019. Height, weight, chest circumference and head circumferences of each child have been measured. The results show unevenness, heterochrony and gender dimorphism both in relation to the absolute values of the indicators and in relation to the rate and reached growth velocity and confirm the general biological regularities of growth in this age period. The observed specific peculiarities in the growth processes are a reflection of the influence of hereditary and environmental factors, operating in the studied population.

Key words: preschool children, height, weight, chest and head circumferences

Introduction

It is known that the different stages in ontogenesis are real reflection of the chain of events in the process of individual growth and development. Each of these stages is characterized by unique and specific combination of biological features which are influenced by a complex of various environmental and genetic factors. The influence of these factors changes during different ages [3, 6, 7, 8, 9, 11, 19, 22], but are especialy more pronounced in early childhood [2, 5, 10, 17, 25, 26]. The genetic and environmental influences manifest themselves by morphometric differences in basic anthropometric features, like as height, weight, body diameters, circumferences, body segments andproportions [5, 6, 16, 20, 24, 28],body composition, fat mass and nutritional status [1, 12, 27, 29, 30], different growth velocity and gender differences [13, 15, 27].

The **purpose** of the present study is to characterize of the basic anthropometric features for evaluation of the physical development such as height, weight, chest and head circumferences of preschool children between 3-6 years of age from Smolyan region, Bulgaria in age and gender aspects.

Materials and Methods:

A transversal anthropometric study of 330 children (161 boys and 169 girls), aged between 3-6 years from eight state kindergartens of Smolyan district, Bulgaria was performed in the period 2017-2019. The average age of the children is 3.5, 4.5, 5.5 and 6.5 years. For example, 4-years old are considered the children at age 4.0 years to 4.99 years (**Table 1**).

Table 1. Characteristics of the sample by age and sex

Age (years)	**Sample A (2017-2019) Number**		
	Boys	**Girls**	**All**
3 y.	23	28	51
4 y.	36	44	80
5 y.	49	53	102
6 y.	53	44	97
Total	**161**	**169**	**330**

All studied children are clinically healthy and are of Bulgarian origin. They were examined during their morning classes in kindergartens.

All ethical principles for medical research involving human subjects according Declaration of Helsinki have been adhered [23]. The design of the study has been approved by the Regional Inspectorate of Education of the Bulgarian Ministry of Education and Science in Smolyan and by the Ethics Committee of Filial Smolyan at Plovdiv University. The informed written consent was obtained from parents of all children participating in the study.

Four main indicators for physical development have been measured for each child, as per the methods of Martin-Saller[4]: height (cm), weight (kg), chest circumference and head circumference (cm). The height is measured by original anthropometer GPM (Siber-Hegner Company, Swiss), with a precision up to 0.1cm, and the weight by body composition scale analyzer Tanita BC 465 (Tanita, Japan), with precision up to 0.100 g. The chest and head circumferences were measured by a millimeters band with a precision up to 0.1 cm. The differences in average values in investigated features between both sexes and absolute year increament were calculated. Also the growth velocity (%) was calculated by the relevant formula: $(X_2-X_1)\ x100)/(X_2+X_1)$, where X_2 is the mean value of a feature for the given age and the X_1 is the mean value of the same feature for the previous age.

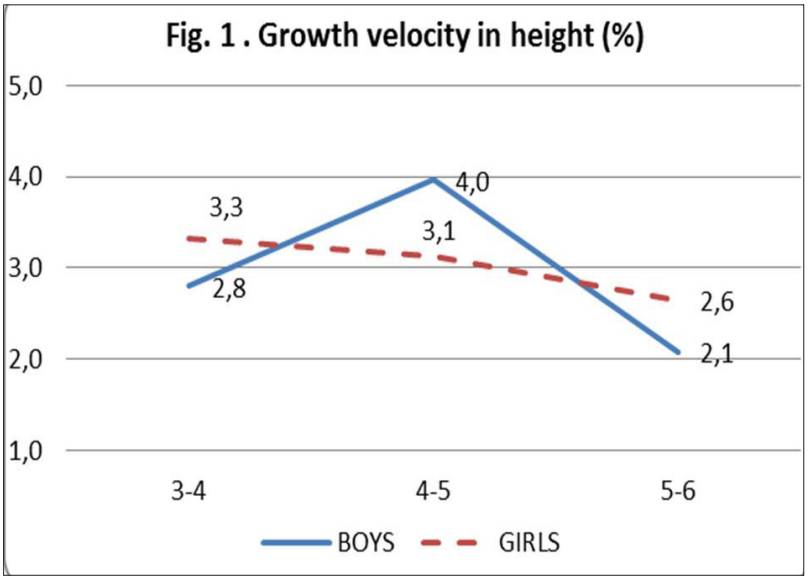
The data have been processed through statistical software suite Statistica 12.0 (StatSoft Inc.), by using analysis of variance. The differences between age and sex groups were evaluated by Student's T-test, with level of significance of $p \leq 0.05$.

Results

The basic statistical characteristics of the height, weight, chest and head circumferences at preschool age Smolyan children are presented in **Table 2**. The growth velocity (%) and inter-sex differences are presented in **Figures 1-5**.

According to the acquired results, **the height** of the present generation of children in preschool age is intensively increasing in both genders (**Table 2**). The average height of the **girls** at age of 3 years is 98.6 ± 4.6 cm. Until they reach to age of 6 years, the height is increased with totally 19.7 cm and reaches value of 118.3 ±4.7 cm. The absolute year increment is between 6.1 and 6.8 cm per year. The growth velocity varies from 2.6% - 3.3%, and for the girls, it is highest in the period between 3-4 years (**Fig. 1**).

For **boys** at age of 3 years, the average height is 100.8 ± 5.9 cm, where it is intensively increasing and reaches values of 120.3 ± 5.7 cm at age of 6 years. The average annual growth in height is intensive during the entire period and the highest values are observed at age between 4 and 5 years, where the height is increased, on average, by 8.8 cm. The growth velocity for the boys varies from 2.1% to 4%, and it is highest at age between 4-5 years. The high growth velocity decrease for both genders at age between 5-6 years (**Fig. 1**).



During the entire studied growth period, the boys are taller than the girls, where the difference in the height are smallest during the 4th year (1.2 cm), and largest, and statistically significant among the children at age of 5 years, where the difference goes up to 3.2 cm in favour of the boys ($p \leq 0.05$) (**Fig. 5**).

In relation to **body weight** (**Table 2**) the results show that at age of 3 years the weight of the girls is 15.7 ± 2.1 kg, and the boys is 16.1 ± 2.1 kg. The weight is intensively growing during the studied period, where for the boys at age of 6 years, it reaches average values of 24.3 ± 6.2 kg, and for the girls, 25.2 ± 7.0 kg. The absolute

Table 2. Statistical characteristics of basic anthropometric measurements in 3-6-year old children

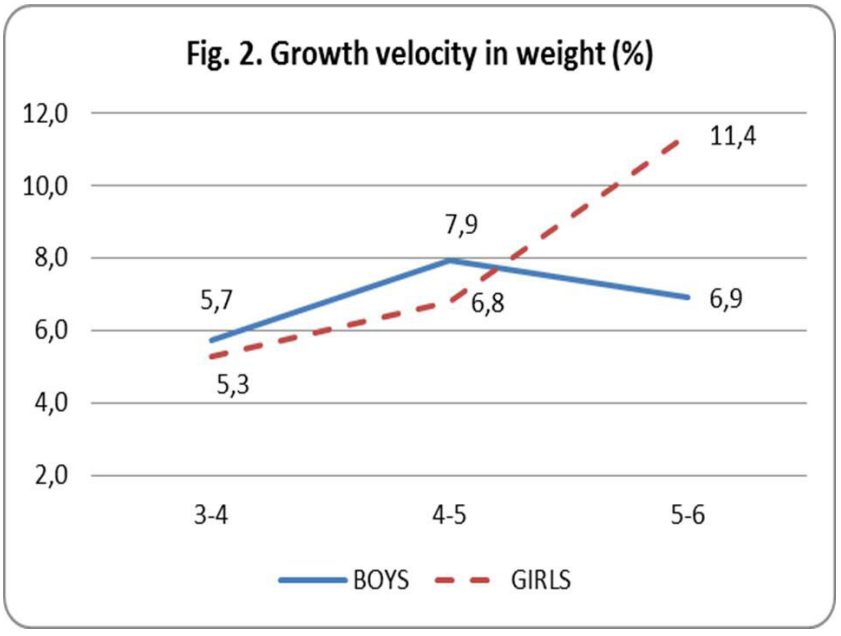
	BOYS			GIRLS					
age (years)	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**Differ. ♂/♀ (absolute values)**	**T-Student ♂/♀**	**p-level ♂/♀**
Height (cm)									
3 y.	23	100.8	5.92	28	98.63	4.79	2.2	1.49	0.142
4 y.	36	106.6	3.94	44	105.4	5.50	1.2	1.06	0.290
5 y.	49	115.4	4.16	53	112.2	5.68	3.2*	3.13	0.002*
6 y.	53	120.3	5.69	44	118.3	4.65	2.0	0.80	0.424
Weight (kg)									
3 y.	23	16.10	2.13	28	15.73	2.08	0.37	0.56	0.573
4 y.	36	18.05	2.39	44	17.48	3.68	0.57	0.80	0.423
5 y.	49	21.16	3.37	53	20.03	4.03	1.13*	2.23	0.027*
6 y.	53	24.31	6.15	44	25.19	7.03	- 0.88	0.65	0.511
Chest circumference (cm)									
3 y.	23	52.53	2.71	28	52.40	1.85	0.13	0.17	0.859
4 y.	36	54.51	2.63	44	52.87	3.75	1.64*	2.21	0.029*
5 y.	49	57.02	3.48	53	54.12	5.96	2.90*	2.95	0.003*
6 y.	53	58.08	3.76	44	58.96	7.45	- 0.88	0.73	0.465
Head circumference (cm)									
3 y.	23	50.26	1.41	28	49.80	1.32	0.46	1.18	0.243
4 y.	36	51.11	2.10	44	50.34	2.29	0.77	1.55	0.124
5 y.	49	51.57	1.47	53	50.64	1.25	0.93*	3.01	0.003*
6 y.	53	52.22	3.76	44	51.52	1.34	0.70*	2.36	0.019*

Note: N – number of investigated persons; Mean – average values; SD – standard deviation; Diff. – differences between both sexes T-Student ♂/♀ – values of criteria of Student test; $p<0.05$* – statistical significance on differences between both sexes.

year increment in the weight for boys varies, average by 2.0 to 3.2 kg, while for the girls varies from 1.8 kg to 5.2 kg. Generally, for the monitored preschool period, the girls grow in weight averagely by 9.5 kg and the boys by 8.2 kg.

The growth velocity of the weight for boys is highest at the age between 4-5 years, when it reaches 7.9%. For the girls, the growth velocity of the body mass is close to that for the boys up to age of 5 years, than it sharply increases and reaches values of 11.4% at age between 5-6 years (**Fig. 2**).

In relation to gender differences, the boys are heavier compared to the girls at same age in the period between 3 to 5 years, where the gender differences have statistical significance only among the children at age of 5 years ($p\leq0.05$). During the 6 year



of their growth, the girls are insignificantly heavier than the boys, which is a result in the jump of body mass accumulation in the period between 5-6 years as well as to significantly higher weight growth speed for girls during that period (**Fig. 5**).

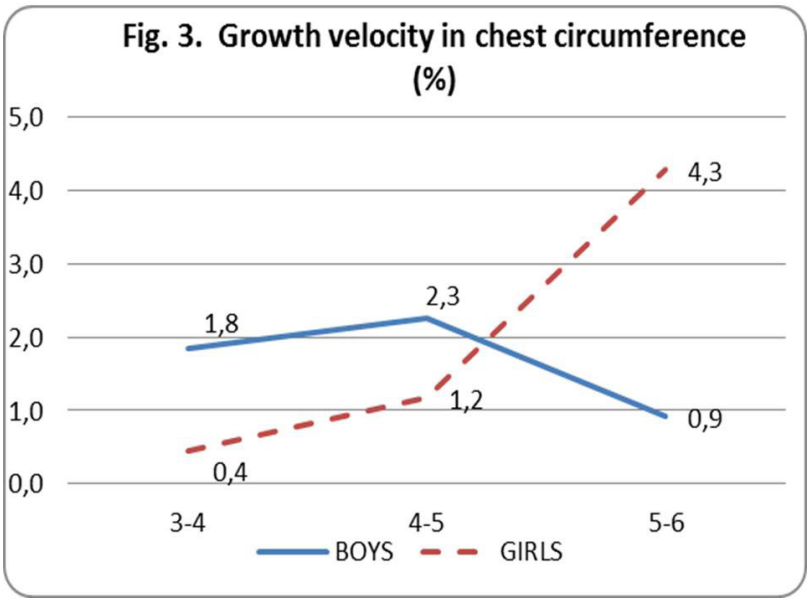
Chest circumference (**Table 2**) is the third main anthropometric indicator, which is used for evaluation of the healthy physical development of the individual in epidemiological studies. Our results show that at age of 3 years, the average chest circumference for boys is 52.5 ± 2.7 cm and for girls it is 52.4±1.9 cm, where at age of 6 years, it reaches values of 58.1 ± 3.8 cm for the boys and respectively, 59.0±7.5 cm for the girls. Generally, the chest circumference increase by 5.55 cm for boys and by 6.56 cm for girls for the period from 3 to 6 years of age.

For the boys the average year increment of the chest circumference increases between 1.1cm to 2.5 cm, while the growth velocity is highest at age 4-5 years (2.3%) and lowest, respectively, at age between 5-6 years (0.9%).

For the girls, the average year increment of the chest circumference is rather uneven – between 0.5 to 4.8 cm, where the growth velocity varies between 0.4 % for age 3-4 years up to 4.3% for age 5-6 years (**Fig. 3**).

In inter-sex aspect, the boys are with larger chest circumference in comparison to the girls during the age between 3 to 5 years, where the differences have statistical significance among the children at age of 4 and 5 years ($p<0.05$). But during the 6th year, the girls insignificantly outrun the boys in terms of that indicator, which is related to the higher average year increment and to the higher growth velocity for the girls in that period (**Fig. 5**).

The **head circumference** (**Table 2**) is the other very important anthropometric indicator for evaluation of the physical development of children.The head circumference of the studied boys at age of 3 years is with average value of 50.3 ± 1.4 cm and for the girls at age of 3 years, respectively 49.8 ± 1.3 cm. For both genders, this indicator grows



with the age, where at age of 6 years for the boys, it reaches average values of 52.2 ± 3.8 cm and for the girls – 51.5 ± 1.3 cm.

In relation to the average year increment, the most intensive increase of the head circumference for the boys is observed at age between 3-4 years (0.9 cm), and the highest growth velocity during the same period is observed as well – respectively 0.8% (**Fig. 4**).

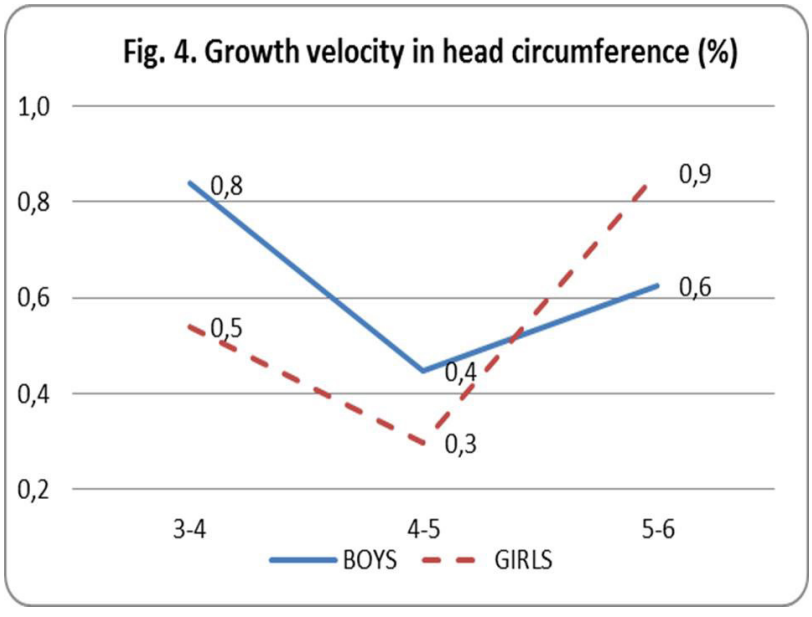
For the girls, the highest average year increment of the head circumference is observed at age between 5-6 years, which corresponds to the highest growth velocity of the indicator (0.9%) (**Fig. 4**). During the remaining age periods, the head circumference grows with slower rate for both genders, which is characteristic for the head features, and as a result of that, the growth of the head circumference for the entire period for the boys is with average total value of 1.96 cm and for the girls 1.72 cm.

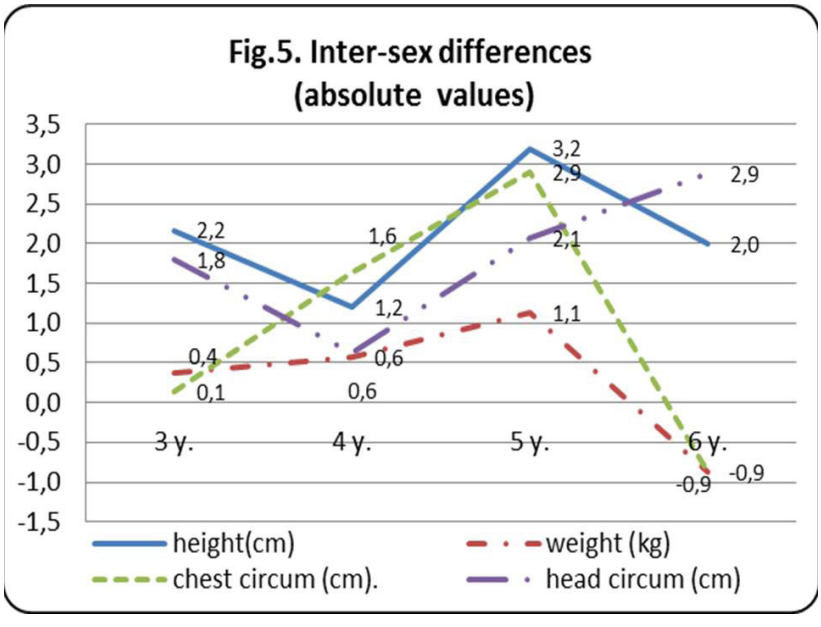
In inter-gender aspect, the boys are with larger head circumference compared to the girls for the entire studied period, where the differences are largest and statistically significant among the children at age between 5 and 6 years ($p \leq 0.05$) (**Fig. 5**).

Discussion

In this work we present, for the first time, new data of growth of the height, weight, chest and head circumferences of today preschool children from Smolyan region, Bulgaria at age between 3-6 years.

Investigated children in this study are in average age of 3.5, 4.5, 5.5 and 6.5 years. For example, as we write in section Materials, 4 years old children are considered the children at age 4.0 years to 4.99 years. We used this age grouping to be able to make a correct comparison with similar data of other Bulgarian preschool children who are group in the same way [30]. In contrast, in our previous publications we used an age group according to which, for example, 4-year-olds are children aged 3.5 to 4.49 [9]. The age





grouping of the data, as well as the few similar data for Bulgarian children in this age period are limiting factors in this study which limited our possibility for comparison of data. The only possible comparison at this stage was with similar data for Sofia city of Zhecheva, Yankova [30], due to the identical research methodology and age grouping.

Anthropometric data on different physical characteristics of children and the dynamics of their growth in preschool age were published earlier by other Bulgarian authors. They mainly affect children from the capital Sofia, Plovdiv and some other

towns in Bulgaria [5, 10, 13,14, 15, 16, 18, 20, 21, 24, 25]. Data on children from rural kindergartens are very rare in the native anthropological literature [5]. The data for the children from Smolyan district, aged from 3 to 6 years, studied in the period 1996/1998, were published in our earlier survey [9]. But in general, the anthropometric data for contemporary children in this age group are very rare.

In relation to the growth processes of the studied features during the critical preschool period, our results show unevenness in the growth of various indicators and heterochrony for both genders in relation to almost all features. An intensive growth of the **body height** for both genders is observed, which is characterized by uneven course among the boys and even course among the girls. The largest growth in height is observed at age between 4-5 years for both genders.

In relation to weight, the age dynamics is characterized with more even course, where the average annual increase is within the range of 2 to 3 kg, while among the girls, the gaining of body mass during that period is uneven and at age between 5-6 years, a sharp growing jump of 5.2 kg on average annual base is observed.

In relation to **chest circumference**, the absolute year increase is smooth and significantly more even among the boys (from 1 to 2.5 cm), while among the girls, once again, we observe unevenness and significant increase in the period between 5-6 years. Due to the fact that the chest circumference reflects the growth of the thorax, respectively provides information about the growth process of some body diameters (transversal and sagital diameters of the thorax).

In relation to **head circumference**, reflecting the development of the brain section of the skull, the growth is different in time for the two genders. For the boys, the largest increase of the head circumference takes place at age between 3-4 years, while for the girls, once again, the process takes place at age between 5-6 years.

Our present new data on the height and weight of preschool children in Smolyan region are very close to the data for Sofiapreschool children, published by Zhecheva and Yankova [30]. The comparison that we made with the previously published data of the authors for the body height showed that Smolyan preschool children differ slightly and insignificant in height from their Sofia coevals. The comparison between body weight on children from two territorial groups showed that the current 3- and 4-year-old boys and the 4- and 5-year-old girls from Smolyan and Sofia have practically the same body weight. But the 5-year-old and 6-year-old Smolyan boys are slightly heavier average with 0.8-1.0 kg than their Sofia peers ($p \geq 0.05$). The Smolyan girls are heavier than their Sofia coevals in 6 years of age, when the difference reaches 2.8 kg and is statistically significant ($p \leq 0.05$).

In summary, our results about age and gender differences in the dynamics of the growth of the main anthropometric indicators (height, weight, chest and head circumference) show unevenness, heterochrony and gender dimorphism both in relation to the absolute values of the indicators and in relation to the rate of growth and reached growth velocity. While among the boys, the peaks in increase of body height, body weight and chest circumference for the studied period (age 3-6 years) match in time and are observed to take place at age between 4-5 years, and for the head circumference, at age between 3-4 year, for the girls, the increase in the body height is most significant in the period between 3 to 5 years, while their weight, chest and head circumference increase at age between 5 and 6 years of their development. These results are also confirmed by earlier data of other authors [29, 30].

Our results confirm uneven and not simultaneous increase of various body segments, uneven and not simultaneous grow rates and pronounced sexual dimorphism in period between 3-6 years of age. It is a more pronounced in boys, both in growth dynamics and in absolute dimensions of the studied measurements.

Our results confirm the general biological regularities of growth in that age and their peculiarity is a reflection of the influence of the hereditary and environmental factors, operating in the studied population.

Our results once again show the complex character of the growth processes, which are presented, in various extent, in the various morphological systems of the body during the different stages of the ontogenesis and are different for the two genders. Most probably these differences are related to the influence of the specific hereditary factors, dominating the growth of the studied indicators in that age as well as with the different ecosensitivity of the body to environmental factors in the earlier critical stages of the development, which will be a subject of our future studies.

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