

Growth and Proportionality of Body and Extremities' Length during Childhood

I. Yankova, Y. Zhecheva

Institute of Experimental Morphology and Anthropology with Museum, Bulgarian Academy of Sciences

The aim of the study is to analyse the metrical data of body and extremities lengths, their proportionality and growth during childhood. Object of the study are 219 fullterm and healthy newborns (110 boys and 109 girls) investigated within 24 hours after birth, and 640 preschool children aged 3-6 years (320 boys and 320 girls). The anthropometrical measurements are taken using the classical methods of Martin-Saller. The results show that: the stature increases most intensively between 0 and 3 years, after that it increases slowly; the length of trunk in 3-6 years old children is proportionately longer in boys; the boys have proportionately longer upper extremities and the girls have proportionately longer lower extremities; the interextremities' index values decreases with age which is associated with more rapid growth of lower extremity length during the period 3-6 years.

Key words: extremities' length, growth, proportionality, newborns, 3-6 years old children.

Introduction

Peculiarity of physical development of neonates and children from early childhood is the specific proportionality between their body parts, which is different from those in adults. Body proportionality is indicator for assessing body structure during different periods of growth and development and characterizes the harmonic physical development in children.

In newborns the upper and lower extremities referred to the stature are relatively short (on average about 1/3 of their height), but their sizes are growing rapidly after birth [1, 3, 4]. The relative extremities' length in adults is 1/2 of their height.

The aim of the study is to analyse the methrical data of body and extremities lengths, their proportionality and growth during childhood.

Materials and Methods

Object of the study are 219 fullterm and healthy newborns (110 boys and 109 girls) investigated through 2001, within 24 hours after birth, and 640 preschool children aged 3-6 years (320 boys and 320 girls, evenly distributed into 4 age groups for both sexes separately) investigated through 2004-2005.

The anthropometrical measurements are taken using the classical methods of Martin-Saller [2]. The data of body and extremities' length and their growth and proportionality in children are analysed using SPSS for windows, version 13.0. The statistical significant differences are established by Student's t-test in $P < 0.05$.

Results and Discussion

The results for body lengths and their proportions are presented in **Table 1**, and results for dynamics of growth – in **Table 2**.

Table 1. Biostatistical data of body lengths and their proportions

Body lengths								Body lengths proportions						
Age	♂			♀			Differences ♂/♀ (cm)	♂			♀			Differences ♂/♀ (%)
	n	mean	SD	n	mean	SD		n	mean	SD	n	mean	SD	
Stature								Upper extremity length × 100 / Lower extremity length						
0	110	50.55	1.49	109	50.13	1.65	0.43*	110	95.33	3.61	109	94.17	2.98	1.16*
3	80	101.20	4.30	80	98.99	3.89	2.20*	80	78.75	1.80	80	77.25	2.79	1.50*
4	80	107.70	4.13	80	106.52	5.39	1.18	80	77.12	1.93	80	75.83	2.07	1.29*
5	80	114.66	4.97	80	113.91	4.97	0.75	80	77.39	1.82	80	76.01	1.72	1.38*
6	80	121.28	4.93	80	120.40	5.16	0.88	80	76.55	1.74	80	75.59	1.82	0.95*
Torso length								Torso length proportion						
0	110	17.29	0.90	109	17.36	0.86	-0.07	110	34.20	1.42	109	34.63	1.39	-0.43*
3	80	30.39	2.00	80	29.43	1.54	0.96*	80	30.03	1.54	80	29.74	1.32	0.29
4	80	32.27	1.78	80	31.25	1.88	1.02*	80	29.97	1.49	80	29.35	1.33	0.63*
5	80	33.41	2.10	80	32.74	1.90	0.67*	80	29.14	1.33	80	28.74	1.08	0.40*
6	80	34.90	1.88	80	34.00	1.76	0.90*	80	28.78	1.18	80	28.24	1.07	0.54*
Upper extremity length								Upper extremity length proportion						
0	110	21.04	0.91	109	20.72	0.79	0.32*	110	41.62	1.37	109	41.36	1.36	0.27
3	80	41.38	2.11	80	39.91	1.86	1.47*	80	40.89	0.89	80	40.32	0.94	0.57*
4	80	44.37	2.09	80	43.27	2.45	1.10*	80	41.20	0.93	80	40.62	1.03	0.58*
5	80	47.53	2.37	80	46.89	2.45	0.64	80	41.45	0.99	80	41.16	0.98	0.29
6	80	50.63	2.36	80	49.71	2.52	0.92*	80	41.74	0.82	80	41.28	0.96	0.46*
Lower extremity length								Lower extremity length proportion						
0	110	22.08	0.83	109	22.02	0.79	0.07	110	43.69	1.36	109	43.94	1.52	-0.25
3	80	52.58	2.95	80	51.72	2.80	0.86	80	51.94	1.17	80	52.24	1.75	0.00
4	80	57.57	2.95	80	57.10	3.45	0.48	80	53.44	1.22	80	53.59	1.31	-0.15
5	80	61.43	2.92	80	61.70	3.11	-0.27	80	53.58	1.00	80	54.17	1.12	-0.59*
6	80	66.16	3.23	80	65.79	3.58	0.38	80	54.55	1.07	80	54.63	1.21	-0.08

* $P \leq 0.05$ – gender differences.

Table 2. Dynamics of growth

Age	♂		♀	
	AYA (cm)	RYA (%)	AYA (cm)	RYA (%)
Stature				
0-3	50.64*	66.74	48.86*	65.54
3-4	6.50*	6.22	7.53*	7.33
4-5	6.96*	6.26	7.39*	6.70
5-6	6.62*	5.61	6.49*	5.54
Torso length				
0-3	13.10*	54.93	12.07*	51.60
3-4	1.88	6.00	1.82*	6.00
4-5	1.15	3.49	1.49*	4.67
5-6	1.49	4.35	1.26*	3.76
Upper extremity length				
0-3	20.34*	65.17	19.19*	63.29
3-4	2.99*	6.97	3.36*	8.08
4-5	3.16*	6.87	3.62*	8.04
5-6	3.10*	6.31	2.81*	5.83
Lower extremity length				
0-3	30.50*	81.69	29.70*	80.56
3-4	4.99*	9.06	5.38*	9.88
4-5	3.86*	6.49	4.61*	7.76
5-6	4.73*	7.42	4.08*	6.41

* $P \leq 0.05$ – interage differences.

AYA – Absolute Year Alteration.

RYA – Relative Year Alteration.

The stature is a major anthropometric feature that has important medical and biological meaning in childhood. In the newborn, it reflected mainly hereditary granted of body sizes. During childhood stature characterized age-gender peculiarities in the child growth.

At birth and from 3 to 6 years the boys have higher values of stature than girls, as the differences are statistically significant ($P \leq 0.05$) in the newborns and in 3 years old children.

The growth of height is the most intensive between 0 and 3 years (49.0-50.0 cm), after this period up to six years of age the stature of children increases with 6.50 to 7.50 cm/year. The girls grow up more rapidly between 3 and 4 years, and the boys – between 4 and 5 years. The differences between both genders are statistically significant ($P \leq 0.05$). The relative year alteration (RYA) is in the range of 5.50% to 7.3% for the 3-6-year-olds.

The length of the trunk is the next important indicator of the body proportionality. In newborn boys and girls the difference is minimal (0.10 cm), but from 3 to 6 years the boys have statistically significant longer trunk than girls.

In both genders the length of the trunk grows most intensively during the first three years (51.6-54.9%). During the next three-year period, the relative growth in the torso

length in boys is 13.8 % and in girls is 14.4% respectively. From the third to the sixth year the increase is greatest during the first annual period when absolute year alteration (AYA) has nearly equal values in both genders. The increase of the torso length in boys is lowest between 4 and 5 years and in girls during the last one-year interval.

The data for the proportionality of the trunk length show that the torso of newborn girls related to the stature is significantly longer (with 0.43%) compared with the torso of the boys. In 3-6 years old children the torso length related to stature is greater in boys. The gender differences are not statistically significant only in 3 years of age. In the other three age groups of boys priority is statistically reliable ($P \leq 0.05$).

The length of the trunk in 3-6 years old children is proportionately longer in boys in contrast with the proportionality in adults where the torso length is longer in women. In both genders the relative length of the trunk decreases with the age and 6 years old children have the lowest values of the torso length proportion.

The metrical data for upper and lower extremities provide information on their size, proportionality and the proportionality between their parts.

The length of the upper extremities in newborns from both sexes is $\frac{1}{2}$ of their stature. From birth to 6 years of age upper extremities of the boys are significantly longer compared with girls ($P \leq 0.05$). The upper extremities length grows most intensively between 0 and 3 years of age (with 19.0-20.0 cm). From 3 to 6 years it increases with 9.00 to 10.00 cm, as the growth is relatively equal during each one-year period. In both genders AYA is greatest between 4 and 5 years, and the lowest between 3-4 years in boys and 5-6 years in girls, as differences between genders are statistically significant ($P \leq 0.05$). The length of the upper extremity at the 6 years old boys is 9.25 cm (20.15%) greater than in the 3 years olds. In girls throughout the studied period between 3 and 6 years of age the length of the upper extremity is increased by 9.80 cm (21.95%).

The relative length of the upper extremity is an important indicator for determining the body proportionality and for the degree of morphological maturity in prenatal ontogenesis and earliest childhood. The newborn boys have bigger absolute sizes of feature and proportionately longer upper extremities, but gender differences are not statistically significant. Between 3 and 6 years of age boys have also proportionately longer upper extremities than girls but found gender differences are significant during all investigated ages, excepting 5-year-olds when the gender gap is smallest (0.29%).

The lower extremity length is a mean feature that determines the growth of man. A characteristic feature of the humans is that between birth and puberty the lower extremities grow relatively faster than the other post-cranial body segments.

In newborn boys and girls the lower extremities length is about $\frac{1}{2}$ of their stature (22 cm) without statistically significant gender differences. In children from 3 to 6 years of age lower extremities have a greater length in boys with the exception of 5 years in which the priority is for girls. The greatest gender differences are reported in the group of three-year (0.86 cm).

From birth to 3 years the lower extremities increases in length with about 30.0 cm (81.0%) in both sexes. During the next three year period the lower extremities of boys and girls increases by 13.58 cm and 14.07 cm respectively. The increase of the lower extremity length is greatest between 3 and 4 years of age, after that growth decreases successively.

The data for the proportionality of the lower extremity show that girls from birth to 6 years of age have proportionately longer lower extremities than boys. The difference between genders is statistically significant ($P \leq 0.05$) only in 5 years old children (0.59%). In other age groups the differences between genders are insignificant (from 0.1% to 0.3%).

Interextremities index expresses the ratio between the upper and lower extremities lengths. Data from this index show that at birth and between 3 to 6 years statistically significant gender differences are available. Boys have significantly higher index values indicating that their upper extremity length relative to the lower extremity length is greater compared with girls. The values of the index decreases with age, which is associated with more rapid growth of the lower extremity length during the period between 3 and 6 years. Only between 4 and 5 years of age, the growth rate is faster in the upper extremity length, so that the index values increased slightly.

Throughout the studied age period the boys have longer upper extremities and the length of the lower extremities is approximately equal in both genders.

Conclusions

This paper contains data describing the stature, trunk length, upper and lower extremity lengths of newborns and children living in the town of Sofia.

The results obtained show that:

1. The stature increases most intensively between 0 and 3 years, after this period up to six years of age it increases more slowly;
2. The length of trunk in 3-6 years old children is proportionately longer in boys in contrast with the proportionality in adults where the torso length is longer in women;
3. The boys have proportionately longer upper extremities and the girls have proportionately longer lower extremities;
4. The interextremities' index values decreases with age, and are associated with rapid growth of the lower extremity length than upper extremity length during the period 3-6 years.

References

1. **Johnston, P. G. B.** Vulliamy's the newborn child. Edinburgh, Churchill Livingstone, 1994, 29-32
2. **Martin, R., K. Saller.** Lehrbuch der Anthropologie in systematischer Darstellung. Stuttgart, Gustav Fischer Verlag, 1, 1957, 322-324.
3. **Nelson, S.** Nelson Textbook of Pediatrics. 14th ed. W. B. Saunders Company, 1992, 15-37.
4. **Бобев, Д., Е. Генев.** Педиатрия. София, 2000.