Institute of Experimental Morphology and Anthropology

Acta morphologica et anthropologica, 9
Sofia • 2004

Basic Body Proportions and Indexes in Newborns from Sofia at the Beginning of the 21st Century

I. Yankova

Institute of Experimental Morphology and Anthropology, Bulgarian Academy of Sciences, Sofia

In the present work data about basic proportions and indexes in newborns are analyzed and the sex differences are estimated as well. During the period of April – May 2001 a total of 219 term (38 – 42 G.W.) and healthy newborns (110 boys and 109 girls) are studied in the first 24 hours after birth. Thirty-eight anthropometrical features are measured by the standard method and four body proportions and seven indexes are calculated. The metrical data show that girls have relatively wider head and longer trunk compared with boys, as well as relatively longer lower extremities but more narrow feet than boys have. The boys have relatively wider shoulders, bigger head circumference, longer upper extremities and wider hands. These results show that even by birth exist sexual differences in body structure of the newborns.

Key words: newborns, body proportions and indexes.

Introduction

The human physical development is an important characteristic for healthy status, the peculiarities of children growth and formation of their body structure. It is estimated by complex of anthropometrical features, whose absolute values characterize metrically the separate body parts or the entire body. The body proportions and indexes have widely application. They give summarized notion about physical aspects and growth changes of the human body.

Many scientists work in the field of human physical development [1, 5, 6, 7, 11] but the data about body proportions and indexes for children, and in particular for newborns are studied scantly [2, 3, 8, 9, 10].

The aim of the present work is to analyze the basic body proportions and indexes in newborns from Sofia at the beginning of the 21st century and to characterize the sex differences, as well.

Material and Methods

The present data are a part of detailed anthropological investigation, carried out during April-May 2001. The study includes 219 full-term and healthy newborns (110 boys and 109 girls) born between 38th - 42nd gestational week, with birth weight > 2500 g. The

metrical data are gathered in 24th hours after birth. Thirty-eight anthropometrical features are measured by Martin, Saller's classical method [4].

In this survey are presented data about sixteen metrical traits on whose base four body proportions and eight indexes are calculated.

Investigated features

Stature	Chest circumf.	Chest depth	Hand length
Head breadth	Torso length	Bicristal breadth	Lower extremity length
Head length	Biacromial breadth	Upper extremity length	Foot breadth
Head circumf.	Chest breadth	Hand breadth	Foot length

Calculated body proportions and indexes

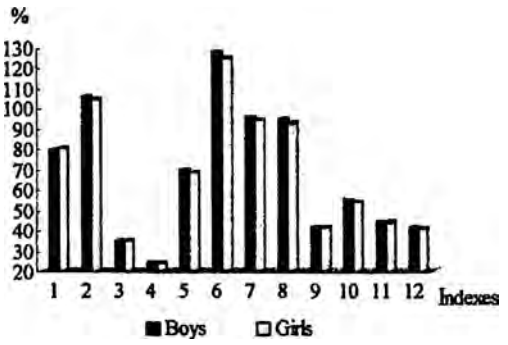
Head index	Thoracal index
Head breadth . 100 / Head length	Chest depth . 100 / Chest breadth
Head circumference . 100 / Chest circumference	Bicristal breadth . 100 / Chest breadth
Torso length proportion	Upper extremity length proportion
Biacromial breadth proportion	Hand breadth . 100 / Hand length
Biacromial breadth . 100 / Torso length	Lower extremity length proportion
Biacromial breadth . 100 / Chest breadth	Foot breadth . 100 / Foot length

The body proportions are indexes and show the ratios between absolute values of the anthropometrical features and stature, or express the ratios between two or more anthropometrical dimensions. They characterize the proportionality in body structure.

The sexual differences are assessed by comparison of the proportions and indexes mean values and by the data from the Index of sexual differences (ISD), calculated by the formula: $ISD = X_{\varphi} \times 100 / X_{\sigma}$.

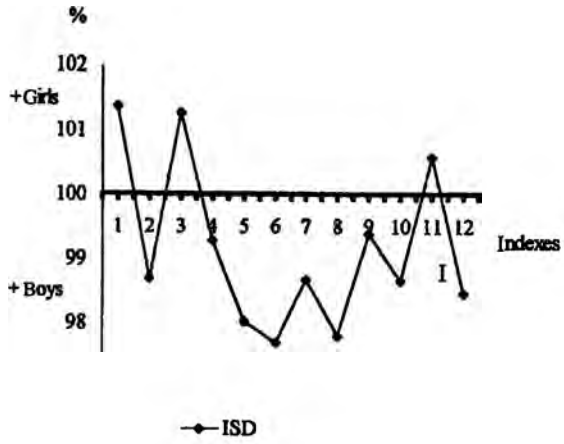
This index provides a possibility for a quantitative estimation of the sexual differences. Its values over 100 % show priority for girls, and below 100 % - for boys. The position of features on the line of 100 % illustrates the absence of sexual differences (Fig. 2).

We compared our data with the data of Slanchev et al. [8] about three proportions (biacromial breadth proportion, upper extremity length proportion and lower extremity length proportion) assessed some changes in the newborns' body structure during the past century.



1 – Head index
2 – Head circumf.100 / Chest circumf.
3 – Torso length proportion
4 – Biacromial breadth proportion
5 – Biacromial breadth . 100 / Torso length
6 – Biacromial breadth . 100 / Chest breadth
7 – Thoracal index
8 – Bicristal breadth . 100 / Chest breadth
9 – Upper extremity length proportion
10 – Hand breadth . 100 / Hand length
11 – Lower extremity length proportion
12 – Foot breadth . 100 / Foot length

Fig. 1. Basic body proportions and indexes in the newborns



1 – Head index
2 – Head circumf.100 / Chest circumf.
3 – Torso length proportion
4 – Biacromial breadth proportion
5 – Biacromial breadth . 100 / Torso length
6 – Biacromial breadth . 100 / Chest breadth
7 – Thoracal index
8 – Bicristal breadth . 100 / Chest breadth
9 – Upper extremity length proportion
10 – Hand breadth . 100 / Hand length
11 – Lower extremity length proportion
12 – Foot breadth . 100 / Foot length

Fig. 2. Sexual differences in the newborns according to the ISD data

The statistical analysis of the data is made by SPSS program and the significance of the established differences is assessed by the Student's t-test at $P<0.05$.

Results and Discussion

The results obtained by the variation analysis are presented in Tables 1 and 2 and Fig. 1. They give a possibility to detect and evaluate the sexual differences in newborns' structure. The data from Table 1 present only metrical information on whose base the body proportions and indexes are calculated and could be not discussed in this work.

The ratio between head breadth and head length (head index) characterizes the head shape in general. The mean value of the index is bigger in the newborn girls compared to the newborn boys and therefore the girls' head is relatively wider with 1.08 % than the boys' head ($P < 0.05$). The ratio of head circumference / chest circumference has great importance for the assessment of proportionality of body development in newborns. The data about this index could be used as predictor of congenital hydrocephalia and microcephalia as well. Up to the fourth month after birth the ratio is more than 1.00, it diminishes under 1.00 after this age and shows that the head circumference in newborns is bigger than their chest circumference [9]. The boys and girls born in 2001 have mean values of this ratio above one (1.05 in boys and 1.04 in girls). The sexual differences are statistically significant (Table 2, Fig. 1).

The data about torso length and biacromial breadth proportions show that the newborn girls have relatively longer trunk and the newborn boys have relatively wider shoulders. The biacromial breadth related to the torso length confirms again that the boys' shoulders are wider with 1.37 % than girls. The index of biacromial breadth / chest breadth has significantly higher values in boys. The shoulder breadth in relation to the chest breadth is bigger in boys with 2.95 %.

The thoracal index gives information about chest form. The data show that the newborn boys have relatively bigger chest depth in comparison with the newborn girls, but the established sexual differences are not statistically significant.

The summarized information about biacromial breadth proportion and indexes: biacromial breadth / torso length and chest depth / chest breadth (thoracal index) demonstrates that by birth the boys have already a male type of shoulders and chest construction.

Table 1. Anthropometrical features of the newborns from Sofia

Anthropometrical features	Boys, $n = 110$		Girls, $n = 109$		t	ISD
	mean	SD	mean	SD	♂ / ♀	%
Stature	50,55	1,49	50,13	1,65	2,1*	99,17
Head breadth	9,46	0,34	9,35	0,34	2,75*	98,84
Head length	11,97	0,40	11,68	0,42	5,8*	97,58
Head circumference	35,28	1,19	34,55	1,18	5,21*	97,93
Chest circumference	33,44	1,58	33,17	1,48	1,35	99,19
Torso length	17,29	0,90	17,36	0,86	0,58	100,40
Biacromial breadth	11,99	0,70	11,80	0,63	2,1*	98,42
Chest breadth	9,41	0,58	9,48	0,57	0,88	100,74
Chest depth	8,96	0,50	8,90	0,46	1,0	99,33
Bicristal breadth	8,88	0,53	8,76	0,54	1,5	98,65
Upper extremity length	21,04	0,91	20,72	0,79	2,67*	98,48
Hand breadth	3,44	0,19	3,35	0,16	4,5*	97,38
Hand length	6,29	0,41	6,21	0,38	1,6	98,73
Lower extremity length	22,08	0,83	22,02	0,79	0,6	99,73
Foot breadth	3,26	0,17	3,17	0,19	4,5*	97,24
Foot length	7,91	0,35	7,80	0,40	2,75*	98,61

* Statistically significant differences ($P<0.05$)

The newborn boys have higher mean value of the index - bicristal breadth / chest breadth and could be considered that they have relatively more massive pelvis.
Concerning the data about proportions of extremities' length we can mark that the boys have relatively longer upper extremities and the girls – relatively longer lower extremities. The differences between both sexes are not statistically significant. Comparing the index values characterizing the hand and the foot forms, it is evident that the newborn boys have relatively wider hands and feet than the newborn girls.

The Index of sexual differences gives more objective quantitative information. The differences between both sexes could be seen very clearly on Table 2 and Fig. 2. For the quantitative estimation of the sexual differences' intensity we constructed the following descendent formulae in which are presented the investigated features with serial number from Table 2.

♂: 6(- 2.31 %) > 8(- 2.20 %) > 5(- 1.97 %) > 12(- 1.55 %) > 10(- 1.35 %) > 7(- 1.32%) > 2(- 1.30 %) > 4(- 0.72 %) > 9(- 0.62 %)

♀: 1(+ 1.37 %) > 3(+ 1.26 %) > 11(+ 0.57 %)

(- %) – Boys have bigger values

(+ %) – Girls have bigger values

The sexual differences are most expressed in the index data of biacromial breadth related to chest breadth (- 2.31 %) in favor of the boys. The newborn boys have priority again in the ratio bicristal breadth / chest breadth (- 2.20 %), following by biacromial breadth related to torso length (- 1.97 %) and the breadth-length index of foot (- 1.55 %). The differences observed in the head index are lower and the girls have significantly

Table 2. Basic body proportions and indexes in the newborns from Sofia

Body proportions and indexes	Boys, n = 110		Girls, n = 109		t ♂ / ♀	ISD %
	mean	SD	mean	SD		
Head index	79,05	2,67	80,13	2,36	3,18 *	101,37
Head breadth × 100 / Head length	(n=109)		(n=108)			
Head circumf. × 100 / Chest circumf.	105,65	4,18	104,28	3,91	2,49 *	98,70
Torso length proportion	34,20	1,42	34,63	1,39	2,26 *	101,26
Biacromial breadth proportion	23,73	1,20	23,56	1,21	1,06	99,28
Biacromial breadth × 100 / Torso length	69,47	4,20	68,10	4,02	2,49 *	98,03
Biacromial breadth × 100 / Chest breadth	127,69	6,71	124,74	6,86	3,21 *	97,69
Thoracal index	95,45	6,17	94,19	6,31	1,48	98,68
Chest depth × 100 / Chest breadth			(n=108)			
Bicristal breadth × 100 / Chest breadth	94,60	5,27	92,52	5,26	2,93 *	97,80
Upper extremity length proportion	41,62	1,37	41,36	1,36	1,44	99,38
Hand breadth × 100 / Hand length	54,79	3,64	54,05	3,23	1,61	98,65
Lower extremity length proportion	43,69	1,36	43,94	1,52	1,32	100,57
Foot breadth × 100 / Foot length	41,30	1,79	40,66	2,36	2,29 *	98,45

* Statistically significant differences (P<0.05)

wider head than boys with 1.37 %. The intensity of sexual differences decreases consequently in breadth-length index of hand, thoracal index and the ratio head circumference / chest circumference. The newborn boys have wider hand, bigger chest depth and bigger head circumference with 1.35 %, 1.32 % and 1.30 % respectively. The sexual differences in torso length proportion are smaller and the girls have longer trunk than boys with 1.26 %. The established differences between both sexes are most slight expressed in the biacromial breadth proportion (- 0.72 %), upper extremity length proportion (- 0.62 %) and lower extremity length proportion (+ 0.57 %).

The data about secular changes of the proportions in the newborns are presented in Table 3 and Fig. 3. The boys and girls born in 2001 have relatively bigger biacromial

Table 3. Comparative data about body proportions in the newborns from Sofia

Body proportions	Boys					Girls				
	Slanchev et al., (1980 – 1982) n=86		Our data. (2001) n=110		t	Slanchev et al., (1980 – 1982) n=51		Our data. (2001) n=109		t
	mean	SD	mean	SD		mean	SD	mean	SD	
Biacromial breadth proportion	22.6	3.2	23.73	1.20	3.14*	22.7	3.0	23.56	1.21	2.0*
Upper extremity length proportion	41.3	3.4	41.62	1.37	0.82	40.5	3.5	41.36	1.36	1.34
Lower extremity length proportion	45.4	4.5	43.69	1.36	3.42*	46.4	4.0	43.94	1.52	4.24*

* Statistically significant differences (P<0.05)

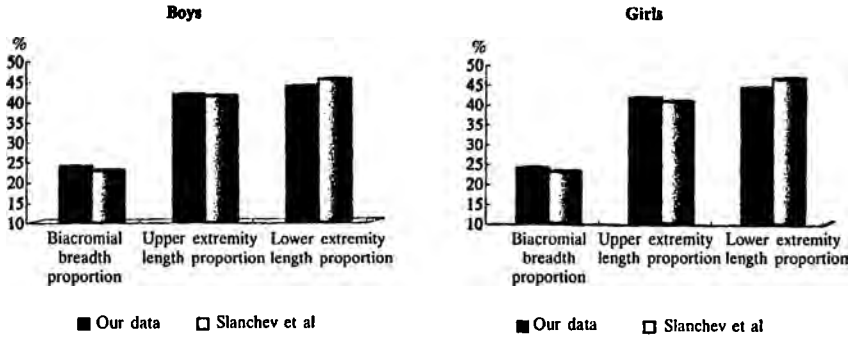


Fig. 3. Comparative data about body proportions in the newborns from Sofia

breadth and relatively longer upper extremities than the generation born during the period 1980-1982. However, the lower extremities are relatively longer in the newborns from both sexes (1980-1982) studied by Slanchev at al. [8]. The differences established between the two generations of newborn boys and newborn girls are statistically significant with the exception of those about upper extremity length proportion.

Conclusions

The results obtained show that even by birth existed sexual differences in the body structure of the newborns similar as in the adults.

- The newborn girls have relatively wider head and longer trunk compared with the newborn boys, as well as relatively longer lower extremities but more narrow feet than boys have.
- The newborn boys have relatively wider shoulders, bigger head circumference, longer upper extremities and wider hands. These results show that even by birth the structure of chest, shoulders and hands' massiveness characterize the male type of body structure.
- The boys and girls born in 2001 have relatively bigger biacromial breadth, longer upper extremities and shorter lower extremities compared with boys and girls born during the period 1980-1982.

References

1. Freeman, J. V., T. J. Cole, S. Chinn, P. R. M. Jones, E. M. White, M. A. Preece. Stature and weight reference curves for the UK, 1990. – Arch. Dis. Child., **73**, 1995, 17-24.
2. Gerver, W. J. M., R. De. Bruin. – Pediatric Morphometrics. Netherlands, Utrecht, 1996, 1-262.
3. Hajniš, K., J. Brůžek, V. Blažek. Growth and changes in trunk proportions during childhood. – Acta Universitatis Carolinae – Biologica 1982 – 1984, **12**, 1985, 233-242.
4. Martin, R., K. Saller. Lehrbuch der Anthropologie in sistematischer Darstellung. Bd. I. Stuttgart, Gustav Fischer Verlag, 1957, 322-324.
5. Taner, J. M., R. H. Whitehouse, M. Takaishi. Standards from birth to maturity for height, weight, height velocity and weight velocity; British children 1965. – Arch. Dis. Child., **41**, 1966, 454 – 471; 613 – 635.
6. Ватев, С. Антропология на българите. С., 1939, 12–49.
7. Дундова, Р. Лонгитудинално проучване растежа на деца от 0 – 3-годишна възраст. Дисерт. труд (София), 1978, 1–158.

8. Слънчев, П., Б. Янев, Ф. Генов, П. Щерев, П. Боев, Д. Сепетлиев, Б. Захариев. Физическо развитие, физическа дееспособност и нервно-психическа реактивност на населението на България (1980-1982). С., Национална спортна академия, 1992, 43–44, 211 – 212, 242–244.
9. Станчев, Здр., Ж. Желев. Физиология и патология на растежа. С., Медицина и физкултура, 1980, 13-74.
10. Цировски, М. Медико-антропологично изследване на деца от периодите кърмачество и ранно детство. Дисерт. труд (Пловдив), 1987, 1–298.
11. Янев, Б., П. Щерев, П. Боев, Ф. Генов, Д. Сепетлиев, И. Ф. Попов, Б. Захариев. Физическо развитие, физическа дееспособност и нервно-психическа реактивност на населението. С., 1982, 7–348.