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RELATIONSHIP BETWEEN SOMATOTYPE AND LONGITUDINAL BODY SIZES IN THE PRACTICALLY HEALTHY CHILDREN OF 6-8 YEARS OLD AND THEIR YEARLING WITH HEARING IMPAIRMENT

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Author contribution:

A – study concept and design; B – data collection; C – data analysis and interpretation; D – paper writing; E – paper editing; F – paper final adoption

Abstract

Introduction. Somatotype is a form of manifestation the natural biological diversity, which is discrete and determines natural composition different variants of the constitution typology. Somatotype reflects main features in the dynamics of ontogenesis, metabolism, reactivity of the organism. These properties form individual features of the structure and, consequently, functions of the organism, determine its response to ever-changing environmental factors.

Aim is to study relationship between somatotype in the children of 6-8 years and longitudinal dimensions of their bodies.

Material and methods: analysis and generalization of scientific and methodological literature, anthropometric measurements included determining length and weight of the body, chest, shoulder, waist and thighs, measuring thickness of the skin and fat folds of the biceps, triceps, forearms, shoulder blades, abdomen, legs and thighs. Determination of somatotype was carried out by W.H. Sheldon: digestive, muscular, thoracic, asthenoid. Attention was focused on the development and ratio of such features as shape of the back, chest, abdomen, legs, state of development the bone, muscle and adipose tissue, statistical analysis.

Results. There are measured and analyzed differences between the longitudinal body sizes in a practically healthy children and children of 6-8 years with hearing impairment depending on their somatotypes. Correlation analysis of a longitudinal body size allowed to determine common for all groups of children tendency to a direct dependence length of the body and torso on the somatotype in the examined children. At the same time, it is shown inverse relationship between somatotype of children with length of the upper and lower extremities, forearms, hands and legs.

Conclusions. Cluster analysis confirmed that formation four subgroups of somatotypes in the children of 6-8 years determined by a longitudinal size of their body. Unlike practically healthy, at the children with disturbance of hearing with asthenoid and thoracic somatotypes, there are no differences between length of the



body and length of the forearm, and in the children with thoracic and digestive somatotypes – between lengths of the hand. There is a different relationship between type of somatotype in the children of 6-8 years with a longitudinal size of their body, which did not depend on the gender and presence of hearing impairment. It is confirmed, that children with higher body and body characteristics belong to the muscular or digestive, and with higher extremities – to the asthenoid and thoracic somatotypes.

Keywords: somatotype, children of primary school age, disorders of hearing, hearing impairment.

Introduction. The priority aspects of education development in Ukraine determined in the Decree of the President of Ukraine «On National strategy of education development in Ukraine for the period up to the year 2021» № 344/2013 from 25/06/2013, the following was mentioned: the development of the children's healthy lifestyle, increasing locomotion routine among the school-aged children due to the improvement of physical education and recreational, mass sporting work in educational institutions, and methodology of physical education of children aimed to nurture a harmoniously-developed, physically and mentally healthy personality.

The analysis of scientific literature approves a coherent view of scientists [4, 6,] on an important role of the school period for building and promoting the students' health, nurturing a comprehensively competent personality, creating basic statements of further harmonious development of a child, building a value-based attitude to one's own health, and stimulating of motor activity [8, 9].

Somatotype is a form of manifestation of natural biological diversity being discrete, which determines natural composition of the body type variants typology [7, 13, 14]. Somatotype shows the main

peculiarities of ontogenesis [10, 12], metabolism, and body reactivity [5] dynamics. The mentioned peculiarities develop individual body type features and functions and determine its response to alternating environmental factors [1, 2, 3, 11].

Connection of the work with important research programs or practical tasks. The paper was completed according to the thematic plan of scientific researches of Dnipropetrovsk State Institute on Physical Education and Sport for the years 2016–2020: «Scientific and research basis of improvement of physical education among different groups of citizens» (state registration number 0116U003010).

The **aim of the research** is to study interrelation between somatotype of 6-8-year-old children and their longitudinal body sizes.

Material and methods of the research.

Research organization. The research was held during 2018–2019 at the department of theory and methodology of sports training of Prydniprovia State Academy on Physical Education and Sport, at I-III stages comprehensive school № 74 of Dnipro city, and at public educational institution «Multidisciplinary educational and rehabilitation resource



and methodological center of correctional work and inclusive learning».

Research contingent. 282 schoolchildren (virtually healthy boys – 85 people, virtually healthy girls – 85 people, boys with hearing impairments – 64 people, girls with hearing impairments – 48 people) have taken part in indicative experiment.

Methods of the research. analysis and synthesis of research and methodological literature; anthropometric measures included determining the body length and mass, circumferences of the chest, shoulder, waist, and thighs as well as measuring the width of skin-fat fold of the bicep, triceps, on the forearm, under the shoulder blade, on the belly, calf and thigh. Somatotype determination was conducted using W.H. Sheldon's system: digestive, muscular, thoracic, and asthenoid [7], at the same time, the focus was made on development and interrelation features such as the shape of the back, chest, belly, and legs, the amount of bone, muscle, and fat tissues.

Statistical analysis. For characterizing the results of the research the methods of descriptive statistics were used. The type of continuous random variabilities' distribution was established according to Shapiro-Wilk test. The evaluation of differences between populations was conducted by calculating parametric (Student t-criterion) and nonparametric (Mann Whitney U test) criteria based on the type of random variabilities' distribution and sample populations' contingency. To compare the share of children Fisher's exact or angular ϕ -test was used. The differences between the indicators of the children's longitudinal

body sizes by somatotype within all groups at the same time were found via calculating Kruskal-Wallis H test. The interrelation between the indicators of longitudinal body sizes among the 6-8-year-old children by somatypes was studied using Spearman's rank correlation coefficient ρ .

The clustering of the longitudinal body sizes indicators among the examined children was conducted using k-means method applying the method of sorting the distances between all objects with further selection of observations on regular intervals as cluster triggers. Original data was previously standardized.

The level of significance indicating the probability of denying the p-value served the criterion of dependability of statistical evaluations. The threshold level was considered 0.05.

All the mentioned calculations were conducted using the Microsoft Excel XP 2010 program software package and Statistica 7.0 program package for statistical analysis developed by the StatSoft Company (USA).

Results of the research and discussion. Determining somatotype using the W.H. Sheldon's system showed the existence of the following somatypes among virtually healthy boys: digestive – 8.2%, muscular – 30.6%, thoracic – 42.4%, and asthenoid – 18.8% of people. Among virtually healthy girls digestive somatotype was found in 14.1%, muscular – in 18.8%, thoracic – in 48.2%, and asthenoid – in 18.8%. The distribution of boys with hearing impairments by somatypes were the following: digestive somatotype – in 10.9%, muscular – in 20.3%, thoracic – in 48.4%, and asthenoid – in



20.3%, and among the girls with hearing impairments 12.5% were defined with digestive somatotype, 18.8% – muscular, 50.0% – thoracic, and 18.8% of people – asthenoid.

The analysis of the differences between the 6-8-year-old virtually healthy boys' longitudinal body sizes approved that depending on somatotype the groups of children have statistically significant difference by the length of core, length of torso, length of forearm, length of hand, and length of calf. Notably, among the examined with

asthenoid somatotype statistically significant declining of the length of the core was proved compared to the children of thoracic, muscular, and digestive somatotypes. At the same time, among the children of thoracic somatotype statistically significant declining of the same indicator was found compared to the children of muscular and digestive somatotypes, and among the children of muscular and digestive somatotypes no statistically significant differences were revealed (*table 1*).

Table 1

Analysis of difference in longitudinal body sizes indicators among virtually healthy 6-8-year-old boys depending on somatotype, n = 85

Indicators	Levels of statistical significance (p) compared to the children's indicators by somatotypes						H(3;85)
	A-T	A-M	A-D	T-M	T-D	M-D	
Length of core, cm	0.012*	0.000*	0.000*	0.013*	0.001*	0.327	45.715**
Length of torso, cm	0.001*	0.000*	0.000*	0.025*	0.000*	0.212	52.773**
Length of arm, cm	0.746	0.333	0.083	1.000	0.679	1.000	7.011
Length of shoulder, cm	1.000	1.000	1.000	1.000	1.000	1.000	0.601
Length of forearm, cm	0.011*	0.000*	0.000*	1.000	0.218	1.000	23.368**
Length of hand, cm	0.010*	0.000*	0.000*	0.405	0.015*	0.397	32.425**
Length of leg, cm	0.173	0.036*	0.013*	1.000	0.465	1.000	11.945**
Length of thigh, cm	1.000	1.000	1.000	1.000	1.000	1.000	0.484
Length of calf, cm	0.000*	0.000*	0.000*	0.575	0.077	0.957	36.447**

Note: * – $p < 0.05$ when comparing the children's indicators by somatotypes; A – asthenoid, T – thoracic, M – muscular, D – digestive body type; ** – $p < 0.05$ when comparing the indicators using Kruskal-Wallis test

The same tendency was found for the length of torso. The length of upper limbs despite higher indicators among the children with asthenoid and thoracic somatotypes did not differ significantly compared to other ones. At the same time, the length of hand and the length of forearm among the children with asthenoid somatotype was more statistically significant among the boys with asthenoid and thoracic somatotypes compared to the examined with muscular and digestive

somatotypes. It was found that the length of lower limbs among the boys with asthenoid somatotype was statistically significantly higher than the same indicator among the children with muscular and digestive somatotypes, and the length of their calves was considerably higher than among the children with other somatotypes.

Similar results can be observed among virtually healthy girls, which are given in the results in table 2.



Table 2

Analysis of difference in longitudinal body sizes indicators among virtually healthy 6-8-year-old girls depending on somatotype, n = 85

Indicators	Levels of statistical significance (p) compared to the children's indicators by somatotypes						H(3;85)
	A-T	A-M	A-D	T-M	T-D	M-D	
Length of core, cm	0.011*	0.000*	0.000*	0.405	0.014*	1.000	30.195**
Length of torso, cm	0.000*	0.000*	0.000*	0.192	0.052	1.000	38.489**
Length of arm, cm	0.836	0.352	0.123	1.000	1.000	1.000	6.314
Length of shoulder, cm	1.000	1.000	1.000	1.000	1.000	1.000	0.970
Length of forearm, cm	0.013*	0.000*	0.000*	0.553	0.320	1.000	22.910**
Length of hand, cm	0.014*	0.000*	0.000*	0.320	0.132	1.000	25.906**
Length of leg, cm	0.138	0.041*	0.015*	1.000	0.842	1.000	11.374**
Length of thigh, cm	1.000	1.000	1.000	1.000	1.000	1.000	1.917
Length of calf, cm	0.000*	0.000*	0.000*	1.000	1.000	1.000	24.473**

Note: * – $p < 0.05$ when comparing the children's indicators by somatotypes;

A – asthenoid, T – thoracic, M – muscular, Д – digestive body type;

** – $p < 0.05$ when comparing the indicators using Kruskal-Wallis test

Among the 6-8-year-old boys with hearing impairments by somatotypes statistically significant difference was diagnosed in equivalent indicators among virtually healthy children. However, contrary to virtually healthy boys, among the examined with hearing derivations with asthenoid and thoracic somatotypes no statistically significant

differences were recorded between the length of core and length of forearm, and among the children with thoracic and digestive somatotypes no statistically significant differences between the lengths of hands of children were proved (table 3).

Table 3

Analysis of difference in longitudinal body sizes indicators among 6-8-year-old boys with hearing impairments depending on somatotype, n = 64

Indicators	Levels of statistical significance (p) compared to the children's indicators by somatotypes						H(3;64)
	A-T	A-M	A-D	T-M	T-D	M-D	
Length of core, cm	0.177	0.000*	0.000*	0.003*	0.001*	1.000	38.238**
Length of torso, cm	0.030*	0.000*	0.000*	0.002*	0.001*	1.000	45.466**
Length of arm, cm	0.678	0.216	0.155	1.000	1.000	1.000	6.656
Length of shoulder, cm	1.000	1.000	1.000	1.000	1.000	1.000	1.463
Length of forearm, cm	0.053	0.001*	0.007*	0.382	0.725	1.000	17.960**
Length of hand, cm	0.013*	0.000*	0.000*	0.127	0.086	1.000	28.528**
Length of leg, cm	0.295	0.032*	0.033*	1.000	0.719	1.000	11.037**
Length of thigh, cm	1.000	1.000	1.000	0.917	1.000	1.000	2.092
Length of calf, cm	0.006*	0.000*	0.000*	0.255	0.386	1.000	26.162**

Note: * – $p < 0.05$ when comparing the children's indicators by somatotypes;

A – asthenoid, T – thoracic, M – muscular, Д – digestive body type;

** – $p < 0.05$ when comparing the indicators using Kruskal-Wallis test



Contrary to virtually healthy children, among the 6-8-year-old girls with hearing impairments no statistically significant differences between the lengths of cores, forearms, hands and torsos among the people with asthenoid and thoracic somatotypes were found (*table 4*).

It is notable that no statistically significant differences between the lengths of forearms and lower limbs were revealed among the girls with

asthenoid and muscular somatotypes. At the same time, no statistically significant differences were revealed between the lengths of cores among the girls with thoracic and digestive somatotypes, and vice versa, it was found that among the girls with thoracic somatotype the length of core is statistically significantly lower compared to the girls of muscular somatotype (*table 4*).

Table 4

Analysis of difference in longitudinal body sizes indicators among 6-8-year-old girls with hearing impairments depending on somatotype, n = 48

Indicators	Levels of statistical significance (p) compared to the children's indicators by somatotypes						H(3;48)
	A-T	A-M	A-D	T-M	T-D	M-D	
Length of core, cm	1.000	0.013*	0.000*	0.056*	0.002	1.000	23.256**
Length of torso, cm	0.036*	0.000*	0.000*	0.4106	0.054	1.000	26.262**
Length of arm, cm	1.000	0.534	0.472	1.000	1.000	1.000	4.639
Length of shoulder, cm	1.000	1.000	1.000	1.000	1.000	1.000	0.847
Length of forearm, cm	1.000	0.195	0.027*	1.000	0.157	1.000	10.127**
Length of hand, cm	0.344	0.001*	0.021*	0.067	0.490	1.000	17.036**
Length of leg, cm	1.000	0.101	0.088	0.557	0.444	1.000	9.014
Length of thigh, cm	1.000	1.000	1.000	1.000	1.000	1.000	0.156
Length of calf, cm	0.141	0.010*	0.005*	0.784	0.319	1.000	15.143**

Note: * – $p < 0.05$ when comparing the children's indicators by somatotypes;

A – asthenoid, T – thoracic, M – muscular, D – digestive body type;

** – $p < 0.05$ when comparing the indicators using Kruskal-Wallis test

Further correlation analysis of the longitudinal body sizes indicators among the 6-8-year-old children make it possible for us to determine the common tendency for all groups of children consisting in direct interrelation of the length of core and torso and somatotypes of the examined. This means that the growth of the skeleton, muscles and fat stores cause

the growth of the length of their cores and torsos. At the same time, reverse statistically significant interrelation was found between somatotype and the lengths of upper and lower limbs, forearms, hands and calves indicating falling of growth of the skeleton, muscles and fat stores in the course of the mentioned longitudinal body sizes' growth (*table 5*).



Table 5

Correlative connection of longitudinal body sizes indicators among the 6–8-year-old children by their somatotypes, n=282

Indicators	Spearman's rank coefficient, ρ			
	VHB, n=85	VHG, n=85	IB, n=64	IG, n=48
Length of core, cm	0.731*	0.593*	0.771*	0.677*
Length of torso, cm	0.778*	0.657*	0.847*	0.744*
Length of arm, cm	-0.267*	-0.270*	-0.321*	-0.313*
Length of shoulder, cm	0.064	0.034	0.115	0.108
Length of forearm, cm	-0.498*	-0.506*	-0.522*	-0.458*
Length of hand, cm	-0.600*	-0.545*	-0.668*	-0.583*
Length of leg, cm	-0.354*	-0.355*	-0.415*	-0.436*
Length of thigh, cm	-0.030	-0.056	0.095	0.030
Length of calf, cm	-0.622*	-0.468*	-0.627*	-0.562*

Note: VHB – virtually healthy boys, VHG – virtually healthy girls;
 IB – boys with hearing impairments, IG – girls with hearing impairments.
 * – Spearman's rank coefficient is statistically significant

The analysis of cluster indicators of longitudinal body sizes among the examined children approved generally similar situation for each group of the examined, that is why to exemplify we

produce the results of clustering of longitudinal body sizes indicators among the 6–8-year-old virtually healthy boys (see Figure 1).

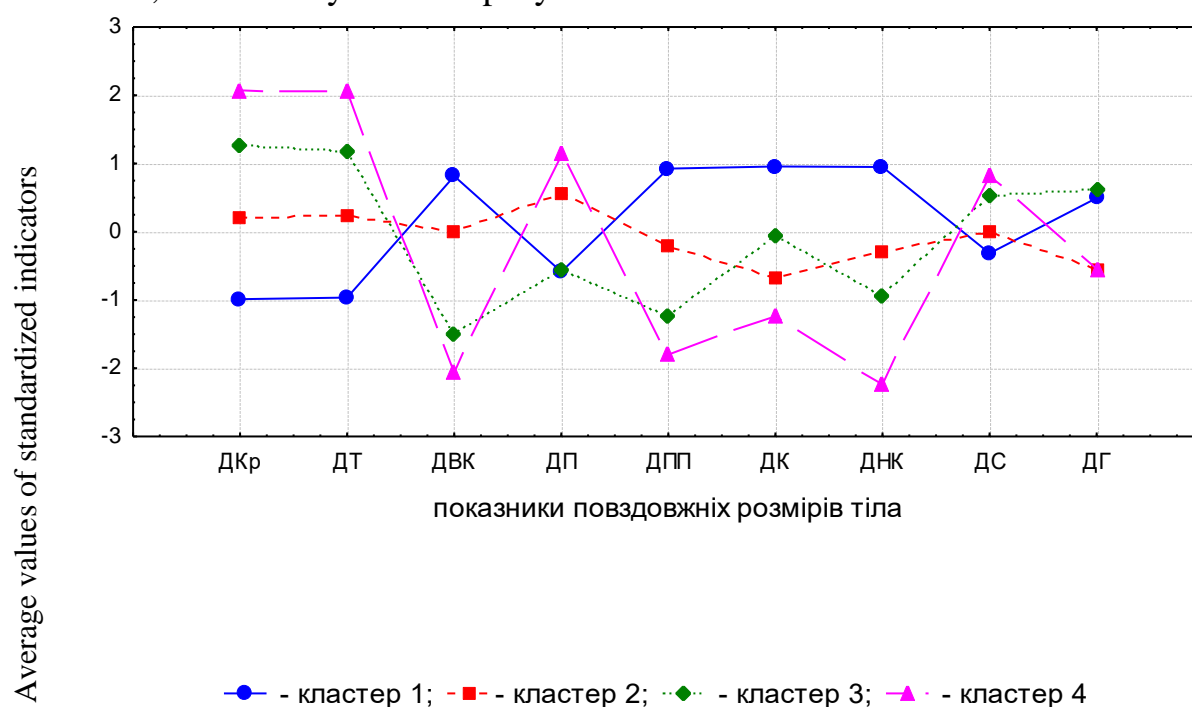


Figure 1. **Cluster analysis of longitudinal body sizes indicators among the 6–8-year-old virtually healthy boys, n=85**

Note: ДКр – length of core, ДТ – length of torso, ДВК – length of upper limb; ДП – length of shoulder, ДПП – length of forearm, ДК – length of hand, ДНК – length of lower limb, ДС – length of thigh, ДГ – length of calf



The picture 1 shows that the cluster 1 includes the boys with low indicators of the length of core and torso along with high indicators of the lengths of forearms, hands and lower limbs. Evidently, these children have asthenoid somatotype.

The cluster 2 combines the boys with thoracic somatotype having average longitudinal body sizes indicators.

The cluster 3 included the children with increased indicators of the lengths of core and torso and lowered indicators of the lengths of upper and lower limbs, which are the children with muscular somatotype.

The cluster 4 includes the children with digestive somatotype characterized by high indicators of the lengths of cores, torsos and shoulders, and low indicators of the lengths of upper and lower limbs, hands and forearms.

As a result of the conducted research, we have revealed statistically significant differences between longitudinal sizes of cores, torsos, forearms, hands, lower limbs and calves depending on somatotype, except the girls with hearing impairments whose lengths of lower limbs does not differ by somatotype. The decreasing of the lengths of cores and torsos against increased indicators of hands, lower limbs and calves among virtually healthy boys with asthenoid somatotype has also been revealed, compared to all the groups of children. The children with thoracic type were characterized by lower indicators of the lengths of cores and torsos compared to the boys with muscular and digestive somatotypes.

A similar situation is among virtually healthy girls aged 6-8 except

for the length of the torso having no differences among the girls with asthenoid and thoracic somatotypes. The lengths of lower limbs among the children with thoracic type exceeded this indicator among the children with muscular and digestive types in all the groups except the girls with hearing impairments.

In each of the examined groups of the children with muscular and digestive somatotypes the longitudinal body sizes did not differ. Contrary to the virtually healthy children, among the examined children with hearing impairments of asthenoid and thoracic somatotypes, there were no differences were found between the lengths of cores and lengths of forearms, and among the children with thoracic and digestive somatotypes – the lengths of hands.

Our found results complement the data by other specialists [4, 6, 7, 14] on morphological peculiarities of elementary school-aged children with different somatotypes. We have also proved the authors' data [7, 11, 15] that 6-8-year-old children fall into four subgroups by somatotypes using the longitudinal body sizes indicators.

In the paper it has been originally revealed that the 6-8-year-old children's somatotypes are more or less caused by longitudinal body sizes interrelated to each other regardless of hearing impairments existence. The lengths of torso, core, forearm, calf, upper and lower limbs as well as of hand and foot are considerable for indicating somatotypes among 6-8-year-old children.

Conclusions.

1. The cluster analysis has proved that developing four subgroups by somatotypes among the 6-8-year-old



children is determined by their longitudinal body sizes. The cluster 1 includes the children with low indicators of the lengths of forearms, hands, and lower limbs (asthenoid somatotype); the cluster 2 combines the children with average longitudinal body sizes indicators (thoracic somatotype); the cluster 3 includes the children with increased indicators of the lengths of cores and torsos, and low indicators of the lengths of upper and lower limbs (muscular somatotype); the cluster 4 includes the children with high indicators of the lengths of cores, torsos and shoulders, and low indicators of the lengths of upper and lower limbs, hands and forearms (digestive somatotype).

2. It was established that, contrary to virtually healthy children, the ones with hearing impairments of asthenoid and thoracic somatotypes there are no differences between the lengths of core and lengths of forearms, and among the children with thoracic and digestive somatotypes – of the lengths of hands.

3. Interrelation between 6-8-year-old

children and their longitudinal body sizes was established: direct interrelation with the lengths of core and torso, a reverse one – with the lengths of upper and lower limbs, forearms, hands and calves. The mentioned interrelation did not depend on the gender and existence of hearing impairments. The correlative analysis proved that the children with higher indicators of cores and torsos belong to muscular or digestive somatotypes, and the ones with higher indicators of the limbs – to asthenoid or thoracic ones. The indicators as the lengths of shoulder or thigh are less informative in the course of determining the children's somatotypes.

Prospects for further research will be connected to research development and approbation of the technology of preventing disorders in biomechanical qualities of a foot among elementary school-aged children with hearing deprivation in the course of adaptive physical education.

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