



Revealing the Peculiarities of Female Students' Physiological Characteristics with Different Somatotypes in the Absence of Compulsory Physical Activity at University

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Abstract

Objectives. The purpose of the study was to determine the parameters of female students' physiological characteristics with different somatotypes, which they achieved by exercising outside the university due to COVID-19 quarantine and air raids during the hostilities in Ukraine.

Material and methods. The study involved 66 female students aged 17.8 ± 0.6 years, who belonged to different somatotypes and had no reservations about engaging in different amounts of physical activity. The Shtefko-Ostrovsky method, modified by S. Darskaja, was used to diagnose the somatotype. The necessary empirical data were obtained through the performing well-known functional tests that allowed to determine blood pressure, heart rate in different situations, vital capacity, vital capacity index, maximum isometric strength index, and Robinson index. The parameters of these characteristics were determined in female students with each of the four available somatotypes during the study, and each parameter was compared with different somatotypes. The testing was conducted at the beginning (January) and at the end (May-June) of the academic semester, but during one academic year.

Results. At the beginning, and even more so at the end of the academic year, the parameters of the studied characteristics in female students with each of the available somatotypes differed from each other (p-values ranging at the level from 0.05 to 0.000). The volumes and conditions of physical activity used during the academic year did not lead to significant changes in the physiological characteristics of all female students, i.e. parameters remained at the previously achieved level. At the same time, the presence of peculiarities caused by the girl's belonging to a certain somatotype was observed.

Conclusions. Identifying the peculiarities in changes of female students' physiological characteristics' parameters, taking into account their somatotypes, is a perspective and significant direction for modernization of physical education at university. The obtained data will contribute to the individualization of the content and normative bases of physical education for female students, using information on the manifestation and change of parameters of various characteristics, including physiological ones.

Keywords: physiological characteristics, female students, differentiation, physical education, physical activity, COVID-19.

Introduction

In recent years, increased attention has been paid to students' physical activity in extracurricular time (American College, 2017; Banakh, 2019; Get Active, 2020; Global action

plan on physical activity 2018-2030). Some of the main reasons are as follows: this physical activity is considered as one of the most effective forms in the successful solution of university physical education tasks (Zhang & Wu, 2020; Abrantes et al., 2022; Wilmore et al., 2022); the number of physical education classes implemented during the week and academic year at universities does not provide the specified number of physical education classes (Piestrzyński et al.,

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2021; López-Valenciano et al., 2021; James et al., 2023); analysis of curricula for bachelor's and master's degrees shows a tendency to further reduce the number of physical education classes (Institute of Medicine, 2013; Wiium, Säfvenbom, 2019; Annear et al., 2022).

At the same time, we have recently noted a further increase in researchers' attention to the problem of modernizing university physical education (Vaquero-Solís et al., 2020; Kljajević et al., 2021; Annear, 2022; Ge et al., 2024). Some of the main reasons for the need to modernize this pedagogical process are largely due to: quarantine during the COVID-19 epidemic, air raids as a result of hostilities, the orientation of the educational process at the university towards the optional nature of physical education, and some other problems of students' physical activity (Romero-Blanco, et al, 2020; Wilson et al., 2021; Misharskyi et al., 2023).

Due to this situation, the problem of individualization and personalization of physical education is particularly relevant, which involves providing students with appropriate counseling services, orientating them to independent physical activity in non-classroom time, and offering each individual the optimal parameters of physical activity (Coulter et al., 2016; Banakh & Iedynak, 2021; Frąckiewicz, 2023). In other words, we are talking about designing an educational route for each student that helps him or her to solve the task (Wiium, Säfvenbom, 2019). The practical implementation of this personalization in physical education, including at university, involves the use of a predictive and effective marker, one of which is the somatotype (Cinarli & Kafkas, 2019; Campa et al., 2020; Iedynak et al., 2021). Knowledge about the peculiarities of physiological characteristics is also important, as they are one of the leading factors in determining the content of the physical activity program for each student (Katzmarzyk & Silva, 2013; Wilmore et al., 2022).

Given the above, it was found that such information is insufficient, and this does not contribute to solving the identified scientific problem. There is no data on the peculiarities of manifestation and changes in the parameters of physiological characteristics of girls with different somatotypes in the absence of compulsory physical activity during their studies at university. Such information is important because it will contribute to the formation of individual programs to successfully solve the problem of improving the physiological characteristics of girls with different somatotypes (Stewart et al., 2014; Iedynak et al., 2017). The importance of achieving this result is due to several reasons, one of which is that the parameters of girls' physiological characteristics are lower than necessary. This, in turn, does not contribute to the quality of girls' educational activities, professional duties in the future, various types of household activities, maintaining and improving their health, physiological capacities, and other important characteristics for ensuring a high quality of life (Campa, Greco, 2022). Thus, given the above information, there is a need to conduct research in this area.

Materials and methods

Study participants

The study involved 66 girls, each aged 17.8 ± 0.6 years. They belonged to different somatotypes and had no reservations about the use of different amounts of physical activity.

The Shtefko-Ostrovsky method in the modification of S. Darskaja was used to diagnose the somatotype. Thus, 12 belonged to the asthenic somatotype (A-type), 22 – thoracic somatotype (T-type), 22 – muscular (M-type), and 10 – digestive (D-type).

Study organization

Somatotypes were diagnosed at the beginning of the experiment. The use of this particular scheme was due to the following reasons: the main characteristics of the scheme are very similar to the Heath-Carter scheme, which is most often used by researchers from Europe and the United States (Carter & Heath, 1990; Stewart et al., 2014; Bertuccioli et al., 2022). The selection of the Shtefko-Ostrovsky scheme makes it extremely possible to establish a certain trend, especially manifestations and changes in physical readiness in comparison with the data of other researchers (Sands, 2012; Iedynak et al., 2021).

The study was based on characteristics that reflected the state of functioning of girls' respiratory, cardiovascular, and neuromuscular systems. At the beginning and end of the study, the parameters of these characteristics were determined in girls with each of the four available somatotypes. In addition, a comparative analysis of the parameters of each characteristic that marked the existing somatotypes was carried out. Each functional test used is well-known, widely used in practice, and recommended by researchers as reliable and informative (American College of Sport Medicine, 2017; Wilmore et al., 2022).

These tests were used to determine vital capacity (VC); heart rate (HR) in different situations (at rest, after using a dosed load, during recovery from the used load); blood pressure (systolic – SBP, diastolic – DBP); vital capacity index ($VCI = VC/\text{body mass}$), maximum isometric strength index ($IMIS = \text{maximum isometric strength}/\text{body mass}$); Robinson index ($RI = (SBP \times HR)/100$). All the specified requirements were met during the application of these tests. The data obtained were interpreted as follows: HR reflected the state of functioning of the heart, and together with blood pressure and RI – the state of the cardiovascular system at rest; the value of VC indicated the ability of the lungs to receive oxygen, the value of VCI – the state of the respiratory system in terms of a full supply of oxygen to the body. The value of IMIS allowed to establish the state of development of the skeletal muscles of girls. This indirectly indicates the state of excessive accumulation in the muscles of structural and energy potentials that increase their working capacity. We used certified equipment: to determine the blood pressure – BP AG1-30 Microlife, to determine the IMIS – handgrip Camry dynamometer, to determine the VC and VCI – CardioSpiro, NDD EasyOne Plus System 2000-2 spirometer. VCI and IMIS included the determination of body mass, for this purpose, OMRON BF 511 scales were used. Testing was conducted at the beginning (January) and end (May-June) of the academic semester during one academic year. The results were compared with each other first in each somatotype, then in different somatotypes. The increase, or decrease in the parameters of a certain characteristic or its manifestation at the previously achieved level was determined.

The study was planned and implemented by the principles of bioethics set out by the World Medical Association (WMA-2013) in the Declaration of Helsinki on Ethical Principles for Medical Research Involving Human

Subjects and by UNESCO in the Universal Declaration on Bioethics and Human Rights. This helped to fulfill the requirements of voluntariness, anonymity, and trust; all girls provided informed written consent to participate in the study. The study protocol was approved by the Ethical Committee of Kremets Regional Humanitarian Pedagogical Academy named after Taras Shevchenko.

Statistical Analysis

All statistical analyses were performed using SPSS Version 21. For each assessment, the following calculations were performed: arithmetic mean (M), standard deviation

(SD), and Kolmogorov-Smirnov Test (KS). The latter allowed us to establish the nature of the distribution of individual values in each sample of girls. Based on the results of this analysis, when comparing two means, the Student's T test for related and unrelated samples or nonparametric methods were used; the 0.05, 0.01, and 0.001 probability levels were used to indicate statistical significance (Robinson, 2016; Weir & Vincent, 2020).

Results

Before studying the empirical data, we analyzed them from the point of view of compliance with the normal distribution of values of each physiological characteristic in

Table 1. Results of girls with different somatotypes at the beginning of the study

N	The name of the parameter	On beginning				K-S, p
		M ₁	SD	Min	Max	
A-type (n = 12)						
1	VC, ml	2380.00	274.84	2110.00	3070.00	<0.10
2	HR at rest, bpm ⁻¹	79.20	3.30	72.00	81.00	>0.20
3	HR after exercise, bpm ⁻¹	119.50	6.50	110.00	130.00	>0.20
4	SBP, mmHg	112.83	8.83	102.00	130.00	>0.20
5	DBP, mmHg	66.75	4.33	60.00	72.00	>0.20
6	Recovery time after exercise, s	148.42	14.48	116.00	165.00	>0.20
7	VCI, ml·kg ⁻¹	44.83	3.83	41.00	53.00	>0.20
8	IMIS, %	45.08	4.76	38.00	52.00	>0.20
9	RI, conditional units	97.17	5.01	87.00	104.00	>0.20
T-type (n = 22)						
1	VC, ml	2750.00	277.85	2350.00	3480.00	<0.20
2	HR at rest, bpm ⁻¹	76.50	3.73	72.00	84.00	>0.20
3	HR after exercise, bpm ⁻¹	112.50	7.18	103.00	126.00	>0.20
4	SBP, mmHg	117.91	5.11	108.00	126.00	>0.20
5	DBP, mmHg	72.09	3.44	68.00	81.00	<0.15
6	Recovery time after exercise, s	150.73	10.11	126.00	168.00	>0.20
7	VCI, ml·kg ⁻¹	44.18	4.72	33.00	51.00	<0.20
8	IMIS, %	47.18	3.47	41.00	54.00	>0.20
9	RI, conditional units	93.41	5.00	84.00	102.00	>0.20
M-type (n = 22)						
1	VC, ml	2490.00	223.61	2150.00	2900.00	>0.20
2	HR at rest, bpm ⁻¹	74.63	2.97	68.00	78.00	>0.10
3	HR after exercise, bpm ⁻¹	110.41	7.69	100.00	132.00	>0.20
4	SBP, mmHg	117.91	4.80	110.00	126.00	>0.20
5	DBP, mmHg	74.09	2.88	68.00	78.00	>0.20
6	Recovery time after exercise, s	150.09	11.33	119.00	163.00	<0.10
7	VCI, ml·kg ⁻¹	43.09	3.49	38.00	51.00	>0.20
8	IMIS, %	47.09	5.68	40.00	62.00	<0.20
9	RI, conditional units	89.82	7.10	71.00	103.00	>0.20
D-type (n = 10)						
1	VC, ml	2550.00	259.14	2230.00	3100.00	>0.20
2	HR at rest, bpm ⁻¹	75.80	2.53	73.00	81.00	>0.20
3	HR after exercise, bpm ⁻¹	128.70	12.79	116.00	150.00	>0.20
4	SBP, mmHg	119.10	6.12	112.00	134.00	>0.20
5	DBP, mmHg	78.10	2.92	74.00	82.00	>0.20
6	Recovery time after exercise, s	164.30	24.65	126.00	198.00	>0.20
7	VCI, ml·kg ⁻¹	37.10	5.30	31.00	46.00	>0.20
8	IMIS, %	40.10	3.87	36.00	50.00	>0.20
9	RI, conditional units	89.60	4.17	84.00	97.00	>0.20

Note: a reliably significant difference between the two means is highlighted in color

the studied samples. The K-S Test was used, and the results in all cases revealed a normal distribution of values (Table 1).

When comparing the parameters of girls with the available somatotypes, differences between them were found. The largest number was found in girls with T-type, namely, in 6 of all 9 characteristics, the values differed by a statistically significant amount (Table 2).

This concerned a pair of samples T-type and A-type, as well as a pair of samples T-type and D-type. Specifying the identified differences, we note that in the first pair, all parameters were better in representatives of T-type, in the second pair – HR after exercise, recovery time after exercise, VCI, and IMIS, while DBR and RI parameters were better in girls with D-type.

At the same time, in the next pair of samples, it was found that D-type girls had higher DBR than M-type girls, while the latter had higher HR after exercise, recovery time after exercise, VCI, and IMIS. The revealed peculiarity of girls with M-type was the same as that of girls with T-type. This led to the detection of almost identical parameters in the studied characteristics in these samples, except VC, which was better in T-type, and DBR, which was higher in M-type.

Comparing the parameters of physiological characteristics of girls with A-type and D-type, which are extreme variants of body composition components development,

the following was found. The former were marked by a better reaction of the cardiovascular system to dosed physical activity because their HR after exercise was $119.5 \pm 6.5 \text{ bpm}^{-1}$, whereas in girls with D-type it was $128.7 \pm 12.79 \text{ bpm}^{-1}$ ($t = 3.725$; $p < 0.001$), as well as VCI (44.83 ± 3.83 and $37.1 \pm 5.3 \text{ ml}\cdot\text{kg}^{-1}$, respectively; $t = 3.967$; $p < 0.001$), IMIS (45.08 ± 4.76 and $40.1 \pm 3.87 \%$; $t = 2.657$; $p < 0.015$).

The repeated study, which took place at the end of the academic year, revealed certain features of changes in the parameters of the studied characteristics. One is the improvement in each somatotype of only certain characteristics, except A-type representatives. They did not have statistically significant changes in any indicator (Table 3).

There was only a certain tendency in their change, the most expressive positive – in VC, recovery time after exercise, VCI, negative – IMIS, RI.

In girls with T-type, the change was found in parameters 2 out of all 9 studied characteristics, in girls with M- and D-types – 1. At that, in T-type parameters IMIS deteriorated by $3.77 \text{ ml}\cdot\text{kg}^{-1}$ ($t = 2.939$; $p < 0.005$), VCI – by 2.59 % ($t = 2.160$; $p < 0.037$). The first of these indicators reflected the state of development of the neuromuscular system, namely the state of excessive accumulation in the muscles of structural and energy potentials that increase their working capacity. VCI showed the state of oxygen supply to the body.

Table 2. Differences in results of girls with different somatotypes at the beginning of the study

Result (points)	The name of the parameter								
	1	2	3	4	5	6	7	8	9
A - T									
t	-3.725	2.073	2.806	-2.134	-3.951	-0.546	0.410	-1.476	2.093
F	1.022	1.276	1.218	2.989	1.589	2.050	1.514	1.876	1.002
p	0.000	0.046	0.009	0.041	0.000	0.589	0.685	0.150	0.044
A - M									
t	-1.264	4.091	3.469	-2.185	-5.936	-0.373	1.344	-1.040	3.170
F	1.511	1.234	1.398	3.384	2.265	1.634	1.206	1.426	2.013
p	0.215	0.000	0.002	0.036	0.000	0.712	0.188	0.306	0.003
A - D									
t	-1.482	2.641	-2.183	-1.894	-7.045	-1.881	3.967	2.657	3.802
F	1.120	1.700	3.870	2.080	2.190	2.900	1.910	1.510	1.440
p	0.154	0.016	0.041	0.073	0.000	0.075	0.000	0.015	0.001
T - M									
t	3.419	1.835	0.933	0.000	-2.094	0.197	0.872	0.064	1.939
F	1.544	1.575	1.148	1.132	1.426	1.255	1.827	2.676	2.016
p	0.001	0.074	0.356	1.000	0.042	0.845	0.388	0.949	0.059
T - D									
t	1.925	0.538	-4.604	-0.575	-4.789	-2.234	3.790	5.162	2.095
F	1.150	2.170	3.180	1.430	1.380	5.940	1.260	1.240	1.440
p	0.064	0.595	0.000	0.570	0.000	0.033	0.001	0.000	0.045
M - D									
t	-0.670	-1.073	-5.043	-0.597	-3.636	-2.259	3.815	3.522	0.090
F	1.343	1.377	2.767	1.625	1.032	4.733	2.307	2.153	2.903
p	0.508	0.292	0.000	0.555	0.001	0.031	0.001	0.001	0.929

Table 3. Results of girls with different somatotypes at the end of the study and the statistical reliability of their change

N	The name of the parameter	At the end				(M ₁ - M ₂)	
		M ₂	SD	Min	Max	t	p
A-type (n = 12)							
1	VC, ml	2410.00	334.72	2010.00	3200.00	-0.240	0.813
2	HR at rest, bpm ⁻¹	79.00	4.29	69.00	84.00	0.107	0.916
3	HR after exercise, bpm ⁻¹	118.08	8.59	105.00	136.00	0.456	0.653
4	SBP, mmHg	112.58	6.79	104.00	127.00	0.078	0.939
5	DBP, mmHg	67.67	3.42	62.00	72.00	-0.576	0.571
6	Recovery time after exercise, s	145.58	15.58	112.00	163.00	0.461	0.649
7	VCI, ml·kg ⁻¹	45.33	5.25	40.00	56.00	-0.267	0.792
8	IMIS, %	44.58	5.38	39.00	54.00	0.241	0.812
9	RI, conditional units	97.67	6.61	85.00	105.00	-0.209	0.836
T-type (n = 22)							
1	VC, ml	2710.00	277.25	2310.00	3440.0	0.478	0.636
2	HR at rest, bpm ⁻¹	75.82	3.98	71.00	84.0	0.586	0.561
3	HR after exercise, bpm ⁻¹	114.09	6.98	105.00	126.0	-0.746	0.460
4	SBP, mmHg	117.09	5.33	106.00	124.0	0.520	0.606
5	DBP, mmHg	72.59	3.89	68.00	84.0	-0.452	0.654
6	Recovery time after exercise, s	146.50	10.57	118.00	164.0	1.355	0.183
7	VCI, ml·kg ⁻¹	40.41	3.78	33.00	52.0	2.929	0.005
8	IMIS, %	44.59	4.43	38.00	56.0	2.160	0.037
9	RI, conditional units	92.59	6.34	83.00	105.0	0.475	0.637
M-type (n = 22)							
1	VC, ml	2502.96	262.09	2150.00	3200.00	-0.176	0.860
2	HR at rest, bpm ⁻¹	75.09	4.14	68.00	84.00	-0.419	0.678
3	HR after exercise, bpm ⁻¹	108.91	7.33	96.00	126.00	0.662	0.512
4	SBP, mmHg	118.23	4.14	110.00	126.00	-0.236	0.815
5	DBP, mmHg	75.09	3.42	68.00	80.00	-1.049	0.300
6	Recovery time after exercise, s	143.09	11.98	110.00	156.00	1.992	0.053
7	VCI, ml·kg ⁻¹	46.32	5.05	41.00	59.00	-2.467	0.018
8	IMIS, %	49.18	7.84	42.00	68.00	-1.013	0.317
9	RI, conditional units	88.91	8.41	69.00	109.00	0.388	0.700
D-type (n = 10)							
1	VC, ml	2600.00	273.74	2090.00	3000.00	-0.420	0.680
2	HR at rest, bpm ⁻¹	76.20	3.19	72.00	82.00	-0.311	0.760
3	HR after exercise, bpm ⁻¹	130.40	9.43	114.00	143.00	-0.338	0.739
4	SBP, mmHg	120.80	6.27	114.00	134.00	-0.614	0.547
5	DBP, mmHg	81.10	2.23	78.00	84.00	-2.579	0.019
6	Recovery time after exercise, s	161.40	17.05	124.00	180.00	0.306	0.763
7	VCI, ml·kg ⁻¹	38.50	2.99	33.00	44.00	-0.727	0.476
8	IMIS, %	42.50	3.60	36.00	50.00	-1.436	0.168
9	RI, conditional units	91.70	5.56	84.00	99.00	-0.956	0.352

Note: a reliably significant difference between the two means is highlighted in color

In girls with M-type, there was an improvement in VCI parameters, which amounted to an average of 3.23 ml·kg⁻¹ (t = -2.467; p < 0.018).

In girls with D-type, an increase in DBR to 81.1 mmHg was detected, but, at the beginning of the study, these parameters were within the age-related norm. Therefore, this result was not considered an option for improving the indicator.

These changes contributed to increased differences between the parameters achieved by girls with a particular somatotype at the end of the school year. In particular, the following trend was found: in each pair of samples, out of all 9 characteristics studied, 5 differed by a statistically significant amount when compared, except the T- and D- samples (Table 4).

At the same time, in girls with A- and T-types, the following characteristics were VC, HR at rest, DBR, VCI,

Table 4. Differences in results of girls with different somatotypes at the end of the study

Result (points)	The name of the parameter								
	1	2	3	4	5	6	7	8	9
A - T									
t	-2.799	2.168	1.470	-2.140	-3.676	-0.204	3.164	-0.004	2.197
F	1.451	1.157	1.515	1.624	1.292	2.122	1.930	1.480	1.086
p	0.009	0.038	0.151	0.040	0.001	0.840	0.003	0.997	0.035
A - M									
t	-0.415	3.038	2.734	-2.504	-5.841	-0.038	-0.060	-1.308	3.192
F	1.760	2.070	1.050	3.060	1.030	1.710	1.120	2.160	2.410
p	0.681	0.005	0.010	0.018	0.000	0.970	0.952	0.201	0.003
A - D									
t	-1.437	1.707	-3.205	-2.926	-10.650	-2.272	3.646	1.043	2.262
F	1.500	1.800	1.210	1.170	2.340	1.200	3.080	2.240	1.410
p	0.166	0.103	0.004	0.008	0.000	0.034	0.002	0.310	0.035
T - M									
t	2.543	0.594	2.401	-0.790	-2.264	1.0009	-4.398	-2.392	1.640
F	1.124	1.080	1.106	1.656	1.291	1.283	1.787	3.139	1.755
p	0.015	0.559	0.021	0.434	0.029	0.323	0.000	0.021	0.109
T - D									
t	1.043	-0.266	-5.487	-1.729	-6.421	-3.037	1.407	1.307	0.382
F	1.030	1.560	1.830	1.380	3.030	2.600	1.590	1.510	1.300
p	0.305	0.792	0.000	0.094	0.000	0.005	0.170	0.201	0.705
M - D									
t	-0.958	-0.750	-7.025	-1.383	-5.061	-3.505	4.527	2.558	-0.955
F	1.090	1.680	1.650	2.290	2.350	2.030	2.850	4.750	2.290
p	0.346	0.459	0.000	0.177	0.000	0.002	0.000	0.016	0.347

Note: a reliably significant difference between the two means is highlighted in color

and RI. Specifying these differences, it was noted that girls with T-type had an advantage over girls with A-type in all these characteristics, except for VCI. The latter indicated better oxygen supply to the body in girls of this somatotype.

When comparing the parameters of functional characteristics of girls with A- and M-types, it was noted that the values of HR at rest, HR after exercise, RI, as well as SBR and DBR differed significantly. All parameters were better in girls with M-type, except for the last two, as in both samples they were within the age norm.

When comparing the parameters of A- and D-type girls, it was noted that HR after exercise, DBR, recovery time after exercise, VCI, and RI were significantly different. At the same time, the results in all these characteristics, except RI, were better in girls with A-type.

The parameters VC and HR after exercise differed in girls with T- and M-types, DBR, VCI, and IMIS. T-type girls had an advantage in the first characteristic, while M-type girls showed better results in the others.

As for the T- and D- samples, statistically significant differences were found in the parameters HR after exercise, DBR, and recovery time after exercise. In all cases, representatives of the T-type showed better results.

The same advantage was noted in girls with M-type when comparing the parameters HR after exercise, DBR, recovery time after exercise, VCI, and IMIS with those obtained in the sample of girls with D-type.

Discussion

The study of the parameters of physiological characteristics achieved by girls with different somatotypes while exercising outside the university due to COVID-19 quarantine and air raids during hostilities is an important task (Banakh, 2019). It is caused by trends related to the modernization of student physical education based on personalization and individualization (Kljajević et al., 2021; Annear, 2022; Ge et al., 2024). At the same time, one of the promising directions of such modernization is related to the identification of means that are interesting for girls and adequate volumes, taking into account individual characteristics (Roure et al., 2021; Hao & Yang, 2022). This direction should involve a shift from partially selective to comprehensive consideration of students' characteristics, including data synthesis and integral perception of the information received (Wium, Säfvenbom, 2019; Banakh,

Iedynak, 2021). In this regard, the question arises of the choice and further application of an effective marker, which, based on individualization and personalization in the physical education of students, will formulate physical activity programs and assess their various characteristics (Coulter et al., 2016; Coimbra et al., 2021; Frąckiewicz, 2023). Researchers' information suggests that somatotype may be one of these markers (Cinarli & Kafkas, 2019; Campa et al., 2020). The latter is considered a conditional marker, which is an external manifestation of a person's constitution (Carter & Heath, 1990; Iedynak et al., 2021; Dinparastisaleh, R. et al., 2023). In turn, the constitution is characterized as the integrity of morphological and functional properties that are inherited and acquired, relatively stable over time, associated with the pace of individual development, peculiarities of the body's reactivity, style of activity and material prerequisites of human abilities (Katzmarzyk & Silva, 2013; Stewart et al., 2014; Silventoinen et al., 2021).

In other words, the somatotype reflects a complex of individual characteristics, which means that it is possible to assess the state of their development and take them into account when developing individual physical activity programs that are adequate to current capabilities and abilities (Pereira et al., 2017; Zorrilla-Revilla et al., 2022). Such information, although only a part of the total, is nevertheless an argument for the effectiveness and efficiency of somatotype in terms of implementing a personalized approach in the practice of physical education of students.

A certain confirmation of this is the information about the normal nature of the distribution of individual values, which was determined by the K-S test in girls with different somatotypes. These data are consistent with the results of another study (Banakh et al., 2023). Also, the results of other researchers show that the values of most morphological and functional indicators in samples of girls and boys show polymodality (Sands, 2012; Silventoinen et al., 2021). The main reason for this is the combination in one sample of two or more qualitatively different populations of the same age and sex, i.e., belonging to different somatotypes (Robinson, 2016; Weir & Vincent, 2020). At the same time, the differences are significantly reduced if the somatotype is taken into account when determining the nature of the distribution of individual values in a particular sample (Iedynak et al., 2021).

Taking into account the above, an experimental study was conducted. Already at its beginning, discrepancies were found in the parameters of the physiological characteristics of girls with different somatotypes. Differences were also found at the end of the study, and they were even more pronounced than at the beginning. Such a result was associated with a complex of reasons, one of which related to the peculiarities of morphofunctional development, namely, the clearly expressed typological dependence of the parameters of these characteristics (Ryan-Stewart et al., 2018; Cinarli et al., 2022; Sliusarchuk et al., 2022). In connection with the peculiarities of such development, it was noted that the growth and development processes begin earlier in D-type women. Compared with them, such processes begin, on average, half a year later in girls with M-type, in girls with T-type one year later, and in girls with A-type – by one and a half years (Hasiuk, 2003). Such a feature determines the unequal pace of development of various functional systems, physiological characteristics, and motor capabilities (Bacil et al., 2015;

Kvintová & Sigmund, 2016; Wilmore et al., 2022). This is confirmed by our results, in particular, the differences in the values of the studied indicators. Thus, at the beginning of the study, the largest number of characteristics, the parameters of which differ by a statistically significant value, were found in pairs of samples T-A and T-D, in particular, there were 6 of them out of all 9 studied. The parameters in the pair of T-M samples were practically the same, except for VC (it was better in T-type) and DBR (it was more in M-type). Between girls with A-type and D-type, the first have a better reaction of the cardiovascular system to dosed physical exertion, the state of providing the body with oxygen (VCI), indicates the state of excessive accumulation in the muscles of structural and energy potentials that increase their working capacity (IMIS). One of the main reasons was associated with excess body weight, which is characterized by girls with D-type (Dinparastisaleh et al., 2023). Such morphological parameters negatively affect the state of the cardiovascular system, they limit physical activity, the consequence of which is different from the necessary possibility of functioning of the respiratory system and, to a certain extent, the effectiveness of the neuromuscular system (Saha, 2014; López-Sánchez et al., 2019). The period during which the experiment took place was marked by limited physical activity due to the epidemic of COVID-19, as well as air alarms. In addition, to a large extent different from the necessary volumes of physical activity were due to the lack of mandatory physical education classes for girls. Such activities, although only partially, increase the amount of physical activity in girls (Piestrzyński et al., 2021).

Data at the end of the study made it possible to obtain not only information about differences in the parameters of the physiological characteristics of girls with different somatotypes but also a change in the parameters of these characteristics during the study in representatives of each somatotype. In the latter case, it was found that in the A-type no characteristic changed by a statistically significant value, in the T-type there was a deterioration of the parameters in two characteristics (IMIS, VCI), and the detection of others at the previously achieved level. Girls with M-type improved VCI, girls with D-type increased DBR, but at the beginning, the value of the indicator also corresponded to the age norm. The main interpretation of such data is the insufficient amount of physical activity used by the girls during the study period. It is this reason that is identified as one of the main reasons for the change in physiological characteristics of both girls and boys (Zhang & Wu, 2020; James et al., 2023). At the same time, the features present in each somatotype determined the obtained results. Researchers emphasize this, in particular, they note that the state and features of development must be taken into account in practical activities, in particular, the features inherent in a certain somatotype (Katzmarzyk & Silva, 2013; Cinarli & Kafkas, 2019). One of the main reasons for the identified discrepancies lies in the unequal genetic program of the development of body systems of a girl of a certain somatotype, compared to representatives of other somatotypes. Such a development program can be adjusted to a certain extent, but only within the limits defined by it; the factors that determine such an adjustment are physical activity, nutritional features, etc. (López-Sánchez et al., 2013; Silventoinen et al., 2021).

The results of the conducted research allow us to get closer to solving the problem of offering each girl an adequate

program of physical activity, the basis of which is taking into account her characteristics. This, in turn, will contribute to strengthening the motivation of girls to engage in physical activity, because the volume and content of physical activity will reflect the wishes and capabilities of each girl, and therefore will strengthen the motivation to achieve success, the proposed normative evaluations will be realistic to achieve (Wiiium & Säfvenbom, 2019; Coimbra et al., 2021).

As for the direction of further research, we see them in the determination of features related to the state of development of motor qualities, and psychophysiological indicators of girls with different somatotypes.

Conclusions

Trends in the modernization of student physical education are largely related to its personalization and individualization. One of the effective markers for the practical implementation of this is somatotype. Therefore, the study of the features that distinguish girls and boys with different somatotypes is an extremely relevant issue.

The experimental study revealed peculiarities in the parameters of physiological characteristics of first-year girls with different somatotypes. At the beginning of the study, most of the characteristics whose parameters differ significantly (at the level of $p < 0.05 \div 0.001$) were found in the pairs of samples T-A and T-D; there were 6 of them out of all 9 subjects. Almost the same parameters were found in the T-M samples, except VC (better in the T-type) and DBR (higher in the M-type). Among girls with A-type and D-type, which are marked by extreme variants of body composition components, the former has a better response of the cardiovascular system to dosed physical activity, the state of oxygen supply to the body (VCI), indicates the state of excessive accumulation in the muscles of structural and energy potentials that increase their working capacity (IMIS).

At the end of the study, it was found that girls with A-type did not improve any physiological characteristics, girls with T-type had deteriorated IMIS and VCI, girls with M-type had improved VCI, girls with D-type had increased DBR, but at the beginning, the value of the indicator also corresponded to the age norm. As for the differences, they increased at the end of the study: in each pair of samples, out of all 9 characteristics studied, 5 differed by a statistically significant amount, except for the pair of T- and D-types, where the difference was in 3 indicators (HR after loading, DBR, recovery time after loading) with the advantage of T-type representatives.

To increase the effectiveness of physical education at the university, it is advisable to differentiate it with further personalization of the content, taking into account the peculiarities of manifestation and changes in the parameters, primarily psychophysiological characteristics and physical abilities, which are characteristic of girls and boys with different somatotypes.

Conflicts of interest

No conflicts of interest exist.

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Виявлення особливостей фізіологічних характеристик дівчат із різними соматотипами за відсутності в університеті обов'язкової фізичної активності

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 11 с., 4 табл., 54 джерела.

Мета дослідження полягала у визначенні параметрів фізіологічних характеристик дівчат із різними соматотипами, яких вони досягли здійснюючи фізичну активність поза межами університету в зв'язку з карантинном Covid-19 та повітряних тривогах під час бойових дій в Україні.

Матеріал та методи. У дослідженні взяли участь 66 дівчат 17,8 ± 0,6 років, які належали до різних соматотипів та не мали застережень щодо використання різних обсягів фізичної активності. Для діагностики соматотипу використовували методику Штефко-Островського у модифікації С. Дарської. Одержували необхідні емпіричні дані за допомогою добре відомих функціональних тестів, що дозволяли визначити артеріальний тиск, частоту серцевих скорочень у різних ситуаціях, життєву ємність легень, життєвий індекс, силовий індекс, індекс Робінсона. Параметри цих характеристик визначали у дівчат з кожним із чотирьох наявних соматотипів протягом дослідження, а також порівнювали кожний параметр у різних соматотипах. Тестування проводили на початку (січень) та наприкінці (травень-червень) навчального семестру під час одного навчального року.

Результати. На початку, а ще більшою мірою наприкінці, навчального року, параметри досліджуваних характеристик у дівчат з кожним із наявних соматотипів відрізнялися між собою (p на рівні від 0.05 до 0.000). Використані протягом навчального року обсяги та умови реалізації фізичної активності не призвели до суттєвої зміни фізіологічних характеристик усіх дівчат, тобто параметри залишилися на досягнутому раніше рівні. Водночас відзначили існування особливостей, що зумовлені приналежністю дівчини до певного соматотипу.

Висновки. Виявлення особливостей у зміні параметрів фізіологічних характеристик дівчат із урахуванням їхніх соматотипів, є перспективним і важливим напрямком модернізації фізичного виховання в університеті. Отримані дані дозволять підвищити дієвість персоналізації змістової та диференціації нормативної основ фізичного виховання дівчат, використовуючи для цього інформацію про вияв і зміну в них параметрів різних характеристик, у тому числі фізіологічних.

Ключові слова: фізіологічні характеристики, дівчата, персоналізація, диференціація, фізичне виховання, студентки, фізична активність, Covid-19.

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