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Effectiveness of Different Models of Physical Activity in Improving the Physiological Characteristics of Girls Studying at University

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Abstract

Objectives. The purpose of the study was to determine the best of two models of physical activity in improving the physiological characteristics of girls during the first year of university study.

Material and methods. The study involved 79 girls, each aged 17.7±0.4 years, belonging to the most numerous thoracic and muscular somatotypes, with no restrictions on the use of different amounts of physical activity, and were randomly assigned to experimental and control groups. A modified Stefko-Ostrovsky method was used to diagnose the somatotype. We studied blood pressure, heart rate in different situations, lung capacity, vital capacity, vital index, strength index, and Robinson index. At the beginning and end of the experiment, which lasted for one academic year, the necessary empirical data were obtained using well-known functional tests. Regarding girls' physical activity, the experimental groups used the model developed by us, and the control groups used the traditional model of physical activity during the first year of study at a higher education institution.

Results. At the beginning of the study, the values of functional characteristics in experimental and control groups practically did not differ from each other, and the nature of the distribution of individual values in each group corresponded to normal. The use of the developed model by girls with thoracic and muscular somatotypes led to the improvement of 7 and 8 of all 9 characteristics studied, respectively, while the use of the traditional model led to their manifestation at the level achieved earlier. At the end of the study, in both experimental groups, the results of detection of all characteristics were significantly better (at the level of $p < 0.05 \div 0.000$) than in the control groups, except for SBP of girls with thoracic, SBP and RI of girls with muscular types.

Conclusions. The author's model of physical activity was experimentally proved to be much more effective than the traditional one in improving the physiological characteristics of girls during the first year of study at university. The following features were revealed peculiarities in the change of parameters of physiological characteristics of girls with different somatotypes will contribute to the increase of efficiency of personalization of organizational, content and differentiation of normative bases of university physical education.

Keywords: physiological characteristics, models of physical activity, university, girls, experimental parameters.

Introduction

In recent years, students' physical activity continues to be an object of increased research attention (American College, 2019; Get Active, 2020; Global action plan on physical activity, 2020). This is due to many reasons, one of the main ones being that physical activity is considered one of the most effective means of solving the various tasks of university physical education (Banakh, & Iedynak, 2021; Abrantes et al., 2022; Wilmore et al., 2022). First of all, it concerns the different from the required state of development of various morphofunctional, psychophysiological, motor characteristics and physical capabilities of student youth (Piestrzyński, 2021; Banakh et al., 2023).

Another important reason for the attention to students' physical activity is related to changes in its organization in recent years, primarily due to quarantines during the Covid-19 epidemic (Wilson et al., 2021; Andrieieva et al., 2023), in Ukraine additionally with frequent air raids due to hostilities (Byshevets et al., 2024). Such changes in the organization of students' physical activity are the dominance of online classes with a teacher, independent group and individual

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classes in their free time (Centeio et al., 2021; Misharskyi et al., 2023). These changes have strengthened the tendency to design university physical education exclusively as an optional discipline, which is assessed negatively by most researchers (Wiium, & Säfvenbom, 2019; Annear et al., 2022; Ge et al., 2024). In addition, it should be borne in mind that the compulsory physical education classes implemented at the university during the academic week and year do not provide the necessary amount of physical activity, and therefore the successful solution of its tasks (López-Valenciano et al., 2021; James et al., 2023).

With this in mind, researchers are looking for promising ways to improve university physical education, and one of them is the personalization of this process. The main idea is to design an educational route for each student to solve the task (Wiium, & Säfvenbom, 2019). Such a route involves orienting the student to independent physical activity in their free time, offering its current focus, adequate content, and providing advice (Coulter et al., 2016; Frąckiewicz, 2023). At the same time, it is especially important to consider the criteria based on which the adequate content of physical activity will be formed for each student (Banah, & Iedynak, 2021). A significant number of researchers propose to use such a marker (predictor) as a somatotype (Cinarli, & Kafkas, 2019; Iedynak et al., 2021).

At the same time, information about the peculiarities of the development of physiological characteristics is needed, since the impact on them by physical activity is one of the main tasks of university physical education (Katzmarzyk, & Silva, 2013; Wilmore et al., 2022). Information about such characteristics is also necessary to establish the degree of risk of harm to the body during training and physical activity (Silventoinen et al., 2021). In addition, high parameters of physiological characteristics contribute to the quality of a young person's performance in educational and various types of household activities, as well as to maintaining and improving health, physical condition, and other important characteristics that ensure a high quality of life and fulfillment of professional duties in the future (Campa, & Greco, 2022).

Given the above information, it was noted that there is a need to conduct research in this area. Therefore, the purpose of the study was to determine the best of two models of physical activity in improving the physiological characteristics of girls during the first year of university study.

Materials and Methods

Study Participants

The study involved 79 girls, each aged 17. 7±0. 4 years. None of them had any reservations about using different amounts of physical activity and belonged to one of the somatotypes that are the most numerous in terms of the number of representatives. It was thoracic somatotype (T-type) and muscular somatotype (M-type), which united 40 and 39 girls, respectively, 18 and 17 of them were in experimental groups (E), 22 – in control groups (C).

Study Organization

Somatotypes were diagnosed at the beginning of the experiment. For this purpose, a modified Shtefko-Ostrovsky scheme was used, because its main characteristics are very similar to the Heath-Carter scheme, which is most often used by researchers from Europe and the United States (Stewart et al., 2014; Bertuccioli et al., 2022). In addition, the Selection Shtefko-Ostrovsky scheme causes an extreme possibility of establishing a certain trend, especially manifestations and changes in physical readiness in comparison with the data of other researchers (Sands, 2012; Iedynak et al., 2021).

Physiological characteristics that reflected the state of functioning of the respiratory, cardiovascular, and neuromuscular systems of girls were studied.

Each functional test used is well-known, reliable, informative, and widely used in practice (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 / body mass), maximum isometric strength index (IMIS = maximum isometric strength/body mass); Robinson index (RI = SBP x HR/100). 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 – Cardio-Spiro, NDD EasyOne Plus System 2000-2 spirometer. VCI and IMIS included the determination of body mass, for which OMRON BF 511 scales were used.

During the use of each test, all the specified requirements were met. Testing took place at the beginning (September) and at the end (May-June) of the study. In each somatotype, the data of girls of E and C groups were compared. In addition, the data of girls of T- and M-types in E and then in C were compared to determine whether the difference was statistically significant. In each characteristic, the increase, decrease in parameters, or their manifestation at the previously achieved level were assessed.

The study was planned and executed in accordance with the principles of bioethics of the Helsinki Declaration for Ethical Principles for Medical Research Involving Human Subjects and the UNESCO Universal Declaration on Bioethics and Human Rights. Thus, the requirements of voluntariness, anonymity, and trust were met, and all girls provided informed written consent to participate in the study.

As for the implemented models of physical activity, the experimental factor was implemented in the "E" group, and the traditional factor in the "C" group. The first one focused on the developed structural and functional model of personalization of physical education of applicants and methodological support of its implementation. The traditional factor involved the implementation of generally accepted practices of universities' organization of physical education and the content of educational material determined by existing recommendations and practice. At the same time, we focused on achieving the maximum possible similarity of the parameters of physical activity of girls in groups "E" and "C". Thus, they had the same time for each compulsory physical education lesson (90 minutes) and each part of it throughout the academic year: preparatory – 5-11 minutes, main – 69-77, final – 8-10. The content of the preparatory part of the lesson included walking, running at a slow pace, and a set of exercises for the muscles of the upper extremities, trunk, and lower extremities. The final part included 2-3 exercises to

relax the muscle groups that were most involved in the session, 3-4 exercises to stretch these muscles in a static mode for 15-20 seconds, and one breathing exercise. The dosage and exercises did not differ from those recommended by researchers (Wuest et al., 2005; Wiium et al, 2019). In the main part, the main task was to improve the girls' physiological characteristics to the highest possible level. In this regard, the baseline load provided a heart rate in the range of 150-170 bpm^{-1} (mostly 60-70 % of the maximum possible value). Taking into account the recommendations (Sliusarchuk et al., 2023), in the first half of the main part of the lesson, we used the content based on the Body Workout fitness program. After the preparatory stage, which lasted two weeks and provided for the preparation of the body for the following loads, during September-October, the variant of the fitness program "26 Mins Full Body Aerobic Workout" was used, during November and further until the end of the academic year – the variant "45 Mins Full Body Aerobic Workout" (Mins+, 2024). The main parameters of such loads provided for 8-12 repeated maxima in exercises for the upper extremities in one series, 12-18 – in exercises for the lower extremities; there was no rest between exercises. Two such series were performed; the rest depended on the heart rate recovery rate (within 45-60 seconds). In addition, the following condition was fulfilled: in the last week of the month, all exercises of the complex were performed with dumbbells of small weight (1-1.5 kg) or rubber bands. After that, the remaining time of the main part of the lesson was used differently. In group C, girls performed educational tasks determined by the teacher, and they were mainly concerned with mastering and improving motor actions in athletics, gymnastics, and the implementation of sports or outdoor games. At the same time, girls in group E used content that they chose on their own based on their interests and wishes (mostly sports and outdoor games).

The teacher here carried out only the general organization, adjusted the use of some means, methods, as well as the intensity of the load and the duration of rest in order to achieve parameters that were adequate to the current capabilities of girls.

In addition, the experimental factor involved the implementation of theoretical and methodological training in physical education in the first semester, aimed at forming the necessary knowledge and skills, strengthening additional motives, and creating new incentives for girls to engage in physical activity in their free time. One of them involved the use of standards for assessing the development of motor skills and identifying peculiarities in functional characteristics developed for each somatotype. The traditional factor is oriented to consideration of only separate questions of theoretical and methodical preparation during practical classes on physical training. To assess the development of these characteristics we used medieval standards recommended by researchers. The load parameters corresponded to the recommendations concerning the development of a certain motor quality; it was a quality with a low level of development, determined by its teacher.

As for physical activity in leisure time, all girls were oriented to its implementation. At the same time, in group C, they chose an individual form of physical activity or as part of a team. Girls were recommended to improve physiological and motor characteristics, the development of which differed most from the required. In the case of physical activity as part of a team, its content was a sports game, which was chosen by most girls. They were oriented to use a load that was adequate to their current capabilities. Girls of group "E" chose an individual form of physical activity, each developing its content together with the teacher, based on the task. It took into account peculiarities of the development of physiological and motor characteristics of a representative of a certain somatotype, her interests and wishes.

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 standard error of the mean (SEM) Kolmogorov-Smirnov Test (KS). The latter allowed us to determine the nature of the distribution of individual values in the samples of girls. Based on the results of this analysis, when comparing two means, the Student's T test was used for related and unrelated samples; the 0.05, 0.01, and 0.001 probability levels were used to indicate statistical significance (Weir, & Vincent, 2020).

Results

At the beginning of the study, the K-S test revealed that in the experimental groups of T- and M-type girls, the distribution of individual values of all physiological characteristics corresponded to normal (Table 1).

Comparing the parameters of T-type representatives in groups E and C, we found no significant difference between them. The result was similar in the experimental groups of girls with M-type (Table 2).

This increased the objectivity of conclusions about the results of the impact of the used models of physical activity on the functional characteristics of girls in the study groups.

Testing of such characteristics at the end of the study showed a completely different result. Thus, girls with T-type of group "C" did not improve any functional characteristics during the academic year; parameters remained at the previously achieved level (Table 3).

In group "E", on the contrary, there was an improvement in all characteristics, except for SBP and DBP, which remained at the previous level. But both indicators at the beginning and end of the school year did not differ from the age norm, so this change was not considered a negative trend.

In girls with M-type of group "C," no improvement in any functional characteristic was found, and the parameters remained at the previously achieved level (Table 4).

In group E, the result was different: all characteristics changed except SBP. However, the change in blood pressure was not taken into account, because in all cases the parameters corresponded to the age-related norm.

According to another criterion, which was used to conclude on the effectiveness of the models used, we obtained a result that was consistent with the one mentioned earlier. In particular, it was found that at the end of the study, T-type women in group E achieved significantly higher parameters of the studied characteristics than women in group C (Table 5).

The exception was SBP, whose parameters in both groups did not differ from each other and corresponded to the age norm. The result was similar in the experimental groups of

Table 1. Results in the experimental groups of girls at the beginning of the study

N	The name of the parameter	On beginning				
		M_1	SD	Min	Max	K-S, p
		T-type (group E – n = 18)				
1	VC, ml	2610.56	163.04	2340.00	2900.00	>0.20
2	HR at rest, bpm^{-1}	77.39	3.33	71.00	84.00	>0.20
3	HR after exercise, bpm^{-1}	114.56	6.51	106.00	126.00	>0.20
4	SBP, mmHg	117.11	3.45	110.00	124.00	>0.20
5	DBP, mmHg	74.72	3.88	68.00	82.00	>0.20
6	Recovery time after exercise, c	152.78	7.89	141.00	165.00	>0.20
7	VCI, $ml{\cdot}kg^{-1}$	44.61	4.31	33.00	48.00	>0.15
8	IMIS, %	47.28	3.44	43.00	54.00	>0.20
9	RI, conditional units	94.11	5.59	85.00	104.00	>0.20
		T-type (group C – 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, c	150.73	10.11	126.00	168.00	>0.20
7	VCI, $ml{\cdot}kg^{-1}$	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 (group E – n = 17)				
1	VC, ml	2500.00	220.57	2130.00	2900.00	>0.20
2	HR at rest, bpm^{-1}	75.71	2.31	70.00	78.00	>0.20
3	HR after exercise, bpm^{-1}	111.12	8.42	98.00	128.00	>0.20
4	SBP, mmHg	119.29	4.26	112.00	124.00	>0.20
5	DBP, mmHg	75.18	4.92	70.00	80.00	>0.20
6	Recovery time after exercise, c	148.35	17.42	94.00	168.00	>0.20
7	VCI, $ml{\cdot}kg^{-1}$	43.94	3.85	40.00	54.00	>0.20
8	IMIS, %	48.06	5.23	40.00	59.00	>0.20
9	RI, conditional units	90.77	6.62	81.00	102.00	>0.20
		M-type (group C – 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, c	150.09	11.33	119.00	163.00	>0.10
7	VCI, $ml{\cdot}kg^{-1}$	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

Table 2. Differences in functional characteristics of girls in the study groups (E and C) at the beginning of the study

Result (points)	The name of the parameter								
	1	2	3	4	5	6	7	8	9
					T-type				
t	-1.879	0.787	0.939	-0.565	2.275	0.703	0.298	0.087	0.419
F	2.904	1.253	1.215	2.198	1.274	1.645	1.196	1.017	1.250
p	0.068	0.436	0.354	0.575	0.029	0.487	0.768	0.931	0.678
					M-type				
t	0.139	1.225	0.274	1.021	1.161	-0.377	0.722	0.546	0.425
F	1.028	1.649	1.199	2.174	1.030	2.364	1.216	1.182	1.151
p	0.890	0.228	0.786	0.314	0.253	0.709	0.475	0.588	0.673

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

Table 3. Results in the study groups of girls with T-type at the end of the study

N	The name of the parameter	At the end				$(M_1 - M_2)$	
		M_2	SD	Min	Max	t	p
		T-type (group E – n =18)					
1	VC, ml	2983.33	190.20	2650.00	3350.00	6.310	0.001
2	HR at rest, bpm^{-1}	69.50	2.09	67.00	74.00	8.581	0.001
3	HR after exercise, bpm^{-1}	100.61	6.70	92.00	112.00	6.352	0.001
4	SBP, mmHg	118.50	2.87	112.00	123.00	1.311	0.833
5	DBP, mmHg	76.06	2.21	72.00	80.00	1.280	0.728
6	Recovery time after exercise, c	109.40	8.11	97.00	122.00	16.251	0.0001
7	VCI, $ml \cdot kg^{-1}$	55.67	4.04	44.00	60.00	7.933	0.001
8	IMIS, %	54.39	6.13	46.00	67.00	4.281	0.001
9	RI, conditional units	82.83	4.36	74.00	90.00	6.752	0.001
		T-type (group C – 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, c	146.50	10.57	118.00	164.0	1.355	0.183
7	VCI, $ml \cdot kg^{-1}$	40.41	3.78	33.00	52.0	1.929	0.945
8	IMIS, %	44.59	4.43	38.00	56.0	1.160	0.737
9	RI, conditional units	92.59	6.34	83.00	105.0	0.475	0.637

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

Table 4. Results in the study groups of girls with M-type at the end of the study

N	The name of the parameter	At the end				$(M_1 - M_2)$	
		M_2	SD	Min	Max	t	p
		M-type (group E – n = 17)					
1	VC, ml	3152.35	302.31	2650.00	3820.00	7.190	0.001
2	HR at rest, bpm^{-1}	68.88	1.87	66.00	73.00	9.471	0.001
3	HR after exercise, bpm^{-1}	94.88	5.18	87.00	102.00	6.782	0.001
4	SBP, mmHg	119.76	2.31	116.00	124.00	0.281	0.833
5	DBP, mmHg	78.35	1.87	76.00	82.00	3.771	0.008
6	Recovery time after exercise, c	112.24	10.51	88.00	126.00	4.930	0.001
7	VCI, $ml \cdot kg^{-1}$	51.24	4.70	45.00	62.00	4.972	0.001
8	IMIS, %	57.47	5.27	48.00	68.00	5.231	0.001
9	RI, conditional units	85.24	5.85	76.00	95.00	2.583	0.001
		M-type (group C – n = 22)					
1	VC, ml	2503.00	302.31	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, c	143.09	11.98	110.00	156.00	1.992	0.053
7	VCI, $ml \cdot kg^{-1}$	46.32	5.05	41.00	59.00	-2.001	0.218
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

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

M-type women, except that, in addition to SBP, RI parameters did not differ in groups E and C.

Discussion

Traditional organization, formation and realization of students' physical activity content do not provide achievement of the necessary results (Banakh, & Iedynak, 2021). First of all, it concerns the state of development of different morphofunctional, psychophysiological, motor characteristics and physical capabilities, which today differ from the required ones (Piestrzyński et al., 2022; Banakh et al., 2023). But despite this result, physical activity continues to be the most effective means of solving this problem and solv-

Table 5. Differences in functional characteristics of girls of the research groups (E and C) at the end of the study

Result (points)	The name of the parameter								
	1	2	3	4	5	6	7	8	9
					T-type				
t	3.681	6.450	6.212	1.321	3.543	12.470	12.242	5.681	5.740
F	2.130	3.620	1.090	3.430	3.100	1.700	1.150	1.920	2.120
p	0.010	0.000	0.000	0.320	0.010	0.000	0.000	0.000	0.000
					M-type				
t	6.750	6.272	5.400	1.473	3.790	8.551	3.130	3.950	1.600
F	1.330	4.920	2.000	3.220	3.350	1.300	1.150	2.210	2.070
p	0.000	0.000	0.000	0.280	0.010	0.000	0.010	0.004	0.240

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

ing some other, but also important tasks (American College, 2019; Get Active, 2020; Global action plan on physical activity, 2019).

At the university, students' physical activity is realized during physical education classes, which is an academic discipline, as well as during independent classes and/or in a section on a particular sport or fitness (Abrantes et al., 2022). At the same time, the use of physical education classes alone does not provide the necessary result in achieving high parameters of various but important characteristics of students (Wilmore et al., 2022). That is why one of the leading trends in the modernization of both physical education and all physical activity of students is the personalization of the process (Annear et al., 2022; Ge et al., 2024). The basis should be means that are interesting to students, as well as adequate methods and volumes of load that take into account the characteristics of each (Roure et al., 2021; Hao, & Yang, 2022). The latter should be based on an integrated approach, i. e. , involve the synthesis of data and an integrated perception of the information received based on an effective predictor (Wiium, & Säfvenbom, 2019; Banakh, & Iedynak, 2021). It is the fulfillment of such conditions that will ensure the formation of an effective physical activity program and an objective assessment of the various characteristics of each student (Coimbra et al., 2021; Frąckiewicz, 2023). Researchers consider somatotype to be one of the most promising predictors (Cinarli, & Kafkas, 2019; Campa et al, 2020). The following information confirms its promise in solving the task: somatotype reflects the integrity of inherited and acquired morphological and functional properties that are relatively stable over time, associated with the rate of development, peculiarities of the body's reactivity, style of activity, material prerequisites of abilities (Katzmarzyk, & Silva, 2013; Stewart et al, 2014).

To some extent, the data obtained in our study confirm this. In particular, at the beginning, the nature of the distribution of individual values (using the K-S test) in all research groups of girls with different somatotypes corresponded to the normal one. If only gender and age are taken into account, the distribution of values of most morphological and functional parameters in such a sample will show polymodality (Silventoinen et al, 2021; Banakh et al, 2023).

The results obtained in our study showed that the model of physical activity currently used in universities provides improvement of only some functional characteristics in group C girls with different somatotypes. This result was attributed to the different content of girls' physical activity from the required one and the parameters of the proposed load. The result is to some extent consistent with that obtained by other researchers (Piestrzyński et al, 2021; Andrieieva et al, 2023), and one of the main reasons, in their opinion, is the decrease in the amount of physical activity of girls during the first year of study at university. To a certain extent, this result is confirmed by the result in group E, where the model of physical activity developed by us was implemented. In particular, the use of adequate parameters of physical activity during the academic year allows to improve the functional characteristics of girls by a value that is significantly better than in group "C".

This result was attributed to a number of reasons. One of the main ones was the motivation of girls to engage in physical activity in their free time. Measures to increase motivation, which were implemented before the study in group E according to the model of physical activity used by these girls, gave a positive result. After all, additional physical activity can improve girls' characteristics during the school year (James et al, 2023). The use of more physical activity by girls of group E than by girls of group C was associated with the improvement of their psychological needs, namely independence, competence, and integration into the team. In our opinion, the model implemented in group C could to some extent contribute to some improvement only in competence and independence. Satisfaction of such psychological needs ensures the formation of an intrinsic type of motivation (Ntoumanis, & Standage, 2011). Without this, it is almost impossible to achieve a positive result in the development of functional characteristics and physical conditions of students (Coimbra et al, 2021).

Another important reason for the result was that the content of physical activity in groups "E" and "C" involved functional systems and mechanisms that ensured the manifestation of unequal characteristics of girls (Silverman, & Deuster, 2014). In addition, the body's reactions to the load parameters provided by the used models of physical activity were different (Wuest, & Bucher, 2005; Astha, 2011). Thus, under the influence of an external factor (in our case, physical activity), a stress response occurs in the body. It involves an increase in the power of functioning of various systems, activation of regulatory functions, and mobilization of body reserves (Wilmore et al., 2022). In group E, the parameters of characteristics that reflected the state of the respiratory system (VCI), blood circulation (HR, RI), and the body's response to stress (RTI) reached significantly higher values at the end of the study than in group C. In other words, the

model of physical activity in group "E" provided for larger, but adequate, load parameters, and their use contributed to a greater positive change in the functional characteristics of girls than the load parameters of the model implemented in group "C".

This is confirmed by the following information from researchers: the more the load parameters correspond to the current state of the body, the more the genetic apparatus of cells is activated, which leads to energy deficiency. This results in an increased increase in energy potential, which leads to a higher result in increasing the body's nonspecific resistance (Nieman, & Wentz, 2018). As a result, such a reaction of the body leads, among other things, to an increase in the number of active motor units, active muscle fibers, the strength and speed of their contraction, as well as the amount of glycogen, ATP, and creatine phosphate (Silverman, & Deuster, 2014). The above is to some extent confirmed by the results of IMIS changes in the study groups of girls. This characteristic reflects the state of development of the skeletal muscles of girls, which indirectly indicates the state of excessive accumulation in the muscles of structural and energy potentials that increase their working capacity. In "E" girls with T-type IMIS at the end of the study reached 54.39 ± 6.13 conditional units, while in "C" – only 44.59 ± 4.43 ($t = 5.681$; $p = 0.000$); at the beginning, the values were almost the same – respectively 47.28 ± 3.44 and 47.18 ± 3.47 conditional units ($t = 0.087$; $p>0.05$). In the M-type, the result was similar: in "E" at the end of the study, the IMIS was 57.47 ± 5.27 conditional units, in "C" – only 49.18 ± 7.84 ($t = 3.950$; $p = 0.004$), and at the beginning – 48.06 ± 5.23 and 47.09 ± 5.68 ($t = 0.546$; $p > 0.05$).

In addition, the generalized stage of the adaptation syndrome or cross-adaptation was considered one of the leading causes of the results obtained in group E (Dai et al., 2024). This was due to the fact that the content of the model implemented in these groups did not provide for a separate impact on each of the functional characteristics studied, but only those identified by the teacher and the girl, taking into account her somatotype and developmental characteristics. In fact, almost all of the studied functional characteristics improved, even those that were not targeted during physical activity. This result was due to the effect of cross-adaptation because it is based not on one, but on a complex of nonspecific reactions of the body to the proposed load (Wilmore et al., 2022); one of the main reasons for the emergence of cross-adaptation is the low functional capabilities of girls. This is evidenced by the data obtained in our earlier studies (Banakh et al., 2023).

Conclusions

Values of functional characteristics in the experimental and control groups of girls with T-type, as well as in girls with M-type, practically did not differ, and the nature of the distribution of individual values in each group corresponded to normal. These results indicated the homogeneity of the formed groups, which increased the objectivity of the information obtained from the use of their data.

Application of the proposed models during one academic year showed greater efficiency of the author's development compared to traditional organization and content of physical activity. Thus, the number of characteristics whose values improved in the experimental groups of girls with T- and M-types was 7 and 8 out of all 9 subjects, respectively; in the control groups, all values remained at the previously achieved level.

In addition, at the end of the study, the experimental groups of girls of both somatotypes achieved significantly better results (at the level of $p<0.05\div0.000$). The values of all characteristics differed in T-type, except for SBP, and in M-type – except for SBP and RI.

Conflicts of Interest

No conflicts of interest exist.

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Ефективність різних моделей фізичної активності у підвищенні фізіологічних характеристик дівчат, які навчаються в університеті

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 9 с., 5 табл., 40 джерел.

Мета дослідження полягала у визначенні кращої з двох моделей фізичної активності в поліпшенні фізіологічних характеристик дівчат під час першого року навчання в університеті.

Матеріал та методи. У дослідженні взяли участь 79 дівчат, вік кожної був у межах 17,7 ± 0,4 років, вони належали до найбільш чисельних торакального та м'язового соматотипів, не мали застережень щодо використання різних обсягів фізичної активності та були розподілені методом випадкової вибірки на експериментальні й контрольні групи. Для діагностики соматотипу використовували модифіковану методику Штефко-Островського. Вивчали артеріальний тиск, частоту серцевих скорочень у різних ситуаціях, життєву ємність легень, життєвий індекс, силовий індекс, індекс Робінсона. На початку і наприкінці експерименту, який тривав один навчальний рік, за допомогою добре відомих функціональних тестів одержували необхідні емпіричні дані. Щодо фізичної активності дівчат, то експериментальні групи використовували розроблену нами модель, контрольні – традиційну модель фізичної активності під час першого року навчання в закладі вищої освіти.

Результати. На початку дослідження значення функціональних характеристик у експериментальних та контрольних групах практично не відрізнялися між собою, а характер розподілу індивідуальних значень у кожній групі відповідав нормальному. Застосування розробленої моделі дівчатами з торакальним і м'язовим соматотипами призвело до поліпшення відповідно 7 та 8 із усіх 9 досліджуваних характеристик, тоді як застосування традиційної моделі – до їхнього вияву на досягнутому раніше рівні. Наприкінці дослідження в обох експериментальних групах результати вияву всіх характеристик були значно кращими (на рівні p <0. 05÷0. 000), ніж у контрольних групах, за винятком SBP дівчат із торакальним, SBP і RI – дівчат із м'язовим типами.

Висновки. Експериментально доведена значно більша дієвість авторської моделі фізичної активності, ніж традиційна, у поліпшенні фізіологічних характеристик дівчат під час першого року навчання в університеті. Виявлені особливості в зміні параметрів фізіологічних характеристик дівчат із різними соматотипами сприятимуть підвищенню дієвості персоналізації організаційної, змістової та диференціації нормативної основ університетського фізичного виховання.

Ключові слова: фізіологічні характеристики, моделі фізичної активності, університет, дівчата, експериментальні параметри.

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