Doroshenko, E., Hurieieva, A., Symonik, A., Chernenko, O., Chernenko, A., Serdyuk, D., Svatiev, A., & Tsarenko, K. (2021). Differentiation of Physical Loads in Female Students of Different Motor Ages. *Teorìâ ta Metodika Fìzičnogo Vihovannâ, 21*(2), 158-166. https://doi.org/10.17309/tmfv.2021.2.09
ISSN 1993-7989 (print). ISSN 1993-7997 (online)

ORIGINAL SCIENTIFIC ARTICLE

DIFFERENTIATION OF PHYSICAL LOADS IN FEMALE STUDENTS OF DIFFERENT MOTOR AGES

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

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Accepted for Publication: May 25, 2021
Published: June 25, 2021

DOI: 10.17309/tmfv.2021.2.09

Abstract

Purpose: To develop and evaluate the impact of a program of sectional recreational aerobics classes, taking into account the differentiation of physical loads in female students of different motor ages.

Materials and Methods. Participants: In the ascertaining experiment, 145 second-year female students were examined, in the formative experiment – 42 female students.

The following indicators were measured: biological age (years) using V. P. Voitenko's method (1991), motor age (years) and the general level of physical conditions (points), heart rate (bpm), heart rate recovery time after 20 squats in 30 s (min, s), the level of physical health (points), physical activity index (c. u.), the level of general physical working capacity (PWC_{170}, kgm · min^{-1}); VO_2 max (ml · kg · min^{-1}) – maximal oxygen consumption. The level of motor qualities development: 2,000 m run (min, s), 4×9 m shuttle run (s), standing long jump (cm), sit-ups in 1 min (times), push-ups (times), seated forward bend (cm).

Results. The study developed and tested an experimental program of recreational aerobics classes, taking into account a differentiated approach to dosing physical loads in female students of different motor ages. Data factorization revealed a rational combination of means for developing motor qualities: strength endurance – 15.88%, dynamic strength – 12.86%, speed and strength endurance – 8.72%, static endurance – 17.87%, flexibility – 12.69%, speed abilities – 14.66%, and coordination abilities – 17.32%. The study found a moderate negative correlation between motor age and the level of physical health ($r = -0.68$ at $p < 0.01$). Three levels of motor age with respect to the levels of physical health were identified.

Conclusions. Taking into account female students' motor age during recreational aerobics classes ensures optimal motor activity and increases the level of physical fitness.

Keywords: motor age, differentiated approach, recreational aerobics, motor qualities, dosage.

Introduction

More and more studies are focusing on scientific substantiation of forms, methods and content of physical education in higher educational institutions. The key goals here are to increase its efficiency (Kondakov et al., 2018) and the level of physical condition (Thorburnet al., 2019; Solohubova et al., 2020; Chernenko et al., 2020), to maintain students' health (Wrench, 2019). Examination of the level of students' physical condition while studying at higher educational institutions shows a steady tendency towards its deterioration. (Krutsevych & Bezverkhnia, 2010).

Our scientific inquiry was based on studies which prove that female students' biological age (Markina, 2001) and motor age (Borodulina, 2014; Vavilova et al., 2008) are almost twice their passport one.

The reasons given for this are:

- insufficient physical activity of students while studying at higher educational institutions (Vavilova et al., 2008; Gillis et al., 2013);

- reduced number of hours of physical education (Burner et al., 2019);
- lifestyle (Tambalis et al., 2019);
- insufficient effectiveness of the existing system of physical education (Malinauskas et al., 2018).

Researchers studied the criteria of differentiation in physical education of students in various aspects, namely:

- combination of recreational training means in accordance with the level of morphofunctional state (Averyanova et al., 2018);
- dosage of physical loads according to the body functional and physical capabilities (Chacon-Cuberos et al., 2018);
- taking into account physical condition, rates of biological development (Bondarchuk, 2012);
- taking into account students' psychophysical state (Ilnytska et al., 2016);
- taking into account the female body biological features (Bogdanovskaya et al., 2014).

The study of physical education curricula of higher educational institutions and analysis of literature which describes the degree of impact of physical education classes on the development and improvement of students' physical qualities revealed contradictions. Some researchers observed a positive effect of classes on students' physical fitness, and some studies point out insufficient effectiveness of the existing program (Sobyanin et al., 2016).

Kondakov et al. (2018), Gonzalez-Valero et al. (2019) note that today's organization of physical education is not effective enough to increase the level of physical fitness, health, motivation, to develop professionally important psychophysical qualities and interest of a large number of students in physical exercises and sports.

However, a lot of studies on optimization of students' physical education do not describe all possible ways to improve it (Bondarchuk, 2012; Sazanova et al., 2017). We have not found any studies investigating a differentiated approach to dosing physical loads in physical education of female students of different motor ages.

In our opinion, the distribution of students in physical education classes by their level of motor age is the most accessible method that does not require special equipment. This method makes it possible to optimize the assessment of the level of physical condition and to effectively dose physical load in female students with different physical fitness.

The analysis of studies shows that there are a great number of opinions on solving the problem of deterioration of students' physical health (Borodulina, 2014; Averyanova et al., 2018). Therefore, our study aimed to solve the problem of successful physical development of female students with the use of sectional recreational aerobics classes, taking into account a differentiated approach to dosing physical loads.

Hypothesis. The study assumed that the introduction of a differentiated approach to dosing physical loads for female students of different motor ages would lead to positive dynamics and optimization of their physical condition.

Purpose. To develop and evaluate the impact of a program of sectional recreational aerobics classes, taking into account the differentiation of physical loads in female students of different motor ages.

Material and Methods

Study participants

In the ascertaining experiment, 145 second-year female students were examined. For health reasons, they were included in a basic and a preparatory medical groups.

In the formative experiment, 42 participants were selected. They were divided into two groups – a control group (CG) (20 girls) and an experimental group (EG) (22 girls).

Study organization

The female students' physical development was assessed by the following indicators: biological age (years) using Voitenko's method (1991), motor age (years) and the general level of physical conditions (points) (Vavilova et al., 2008), heart rate (determined by palpation, bpm), heart rate recovery time after 20 squats in 30 s (min, s), the level of physical health (points) (Belous et al., 2005; Krutsevych et al., 2011), physical activity index (c. u.) (Sazanova et al., 2017). The study also measured: the level of general physical working capacity (PWC_{170}, kgm min^{-1}) – an integral indicator of the body physical condition; VO_2 max (ml•kg•min^{-1}) – maximal oxygen consumption – an indicator of the body aerobic endurance (Malikov et al., 2006).

Tests for assessing the development of motor qualities were selected taking into account the physical education program for students of higher educational institutions (Kurochenko, 2004). The study recorded the results of all the participants in the following tests: 2,000 m run (min, s), 4×9 m shuttle run (s), standing long jump (cm), sit-ups in 1 min (times), push-ups (times), seated forward bend (cm).

At the first stage, the ascertaining experiment was conducted to determine the impact of physical education classes on the parameters under study. Also, factor analysis was performed to find a rational combination of physical education means for developing motor qualities in female students.

The formative experiment used the annual educational cycle (macrocycle), which is divided into 2 periods corresponding to I – fall-winter and II – winter-spring semesters. Each macrocycle, in its turn, consists of 2 mesocycles (modules) lasting 8 weeks. The mesocycles were based on 4-week microcycles.

During extracurricular sectional classes (twice a week), all the female students were engaged in recreational aerobics. During classes, the CG participants' motor age was not taken into account. Physical load was the same for all the students. For the EG participants, a differentiated approach was used; load was dosed taking into account their motor age.

Motor age was calculated using Vavilov's method (1997) "Test Yourself": in Table 1 of age assessment standards, we find the age corresponding to your result in each test, sum up all the found values of ages and divide by the number of tests. The resulting number is your motor age.

Table of age assessment standards (Table 1), where: P – push-ups, times; J – standing long jump, cm; S – sit-ups, times; H – bar hang, s; B – seated forward bend, cm.

The first period of the macrocycle (fall-winter semester) began in September, lasted 17 weeks and consisted of 2 mesocycles (modules): preparatory (4 weeks) and main (basic) (13 weeks). The second period (winter-spring semester) lasting

Table 1. Table of age assessment standards for women (Vavilov, 1997)

Age	Results of tests				
	P	J	S	H	B
7	8	104	12	6	6
8	9	120	13	9	7
9	10	132	14	12	8
10	11	142	15	15	9
11	12	152	16	19	10
12	13	160	17	23	11
13	14	167	18	27	12
14	14	173	19	31	12
15	15	177	20	35	13
16	16	180	21	39	13
17	16	180	21	41	13
18	16	178	21	42	13
19	16	176	20	41	13
20	15	172	19	39	12
21	15	167	18	35	12
22	15	161	17	30	11
23	14	155	16	25	10
24	14	149	14	22	9
25	13	143	12	19	8
26-29	11	137	10	16	7
30-34	9	131	8	13	6
35-39	7	125	6	11	5
40-44	5	120	5	9	4
45-49	3	115	4	8	3
50-54	2	110	3	7	2
55-59	1	105	2	6	1
60-64	1	100	2	5	1
>65	1	95	2	4	1

16 weeks began in February and consisted of mesocycles: preparatory (4 weeks) and main (basic) (12 weeks).

Pedagogical control of the level of physical condition, motor age, and physical fitness of the female students was carried out at the beginning and end of the academic year. To control the correction of the training program, the indicators of motor age, physical health, and physical fitness were measured at the end of each module (mesocycle).

Statistical Analysis

The study materials were processed by the statistical analysis software - IBM SPSS 20. The study used the analysis of variance techniques with the calculation of the arithmetic mean (X); standard deviation (s); non-sampling error (standard error) (S); Student's t-test; Pearson's goodness-of-fit test ($\chi 2$) (Chi-square) – a statistical test used to verify the hypothesis that the observed random variable obeys a certain theoretical distribution law; Spearman's rank correlation coefficient (r). In testing the validity of $p = 0.95$, significance levels of < 0.05; < 0.01; < 0.001 were taken as a basis.

To determine the structure of the female students' physical condition, factor analysis was conducted. The factor analysis used a principal component analysis model with the rotation method: Varimax with Kaiser normalization.

Results

Data factorization of the ascertaining experiment using the Varimax method of orthogonal rotation of the primary matrix with Kaiser normalization identified 9 factors that describe the structure of the female students' physical condition (Table 2).

The most significant factor is the one described by a group of variables which characterize the degree of development of basic motor qualities (motor age, shoulder muscle static endurance, shoulder muscle strength endurance, dynamic strength – 13.62% of data variance). The second factor (8.99%) describes the frequency of diseases and self-assessment of health (according to V. P. Voitenko). The third factor (10.41%) describes anthropometric indicators. The fourth factor (6.67%) describes the indicators of systolic and diastolic blood pressure, which directly affect the presence or absence of arterial hypertension or hypotension, respectively. The fifth factor (5.57%) determines the indicators of heart rate at rest and after exercise (recovery time). The sixth factor (9.84%) describes the characteristics of training experience, assessment of attitude towards a healthy lifestyle, and flexibility. The seventh factor (5.19%) characterizes reaction time and physical activity index. The eighth factor (5.56%) describes the indicators of age and static balance. The ninth factor (3.2%) is theoretical knowledge.

Based on factor analysis, a rational combination of means for developing motor qualities in female students was determined (Fig. 1).

The results of statistical analysis using the non-parametric test Spearman's rank correlation coefficient showed a moderate negative correlation between the level of physical health and motor age $r = -0.68$ at $p < 0.01$.

The results of correlation analysis suggest that a decrease in motor age indicators will help increase the level of physical health.

The current realities of physical education in higher educational institutions make it impossible to allocate time during PE classes for assessing the level of students' physical condition. This is due to collecting and analyzing a fairly large number of indicators, even with the use of rapid methods and the availability of additional equipment (height meter, medical scales, spirometer, blood pressure meter, etc.).

We proposed a differentiated dosage of physical loads according to motor age on the basis of the discovered statistically significant relationship between motor age and the level of physical health.

As a result of experimental data ranking, we identified three levels of motor age with respect to the level of physical health.

Motor age deviations from calendar age from 0 and less to 11 years are characteristic of a "safe" level of motor age, which includes female students with a very high and high level of physical health.

Female students whose motor age is 12 years ± 1 year older than their calendar one are in a "borderline" zone and have an average level of physical health.

If motor age exceeds calendar age by 13 years, it can be concluded that the body is in a "dangerous" zone.

The ascertaining experiment showed that in the EG, 50% (n = 11) of the female students have the dangerous level of motor age, 18.2% (n = 4) – the borderline level, and 31.8% (n = 7) – the safe level of motor age.

Table 2. Factor structure of the female students' physical condition. Principal component analysis with Varimax rotation and Kaiser normalization (n = 145) |r > 0.3|

Variables	Component								
	1	2	3	4	5	6	7	8	9
Age	0.150	0.101	0.058	0.235	0.037	0.096	-0.210	0.610	0.220
Body mass	-0.435	0.109	0.568	0.375	-0.034	0.170	-0.231	0.084	-0.055
Body height	-0.226	0.014	0.662	-0.022	0.024	-0.011	0.287	-0.020	0.116
Heart rate	-0.028	-0.060	-0.088	0.000	0.801	-0.125	0.047	0.130	-0.040
Systolic blood pressure	-0.096	0.043	0.134	0.851	0.135	0.086	0.010	-0.021	-0.053
Diastolic blood pressure	-0.068	0.156	0.085	0.823	0.038	-0.179	0.035	0.085	-0.039
Lung capacity	-0.017	-0.038	0.794	0.017	-0.026	-0.050	-0.086	0.043	-0.099
Training experience	-0.025	-0.128	0.035	-0.043	0.035	0.762	-0.008	0.067	-0.039
Cold-related illnesses per year	-0.124	0.700	0.039	-0.005	0.188	-0.183	0.155	0.225	0.031
Chronic conditions	-0.065	0.793	-0.020	0.069	0.045	0.101	-0.034	-0.134	0.139
Dynamometry	0.214	0.051	0.584	0.303	0.023	0.100	0.052	0.082	0.104
Heart rate recovery time after 20 squats	-0.004	0.305	-0.002	0.137	0.657	0.197	0.035	-0.225	0.119
Static balance	0.155	0.033	-0.064	.079	0.026	0.025	-0.187	-0.781	0.131
Reaction time	0.049	0.001	-0.071	-0.122	-0.088	0.024	-0.661	-0.013	-0.052
Assessment of attitude towards a healthy lifestyle	-0.167	-0.185	-0.248	-0.016	-0.092	0.469	0.118	-0.230	0.416
Self-assessment of health	-0.047	0.756	0.022	0.135	0.020	-0.074	0.030	0.010	-0.094
Theoretical knowledge	0.127	0.114	0.077	-0.093	-0.014	-0.126	-0.081	0.024	0.801
Physical activity index	0.062	0.102	-0.019	-0.085	-0.139	0.029	0.637	0.024	-0.102
Strength endurance	0.716	-0.082	-0.076	0.107	-0.084	-0.051	-0.265	-0.065	0.108
Dynamic strength	0.580	-0.240	0.211	-0.178	0.021	0.057	0.251	0.122	0.197
Speed and strength endurance	0.393	-0.220	-0.017	0.093	-0.127	0.349	0.108	0.327	0.391
Static endurance	0.806	0.004	-0.091	-0.172	0.066	-0.128	0.045	-0.071	-0.099
Flexibility	0.215	0.333	0.154	-0.022	-0.277	0.572	-0.046	0.014	-0.200
Motor age	-0.910	0.009	0.065	0.022	0.137	-0.210	-0.024	-0.033	-0.054
VO2 max	0.120	-0.183	-0.202	-0.155	-0.593	0.179	0.298	0.013	0.190
total variance	3.41	2.45	2.61	1.67	1.39	2.46	1.30	1.39	0.80
variance, %	13.62	8.99	10.41	6.67	5.57	9.84	5.19	5.56	3.20

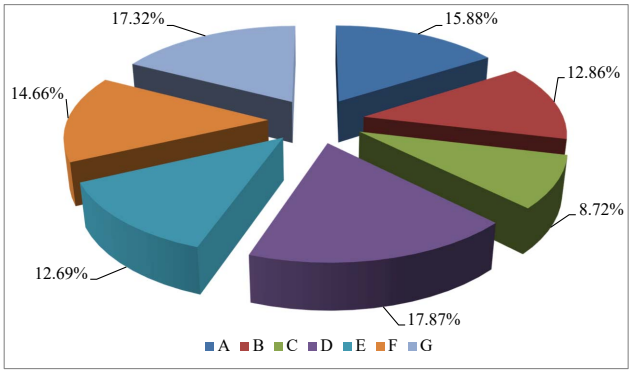

Fig. 1. Rational combination of physical education means for developing motor qualities in female students: A – strength endurance; B – dynamic strength; C – speed and strength endurance; D – static endurance; E – flexibility; F – speed abilities (reaction time); G – coordination abilities (static balance)

The obtained data confirmed the need to correct the female students' physical condition. The results served as the basis for developing a program of sectional recreational aerobics classes, taking into account a differentiated approach to dosing physical loads for female students of different motor ages.

The intensity of classes was regulated taking into account the level of motor age. The dosage of the amount and intensity of physical exercises was achieved by a certain number of repetitions, the pace of performance, changes in stance width, the use of long and short levers, changes in starting positions, and the way of performing exercises, a rational alternation of the time of load and rest, the use of various objects and apparatuses, music, words, means of visual impact on the female students' bodies.

Taking into account the individual level of motor age, the students were lined up in two ranks during the class, so that the instructor could differentiate physical load:

- first rank – students with the "dangerous" level of motor age;
- second rank – students with the "borderline" and "safe" level of motor age.

The trainees' activities were organized frontally (everyone performs exercises at the same time) and individually (independent performance of the task under the instructor's guidance).

The program of sectional recreational aerobics classes, taking into account a differentiated approach to dosing physical loads in female students with different levels of motor age has the following peculiarities:

- for students with the "dangerous" level of motor age – the intensity is 30-35% of maximal oxygen consumption, the step platform height is 15 cm without the inclusion of arm movements and the use of swing movements, the number of repetitions of strength exercises is 25-30% of the maximum, the dumbbell weight is 0.5-1 kg;
- for students with the "borderline" level of motor age – the intensity is 35-40% of maximal oxygen consumption, the step platform height is 15 cm with the inclusion of simple movements of arms, without raising them above shoulder level and using swing movements, the number of repetitions of strength exercises is 35-40% of the maximum, the dumbbell weight is 1-1.5 kg;
- for students with the "safe" level of motor age – the intensity is 45-50% of maximal oxygen consumption, the step platform height is 15 cm with the inclusion of simple arm movements and the use of swing movements, the number of repetitions of strength exercises is 40-45% of the maximum, the dumbbell weight is 1.5 kg.

The duration of classes was 80 minutes. The tempo of music was 118-122 beats per minute. The training zone of heart rate with the "dangerous" level of motor age was 100-115 bpm^{-1}, with the "borderline" level – 110-125 bpm^{-1}, and with the "safe" one – 120-140 bpm^{-1}.

The initial comparative analysis of indicators proved a relative homogeneity of the control group and the experimental group. This became the basis for an objective assessment of the program we developed.

The repeated determination of indicators revealed the following. By the end of the formative experiment, the EG students had significantly higher ($p < 0.05$; $p < 0.01$ and $p < 0.001$) values of practically all parameters of the level of physical condition, motor age, physical fitness than the CG students (Table 3).

So, the indicators of heart rate decreased by 6.77% ($p < 0.01$), heart rate recovery time after 20 squats in 30 s by 19.81% ($p < 0.05$), biological age by 11.21 %, and motor age by 28.72% ($p < 0.001$), PWC_{170} by 7.3% ($p < 0.05$); physical activity index increased by 8.06% ($p < 0.05$), maximal oxygen consumption by 2.17%.

The general level of physical conditions changed from satisfactory to good ($p < 0.001$) (Table 4).

There was a significant increase in the level of dynamic strength ($p < 0.01$), speed and strength endurance of the abdominal muscles ($p < 0.001$), flexibility ($p < 0.05$), strength endurance ($p < 0.01$), static endurance ($p < 0.01$). The time of overcoming the 2,000 m distance decreased by 3.15%, and dexterity by 2.54%.

The average score of the level of physical health changed ($p < 0.001$) from an average (3.33 ± 0.12) to a high (4.15 ± 0.11) level with a relative increase in the result by 19.76%.

At the beginning of the formative experiment, 50% (n = 11) of the female students had the "dangerous" level of motor age, 18.2% (n = 4) had the "borderline" level, and

Table 3. Comparative assessment of the studied indicators in the experimental group (EG n = 22) and the control group (CG n = 20) female students

Indicators		Beginning of academic year	End of academic year	t	p
		x±S	x±S		
Age, years	EG	18.04 ± 0.14	18.44 ± 0.10	2.32	<0.05
	CG	18.00 ± 0.19	18.39 ± 0.12	1.74	>0.05
Biological age, years	EG	34.92 ± 1.79	31.40 ± 1.09	1.68	>0.05
	CG	32.46 ± 1.61	30.50 ± 1.30	0.95	>0.05
Motor age, years	EG	30.16 ± 1.16	23.43 ± 0.57	5.21	<0.001
	CG	29.39 ± 1.02	27.26 ± 1.07	1.44	>0.05
Heart rate, bpm^{-1}	EG	75.68 ± 1.20	70.88 ± 0.99	3.09	<0.01
	CG	76.11 ± 1.80	70.00 ± 1.70	2.47	<0.05
Heart rate (recovery time), min	EG	2.54 ± 0.14	2.12 ± 0.12	2.28	<0.05
	CG	2.42 ± 0.22	2.32 ± 0.18	0.35	>0.05
Physical health, points	EG	3.33 ± 0.12	4.15 ± 0.11	5.04	<0.001
	CG	3.24 ± 0.09	3.76 ± 0.11	3.66	<0.001
PWC_{170}, $kg \cdot m^{-1} \cdot min^{-1}$	EG	604.14 ± 13,41	651.74 ± 19.73	2.01	<0.05
	CG	637.92 ± 20.39	683.95 ± 16.81	1.74	>0.05
Maximal oxygen consumption, $ml \cdot kg^{-1} \cdot min^{-1}$	EG	42.45 ± 0.40	43.39 ± 0.54	1.40	>0.05
	CG	43.66 ± 0.65	44.28 ± 0.50	0.76	>0.05
Physical activity index, points	EG	31.58 ± 0.44	34.14 ± 0.95	2.45	<0.05
	CG	32.80 ± 0.95	34.84 ± 1.25	1.30	>0.05
General level of physical conditions, points	EG	-0.31 ± 0.03	-0.12 ± 0.03	4.48	<0.001
	CG	-0.26 ± 0.02	-0.20 ± 0.03	1.66	>0.05

Note: EG – experimental group, CG – control group.

Table 4. Comparative assessment of motor qualities development according to state tests in the experimental group (EG n = 22) and the control group (CG n = 20) female students

Group	before experiment x±S	assessment	after experiment x±S	assessment	t	p
2,000 m run (min, s)						
EG	11.47 ± 0.2	2	11.12 ± 0.22	3	1.18	>0.05
CG	11.36 ± 0.2	2	11.13 ± 0.18	3	0.85	>0.05
4×9 m shuttle run (s)						
EG	10.88 ± 0.13	3	10.61 ± 0.09	3	1.71	>0.05
CG	10.86 ± 0.12	3	10.62 ± 0.09	3	1.60	>0.05
Standing long jump (cm)						
EG	163.52 ± 2.97	1	177.08 ± 3.35	2	3.03	<0.01
CG	156.61 ± 3.44	0	164.94 ± 3.12	1	1.79	>0.05
Sit-ups in 1 min (times)						
EG	36.72 ± 0.89	2	43.6 ± 0.74	4	5.94	<0.001
CG	37.22 ± 1.65	3	42.11 ± 1.34	4	2.30	<0.05
Push-ups (times)						
EG	5.00 ± 0.61	0	9.04 ± 1.09	1	3.63	<0.01
CG	3.94 ± 0.37	0	5.44 ± 0.44	0	2.61	<0.05
Seated forward bend (cm)						
EG	13.16 ± 1.34	2	16.72 ± 1.12	3	2.04	<0.05
CG	15.22 ± 0.89	3	15.44 ± 1.36	3	0.14	>0.05

Note: EG – experimental group, CG – control group.

31.8% (n = 7) – the "safe" level of motor age. Upon completion of the experiment, all the students with the "dangerous" level of motor age moved to higher levels, so only 4.5% (n = 1) have the "borderline" level, and the level of motor age of 95.5% of the students (n = 21) is assessed as "safe".

Discussion

At the beginning of our study, we assumed that the introduction of a differentiated approach to dosing physical loads for female students of different motor ages would lead to positive dynamics and optimization of their physical condition.

Examination of the level of students' physical condition while studying at higher educational institutions often shows a steady tendency towards its deterioration. This is due to insufficient effectiveness of the traditional training program, which is confirmed by our data and other authors' findings (Kondakov et al., 2018).

The studies of the authors (Tambalis et al., 2019; Wang et al., 2019; Kozina et al., 2019) argue that the use of aerobics means helps optimize certain components of physical condition. Our study has broadened the understanding of the impact of recreational aerobics on girls' bodies. The effectiveness of the program that we developed was assessed through a holistic and integrated monitoring of indicators of biological and motor age, the level of physical health, and assessment of motor qualities development. This created the basis for scientific substantiation of taking into account motor age when determining physical load for female students. On the basis of correlation analysis, we found a relationship between female students' motor age and level of physical health. This made it possible to find the most accessible way to differentiate physical loads for female students according to different motor ages.

Drawing on the results of our own research and the studies by the authors Chernenko and Kokarev (2017), Kibalnyk and Tomenko (2010), we developed a program of sectional recreational aerobics classes. In contrast to the existing programs, the specially developed program envisaged: an organizational structure of recreational classes; factor analysis of the ascertaining experiment results; differentiation by the levels of motor age, taking into account the dynamic management of correction of the level of physical health; load intensity; pulse mode; a rational combination of means for developing motor qualities. In addition, to optimize classes, the study used: various types of aerobics (basic aerobics, step aerobics, power aerobics, and aerobics with objects); interval or repeated ways of exercise repetition; differentiated and person-centered approaches to working with female students; medical and pedagogical control (at the end of each module).

The introduction of the program helped to increase the level of physical activity and improve the physical condition of the study participants. It is important to note that the results obtained during the formative experiment confirm the findings of a number of authors about a positive effect of recreational aerobics means on female students' physical condition (Wang et al., 2019; Niu et al., 2018). The relationship that we discovered between female students' motor age and level of physical health made it possible to find the most accessible way to differentiate physical loads for female students according to different motor ages. This principle was implemented taking into account load power, intensity, a rational combination of means for developing motor qualities (strength endurance, dynamic strength, speed and strength endurance, static endurance, and flexibility).

Thus, the findings of the study made it possible to broaden the knowledge of effective ways to optimize the motor activity and correct the physical condition of female students

of higher educational institutions. We confirmed the information on the need to improve the basic physical education program in higher educational institutions (Kondakov, Voloshina, et al., 2018; Sobyanin et al., 2016).

The obtained results confirm and supplement the studies on the indicators of physical development and morphofunctional features of students (Borodulina, 2014; Kuzmin et al., 2016). In addition, we confirmed the data of Kondakov et al. (2018), Krutsevych et al. (2010) on the unsatisfactory state of students' physical health and physical fitness; the tendency for deterioration of these indicators while studying at higher educational institutions; the significant excess of biological age (Markina, 2001) and motor age (Borodulina, 2014; Vavilova et al., 2008) over calendar one.

We supplemented the findings of Niu et al. (2018), Kuna et al. (2018) about the optimization of physical education of students of higher educational institutions by using the most popular and accessible types of physical exercises; the data of Kondakov et al. (2018) on insufficient physical activity of young people; the data of Yarmak et al. (2018) on the factor structure of physical condition of female students of higher educational institutions; the information of Ilnytska et al. (2016), Borras et al. (2017), Wang et al. (2019), Kuna et al. (2018) on the effectiveness of using recreational aerobics means to improve the level of students' physical condition.

Research in this area will make it possible to ensure optimal physical activity of students; increase the level of physical fitness and health; develop professionally important psychophysical qualities and interest in regular exercise and sports.

Conclusions

The results of the experiment confirmed that the process of teaching students using the basic physical education program for higher educational institutions needs to be supplemented and improved.

As a result of factor analysis, a rational combination of means for developing motor qualities was determined. The study found a correlation between motor age and the level of physical health, ranked these indicators and identified three levels of motor age with respect to the levels of physical health.

It was found that the experimental program significantly improved the indicators of physical fitness, physical health, and motor age.

This study does not cover all the tasks of the selected problem. We see the prospect of further research in studying the application of the differentiated approach to dosing physical loads for students of different motor ages using other means of physical education.

Conflict of Interest

The authors declare no conflict of interest.

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ДИФЕРЕНЦІАЦІЯ ФІЗИЧНИХ НАВАНТАЖЕНЬ У СТУДЕНТОК З РІЗНИМ РУХОВИМ ВІКОМ

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Реферат. Стаття: 9 с., 4 табл., 1 рис., 37 джерел.

Мета – розробити і оцінити вплив програми секційних занять оздоровчою аеробікою з урахуванням диференціації фізичних навантажень у студенток з різним руховим віком.

Матеріали та методи. Контингент – в рамках констатувального експерименту обстежено 145 студенток 2 курсу, в формуючому експерименті – 42 студентки. Визначалися такі показники: біологічний вік (років) за методикою Войтенко В.П. (1991), руховий вік (років) і загальний рівень фізичних кондицій (бали), частота серцевих скорочень (уд/хв), час відновлення частоти серцевих скорочень після 20 присідань за 30 с (хв, с), рівень фізичного здоров'я (бали), індекс рухової активності (у.о.), рівень загальної фізичної працездатності (PWC_{170}, кгм · хв$^{-1}$); МПК (мл · кг · хв$^{-1}$) – максимальне споживання кисню. Рівень розвитку рухових якостей: біг 2000 м (хв, с), човниковий біг 4×9 м (с), стрибок в довжину з місця (см), піднімання тулуба в сід за 1 хв (раз), згинання та розгинання рук в упорі лежачи (раз), нахил з положення сидячи (см).

Результати. Розроблено та апробовано експериментальну програму проведення занять з оздоровчої аеробіки з урахуванням диференційованого підходу в дозуванні фізичних навантажень у студенток з різним руховим віком. Факторний аналіз дозволив виявити раціональне співвідношення засобів для розвитку рухових якостей: силова витривалість – 15,88%, динамічна сила – 12,86%, швидкісно-силова витривалість – 8,72%, статична витривалість – 17,87%, гнучкість – 12, 69%, швидкісні здібності – 14,66% і координаційні здібності – 17,32%. Встановлено помірний негативний взаємозв'язок рухового віку з рівнем фізичного здоров'я ($r = -0,68$ при $p < 0,01$). Визначено три рівні рухового віку щодо рівнів фізичного здоров'я.

Висновки. Облік рухового віку студенток при проведенні занять оздоровчою аеробікою дозволяє забезпечити оптимальну рухову активність, підвищити рівень фізичної підготовленості.

Ключові слова: руховий вік, диференційований підхід, оздоровча аеробіка, рухові якості, дозування.

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Cite this article as: Doroshenko, E., Hurieieva, A., Symonik, A., Chernenko, O., Chernenko, A., Serdyuk, D., Svatiev, A., & Tsarenko, K. (2021). Differentiation of Physical Loads in Female Students of Different Motor Ages. *Teorìâ ta Metodika Fìzičnogo Vihovannâ, 21*(2), 158-166. https://doi.org/10.17309/tmfv.2021.2.09

Received: 11.02.2021. Accepted: 25.05.2021. Published: 25.06.2021