PHYSICAL EDUCATION OF STUDENTS

Integrative pedagogical technique of physical education of female students with overweight

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Abstract

Purpose: design and testing of the integrative pedagogical technique of physical education, aimed at the female students' overweight correcting.

Material: The anthropometric examination of 1st-year female students (n = 397) was carried out. The female students were referred to the special medical group according to the health condition. Overweight female students (n = 86) were selected for the pedagogical experiment. The female students were divided into 2 groups: experimental (n = 42) and control (n = 44). Anthropometric and physiometric parameters were determined. The body mass index, Robinson index, and power index were calculated. The motor qualities of female students were evaluated by tests. The female students attended the academic classes "Elective courses in physical education and sports" 2 times a week. The pedagogical technique "inverted class" was applied: the previous self-study of the material on electronic gadgets or on the Internet; subsequent detailed analysis of the gained knowledge in the classroom.

Results: By the end of the pedagogical experiment, the female students of the experimental group demonstrated the decrease in body mass in 12.6%, functional characteristics of the cardiovascular system improved, and power and motor abilities' parameters increased ($p < 0.05$). The body mass index corresponded to normal values in 20 female students (47.6%) at the end of the experiment. The body mass index decreased by 13.8% in 12 female students (28.6%). The body mass index did not change in 10 female students (23.8%). The female students of the control group demonstrated lower results than female students of the experimental group.

Conclusions: The integral pedagogical technique is based on a combination of the "inverted class" method and digital learning. Pedagogical techniques considered to be more effective for female students' body mass correcting than the traditional one.

Keywords: female students, body mass correction, integral pedagogical technique, physical education.

Introduction[1]

The World Health Organization (WHO) experts note that in many countries of the world there is a decrease in the number of people with normal body mass [1]. The particular importance in scientific research is given to the study of the body mass deviations from the norm among students.

The important task of the higher education system is to create conditions for students' health maintaining and promotion. The special role is given to physical education, which is a leading factor in health promotion [2] and students' mental performance optimizing.

Physical educations classes are conducted according to the standard methodology (2-3 times a week) and do not always lead to a positive result on the students' body mass correction. It is not possible nowadays to increase the number of academic classes in physical education. Therefore, some authors propose the additional use of corrective classes programs at the out-of-lesson time [3]. However, elective physical education classes are not always highly effective [4]. Therefore, an important direction of the health-saving process is the search for new pedagogical techniques (form organization of academic classes) to increase motor activity and students' body mass correction.

The important issue in the physical education of students is the use of information and communication technologies. Such a direction is a good promotion of fitness systems and physical activities. This is especially important for the younger generation and students.

One of the important parameters of the physical development of an individual is a person's body mass. The body mass is considered as an integral level characteristic and condition of metabolic, hormonal, growth, energy processes in the body [5, 6]. The body mass deviation from the norm should be considered as a predictor of human health deterioration.

Overweight and obesity can significantly affect the somatic, physical, reproductive and mental health of the person. This contributes to type 2 diabetes, atherosclerosis, hypertension [7], which leads to coronary and cerebral blood supply disturbance [8]. The hormonal status disorders [9], impaired productivity [10] and a decrease in life expectancy [11] are fixed in obese people.

The body mass deviation from normal indicates a serious violation of energy processes in the body [12, 13]. This parameter negatively affects the professional

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sphere of activity [14], complicates pregnancy and childbirth [15], and may affect the biological function of motherhood [16].

Recent studies show that body mass deviations from the norm are widespread among the world's population. In 2016, more than 39% of the world's adult population has overweight, and 13% were obese [1]. The Russian Federation is not an exception, where the annual increase in obesity is 0.4% [17] of the population. The number of students with body mass deviation at educational institutions of the Russian Federation reaches 30–40% [18]. The following results were revealed In Russian universities: 10.7% of medical students in Kemerovo had overweight, and 4.8% are obese [19]; the overweight was revealed in 18.6% of students in Tomsk [11]; the overweight was revealed in 7.2% of students in Ufa [20]; 10% of female students in Yaroslavl had obesity [21]. The similar results were determined in Polish universities: during the last fifty years, the average percentage of fat in students from a technological university increased by 6.3%, while this parameter in students from physical education university increased by 3.5% [22]. The average body mass index in the United States students was 27.29 ± 6.20 kg/m2 in the overweight range [23]. Students in Ghana have 12.2% of overweight [24]. 12.1% of Ukrainian students had obesity [25].

The reasons for body mass deviation from the norm can be the follows: eating disorders and disruption of the hormonal condition of a person [11]; decrease of the physical activity [26]; mental trauma [27]; adverse environmental and anthropopressor factors. More obese people live in urban areas than in rural areas [2]. Insufficient physical activity is observed in almost 40% of the population of Russia: 37.0% of men, 42.0% of women [28].

In the WHO documents [29], the leading role in overweight prevention is given to increasing the level and quality of the motor activity. This is related to educational institutions and the nutritional correction of various population groups. The use of fitness technologies helps to normalize body mass [30, 31], especially in combination with nutrition correction [32]. Some researchers offer programs for extra health classes at an out-of-lesson time for students [18]. Regular sport exercises can solve many problems associated with overweight [33, 34]. The urgent problem remains the search for new methods and improvement of existing methods and forms of fitness techniques aimed at body mass correction.

The use of information and communication platforms in physical education and sports is considered to be a promising direction [35, 36]. The pedagogical technique "inverted class" provides for the previous self-study of the material on electronic gadgets or on the Internet; subsequent detailed analysis of the gained knowledge in the classroom [37]. However, this technique is not presented in the literature related to body mass correction.

The method of self-study using video cases, which represent the short and understandable programs is becoming popular [38]. The use of the integrative pedagogical technique (a combination of the "inverted class" teaching method and the digital learning method) for body mass correcting of female students of the special medical group is not presented in the literature.

Purpose of work: design and testing of the integrative pedagogical technique of physical education, aimed at students' overweight correction. The basis of this technique is a combination of the "inverted class" method and the digital method.

Material and methods

The participants. The study was conducted during the school year (35 weeks, September 2018 – May 2019). It was performed using standard methods [39], anthropometric and physiometric monitoring of 1st-year female students (n = 397) (Russia, Irkutsk National Research Technical University). The female students were referred to the 3rd functional group (special medical group) according to health reasons. 86 students with a high body mass index (BMI) were selected for the pedagogical experiment. Among them 73 female students (18.3%) had overweight. 13 female students (3.3%) had first-degree obesity. The female students divided into 2 groups: experimental (EG, n = 42) and control (CG, n = 44).

To characterize the anthropometric and physiometric parameters of the female students the following parameters were determined:

- body length, cm;
- body mass, kg;
- chest circumference (CC), cm;
- Martine-Kushelevsky test (physical activity in the form of 20 squats in 30 sec):
- heart rate before loading (HR), beat/10 s;
- heart rate after 20 squats in 30 s (HR), beat/10 s;
- recovery time of heart rate after 20 squats, min;
- systolic blood pressure (SBP) and diastolic blood pressure (DBP), mm Hg;
- Hand dynamometry, kg (Handgrip Strength Test, kg).

It was expected the following:

- the Kettle's mass-height index (body mass index) [40];
- BMI = body mass / body length², kg / m²);
- Robinson index [41] [IRob = (HR x SBP) / 100 c.u.);
- power index [SI = (muscle strength of the hand / body mass) x 100%] [42].

BMI was evaluated according to the WHO classification (1999) [43]. The following parameters determined: body mass deficit (BMI <18.5 kg/m^2); norm (BMI = 18.5-24.99 kg/m^2); overweight (BMI = 25.0-29.9 kg/m^2); various degrees obesity (BMI> 30 kg/m^2).

During the same periods of observation, students' motor qualities were evaluated. A set of tests was used [38, 39]:

1) 1000 m run, min, s;
2) 30 m run from a high start, s;
3) Bent Arm Hang Test (two hands), s;
4) Standing Forward Bend, cm;
5) Standing Long Jump Test (Broad Jump), cm;
6) Cadence Push-Up Test, the quantity of times;

7) Eurofit Sit Up Test (for 30 s), the quantity of times.

Organization of research. The pedagogical experiment performed from September 2018 to May 2019.

Students attended academic classes "Elective courses in physical education and sports" 2 times a week. The students had a doctor's permission to perform prolonged aerobic exercise.

To increase the weekly motor activity and motivation of the female students from the EG, the "Do it by yourself" video exercise complex was used. The video system sent to the personal email address of each female student. The video complex designed at the Department of Physical Culture of the Irkutsk National Research Technical University (Russia). The video complex aimed at reducing body mass. The video complex contains comments and recommendations on self-study of 10 body-oriented physical exercises of a power orientation. 30 s was given for performing each exercise. 30 s was given to take rest after the exercise. The duration of the full complex was 10 min. The female students were recommended to perform 2 sets (only 20 minutes per day) 5 times a week.

At the end of the preparatory part of the academic class of the discipline "Elective courses in physical education and sports", students of the EG performed pre-learned exercises (1 set of "Do it by yourself" complex of 10-12 min). The motor density of the lesson was increased by reducing the time for explanation and demonstration of exercises. We consider such a teaching method as an element of pedagogical technique "inverted class". In the main part of the class (40-45 min), power exercises with physical activity of aerobic nature of low and medium intensity were offered. The final part of the lesson (10-15 min) includes relaxation exercises, movements' coordination, and flexibility, breathing recovery. The directed physical activity of the EG female students was 280 minutes per week (180 minutes of classes and 100 min of self-study). The weight in the form of 0.5 kg dumbbells and body mass was proposed to use. Additionally, the female students of the EG were recommended a list of Internet web sites devoted to eating behavior and motor condition.

The female students of the CG have engaged only in the standard curriculum of the discipline "Elective courses in physical education and sports": weekly physical activity is 180 minutes.

The carried out work does not infringe upon the rights and does not endanger the well-being of students following the ethical standards of the Committee on Experimental Rights of the 2008 Helsinki Declaration [46].

Statistical analysis. The arithmetic mean of the indicators (M), standard deviation (σ) and standard error (m) were determined. The significance of differences in the average values of independent samples evaluated by parametric methods applying Student's t-test. The differences between the values of indicators with a level of $p < 0.05$ were considered significant.

Results

At the beginning of the experiment (September 2018), the morphofunctional values of the indicators of the female students of the EG and CG did not significantly differ, $p > 0.05$.

At the end of the experiment (June 2019), a significant difference was found in the values of the body mass index of female students in the EG, $p < 0.05$ (Table 1).

By the end of the experiment, female students of EG had a decrease in body mass by 12.6% and an average BMI of 14.2%. Body mass and BMI in female students of

Table 1. Morphological and functional indicators of female students in the EG and CG before and after the experiment (M ± m)

Parameters		Experimental group (n=42)		Control group (n=44)	
		Before	After	Before	After
Body length, cm		163.6±0.70	164.7±0.73	163.8±0.68	164.4±0.72
Body mass, kg		73.5±0.93	64.2±0.89 *	72.8±0.89	70.2±0.93
BMI, kg/m^2		27.5±0.35	23.6±0.29 *	27.1±0.34	26.3±0.33
Chest circumference, cm		84.6±0.58	84.1±0.57	85.1±0.55	85.9±0.56
Systolic blood pressure, mm Hg		122.6± 1.35	117.0±1.42 *	125.4±1.33	123.5±1.44
Diastolic blood pressure, mm Hg		69.8±1.26	66.3±1.18 *	65.3±1.23	67.7±1.32
Martine-Kushelevsky test (HR, b/10 s)	Before load	14.9±0.35	14.5±0.32	14.3±0.24	14.2±0.34
	After load	22.2±0.31	21.3±0.36 *	21.6±0.16	20.8±0.20 *
Recovery time of heart rate after 20 squats, s		95.03±0.3	78.8±0.45 *	94.4±0.34	93.8±0.46
Robinson index, c.u.		109.6±1.23	101.8±0.72 *	107.6±0.87	105.5±0.70
Handgrip Strength Test, kg	Left hand	23.3±0.46	26.8±0.53 *	24.3±0.28	26.4 ±0.29 *
	Right hand	24.5±0.32	27.1±0.37 *	25.0±0.29	27.4±0.28 *
Power Index, %	Left hand	31.7±0.49	41.8±0.53 *	33.1±0.58	37.6±0.68 *
	Right hand	33.3±0.41	42.2±0.55 *	34.3±0.53	39.0 ±0.71 *

Note. * The significant difference in values at the end of the experiment ($p < 0.05$)

CG decreased by 3.6% and 4.1%, respectively.

There was a decrease in the values of the Martine-Kushelevsky test parameter "before the load" among female students of EG by 2.7%, in the CG – by 0.7%. After performing 20 squats, the female students of EG showed a decrease in heart rate by 4.05%, the CG – by 3.7%. The recovery time of heart rate "after exercise" in the CG decreased by 0.6%, in the EG by 17%. This indicates that the recovery of heart rate in the EG occurred 28.3 times faster than in the CG. The Robinson index in female students of EG decreased by 3.6 times relative to the CG (7.1% and 1.95%, respectively). After the experiment, the values of functional indicators of the cardiovascular system in female students of the EG were higher compared to the CG.

Discussion

The WHO materials [29] emphasize the importance of controlling and preventing overweight and obesity by normalizing the nutrition of people and the widespread use of physical activity of all population groups in different countries.

The physical aerobic activity allows the body to not only split fats [47], but also helps to improve the functional characteristics of the cardiorespiratory system. This is confirm with studies carried out by other authors [48]. This is especially important for overweight female students, because they have lower values of the cardiovascular system and external respiration parameters than students with normal mass.

At the end of the experiment, the female students of the EG increased the strength of the left hand by 15.0%, the right hand – by 10.6%. The increase of strength value indicator of the left and right hands in the female students of the CG was lower: 8.6% and 9.6% (left and right hand), respectively.

Compared to the beginning of the experiment, the power index increased in both groups. The power index in the EG increased 2.3 times for the left hand and in 1.9 times for the right hand. Other researchers [49] determined the similar dependence of the physiometric indicators of the human body on the body mass index.

The increase in the physical fitness of the female students in the EG and the CG was determined at the end of the experiment. The results of their motor tests confirm that (Table 2).

The significant improvement in motor qualities in female students of EG was defined in five out of seven tests (Table 2). Indicators of speed (30 m run test), muscle strength of the upper shoulder girdle [Bent Arm Hang Test (two hands), s; Cadence Push-Up Test, quantity of times], trunk muscle strength [Eurofit Sit Up Test (for 30 s), quantity of times] and dynamic strength of lower limb muscle [Standing Long Jump Test (Broad Jump), cm]. The significant increase is fixed in three out of seven motor tests In female students of the CG: trunk muscle strength indicators, flexibility and dynamic strength of the lower limb muscle improved.

Improving the indicators values of motor qualities of female students in EG is associated with their higher physical activity and increased muscle component in the body. It is also associated with BMI normalizing. Studies [50-52] showed that the physical fitness of youth with overweight is significantly lower than that of students with normal mass. These data and the results of our research confirm the relevance of body mass normalizing in female students to increase their physical fitness.

It was shown [3] that classes only according to the standard methodology of physical education do not always lead to a positive result. Therefore, researchers [53] think that additional classes on correction of body mass are necessary.

High efficiency of mastering the educational material of the discipline was shown: Testing of pedagogical technologies "inverted class" [37]; the use of digital technologies for physical training in higher military educational institutions [54]; the use of information and communication technologies in students' physical

Table 2. Results of motor tests of female students in the EG and CG before and after the experiment (M ± m)

Parameters	Experimental group (n=42)		Control group (n=44)	
	Before	After	Before	After
1000 m run, min, s	7.20±0.56	7.04±0.55	7.02±0.26	7.24±0.27
30 m run of the high start, s	6.23±0.06	5.86±0.06*	6.22±0.08	6.18±0.05
Bent Arm Hang Test (two hands), s.	2.89±0.30	3.8±0.32 *	2.32±0.37	3.12±0.43
Cadence Push-Up Test, quantity of times	16.1±0.55	19.5±0.63*	17.0±0.44	18.2±0.55
Eurofit Sit Up Test (for 30 s), quantity of times	15.7±0.37	17.6±0.43 *	15.9±0.3	17.0±0.29 *
Standing Forward Bend, cm	14.1±0.56	14.7±0.58	14.5±0.23	16.7±0.29 *
Standing Long Jump Test (Broad Jump), cm	150.2±2.4	158.2±2.9 *	151.3±1.9	158.5±2.1 *

Note. * The significant difference in values at the end of the experiment ($p < 0.05$)

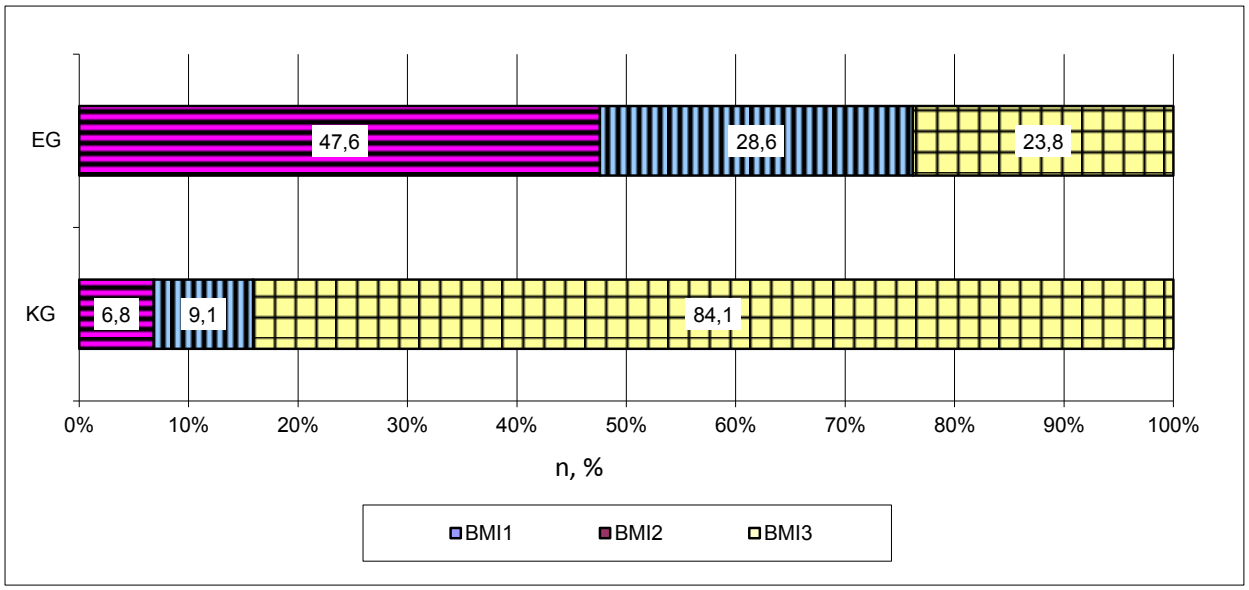

Fig. The results of the pedagogical experiment on the correction of body mass of students: EG - experimental group; CG - control group; BMI1 - body mass index (normal); BMI2 - body mass index (decreased); BMI3 - body mass index (unchanged); n% - the number of students, %.

education [35, 36].

The results of the pedagogical experiment on the correction of the body mass of students using the integrative method "inverted class" and digital learning given in the figure.

The BMI corresponded to normal values in 20 female students of EG (47.6%) at the end of the experiment. The BMI decreased by 13.8% in 12 female students (28.6%). The BMI did not change in 10 female students (23.8%). The BMI decreased to normal values in 3 female students (6.8%) in the control group. The BMI decreased by 5.4% in 4 female students (9.1%). The body mass index did not change in 37 female students (84.1%).

The use of visual familiarization of female students with educational material ("Elective courses in physical education and sports") allows improving the quality of teaching the subject; increase the motor density of the class; reduce the time for the explanation and demonstration of motor actions; to achieve the body mass normalization in a significant number of students.

Conclusion

The use of standard physical fitness technologies in physical education to normalize the mass characteristics of students is not always effective. This provokes the necessity to improve the pedagogical methods and of training and education means aimed at body mass correcting.

The integrative pedagogical technique proposed by the article authors based on cognitive teaching methods. The combination of the "inverted class" method and digital learning considered to be a more effective pedagogical technique than the traditional one.

Such organization and conducting the academic classes and independent work of female students allowed increasing the motor density of the class; correct body mass; improve the functional characteristics of the cardiovascular system and the physical fitness of female students; increase motivation and interest in physical activity.

Conflict of interest

The authors report no conflict of interest.

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