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In general, the editors express hope that the journal “Physical Education of Students” contributes to information exchange to combine efforts of the researchers from the East-European region to solve common problems in health promotion of students, development of physical culture and sports in higher educational institutions.
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Methodical basis of training of cadets for the military applied heptathlon competitions
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Abstract

Purpose: of the research is to develop methodical bases of training of cadets for the military applied heptathlon competitions.

Material: Cadets of 2-3 courses at the age of 19-20 years (n=20) participated in researches. Cadets were selected by the best results of exercises performed included into the program of military applied heptathlon competitions (100 m run, 50 m freestyle swimming, Kalashnikov rifle shooting, pull-up, obstacle course, grenade throwing, 3000 m run). Preparation took place on the basis of training center. All trainings were organized and carried out according to the methodical basics: in a week preparation microcycle five days cadets had two trainings a day (on Saturday was one training, on Sunday they had rest). The selected exercises with individual loads were performed.

Results: Sport scores demonstrated top results in the performance of 100 m run, 3000 m run and pull-up. The indices of performing exercise “obstacle course” were much lower than expected. Rather low results were demonstrated in swimming and shooting.

Conclusions: Results of researches indicate the necessity of quality improvement: cadets’ weapons proficiency; physical readiness to perform the exercises requiring complex demonstration of all physical qualities.

Keywords: cadets, military, applied, heptathlon, physical, fire, readiness.

Introduction

The competitions in different directions of future professional activity take a certain place in structure of cadets’ training of military educational institutions. Military applied heptathlon competitions are the most difficult among them. Such competitions allow to estimate the cadets’ training level. They require demonstration of the maximum physical and psychological skills by cadets.

Cadets’ future professional activity provides a possible participation in regime and force actions [7]. Therefore the problem of cadets’ high-quality training is still particularly essential. Increase of loads of cadets’ vocational physical training couldn’t provide the solution of the application tasks [3]. The different researches indicate the requirement of cadets’ good physical training [8]. According to O. Rolyuk’s opinion [11] the military man must have physical endurance, strength, speed, accuracy, reliability of actions in the conditions of time’s deficit and absence of additional information. Other researches were aimed at the development of cadets’ applied physical qualities for effective implementation of fight’s methods [16]. Authors mark that increase in level of special endurance of cadets-fighters should be carried out simultaneously with improvement of the general physical training [14]. In other research [17] were defined typical mistakes done by cadets during mastering submission hold. Authors considered improvement of training’s methods with a point of view of advanced theoretical researches devoted to processes of movements’ regulation. Such approach allowed to improve considerably the quality of cadets’ training. It is possible to use complex technique of cadets’ training [15]. Authors recommend to combine subjects of vocational training: physical, tactical training and weapons proficiency. Multiathlon and battle marches on different distances are effective activities to improve physical, moral and volitional powers of cadets. Such trainings contain various obstacles (high-rise constructions, ferryings, firing lines, etc.) [15, 19]. It is determined that the long stay in conditions of positional defense is not a problem for implementation of military men requirement for physical improvement [18].

The important components of cadets’ training are the followings: appropriate organization of pedagogical control [30]; choice of adequate and reliable tests [28, 42]; optimization of physical loads [21, 35]; planning of preparation cycles of taking into account the morphofunctional features of an organism [38, 40].

It is possible to distinguish the following directions of cadets’ training: approaches to increase the level of special and general endurance [23, 29, 33]; basics of nutrition [26] and its influence on body weight [32]; physical rehabilitation and prophylaxis of traumatism during physical exercises’ performance [41]; keeping of healthy lifestyle [34]; influence of various factors on motor behavior of a person [25, 27]; methodological provision of training’s quality [31, 39, 46]; satisfaction of sports activity [44, 45]; individual approach to difficult exercises training [36, 37, 47];

It is necessary to consider that cadets’ weapons proficiency depends on psychophysiological features of person [22, 24, 43]. The modern military applied heptathlon is notable for exceptional complexity. Each of its types can significantly affect the general result of competitions [15, 19]. As a rule, the training process is rather difficult. It is connected with the requirement of training’s camps organization, existence of necessary material resources. Proficiency level of specialists in all types of training is also important.

The analysis of scientific literature allows to confirm that the major factor is absence of methodical basics...
of studying and training process creation of cadets’ preparation for complex competitions.

The purpose of the research is to develop methodical bases of training of cadets for the military applied heptathlon competitions.

Material and methods.

Participants. Cadets of 2-3 courses at the age of 19-20 years (n=20) participated in researches.

Organization of researches. The research had two stages. The first stage corresponded to the preparatory period. Tasks of that stage were the following:

1. carrying out of preliminary monitoring of cadets’ readiness level by seven types of multiathlon;
2. preparation for competitions;
3. selection of cadets for competitions according to the results of the current monitoring.

This stage was carried out in the training center. At this stage all trainings were organized and were carried out according to the methodological bases of preparation:

- rational week distribution of training load by types of multiathlon for cadets of military educational institution (tab. 1) was made;
- within one training exercise the shooting were carried out only after exercises in swimming;
- exercises in swimming and shooting weren’t crossed with exercises in grenade throwing;
- in a week microcycle of preparation five days cadets had two trainings a day (on Saturday was one training, on Sunday they had rest);
- Individualization of load considered evaluation method of multiathlon types fulfillment and results, and also the current physical state of cadets. To the development of these methodical basics we have come after the analysis of cadets’ participation experience in competitions in separate types of multiathlon.

Preparation for the first type of the competitions “100 m run” consisted of the following exercises: start from different poses: front lying position with bent arms; back lying position; front lying position; squat position face and a back towards movement; squat position back towards movement jumping squat with turn on 180°; squat position back towards movement jumping squat with turn on 360°; run downhill; run downhill on sand; run downhill on sand with weighted (a car tire – the rope with turn on 360°; run downhill; run downhill on sand; run downhill on sand; run downhill on sand; run downhill on sand; run downhill on sand; run downhill on sand; run downhill on sand).

On a distance with partner as weighted; jumping exercises (jumping squat with advance forward, jumps on the right leg with advance forward and pulling of the left leg to a breast up, the same for the left leg); run (10-30 m flying start, 30 m, 60 m, 100 m). The main method of exercises fulfillment was repeated one [4].

Preparation for the second type of multiathlon “50 m freestyle swimming” was carried out on the course of an open waters and consisted of the following exercises: 25-50 m freestyle swimming, practice of turn and start. Interval and repeated methods were used to perform these exercises [4].

In competitive exercise “shooting from a military weapon” Kalashnikov (exercise of AK-1) was used. This exercise consists of three trial shots and ten exam shots. During cadets’ training were used: training in preparation for shooting from small weapons from different positions. After that preparation was directed to practice of exercises of basic shooting from small weapons. Exercises of basic shooting consist of shooting from different positions: shooting from prone position; shooting from standing on one knee position; firing from standing position (3 shots from each position). Further exercises of basic shooting were executed, including fast shooting, from personal weapon (AK-1). Preparation finished by trainings and execution of special exercises of shooting from personal weapon (AK-1). Special exercises of shooting consist of firing from different positions: prone, knee, standing of 5 shots from each position.

The “Pull-up” exercise was the fourth type of multiathlon. During cadets’ training the following exercises were used: hip-swing-up; muscle-up; arm-pumping exercises (support on parallel bars, front lying support, front lying support weighted – with carryall bag of sand on the back); movement on hands on parallel bars; movement on straight arms on parallel bars (to hold legs cross); bench pressing (70-80% of body weight).

Passing of obstacle course demands from cadets fulfillment of traditional set of exercises: to throw 600 g grenade from dug position on 20 m on a wall (breaches) or on 1x2,6 m field before a wall (direct hit is ruled valid; missing the hit by the first grenade to continue throwing – no more than three grenades before target hit); to jump out of trench; 100 m run on the track in the direction to the start; to run around a flag; 20 m run and to jump over 2,5 m wide fire trench; to run through the maze; to climb

<table>
<thead>
<tr>
<th>Table 1. Week distribution of a training load by types of multiathlon</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of competition exercise</strong></td>
</tr>
<tr>
<td>---------------------------------</td>
</tr>
<tr>
<td>100 m run</td>
</tr>
<tr>
<td>50 m freestyle swimming</td>
</tr>
<tr>
<td>Military weapon shooting (AK-1)</td>
</tr>
<tr>
<td>Pull-up</td>
</tr>
<tr>
<td>Obstacle course</td>
</tr>
<tr>
<td>Grenade throwing F-1</td>
</tr>
<tr>
<td>3000 m run</td>
</tr>
</tbody>
</table>
over a fence, to climb on a vertical ladder on the second segment of the destroyed bridge; to run on the bars, to skip on the other bar, to jump off on the land from a standing position from the end of the last segment of the bar; to overcome three steps of the destroyed ladder (mandatory contact with two legs of the land between steps), to run under the fourth step; to creep in a wall breach; to jump down in a trench, to pass on a trench; to jump out of a well; a jump to overcome a wall; to run up an inclined ladder on the fourth step and to run down on steps of the destroyed ladder; to climb on a vertical ladder on the bar of the destroyed bridge, to run on the bar (bars are located sequentially at small distance from each other), to run down on inclined board; to jump over 2 m wide fire trench; to run 20 m, to run around the flag, to run 100 m in the opposite direction on the track to the finish. Total length of an obstacle course is 400 m. The main method of training is repeated. Each element and exercise was practiced individually and in complex.

The next type of multiathlon was grenade throwing. There were some difficulties. Cadets practically did not know technique of running start and swing. The personal optimum distance of running start for effective fulfillment of a throw was selected. The main method of exercises fulfillment was repeated.

Final type of multiathlon is 3000 m run. For effective preparation for this type of competitions was used so-called “sidestep” run: 1 km – 2 km – 3 km – 2 km – 1 km in case of the heart rate (HR) within 155-165 beats/ min. Run was fulfilled by a equal and variable methods. Besides cadets run 3-5 km in the same pulse mode.

The cadets’ preparation and participation in competitions was carried out under the leadership of the physical training teachers and weapons proficiency teachers with profile education.

Protocols of competitions were analyzed during the researches: results of personal and team performances by each type of multiathlon. In pedagogical testing were applied standard test exercises for cadets: 100 m run and 3000 m, 50 m freestyle swimming, pull-up; obstacle course; grenade throwing; Kalashnikov rifle shooting. Pedagogical observation was carried out for improvement of training load value; detections of cadets mental response to the considerable physical activities; for determination of performance spirit in competitions.

Statistical analysis. The received results were processed by means of statistical soft Microsoft Excel with calculation of the following indices: arithmetic middling (X); mean-square deviation (σ), Student t-test (t).

Results
Results of the first stage of researches are provided into tab. 2. The analysis of results of fulfillment by cadets the first type of multiathlon – 100 m run confirms rather high level of high-speed and force abilities development. According to the standards for physical training for cadets of military educational institution [5] the average result of team much more exceeds the mark “excellent”.

There is a fact that in standards of physical training for cadets there is no swimming at all. There are only norms for overcoming a distance in full gear [5]. During preparation in swimming we were guided by results in sport. As a result the average result of each team in 50 m freestyle swimming is much lower, than demonstrate children of elementary sport school. Individual results of cadets were also very low.

Results of shooting are at the low level. Therefore preparation for this type of competitions requires special attention. The average result of team in pull up (the fourth type of competitions) is rather high and according to the standards [5] much more exceeds the mark “excellent”. The average result of team during overcoming “obstacle course”, in comparison with standards [5] exceeds mark “excellent”.

Results of grenade F-1 throwing on distance demonstrate the lack of the appropriate method of performance. As a result, the most of cadets demonstrated rather low individual results. At the same time the average result of team in comparison with standards [5] corresponds to the mark “good”.

In 3000 m run cadets demonstrated rather high individual results: the average induce of team in comparison with standards [5] exceeds the mark “excellent”.

The above mentioned data confirmed that cadets demonstrate higher results in the following types of multiathlon: 100 m and 3000 m run, pull-up, obstacle course. The lower results in 50 m freestyle swimming, grenade throwing and shooting were noted. It can lead to loss of scores in all-team competition. Results of preliminary monitoring allowed to reveal weaknesses and strengths of cadets physical training and weapons proficiency, their moral and strong-willed spirit. It allowed

Table 2. Results of cadets’ preliminary monitoring fulfillment of seven types of sport applied multiathlon, (n=20)

<table>
<thead>
<tr>
<th>Type of exercises</th>
<th>X̄, m</th>
<th>σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 m, sec</td>
<td>13,2</td>
<td>0,4</td>
</tr>
<tr>
<td>50 m freestyle swimming, sec</td>
<td>45,5</td>
<td>3,2</td>
</tr>
<tr>
<td>AK-1 (shooting), scores</td>
<td>75,8</td>
<td>10,4</td>
</tr>
<tr>
<td>Pull-up, times</td>
<td>19,4</td>
<td>1,3</td>
</tr>
<tr>
<td>Obstacle course, min, sec</td>
<td>2,02</td>
<td>0,2</td>
</tr>
<tr>
<td>Throw of grenade F-1, m</td>
<td>38,3</td>
<td>1,2</td>
</tr>
<tr>
<td>3000 m, min, sec</td>
<td>11,10</td>
<td>0,36</td>
</tr>
</tbody>
</table>
to define tasks of the preparatory and competitive periods, to develop a technique of preparation for the forthcoming competitions.

The carrying out the preparatory period on the basis of training center allowed to apply wider arsenal of preparatory exercises. Use of different modifications of exercises in run and jumps on sand, down the hill, with weighted, etc. contributed to the development of physical and moral and strong-willed qualities of cadets.

At the end of the preparatory period the current monitoring was carried out. 10 cadets were selected for participation in the military applied heptathlon competitions. Results of the current monitoring and results of competitions are provided into tab. 3.

The table 3 testifies that during preparation period cadets substantially improved the results in the following disciplines of multiathlon: 100 m and 3000 m run, 50 m swimming, grenade throwing on a distance. At the same time the team of National Academy of the National Guard took the 5th place following the results of competitions. The general result was substantially affected by low result in exercise “50 m freestyle swimming” and the considerable errors in shooting.

**Discussion.**

The analysis of scientific and methodical literature of the last few years can be argued that in preparation of cadets training camps organize and carry out only for sport teams. Most often it is fighting types of single combats [14, 16, 17]. At the same time the technology of preparation for different types of multiathlon is almost lost. The analysis of curricula demonstrates a priority of theoretical subjects of a humanitarian profile over practical disciplines. Thereby the number of physical education classes and cadets’ sport training is reduced.

Preparation for participation in competitions includes physical, technical and psychological training. We developed the methodical basics of preparatory period organization of preparation for participation in military applied heptathlon competitions which helped to lead substantially physical capacities of cadets to the required level. Obtained data confirm a first priority of physical fitness level factor in support of personal combat readiness of cadets. It is also confirmed by other researches [1, 11, 13]. Data on relevance of cadets’ basic physical training factor are added [13, 18]. Results of competitions testify to the problem of cadets’ psychological readiness for fulfillment tasks similar to the military mission.

It was important to use in the training activities the specific means and methods of training; simulations of the most serious conditions of military multiathlon. Also during training process the current results of cadets were compared with predicted ones. When results had some discrepancies the value and directivity of a training load was improved.

Total control was carried out during prestarting preparation period on next to last week. The fact that preparation was fulfilled in field conditions was considered and there was no opportunity to hold preliminary competitions with strong rivals. It would help to set cadets up for variability of fight methods in different types of multiathlon from the psychological point of view [12].

The results received during the competitions demonstrate their improvement in comparison with preliminary ones. Results of exercises “shooting” and “obstacle course” during competitions were worse than during preliminary period. Comparison of results of preliminary, current and total control testifies the increase of indicators which doesn’t have reliable character (p>0,05).

In the conditions of an open waters there isn’t opportunity of practice turns and start. This factor is an important component of good result in swimming [9].

The cadets often make mistakes passing an obstacle course; this makes result of exercise performance worse. Therefore work on prevention of possible mistakes, training of each element technique and obstacle course in general was fulfilled [1, 19]. Nevertheless, cadets during the competitions couldn’t confirm the preliminary results. In our opinion, the psychological factor during fulfillment a difficult set of exercises (“obstacle course”) plays an important role.

Today training of cadets for different types of competitions (in particular similar to combat-field conditions) cause some difficulties. Shooting is the specific type demanding special preparation. An opportunity to use in competitions a military weapon is followed by difficulties with its transportation and protection. There are also not enough bullets for training. The following factors have significant influence on results of shooting:

### Table 3. Results of cadets’ preparation and performance in military applied heptathlon competitions

<table>
<thead>
<tr>
<th>Type of exercises</th>
<th>Current control, ( n=10 )</th>
<th>Final control, ( n=10 )</th>
<th>( \bar{T}_{1-2} )</th>
<th>( p_{1-2} )</th>
<th>Team’s place</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 m run, sec</td>
<td>( \bar{x}, \sigma )</td>
<td>( \bar{x}, \sigma )</td>
<td>0,64</td>
<td>&gt;0,05</td>
<td>1</td>
</tr>
<tr>
<td>50 m freestyle swimming, sec</td>
<td></td>
<td>12,68 0,3</td>
<td>39,46 2,84</td>
<td>0,81 &gt;0,05</td>
<td>6</td>
</tr>
<tr>
<td>AK-1 (shooting), scores</td>
<td>82,6 11,3</td>
<td>68,9 16,32</td>
<td>0,69 &gt;0,05</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Pull-up, times</td>
<td>22,2 2,4</td>
<td>22,7 2,84</td>
<td>0,13 0,05</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Obstacle course, min, sec</td>
<td>1,52 0,4</td>
<td>1,58 0,31</td>
<td>0,12 &gt;0,05</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Grenade F-1 throw, m</td>
<td>40,15 1,62</td>
<td>43,14 2,79</td>
<td>0,92 &gt;0,05</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>3000 m run, min, sec</td>
<td>10,55 0,15</td>
<td>10,42 0,41</td>
<td>0,30 &gt;0,05</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
cadet’s psychological features; skeletal muscles tension; chosen speed and a rhythm of shooting [2, 6].

**Conclusions:**
1. The analysis of references testifies that teachers in higher education institutions of a military profile have accumulated work experience of cadets’ training for profession basics. However there are losses in complex techniques of teaching profile subjects: physical training and weapons proficiency. It influences significantly on the process of cadets’ training.

2. Results of researches testify the necessity to increase quality of cadets’ weapons proficiency; physical readiness to perform the exercises demanding complex demonstration of all physical qualities.

**Conflict of interests**
The authors state that there is no conflict of interest.

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Programming of skilled football players training process in the second cycle of specially created training during the year
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Abstract
Purpose: of the research is to prove experimentally the skilled football players training process in the annual macrocycle on the basis of programming.
Material: the skilled football players participated in a research (n=20, age 18-23 years). Control provided use of the following tests: 30 m run; shuttle run 7x50 m; long jump from the spot; Cooper’s test.
Results: programs of training microcycles were developed. In each program such components of the training were considered: value and orientation of loads; means (non-specific and specific); modes of coordination complexity of exercises performance; training time; time for renewal of competition form; theoretical and psychological preparation; load coefficient value; intensity of training load coefficient.
Conclusions: Programming of training process has to be carried out on the basis of systemically structural approach: the development of programs of less structural formations has to be subordinated to the main structural formations. The structure of microcycles includes programs of trainings. Programs of stages consist of a series of training microcycles programs. The program of a training cycle unites all structural formations.
Keywords: training process, football players, planning, programming, macrocycle.

Introduction
The present state of football development demands search of the most optimum ways of the organization of athletes training process at different stages of the annual training cycle.

Creation of training process has to be carried out on the basis of conceptual approach which provides:
• system approach to creation of structural formations of training process (set of exercises and complexes, trainings, micro and mesocycles, stages, periods, macrocycles);
• pachicity of development of athletes’ competition form; the highest level of it has to be on the period of the main competitions: planning of athletes’ training process has to be carried out on the basis of competitions’ calendar;
• accounting of sport development tendencies and created system of athletes training at the stages of long-term training;
• character and features of competitive activity in sport: intensity of sport fight, loss of power during the competition.

Training process of athletes is carried out on the basis of planning: long-term, perspective, annual, set of stages. The planning is previously planned operations procedure necessary for achievement of desired goal. Planning provides quantitative parameters of athletes’ training during the certain period of their preparation. There is a question: as far as planning is an effective component in the general structure of administrative decisions?

Planning allows to distribute parameters of athletes’ training during a certain cycle. Planning also allows to determine the content of structural formations of training process (training occupations, micro and mesocycles). But it is difficult to consider process of athletes’ training in dynamics on the basis of planning, in interrelation with the different parties of preparation. The main thing is that planning doesn’t allow to define purposeful influence on training effects’ formation: urgent, delay, cumulative. Programming of training process can be used for this purpose in structure of administrative influences.

Programming is an improvement of training process content according to the target tasks of athletes’ training and the specific principles which define rational forms of training loads organization within a certain training stage [2]. Programming began to be used in the course of study in the 20th years of the last century by the American scientists: B.F. Skinner has developed the linear program of study; N. Krauder has developed the branched program of study.

S.V. Malynovskyi was one of the first scientists who introduced programmable study in physical training. The author has developed universal programs of training material study [14]. The basic methodical principles of programming and organization of skilled athletes training process have been created by Yu.V. Verkhoshanskyi [2].

In the system of athletes’ training the fundamental problem is proved of programming theoretical and methodical bases at the present stage of sport’ development. This problem is studied at the works of native [16, 19] and foreign [22, 23] scientists. Certain aspects of implementation of basic provisions of programming in team game sports were considered by many experts: development of effective programs of athletes’ training in field hockey [12], football [13], volleyball [20].

Results of numerous researches of athletes’ training problems in team game sports demonstrate prospects of individual programs application. In particular, use of the factorial analysis allows to find the most developed skills of players. It is necessary to develop the backward skills at creation of individual training process [9]. Experts note the necessity of individual approach to planning of volumes and intensity of achievement training loads. Its adaptation is significantly limited by individual capability of athletes [31].
Development and implementation of training programs of selective orientation are characteristics features of sport games. Efficiency of speed and strength skills improvement is proved as main for the achievement of good results in basketball [3]. It is recommended to use loads of strength [25, 34], anaerobic [32] and aerobic [36] orientations for rational training of football players. Training programs for the different categories of readiness is applied in practice of athletes’ training of team game sports [12, 21]: technical and tactical [7, 29], physical [33, 34]. In the system of a sports training deserve attention: the flowchart of programming of skilled athletes’ training [10]; programs of pedagogical [15, 28] and medico-biological [24, 35] control.

The research of programming problem is relevant in practice of football players’ training of different qualification. S. Yu. Tyilenkov [17] has developed programs of football players training of high qualification at the different stages of annual training cycle. M.A. Bukuyev [1] studied technique of landmark programming of training loads. V.M. Shamardinim [18] investigated the management technology of long-term training system of the football teams of the top qualification. The author proved two versions of training programs for football team which participates in Eurocups.

Researches of foreign scientists were devoted to the problem of programming of skilled football players training process. The famous Dutch trainer R. Michels [30] developed the basic tactics principles of total football on the basis of programming. Programs of the differentiated approach in the training process of football players were investigated by H. Kormelink, T. Seeverens [26, 27]. Famous Canadian expert T. O. Bompa revealed the system of a complex training on the basis of programming [22].

The carried out analysis of references allows to claim that the problem of training process’ creation of athletes on the basis of programming is relevant and perspective. At the same time it should be noted that development and proofment of methodical approaches concerning creation of training process of the skilled football players on the basis of programming within an annual macrocycle are almost unresolved.

Hypothesis. It is provided that creation of skilled football players training process on the basis of programming will increase its efficiency.

The purpose of the research is to prove experimentally the skilled football players training process in annual macrocycle on the basis of programming.

Material and methods.

The qualified football players of Kamyanets-Podilsky Ivan Ohienko National University participated in a research (n=20, age 18-23 years). All participants gave a written approval of participation in this experiment.

Organization of a research. The research was conducted within two years. In the course of pedagogical observation over training activities of football players realized timing of trainings (fixing of character and time of exercises). The heart rate (HR) was simultaneous registered. The monitor of heart rate Polar Rs800cx was used.

The analysis of output data allowed to define:
1) pedagogical directivity of means:
   • nonspecific exercises (without balls) or specific (with balls), general training, special training, preliminary or competitive exercises, speed, speed and strength preparedness [12, 16];
   • mode of coordination complexity. The technical and tactical actions (TTA) belonged to the first mode of coordination complexity (MCC) which executed on the spot or on convenient traverse speed. TTA executed in movement with restriction in space and time belonged to the second MCC. TTA executed in the conditions of the active counteraction from the rival [12, 28] belonged to the third MCC;
2) physiologic directivity of loads: loads of an aerobic, mixed aerobic and anaerobic, anaerobic alactic or anaerobic glycolytic orientation [4, 16, 35];
3) load value coefficient was defined according to the formula [6, 12]:
   \[ LMC = \sum_{i=1}^{n} t_i \cdot I_i, \]
where: \( LMC \) – load value coefficient; \( n \) – number of exercises; \( t_i \) – duration of separate exercise; \( I_i \) – intensity of exercise depending on HBR [6, 12]:
   - intensity of exercise with HBR 114 bpm is evaluated in 1 point; 120 bpm – 2 points; 126 bpm – 3 points; 132 bpm – 4 points; 138 bpm – 5 points; 144 bpm – 6 points; 150 bpm – 7 points; 156 bpm – 8 points; 162 bpm – 10 points; 168 bpm – 12 points; 174 bpm – 14 points; 180 bpm – 17 points; 186 bpm – 21 points; 192 bpm – 25 points; 198 bpm – 33 points;
4) training load intensity coefficient was defined according to the formula [12, 28]:
   \[ IC = \frac{LMC}{T}, \]
where: \( IC \) – training load intensity coefficient; \( T \) – time of training.

Data on the each training have been written in the scheme of a microcycle [12]. As a result of synthesis of the obtained data it has been defined: volume, value and intensity of training loads; ratios of means and loads of different orientation in separate structural formations of training process.

Use of modeling methods at the forming stage of experiment has allowed to develop models of structural formations programs of training process.

Development of structural formations programs of training process of the skilled football players was based on the system conceptual approach and was carried out according to the scheme: the choice of model of an annual macrocycle (special planning has been chosen) □ development of the program of each of preparation cycles □ development of the training program of (competitive) microcycles □ development of programs of separate
Trainings. Such approach to creation of training process has allowed to plan optimum training influences by application of loads of different orientation, different means of training and different types of training of the skilled football players.

The program of a separate macrocycle of the skilled football players consisted of four blocks. In these blocks presented: terms of carrying out periods or stages of preparation; general parameters of trainings (training days, training occupations, games); ratio of training means and loads of different orientation; criteria of players preparedness [13].

Control of players’ physical preparedness indicators was executed at the all stages of a pedagogical experiment. Control provided tests which meet the requirements of reliability and informational content and are applied in practice of skilled football players training [6, 12, 18]: 30 m run, shuttle run 7x50 m, long jump from the spot, Cooper’s test. Testing was carried out according to the standard technique in the main part of training after obliging warm-up. Athletes were previously provided instructions concerning correctness of test performance.

For 30 m run was considered the best result of the player from two attempts (rest between attempts was 3-5 minutes). Shuttle run 7x50 m provided passing by football player 50 m distances with obliging condition that the supporting leg put over the line of start and finish. Three attempts were provided for the athlete to perform a long jump from the spot and the best result was fixed. Cooper’s test for evaluation of the general endurance of football players provided continuous run during 12 minutes with definition of distance which was passed by the player (firstly 15 minute warm-up was carried out, then was 5 minutes rest and after that the test was carried out).

Statistical analysis. The descriptive statistics was used during processing results of research. It were defined indicators which characterize selection of objects (an arithmetic average, an average square deviation), Shapiro-Wilkie criterion of coherence, Student’s t-test parametrical criterion. The difference between indicators was considered reliable on significance value \( p<0,050 \). Processing of results of research was carried out with the help of software Excel, Statistica 10.0.

Results.

The program of the second cycle within annual training of the skilled football players at the forming stage of experiment (123 days) is presented in fig. 1.

The programs of training microcycles were developed on the basis of the second cycle program of skilled football players training (tabl.1) In each program of training microcycles were considered the following components of trainings: value and orientation of loads; means (nonspecific and specific); modes of coordination complexity of exercises’ performance; training time; time for renewal of competition form, theoretical and psychological preparation; load coefficient value; intensity of training load coefficient.

Each program of training microcycle consisted in loads of different orientation and volume and intensity of trainings (fig. 2).

In general for the 2nd cycle of annual training of the skilled football players training influences were stipulated by application of glycolytic loads: 55.7% of aerobic, 37.9% of mixed, 3.5% of anaerobic alactic and 4.5% of anaerobic.

The biggest volume of the general physical training means (GPT) was observed at the preparatory period (56.3%) and at the intermediate stage (100.0%). Means of the special physical training (SPT) were mostly used at the preparatory period (17.8%). At the competitive period the biggest part was means of technical and tactical (TTP) (28.6%) and game (GP) (19.7%) preparation. Content of training influences on the preparatory of players during the 2nd cycle of annual preparation has been stipulated by means: GPT – for 49.2%; SPT – for 8.5%; TTP – for 25.1%; GP – for 17.3%.

The analysis of control tests’ results at forming stage of experiment has confirmed efficiency of programming of skilled football players training process.

In comparison with statement stage of experiment were positive changes in speed and strength qualities’ indicators at the preparatory and competitive periods; special and general endurance. At the preparatory period indicators of 30 m run have increased by 2.1% \( (p<0,050) \), a long jump from the spot – by 2.8% \( (p<0,050) \), shuttle run 7x50 m – by 3.2% \( (p<0,050) \), Cooper’s test – by 4.8% \( (p<0,050) \). Positive dynamics in results of football players preparedness was observed also during the competitive period. Decrease in indicators of preparedness at intermediate stage is connected with considerable reduction of loads volumes.

Discussion.

The analysis and comparison of the obtained data allows to state exclusive practical value of use of the offered systemical and conceptual approach to the development of programs of training of football players. It is connected with the fact that researches concerning problems of realization in practice of reasonable theoretic and methodical provisions of programming of football players training are limited [17]. In comparison with model and target approach [11, 12] the programming allows to plan optimum training influences. Programming is carried out by a variation of load components and training means at the different stages of annual and long-term training of football players.

Current trends of team game sports’ development stipulated the necessity of application of integrated scientifically-based approach [7, 9, 12]. The offered technique of programming of the skilled football players training is the perspective direction of training process’ optimization: programs of trainings, micro and mesocycles, stages and periods of annual macrocycle weren’t limited by selective influence on the separate sides of preparation. The received results were compared with other researches [25, 29, 32, 33]. The offered program
Table 1. The fragment of 6-day preliminary microcycle program of the 2nd cycle of annual training of football players at the stage of forming experiment

<table>
<thead>
<tr>
<th>Forms and components of trainings</th>
<th>Training days</th>
<th>First MT</th>
<th>ET</th>
<th>Second MT</th>
<th>ET</th>
<th>Third MT</th>
<th>ET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of loads</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orientation</td>
<td>AA- MX</td>
<td>A- MX</td>
<td>AA- MX</td>
<td>A- MX</td>
<td>AG-MX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AR</td>
<td>8^4</td>
<td>6^4</td>
<td>6^4</td>
<td>6^4</td>
<td>6^4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Str.</td>
<td>8^2</td>
<td>6^2</td>
<td>6^2</td>
<td>6^2</td>
<td>6^2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RE</td>
<td>8^4</td>
<td>6^4</td>
<td>6^4</td>
<td>6^4</td>
<td>6^4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-specific exercises</td>
<td>GPT</td>
<td>SPT</td>
<td>SPT</td>
<td>SE</td>
<td>3B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special preparatory exercises</td>
<td>SSE</td>
<td>16^12</td>
<td>18^14</td>
<td>SE</td>
<td>16^7</td>
<td>22^17</td>
<td></td>
</tr>
<tr>
<td></td>
<td>standard</td>
<td></td>
<td></td>
<td>provisions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preliminary exercises</td>
<td>TTP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-st MCC</td>
<td>12^5</td>
<td>12^5</td>
<td>6^5</td>
<td>8^6</td>
<td>12^5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-nd MCC</td>
<td>22^8</td>
<td>12^8</td>
<td>8^8</td>
<td>12^10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-rd MCC</td>
<td>12^10</td>
<td>4^10</td>
<td>12^12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Means specific exercises</td>
<td>GP</td>
<td>20^8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renewal, minutes</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Theoretical and psychological preparation, minutes</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>45</td>
<td>60</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Time of training, minutes</td>
<td>74</td>
<td>92</td>
<td>84</td>
<td>98</td>
<td>88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LVC, points</td>
<td>540</td>
<td>772</td>
<td>670</td>
<td>836</td>
<td>842</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{tli}$ point$^{-1}$min^-1</td>
<td>7,3</td>
<td>8,3</td>
<td>7,9</td>
<td>8,5</td>
<td>9,6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Consisted of generally prepared, specially prepared, preliminary, competitive means and loads of different orientation. They were used for improvement of the general and special physical, technical, tactical and game preparation of football players. Such means and loads which are rationally connected to the means of physical efficiency renewal of players: control system; means of theoretical and psychological preparation. Integrated scientifically-based approach at creation of microcycles programs at the forming stage experiment provided such basic provisions and regularities as [4, 6, 8, 16]:

- each microcycle (except the renewal) has to consist of two phases – stimulation (connected with performance of determined volume and orientation of load) and renewal;
- within separate microcycles there is an interaction of the set aside training effects of each previous occupation with urgent training effect of the next occupations;
- changing of occupations in a training microcycle has to consider a renewal heterochronia of different functions. Changing of occupations in a training microcycle has to be carried out in the following way: loads are planned by time intervals sufficient for achievement of supercompensation phase of the leading function; load of other training influence shouldn’t have negative impact on renewal of dominant function.

Programming of structural formations of training process has allowed to define: volume, intensity and volume of load; ratios of means and loads of different
Results of research confirmed phasicity of athletes’ competitive form development [12, 16, 18]. The developed system of training process provided development of preparation programs with such condition that each of phases of competitive form correspond to certain stage of training cycle: at the preparatory period were solved tasks of competitive form formation; in competitive – its keeping and the subsequent increase; at a intermediate stage – temporary loss. Therefore the concept of planning of skilled football players training process provided:

1) increase in volumes of specific means of trainings from microcycle to microcycle during the preparatory period; an optimum ratio of nonspecific and specific means in the competitive period;

2) gradual inclusion to the training process of anaerobic alactic and then anaerobic glycolytic loads (for maintenance of condition of players’ competitive form such loads were planned also in the competitive period) against the background of the sufficient volume of aerobic loads.

The analysis of dynamics of physical preparedness indicators of the skilled football players at stages of macrocycle displays phases of players’ competitive form formation.

The program of the second cycle of annual preparation has been developed for the purpose of effective preparation and participation in competitions of futsal. These competitions were mainly carried out in winter months. The structure and content of training process provided features of players’ competitive activity in a futsal. On the other hand it was provided that loads on the volume and intensity had to be easier from the first and third cycles of annual preparation. The second cycle of preparation had supporting character. First of all it has been caused by features of competitions calendar of the college football teams on the basis of which shorter intermediate stages of the first and second cycle of annual preparation have been planned. The received results were compared with researches of V.M. Shamardin [18]. At the preparation period of the second macrocycle it is found big loads of aerobic orientation and smaller loads of anaerobic. The received results confirm the previous researches [11, 12, 28] concerning ratio of training’s means of the skilled football players in the periods of the second macrocycle.

The optimum ratio of training work means and
loads of different orientation allows to optimize process of training of the skilled football players. The received results of a research have confirmed a hypothesis: creation of training process of the college football teams on the basis of programming is effective.

Conclusions.

1. The research of optimum ways of creation of training process of training of athletes is important at the present stage. Programming is one of structural formations of the training process.

2. Programming of athletes’ training process has to be carried out on the basis of systemical and structural approach: development of programs of less structural formations has to be subordinated to main structural formations. Thus, programs of training occupations formations included into structure of microcycles. Programs of stages consist of series of training microcycles programs. The program of a training cycle unites all structural formations.

3. Programming allows to determine accurately the volume and orientation of training influences (both in the course of the separate training occupations, and within microcycles, stages of an annual macrocycle), purposefully to form training effects. The programs of structural formations of skilled football players training process were developed and experimentally proved in the course of the research.

4. The subsequent researches of scientific problem will be directed to programming of training process of football players of different qualification.

Special moments. Programming of training process is one of perspective methodical approaches in the course of athletes’ training. Programming has differences from planning of training process. Programming allows to form training effects purposefully: urgent, set aside, cumulative. First of all it is caused by programs of trainings and training microcycles. The main structural unit of training programs is model training tasks. Such tasks aren’t considered in this article.

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The teams’ formation in sport aerobics on the basis of application of multidimensional analysis methods

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Abstract

Purpose: The purpose of the research is to develop the principles of team's formation in sport aerobics with application of factorial and cluster analysis’ methods.

Material: in a research girls (n=24) from the sport aerobics national team (Kharkiv, Ukraine) participated. The athletes were given full medical examination by determination of functional condition of an organism (arterial blood pressure, indicators of a variability of the rhythm of the heart, treadbahn testing), a psycho-physiological condition (time’s determination of simple and complex reaction). It was defined physical development and physical fitness and vestibular stability.

Results: The mathematical and visual models of each group of athletes were developed. The cluster analysis permitted determination of simple and complex reaction). It was defined physical development and physical fitness and vestibular stability.

Conclusions: The possibilities of athletes’ groups formation (in pairs, in trio, in five) for mixed performances are revealed. It is determined that it is possible to select athletes with similar qualities (representatives of one cluster) and with different qualities (representatives of different clusters) for mixed performances.

Keywords: personal, algorithm, aerobics, cluster, analysis.

Introduction

The sport aerobics contains complex, coordination and intensive motor actions. These motor actions include elements of acrobatics, artistic and rhythmic gymnastics. In the course of the training the large arsenal of motor skills with the high coordination exactitude and complexity are formed. Other distinctive feature of sport aerobics is development of strength opportunities: dynamic, static, explosive strength, high-speed and strength endurance. One more feature of sport aerobics is a specificity of competitive activity. The physical activity in sports aerobics is characterized by complex coordination exercises. The exercises are carried out in a zone of the submaximal power in the high-speed and strength, anaerobic and glycolytic mode. The sport aerobics assumes limited mobilization of cardiovascular system’s functions at high economical efficiency of power supply mechanisms.

Hu C. F. et al. [1] point that the main sense of aerobics consists in manifestation of beauty of art and the motor action. The aerobics gives the chance to enjoy the beauty of motor compositions.

Jiang G. P. et al. [2] investigated jumps with obstacles in sport aerobics. The authors have determined that in a phase of take-off there are two peak phases of manifestation of the maximum strength of a hip and a shin. The peak phase of hip muscles’ tension is appeared in a preparatory phase of a jump, and of shin muscles’ tension is appeared in a take-off phase. In phase of action in the air the various segments of a body exert various impacts on the effect of the turn. In a landing phase the maximum rotary moment of a cox is much more, than at other joints. The author recommends using the obtained data in training technology of jumps in aerobics.

Li L. [3] offered to use the interactive technologies for learning efficiency’s increasing in sport aerobics. The offered technologies promote the development of motors system’s visualization in aerobics. It is permitted to realize interactive actions between teachers and pupils. The technology offered by the author represents a new method of the built-in computer system in sports training.

In earlier researches Liu C. S. [4] has offered to use the similar computer network technologies in evaluation of sports competitions.

Nehra N. K. [5] analyzed the reasons and precautionary measures concerning athletic injuries in sport aerobics. The author points that the irrational motor actions, non-standard platforms and unreasonable methods of training lead to injuries. The muscular and popolar deformations, injuries of an ankle joint and knee joint are the most often observed injuries. Injuries of hip muscles are the most often observed. The author also points that insufficient
warm-up is the main reason of sports injuries.

Nunez R. A. et al. [6] revealed that the most often observed injuries are injuries of limbs. The author points that scientific justification in this sport isn’t enough. The large amount of researches devoted to sport aspect of aerobics is concentrated in Spain.

Qiu Q. E. et al. [7] have conducted pilot study of mechanical properties of single materials of sports footwear applied in aerobics. The antiskid properties of Reebok and Huakang footwear were also investigated. The mechanical effect of sports footwear for aerobics was estimated.


Wang Z. C. et al. [9] analyzed the sequence of training of complex motor actions in sport aerobics. The authors revealed interrelation between quality of motor action and physical qualities. The authors determined the consequences of principles of motor skills’ transfer for training the complex motor actions. The authors point that the consequences of training the complex motor actions could influence on effects of training. It is revealed that high physical qualities could be useful for fulfillment of complex motor actions. The pupils with high physical qualities could cope better with difficulties in motor actions training. Moreover, they study quickly the combination of motor actions with similar structures or general elements. The teachers of aerobics have to find the reasonable consequences of different complex motor actions’ training.

Wu T. [10] offered the dynamic hierarchical mode in training process and in creation of compositions in sport aerobics.

Xu W. J. [11] offered the model of training technique of motor actions in sport aerobics based on biomechanics of the human. The technique combines the theory of aerobics training with biomechanical methods of research. The technique is based on the analysis of biomechanical parameters of rotation angle in 720 degrees for athletes. The author revealed the irrational technique during a full course of athletes’ actions. The ways of efficient increasing of athletes’ training which provide theoretical basis for rational technique’s training in sports aerobics are offered.

Yang H. et al. [12] carried out the kinematic analysis of motor actions in sport aerobics. The authors revealed that the structure of skills and key moments of motor action are evidence-based criteria. Such criteria could be used in diagnostics of motility level and selection of talented athletes in elite sport aerobics.

Huang W. Y. et al. [13] studied athletes’ heart rate variability in aerobics with use of the telemetric monitor of heart rate continuous registration (Polar RS800). The conclusion was drawn that athletes’ age, professional level, heart beats rate and gender influence on the variability of heart rate.

Li L. et al. [14] developed the theory of application of musical work digital editing methods in sport aerobics. The author offers a technique of carrying out a preliminary research of digital technologies used in creation of musical work in sport aerobics.

Luo M. F. et al. [15] noticed that sport aerobics has a certain charm and has a certain spiritual values. The authors interpret value orientation of aerobics for creation the bases of deep understanding of its problems. It will permit creating premises for external manifestation of its intrinsic values.

Zhao J. J. et al. [16] pointed out that scientific and reasonable methods of training promote innovations and the development of complex coordination motor actions.

Other researches studied important aspects of athletes’ training: mastering of physical fitness [17]; relocation in dancing games [18]; motivation of success achievement [19, 20]; biomechanical parameters of jumps [21]; mastering of physiological indicators [22]. The authors also considered approaches to optimization of physical activities [23, 24]; didactic bases of training [25, 26]; choice of appropriate tests and pedagogical monitoring [27, 28]; periodization of training process [29, 30] and competitive activity [31, 32]; factors of athletes’ success [33, 34] and choice of optimized motor action’s parameters [35, 36].

Nowadays there is insufficiency of theoretical and methodical bases’ development of training process’ formation in sport aerobics. It is connected to many factors: 1 – sport aerobics is rather young sport; 2 – the aerobics is considered in literature as means of health improvement for people of different age groups. In the modern literature there are a lot of researches devoted to problems of training process’ formation in sport aerobics.

Thus, there are problems in training process in sporting aerobics. The greatest attention is paid to physical training of athletes, problems of traumatism and rehabilitation after injuries, to the analysis of biomechanical structure of different motor actions, using of interactive technologies. However the problem of individual approach and teams’ formation for group performances in different competitive categories is not practically investigated. Thus, in the modern sport aerobics the principles of athletes’ division according to groups for teams’ formation are only descriptive. They do not consider the quantitative models and the principles of mathematical and statistical modeling.

The point of the research is to develop the principles of teams’ formation in sport aerobics on the basis of application of cluster and factorial analysis.

Material and methods

Participants. The athletes (girls, n=24) of the national team and reserve team of sport aerobics (Kharkiv, Ukraine) participated in a research.

Organization of a research. It were used: methods of determination of functional condition of athletes’ organism (arterial blood pressure, indicators of variability of the rhythm of the heart [13], treadmill testing), psycho-physiological methods of a research (time determination of simple and complex reaction); methods of physical development and physical fitness’ determination; method
of vestibular stability’s determination; simulation method; method of mathematical statistics.

For the analysis of vegetative regulation of heart activity was used a variability of the rhythm of the heart. The record of a signal was carried out on the portable cardiographic equipment «Cardiolab» (Computer electrocardiograph «Cardiotest» permits to register 12 channels standard ECG, ECG in the lead system by Neb and Frank. For the indicators’ analysis is used Dialog box «Complex» Dialog box «Lens» http://www.dx-sys.com.ua/en/products/). The monitor of continuous registration of heart rate model «Polar» with the appropriate software was also used. The record was registered during 5 minutes in a lying position after 5-minute rest.

The subsequent processing of cardiointervals permitted to define a row of statistical characteristics of variability of the rhythm of the heart [13, 37]:

As indicators of heart beats rate we found:
1. \( \text{Mo} \) (mode of RR-intervals’ duration) the most frequent interval between teeth RR (sec.);
2. \( \text{AMo} \) (amplitude of mode of duration of RR-intervals) – percentage of intervals’ quantity (the most frequent) to the total quantity of the measured intervals (in our case we used 50 RR-intervals) (%);
3. \( \Delta x \) – variation range of RR-intervals’ duration: there is difference between the highest and the least value of RR-intervals (sec.);
4. Index of tension (conv. un) of regulatory mechanisms (IT) we found by formula:
   \[
   \text{IT} = \frac{\text{AMo}}{2 \text{Mo} \cdot \Delta x} \quad (1),
   \]
   Where \( \Delta x \) – is the value of variation range of RR-intervals’ duration (sec.);
   \( \text{Mo} \) – mode of RR-intervals’ duration (sec.);
   \( \text{AMo} \) – amplitude of mode of duration of RR-intervals (%).

In the analysis of heart rate indicators we were guided by the fact that indicators of a heart rate reflect a different contribution of sympathetic and parasympathetic branches of the autonomic nervous system to the process of heart activity regulation. The mode of RR-intervals’ duration (Mo) indicates resultant effect of regulatory influences. It reflects the steadiest functioning level in these conditions. The variation range reflects the range of possible deviations option of casual process. It is defined expression of breathing vibration of heart rate. Therefore this indicator is considered as activity indicator of closed-loop control. The amplitude of mode of duration of RR-intervals (AMo) permits to judge about activity of closed-loop control. Thus, increase of AMo duration of RR-intervals and IT witness about tonus increase of sympathetic branch of the autonomic nervous system. Increasing of variation range of RR-intervals’ duration witnesses about increase of parasympathetic branch influence of the autonomic nervous system [13, 37].

Our research carried out the testing to define the time of simple and complex reactions to sound and visual stimuli. Time of complex reaction was determined by testing with feedback. Time of the latent period of reaction, an average quadratic deviation, and quantity of mistakes, time of the minimum exposition and time of reach the minimum exposition were defined by time definition of complex visual and motor reaction with feedback [38].

The strength and mobility of nervous system were determined by following: 1) higher strength of a nervous system is provoked by less quantity of mistakes in a submode of complex visual and motor reaction with feedback; 2) higher mobility of a nervous system is provoked by less time in a mode of complex visual and motor reaction with feedback [38].

The vestibular stability was determined with the help of Barany mechanical chair. Rotation of chair was ensured by hand during 20 sec at speed of 2 r.p.sec⁻¹. After every 2 sec. we registered heart beats rate (HBR) with the help of photoelement equipment. HBR was also registered after rotation during 10 sec., after every 2 sec. Increase of HBR before and after rotation was considered as proper reaction to rotation. It is activation of sympathetic branch of autonomic nervous system. Decreasing of HBR before and after rotation was considered as inappropriate reaction to rotation. It is activation of parasympathetic branch of autonomic nervous system (motion sickness). In case of data analysis the HBR indicators on the 2nd sec after the beginning of rotation were selected. The indicators after rotation were also selected [37].

Simulation method. In our research the athletes’ models with different structure fitness features were created. The 2 types of models were developed: mathematical and visual. The mathematical models were created based on results of factorial and cluster analysis of personal structure of athletes’ fitness. These models were also displayed graphically. The visual models were developed by means of MakeHuman software.

Statistic analysis. Digital material was processed by means of traditional methods of mathematical statistics. The arithmetic average value \( X \), an average quadratic deviation of \( S \) (a standard deviation) was determined by each index. The factorial and cluster analysis of testing indicators were also carried out. The obtained data processed by means of Excel and SPSS software.

Results.
The personal factorial models of athletes (girls) structure fitness were analyzed. The optimum alternative of athletes division on groups for teams’ formation is also analyzed. Factorial analysis permitted selection of 4 factors in structure of girls’ fitness: «Parasympathicotonia», «Mobility of nervous system», «Strength», «Motor timing». The personal factorial structure of fitness was revealed for each girl. The cluster analysis was carried out for determination the optimum alternative of athletes’ selection to the team.

In hierarchical cluster analysis every particular item (athlete) forms firstly the separate cluster. On each stage two the closest clusters incorporate in one cluster. Firstly athletes with the closest analyzable indicators incorporate. Then athletes, similar to them on analyzable indicators join the formed couples. Thus there appear groups of athletes which can be considered as the most similar in
the fitness structure. Stages of incorporation to clusters are provided in table 1.

It is possible to notice that the cluster structure of female athletes is more complex on comparing with male athletes. It can be also connected with big variety of types and styles of sport activities at female athletes. The female athletes have not accurately expressed cluster groups, there are intermediate variants. We will consider the formed clusters (groups) of female athletes.

The tab. 1 and fig. 1 provide the following: 1) on the first stage athletes №№ 17 and 24 were incorporated in one cluster. Thus, these athletes are close by the structure of complex fitness. It needs to be considered in case of: teams’ formation for performances in different competitive categories; development of competitive programs; selection of means and methods in training process.

At the following stage of cluster analysis athletes №№ 16 and 23 incorporated. It means that they are close by fitness structure. These athletes differ from the previous incorporated pair (№№ 17 and 24). On the third stage №№ 15 and 22, on the fourth – №№ 4 and 8, on the fifth – №№ 1 and 19 incorporated. On the sixth stage №№ 1 and 19 incorporates with №№ 4 and 8, incorporating with № 4.

From the sixth stage there is an adding of new athletes in already existing pairs. So, on the seventh stage №№ 21 incorporates with №№ 4 and 8. On the eighth stage this group increases by adding № 2 to №№ 4; 8; 21 incorporating with № 4.

The optimum quantity of clusters is further defined:

Table 1. The agglomeration order in cluster analysis of psycho-physiological testing indicators of athletes (n=24)

<table>
<thead>
<tr>
<th>Stage, №</th>
<th>Cluster 1</th>
<th>Cluster 2</th>
<th>Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17</td>
<td>24</td>
<td>,000</td>
</tr>
<tr>
<td>2</td>
<td>16</td>
<td>23</td>
<td>,000</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
<td>22</td>
<td>51,158</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>8</td>
<td>54,987</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>19</td>
<td>71,573</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>21</td>
<td>71,865</td>
</tr>
<tr>
<td>7</td>
<td>20</td>
<td>24</td>
<td>85,334</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>17</td>
<td>90,160</td>
</tr>
<tr>
<td>9</td>
<td>18</td>
<td>20</td>
<td>104,215</td>
</tr>
<tr>
<td>10</td>
<td>7</td>
<td>10</td>
<td>111,569</td>
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<td>6</td>
<td>131,550</td>
</tr>
<tr>
<td>12</td>
<td>4</td>
<td>16</td>
<td>135,590</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>13</td>
<td>169,041</td>
</tr>
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<td>14</td>
<td>13</td>
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<td>7</td>
<td>19</td>
<td>270,578</td>
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<td>2</td>
<td>12</td>
<td>299,583</td>
</tr>
<tr>
<td>17</td>
<td>3</td>
<td>10</td>
<td>316,255</td>
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<tr>
<td>18</td>
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<td>9</td>
<td>379,291</td>
</tr>
<tr>
<td>19</td>
<td>1</td>
<td>7</td>
<td>381,478</td>
</tr>
<tr>
<td>20</td>
<td>5</td>
<td>15</td>
<td>505,204</td>
</tr>
<tr>
<td>21</td>
<td>2</td>
<td>2</td>
<td>538,594</td>
</tr>
<tr>
<td>22</td>
<td>3</td>
<td>5</td>
<td>1683,142</td>
</tr>
</tbody>
</table>

is added to this group, incorporating with № 20 (tab. 1). Thus, the new group of athletes (fig. 1) appears.

On the tenth stage new pair is also formed – №№ 7 and 10. On the eleventh stage – № 6 is added to №№ 1 and 19. On the twelfth stage to №№ 4; 8 and 21 joins №№ 16. It incorporates with № 4. The group of athletes №№ 16 and 23 extends. As a result the group of athletes №№ 4; 8; 16; 23; 21 appears.

At the following stages №№ 13 is added to group №№ 1; 19 and 6 (stage 13). Also groups №№ 4; 8; 16; 23; 21 joined. On the fourteenth stage №№ 14 with №№ 13 (tab. 1) are joined them.

On the fifteenth stage the group №№ 1; 19 and 6 extends by adding №№ 7 and 10.

The following groups are selected:
- №№ 17; 24 and the closest to them on fitness structure №№ 2; 18; 20;
- №№ 16; 23; 4; 8; 21
- №№ 13 and 14, the closest on fitness structure to №№ 16; 23; 4; 8; 21
- №№ 15 and 22 and the closest to them on fitness structure №№ 5; 11; 12;
- №№ 1; 19; 6; 7; 10.

Athletes №№ 9 and №№ 3 are differ from others. They are added last to the existing groups with big cluster coefficients. They can represent separate clusters.

Thus, it is possible to select several clusters (groups) of athletes.
to subtract from the total quantity of athletes the number of a stage on which cluster coefficients begin to increase non-linearly. In our case there are several such stages (tab. 3): №№ 4; 16; 21; 23 stages. Consequently, the optimum quantity of clusters can be:

- 24-23=1 (i.e. all athletes incorporate in one group);
- 24-21=3 (athletes incorporate in 3 groups);
- 24-16=8 (athletes incorporate in 8 groups);
- 24-4=20 (athletes incorporate in 20 groups).

According to the carried-out analysis, we selected incorporation of athletes in 8 groups. Two groups of these athletes will form independent clusters. One group of athletes with the intermediate fitness structure is also selected. The last three groups can be parts of other groups. In this case 5 clusters are formed.

We received 8 clusters or 8 groups of athletes. The figure 1 demonstrates belonging of each athlete to a certain cluster.

Then the analysis of personal factorial fitness’ structure of athletes was carried out. The formed groups received characteristics. The visual graphic models of athletes’ fitness structure of each group (fig. 2) were developed.

The groups №№ 17; 24; 2 have expressed factor – «Mobility of a nervous system» (fig. 2). It signified that the specified athletes can incorporate with each other in pairs or in trio. They have success in programs which emphasize speed. Such musical works as «Flight of a bumblebee» (N.A. Rimsky-Korsakov), «Joke» (S. Bach), «The Turkish march» (W. Mozart) and others are successful for emphasizing performances story’s lines of these athletes.

The athletes №№ 20 and 18 (fig. 2) could be added to the first group as closest on fitness structure for performances in five. They have high expressiveness of factor «Mobility of a nervous system» and factor «Parasympathicotonia» (fig. 2). In story lines for such athletes it is expedient to select programs with music which combines speed, easiness and lyrics (for example, W. Mozart «The symphony G-major»).
The following group is athletes №№ 16; 23; 8; 4; 21 (fig. 2). They have most expressed factor «Strength». They have success in programs with accentuation of strength elements: static holdings of partners in different positions. These athletes can play in team with other groups (their role is solo). Such musical works as «Symphony №5» (L. Beethoven) and others will be successful for them.

The athletes №№ 13 and 14 are similar to athletes of this cluster. They form a separate cluster. They have the most expressed factors «Strength» and «Parasympathicotonia» (fig. 2). The programs with the following music will be successful for them: «Sonata № 23», «Appassionato» (L. Beethoven), blues music. The following cluster is formed by athletes №№ 15 and 22. They have highly expressed factor «Strength». These athletes expressed the factor «Motor timing» (fig. 2). They can form team with athletes of the previous clusters (№№ 13; 14 and №№. 16; 8; 16; 21).

Particular interest is represented by group of athletes with the greatest expressiveness of factor «Parasympathicotonia» №№ 19; 1; 7; 10; 6 (fig. 3) People with prevalence of parasympathetic branch of the autonomic nervous system in a regulation of vegetative balance differ in predilection: to languishing, to asthenia, to emotionality; to dreaminess, to imagination, to contemplation, to figurative perception.

For this group of athletes the high relevance has programs with interesting story line referred to the demonstration of deep feelings and experiences. In their training process the accent should be made on development of visual thinking and ability to demonstrate story structures of the program with the help of various motor actions. The story programs corresponding to the following music works «Seasons» (P. Tchaikovsky), I. Strauss’s waltzes, some works F. Chopin are successful for these athletes.

It is necessary to notice that existence of the story line in the performance program in sport aerobics and ability to demonstrate this story line in the motor actions raise a performance of athletes to the new level. It significantly raises level of performance. Such athletes take the leading positions in the world-class championships. Therefore in training of athletes it is important to pay attention to development of visual thinking, ability to demonstrate various images with the help of the motor actions. This ability is the leader at athletes with the most expressed factor «Parasympathicotonia»

The athlete №3 is also selected in a separate cluster (fig. 2). She has approximately equal expression of all factors. She can forms a team with any other clusters and also will be successful in single programs.

Practical work of trainer requires visualization of

Fig. 2. The examples of individual factorial structure of functional and psycho-physiological opportunities at athletes: results of mathematical and visual 3D-modeling: 1 – Factor «Parasympathicotonia»; 2 – Factor «Strength»; 3 – Factor «Mobility of a nervous system»; 4 – Factor «Sympathicotonia». 
external features of athletes with different expression of factors in fitness structure. For athletes types’ visualization were created their visual models. Such approach permits creating and visualizing the virtual people.

To create a 3D model of the human (fig. 2), it is necessary to make manipulations and to adjust numerous characteristics of a human body. There are more than 1170 effects which can be changed (age, gender, height, shape of the face and others). In our research these parameters were set according to parameters of athletes – representatives of various clusters.

Thus, for definition of groups optimum alternative for performances in various competitive categories the cluster analysis of testing indicators was carried out. The results of cluster analysis were compared with individual factorial values, athletes’ profiles were compiled. On the basis of the obtained data groups of athletes for performances in various competitive categories were formed.

**Discussion**

In our research models of athletes with various features of fitness structure were created [39]. The models of 2 types were developed: mathematical [40] and visual. The mathematical models were created on the basis of results of the factorial and cluster analysis of testing indicators and individual factorial structure of athletes’ fitness [41, 42]. These models were also displayed graphically. The visual models were developed by means of MakeHuman software.

Such analysis tools were chosen because selection of athletes for incorporation in pairs and groups for performances is a difficult task. It is connected with complexity of sport aerobics.

In our opinion, sport aerobics combines several aspects of motor and psychological activity. The sport aerobics has much in common with dances. Besides, very important components in sport aerobics are artistic and rhythmic gymnastics and acrobatics. The sport aerobics consists of elements of sport and art. The athletes have to have sport and art qualities. The athletes demonstrate these qualities in different ways. That’s why the variety of options of differ athletes combinations gives great opportunities for realization of the art and sports ideas.

Nowadays the greatest success in sport aerobics is made by teams which manage to realize any story line in the program. For example, the team from Belgium (trio) in the World Cup in 2014 became the winner of competitions grace to successful selection and demonstration of story
line. The integrated picture of a certain story was given by music work (music from the ballet «The swan lake» by P.I. Tchaikovsky), suits of participants, character of a performance. The story lines are demonstrated in the best way with the help of dances. Therefore elements of dance are very important for success of performances in sport aerobics. The abilities to demonstrate the necessary story line of the program are especially important.

The dance is one of the most ancient forms of art. The complexes of the special motor actions subordinated to the single story line (hunting, migration, household activities) began to appear. Egyptian images which demonstrate dances are the most popular from the most ancient dancing instructions. Each pose had the value [15]. Thus, presence of the story line is an integral part of the dance.

Nowadays not all teams manage to combine harmonically elements of the competitive program with any story lines which demonstrate with the help of motor actions. The selection of necessary athletes for group formation in different competitive programs also causes difficulties.

In our research was made an attempt to make recommendations about optimum athletes’ selection, search of optimum alternative of athletes’ incorporation for performances in different competitive categories. The formed groups of athletes were described by leading factors in their personal factorial structure of fitness [39, 42].

Recommendations about selection of the successful story lines were developed for each group of athletes during creation of competitive performances programs. The characteristics of the functional and psycho-physiological conditions of athletes were considered.

Such approach gives perspectives of further development of this problem. The advanced study of athletes’ classification bases in sport aerobics and selection of competitive programs form backgrounds of this problem.

Conclusions
1. The cluster analysis permitted selecting 8 groups of athletes. The athletes in each group can incorporate with each other for performances in different competitive categories. Each group of athletes should select appropriate programs according to features of their personal factorial fitness’ structure. The general recommendations about selection of programs’ story lines for athletes of each group are developed. The visual models of each group athlete’s appearance are created.

2. It is revealed that the cluster structure of athletes is rather complex. The athletes have not accurately expressed cluster groups. The groups of athletes received characteristics to the factors which are the most expressed in their fitness structure. The visual graphic models of athletes’ fitness structure of each group were also developed.

3. The possibilities of athletes groups forming (pairs, trio, five) for mixed performances are determined. It is revealed that for mixed performances it is possible to select athletes with similar qualities (representatives of one cluster) and with different qualities (representatives of different clusters). The creation principles of athletes’ competitive programs for each group are developed.

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Conflict of interests
The authors state that there is no conflict of interest.
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Age dynamic of physical condition changes in pre-school age girls, schoolgirls and students, living in conditions of Eastern Siberia

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Abstract
Purpose: to analyze dynamic of physical condition, considering sex (females) and age of the tested, living in region with unfavorable ecology.
Material: we studied pre school age girls (n=1580, age 4–7 years). In the research we did not include children with chronic diseases, who were under observation. We tested schoolgirls (n=3211, age 7–17 years) and girl students (n=5027, age 17–21 years, 1–4 years of study. Girl students were divided into five age groups: from 17 to 21 years. All participants lived in conditions of Eastern Siberia (Irkutsk). This region is characterized by unfavorable ecology and climate geographic characteristics.
Results: in dynamic of physical condition of pre-school girls, schoolgirls and students we marked out three substantial periods of it characteristics’ changes. Age 7-8 years is critical (transition from 1st to 2nd stage). The least values of these characteristics are found in older (after 17–18 years) ages. In students we observed relative stabilization of these indicators.
Conclusions: the received results shall be considered in building physical education training process in pre-school educational establishments, secondary comprehensive schools and higher educational establishments.
Keywords: pre school age girls, schoolgirls, girl students, physical condition.

Introduction
Physical education is one of leading criteria, improvement of whose indicators shall witness about health strengthening of rising generation. This criterion is external manifestation of adequacy of growth and development processes to living conditions and age [14]. Its assessment shall be built on comparison of testing results with test requirements and on dynamic of its results’ increment. Such assessment shall be realized for every age group [12].

Single studies of morphological or functional indicators permit to assess only physical condition of the tested. These indicators cannot serve as the base for assessment of population physical state [6]. Dynamic observations shall include complex analysis of indicators. It will permit to predict reliably child’s development and his/her functional potentials [13]. With it, it is necessary to consider homogeneity of group results, to admit tolerance for age and processes of natural growth and development of children, adolescents and youth [3].

The basis for monitoring of population’s physical state (of all age groups) is: unfavorable medical-demographic situation; insufficiently effective system of first medical aid organization; growth of somatic morbidity; harmful habits and negative social phenomena [8].

System of monitoring permits to actually assess harmony of children’s adolescents and youth’s development [11]. It is the base for working out of correction programs, directed at health strengthening and physical fitness improvement. The main sphere of practical application of monitoring is information servicing of its management [12].

In other studies authors note demand in the following: consideration of youth’s individual features in physical culture [21, 27] and sport practicing [24, 26]; choice of optimal loads [30] and adequate motor tests [22, 25] as well as health level [32, 33].

Unfavorable ecological and climate geographic characteristics of Irkuts region influence negatively on the following: rising generation’s physical development and physical fitness [4]; main medical demographic indicators (birth rate, mortality and morbidity. With it, their values in population of Eastern Siberia are much lower than in population of European and central parts of Russia. For children’s population of Siberian region’s industrial cities some morphological functional peculiarities are characteristic. These peculiarities are connected with living conditions and specific of environmental pollution [7].

In other works it is noted that climatic conditions influence on pre school age children’s perception of motor tasks [22]. These peculiarities shall be considered when preparing motor training programs [28]. Besides, it is recommended that members of family, peers and sportsmen were examples in programs of youth’s physical activity’s increasing (on example of Australia) [34]. Such approach facilitates formation of positive attitude to own health and involves youth in active sports’ practicing [29, 31]. It is noted that physical culture teachers shall have certain competences. It was found that application of
information-communication technologies is an important factor, which influences on teachers’ competences in Turkey [20].

In Irkutsk region specialists in physical culture and medicine rarely analyzed dynamic of children’s population’s physical development. Only some weight height indicators of this age group were regarded and compared with average indicators in Russia. Besides, there are practically no scientifically substantiated regional standards of assessment of rising generation’s physical health. Only in 2002–2014 the group of scientists, guided by Prof. V.Yu. Lebedinskiy fulfilled work on monitoring of pre schoolchildren’s physical development [17], schoolchildren [18] and students [2] of Irkutsk. The authors considered age, gender and typological peculiarities of children and youth.

Hypothesis: study of physical development peculiarities of pre school girls, schoolgirls and girl students will permit to raise effectiveness of physical education in municipal pre school educational (MPSEE) and comprehensive schools (MEE SCS) and in higher educational establishments.

The purpose of the research was to analyze dynamic of pre school girls, schoolgirls and girl students, living in region with unfavorable ecology, physical condition.

Material and methods
Participants: 1. pre school age girls. We tested girls (n=1580, age 4–7 years), who attended MPSEE № 75, 79, 148 in Irkutsk. In the research we did not include children with chronic diseases, who were under observation.

2. Schoolgirls: we tested girls (n=3211, age 7–17 years), who learn in 22, 25, 44 of MEE SCS in Irkutsk.

3. Girl students: we tested girls (n=5827, age 17–21 years, 1–4 years of study), who study in Irkutsk national research technical university (IrkSRTU). The girl students were divided into 5 age groups: from 17 to 21 years age.

All parents gave consent for their children’s participation in the research. The protocol of the research was approved by ethic committee of Irkutsk national research technical university.

Organization of the research: the main complex of this research’s methods was worked out as per special program [1]. We found main indicators of physical development and physical fitness and methods of their study [9].

The studies were conducted from September 2004 to May 2007 – twice a year: at the beginning (September) and at the end (May) of academic year. We used: anthropometric measurements (height, weight, chest circumference –CC) and physiometric examinations (dynamometry) of physical development.

Statistical analysis: the received data were processed with Microsoft Excel 7.1., «Statistica 6.1 » programs. Confidence of average values’ differences in independent samples was assessed by Student’s t-test.

Results
In our work we used only those data, which (according to monitoring) can be observed in age from 4 to 21 years age (see table 1).

Research of height parameters’ changes in the tested pre school age girls, schoolgirls and girl students can be conventionally divide into four periods (see fig. 1).

I. Body length of girls from 4 to six years age increases

<table>
<thead>
<tr>
<th>Age</th>
<th>Height (cm)</th>
<th>Weight (kg)</th>
<th>Chest circumference (cm)</th>
<th>Right hand dynamometry (kg)</th>
<th>Left hand dynamometry (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 years</td>
<td>102,5±0,3</td>
<td>16,3±0,1</td>
<td>51,5±0,1</td>
<td>1,3±0,1</td>
<td>1,0±0,1</td>
</tr>
<tr>
<td>5 years</td>
<td>108,0±0,3*</td>
<td>18,0±0,1*</td>
<td>52,7±0,1*</td>
<td>2,2±0,1*</td>
<td>1,7±0,1*</td>
</tr>
<tr>
<td>6 years</td>
<td>114,6±0,2*</td>
<td>19,9±0,1*</td>
<td>54,3±0,1*</td>
<td>3,2±0,1*</td>
<td>2,5±0,1*</td>
</tr>
<tr>
<td>7 years</td>
<td>123,8±0,5*</td>
<td>23,4±0,4*</td>
<td>57,3±0,4*</td>
<td>11,1±0,2*</td>
<td>9,3±0,3*</td>
</tr>
<tr>
<td>8 years</td>
<td>127,0±0,3*</td>
<td>25,1±0,3*</td>
<td>58,7±0,3**</td>
<td>12,0±0,2***</td>
<td>10,1±0,2**</td>
</tr>
<tr>
<td>9 years</td>
<td>131,2±0,4*</td>
<td>27,7±0,3*</td>
<td>60,8±0,3*</td>
<td>13,1±0,2*</td>
<td>11,1±0,2*</td>
</tr>
<tr>
<td>10 years</td>
<td>137,9±0,4*</td>
<td>31,2±0,3*</td>
<td>62,2±0,3**</td>
<td>13,9±0,2*</td>
<td>11,8±0,2**</td>
</tr>
<tr>
<td>11 years</td>
<td>144,9±0,4*</td>
<td>35,2±0,3*</td>
<td>64,2±0,2*</td>
<td>15,4±0,1*</td>
<td>12,9±0,1*</td>
</tr>
<tr>
<td>12 years</td>
<td>150,6±0,3*</td>
<td>39,2±0,3*</td>
<td>66,4±0,2*</td>
<td>17,0±0,1*</td>
<td>14,6±0,1*</td>
</tr>
<tr>
<td>13 years</td>
<td>156,7±0,3*</td>
<td>44,7±0,4*</td>
<td>68,4±0,2*</td>
<td>18,9±0,2*</td>
<td>16,4±0,2*</td>
</tr>
<tr>
<td>14 years</td>
<td>160,5±0,3*</td>
<td>48,6±0,4*</td>
<td>69,8±0,2*</td>
<td>20,9±0,2*</td>
<td>17,9±0,4*</td>
</tr>
<tr>
<td>15 years</td>
<td>163,0±0,3*</td>
<td>51,7±0,4*</td>
<td>70,7±0,3***</td>
<td>22,9±0,2*</td>
<td>19,9±0,2*</td>
</tr>
<tr>
<td>16 years</td>
<td>164,2±0,4*</td>
<td>53,9±0,6**</td>
<td>72,1±0,4**</td>
<td>24,2±0,3*</td>
<td>21,2±0,3*</td>
</tr>
<tr>
<td>17 years</td>
<td>164,9±0,2</td>
<td>55,2±0,7</td>
<td>74,2±0,5**</td>
<td>25,8±0,4**</td>
<td>22,5±0,4**</td>
</tr>
<tr>
<td>18 years</td>
<td>165,0±0,5</td>
<td>55,3±0,2</td>
<td>83,9±0,4*</td>
<td>26,6±0,3*</td>
<td>24,6±0,2*</td>
</tr>
<tr>
<td>19 years</td>
<td>165,0±0,2</td>
<td>55,8±0,2</td>
<td>86,3±0,3*</td>
<td>26,7±0,2</td>
<td>24,8±0,2*</td>
</tr>
<tr>
<td>20 years</td>
<td>165,1±0,1</td>
<td>56,1±0,2</td>
<td>86,6±0,4</td>
<td>27,1±0,1</td>
<td>25,0±0,3</td>
</tr>
<tr>
<td>21 years</td>
<td>165,5±0,3</td>
<td>56,1±0,3**</td>
<td>88,1±0,2</td>
<td>27,7±0,2</td>
<td>25,3±0,1**</td>
</tr>
</tbody>
</table>

P ***<0,05, P **<0,01, P *<0,001 in respect to previous age
by 6 cm (P<0,001) a year. The highest value (P<0,001) of yearly increment (by 9.2 cm) was registered in 7 years age children.

2. In 8 and 9 years age girls increment (P<0,05) of this indicator reduces to 4 cm a year.

3. From 10 to 13 year age change of height again becomes noticeable (P<0,001) increases to 6–7 cm a year. By 14 years (P<0,05) these indicators are 4 cm a year.

4. From 15 to 21 years age increment of this indicator significantly reduces (P<0,05). From 17 years to 21 years age this indicator practically does not change (P>0,05).

Increase of body mass of the tested (see fig. 2) is conventionally divided into 3 stages.

1. From 4 to 9 years it increases by 2–3 kg a year (P<0,05).

2. From 10 to 15 years age in schoolgirls significant weight increase is observed (P<0,001) by 3–5 kg.

3. From sixteen years the girls weight increment (P>0,05) is insignificant – less than 1 kg a year.

In changes of chest circumference (see fig. 3) we can also conventionally mark out three stages:

1. From 4 to 6 years age we observe significant increase (P<0,001) of indicator is by 1.6 cm a year.

2. In seven years girls it is higher – 3 cm (P<0,001), and in next ages up to 17 years age inclusively it changes (P<0,05) from 1 to 2,2 cm a year.

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**Fig. 1.** Dynamic of P (height, cm) indicators’ changes from Y (age, years)

**Fig. 2.** Dynamic of M, kg (weight) indicators’ changes from Y (age, years)

**Fig. 3.** Dynamic of CC (chest circumference, cm) indicators’ changes from Y (age, years)
3. In 18 years age the stage starts from the most significant CC increment (P<0.001) (9.7 cm). Next years (up to 21 year) its changes are less expressed (P>0.05) (to 2,4 cm a year).

Dynamic of left and right hand strength changes (fig. 4, 5) has the same character and can also be conventionally divided into 3 stages:

1. From 4 to 6 years it is characterized by little (P<0.05) change of muscles’ strength – up to 1 kg a year.

2. In seven years girls we observed the highest increment (P<0.001) of right and left hands’ strength: 7–9 and 6–8 kg accordingly. In next ages up to 17 year age (right hand) and 18 –left hand these indicators increase relatively uniformly by 0,7–2,1 kg a year. It should be noted that age 11–13 years (right hand) and 12-15 years (left hand) is characterized by more expressed (P<0,001) increments of indicator.

3. In 18 years age and older right and left hands strength increases insignificantly (P>0,05) to 0,8 kg a year.
Discussion

By results of physical condition comparison in children from MPSEE (Irkutsk) with children from other regions of Russian Federation we found the following: in 4 years pre school age girls height parameters do not differ significantly from general Russian standards [17]; in 5 and 6 years age their height parameters improve and go ahead of their peers; in 7 yrs age – they coincide.

In the plots below the borders of regional standards of pre school age girls physical condition (Irkutsk) are depicted by dotted line; continuous line – general Russian standards.

Weight parameters of 4 years Irkutsk pre school age girls (see fig. 6) also do not noticeably differ from average values in Russia.

By 5 and 6 years their parameters improve and go ahead their peers; in seven years they again practically coincide with general Russian standards.

By CC dimensions Irkutsk pre school age girls yield their peers of 4 and 5 years age. Then, in 6 and 7 years age theses dimensions increase and reach general Russian standards, though remaining a little less than general Russian standards. Analysis of vital capacity of lungs’ indicators (VCL) of 4-5 Irkutsk girls show the following: CC was a little less that in their peers from other regions. Since 6 years this indicator improves and by 7 years age coincides with general Russian standards.

When analyzing right hand dynamometry indicators we found that in 4 years age Irkutsk girls show absolute low results, comparing with peers from other Russian regions. Then they start to reach the peers from other Russian regions, though this indicator of them is still lower (see fig. 7).

The same picture is noticed in left hand dynamometry. In 4 years age Irkutsk girls demonstrate very low results. But, by 7 yrs age results increase. They have lower indicators even better than in other Russian regions.

Comparing of Irkutsk girls regional standards with general Russian indicators permits to make conclusion that by height and body weight 5-6 yrs age Irkutsk girls are before their peers. However, by CC, VCL and left and right dynamometry indicators are less in all ages. Especially these distinctions are expressed in 4-5 yrs age. From 6 to 7 years the borders of regional standards expand and approach to general Russian to some extent.

When comparing age dynamic of some indicators of schoolgirls’ physical condition (Irkutsk, 7-17 yrs age) with general Russian standards we found some differences [18]. It is determined by living conditions in Eastern Siberia.

It was found that their height parameters do not differ from average characteristics in Russia. But, form 11 to 14 years age their height parameters improve and become a little better than their peers’ in other regions. By 15 yrs age height parameters again practically coincide with general Russian data Changes of weight indicators also practically coincide with general Russian standards. Especially it is noticeable in 16-17 yrs age.

When analyzing CC characteristics we noted that from 10 yrs age Irkutsk schoolgirls lag behind for their peers in other regions. It is the most expressed since 13 yrs age (see fig. 8).Analysis of VCL changes of Irkutsk schoolgirls shows that its indicators also were lower that in their peers from other regions.. They practically correspond each other only in 7 yrs age. Then, in Irkutsk schoolgirls they become a little higher (in 8 yrs age) and we observed the tendency to their increase up to 17 yrs age.

Changes of right hand dynamometry indicators show that in Irkutsk schoolgirls from 7 to 13 yrs age they are higher than in their peers from other regions. These indicators are compared in 14 and 15 yrs. By 16-17 yrs age they do not practically differ (see fig. 9). In age 7-10 yrs age they are much higher.

The same picture can be seen by left hand dynamometry: Irkutsk schoolgirls (especially in 7-10 years) have advantage over their peers. These indicators are less expressed in 11-15 yrs age. In 16-17 yrs age these indicators do not differ.

When comparing physical condition standards with their peers from other regions it was found that they are practically equal by height and weight. In a number of indicators advantage of general Russian standards is registered only in senior school age. In junior age differences smooth. Especially it is expressed from 12 years age. From 7 to 12 yrs age Irkutsk schoolgirls have better results in left and right hands dynamometry.

Analyzing students’ physical development [2] we...
found that their anthropometric indicators practically do not change. Physio-metric indicators, which differ more intensively and confidently during first two years of study at university demonstrate deeper changes. At senior years of study their stabilization happens.

Comparing physical condition of different age girl students we found:

- We did not observe significant differences in physical condition indicators (weight, height). But from 17 to 21 yrs age they insignificantly change.
- In CC characteristics we registered significant \( P<0.001 \) differences 18, 19 and 21 years;
- We found noticeable changes in dynamometry of left and right hands in 18 and 20 yrs age \( P<0.01 \).

Conclusions:

1. Physical condition’s indicators of Irkutsk schoolgirls can be divided into three main periods. The most expressed their increment was registered in pre school age.

7-8 yrs age is the most critical (transition from 1st to 2nd stage) After 18 yrs we registered relative stabilization of indicators. It shall be considered in building educational process in schools and HEEs.

2. The created bank of testing results and worked out standards of Irkutsk girls’ physical condition (4-21 yrs age) can serve as the base for further scientific researches of physical condition of different population strata.

3. Application of monitoring [14] over physical condition of pre school age girls, schoolgirls and girl students in MPSEE, MEE and HEE permits:
- Assess initial level of physical and motor conditions;
- Correct educational and educational-training processes;
- Assess successfulness of their mastering of motor skills;
- Fulfill comparative characteristics of different population strata physical health (age, class, group and so on);
- To assess effectiveness of physical culture a instructors’ and teachers’ work.

The received results can be used in educational and training work in MPSEE, MEE and physical culture departments of other HEEs of region. The results are innovative technology of physical education with application of individual differentiated training at physical culture lessons and in sports practicing.

Conflict of interests

The authors state that there is no conflict of interest.

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Special motor program in the experienced dart players: support from kinematic data
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Abstract
Purpose: Especial advantage known as especial skills have come to mind specifically perspective in human motor control. The main objective was to explore the relative timing of throwing kinematics data in experienced daters so that it would provide examine specificity perspective.

Material: Seven experienced players executed 252 throws from seven distances with recording the kinematic data from the elbow.

Results: Data analysis was shown the especial relative timing in the most practiced distance in five from seven samples. We concluded that repetitive practices may lead to especial structure and kinematic pattern of limb that could interpret as a special motor program. The findings showed that as the massive workouts of experienced players have changed relative timing at kinematics levels, they show a special motor program in five samples and GMP in two samples. These findings indicate that the level of motor control not only cannot be GMP, but also may be a specific motor program.

Conclusions: For the first time, findings of this study evident a specific motor program in the kinematic levels. Findings did not support the GMP theory which creates a new view to schema theory.

Keywords: GMP, Relative timing, Special motor program, Especial skills, kinematic pattern

Introduction
One of main theories about the motor control structure that handle open loop action is motor program. It has a long history in the research literature [8-10]. The motor program notion has been challenged by many researchers [1, 16, 17]. Adams [1] advocate with the limited version of motor program that responsible for free feedback actions without any role in the remained movement. From this view, the CNS has a mechanism that manages the errors and feedback from the movement with perceptual traces as “program” in the close loop actions instead of the motor program. Some strong hypothesizes have made one modified motor program structure which have some extended features than originally did. Generalized motor program (GMP) had proposed by Schmidt [17]. He expresses that perceptual trace and motor program has two fundamental issues. The storage problem is first that refer to limited capacity of human CNS to store the many thousands of motor programs for per little movement. Second issue is the novelty problem that refer to some novel actions as unique version of the motor action which have not account for the motor program yet. GMPs are the suggested solution for these two issues that many researches have investigated its truth for invariant features (relative timing, relative force) and variant parameters (total time, total force) [16, 17]. They can manage the class of actions that have same constant feature which probably differ from another class by different invariant features.

One violation of the GMPs is the especial skills debate [5, 7]. These researches have reported the especial advantages creating by the massive amount of practices and thousands of repetitions in the one member of the actions’ class in the basketball free throw [5, 6], baseball pitch [17], basketball jump shot in a favorite location [13], wheelchair basketball [4], archery [11-13]. New findings in the recent years have revealed a gap in the generalizability of the GMP which raise probability of co-occurrence of the MP and GMP or specificity and generality of motor program in the human motor control especially for rapid pre-programmed actions. The question about the interpretation of the especial advantages in the experienced level of performance remained unclear. One of main hypothesizes about these especial advantages has been the there may train special motor program to explain different behavioral performance in one member of the class of the GMP. Breslin et al. [3] has searched for special coordination pattern in the elite basketball players. Participants performed free throws from the 4.5 meters from the basket and other locations. Breslin et al. [3] record also the kinematic pattern of the throwing hand for relative timing analysis. Their findings did not support the different coordination pattern (GMP) in most practiced distances (fit line) than other locations. This research [3] was only research in which special motor program is explored in the kinematic level. The present paper tries to provide more evidence about any effect of the massive amount of practice on the relative timing of the skilled players. We expect new timing structure in one member of the class of actions rather than other members of that in experienced dart players. It seems dart is more fine skill in which experienced players perform dart throw with the more accurate target. This skill also performs with the constant way than basketball free throw with sometime variable practice. These variable make dart throw as more valid task of explore the especial effect in the especial skills issue. We have skipped behavioral data so we have tested relative timing of throwing pattern in kinematic level to search for especial motor program in the 2.37 meter from the target that has massive practice than other nearer and further distances. We also compare elbow angle, angular velocity and angular acceleration in
the most practiced distance (2.37 m) and other distances to prepare more details about the especial motor program hypothesis.

Material and methods

Participants

The samples included eight experienced dart players who had a variety of experience from minimum of 1 year to a maximum of 11 years at Darts (M = 6.38, SD = 2.78). In similar researches, a number of examples have been used in the nearby range [3, 5, 6, 17]. All players’ age ranges were between 18 and 37 years old (M = 30.37, SD = 7.19). All of them had complete vision and had inclusion criteria for research. Players must have the following conditions to enter and participate in the final experiment:

2. The main goal of the players in practice and competition was triple 20.
3. All participants were right handed.
4. Standing position has been 45 degrees over the most years of practice and competition.

Procedure

First, we measured 2.37 from the center of the dart on the ground in the distance from the dart throw according to the world dart federation rules. Then the players were asked to sit on the chair to prepare for the installation of the markers. Markers were installed based on the Helen Hayes marker system. Before placement, the marker position was detected in the joint by touch, and then the marker was installed to measure the external and internal elbow [10]. Two markers were installed in the players’ right hand. The kinematic variables considered in this study are the time difference between the landmarks (before peak, first peak and second peak) in the acceleration, velocity and angle curve of the elbow [3]. Before the experiment, the cameras were set on throwing zone. After calibrating the cameras, the cameras were checked again after each set (seven distance completed) in order to increase the accuracy of the kinematic data; then the cameras were calibrated again if necessary. After the markers were installed on the designated anatomical distances, the players were asked to take a few trials throws so that made players fit with the markers’ adhesive. They were also asked to announce the start of the experiment with their full readiness. After the announcement of the player, the experiment began. The recording process was such that the start time of cameras was open (open time) in order to recall neutral throw. It means that the time would begin without the player’s knowledge in which, when he was ready to start the throw was started recording by the trigger (lab operator).

252 Dart throws were executed in three sets by each sample from the standard distance (middle distance underline) which experience massive amount of practice and 6 other distances (1.44, 1.75, 0.26, 2.37, 2.68, 2.99 and 3.30 m) from the target. The players executed the throws in the form of 3 sets. A total of 36 throws were executed in total of each distance. The players completed 12 throws at each distance and then went to the next (except two participants with 6 throws in each distance). Distances were numbered 1 to 7 from near to far one. Setting distances and their markings were done in such a way that distances were not recognizable in order to decrease any deliberate intention to throw from standard distance (2.37 m). To change distances, the board was displaced over these distances instead of moving players who performed their throws from fixed point without their own displacement. The dart board and its foundation were displaced in distances with the fingers cue (showing distance numbers) by experimenter 1 so that the players only saw the board displacement without knowing the distance. In order to reduce the order effect, the distances order for each sample was personally designed which was different for each sample in per set. The throws were performed by the personal pattern of the players and they were told that they would not restrict their throws. Players were asked to report any restrictions on markers during throws to correct it. After completing seven random distances (one set), the players were rested for five minutes and then performed the second set in the same way with another random order. Players only received visual feedback with providing score information. There was no one in the experiment room other than the darts player and 3 experimenters (Lab Operator, Score Record and Board Setting).

The experiment was done in the TAK Laboratory in Mashhad, Iran. The personal darts of the players were used, all of which were standard darts that used in their practices and competitions. The task was darting throw because of the greater execution stability, which give more balance and less variability in performance rather than basketball free throw [3, 5, 6, 12]. QTM software and eight Qualysis cameras with marker based and 3D method were used. Double-sided adhesives were applied to install markers on elbow that were 1 cm in diameter.

Data Processing

First, the kinematic data were digitized in which marker is labeled and each throw is extracted from the separate data file so that the time windows for each throw were specified which the data was exported in each time window (figure 1). The time window was from the moment when the initial movement of the hand to the back has begun, until the darts were thrown and the hand has begun to move downward. Then 4 throws from all 12 throws were selected as middle throw in per round (each 3 throw is 1 round) in order to decrease any fatigue or warm up effects in initial throw in each round. It means that the 2, 5, 8, 11th throws were chosen to process at each distance and 2, 3, 4, 5th throws in two samples with 6 throws in each distance so that first and last throws were ignored. Before processing, seven distances were set in the original order in the new folders. A low pass butter worth filter with 6 orders were applied so the mean and normal values were extracted as the elbow angle, angular velocity and angular acceleration of the elbow (figure 3).
Figure 1. Time window sample for each throw that used to extract kinematic variables and relative timing landmarks according to the first peak and the last peak of the throw curve.

Figure 2. From top to down, elbow angle, angular acceleration and angular velocity of elbow in which peak and land of each plot determined landmarks A-F.

Kinematic landmarks A to E were also extracted from the elbow angle, velocity and acceleration time series data (figure 2) that normalized to 101 points. Obtained data, then used for statistical analysis.

Statistical analysis. Shapiro-Wilk test was used to test the normality of kinematic data. To compare the kinematic landmarks and variables in the distant 4 and 6 other distances U Man-Whitney or analysis of variance were used based on the normality results. LSD test was applied as tracking measures in normal distributions.

Results

We used individual data for statistical analysis to decrease any bias in the relative timing and kinematic analysis. Before any analysis at a significant level of 0.05. All landmarks data were used after they normalized to 100 points to synchronize all samples with variable time series.

In sample A, to compare kinematic variables at different distance Mann-Whitney test was used. The results of this test have shown in table 1. These findings showed a significant difference in the elbow angles between 1 and highly practiced distance (4) distance. Similarly, there is a significant difference in the elbow angular velocity between 4 and the 3 and 5 distances. In the elbow angular acceleration, there is a significant difference between 4 and 1, 2 and 7 distances. LSD test was shown there were also no significant differences
between the highly practiced distance and six other distances in the relative timing landmarks B, A and F. But the D and C landmarks were shown different in the distance 4 and six other distances, which relate to the peak of the angles of velocity and angular acceleration.

In sample B, to compare kinematic variables at different distance, LSD test was used (see table 1) which showed there was significant difference between the three kinematic variables in the seven distances. Therefore, in order to examine the extent of the variation of the kinematic relative timing landmarks in seven distances, the Mann-Whitney test was used. The results of Mann-Whitney test show that there is significant difference between distance 4 and 7 in the E and D landmarks. However, there were no significant differences between the mass practiced distance and six other distances in remained landmarks of relative timing.

In sample C, the results of ANOVA in table 1 indicate the significant difference between the distance 4 where the massed practiced skills and the other six distances at elbow angular velocity and the angular acceleration but not observed in elbow angle. The U-Man-Whitney test was used to determine the difference between the kinematic landmarks of relative timing in seven distances. The results showed that there were significant differences between the distance 4 and 3 in the B, D, C landmarks and between distance 4 and two in Landmark A, respectively but there were not any significant differences in Landmark E and F.

In sample D, the results of the U-Mann-Whitney test confirmed that greatest difference between the distance 4 and all other six distances exist at the elbow angular velocity but not observed in the angular acceleration and the elbow angle. The LSD test was shown that there is a significant difference between the distance 4 and the distance 2, 5 and 6 in the landmark D. In Landmark A and E, there is a significant difference between the distance 4 and 6. There is a significant difference in the landmark C between distance 4 with further distances 5, 6 and 7. But in Landmark E and F there is no any significant difference.

In sample E, to compare the mean kinematic variables of distance 4, the Mann-Whitney test was used. The results of this test are shown in Table 1. These findings showed the angular velocity of the elbow has significant difference between 4 and 3, 6 7 distances that means and confirms these special changes. In order to examine the specificity of the kinematic relative timing landmarks in seven distances, U Mann-Whitney test results showed that there is a significant difference between the distance 4 and the distance 6 and 7 in the relative timing landmark D. There was a significant difference in landmark A between distance 4 and distance 3 and 5. In landmark C, there was a significant difference between distance 4 with distances of 3, 5, 6 and 7. But in Landmark B, E and F, there was not seen.

In sample F, the results of ANOVA test showed that there is a significant difference between distances in angular velocity and acceleration but not in elbow angle. For further examination, the LSD follow-up test showed that there is significant difference in the angular velocity between distance 4 and 1 also in the angular acceleration between 4 and 3, 5 and 7. The ANOVA was used to determine the difference between the kinematic relative timing landmarks in 7 distances. The results showed that there was significant difference between distance 4 and 3, 6 and 7 distance in D landmark. In the C landmark, there is significant difference between the distance 4 with all distances except the distance of 5. However, there is no

Figure 3. Respectively, the elbow angle curves, angular acceleration and angular velocity of the elbow marker. Landmarks A to E are calculated according to the first landing and the last peak in each curve (Breslin et al, 2012)
significant difference in landmark A between distances. In landmarks E and F, there were only significant differences between 4 and 3 distance.

In sample G, to compare mean kinematic variables with a distance 4, the U-Mann-Whitney test is used. The results indicated that there was difference between distance 4 where the mass practices were done, and distances away from the target (6 and 7) at the angular velocity of the elbow but not observed in the elbow angle and angular acceleration. About relative timing landmarks, the results of the U-Mann-Whitney test showed that there was only a significant difference between the distance 4 and the 6, 7 distance.

In total, at the angular velocity, six samples have a minimum of three distances which showed significant differences with distance 4. In the case of angular acceleration, three of seven samples have had a minimum of three distances which indicated significant differences with a distant 4. At the elbow angle, only one of the three samples showed a significant difference with the distance 4. Landmarks of relative timing analysis showed that there was significant difference between the relative timing of landmarks A, C, and D at the distance 4 and at least three other distances in seven samples. Also, in landmark B, except for two distances in sample A and one distance in the sample F, did not show the difference between

Table 1. Differences between three kinematic variables and relative timing landmarks A-F of distance 4 and other 6 distances in all samples calculated by ANOVA and U Man Whitney tests which selected based on the normality test results. Significant value is shown at 0.05 level with bold numbers.

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the distance 4 and the other distances. The landmark E analysis also showed that there was significant difference between the distance 4 in sample A, C, D, E and F. In the landmark F there is only a significant difference between distance 4 and others in sample F.

Discussion
The main objective of the experiment was investigating the existence of “special motor program” in the 2.37 meters from target that have executed massive amount of practice by experienced dart players. The results of kinematic data support the existence of a specific structure that may be separate from other locations in which data mainly support the main role of angular velocity of elbow and less in the angular acceleration with different qualifications at the kinematic level that may have been created through high repetitions in the 4th distance. These findings are supported in part the claim that a massive exercise at a member of a class of actions or movements (dart throw) can lead to special advantages which separate that member from the others. This special advantage can cause to form new motor program at a distance 4. In this regard, Breslin et al. [2] examined the hypothesis of the special motor program (new coordination pattern) in experienced basketball players who have done massive amount of practices on 4.5 meters from the basket. They examined the difference between coordination patterns of the highly practiced distance and other near and far distances by one foot. The findings of this research did not support this hypothesis so that there is no significant difference in the 4.5 meters’ distance away from the surrounding area.

We also consider relative timing of the dart throws was extracted from the data related to angle, angular velocity and acceleration of elbow. Except sample B (with lowest experience) and sample G, other samples appear to have a specific relative timing at distance 4. This hypothesis is confirmed more strongly in samples A, E and F, and it is more likely that specific coordination and kinematic pattern can be determined from the mass exercises at a distance 4. The results showed that at least, there is a specific relative timing in the A, C and D landmarks at a distant 4 in all samples (except to two samples). These findings clearly support the existence a specific motor program at 2.37 meters in five samples and suggests that massive amount of repetitions in experienced darters can change the structure of the GMP and be visible at the kinematic level. Breslin et al. [2] conducted this experiment on experienced basketball players. They set five distances and five landmarks for determining the relative timing of the throw patterns. The final results of this analysis showed that there is similarity between the landmarks in a distance 4 (highly practiced) from the surrounding distances. Breslin et al reported that at least kinematic level may does not create a specific motor program for experienced dart players in mass practiced distance than all distances are implemented as a class of movement by same GMP management. However, the results do not support the results of Breslin et al. [2] which confirms the hypothesis that there may be special motor program in experienced Dart players at a distance of 2.37 meters, which separates GMP from another except to two sample who one of them had most less experience rather than other five samples.

Especial motor program instead of GMP in control of skillful actions?
The results of this study flicker the probability that it may with GMP background, with increasing the skill level (or repetitions) in actions and sensorimotor tasks, GMP upgraded to especial type of that. This hypothesis is highly probable that GMP structure probably could not generalize as Schmidt et al. [14, 15] and other research literature reported. By increasing skill levels and repetitions, this structure is allocated to a specific neuronal element in a mass practiced distance, more related with relative timing of the kinematics components. At higher levels of skill and in more repetitions (many years of experience), it may other structures appear to be the management of the upper-shoulder throwing skills that have a higher upgraded range and possibly up to 90 cm ahead support. But whether these structures can be managed right and left with a range of 90 cm, this is a question but this is possible! It is also likely that these specific structures with limited generalizability will be created for other skills with high repetitions and experience in the homework with targeting skills. These structures, in the event of recurrence, create storage and novelty problems again which had been two main reasons for suggesting the generalize motor program instead of separate motor program for many of human movement tasks.

Conclusion:
The purpose of this study was to investigate the effect of mass training on the kinematic level of GMP. The findings showed that as the massive workouts of experienced players have changed relative timing at kinematics levels, they show a special motor program in five samples and GMP in two samples. These findings indicate that the level of motor control not only cannot be GMP, but also may be a specific moto program. For the first time, findings of this study evident a specific motor program in the kinematic levels. Future research could investigate other determinant of the GMP in different task contexts.

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Conflict of interests
The authors state that there is no conflict of interest.
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The influence of special graduated weight load in Greco-Roman wrestling on the growth of students’ sports results

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Abstract
Purpose: to assess the impact of a special dosage load in Greco-Roman wrestling on the growth of students’ sports results.
Material: in research participated 2-3 courses students (n=29, age 16-19 years). The students were divided into two groups: experimental (EG, n=14) and control (CG, n=15). All students were engaged in 4 times per week for 2 hours. Complexes of technical-tactical and psychophysical tasks in the process of each training are realized for 7 – 7.5 minutes (with a break of 30 seconds).
Results: A special diagnostic toolkit has been developed to monitor the effectiveness of wrestlers’ training in three indicators: physical, intensive and effective. It was revealed that in order to intensify the intensity of the competitive duel, a special loading dosage should be used. It is established that performing exercises with weights without taking into account the special loading dosing leads to a decrease in the speed of the wrestler’s movements and to a slowing down of the tempo of the fight. At maximum speed-strength exercise, the athlete’s ability to concentrate on coordinating his performance (on the technique of performing the exercise during a competitive duel) is lost.
Conclusions: In case of a maneuver attack, wrestlers play out their opponent with false and preparing attacks. The technique of attacking style requires fast, sharp movements of the body with the capture of the opponent. Therefore, it is advisable to train an athlete in the conduct of a duel using the weight of his own body.

Keywords: training process, students, Greco-Roman wrestling, loading dosing.

Introduction
The growth of sports results in Greco-Roman wrestling causes the improvement of the training process. The growth rates of wrestlers’ sports skills include tasks of improving technical and tactical skills and developing psychophysical qualities. Such tasks provide the maximum level of special psychological and physical preparedness of wrestlers.

One of the ways to improve the effectiveness of the educational-training process of training sambo athletes is the use of a complex of psychophysical, technical and tactical exercises. This is provided by a special load metering system [2].

Competitive activity of wrestlers is characterized by actions performed against a background of strong physical and mental stress. The wrestler during the fight must take into account the actions of the enemy. In this regard, the education of psychological qualities (perception of the situation, accurate calculation of time and distance, the ability to counterattack and optimally distribute the load in a duel) are relevant in the theory and practice of athletic training of wrestlers. Therefore, strengthening force and speed endurance, explosive force, coordination of movements are necessary attributes of improving sports skills.

In modern wrestling, the time for a fight has decreased, a break has been added, the process of fighting has started to pass faster and more actively, continuous attacking actions are encouraged [17]. In the Greco-Roman wrestling the duration of the fight is 6 minutes: 2 periods of 3 minutes (break 30 seconds). The summation of points for carried out technical actions is based on the results of the whole match [5].

Latyshev S.V. and Korobeynikov G.V. [10] outlined the issues of theoretical and methodological support for the training process of wrestlers. The authors prove the necessity of introducing an individual-differentiated approach in the training of athletes. In the practice of conducting a duel in the Greco-Roman wrestling, motor abilities acquire a specialized individual character. They are expressed in the inclination of the fighter to the tempo, force or at the same time speed-power conduct of the duel. Individual style of conducting a duel is seen through the prism of technical and tactical actions: election of an attacking, counterattacking or combined manner of conducting a duel.

Similar proposals for applying a systems approach in training Greco-Roman wrestlers are presented in another study [9]. To increase the functionality of wrestlers during the fight, it is proposed to use an individual approach [16]. Equally important for wrestlers is: - optimization of physical activity [35, 37]; selection of adequate tests and pedagogical control of the level of training [30, 38]; planning of training cycles, taking into account the general patterns of training construction [34], morphofunctional features of the organism [39], reactions to physical activity [29]; optimization of nutrition [26, 32]; genetically conditioned personality characteristics [24, 33]; features of aerobic and anaerobic mechanisms of energy supply to muscular activity [40].

N.A. Alekseev et al. have developed special methods for the development of general and special endurance of wrestlers [1]. The importance of the development of general and special endurance is noted in other studies [22]. E.A. Bavykin for improving endurance offers the use of indices: absolute strength, special endurance and recovery [2].

Kuzmin M.A. and Dorofeeva V.A. suggest to include in the training process complexes of psychological exercises [6]. Kuznetsov A.S. and Zakirov D.R. in detail justify the role and importance of methods of psycho-regulation and special pedagogical methods in the training of Greco-
Roman wrestlers [7]. Similar approaches of psychological preparation are shown in other studies [28, 31].

In other studies, questions of tactical and technical training of wrestlers are being raised. Jagiello W. et al. have presented the process of development and diagnosis of technical skills of athletes in the aspect of monitoring the throwing action of judo athletes [4]. Gierczuk D. et al. have established correlations between the simple reaction time and the technical and tactical actions of elite Greco-Roman wrestlers during the match [25]. Nikooie R. et al. have investigated the physiological determinants of the success of the struggle of Greco-Roman wrestlers [36]. The authors found that muscular strength, muscular endurance and anaerobic ability are the most important variables in the Greco-Roman wrestling. Demirkan E. et al. have established the physical and physiological determinants of success in the Greco-Roman wrestling [23]. Chaabene H. et al. note that to achieve success, training should focus on the development of anaerobic strength and power, aerobic energy, maximum dynamic and isometric force, explosive strength and strength. [21]

Let us highlight the practical orientation in the psychophysical training of Greco-Roman wrestlers. A.Y. Barkov proposes to focus on technical and tactical actions in a time of shortage of fight. Such exercises increase the speed of performance of techniques and stimulate the athlete’s thinking [3]. Sawczyn S. et al. have suggested a technique for training qualified fighters, depending on their predisposition to work in different energy regimes [20]. Jagiello W. and Kruszewski A. suggest to take into account the morphological characteristics of wrestlers in the competitive period [27].

Summing up, we will outline the following: a tendency has been revealed to simplify the technique, to increase the intensity of the duel, to strengthen the technical arsenal of wrestlers, to manifest psychophysical qualities during the duel.

Hypothesis of research. It is assumed that the concentration of efforts in the training process of students on Greco-Roman wrestling to use psychophysical load on a special dosage will positively affect the growth of sports results.

The purpose of the study: to evaluate the effect of a special dosage load in Greco-Roman wrestling on the growth of students’ sports results.

In the work is substantiated the application of the activity approach in correlation with the system, individual-differentiated and personality-oriented approaches [11]. The solution of issues is provided by methods of theoretical analysis, practice and experience in the field of training athletes.

Material and methods.

Participants of the study: in the study took part 2-3 courses students (n=29, age 16-19 years). The students were divided into two groups: experimental (EG, n=14) and control (CG, n=15). The students in EG have been training with coach R.S. Nagovitsyn (Master of Sports of Russia) and CG – with coach A.T. Lopatin (Master of Sports of Russia). The choice of a coach and a group was carried out by students on a territorial basis. Classes in the section of Greco-Roman wrestling took place in various gyms and parts of the city. All students were engaged in the sports section of the Greco–Roman wrestling 4 times a week for 2 hours. The participants of the experiment have obtained a consent to participate in this research.

Organization of the study. An experimental research was conducted at the Glazov State Pedagogical Institute (College of Social and Information Technology, Faculty of Pedagogical and Art Education).

In the EG, the main part in training was given to the development of psychophysical qualities and training in technical and tactical actions. The basis of training includes a special dosage load. The repeated method of strictly regulated exercise with weight of own body was applied. In CG was used: a repeated method of strictly regulated exercise with weights.

In the EG was implemented the training process on the author’s method of preparing students in the sports section for Greco-Roman wrestling for 3 years. The main aspect of such exercises was based on dosing the psycho-physical load (4 lessons per week). Students spent 3 weeks a month on the author’s method (Table 1) and 1 week on the CG program (see below).

Complexes of technical-tactical and psychophysical tasks in the process of each training are realized for 7 – 7.5 minutes (with a break of 30 seconds). The application of the presented dosage of tasks will allow the wrestlers in the conditions of the competition to “feel” the time period of the fight, maximally concentrate their technical, tactical, physical and psychological potential within 7 – 7.5 minutes.

The systematic application of these tasks in the training process contributes to the rebuilding of the organism and psyche of the athlete.

The main type of motor activity in the training process of wrestlers is special physical training. The performance of cyclic physical exercises contributes to the development of speed-strength abilities. These qualities developed when performing exercises against a background of high intensity and low volume. Repeated performance of physical exercises of a high-speed character requires the inclusion of psychological qualities: strong-willed efforts, desire, perseverance, and diligence. It is pertinent to assume that the above mentioned psychological qualities do not develop without overcoming efforts on oneself. In training, such psychological qualities as persistence, perseverance, purposefulness, ability to endure and overcome fatigue were brought up. Methods of development of physical qualities are as follows: the method of repeated performance of speed-strength exercises without burdening; method of repeated execution of speed-strength exercises with weights of small and medium weight; the method of exercise performed in the mixed mode of the muscles.

In CG, for 3 years, is implemented the training process according to the following program: three classes for 120 min. each in the gym and one lesson for 90 min. in
the gym. Particular attention was paid to speed-strength exercises.

In the preparatory part (warming up), the following tasks were solved: organizing a favorable emotional background, establishing contact of the trainer with wrestlers, mobilizing attention and perception, activating vegetative functions, increasing the functional activity of organs and systems, providing mental and functional prerequisites for working the body in the main part of the training.

In the main part of the training of wrestlers, educational, developmental and health issues were solved. Specificity of such tasks is due to the individual skill of students and the stage of Greco-Roman wrestling.

In the final part of the exercise, physical exercises were aimed at reducing the physiological activity of organs and systems, reducing the excessive tension of individual muscle groups, reducing emotional excitement, reducing the degree of activity of autonomic functions and the central nervous system.

The main postulates of this training process: the exercises are performed with an amplitude of movements, close to the competition elements. At the beginning of motor activities, the muscles that actively participate in a duel are loaded. The amount of exercise power is close to the athlete’s efforts in the competitive exercise. By increasing or decreasing the mode of the muscles, the wrestler develops either absolute or explosive power. Also the athlete develops power endurance.

The training regimes are as follows: for replenishment of energy costs, wrestlers speed-strength abilities train 1-2 times a week; exercises are performed at a high tempo up to 15 seconds; the rest interval between the exercises is determined until complete recovery: 1-2 min.; between series of tasks up to 10-15 min.; for the development of strength are performed exercises with weights; in one lesson or in a microcycle are alternated speed and strength exercises [14].

To test the effectiveness of the implementation of the training process on the basis of the development of the author’s methodology, a special diagnostic tool was developed to monitor the effectiveness of training wrestlers [12]. Three indicators are determined in three levels:

- physical: testing according to the specifications of the All-Russian Complex “Ready for Labor and Defense” (high – gold or silver badge, medium – bronze badge, low – no badge) [13, 14];
- intensive: the analysis is carried out on average for all competitive battles of a certain time interval (high – in a competitive duel victory in a “carcass”, “purely technical” or an increase in points in the second period of more than 2 points, average – in the competition duel increase or decrease points in the second period not more than 2 points inclusive, low – in a competitive duel, a decrease in points in the second period by more than 2 points);
- effective: the analysis is carried out on average for all competitive bouts (high – 1-3 place in the All-Russian or 1 place at the regional level, average – 2-3 place at the regional or 1 place at the city level, low – 2-3 place in the city level or without prizes).

In the process of performing motor actions, physical, functional, psychological and technical-tactical qualities are manifested and developed by athletes. Speed-strength qualities of a wrestler develop when performing exercises against a background of high intensity and low volume. The raise of increase in speed-strength indicators are achieved when performing exercises of a complex nature or train only one physical quality – speed or strength.

Repeated performance of physical exercises of a high-speed character requires the inclusion of psychological qualities: strong-willed efforts, desire, perseverance, and diligence. Education of psychological qualities (perseverance, perseverance, purposefulness, ability to endure and overcome fatigue) determines the effectiveness in a duel.

In the exercises wrestlers use three components: the optimal weight of burdening or working with your own body, the rate of movement and the duration of work. These components are interdependent: reducing the weight of loads leads to an increase in the rate of movement and prolonged work; increasing the weight of load helps to reduce the rate of work and reduce its duration. Therefore, the choice of loads for the development of speed-strength ability in wrestlers is of paramount importance. The individual approach is the most effective for selecting weight of loads [12].

Statistical analysis: the results of the study were processed using the method of mathematical statistics, which was used for quantitative analysis of experimental data. For comparison of EG and CG groups we used the X2 method. At the end of the experiment, a significantly significant difference P<0,05 was determined in the EG and CG in the intensive and effective indices. According to the physical index, the reliability of differences P> 0,05 is not revealed.

Results.

At the preliminary stage (January-March 2014) and the control phase (January-March 2014), 3 competitions (city, regional and all-Russian levels) were held, in which students from both groups participated (only those students were allowed to compete at the all-Russian level, which won prizes in a regional competition). The results of the experimental study are presented in Table 2 and in Figures 1-3.

Comparative analysis revealed the following:

1. Relatively significant difference (P<0,05) was determined between the results of the preliminary and control stages in both groups for all indicators and for all levels. This confirms that the implementation of the training process on the experimental and traditional methods positively affects the improvement of physical qualities of athletes. Systematized training increases the intensity of conducting a competitive duel. Training increases the effectiveness of performance at competitions of city, regional and all-
Table 1. The plan of the weekly training cycle of Greco-Roman wrestlers in the aspect of special loading dosing

<table>
<thead>
<tr>
<th>Day of week</th>
<th>Level of intensity</th>
<th>Monday / Tuesday</th>
<th>Tuesday / Wednesday</th>
<th>Thursday / Friday</th>
<th>Friday / Saturday</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Below-average</td>
<td>Above average</td>
<td>High</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>The content of training and dosage</td>
<td>1. 15-20 min. – warm up</td>
<td>1. 15-20 min. – warm up</td>
<td>1. 15-20 min. – warm up</td>
<td>1. 15-20 min. – warm up</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. 7 min. – to work-out exercises in the starting position (1 number)</td>
<td>2. 7 min. – to work-out exercises in the starting position (1 number)</td>
<td>2. 7 min. – to work-out exercises in the starting position (1 number)</td>
<td>2. 7 min. – to work-out exercises in the starting position (1 number)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. 7 min. – to workout exercises in the starting position (2 number)</td>
<td>3. 7 min. – to workout exercises in the starting position (2 number)</td>
<td>3. 7 min. – to workout exercises in the starting position (2 number)</td>
<td>3. 7 min. – to workout exercises in the starting position (2 number)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. 7 min. – to work-out in a pit (1 number)</td>
<td>4. 7 min. – to work-out in a pit (1 number)</td>
<td>4. 7 min. – to work-out in a pit (1 number)</td>
<td>4. 7 min. – to work-out in a pit (1 number)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. 7 min. – to workout in a pit (2 number)</td>
<td>5. 7 min. – to workout in a pit (2 number)</td>
<td>5. 7 min. – to workout in a pit (2 number)</td>
<td>5. 7 min. – to workout in a pit (2 number)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. 7 min. – to work-out in the starting position with 50% strength (1 number)</td>
<td>6. 7 min. – «take out» in a pit back / reverse (1 number)</td>
<td>6. 7 min. – «take out» in a pit back / reverse (1 number)</td>
<td>6. 7 min. – «take out» in a pit back / reverse (1 number)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7. 7 min. – to work-out in the starting position with 50% strength (2 number)</td>
<td>7. 7 min. – «take out» in a pit back / reverse (2 number)</td>
<td>7. 7 min. – «take out» in a pit back / reverse (2 number)</td>
<td>7. 7 min. – «take out» in a pit back / reverse (2 number)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8. 7 min. – to work-out in a pit with 50% strength (1 number)</td>
<td>8. 7 min. – «take out» in a pit with 50% strength (1 number)</td>
<td>8. 7 min. – «take out» in a pit with 50% strength (1 number)</td>
<td>8. 7 min. – «take out» in a pit with 50% strength (1 number)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9. 7 min. – to workout in a pit with 50% strength (2 number)</td>
<td>9. 7 min. – «take out» in a pit with 50% strength (2 number)</td>
<td>9. 7 min. – «take out» in a pit with 50% strength (2 number)</td>
<td>9. 7 min. – «take out» in a pit with 50% strength (2 number)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10. 7 min. – to work-out of key grips with 50% strength (1 number)</td>
<td>10. 7 min. – «take out» in a pit with 50% strength (2 number)</td>
<td>10. 7 min. – «take out» in a pit with 50% strength (2 number)</td>
<td>10. 7 min. – «take out» in a pit with 50% strength (2 number)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11. 7 min. – to work-out of key grips with 50% strength (2 number)</td>
<td>11. 7 min. – «take out» in a pit with 50% strength (2 number)</td>
<td>11. 7 min. – «take out» in a pit with 50% strength (2 number)</td>
<td>11. 7 min. – «take out» in a pit with 50% strength (2 number)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12. 1(2) half – 7 min. – power game «stretch again»</td>
<td>12. 1(2) half – 7 min. – power game «stretch again»</td>
<td>12. 1(2) half – 7 min. – power game «stretch again»</td>
<td>12. 1(2) half – 7 min. – power game «stretch again»</td>
<td></td>
</tr>
<tr>
<td></td>
<td>13. 7 min. – Stretching</td>
<td>13. 7 min. – Stretching</td>
<td>13. 7 min. – Stretching</td>
<td>13. 7 min. – Stretching</td>
<td></td>
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<td></td>
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</tbody>
</table>

Fig. 1. The results of the comparative analysis of EG and CG on the physical indicator: 1 – EG in the preliminary stage, 2 – EG – at the control stage, 3 – CG in the preliminary stage, 4 – CG – at the control stage, A – high level, B – average level, C – low level, D – level, N – number.
Fig. 2. Results of a comparative analysis of EG and CG for the intensive indicator: 1 – EG in the preliminary stage, 2 – EG in the control stage, 3 – CG in the preliminary stage, 4 – CG in the control stage, A – high level, B – middle level, C – low level, D – level, N – number.

Fig. 3. Results of a comparative analysis of EG and CG on the effective score: 1 – EG in the preliminary stage, 2 – EG at the control stage, 3 – CG in the preliminary stage, 4 – CG at the control stage, A – high level, B – average level, C – low level, D – level, N – number.

Table 2. The results of the pilot study at the preliminary and control stages

<table>
<thead>
<tr>
<th>Parameter</th>
<th>EG levels</th>
<th>CG levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
<td>Average</td>
</tr>
<tr>
<td><strong>Preliminary stage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>( P &gt; 0.05 )</td>
<td>( P &gt; 0.05 )</td>
<td>( P &gt; 0.05 )</td>
</tr>
<tr>
<td>Intensive</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Effective</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td><strong>Control stage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>( P &gt; 0.05 )</td>
<td>( P &lt; 0.05 )</td>
<td>( P &lt; 0.05 )</td>
</tr>
<tr>
<td>Intensive</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Effective</td>
<td>5</td>
<td>8</td>
</tr>
</tbody>
</table>
Russian levels.

2. After the experiment, for all levels in the EG and CG was determined unreliable significant difference at the control stage the physical index. According to the intensive and significant indices was determined reliably significant difference for all levels in the EG and CG. The analysis revealed the effectiveness of the implementation of the author’s approach to the intensive and effective indicator. The experimental study had no statistically significant effect on students in the development of physical qualities.

Discussion.

The analysis of the studies revealed two main directions in the framework of improving the training process in the Greco-Roman struggle. The first direction assigns the main role to the use of speed-strength exercises in training. In the opinion of the authors, this will allow the wrestlers to choose an attacking, counter-attacking or combined style of conducting a duel [2, 6, 8]. The second direction includes the tasks of improving the technical and tactical skills and development of psychophysical qualities. This ensures the maximum level of special psychological and physical preparedness of wrestlers [15, 16]. The authors of the first direction chose the development of physical qualities as a basis. The main emphasis in the training of wrestlers should be directed to the development of cardiovascular system, coordination abilities and speed-strength qualities [10].

The characteristics of physical activity include: the quality of the level of efficiency; complex of physical exercises (ratio of exercises); quantitative evaluation (volume) of training work; intensity of training work. The resulted indicators of physical activity should be supervised. This will increase the level of development of physical qualities in wrestlers.

N.A. Alekseev et al. found that the manifestation of speed-strength qualities is due to the athlete’s ability to realize high-speed and power capabilities in a specific motor skill [1]. The speed-strength training is based on the athlete’s ability to exercise maximum speed and strength in the shortest time [5]. E.A. Bavykin argues that in the Greco-Roman wrestling classes, there is not enough general physical training to develop speed-strength qualities. It is necessary to include in the training process special speed-strength exercises from various sports (kettlebell lifting, power gymnastics, weightlifting, aerobics and others). Consequently, the main type of motor activity for the development of speed-strength qualities in wrestlers is special physical training [2]. S.V. Latyshev has established: the raise of increase in speed-strength indicators can be achieved by a differentiated approach: to train only one physical quality – speed or force [8]. Kuzmin M.A. and Dorofeeva V.A. determined that the raise of increase in speed-strength indicators can be achieved through exercises of a complex nature [6]. An integrated approach to the improvement of the training process in the Greco-Roman struggle must be considered through modeling the conditions of competitive activity.

The model should be based on indicators of psychoregulation and special pedagogical methods [7].

We believe that performing exercises with weights without taking into account the special loading dosing leads to a decrease in the speed of the wrestler’s movements and to a slowdown in the pace of the fight. At maximum speed-strength exercise, the athlete’s ability to concentrate on coordinating his performance (on the technique of performing the exercise during a competitive duel) is lost.

With a maneuver attack, wrestlers perform an overtraining of the opponent with the use of false and preparing attacks. The technique of attacking style requires fast, sharp movements of the body with the capture of the opponent. Therefore, it is advisable to train an athlete in the conduct of a duel using the weight of his own body. It is also necessary to strictly orient the training process to the temporary conditions of the bout.

The emphasis in training for the development of physical qualities of wrestler averages the technical and tactical actions. For example, the predominance of strength abilities in a fighter contributes to the use in the fight only the tactics of attack. In this case, the fighter puts all his physical power in one go. To defeat the enemy it is enough to use one method or to suppress the enemy. However, a technically prepared opponent can apply maneuvering and retreat. This will allow him successfully counterattack.

Tropin Y.N. et al. substantiates the tendency to simplify the technique, increase the intensity of the duel, strengthen the technical arsenal of wrestlers [19]. Jagiello W. et al. consider the training of wrestlers in the aspect of monitoring the throwing action [4].

In our opinion, in order to increase the efficiency of the training process, it is necessary to create software and methodical support on the basis of special loading dosing. The methodical unit should include all aspects of the training of wrestlers. In the duel of wrestlers, the main option is a combination attack – holding combinations with false and leading attacks.

The author’s technique provides loading dosing taking into account modern requirements of competitive activity. Adapted to a competitive fight, the time for executing a training task allows you to mobilize physical and functional capabilities for rational use of them for a given period of time. The research that we completed complements the work of other scientists on this issue. The results obtained by us have a scientific novelty and special practical significance: the development of the author’s methodology for preparing students for Greco-Roman wrestling, taking into account the modern requirements of competitive activities. The materials of our study broaden the notion of the use of a special diagnostic tool for monitoring the effectiveness of training wrestlers.

Conclusions

To activate the intensity of the competition, use a special loading dosage in the training process. Using the author’s methodology will allow to reach a higher quality
level of the training process, which ensures the growth of sports skills. The diagnostic toolkit and the author’s technique can be used at construction of training process in various kinds of single combats.

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The authors state that there is no conflict of interest.

Conflict of interests
The authors state that there is no conflict of interest.

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Abstract

Purpose: to study reaction of cardiovascular system and erythrocyte homeostasis in students with different fitness for physical load.

Material: we tested students (n=150, from them n=105 – boys and n=45 – girls), (zimeva). Measurements were fulfilled after maximal physical load on ergo meter (Kettler, German). The load was 2.7 W/kg.

Results: indicators of vegetative blood circulation’s regulation depend on fitness level to maximal physical load. In 1st group students if manifested as sharp asymmetric indicators’ reverse between sympathetic and para sympathetic regulation of blood circulation. Besides, there appear reversibly and irreversibly changed forms of erythrocytes in periphery blood. In 2nd group students maximal physical load causes higher indicators of sympathetic circuit. In 3rd group students, under maximal physical load we did not find asymmetry between sympathetic and para sympathetic blood circulation’s regulation.

Conclusions: between changes of vegetative blood circulation’s regulation and students’ fitness to maximal physical load there are multidirectional vectors of organism’s functional state. They manifest as natural changes of forms of periphery blood erythrocytes.

Keywords: functional state, vegetative regulation, blood circulation, erythrocytes, students.

Introduction

For sustaining of homeostasis continuous metabolism and energy exchange with environment are required [7, 8]. It ensures self-regulation of physiological functions and sustains life activity at optimal and relatively constant level. In this respect human organism is half closed thermodynamic system, which consists of different organs and tissues [30]. According to requirements of internal medium and organism action’s stability in respect to external conditions two systems are used: vegetative nervous system (VNS) and endocrine system. The first realizes general regulation: with sympathetic and para sympathetic sectors. The second influences all organism’s cells with influence of hormones and biologically active substances. Integral system is [32] is Eritrean system, in which the effecting final link is erythrocyte (Ep).

The mentioned above VNS sectors have their own sensor components, which perceive physical and chemical indicators of internal medium. Ep is directly information form of alive, which plays the role of feedback between two regulation systems. Ep is a formation component of organism’s functional system (OFS) in [30, 34].

M. Holcik [33], F. B. Jensen [34], H. Mairbäurl [44] devoted their works to Ep different morphological functional properties. It permits to predict OFS state under influence of the following: external and internal factors, not standard, stress or de-adaptation development of processes [36, 37].

In other works influence of walking training on iron metabolism [41]; influence of resistance to insulin reduction on ferritin concentration after trainings [40]; change of ultra-marathon runners’ blood morphology and chosen biochemical parameters [35]; changes of pro-inflammatory markers and lysine concentration in response to trainings [31, 39] are noted.

Extreme factors are connected with trainings loads and psycho-emotional stress. Extreme factors are such external factors of influence on human OFS [25, 27].

In such conditions there appears OFS tension, resulted in not saving expenditure of functional reserves and their quick exhaustion. The temporary dynamic of such changes is studied rather completely in different studies [26, 42].

However, such data are not systemized. The have not contain complex approach to studying of mechanisms of adaptive reaction’s (OFS) formation [8, 49]. Even to less extent organism’s reactions to extreme conditions and psycho-physical factors’ influence on students’ Ep are studied [38, 50]. Insufficient attention to this problem [43, 45, 46] can manifest in the future as reduction of mental and physical workability, weakening of educational processes’ effectiveness. Besides, it can cause disorder of health and disharmony of students’ health, who are differently prepared for physical loads (PL_max).

As N.V. Ivanova [9] and B.P. Lisovskyi [13] note, in unfavorable conditions there are: reduction of sensitivity to extreme action on students’ organism PL_max; reduction of OFS reserves to homeostasis restoration, caused by this factor.

In this respect cardio vascular system (CVS) and erythrocyte link of homeostasis are the weakest [1, 11]. Vegetative and neuro motor regulation of nervous muscular system (NMS) has a number of general systemic structural functional properties, which naturally reflect in state of Ep [44, 46]. There is certain interest to influence of sympathetic and para sympathetic sectors of CNS on athletes’ CVS. With it no attention is paid to homeostatic function of Ep and CVS reaction with PL_max on students.
The purpose of the work: to study reaction of cardiovascular system and erythrocyte homeostasis in students with different fitness for physical load.

Material and methods
Participants: The research was fulfilled in Vasyl Stefanyk Precarpathian National University and National Academy of Home Affairs (Ivano Frankovsk). We tested students (n=150, from them n=105 – boys and n=45 – girls).

Students were divided into 3 groups. In 1st groups students practiced physical culture from time to time (n=48). In 2nd group students practiced physical culture regularly (n=68). In 3rd group students practiced regularly different kinds of sports (n=34).

Organization of the research: The measurements were fulfilled within standard physical culture lesson. The measurements were fulfilled after maximal physical load on ergo meter (Kettler, German). The load was 2,7 W/kg.

With the help of program «CardioLab+» we fulfilled 5 minutes recording of R-R-cardio intervals. All data were processed with special program [29].

For studying of erythrocytes’ conformation and biochemical properties we took capillary blood by protocol of glucose concentration in blood determination [46]. Sampling of material was fulfilled directly before PL MAX and 1-3 minutes after recreation period.

Hemoglobin concentration was studied by standard method. Erythrocytes’ quantity was studied by unified calculation method in Goryayev chamber. Gematocrit was studied by micro-method with the help of application of standardized geparinized capillary [24]. Morphological study of erythrocytes was fulfilled on scanning electronic microscope «JEOL-25M-T220A» (Japan) as per commonly accepted methodic [28].

Statistical analysis: for statistical comparison of OFS indicators with PL MAX we used earlier calculated data [16].

Statistical processing of results we fulfilled with the help of program GrafPad Prism 4.0 (GrafPad Swotware Inc., CIII). We used non parametric methods of the research (Wilcoxon, Manna-Whitney tests). Selective parameters have the following values: \( <x> \) – mean arithmetic; \( D^*_{xx} \) – statistical dispersion; \( \delta_{xx} \) – mean square deviation; \( \delta^*_{xx} \) – mean square deviation from mean arithmetic; \( [<x>±\delta x] \) – interval of confidence. The found changes were considered to be significant, when the received level was less that the level of confidence (P<0,05).

Results
It was found that generalized indicators of sympathetic nervous system’s activity (ISNS) in respect to PL MAX in 1st group students had mean arithmetic 4.5. After PL MAX this indicators was 15.1. Indicators of para sympathetic nervous system’s activity (PSNS) in respect to PL MAX was 19.0. After PL MAX this indicators was 4.7 (see table 3). Vegetative system complex in 1st group boys had characteristic changes: indicators ISNS increase 3.9 times and indicator of para sympathetic nervous system reduces nearly 4.8 times. The same changes were observed in girls of 1st group: ISNS increases 3.2 time s and indicator of para sympathetic nervous system reduces 2.3 times.

After PL MAX in 1st group students we observed especially great changes by Bayevskiy’s index [1]: in 5.8 times and in girls - 5.6 times. However, absolute indicators of girls (223,4) were much less the of boys (417,3).

The calculations’ combined results of 1st group are given in tables 1 and 2.

Girl students of 2nd group differ by ISNS and PSNS indicators. ISNS mean arithmetic values before and after PL MAX were 4.0 and 6.7. PSNS indicators were: before PL MAX -16,2 and after PL MAX - 10,5 (see table 3). ISNS indicators of 2nd group boys were: before PL MAX - 4,5; after PL MAX - 11,2 (p<0,05). PSNS indicators were: before PL MAX - 16,8; after PL MAX - 6,8 (see table 4). Comparing with 2nd group girls, the boys’ ISNS indicators are higher and PSNS indicators are lower (before and after PL MAX). In boys we also observed reverse of ISNS and PSNS indicators in Table 1. Cardio-respiratory indicators of 1st group girls’ functional system after physical load.

Table 1. Cardio-respiratory indicators of 1st group girls’ functional system after physical load

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Before load</th>
<th>After load</th>
<th>Before load</th>
<th>After load</th>
<th>Before load</th>
<th>After load</th>
<th>Before load</th>
<th>After load</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISNS</td>
<td>3,27</td>
<td>4,33</td>
<td>2,08</td>
<td>0,56</td>
<td>2,07</td>
<td>4,46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSNS</td>
<td>17,13</td>
<td>22,78</td>
<td>4,77</td>
<td>1,28</td>
<td>14,39</td>
<td>19,87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HBR</td>
<td>8,26</td>
<td>14,71</td>
<td>3,83</td>
<td>0,81</td>
<td>6,57</td>
<td>9,95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ITB</td>
<td>99,69</td>
<td>693,86</td>
<td>26,34</td>
<td>5,61</td>
<td>88,07</td>
<td>111,3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPO₂</td>
<td>98,6</td>
<td>0,37</td>
<td>0,61</td>
<td>0,16</td>
<td>98,25</td>
<td>98,95</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: ISNS – contribution of sympathetic sector of CNS in organism’s regulatory processes; ISNS - contribution of para sympathetic sector of CNS in organism’s regulatory processes; ITB – index of tension by Bayevskiy, reflecting regulatory systems’ tension and prevailing of central mechanisms over autonomous; HBR – hear beats rate; SPO₂ – Oxy-hemoglobin concentration in blood %.
For 2nd group girls such reversing is not characteristic. They have ISNS increase 1,5 times and PSNS reduction 1,6 times. In 2nd group girls its increment after PL_{max} is only 2,4 times.

In 3rd group the same dynamic is observed. But in 1st and 2nd group these indicators change to less extent.

Study of erythrocyte link showed that after PL_{max} in 1st group there is significant increase of hematocrit and hemoglobin y (P<0,05). In 3rd group (boys and girls) it happens against the background of erythrocyte quantity increase. It is facilitated by progressing of hemo-concentration. PL_{max} in 2nd group students causes reduction of periphery erythrocytes (PE) (in average by 15,3±1,25%, P <0,05).

In 1st group, comparing with 2nd group, fig. 1 a, we found many reversibly and irreversibly changed forms of PE (see fig. 1 b). In 3rd group erythrocytes after PL_{max} remain nearly unchanged (see fig. 1 c).

Table 2. Cardio-respiratory indicators of 1st group boys’ functional system before and after physical load
dо і після фізичного навантаження

<table>
<thead>
<tr>
<th>Indicators</th>
<th>&lt;x&gt;</th>
<th>D*&lt;sub&gt;∞&lt;/sub&gt;</th>
<th>δ&lt;sub&gt;∞&lt;/sub&gt;</th>
<th>δ*&lt;sub&gt;∞&lt;/sub&gt;</th>
<th>&lt;x&gt;±dx</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISNS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before load</td>
<td>4,53</td>
<td>14,77</td>
<td>3,84</td>
<td>0,906</td>
<td>2,63;6,43</td>
</tr>
<tr>
<td>After load</td>
<td>15,13</td>
<td>80,52</td>
<td>8,97</td>
<td>1,67</td>
<td>11,72;18,55</td>
</tr>
<tr>
<td>PSNS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before load</td>
<td>19</td>
<td>33,15</td>
<td>5,76</td>
<td>1,36</td>
<td>16,15;21,85</td>
</tr>
<tr>
<td>After load</td>
<td>4,73</td>
<td>18,73</td>
<td>4,33</td>
<td>0,8</td>
<td>3,08;6,38</td>
</tr>
<tr>
<td>HBR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before load</td>
<td>81,26</td>
<td>181,56</td>
<td>13,47</td>
<td>3,17</td>
<td>74,59;87,93</td>
</tr>
<tr>
<td>After load</td>
<td>116,9</td>
<td>393,16</td>
<td>19,83</td>
<td>3,68</td>
<td>109,5;124,5</td>
</tr>
<tr>
<td>ITB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before load</td>
<td>71,05</td>
<td>4546,26</td>
<td>67,43</td>
<td>15,89</td>
<td>37,68;104,6</td>
</tr>
<tr>
<td>After load</td>
<td>417,3</td>
<td>116366,1</td>
<td>341,12</td>
<td>63,35</td>
<td>287,5;547,2</td>
</tr>
<tr>
<td>SPO₂</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before load</td>
<td>98,05</td>
<td>1,84</td>
<td>1,36</td>
<td>0,32</td>
<td>97,38;98,72</td>
</tr>
<tr>
<td>After load</td>
<td>97,93</td>
<td>0,66</td>
<td>0,81</td>
<td>0,15</td>
<td>97,62;98,24</td>
</tr>
</tbody>
</table>

Notes: see table 1.

Table 3. Cardio-respiratory indicators of 2nd group girls’ functional system after physical load

<table>
<thead>
<tr>
<th>Indicators</th>
<th>&lt;x&gt;</th>
<th>D*&lt;sub&gt;∞&lt;/sub&gt;</th>
<th>δ&lt;sub&gt;∞&lt;/sub&gt;</th>
<th>δ*&lt;sub&gt;∞&lt;/sub&gt;</th>
<th>&lt;x&gt;±dx</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISNS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before load</td>
<td>4</td>
<td>12,76</td>
<td>3,55</td>
<td>1,17</td>
<td>1,356;6,67</td>
</tr>
<tr>
<td>After load</td>
<td>6,73</td>
<td>30,26</td>
<td>5,50</td>
<td>1,02</td>
<td>4,64;8,83</td>
</tr>
<tr>
<td>PSNS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before load</td>
<td>16,17</td>
<td>38,33</td>
<td>6,12</td>
<td>1,98</td>
<td>11,7;20,63</td>
</tr>
<tr>
<td>After load</td>
<td>10,46</td>
<td>30,38</td>
<td>5,51</td>
<td>1,02</td>
<td>8,36;12,6</td>
</tr>
<tr>
<td>HBR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before load</td>
<td>87,55</td>
<td>103,69</td>
<td>10,07</td>
<td>3,33</td>
<td>79,99;95,12</td>
</tr>
<tr>
<td>After load</td>
<td>99,3</td>
<td>359,41</td>
<td>18,95</td>
<td>3,52</td>
<td>92,08;106,5</td>
</tr>
<tr>
<td>ITB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before load</td>
<td>73,89</td>
<td>4661,42</td>
<td>67,34</td>
<td>22,35</td>
<td>39,43;124,5</td>
</tr>
<tr>
<td>After load</td>
<td>181,16</td>
<td>60986,1</td>
<td>246,9</td>
<td>45,85</td>
<td>87,16;275,2</td>
</tr>
<tr>
<td>SPO₂</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before load</td>
<td>97,85</td>
<td>3,12</td>
<td>1,74</td>
<td>0,56</td>
<td>96,57;99,11</td>
</tr>
<tr>
<td>After load</td>
<td>97,7</td>
<td>2,87</td>
<td>1,69</td>
<td>0,31</td>
<td>97,05;98,3</td>
</tr>
</tbody>
</table>

Notes: see table 1.

Table 4. Cardio-respiratory indicators of 2nd group boys’ functional system after physical load

<table>
<thead>
<tr>
<th>Indicators</th>
<th>&lt;x&gt;</th>
<th>D*&lt;sub&gt;∞&lt;/sub&gt;</th>
<th>δ&lt;sub&gt;∞&lt;/sub&gt;</th>
<th>δ*&lt;sub&gt;∞&lt;/sub&gt;</th>
<th>&lt;x&gt;±dx</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISNS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before load</td>
<td>4,5</td>
<td>14,54</td>
<td>3,55</td>
<td>1,05</td>
<td>2,17;6,81</td>
</tr>
<tr>
<td>After load</td>
<td>11,21</td>
<td>77,12</td>
<td>8,78</td>
<td>1,37</td>
<td>8,47;13,15</td>
</tr>
<tr>
<td>PSNS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before load</td>
<td>16,82</td>
<td>45,89</td>
<td>6,76</td>
<td>1,99</td>
<td>12,44;21,2</td>
</tr>
<tr>
<td>After load</td>
<td>6,80</td>
<td>24,01</td>
<td>4,90</td>
<td>0,76</td>
<td>5,28;8,34</td>
</tr>
<tr>
<td>HBR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before load</td>
<td>86,5</td>
<td>92,48</td>
<td>11,72</td>
<td>3,47</td>
<td>78,86;94,1</td>
</tr>
<tr>
<td>After load</td>
<td>105,17</td>
<td>152,95</td>
<td>12,37</td>
<td>1,93</td>
<td>101,3;109,0</td>
</tr>
<tr>
<td>ITB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before load</td>
<td>72,77</td>
<td>7233,2</td>
<td>72,43</td>
<td>21,66</td>
<td>25,17;120,3</td>
</tr>
<tr>
<td>After load</td>
<td>260,47</td>
<td>48623,59</td>
<td>220,51</td>
<td>34,44</td>
<td>191,6;329,4</td>
</tr>
<tr>
<td>SPO₂</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before load</td>
<td>98,29</td>
<td>0,54</td>
<td>0,69</td>
<td>0,2</td>
<td>97,85;98,74</td>
</tr>
<tr>
<td>After load</td>
<td>97,5</td>
<td>1,29</td>
<td>1,14</td>
<td>0,178</td>
<td>97,14;97,86</td>
</tr>
</tbody>
</table>

Notes: see table 1.
In students athletes we observed increase of EP aggregation ability (content of aggregates increased by 15.0%) and rising of their deformation coefficient (by 18.0%), caused by muscular work (see fig. 1).

**Discussion**

For finding of CNS and Er reactions we used structural functional study of EP and automatic data analysis. We used variation pulse metering and rhythm cardio monitoring. Analysis of results showed that VNS activity is determined by results of control of organism’s vegetative system’s regulation: by reaction of CNS and EP [16, 47]. Here the most feasible parameter of regulation process is rhythm of heart beat. Dynamic characteristics of heart beats rate permit to assess sympathetic and para sympathetic disorders in students’ state [48].

Heart beat rate is easy to be registered. It reflects vegetative regulation processes [10, 16, 23]. With it HBR is indirect characteristic. It reflects regulation result at different OFS levels [15].

Different combinations of VNS links, ensuring vegetative homeostasis can correspond to one and the same HBR [6]. Tonus weakening of VNS para sympathetic sector can be followed by reduction of sympathetic sector’s activity: with average HBR remaining constant [1, 20]. HBR change under stress appear earlier than hormonal and biochemical disorders. It is conditioned by the fact that nervous system’s reaction goes in advance of humoral factors. It permits to timely find stress reaction’s peculiarities including to EP under physical load [29]. Cardio interval metering is one of modern methods of myocardium and organism’s in general diagnostic [48]. It can be used for the following: characteristic of heart condition; organism’s adaptive potential in selecting for different kinds of sports; control of life provisioning processes in training and competition periods [23].

The conducted earlier studied showed [25, 50], that at the end of academic year students athletes have low functional state of organism. It requires more careful attention to their physical condition.

PL\(_{\text{max}}\) of different intensity plays important role in formation organism’s general endurance [37]. It reflects general level of human workability. Endurance integrates great number of processes, which take place at different levels – from cell to the whole organism [18]. In most cases leading role in studying of endurance is played by finding factors, facilitating activation of energetic exchange and vegetative functions of its provisioning: cardio-respiratory and central nervous systems. With it study of cells’ reactions under PL\(_{\text{max}}\) (EP, in particular) are remaining out of attention [37, 38].

EP is a convenient object for such kinds of researches. EP participate in sustaining of homeostasis at level of the whole organism [34, 44, 45]. These cells can participate in regulation of acid-alkaline and water electrolyte balance, on micro-reological blood status. That is why with intensive PL\(_{\text{max}}\) it is interesting in students’ OFS regulation [36, 49, 50].

We found that in 57.0% if 1\(^{st}\) group students, under PL\(_{\text{max}}\) there appear negative morphological changes of EP. It is conditioned by metabolic disorders. The basis of such changes is exhaustion of organism’s biosystem’s functional potentials. It happens under negative influence of increased mental and physical loads of academic year [26, 27].

The received data witness that under PL\(_{\text{max}}\) High requirements are set to 1\(^{st}\) group’s students’ organism (to energy supply systems and heart’s external work. High external work of heart can be explained by prevailing of systolic blood pressure (BPs), which is accompanied by increase of myocardium demand in oxygen [18].

It was found that under PL\(_{\text{max}}\) in boys changes of VNS indicators are more significant, comparing with girls. It can be explained by insufficient physical fitness of girls and specific reactions of female organism to academic loads [8, 9, 15].

The received by us data show that VNS indicators i 3\(^{rd}\) group witness about students’ better adaptation to changing conditions: the better is physical fitness, the higher are OFS compensatory mechanisms as well as

**Table 5.** Cardio-respiratory indicators of 3\(^{rd}\) group boys’ functional system before and after physical load

<table>
<thead>
<tr>
<th>Indicators</th>
<th>&lt;x&gt;</th>
<th>D*&lt;sub&gt;0,05&lt;/sub&gt;</th>
<th>δ&lt;sub&gt;0,05&lt;/sub&gt;</th>
<th>δ*&lt;sub&gt;0,05&lt;/sub&gt;</th>
<th>&lt;x&gt;±dx</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISNS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before load</td>
<td>4,14</td>
<td>15,22</td>
<td>3,9</td>
<td>0,85</td>
<td>2,48;5,8</td>
</tr>
<tr>
<td>After load</td>
<td>10,92</td>
<td>113,03</td>
<td>10,63</td>
<td>2,17</td>
<td>6,45;15,39</td>
</tr>
<tr>
<td>PSNS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before load</td>
<td>16,09</td>
<td>59,29</td>
<td>7,7</td>
<td>1,68</td>
<td>12,8;19,38</td>
</tr>
<tr>
<td>After load</td>
<td>9,92</td>
<td>36,47</td>
<td>6,04</td>
<td>1,23</td>
<td>7,38;12,46</td>
</tr>
<tr>
<td>HBR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before load</td>
<td>77,47</td>
<td>180,86</td>
<td>13,44</td>
<td>2,93</td>
<td>71,72;83,22</td>
</tr>
<tr>
<td>After load</td>
<td>99,16</td>
<td>200,77</td>
<td>14,17</td>
<td>2,89</td>
<td>93,2;105,11</td>
</tr>
<tr>
<td>ITB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before load</td>
<td>53,80</td>
<td>2592,26</td>
<td>50,91</td>
<td>11,11</td>
<td>32,03;75,57</td>
</tr>
<tr>
<td>After load</td>
<td>221,3</td>
<td>47233,0</td>
<td>217,3</td>
<td>44,36</td>
<td>129,9;312,7</td>
</tr>
<tr>
<td>SPO&lt;sub&gt;2&lt;/sub&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before load</td>
<td>98,14</td>
<td>1,52</td>
<td>1,23</td>
<td>0,26</td>
<td>97,62;98,66</td>
</tr>
<tr>
<td>After load</td>
<td>97,52</td>
<td>1,37</td>
<td>1,17</td>
<td>0,238</td>
<td>97,03;98,01</td>
</tr>
</tbody>
</table>

Notes: see table 1.

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organism’s adaptation to environment is quicker [1, 3].

Specific feature of students’ athletes’ hemo-dynamic reacting to $PL_{max}$ is active work of mechanisms of blood circulation’s periphery regulation. It is connected with strengthening of local blood flow [2, 4, 15]. The main mechanism of sustaining HBR low level is contracting abilities of left ventricle. With it general periphery resistance of vessels is low. Hearts of 1st group students work in not effective regime. That is why its compensatory potentials are limited. For these students high ISNS indicators are also characteristic. In homeostasis sustaining tonus of artery link dominates. As per our research general periphery resistance is high, while the power of left ventricle is minimal [1]. This type of blood circulation is the least effective and has low adaptation potential [18].

As a number of authors note [6, 9, 10], human organism, depending on type of VNS on blood circulation, reacts to $PL_{max}$ in complex way: changes in CNS work compulsory manifest also by changes of EP. When comparing ISNS values under $PL_{max}$ we noticed a tendency to increase of changed EP forms. Independent on students’ groups, under $PL_{max}$ we observed changed EP indicators. However, comparing with relaxed state they increase only in 1st group (2.46 times) and 2nd group (1.79 times, $p<0.05$).

By results of work of A. Ebner et al. [28], J. González-Alons [32], F. B. Jensen [36] it is known that the quantity

---

**Fig. 1.** Structural reconstruction of periphery erythrocytes in 1st group (a), 2nd group (b) and 3rd group (c) after single maximal physical load. Legend: 1 – normal forms of erythrocytes; 2 – reversibly changed forms of erythrocytes; 3 – irreversibly changed forms of erythrocytes. Method: scanning electronic microscopy (scale 3500:1).
of circulating EP is one of factors for determination of blood rheological properties. Change of these indicators under PLmax can substantially influence on oxygen transportation blood function. Such change can result in disorders in microcirculation system. It changes students’ OFS level.

Such phenomenon is conditioned by influence of factors, which accompany muscular activity. They include increased blood circulation, rising of temperature and acidosis [38, 44, 46].

Under such conditions disorder of EP wholeness appears, which can result in “anemia of load” [46]. Such changes influence negatively on somatic health, physical workability and educational progress of students.

All these require appropriate correction of training process and working out of adequate measures, directed on elimination of possible pathologies in students’ organism, depending on their fitness to PLmax.

Conclusions

1. Depending on students’ fitness to PLmax cardio-hemo-dynamic non uniformity of blood circulation manifests in the form of different indicators of blood circulation’s vegetative regulation.

2. In the process of adaptation to maximal physical load in 1st group we observed sharp asymmetric reverse of indicators between sympathetic and para sympathetic regulation of blood circulation. With it, periphery link of blood circulation’s regulation starts actively work. It manifests by emersion of reversibly and irreversibly changed forms of periphery erythrocytes.

3. Reacting of blood circulation system in 2nd group to maximal physical load manifests in gender distinctions of blood circulation vegetative regulation: boys demonstrated higher indicators of sympathetic circuit and lower – of para sympathetic one. It conditions symmetric reverse of these indicators before and after physical load. It depends on the presence of increased quantity of reversibly changed forms of periphery erythrocytes.

4. In 1st group, under maximal physical load we observed insignificant rising of sympathetic level and a little bit rising of para sympathetic one. It manifests as insignificant increase of quantity of deformed erythrocytes, without reduction of their sizes.

Conflicts of interests

The authors state that there is no conflict of interest.

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Modernization of physical education of student youth
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Abstract

Purpose: to develop and experimentally substantiate fitness technology for students taking into account their individual peculiarities.

Material: The experiment was performed by girls (n=51, age 17-20) who were divided into experimental (n=25) and control (n=26) groups. Classes were held twice a week during the year: 66 hours in the hall and 95 hours of independent study. At the beginning and at the end of the study, all students met the control standards, which allowed to determine the level of development of physical qualities and level of physical fitness.

Results: 8 exercise complexes were developed to implement our fitness technology. Complexes were taken into account: interests, age, individual characteristics and level of physical fitness of students. At the first lessons the loading was about 45-50%. In the future, the loading increases to 70-75% of the total time of classes.

Conclusions: When constructing fitness technology using varieties of fitness it is necessary to take into account: the type and nature of exercises, the volume and intensity of exercises, the number of repetitions and the amount of weight, the frequency of training sessions and the duration of work, intervals of rest, the number and alternation of exercises.

Keywords: technology, fitness, complexes of exercises, physical qualities, students.

Introduction

In recent years health fitness becomes very popular and aimed at achieving and maintaining an optimal physical condition and reducing the risk of cardio respiratory, immune, endocrine and other diseases [1, 3, 11]. In the system of physical education of students there is an urgent need for classes, based on the possibilities and inclination to various types of health activities. The variety of classes in many cases predetermines the interest and desire of students to do physical exercises and fitness [4, 7, 32].

A large number of publications are devoted to the search for means to increase the efficiency of the physical education of student youth. The organizational-pedagogical and methodological basis for improving the system of physical education of students is shown in the directions: the influence of the new fitness system on the development of the level of physical fitness of youth [2, 12]; influence of physical exercises on the level of physical and functional preparedness of students with different levels of physical health [5]; peculiarities of constructing the process of physical education using exercises of a power nature [14, 36]; modernization of the structure of education of physical qualities in student youth [42].

Researches are devoted to differentiated physical education: Ivchatova T.V. et al. and Subbota Iu.V. developed recommendations for self-study with health-improving physical exercises, which will promote an increase in the overall tone of the body [6, 11]; Krucievich T.Iu. – systematization of studies used to determine the level of physical development, physical fitness and functional state of children and athletes aged from 6 to 21 years old [8]; Moskalenko N.V. and Korzh N.L. – the technology of formation of value attitude of students to independent studies by physical culture [9]; Apache R. – varieties of motor activity and its influence on the development of motor qualities [13]; Savchuk S. and Kovalchuk V. – are shown the possibilities of differentiated approach to teaching students with different levels of physical health [43].

Other studies on the use of fitness technology were as follow:
- justified the expediency of using fitness yoga to strengthen the psychophysical state and psychosocial health of students of special medical groups in training and recreation classes on physical culture [44];
- justified and developed modified test, directed on the assessing the functional capabilities of students with disabilities in the state of health [18, 27];
- determined a substantial increase in the level of physical development and health of students through the use of modern methods of cardio-strength training [30, 34, 35];
- estimated the level of physical health and biological age of students according to their level of physical activity [19];
- estimated the state of health of schoolchildren as a subspecialty of alimentary genesis, the manifestations of which are overweight [25, 37].

An important component in engaging with students is the inclusion of: morpho-functional indicators [38]; the influence of modern means and methods of teaching [26, 33]; the values of physical activity [22, 28, 29] and the duration of training [16, 23].

Studies of foreign specialists are aimed at solving various problems of raising the level of health of young people:
- raising the level of health and rehabilitation of youth [39, 40];
- school needs comfortable intervention programs that increase the level of student activity and knowledge about healthy behavior [21];
- presented proposals that will help teachers to structure fitness programs and pedagogical approaches (meeting needs and benefits) [31];
- the program for improving the quality of physical education can be used as a valuable foundation aimed at increasing the level of motor activity of students [45];
- the right goals and abilities / skills of the game are a...
guarantee of public health for the youth [20];

- well-designed physical education program can minimize the impact of various value orientations of teachers on the implementation of curricula and student learning [17].

From the stated positions, our topic of research is relevant and timely.

The purpose of the study is to develop and experimentally substantiate the fitness technology for students aged 17-20 years old, taking into account their individual characteristics.

Material and methods.

Participants. In the experiment participated girls (n=51, age – 17-20 years) who were divided into experimental (n=25) and control (n=26) groups. All participants have been assigned to the main medical group (no deviation in the state of health) according to a state of health.

Organization of research. The study was conducted from February 2016 to December 2016. Also, the vacation period was taken into account. In the control group, the classes were conducted according to the program, which included the development of physical qualities for the successful assimilation of motor activity techniques. During the retirement period, there have not been any proposed tasks regarding the development of physical qualities. In the experimental group, classes were conducted using developed fitness technology, taking into account the individual characteristics of students.

For the vacation period students of the experimental group offered varieties of physical exercises that would be desirable to perform during the summer holidays. These exercises were chosen in such a way as to make them as comfortable as possible for students [6, 11]. Equipment for such classes was available regardless of location and recreation area. When constructing our fitness technology using fitness varieties were taken into account a number of important factors: the type and nature of exercises, the volume and intensity of exercises, the number of repetitions and the amount of weight, the frequency of training sessions and the duration of work, intervals of rest, the number and alternation of exercises. Also used varieties of respiratory exercises, which contributed to the restoration of the body after significant loads [3].

There were developed 8 exercise complexes for implementation our fitness technology. The following complexes were taken into account: interests, age, individual characteristics and level of physical fitness of students (Table 1). Also in the methodology we used such methods as: uniform, repeated, interval, circular training.

A uniform method involves performing exercises continuously with relatively constant intensity, rate of work and amplitude of movements. With this method, we helped to prepare the body for the next job. The duration of continuous work was able to vary from 15 to 90 minutes and more [2].

The repeated method involves repeated exercises through intervals of rest. During the rest there was a complete restoration of the working capacity of the body of girls. The intensity of the load varied depending on the task. The intensity of the load could be 75 - 95% of the maximum in the chosen right. It could also be almost marginal and marginal - 95-100%. The duration of the exercise was also different depending on the task [8, 42].

Interval method involves performing exercises (duration and intensity) through intervals of rest. In this method, the training activity has an interval of rest (with full intervals of rest between approaches: until complete recovery. Intervals varying from 3 to 5 minutes) [6].

The method of circular training provided streaming, the consistent implementation of a specially selected set of physical exercises. At the end of March and October there was an increase in the density of occupations. At the first lessons load was about 45-50%. In the future, the load increases to 70-75% of the total time of employment [2, 15].

Each complex of exercises has always included exercises of health and preventive character. These methodical techniques contributed to the development of the motivation of girls to further work during the class. It also contributed to the discipline that ensured the safety of physical exercise.

The number of hours and duration in the control and experimental groups was the same. Classes were held twice a week: during the year, 66 hours of classes in the room and 95 hours on independent study.

At the beginning and at the end of the study, all students met the control standards, which allowed to determine the level of development of physical qualities and level of physical fitness.

Flexibility tests were used:

- “tilt of the trunk forward from sitting position” (cm): the student sat down on the floor without shoes, the distance between the feet is 20-30 cm. The partner is on the right and holds his knees to avoid bending them. The maximum inclination was to hold for 2-3 seconds: the fingers should be fixed on the markings.

- “Deduction of straight legs in the sides” (cm). The starting position – the student lies on the back. The student breaks straight legs to the sides. The result of the test is to measure the distance between the right and left ankle joint.

Testing of abdominal muscle strength abilities: “lifting the trunk in the sled in 1 minute” (number of times). The student lay on his back for a gymnastic mat, his knees bent at right angles, the distance between the feet – 30 cm, fingers at the head. The partner held his feet so that the five touched the mat. The command “Can!” . The student moves to sitting position. The student touches the elbows of the knees and returns to the starting position again. The result of the test was the number of ascent from a position lying in position sitting in one minute.

The development of strength abilities of muscle of hands. It was used the test “flexing and expanding the hands in the emphasis by lying” (number of times). The student bends her arms in the elbow and touches the tennis
Then the student returned to the starting position. The result of the test was the maximum number of times of touching a tennis ball in the chest.

Endurance testing. The 12-minute run was used. The result is the length of the distance, which the competitor ran for a set time with an accuracy of 1m.

Assessment of coordination abilities. We used the “Eight” test (Kopylov’s exercise) (c). The student gets the starting position: the tilt of the trunk ahead, the ball holds in one hand. With the command “Can!” as quickly as possible, the ball makes an imaginary eight between the legs at the level of the knees (Fig. 1). At the same time

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Table 1. Methodology of use fitness technology for girls aged 17-20 years

<table>
<thead>
<tr>
<th>Month</th>
<th>Method</th>
<th>Features of fitness technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>February (ending)</td>
<td>TESTING (1)</td>
<td>- exercises aimed at the development of general and special endurance;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- each lesson ended with a force block and exercises for restoration of breathing and normalization of arterial pressure;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- work in aerobic mode, 130-180 beats / min.;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- complex 1, complex 2</td>
</tr>
<tr>
<td>March</td>
<td>Uniform method</td>
<td>- exercises of force orientation was carried out;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- each lesson ended with exercise on the development of flexibility using the “Stretching”;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- work in aerobic mode, 130-160 beats / min.;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- complex 3, complex 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- exercises for flexibility with different intervals;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- general development of physical qualities;</td>
</tr>
<tr>
<td>April</td>
<td>Repeated method</td>
<td>- each lesson ended with exercise using Pilates method;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- work in aerobic mode, 160-180 beats / min.: before the next repetition of the exercise pulse 120 - 140 beats / min. (not full recovery);</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- complex 1, complex 4</td>
</tr>
<tr>
<td>May</td>
<td>Interval method</td>
<td>- exercises for flexibility with different intervals;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- general development of physical qualities;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- each lesson ended with exercise using Pilates method;</td>
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<tr>
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<td>- work in aerobic mode, 160-180 beats / min.: before the next repetition of the exercise pulse 120 - 140 beats / min. (not full recovery);</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- complex 1, complex 4</td>
</tr>
<tr>
<td>June (middle)</td>
<td>TESTING (2)</td>
<td>Vacation season (July – August)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Varieties of physical exercises for independent work are offered</td>
</tr>
<tr>
<td>September (beginning)</td>
<td>TESTING (3)</td>
<td>- exercises aimed at the development of general and special endurance;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- each lesson ended with a force block and exercises for restoration of breathing and normalization of arterial pressure;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- work in aerobic mode, 130-180 beats / min.;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- complex 1, complex 2</td>
</tr>
<tr>
<td>September</td>
<td>Uniform method</td>
<td>- performed speed-force exercises;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- each lesson ended with the implementation of breathing exercises;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- work in aerobic mode, 130-160 beats / min.;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- complex 5, complex 6</td>
</tr>
<tr>
<td>October</td>
<td>Circular training method</td>
<td>- performance of dance-choreographic exercises at different intervals;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- general development of physical qualities;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- each lesson ended with the implementation of relaxation exercises with musical accompaniment;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- work in aerobic mode, 160-180 beats / min.: before the next repetition of the exercise pulse 120 - 140 beats / min. (not full recovery);</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- complex 7, complex 8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- exercises of force orientation was carried out;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- each lesson ended with exercise exercises on the development of flexibility using the “Stretching”;</td>
</tr>
<tr>
<td>November</td>
<td>Interval method</td>
<td>- work in aerobic mode, 160-180 beats / min.: before the next repetition of the exercise pulse 120 - 140 beats / min. (not full recovery);</td>
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<td></td>
<td>- work in aerobic mode, 130-160 beats / min.;</td>
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<tr>
<td></td>
<td></td>
<td>- complex 1, complex 4</td>
</tr>
<tr>
<td>December (middle)</td>
<td>Repeated method</td>
<td>- exercises of force orientation was carried out;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- each lesson ended with exercise exercises on the development of flexibility using the “Stretching”;</td>
</tr>
<tr>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>- complex 1, complex 4</td>
</tr>
<tr>
<td>September</td>
<td>TESTING (3)</td>
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<td></td>
<td>- work in aerobic mode, 130-160 beats / min.;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- complex 5, complex 6</td>
</tr>
<tr>
<td>November</td>
<td>Interval method</td>
<td>- performance of dance-choreographic exercises at different intervals;</td>
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<tr>
<td></td>
<td></td>
<td>- general development of physical qualities;</td>
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<td></td>
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<td></td>
<td>- work in aerobic mode, 160-180 beats / min.: before the next repetition of the exercise pulse 120 - 140 beats / min. (not full recovery);</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- complex 7, complex 8</td>
</tr>
<tr>
<td>December (ending)</td>
<td>TESTING (4)</td>
<td>- exercises of force orientation was carried out;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- each lesson ended with exercise exercises on the development of flexibility using the “Stretching”;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- work in aerobic mode, 130-160 beats / min.;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- complex 1, complex 4</td>
</tr>
</tbody>
</table>
the ball is passed from hand to hand. Result – the time of execution of ten “eight”, registered up to 0.1 s. [10, 41].

Statistical analysis. Calculations of the following values are made: average arithmetic mean, mean square deviation, coefficient of variation, standard error of mean arithmetic, correlation coefficient. The received data was processed using the Microsoft Excel program.

Results

One of the most promising areas for optimizing physical education is the rational use of effective tools, methods and technologies. This approach allows to increase the level of physical development, physical fitness of students.

Table 2 shows the results of testing the level of development of girls’ physical qualities. The vacation period was also taken into account. Therefore, an intermediate test was conducted. The results of such testing showed that the figures actually decreased slightly after the holidays. This is due to the fact that for the period of holidays, students were engaged independently and chose physical exercises as they wish.

Data in table 2 show that the experiment is consistent with the indices of all tests of the group. Testing of students in early September (testing 3) indicates the need to build fitness technology.

At the end of the experiment, the results of the test “Tendency of the torso forward” increased significantly: the control group was 19 ± 1.25 (cm); the experimental group was 23 ± 1.18 (cm) (p < 0.05). After the experiment on the test “Lifting the trunk in the shed for 1 min.” The following indicators were established: control group - 43±1.38 (times); experimental group - 49±1.05 (times) (p <0.05). After experimenting with the test “Bending and extending hands in lying down”, the following indicators were set: control group - 23±1.94 (case); the experimental group was 28 ± 1.78 (case) (p <0.05). Before and after the

<table>
<thead>
<tr>
<th>Tests</th>
<th>Girls n – 26 Control group Testing</th>
<th>Girls n – 25 Experimental group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tendency of the torso forward, (cm)</td>
<td>15, 17, 16, 19, 15, 21, 19, 23</td>
<td></td>
</tr>
<tr>
<td>Lifting the trunk in the shed for 1 min. (times)</td>
<td>19, 21, 20, 23, 19, 24, 22, 28</td>
<td></td>
</tr>
<tr>
<td>Bending and extending hands in lying down, (times)</td>
<td>7,28, 7,94, 7,77, 6,91, 5,25, 6,65, 6,81, 6,93</td>
<td></td>
</tr>
<tr>
<td>Dropping straight legs to the sides, (cm)</td>
<td>126,84, 134,53, 130,12, 136,53, 126,11, 138,32, 135,09, 140,10</td>
<td></td>
</tr>
<tr>
<td>12-minute run, (m)</td>
<td>15,19, 12,83, 17,05, 11,28, 16,10, 11,45, 16,93, 13,24</td>
<td></td>
</tr>
<tr>
<td>«Eight», (с)</td>
<td>0,88, 0,57, 0,63, 0,45, 0,54, 0,48, 0,59, 0,72</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Statistical values of indicators of girls’ motor qualities development of aged 17-20 years during the experiment.
experiment, the high results of the test “Dropping straight legs to the sides” were established. Before the experiment: control group was 126.84±5.31 (cm); experimental group 126.11±5.77 (cm). After the experiment: control group - 136.53±6.33 (cm); experimental group - 140.10±7.03 (times) (p <0.01). After the experiment according to the “12-minute run” was set the following parameters: control group - 2982±11.02 (m); experimental group is 3035±13.01 (m) (p <0.05). After the experiment according to the test “Eighth” (Kopylov’s exercises), the following parameters were established: control group - 8.60±0.69 (s); experimental group is 7.66±0.63 (s) (p <0.01).

Also, it was analyzed the percentage increment of indicators of physical qualities development before and after experiment (Fig. 2). Indicators of the percentage increase indicate that the greatest increase was in the tests: “tilt of the trunk ahead”; development of flexibility; “flexing and extending the arms in the emphasis”; development of power qualities; test “eight”; development of agility.

The results of the study confirmed the effectiveness of our experimental fitness technology.

Discussion

In recent years fitness has become more popular among various types of health improvement and wellness programs. The main goal of fitness is to achieve internal harmony and external attractiveness of a man. This is the main motive for people who want to look good and feel good [2, 45].

Analysis of scientific literature [5, 9, 15, 31] confirmed that to date, a large variety of health-improving technologies leads to the invention of optimal fitness technology. Such technologies should take into account the age and individual characteristics of students. That confirmed our study. When constructing our fitness technology, we took into account the following: features of body building of students, physical health, set of algorithm of actions. This approach increases the efficiency of the health process. This ensures a guaranteed achievement of the result. The basis of such approach is free motivated selection of exercises. It is recommended to use innovative means, methods and organizational forms of training. It is also necessary to use modern inventory and equipment. The main goal of our fitness technology is to achieve inner harmony and external attractiveness. This is the main motive for students who want to look good and feel good.

It is important to take into account the vacation period. During the holidays, students were able to motivate and control themselves. Students were more responsive to the choice of physical exercises and their implementation. An important aspect of our study was that we conducted four tests, taking into account the vacation period. The obtained data revealed fluctuations in the test scores. This testified that not all students carefully approached independent classes. But during the final testing, the data showed high results. This gave us the opportunity to argue about the correctness of our approaches to the construction of the training process of students of the

Fig.2 Growth of indicators of physical qualities development in percent among control (CG) and experimental (EG) groups.

* where:
- control group,
- experimental group,
1 – test “tilt of torso forward”,
2 – test “lifting the trunk in the seat in 1 minute”,
3 – test “bending and extension of arms in the emphasis”,
4 – test “pulling straight to the sides”,
5 – test “12-minute run”,
6 – test “Eight” (Kopylov’s exercise).
fitness technology. In the experimental and control group, the greatest increase was found in the development of motor qualities: flexibility, agility and strength.

Conflict of interest.
The authors state that there is no conflict of interest.

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