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**Dynamic of primary school age pupils’ physical fitness**

**Bodnarchyk O.N., Stefanyshyn V.M., Malanchuk G.G.**

**Lviv State University of Physical Culture, Lviv, Ukraine**

---

**Abstract**

**Purpose:** assessment of 6-9 yrs age pupils’ (1st – 3rd forms) physical fitness level.

**Material:** in the research pupils of 6-9 yrs age participated \( n = 94; \) boys \( 46, \) girls \( 48 \). The pupils’ physical fitness testing was carried out in compliance with school program norms.

**Results:** as per the norms of school program most of pupils (60.9%) demonstrated high level of fitness. Exclusion was the boys’ indicators in test for flexibility. Only 12.6% of pupils fulfilled the test without remarks. 9.7% fulfilled the test at average level. 16.7% of pupils fulfilled the test at initial level. So we observed non uniform distribution of results. In the whole, by most of physical fitness indicators we observed gradual increment of result with every year. Significant improvement of results in 2nd and 3rd forms can be explained by more conscious and clear fulfillment of tests’ technique.

**Conclusions:** we found pupils’ high physical fitness level by norms of school program. But the objectiveness of the program’s norms is doubtful. May be these norms are lowered and require reviewing.

**Keywords:** pupils, physical qualities, health, tests, program.

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**Introduction**

In modern Ukrainian social-economic conditions great number of schoolchildren has weak health, low motor activity and physical fitness [12]. For example at the moment of entering school 10-20% of children have health problems; at the end of primary school – 50-60 % have the same problems [20]. It is important that just in this period motor functioning is especially required, because it facilitates: smooth character of organism’s functional systems’ reconstructions; physical development and physical qualities’ formation, which will be required in adult age [5].

For physical loads’ rationing the data about pupils’ physical fitness are important because they characterize the level of physical qualities and physical health condition [12, 19]. Physical fitness is a result of human physical activity; his/her integral indicators and to large extent reflects influence of physical education. Constant registration and assessment of physical fitness level permit to speak about physical education effectiveness [5].

Many authors pay attention in their publications to analysis of content, to structure and organization of primary schoolchildren’s physical training [5, 18]. Assessment of physical fitness level of primary [4, 6, 19], secondary [1, 15] and senior schoolchildren [3, 16] has been fulfilled. Nevertheless it shall be constantly paid attention to by scientists; especially informative are researches of dynamic of pupils’ physical fitness. In the mentioned aspect we can stress on the following topics:

- Modeling of schoolchildren’s physical education [9, 24];
- Physical loads’ rationing for schoolchildren [26, 30];
- Tendencies and status of children’s physical fitness in different countries: Australia [21], Brazil [22], China [29], Switzerland [27], Check Republic [33];
- General status of children’s health [35];
- Influence of physical activity on pupils’ health [23, 25];
- Correlation of children health’s different components [28, 31, 32, 34].

The authors note that it is necessary to perfect approaches to children’s health improvement. It is underlined that pupils’ physical fitness is the most important component of their health.

**Hypothesis:** it is assumed that physical qualities’ increment will permit to judge about positive or negative changes in the definite period of time and form objective norms for schoolchildren.

**The purpose of the research was to assess 6-9 yrs age pupils’ physical fitness level.**

**Material and methods**

**Participants:** in the research pupils of 6-9 yrs age participated \( n = 94; \) boys \( 46, \) girls \( 48 \).

**Organization of the research:** the work was fulfilled on the base of Lvov comprehensive school № 9, № 13. For objectiveness we followed identification and terms of program tests’ passing: we tested the same children; testing itself was conducted in October (at the beginning of academic year in 1st, 2nd and 3rd forms, children’s age – 6–9 yrs.) in gym conditions.

Testing of pupils’ physical fitness was conducted as per norms, envisaged by school physical culture program [10, 13, 17]. The tests were: long jump from the spot from initial position – feet at shoulder width and toes behind start line. With legs’ bending in knees, the tested waved arms backward and throwing the arms forward – jumps. The result is registered by a distance from start line to the point of heels’ touching the mat. The result is measured in centimeters by the better of two attempts.

“Shuttle” run 4 x 9 meters was fulfilled from high start behind the start line. By command it was necessary to run 9 meters to other line, take one of two cubes, which are inside a circle; then run back, put the cube in start circle and run for the other cube, to put it also in start circle. The result was measured in seconds: from start to the moment of the second cube’s putting in start circle.

Forward torso bending from sitting position: legs – at
shoulder width; distance between feet - 20 – 30 cm; hand are on the floor between knees, palm – down. By command the tested smoothly bend forward, trying to stretch arms as far as possible without bending knees. The position of maximal bent shall be kept for 2 seconds. Finger shall be fixed on marking. The result is measured in centimeters.

Statistical analysis for assessment of physical fitness level was used on the base of Microsoft Office Excel program.

Results

For assessment of physical fitness level we used school norms [13], which showed the following levels: speed-power qualities (long jump from the spot); dexterity (shuttle run 4 x 9 m) and flexibility (forward torso bending from sitting position) [10, 13, 17].

For period from 1st to 3rd forms, by every school normative we observed gradual increment of results (see table 1). In every test improvements have certain specific features and statistically confident difference (p < 0.001).

It should be noted that boys demonstrated better results than girls (p < 0.001) in long jumps from the spot and “shuttle” run 4 x 9 m. It is explained by the fact that in sensitive period increments of muscular strength do not coincide in girls and boys. Besides, strength of boys’ torso and arms is greater than girls’ [5, 11].

Only in test “Forward torso bending in sitting position” girls’ results were better (p < 0.001). As per other researches the highest increment of flexibility is observed from 7 to 8 yrs age. Girls have better joints mobility: approximately by 10-15% than boys. It is conditioned by greater elasticity of woman’s organism [11].

The presented in table 1 results show that the tested groups were homogenous from 1st to 3rd forms by results of “shuttle” run 4 x 9 m (V < 8.2%). By results of long jump from the spot (V < 15.5%) homogeneity was on average level. Significant difference in indicators was in forward torso bending in sitting position (V > 151.1%). Dispersion of boys’ results is greater (V = 98.7 – 151.1%), than the girls’ (V = 65.7 – 100.5%). Substantial non homogeneity of children’s contingent is explained by the following: high flexibility of the part of children, resulted from their attending choreographic trainings and sport circles; low flexibility of the rest of children. Besides, at physical culture lessons this physical quality is paid insufficient attention to.

In general, by most of physical fitness indicators gradual improvement of results is observed from year to year. For example, increment of girls’ results in “long jump from the spot” is 16.2 cm every year. Boys improved this indicator by 13.6 cm by the 2nd form. From 2nd to 3rd forms boys improved this indicator by 10.2 cm (p < 0.05). In the 1st form boys jump better than girls by 15.5 cm. In the 3rd form difference between results reduces up to 9.5 cm.

The data, characterizing flexibility, have the following statistically confident difference in girls (p < 0.001). In the 1st form girls improved this result by 1.8 cm; during 2nd form – by 1.4 cm. Concerning boys, we did not observe such confident difference (p > 0.05). Increment of every following year’s results is, in average, 0.4 cm. Girls are more flexible in 1st form than boys by 2.9 cm. In 2nd form girls are more flexible than boys by 4.2 cm and in the 3rd form – by 5.2 cm.

Statistically confident difference between boys and girls was registered in “shuttle” run 4 x 9 m (p < 0.01). During 1st form girls improved this result by 0.6 cm. Increment of boys results with every coming year was 2.3 sec. and 0.8 sec. In 1st form boys have better dexterity than girls by 0.8 sec. In 2nd form boys have better dexterity than girls by 0.5 sec. and in 3rd form – by 0.7 sec. (see table 2).

Significant results’ improvement in 2nd and 3rd forms can be explained by more conscious and accurate tests’ fulfillment as well as quick increase of dexterity, which

Table 1. Comparative characteristics of pupils’ physical fitness in period from 1st to 3rd forms (n = 94)

<table>
<thead>
<tr>
<th>School norms</th>
<th>Boys (n = 46)</th>
<th>Statistical characteristics</th>
<th>Girls (n = 48)</th>
<th>1st form</th>
<th>2nd form</th>
<th>3rd form</th>
<th>1st form</th>
<th>2nd form</th>
<th>3rd form</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st form</td>
<td>2nd form</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long jump from the spot (cm)</td>
<td>M</td>
<td>108.5</td>
<td>122.1</td>
<td>132.3</td>
<td>90.1</td>
<td>106.6</td>
<td>122.8</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>16.5</td>
<td>17.5</td>
<td>20.5</td>
<td>13.9</td>
<td>16.5</td>
<td>16.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>V, %</td>
<td>15.2</td>
<td>14.3</td>
<td>15.5</td>
<td>15.4</td>
<td>15.5</td>
<td>13.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Shuttle” run 4 x 9 m with carrying objects (sec.)</td>
<td>M</td>
<td>14.7</td>
<td>12.4</td>
<td>11.6</td>
<td>15.5</td>
<td>12.9</td>
<td>12.3</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>1.1</td>
<td>1.1</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>V, %</td>
<td>6.4</td>
<td>7.0</td>
<td>8.0</td>
<td>7.1</td>
<td>8.2</td>
<td>7.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward torso bending in sitting position (cm)</td>
<td>M</td>
<td>1.8</td>
<td>2.3</td>
<td>2.7</td>
<td>4.7</td>
<td>6.5</td>
<td>7.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>2.8</td>
<td>2.4</td>
<td>2.6</td>
<td>4.8</td>
<td>4.6</td>
<td>5.2</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>V, %</td>
<td>151.1</td>
<td>104.9</td>
<td>98.7</td>
<td>100.5</td>
<td>70.7</td>
<td>65.7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p – difference between boys’ and girls’ physical fitness results.
progresses in primary school age. In this age period new motor skills and abilities to reconstruct them successfully are easily formed [5, 11].

We can state that boys and girls’ speed power abilities by indicators of “long jump from the spot” and “shuttle run 4 x 9 m (except 1st form) corresponds to high level. This level meets school program norms (see table 2).

The girls’ flexibility indicators in “Torso bending in sitting position” are at high level. In boys these indicators are at sufficient and high level.

Discussion
As numerous studies show, recent time there has been a tendency to children’s health, physical fitness and physical workability worsening [22, 28, 35]. By our data increment in speed-power abilities, flexibility and dexterity points are positive changes. It is explained by natural changes in child’s organism and influence of physical culture lessons. Physical fitness results, presented by us, coincide with results, received in other works [6, 8, 14, 18].

According to school program most of pupils (60.9%) demonstrate high level of fitness. Exclusion was boys in test for flexibility. Sufficient level was achieved only by 12.6% of pupils. 9.7% fulfilled the test at average level and 16.7% - at initial level. Non uniform distribution is observed. It causes doubts about objectiveness of program

<table>
<thead>
<tr>
<th>Table 2. Comparison of physical fitness mean indicators of 1st – 3rd forms pupils according to school norms</th>
</tr>
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<tbody>
<tr>
<td><strong>Form</strong></td>
</tr>
<tr>
<td><strong>Long jump from the spot</strong></td>
</tr>
<tr>
<td>Boys</td>
</tr>
<tr>
<td>Girls</td>
</tr>
<tr>
<td>Boys</td>
</tr>
<tr>
<td>Girls</td>
</tr>
<tr>
<td>Boys</td>
</tr>
<tr>
<td><strong>Forward torso bending in sitting position, cm</strong></td>
</tr>
<tr>
<td>Boys</td>
</tr>
<tr>
<td>Girls</td>
</tr>
<tr>
<td>Boys</td>
</tr>
<tr>
<td>Girls</td>
</tr>
<tr>
<td>Boys</td>
</tr>
<tr>
<td><strong>“Shuttle” run 4 x 9 m with carrying objects, sec.</strong></td>
</tr>
<tr>
<td>Boys</td>
</tr>
<tr>
<td>Girls</td>
</tr>
<tr>
<td>Boys</td>
</tr>
<tr>
<td>Girls</td>
</tr>
<tr>
<td>Boys</td>
</tr>
</tbody>
</table>

Notes, level of achievements: * – initial; ** – average; *** – sufficient.
Conclusions

1. In the period from 1st to 3rd forms there happens improvement ($p < 0.001$) of physical fitness by all the tests in boys and girls. Boys’ results in tests for dexterity and speed power qualities were better than girls’. But girls had ahead in test for flexibility.

2. High level of pupils’ results in practically all the tests may be explained by lowered school norms that requires their reviewing.

Conflict of interests

The authors declare that there is no conflict of interests.

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Adaptive characteristics of main muscular groups’ static endurance in 6 years children in initial school period

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Abstract

Purpose: to study adaptation of 6 years children’s muscular skeletal apparatus to learning work by indicators of static endurance dynamic.

Material: in the research 6 years children participated (n=64, boys – n=36, girls– n=28). Indicators of main muscular groups’ static endurance were studied.

Results: we determined comparative topography of 13 muscular groups’ static endurance and substantial sex dimorphism was found. In 9 muscular groups the boys advantage was 11.7 – 50.2% (p < 0.05 ÷ 0.01). The level and correlation of muscles-antagonists’ static endurance from the point of evolutionary and ontogeny development of muscular-skeletal apparatus were substantiated. At the end of semester we found significant (p < 0.001) reduction of static endurance indicators as well as the fact that torso muscles were the most sensitive to influence of learning work’s static component. The level of static endurance weakening, under which syndrome of static over-tension appears, was determined.

Conclusions: the research results permit to balance the volumes of learning load at initial stage of school work. Organizational-methodic principles of learning and physical education system for children shall be oriented on overcoming muscular-skeletal apparatus’s dysfunctions.

Keywords: children, school loads, static endurance, posture, endurance, static.

Introduction

Adaptation of children’s organism to school loads attracts more and more attention. It is connected with great influence of learning loads on schoolchildren’s health. Dynamic of schoolchildren’s health worsening with every school year is commonly known.

It is proved by numerous data about causal relationship between the temps of learning process’s intensification and dynamic of pupils’ health worsening [1, 2, 22, 30].

But medical specialists think that for complete and objective characteristic of children’s health it is necessary to study age specificities and laws of physical, mental and functional state in different periods of ontogeny. For this purpose it is necessary to regard all processes of growth, in particular through physical and nervous-pyschic adaptation to environmental factors. That is why “children’s health” is studied in respect to biological age: life activity, harmonious balance of physical and intellectual characteristics, conditioned by genetic factors and environmental impacts [12, 20].

Adaptation of children’s organism to school loads, the type of life activity completely changes. Correlation between motor system’s dynamic and static components changes in favor of static component, comparing with pre-school period. This component is conditioned by need in long term sustaining of body static position during lesson. Actually static component is the main learning background, against which the main learning skills of a pupil are formed: reading, writing and counting. In this connection specialists-physiologists stress on the fact that for children, from all three kinds of school loads (mental, dynamic and static) the most tiresome is static [9, 31, 39].

Static component of school loads has great deformation potential, which negatively influences on morphological functional state of backbone. Deviations in muscular-skeletal apparatus and posture are the most wide-spread nosologies of primary schoolchildren [8, 18, 32, 35]. It was found that weakening of primary schoolchildren’s static endurance negatively impacts on such goniometric indicators of backbone as: cervical lordosis, thoracic kyphosis in sagittal plane, backbone scoliosis in frontal plane [2, 24, 26].

That is why it is important to study adaptation reactions of muscular skeletal apparatus through dynamic of static endurance indicators of different muscular groups. Study of children’s adaptation to learning loads can have great diagnostic importance. It can help to prevent from posture disorders even at pre-nosological and pre-morbid levels.

It explains specialists’ attention to indicators of torso muscles static endurance in schoolchildren of all age groups [19, 27, 29, 38]. Especially it concerns primary schoolchildren [22, 35, 37]. Some works are devoted to topography of static endurance of different muscular groups [5, 31, 28]. In analytical researches authors note difficulties, which appear as result of instrumental methodic application (dynamometers with “falling hands”) and inaccuracy in static endurance measuring with the help of field tests: Sorensen’s test and its modifications (test of Biring-Sorensen, BCME) for primary school age children [33].

But we have not found any works, devoted to static endurance adaptation in initial school period in available data base.

The hypothesis of the research stipulated that static component of school loads shall reflect in indicators of static endurance of children’s main muscular groups in the process of adaptation to school loads.

The purpose of the work is to study adaptation of 6
years children’s muscular skeletal apparatus to learning work by indicators of static endurance dynamic during first semester.

Material and methods

Participants: in the research 6 years children participated (n=64, boys – n=36, girls– n=28), school № 18, 31 (Kropivnitskiy), who, by results of the last medical examination, were related to main and preparatory health groups. The parents gave consent for their children’s participation in experiment.

Organization of the research: the methodic of static endurance study shall consider the following age characteristics of children: inability to keep static muscular effort at one level; absence of exact differentiated static effort; spontaneous changing of physical workability phases [5, 9]. The methodic of dynamography by Ianchevskij A.A. meet such requirements [6]. It permits to measure static endurance (in contrast to other methodic, which only register the duration of effort) by the functions of two variables of static effort: force and time. It permits to calculate the results in units of impulse (kg/sec). When recording on electrotensodynamograph the value of area under the curve of effort’s reduction will be an integral indicator of static endurance. Romanenko V.A. also notes the purposefulness and advantages of such methodic [13].

In our research we used electrotensodynamograph ETD – 1 [11]. Recording of static efforts took place at speed of tape movement 90 mm per minute on coordinate paper. Preciseness of force function’s recording was ± 100 g, and time function – 0.1 sec. Measurements of strength and static endurance of hand’s, torso and foot muscular groups were realized in positions, recommended by Korobkov A.V. [10]. Muscular groups of upper and lower limbs were measured as per recommendations of Rybalko BM. [15]. For this purpose we made dynamometric platform.

The scheme of the research included registration of strength and static endurance indicators at the beginning and at the end of first academic semester. It corresponds to the ideas about formation of formation of urgent, not stable and long-term adaptation of pupils’ organisms to school loads [1, 2, 9].

Statistical analysis: the received results were processed with the help of mathematical statistic methods. We calculated the following values: mean arithmetic (M), mean square deviation (δ); average error of mean arithmetic (m). Confidence of differences was found with the help of Student’s t-test at admissible 5% level of significance (p < 0.05).

Results

Initial registration of indicators, conducted at the beginning of semester gave the following results:

The received data show that in 6 yrs children sex dimorphism are rather clear in static endurance indicators. Boys’ advantage was registered in 8 muscular groups and was 12 – 26%. In six muscular groups advantage was statistically confident.

By static endurance indicators extensors dominate over flexors, excluding arm flexors. It coincides with the data of other authors [5, 35]. Foot flexors are not

<table>
<thead>
<tr>
<th>Muscular groups</th>
<th>Indicators of static endurance (kg/sec.)</th>
<th>Boys (n=36)</th>
<th>Girls (n=28)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper limbs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forearm flexors</td>
<td>135 ± 5,31</td>
<td>122,4 ± 5,09</td>
<td></td>
</tr>
<tr>
<td>Forearm extensors</td>
<td>174,2 ± 6,46</td>
<td>165,2 ± 7,60</td>
<td></td>
</tr>
<tr>
<td>Arm flexors</td>
<td>168,5 ± 6,95</td>
<td>176,6 ± 4,86</td>
<td></td>
</tr>
<tr>
<td>Arm extensors</td>
<td>119,9 ± 4,86</td>
<td>73,2 ± 2,98</td>
<td></td>
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<tr>
<td>Lower limbs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foot flexors</td>
<td>240,9 ± 15,35</td>
<td>188 ± 10,33</td>
<td></td>
</tr>
<tr>
<td>Foot extensors</td>
<td>122,4 ± 3,37</td>
<td>81,4 ± 6,58</td>
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</tr>
<tr>
<td>Shin flexors</td>
<td>8,97 ± 3,01</td>
<td>52,7 ± 3,37</td>
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</tr>
<tr>
<td>Shin extensors</td>
<td>173,8 ± 8,82</td>
<td>131,3 ± 5,96</td>
<td></td>
</tr>
<tr>
<td>Thigh flexors</td>
<td>81,7 ± 3,83</td>
<td>64,1 ± 3,46</td>
<td></td>
</tr>
<tr>
<td>Thigh extensors</td>
<td>297,9 ± 14,74</td>
<td>244,1 ± 9,08</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Indicators of 6 yrs children’s static endurance at the beginning of semester (September) M ± m

<table>
<thead>
<tr>
<th>Muscular groups</th>
<th>Indicators of static endurance (kg/sec.)</th>
<th>Boys (n=36)</th>
<th>Girls (n=28)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand’s flexors</td>
<td>234,3 ± 5,26</td>
<td>156 ± 9,42</td>
<td></td>
</tr>
<tr>
<td>Torso flexors</td>
<td>414,4 ± 16,28</td>
<td>371,1 ± 13,98</td>
<td></td>
</tr>
<tr>
<td>Torso extenders</td>
<td>568,4 ± 17,90</td>
<td>549,8 ± 17,84</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Static endurance indicators of the most sensitive for learning work’s static component muscular groups of 6 yrs children (September) M ± m
considered because of their anatomic specificity.

It was also found that rank levels of static endurance indicators do not coincide with biomechanical indicators of muscular groups’ mass. Especially it is noticeable in case of lower limbs, where static endurance maximal indicators were registered in the most massive thigh extensors and in the least massive (foot flexors). Such peculiarities shall be connected with evolution process of formation of human orthography body position: with functions of straight carriage, based on tension of the mentioned muscular groups [8].

Functionally it is ensured by mechanisms of long term adaptation reactions to influence of specific for cells and their structural elements physical loads [4].

It is important to study children organism’s adaptation to static component of school loads, especially muscular groups of torso and hand. It is connected with ergonomic specificities of pupils’ learning work, which requires forced motor functioning. This functioning is regulated by algorithm of educational process. This algorithm envisages working sitting position with restricted movements of hands and torso [7].

By the data of table 2 boys’ advantage in the mentioned muscular groups was also expressive. In hand’s flexors by 50.2% (t = 7.26; p < 0.001), in torso flexors – by 11.67% (t = 2.03; p < 0.05), in torso extensors – by 31.8% (t = 0.74; p > 0.05). It was found that torso muscular groups have the highest indicators of static endurance among all thirteen segments of body. Torso extensors have confident advantage in boys by 37.2% (t = 6.37; p < 0.001) and in girls – by 48.2% (t = 7.9; p < 0.001).

The next registration of static endurance indicators was fulfilled in December. It permitted to determine of 6 yrs. children’s adaptability to school loads and influence of their static component.

The data of table 3 show adaptation process of 6 yrs children’s muscular skeletal apparatus to static component of learning work. Static endurance indicators of upper limbs have tendency to reduction in all four muscular groups. In boys it was registered in the range 5.4 – 24.5%; in girls – 2.7 – 22.3%. In boys static endurance reduction of forearm extensors and arm flexors are confident, accordingly 24.5% (t = 4.38; p < 0.01) and 13.2% (t = 2.26; p < 0.05). In girls such noticeable reduction was found in forearm extensors – 22.3% (t = 3.1; p < 0.01) and arm flexors 10% (t = 2.52; p < 0.05).

In indicators of lower limbs’ static endurance we also registered general tendency to reduction of results. In boys it reached 5 – 28.7%. In boys the highest reduction of static endurance was in group of thigh extensors – 28.7% (t = 2.19; p < 0.05). In girls the range of reduction was 12.1 – 17.4%, while in group of thigh extensors the values become confident (t = 2.28; p < 0.05).

It should be noted that static endurance of lower and upper limbs noticeably inhibits under influence of new learning conditions of children’s life activity. Muscles of torso prove it even more expressively.

By the data of table 4 we see negative type of dynamic of torso static endurance indicators at the end of semester. In boys, in torso flexors’ group this reduction was 22.4% (t = 12.4; p < 0.001), and in torso extensors’ group – 13.1% (t = 3.61; p < 0.001).

### Table 3. Static endurance indicators of 6 yrs children at the end of first academic semester (December) M ± m

<table>
<thead>
<tr>
<th>Muscular groups</th>
<th>Indicators of static endurance (kg/sec.)</th>
<th>Boys (n=36)</th>
<th>Girls (n=28)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper limbs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forearm flexors</td>
<td>127.7 ± 8.18</td>
<td>119.1 ± 7.68</td>
<td></td>
</tr>
<tr>
<td>Forearm extensors</td>
<td>131 ± 7.28</td>
<td>128.4 ± 9.16</td>
<td></td>
</tr>
<tr>
<td>Arm flexors</td>
<td>146.2 ± 7.0</td>
<td>159 ± 5.02</td>
<td></td>
</tr>
<tr>
<td>Arm extensors</td>
<td>104.2 ± 5.12</td>
<td>70.4 ± 6.14</td>
<td></td>
</tr>
<tr>
<td>Lower limbs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foot flexors</td>
<td>201 ± 16.11</td>
<td>167.4 ± 12.44</td>
<td></td>
</tr>
<tr>
<td>Foot extensors</td>
<td>116.3 ± 8.16</td>
<td>70.5 ± 10.17</td>
<td></td>
</tr>
<tr>
<td>Shin flexors</td>
<td>38.6 ± 4.15</td>
<td>46.3 ± 5.48</td>
<td></td>
</tr>
<tr>
<td>Shin extensors</td>
<td>167.4 ± 9.16</td>
<td>119.2 ± 10.21</td>
<td></td>
</tr>
<tr>
<td>Thigh flexors</td>
<td>64.9 ± 3.26</td>
<td>59.9 ± 4.08</td>
<td></td>
</tr>
<tr>
<td>Thigh extensors</td>
<td>212.4 ± 36.11</td>
<td>201.6 ± 73.18</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4. Static endurance indicators of the most sensitive for learning work’s static component muscular groups of 6 yrs children (December) M ± m

<table>
<thead>
<tr>
<th>Muscular groups</th>
<th>Indicators of static endurance (kg/sec.)</th>
<th>Boys (n=36)</th>
<th>Girls (n=28)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand’s flexors</td>
<td>231.7 ± 13.91</td>
<td>159.5 ± 12.16</td>
<td></td>
</tr>
<tr>
<td>Torso flexors</td>
<td>321.4 ± 17.26</td>
<td>177.2 ± 17.06</td>
<td></td>
</tr>
<tr>
<td>Torso extensors</td>
<td>494 ± 10.28</td>
<td>465 ± 18.08</td>
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</tr>
</tbody>
</table>
In girls static endurance indicators of torso flexors reduced by 52.3% (t = 8.81; \( p < 0.001 \)) and extensors – by, 15.4% (t = 3.34; \( p < 0.001 \)).

In our opinion just this, critical reduction of static endurance explains higher quantity of deviations and posture disorders in primary school age girls[3, 8, 12]. Our assumption about reduction of hand’s flexors turned out to be mistaken, as far as we registered only slowing of dynamic of indicator within 1 – 2%.

**Discussion**

The received by methodic of Ianchevskij A.A. [6] data permitted to collect rather complete information about comparative topography of static endurance indicators in main muscular groups of children at the beginning of school learning.

In the area of upper limbs the highest indicators were registered in forearm’s extensors and the lowest – in arm’s extensors. In girls such changes were found in flexors and extensors of arm. In muscular group of forearm the situation was quite opposite – extensors’ indicators prevailed. In the area of lower limbs static endurance indicators were higher in the group of thigh and shin extensors.

Such functional variety in static endurance indicators in all groups of flexors-extensors is explained by the fact that all muscular groups participate differently in children’s motor functioning. That is why they change differently by absolute indicators of static endurance and by temps of their increment with age [5].

In our opinion specificity of static endurance topography in different body segments is explained by two main factors: biomechanical mass of muscular group and their evolution adaptation to static regimes of work. The received data of indicators of torso muscular groups, which have the highest mass and static endurance, prove our affirmations. One more argument is phenomenon of foot flexors (which have the least mass) and whose static endurance is dominating in limbs’ segments. It is considered that it is connected with ontogeny formation of muscular skeletal apparatus: function of upright moving and interaction with gravitation factors in the process of posture formation. Formation of posture can be regarded exactly as a product of evolution morphological perfection of muscular skeletal apparatus under influence of human gravitation interaction with surrounding world [5, 8].

Thus, correlation of lower limbs’ and torso’s static endurance indicators should be explained by their functional significance in ensuring upright walking: achievement and sustaining of optimal regional postural muscular balance (tonus-power balance of muscles-antagonists, which ensures physiological uniformity of load on backbone) [17].

It was also found that in indicators of boys’ and girls’ static endurance sex dimorphism is rather clear in all studied muscular groups. The boys’ advantage was statistically confident in the range (\( p < 0.05 \times 0.001 \)). The data of different researchers in this question are rather contradictory that is explained by application of different methodic. Rather often such methodic did not meet age characteristics of primary school age children. In other work it is stated that eight age children were not able to sustain constant effort of 50% from maximal strength. It forced to repeat attempts [5].

Unanimity of scientists’ positions in respect of static endurance of different age people means recognition of the fact that indicators of development in ontogeny has progressive and non uniform character. Primary school age has insignificant increments of strength indicators. That is why this age is characterized by noticeable increase of static endurance [5, 35].

The received data deepen and supplement information about children organism’s adaptation to static component of school loads: change of motor regime of life activity in general. It was found that inhibited and negative type of static endurance dynamic is present, in different degree, in all thirteen studied muscular groups. It was found that the most sensitive to static component’s influence were torso extensors and flexors. We think that it is connected with absence of formed, stable correct working position at school desk. Besides, it is connected with the fact that children cannot control position of torso and head, when mastering reading, writing and other required skills [36].

Reduction of torso flexors’ static endurance indicators was much higher than extensors’ both in boys and girls. It results in statement that there is syndrome of static over-loading (the term, proposed by us) of primary school children’s organism. This term appeared after four months’ school learning, providing all requirements to organization of educational process in primary school were observed.

From position of ecological physiology (the branch of labor physiology) [16] syndrome of static over-loading shall be regarded as localization of general over-loading syndrome in nervous-muscular apparatus of 6 yrs children. It is formed as a result of log term static fatigue, not completely compensated in restoration period [14]. It results in chronic disorders. The work, fulfilled under impact of stimulus is characteristic feature of chronic disorders. Ul’mer G. Notes that syndrome of over-loading is especially noticeable in organs, sustaining body position [16]. In our case deforming influence of long term sitting on children organism’s postural and motor systems causes emersion of constant disorders of backbone. It is noticeable after leaving primary school [1, 2, 8, 12].

In the works by Bazarnyj V.F. [1] reflex of bent head was found in most of primary school pupils. This reflex also appeared at the end of December. It witnesses about formation (to be more exact about functional disorder of cervical and thoracic backbone segments) of kyphosis carriage – slouch. It I a result of static over-loading syndrome’s progressing.

It is quite clear that the conducted research covers chronologically only the stages of urgent and non stable adaptation of children to static component of school loads. It is only a part of all adaptation process. It makes narrower the opportunity of conclusions about generalized characteristics of adaptation process’s formation in 6 yrs
Children.

The prospects of further researches imply studying laws of primary school age children’s long term adaptation mechanisms to school loads. The received data contradict to researches, which indirectly support further intensification of education process and do not consider biological potentials of pupils [9, 37].

The novelty in our work is: we are the first who received detail and complete topography of static endurance of al thirteen 6 yrs boys’ and girls’ muscular groups. We found significant and statistically confident sex dimorphism between static endurance indicators of boys and girls in all muscular groups. We also made an attempt to substantiate the level of static endurance first of all in: foot flexors; thigh extensors; torso flexors and extensors. This attempt was regarded from positions of all in: foot flexors; thigh extensors; torso flexors and extensors.

Analysis of static endurance indicators’ dynamic permitted to differentiate, for the first time, syndrome of static overloading. It can be regarded as pre-morbid state in respect to possible deformation of sitting posture at school desk and in general the posture of primary school age children. We deepened the ideas about duration and special aspects of 6 yrs children’s adaptation to static component of school loads.

Conclusions

Study of 6 yrs children’s adaptation to static component of school loads by static endurance indicators permits to substantiate the need in reducing the volumes of school loads at initial stage of school period.

Static endurance of lower limbs and torso muscles is an important factor in achievement of optimal postural muscular balance between muscles-antagonists. It is important in formation of correct sitting posture at school desk and carriage in 6 yrs children. Dynamic of static endurance indicators of torso muscular groups is a sensitive integral indicator of organism’s fatigue under influence of school loads’ static component.

Reduction of static endurance indicators of torso flexors and extensors at the end of first academic semester illustrates emersion and formation of static over-loading syndrome.

Organizational principles of primary school pupils’ teaching and the system of physical education shall be oriented on overcoming of failure in 6 yrs children’s motor stereotype, which appears in the process of adaptation to school loads’ static component.

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Conflict of interests

The author declares that there is no conflict of interests.

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Self-assessment and aggression’s manifestation of judo wrestlers in age and qualification aspects

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2Mykolas Romeris University, Vilnius, Lithuania

Abstract

Purpose: to determine self assessment and aggression's manifestations of judo wrestlers in age and qualification aspects.

Material: in the research boys – Judo wrestlers from sport schools of Kaunas (Lithuania) participated (n=90, age – 16.9 ± 2.0 years). The athletes were divided into three groups. In qualification aspects were divided into two groups. The first group was composed as per sport achievements – the members of combined Lithuanian teams. The second group consisted athletes of different sport categories, which were not the members of combined teams. We used questionnaire as per scale of self assessment of M. Rosenberg and questionnaire of aggressiveness of Buss-Perry. Estimation of the received data was fulfilled with the help of U criterion of Manna-Whitney, H criterion of Kruskall-Wallis and χ2-criterion. Assessment of confidence of mean group data's differences was fulfilled by Student’s t-test. Correlations of indicators were determined with the help of correlation coefficient of Spearmen.

Results: with increasing of Judo wrestlers' age we observed the tendency to increasing of their self-assessment. The older sportsmen become the higher is theirs aggressiveness. Depending on self-assessment level we did not find statistically confident differences in their aggression indicators. Large quantity of elite Judo wrestlers has high self-assessment. Self assessment and aggression indicators of sportsmen with sport categories statistically do not differ for elite Judo wrestlers' indicators. Correlation between mean level of self assessment and aggression are present only in young Judo wrestlers.

Conclusions: in all age groups of Judo wrestler’s average level of self assessment prevails. Higher level is characteristic only for members of combined teams of the country. Judo wrestlers' aggression depending on age differs only by one component (more adult wrestlers are more aggressive than juniors). In respect to the level of sportmanship – differences are absent.

Keywords: Judo, self-assessment, aggression, age group, sportsmanship.

Introduction

Self-assessment is one of the most important psychic structures, which control people’s attitude towards themselves and events around them. It is the central component of personality and plays the role of activity’s regulator. Self-assessment ensures the best adaptation to constantly varying life conditions. It facilitates achievement of high results in any activity [2, 3, 26].

Self-assessment is defined as assessment of person’s own physical and psychic qualities, behavior, achievements and failures, advantages and drawbacks, own potentials and abilities [1, 3, 8, 28].

Aggression is closely connected with sport activity. It is observed at all its levels – from junior to professional leagues [16]. Recent time, in scientific literature, different factors or reasons, facilitating unbearably aggressive adolescents’ behavior, practicing sports, have been being analyzed. Competitions (contest), by its nature, imply impulses of aggression. But such aggression is determined by competition rules. It depends on many factors. Individual self-assessment is closely connected with the following: aggressive reactions; ability to control aggressive impulses; ability to manifest such energy in socially acceptable way. Self assessment is especially important in adolescent’s age. In this age self cognition expands; new forms of self control appear. Self assessment is one of personality’s qualities, influencing significantly on individual understanding own self-sufficiency, interpersonal communication, demand in contest with surrounding people [20].

To larger extent aggressiveness is noticeable in athletes and physically active people [7, 21, 32]. Sports permit to express aggressive feelings. It does no harm to other people and forms constructive ways of sportsmen’s aggressive behavior [7]. Aggression is characteristic for many kinds of sports [10, 22, 23]. As a phenomenon aggression is studied in different aspects. Endresen & Olweus [15] stresses on influence of personalities’ qualities on aggressiveness in sports. The authors affirm that expression of aggression in certain kind physical activity coincides with aggressiveness in everyday life. The authors note that earlier quite an opposite opinion existed: it was considered that sports practicing weakened behavior aggressiveness.

In sport activity the so-called instrumental aggressiveness is manifested most frequently: i.e. aggressiveness is used for achievement victory [24, 30, 34, 37]. For victory in competition coaches create attacking strategy. Such aggressive strategies are most frequent in kinds of sports, where frequent and close physical contacts with opponent take place [12]. The distinctive feature of opponents’ such contacts is tolerable perception of instrumental aggression. Often such strategy comes out of frames of permitted competition rules. This makes sports still more cruel and aggressive [33].
In some kinds of sports aggressive behavior is admitted and encouraged, for example in boxing and hockey. Though, it contradicts moral and social norms and rules. For achievement victory athletes are recommended to behave aggressively [18, 35].

The problem of aggressive behavior is regarded rather in detail in scientific literature. However there are still little works, devoted to self assessment and aggression of people, practicing sports (especially martial arts). That is why the object of the present research is study of interconnections of aggressions and self assessment of Judo wrestlers.

The hypothesis of the research was assumption that self-assessment and aggression of older and elite Judo wrestlers are higher than of younger sportsmen.

The purpose of the research is to determine self assessment and aggression’s manifestations of Judo wrestlers in age and qualification aspects and to determine self assessment and aggression’s manifestations of Judo wrestlers in age and qualification aspects.

Material and methods
Participants: in the research boys – Judo wrestlers from sport schools of Kaunas (Lithuania) participated (n=90, age – 16.9 ± 2.0 years). The athletes were divided into three groups. In qualification aspects were divided into two groups. The first group was composed as per sport achievements – the members of combined Lithuanian teams. The second group consisted athletes of different sport categories, which were not the members of combined teams (see table 1).

The athletes were selected by method of “convenient” sampling (coming from possibilities of questioning). Before questioning we received the consent for participation in the researches of: sportsmen, their parents, coaches and administrations of sport organizations.

Organization of the research: the research was fulfilled in 2015. We used anonymous questioning. For self assessment of the tested we used the scale of M. Rosenberg (The Rosenberg Self-Esteem Scale (SES, 1965). The scale consisted of 10 affirmations, characterizing human state. Sportsmen were to assess every affirmation, choosing one of four variants of answers: from “completely agree” to “flatly disagree”. The sum of answers was estimated from 0 to 30 points. The highest was the sum of points the greater was self-assessment: less than 10 points meant low self-assessment; 11-20 points – average self-assessment and 21-30 points – high self-assessment [31] with indicator of internal reliability of scale Cronbach α = 0.78.

For determination of aggression’s kinds we used Personality questionnaire Buss-Perry Aggression Questionnaire (BPAQ, 1992. The questionnaire consists of 29 statements. It has the following sub-scales: physical and verbal aggression, anger and hostility [13] with indicator of internal reliability of scale Cronbach α = 0.89. Every statement of the scale was estimated from 1 (have no) to 7 (very typically) points. The more aggressiveness is expressed, the higher was the sum of points: physical aggressiveness – 9 statements; verbal aggression – 5 points; anger – 7 statements and hostility – 8 statements.

Statistical analysis: the received data were processed with the help of SPSS (Statistical Package for Social Science) 17.0 programs. The received data were estimated with the help of non parametrical criteria. Two independent samples were compared with Mann-Whitney U-test. More than two independent samples were compared with H- Kruskal-Wallis test [25]. Confidence of mean group data differences was found with Student’s t-test at significance level of p<0.05. For comparison of self assessment levels of different groups’ tested we used χ² criterion. Correlations of indicators were determined with the help of correlation coefficient of Spearmen.

Results
The fulfilled questioning permitted to find self-assessment and aggressiveness indicators of the respondents (see table 2). It was found that the highest self assessment was intrinsic to older sportsmen (juniors) and reaches 20.56 ± 3.52 points. Self assessment of younger athletes does not differ statistically (p>0.05) though it is a little lower.

Physical and verbal aggression, as well as anger are not influenced by age of Judo-wrestlers (see table 2) (p>0.05). However, the older Judo wrestlers become the higher their hostility rises statistically (p<0.05).

Most of all age groups’ sportsmen have average self-assessment: youngsters – 73.1%, cadets – 64.0%, juniors – 59.0%. With increasing athletes’ age the tendency to their self-assessment rising is observed (p>0.05) (fig.1).

We have not found statistical differences between aggression indicators depending on respondents’ self assessment (p>0.05): i.e. all forms of aggression are distributed uniformly (see table 3).

Average self-assessment of combined teams’ members

Table 1. Characteristics of athletes

<table>
<thead>
<tr>
<th>Groups</th>
<th>Age (years)</th>
<th>The quantity of respondents (n)</th>
<th>The quantity of respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys (U–16)</td>
<td>14–15</td>
<td>26</td>
<td>28.9</td>
</tr>
<tr>
<td>Cadets (U–18)</td>
<td>16–17</td>
<td>25</td>
<td>27.8</td>
</tr>
<tr>
<td>Juniors (U–21)</td>
<td>18–20</td>
<td>39</td>
<td>43.3</td>
</tr>
<tr>
<td>Elite sportsmen</td>
<td>14–20</td>
<td>29</td>
<td>32.2</td>
</tr>
<tr>
<td>Sportsmen with sport categories</td>
<td>14–20</td>
<td>61</td>
<td>67.8</td>
</tr>
</tbody>
</table>
is 20.52 ± 3.66 points; physical aggression reaches 37.34 ± 7.07, verbal – 19.48 ± 5.38 and anger – 28.79 ± 5.12; hostility is – 32.28 ± 5.36 points (see table 4). Indicators of sportsmen’s with sport categories self assessment and aggression statistically do not differ from the same of elite athletes (p>0.5).

Analysis of self-assessment data, depending on athletes’ sportsmanship showed that no one of them had low self assessment level (see table 5). But high self assessment level have confidently greater quantity of combined teams’ members than athletes with sport categories (p<0.5).

No correlations were found between self assessment and aggression’s kinds of cadets and juniors. For youngsters we found average level correlation between self assessment and physical aggression (see table 6).

**Discussion**

The problem of correlations between self assessment and aggression in sports has being always existed. Till nowadays different contradictory hypothesis has been formulated. In these polemic martial arts, popular among athletes of different age, take special place.

The hypothesis, formulated by us, was proved partially. Athletes’ self assessment in respect to their age statistically does not differ, but it differs depending on sportsmanship (higher self assessment is characteristic for combined teams’ members). Judo wrestlers’ aggression, depending on age, differs only by one component (hostility), while depending on sportsmanship differences are absent.

It was found that manifestations of anger, physical and verbal aggressions of different age Judo wrestlers are nearly the same (p>0.05), while manifestation of hostility is different. More adult athletes have confidently greater hostility (p<0.05). The level of sport qualification practically does not influence oh Judo wrestlers’ aggression.

The received by us results partially coincide with results of other work [36]. This author found that there is the tendency of self assessment and aggression rising in adolescents, depending on improvement of their sport results.

| Indicators   | Group | x̅      | SD   | H-criterion | p =  
|--------------|-------|---------|------|-------------|------
| Self assessment | Youngsters | 19.38 | 2.90 | 2.833 | 0.243 |
|              | Cadet | 19.08 | 3.35 | 0.878 | 0.645 |
|              | Juniors | 20.56 | 3.52 | 3.610 | 0.164 |
|              | Youngsters | 36.50 | 7.23 | 1.210 | 0.546 |
| Physical aggression | Cadet | 34.08 | 5.45 | 6.135 | 0.047 |
|              | Juniors | 34.77 | 4.59 | 29.84 | 5.01 |
|              | Youngsters | 20.04 | 4.39 | 28.96 | 5.86 |
| Verbal aggression | Cadet | 19.72 | 3.69 | 19.84 | 5.01 |
|              | Juniors | 17.92 | 4.01 | 27.23 | 3.77 |
|              | Youngsters | 28.69 | 5.41 | 28.96 | 5.86 |
| Anger       | Cadet | 27.68 | 4.31 | 27.23 | 3.77 |
|              | Juniors | 27.23 | 3.77 | 28.96 | 5.86 |
|              | Youngsters | 28.69 | 5.41 | 28.96 | 5.86 |
| Hostility  | Cadet | 29.84 | 5.01 | 29.84 | 5.01 |
|              | Juniors | 32.79 | 6.74 | 32.79 | 6.74 |

**Fig. 1.** Self assessment of different age Judo wrestlers (%). (χ² (2) = 1.357; p>0.05)
In other study it was determined that self assessment of young rugby players is lower than the same of older athletes [37]. For the tested by us Judo wrestlers it is not characteristic. The tested by us athletes had average self-assessment level. It coincides with other data [4]. The authors found certain reduction of self assessment of athletes with sport categories in conditions of competitions [4]. It was found that adolescents, practicing sports, have higher self assessment [17].

It was also found that self assessment of elite athletes in different kinds of sports is confidently higher, comparing with athletes of lower qualification [5, 8, 11]. In opinion of a number of scientists [6], the most efficient are athletes with high self-assessment [2, 3].

Comparing with the tested by us athletes the boys from Lithuanian sport schools have higher self-assessment: high level - 56% and low – y 18% [27]. In our case high self assessment is characteristic for 51.7% members.

Table 3. Aggression indicators depending on self assessment of the tested (points)

<table>
<thead>
<tr>
<th>Kinds of aggression</th>
<th>Self-assessment level</th>
<th>n</th>
<th>x</th>
<th>SD</th>
<th>U-criterion</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical</td>
<td>Average</td>
<td>58</td>
<td>34.45</td>
<td>4.37</td>
<td>818.5</td>
<td>0.354</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>32</td>
<td>36.22</td>
<td>7.51</td>
<td>834.5</td>
<td>0.429</td>
</tr>
<tr>
<td>Verbal</td>
<td>Average</td>
<td>58</td>
<td>19.05</td>
<td>3.87</td>
<td>925.5</td>
<td>0.983</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>32</td>
<td>28.31</td>
<td>5.64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anger</td>
<td>Average</td>
<td>58</td>
<td>27.48</td>
<td>3.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>32</td>
<td>28.31</td>
<td>5.64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hostility</td>
<td>Average</td>
<td>58</td>
<td>30.79</td>
<td>6.84</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Aggression and self assessment indicators depending on sportsmanship of the tested (points)

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Group</th>
<th>n</th>
<th>x</th>
<th>SD</th>
<th>U-criterion</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical aggression</td>
<td>I</td>
<td>29</td>
<td>20.52</td>
<td>3.66</td>
<td>739.0</td>
<td>0.206</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>61</td>
<td>19.48</td>
<td>3.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal aggression</td>
<td>I</td>
<td>29</td>
<td>37.34</td>
<td>7.07</td>
<td>670.5</td>
<td>0.064</td>
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<tr>
<td></td>
<td>II</td>
<td>61</td>
<td>34.00</td>
<td>4.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anger</td>
<td>I</td>
<td>29</td>
<td>19.48</td>
<td>5.38</td>
<td>823.5</td>
<td>0.597</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>61</td>
<td>18.82</td>
<td>3.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hostility</td>
<td>I</td>
<td>29</td>
<td>28.79</td>
<td>5.12</td>
<td>735.5</td>
<td>0.197</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>61</td>
<td>27.30</td>
<td>4.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>32.28</td>
<td>5.36</td>
<td>697.0</td>
<td>0.104</td>
</tr>
</tbody>
</table>

Table 5. self-assessment of different sportsmanship athletes

<table>
<thead>
<tr>
<th>Self assessment</th>
<th>Members of combined teams of Lithuania</th>
<th>Sportsmen with sport categories</th>
<th>Statistical indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Low</td>
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<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>Average</td>
<td>14</td>
<td>48.3</td>
<td>44</td>
</tr>
<tr>
<td>High</td>
<td>15</td>
<td>51.7</td>
<td>17</td>
</tr>
</tbody>
</table>

Table 6. Correlations between self assessment and aggression's kinds in Judo wrestlers- youngsters (r)

<table>
<thead>
<tr>
<th>Indicators</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.520</td>
<td>0.364</td>
<td>-0.065</td>
<td>0.136</td>
</tr>
<tr>
<td>2</td>
<td>0.339</td>
<td>0.318</td>
<td>-0.302</td>
<td>-0.250</td>
</tr>
<tr>
<td>3</td>
<td>-0.118</td>
<td>-0.118</td>
<td>-0.250</td>
<td>-0.118</td>
</tr>
<tr>
<td>4</td>
<td>0.118</td>
<td>0.118</td>
<td>0.118</td>
<td>0.118</td>
</tr>
</tbody>
</table>

Indicators: 1 – self assessment; 2 – physical aggression; 3 – verbal aggression; 4 – anger; 5 – hostility.
of Judo combined teams of Lithuania and for 27.9% of athletes with sport categories.

In opinion of some researchers [19, 20], just low self-assessment is a risk factor of aggression’s emersion. In our study we did not register low self-assessment.

According to other work, on initial stages of martial arts’ training aggression is connected with the following: sport results; victory on competitions; with intransigence to drawbacks; with strive for self-affirmation at the account of other people [9]. Experience of martial arts training causes reduction of aggression. Some changes in personality’s vaules take plac. It conditiones shift of value orientation from practical result to the training process itself [9].

We did not find any correlations between self-assessment and aggression’s manifestations of Judo-juniors and cadets. In Judo youngsters we found average level correlation between self-assessment and physical aggression: the higher self assessment is, the more expressed is physical aggression.

In a number of works correlation of other kind was found: in adult rugby players there is no connection between self-assessment and total indicator of aggression. In younger rugby players there is negative correlation: the lower self assessment is, the greater is total indicator of aggression [37].

In martial arts such forms of aggression can exist: instrumental, hostility or unfriendly behavior [35]. Instrumental aggression is motivated by strive for achievement of target. Such behavior looks like as previously planned for achievement of certain strategic advantage in fight. Martial arts athletes plan their tactic and fighting technique beforehand. Technical and tactical training directed at victory is the basis of all martial arts. It means that athlete shall traumatize his opponent or fulfill other aggressive actions for obtaining certain advantage or to win.

Rather often sport activity pre-conditions negative behavior. Unfortunately, coaches and spectators often encourage such athlete’s behavior and explain it by need in formation sport character. Dunn et al. affirm that since early childhood it is necessary to cultivate negative attitude to aggression, to humiliation of human dignity. It is necessary to cultivate the idea that such behavior is not and cannot be the norm of life [14].

Endresen & Olweus found that for athletes with bent to aggression (martial arts and power kinds of sports) destructive behavior even out of gym is characteristic [15]. There is an opinion that too high self assessment is connected with non adaptive manifestations of aggressiveness [29].

The prospects of the research imply working out of practical recommendations on formation of adequate self-assessment of Judo wrestlers and regulation of their aggressiveness by them.

Conclusions
In all Judo wrestlers’ age groups average self-assessment prevails. Higher self assessment is characteristic for members of Lithuanian combined teams (p<0.05). Depending on age Judo wrestlers’ aggression differs only by one component (youngsters are more hostile than juniors and cadets). Depending on sportsmanship, there are no differences.

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Conflict of interests
The authors declare that there is no conflict of interests.

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Central hemodynamic response to interval aerobic jogging in healthy male students

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Abstract

Purpose: Regular training improves maximal oxygen consumption (VO2max) and cardiovascular function. The aim of this study was to determine the central hemodynamic adaptation after interval aerobic jogging in healthy male students.

Material: Twenty untrained male students (aged 18-20 years) were volunteered and randomly divided into two groups: interval (I; n=10) and control (C; n=10). Countryside interval jogging programme 5×9 min at 70% of Maximum Heart Rate interspersed with 4 min inactive recovery, 3 days/week for 8-weeks performed. The control group remained sedentary during the period. VO2max obtained using the step-test. Standard medical method of tetrapolar chest reography (impedance cardiography) was performed for hemodynamic parameters, during resting and after workload (Step-test) conditions, before and after the training.

Results: Using t-test, after eight weeks the resting heart rate in both groups did not change significantly (P>0.05). The stroke volume increased significantly in I group after workload (P<0.05). The cardiac output (CO) did not change significantly in both groups (P>0.05). The diastolic blood pressure in I group decreased significantly at rest and after workload (P<0.05). The diastolic blood pressure did not change significantly in both groups (P>0.05). The systolic blood pressure in the both groups did not change significantly (P>0.05). The maximal aerobic capacity absolute and relative increased significantly in 1 group (P<0.05). Significant difference between groups in stroke volume, cardiac output, VO2max absolute and relative (P<0.05) was found.

Conclusions: Eight weeks aerobic interval jogging can influence on central hemodynamic and VO2max in male students.

Keywords: stroke volume, blood pressure, cardiac output, maximal oxygen consumption.

Introduction

Physical training, as part of cardiac rehabilitation, is effective in improving vascular function, pulmonary circulation, ventricular remodeling and functional capacity and quality of life in patients with coronary artery disease [16, 20]. However, the benefit of training on left ventricular diastolic and systolic function is controversial [11, 39, 46]. The most cases of physiological modification are heart rate and blood pressure due to physical activity [28]. The response of the heart rate and blood pressure to exercise depends on factors like active muscle mass, type of muscle fiber, intensity and the training method [23, 29].

Measures of cardiac output (CO) help to develop the information about physiological responses and mechanisms of adaptation due to the physical training, sedentary lifestyle and chronic disease. CO – the product of stroke volume (SV) and heart rate (HR) – indicates the body’s ability to meet the metabolic demands of training; it may increase from 5- to 6-fold during training [44]. Coordination of the function of autonomic nervous system (marked with rapid and sustained parasympathetic withdrawal coupled with sympathetic activation) is required for this to happen. The increase in HR is responsible for the majority of the enhancement the CO during training, and peak HR is a basically limiting factor of peak exercise capacity in healthy person. Maximal HR does not increase with training. In contrast, with prolonged physical training increases in SV – both at rest and during exercise – demonstrated [4].

Studies show that during physical activity increase in HR is responsible for 50 to 70 percent, contractility 15 to 25 percent and ventricular work for 15 to 25 per cent of myocardial oxygen consumption is responsible [10].

Intensive Interval training is divided into two main categories: sprint and aerobic types. Sprint-type interval training improves maximal oxygen consumption (VO2max) mainly through increased oxidative capacity in peripheral muscles [14]. Aerobic-type interval training improves VO2max mainly through improved cardiac function [45]. The lowest intensity for improving VO2max seems to be approximately 55 - 65% of maximal heart rate [25]. Studies confirm that training programs that involve relatively high-intensity are more effective in improving VO2max, cardiac function than moderate intensities, in healthy individuals [18, 26, 41]. Gibala et al. [15] have shown that interval training as compared with continuous training is more efficient in inducing rapid adaptations in skeletal muscles and exercise performance. Molmen-Hansen et al. [30] demonstrated that interval training could reduce blood pressure (BP) and improve heart function of hypertensive patients. In addition, several previous studies had reported that high intensity interval training could be used in both clinical practice and experiments, and that such exercise modality had greater beneficial effects on the heart [123, 45]. However, the sub-acute effects occur immediately after finishing the training, and involve chronic physiological adaptations that develop over the training period [9]. Information about heart function during low intensity aerobic interval training is limited and more studies have investigated the effects of intensive interval training.

Tjonna et al. [40] found that aerobic interval and
continuous training on average three times a week on a treadmill for 16 weeks reduced systolic and diastolic blood pressure in patients with metabolic syndrome. Ciocloc et al. [8] observed a decrease in mean 24-h systolic and diastolic blood pressure in long-term treated hypertensive patients. Sije T et al. [38] showed no significant change in SBP and DBP after 15-week high intensity interval training in overweight young women. Ricardo Fontes-Carvalho et al. [12] showed 8-weeks aerobic training after myocardial infarction did not significantly improve diastolic or systolic function parameters, although it was associated with a significant improvement in VO\textsubscript{2max}.

Despite much research, still cannot be said with certainty that aerobic interval training have a significant impact on the function of cardiovascular system. Therefore, in this study the effect of aerobic interval jogging on central hemodynamic parameters of heart in male students investigated.

Material and methods

Participants. The study was performed on 20 non-athletic male students of the Belarusian state University of physical culture (Belarus) aged from 18-20 years (interval training group IG; n=10 and control group CG; n=10), who took part in the study. Each participant gave informed consent before enrolment. The students did not have any sports category. The criterion for cardiovascular health was the data obtained from the questionnaire devised by the researcher. Before the initiation to participate in the study, the subjects were informed of the process and filled out the medical sport questionnaire and the consent form.

Training programme. Training programme was designed including a 45-minutes countryside interval jogging with 70% of the maximum heart rate (MHR), three times a week for eight weeks, 5,9 minutes with 4-minute inactive rest intervals between them. The subjects warmed up for 10 min before starting the main programme, and cooled down for 10 min after the main programme. All the training sessions were supervised by the researcher. The control group remained sedentary during the period.

Complex «Impedcard-M TU RB14563250. 017-96. made in Belarus» was used to study central hemodynamics (HR, SV, CO, SVR) with application of standard medical method of tetrapolar chest reography (impedance cardiography).

Blood pressure (BP) was measured manually using mechanical aneroid sphygmomanometer and a quality stethoscope (MD  d Calibra Professional Aneroid Sphygmomanometer and Stethoscope). Resting blood pressure (BP) was measured 3 times in the seated position. The average of the 3 readings was used for the representative examination value. The measurement was performed under controlled conditions in a quiet room. The cuff of the blood pressure monitor was placed around the upper right arm.

The heart beat while resting was measured by 60-s count, maximum heart rate was determined by the formula:

\[
HR_{\text{max}} = 220 \text{ beats/min} - \text{age.}
\]

It is a simple step-test that uses a step bench that is 40 cm high for males. Subjects exercise with a step frequency of 22.5 steps per minute under the metronome for 6 minutes. Aerobic capacity was expressed as estimated maximal oxygen consumption (VO\textsubscript{2max}), obtained using the step-test and the Astrand-Ryhming nomogram from the steady state heart rate (HR) and workload [1].

Results

General features and demographic characteristics of the participants are summarized in Table 1. Absolute values of central hemodynamic features of the participants are summarized in Table 2. After eight weeks the resting heart rate (HR) in the interval and control groups did not change significantly (P>0.05). The stroke volume (SV) increased significantly in the interval group after workload (P≤0.05). The cardiac output (CO) did not change significantly in both groups (P>0.05). The systolic blood pressure (SBP) in the interval group decreased significantly at rest and after workload (P≤0.05). The diastolic blood pressure did not change significantly in both groups (P>0.05). The systemic vascular resistance (SVR) in the interval and control groups did not change significantly (P>0.05). The maximal oxygen consumption absolute and relative (VO\textsubscript{2max} absolute, VO\textsubscript{2max} relative) increased significantly in the interval group (P≤0.05). Significant difference were observed between groups in SV, CO, VO\textsubscript{2max} absolute and VO\textsubscript{2max} relative (P≤0.05).

Discussion

In the present study, HR decreased no significantly in the interval group after 8-weeks training in rest and after workload. Meyer et al. [26] observed increase in the HR, on the other hand, Rodrigues et al. [36] showed decrease in HR after aerobic training. SV increased in rest and workload but was significantly in workload. Aerobic

### Table 1. General characteristics of the subjects

<table>
<thead>
<tr>
<th>Variables</th>
<th>Interval training</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (year)</td>
<td>18,5±0,5</td>
<td>18,2±0,2</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>175,9±5,1</td>
<td>176,2±4,5</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>69,2±6,1</td>
<td>71,8±3,84</td>
</tr>
</tbody>
</table>
exercise for a long time can affect the parasympathetic nerve, thus increasing SV and reducing the resting HR [3, 5, 35]. Increase in SV due to increases in ventricular end-diastolic volume and due to reductions in end-systolic volume [31]. CO increased in rest and workload but did not significantly. Regular training is associated with central and peripheral cardiovascular adaptations that help the generation of a large and sustained cardiac output and a large stroke volume [2, 33]. Increase in SV at workload demonstrates adaptation of cardiovascular system participants after 8-weeks interval training and increase efficiency heart function alongside a decrease in HR and stronger heart contractions leads to increase CO. After 8-weeks SV interval group was significantly higher than control group.

After 8-weeks interval training SBP significantly decreased, DBP decreased no significantly in rest and workload. Kelley GA et al. [22] reported reductions in resting systolic and diastolic blood pressure 3.3 mm Hg in normotensive, 5.4 mm Hg in borderline hypertensive, and 10.8 mm Hg in hypertensive individuals after aerobic training. Tjonna et al. [41] investigated that the intensity aerobic interval training reduces SBP and DBP in healthy men. Park et al. [32] showed significantly decrease in systolic blood pressure after aerobic exercise. On the other hand, some researchers noted no significant changes in blood pressure after aerobic exercise [17, 37]. After 8-weeks DBP interval group was significantly less than control group.

Mean arterial blood pressure increases in result of dynamic exercise, largely owing to an increase in systolic blood pressure, because diastolic blood pressure remains at near-resting levels. Increase in mean arterial pressure results from an increase in cardiac output and decrease in total peripheral resistance [9, 34]. The mechanism in which exercises have effect on blood pressure is different depending on exercise intensity, time, and exercise types, but it is known that blood pressure is decreased due to decreased activity of sympathetic nervous system and decreased peripheral resistance [7]. That confirmed with decrease in SVP at rest and after workload.

After 8-weeks interval training VO\textsubscript{2}\text{max} (absolute and relative) increased significantly in rest and workload. Gormley SE et al. [17] in study on sixty-one healthy young adult were randomly assigned to (moderate, vigorous, near-maximal-intensity) aerobic training groups, showed increase the VO\textsubscript{2}\text{max} significantly in all exercising groups by 7.2, 4.8, and 3.4 ml.min\textsuperscript{-1}.kg\textsuperscript{-1}. Mazurek K et al. [24] reported aerobic interval training resulted in a significantly greater improvement in VO\textsubscript{2}\text{max} absolute and VO\textsubscript{2}\text{max} related than in continuous aerobic training in college females. Tjonna et al. [41] showed the intensive endurance training significantly improves VO\textsubscript{2}\text{max} after 10-week of training in healthy men.

### Table 2. Absolute values of central hemodynamic features in the interval and control groups

<table>
<thead>
<tr>
<th>Variables</th>
<th>Groups</th>
<th>Interval</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR, beats.min\textsuperscript{-1}</td>
<td>Status</td>
<td>Before training</td>
<td>After 8-weeks training</td>
</tr>
<tr>
<td>Rest</td>
<td>68,2±6,5</td>
<td>66,2±3,7</td>
<td>71,3±7,5</td>
</tr>
<tr>
<td>Step-test</td>
<td>135,2±11,2</td>
<td>124,0±8,5</td>
<td>132,2±20,7</td>
</tr>
<tr>
<td>SV, ml</td>
<td>Rest</td>
<td>81,2±19,2</td>
<td>89,1±22,1\textsuperscript{,**}</td>
</tr>
<tr>
<td>Step-test</td>
<td>70,3±18,1</td>
<td>84,1±14,9\textsuperscript{'}</td>
<td>72,4±14,3</td>
</tr>
<tr>
<td>CO, l.min\textsuperscript{-1}</td>
<td>Rest</td>
<td>5,6±0,7</td>
<td>5,8±0,8</td>
</tr>
<tr>
<td>Step-test</td>
<td>9,3±1,8</td>
<td>10,5±1,4</td>
<td>9,8±1,9</td>
</tr>
<tr>
<td>SBP, mmHg</td>
<td>Rest</td>
<td>128,7±6,2</td>
<td>115,3±4,2\textsuperscript{'}</td>
</tr>
<tr>
<td>Step-test</td>
<td>158,5±14,0</td>
<td>140,3±5,9\textsuperscript{''}</td>
<td>150,0±10,0</td>
</tr>
<tr>
<td>DBP, mmHg</td>
<td>Rest</td>
<td>78,7±2,18</td>
<td>75,0±5,0</td>
</tr>
<tr>
<td>Step-test</td>
<td>76,8±8,9</td>
<td>69,8±8,1\textsuperscript{''}</td>
<td>81,6±2,9</td>
</tr>
<tr>
<td>SVR, dynes.sec.cm\textsuperscript{-5}</td>
<td>Rest</td>
<td>1056,2±109,3</td>
<td>1007,8±107,8</td>
</tr>
<tr>
<td>Step-test</td>
<td>1026,8±126,1</td>
<td>927,0±104,5</td>
<td>1065,9±120,3</td>
</tr>
<tr>
<td>VO\textsubscript{2}\text{max} absolute, l.min\textsuperscript{-1}</td>
<td>Step-test</td>
<td>4,1±0,6</td>
<td>4,7±0,5\textsuperscript{,**}</td>
</tr>
<tr>
<td>VO\textsubscript{2}\text{max} relative, ml.kg\textsuperscript{-1}.min\textsuperscript{-1}</td>
<td>Step-test</td>
<td>52,6±8,8</td>
<td>62,9±6,3\textsuperscript{,**}</td>
</tr>
</tbody>
</table>

Note: Significantly different than before training at statistical level: * in groups, ** between groups – P≤0.05
During exercise in untrained subjects oxygen consumption reach maximal values of 30–50 ml·kg⁻¹·min⁻¹. The variability of VO₂max is due to the body composition, level of training, blood volume, hemoglobin mass, stroke volume and genetic factors. With intense aerobic training, healthy men can get a VO₂max near 60 ml·kg⁻¹·min⁻¹. In elite male endurance athletes, a VO₂max in the 70–85 ml·kg⁻¹·min⁻¹ range reported [20, 43]. Previous studies indicated that aerobic interval training improves VO₂max by improving cardiac function [45]. Improvements in VO₂max in interval training resulted by the improvements in cardiac output and more specifically stroke volume [6, 19]. Trilk et al. [42] demonstrated that interval training improved cardiac function by reducing HR and increasing SV. The initial level of aerobic fitness has a significant influence on the magnitude of improvement, since sedentary individuals achieve greater positive changes compared to athletes. In our study after 8-weeks interval training VO₂max increased significantly alongside a reduction in HR and elevated SV. After 8-weeks VO₂max in interval group was significantly higher than control group.

**Conclusion**

The present study demonstrated that eight weeks aerobic interval jogging increases VO₂max and stroke volume and reduces blood pressure and systemic peripheral resistance. The author recommends comparing the effects of low-intensity and high-intensity Interval training in project to obtain more accurate results. For people with a low level of fitness, low-intensity interval training as a procedure to increase the performance of the cardiovascular system is recommended. In general, eight weeks aerobic interval jogging can cause central hemodynamics adaptation in healthy male students at rest and workload.

**Conflict of interests**

The author declares that there is no conflict of interests.

References


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Dynamic of kayak rowing technique in the process of competition activity

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Abstract

Purpose: To study the dynamic of kayak rowing technique in the process of competition activity and influence of special physical qualities on technique of athletes’ movements.

Material: in the research 17 elite athletes participated.

Results: it was found that with boat speed the values of maximal and average efforts, applied by athlete to oar; duration of efforts; the moment of torso turn start in respect to water catching and in the moment of stroke fulfillment confidently and steadily correlate. The studies showed that power of stroke plays decisive role for speed sustaining at the beginning and in the middle of distance. By the end of distance the significance of indicators, characterizing effectiveness of athletes’ movements; boat motion during strike; duration of efforts noticeably grow.

Conclusions: dynamic of rowing technique is pre-conditioned by re-constructions of system of movements at different levels of its organization and control. Constant and substantial varying of contribution of movements system’s secondary elements conditions stability and effectiveness of movements’ biomechanical characteristics and workability indicators.

Keywords: Kayak, technique of movements, bio-mechanic, power, workability.

Introduction

One of promising directions of elite training process’s intensification is usage of individualization principles in control over trainings. Individualization determines effectiveness of adaptation mechanisms usage and possibility of functional potential’s maximal realization in conditions of competition activity [18]. Sport result at elite level is conditioned by combination of numerous factors. It requires searching of individual conditions for optimization of different organism systems’ functioning with reaching extreme workability of athletes [4, 14, 27]. Competition functioning in cyclic kinds of sports is not a homogenous process. It implies solution of multiple tasks, the sum of which gives idea about final results [22, 26]. Most of scientists conventionally mark out start, distance and finish segments [1, 21, 24, 25]. Recent years experimental pre-conditions for more detail dividing of competition distance, considering specificity of a kind of sports, have been created [3, 10, 13]. The task of competition functioning structure’s optimization implies improvement of separate components’ fulfillment. Besides, it is necessary to seek the most effective variants of qualitative and quantitative interconnection of different sides of athletes’ special fitness. In this case it is necessary to consider individual features of athletes [5, 19, 28]. Effectiveness of the mentioned elements can significantly influence on final sport result [8, 16, 20].

Competition functioning of elite athletes is regarded as significant factor of pedagogic and physical impact. This factor is characterized by extreme character of conditions, in which different sides of special physical fitness are demonstrated. Besides, competition activity is an effective mean of maximal realization of athletes’ functional potentials [2, 6, 12, 17]. Optimization of control over training process implies solution of a number of theoretical and practical questions, connected with methodic means of improvement of athletes’ motor abilities’ effectiveness [7, 9, 11, 30]. Besides, working out of bio-mechanical pre-conditions of competition functioning structure’s optimization, becomes very important [15, 29].

The purpose of the work is to study the dynamic of kayak rowing technique in the process of competition activity and influence of special physical qualities on technique of athletes’ movements.

Material and methods

Participants: in the research 17 elite athletes (members of kayak rowing combined team of Ukraine) participated.

Organization of the research:

Special aspects of athletes’ movements’ coordination structure were studied in natural experiment, simulating competition functioning (500 meters’ distance). Dynamic of kinematic and dynamic characteristics was analyzed as well as bio-electrical activity of arms’, chest, back and abdomen muscles. We registered amplitude and frequency of bio-potentials’ oscillations; rhythm structure of bio-electrical activity; integrated bio-electrical activity of muscles in absolute and relative units. Besides, we calculated effectiveness and motor efficiency indicators. Besides, we determined variability of the tested motor characteristics. Control of rowing speed was realized with the help of electronic leader of speed [23].

Statistical analysis: we calculated the following: mean values of indicators and their errors (X±m); difference between mean values and confidence of these differences (t, p). Besides, we found the value of dispersion (variant around average - σ, CV). Correlations between the studied indicators were also determined (r).

The researches, in which athletes participated, were conducted in compliance with Ukrainian health
Results

The received data witness about presence of substantial changes in dynamic and character of correlations between movements’ structure indicators on competition distance. The longer segment of distance is passed the higher is the value of functional changes in athletes’ organisms. Besides, athletes’ power, motor efficiency and effectiveness of athletes’ efforts reduce. We found dependences of distance length and relative contribution of some rowing technique’s bio-mechanical characteristics in formation of resulting motor effect.

Indicators, which confidently correlate with boat speed at the beginning of distance, were also found. Specific weight of such indicators noticeably reduces with distance passing. But the role of other indicators in sustaining of workability substantially increases. When passing distance the following indicators confidently and steadily correlate with boat speed: maximal and average forces, applied by athletes to oar (r=0.87; p<0.05); Duration of efforts’ sustaining (r=0.67; p<0.05); The moment of torso turning start in respect to water catching (r=0.76; p<0.05); Speed of torso turn at the moment of water catching and in stroke fulfillment (r=0.79; p<0.05).

Indicators of confident correlations with boat speed on all distance are: power of stroke and in rowing cycle (r=0.79; p<0.05); time of force application in stroke (r=0.73; p<0.05); boat’s movement in stroke period (r=0.81; p<0.05). Our study also showed that stroke power plays decisive role for sustaining speed at the beginning and in the middle of distance. By the end of distance the role of the following indicators increases: motor effectiveness of athletes (r=0.74; p<0.05); boat’s movement during stroke (r=0.69; p<0.05); time of forces application (r=0.78; p<0.05).

There is noticeable tendency to re-distribution of muscular activity indicators in the process of distance passing by athletes. Passing of the beginning of distance is characterized by maximal usage of torso rotation’s inertia. It is ensured by activity of abdomen external oblique muscles (r=0.72; p<0.05). In the middle of distance traction component of force is realized with accent on maximal rigidity of force transmission for athlete’s torso to arms and oar (r=0.76; p<0.05). Achievement of maximal working effect (by the end of distance) is facilitated by force component, which is ensured by movements of athlete’s arms (at the account of deltoid muscles), (r=0.88; p<0.05).

For start acceleration the most significant are the following indicators: athletes’ power (r=0.66; p<0.05); speed of progressing and the value of functional changes in organism (r=0.77; p<0.05); speed of reaction to start command (r=0.87; p<0.05). When rowing on distance all main indicators of special fitness are approximately of the same importance. When passing finish segment effectiveness of applied forces and their symmetry take the first place (r=0.76; p<0.05). In the process of distance passing, there happens gradual reduction of athlete’s power. It can be conditioned by strategy of forces’ distribution or correlation of different physical levels.

Let us regard peculiarities of competition distance passing by elite athletes: 1) with speed power qualities’ prevalence; 2) with prevailing of special endurance; 3) with equal level of speed power qualities and special endurance.

For athletes of first group, indicators, which reflect power and efficiency of the fulfilled work, are more characteristic. For second group indicators of effectiveness of the applied forces and movements’ symmetry are more characteristic. In third group we registered average level of special endurance indicators. Athletes with prevailing speed-power qualities and special endurance do not significantly differ by speed of distance passing and by heart beats rate. But by other indicators of special endurance we found confident difference. Athletes with uniform levels of physical qualities differ by all registered indicators.

The lowers boat speed was registered at 250-375 meters from start. Athletes with prevalence of special endurance pass distance more evenly. In these athletes reduction of boat speed is expressed weaker. The dynamic of boat’s speed is directly connected with reconstruction of athletes’ movements’ structure [4, 9].

With it, it is necessary to note very bad compensation of weakening power of work. Only at segment of 200-300 meters from start reduction of boat’s speed is observed. But simultaneously improvement of movements’ symmetry is registered. More noticeable reconstructions in motor coordination were found in athletes, who have prevalence of special endurance. For them it is characteristic reduction of applied forces with simultaneous increase of arms movements’ asymmetry.

Thus, in passing distance we can note several distance segments. Effectiveness of these segments’ passing is connected with qualitative changes in athletes’ motor coordination. The most often such segments are 200-250 m and 400-450 meters from start.

Analysis of the received results permits to mark out a number of mistakes in motor technique. Conventionally they can be grouped by levels of athletes’ motor structure. First group includes mistakes, which appear at level of muscular coordination. Second group consists of mistakes in rhythmic and space structures of athlete’s movements. Third group implies mistakes in dynamic of forces’ application.

Results of the research showed close interconnection between mistakes, appearing at three levels. The first level includes mistakes, connected with wrong rigidity of forces’ transmission in system “athlete’s body-arms, oar –oar paddles – water”. The second level is connected with irrational usage of body mass. The third level implies biomechanical mistakes (excessive movements of athlete’s arms. The presence of mistakes in athletes’ technique is strictly individual. It was found that for one group of athletes it is characteristic the absence of mistakes at the
beginning of distance and the presence of them at the end. For other group of athletes it is characteristic irrational motor structure and technical mistakes at the beginning of distance and absence of mistakes at finish segment. The third group is characterized by the presence of mistakes during all distance.

Elite athletes have higher qualitative reconstructions in motor structure, when passing distance. For athletes with prevalence of speed power qualities it is characteristic: sharp reduction of speed by the end of 200 meters’ segment; keeping of boat’s speed at the account of effectiveness of forces’ application to oar. After passing 400 meters segment these athletes significantly improve motor symmetry. It is a compensatory mechanism with exhaustion of potentials. In this case effectiveness of forces’ application to oar is also observed.

Analysis of elite athletes’ competition functioning puts forward studying of motor functioning’s compensatory mechanisms. It permits for athlete to demonstrate higher average speed and achieve good sport result. We found the dynamic of bio-mechanical characteristics and its interconnection with physical qualities. These data witness about different contribution of special fitness components in athletes’ motor structure. In a number of cases physical qualities’ level renders de-stabilizing impact and prevents from effective motor actions. In other cases, these changes are compensatory and facilitate sustaining of working effect. Both groups of changes are interconnected. The value of this interconnection is more expressed if athletes’ qualification rises. In elite athletes the quantity and quality of compensatory changes sharply increase. It is a response to changes of de-stabilizing character.

Discussion
The received data witness that in assessment of sport movements’ technique main attention should be paid to compensatory adaptive processes [5, 7, 28]. In athletes’ training it is not necessary to orient on elimination of de-stabilizing changes in motor structure.

With rising of athletes’ qualification and fitness the role of adaptive reactions, which take place in motor structure, increases. Such reactions determine opportunities for achievement final high sport results. The level of athletes’ fitness is determined by quality of compensatory processes in his motor structure [21, 29].

Interconnections between competition activity elements and athletes’ fitness have integral character. With it, effectiveness of motor actions on start is connected with level of specialized speed-power qualities. Effectiveness of motor actions on finish is determined by level of special endurance. Balanced correlation of these qualities permits for athlete to achieve high sport result. With it, optimal motor structure in conditions of competition activity is ensured [1, 7, 15].

Conventionally, athletes can be divided into three groups according to motor structure, competition functioning and special fitness [8, 9, 30]. These groups are: athletes with prevalence of speed-power qualities; athletes with prevailing of special endurance and athletes with equal levels of speed-power qualities and special endurance. With it physical qualities and their correlation play connecting role. Correlation of physical qualities reflects in structure of special and technical fitness. In its turn it reflects in the structure of athletes’ competition activity [2].

Practical possibility of working out of motor actions’ individual model characteristics, including the most significant for the given athlete technical parameters, becomes evident. Such individualized model can be corrected in the process of change of athlete’s physical and anthropometrical parameters. Directly in passing competition distance the moments of discordance of motor structure elements are registered by bio-mechanical indicators. On the base of it the tactic of passing of different distance segments is formed.

The presented by us actual material permits to rather reasonably formulate the tendency of motor characteristics’ changes. Such characteristics depend on individual features of athletes’ adaptive reactions. It permits to mark out the complex of indicators, reflecting the following: effectiveness and efficiency of motor actions; variability and symmetry of athletes’ movements.

The presented by us system of diagnostic of athletes’ motor structure is based on specific means of integral and bio-mechanical motor characteristics’ determination. In this connection it becomes evident that it is important to work out adequate tools for measuring of athletes’ motor functioning parameters. It permits to study motor structures in natural conditions of training or competitions without any limits [21, 29].

Conclusions
The research showed that motor structure on competition distance substantially changes. Dynamic of motor coordination structure is pre-conditioned by reconstructions of movements’ system on different levels of its organization and control. With it, constant and substantial varying of contribution of movements’ system’s elements is observed. It conditions significant stability and effectiveness of integral bio-mechanical motor characteristics and workability indicators of athletes.

Conflict of interests
The author declares that there is no conflict of interest.
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SPECIAL ASPECTS OF 12-14 YRS CHILDREN’S PSYCHOLOGICAL PROTECTION

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Abstract
Purpose: to analyze special aspects of 12-14 yrs children's psychological protection's manifestations.
Material: In the research children of 12 years (n=5), 13 years (n=7) and 14 years (n=13) participated.
Results: The greatest quantity of correlations was observed between compensation and hyper-compensation with other kinds of psychological protection. It was found that projection is the most frequently used by children psychological protection mechanism. It is observed in 76.7% of children. Second place is taken by refusal (50.9%). On third place stands compensation (50%) and hyper-compensation (50%). The greatest quantity of interdependent correlations we received between compensation and other kinds of psychological protection (5 correlations) and projection (4 correlations).
Conclusions: Children's behavior can be regarded from the point of their emotional sphere, conscious and not conscious behavioral manifestations of this sphere. We give information to school psychologists about psychological everyday state of children. This information will help to understand the reason of de-adaptation or difficulties' emersion in children's life as well as permit to find appropriate means of work with problems and their correction.
Keywords: psychological protection, children, projection, compensation, rationalization, regression.

Introduction

Doctrine of psychological protection (or its mechanisms) belongs to classic psychoanalysis of 20th century. Theoretical ideas of modern researchers base on ideas of Z. Freud and A. Freud [14, 15]. The representatives of this direction regarded psychological protection as the mean of solution the conflict between conscious and unconscious [12, 13, 16, 18]. By opinion of some scientists [6, 7, 10, 19], the most constructive psychological protection kinds are compensation and rationalization. The most destructive are projection and exclusion. With it, application of constructive protections reduces the risk of conflict or its aggravation.

A number of authors [2, 13, 24, 32] studied psychological protection mechanisms of adolescents with different behavioral styles in conflict. The authors determined that leading mechanisms of psychological protection are replacement and intellectualization. It is known that adolescents are in sensitive period of their growth. They are more flexible and adaptive, depending on situation.

The psychology of youth is one of important, interesting and insufficiently studied parts of age psychology. Peculiarities of this age depend on many factors: individual and social [8, 14, 25, 30]. These distinctions are connected with reaching anatomic-physiological maturity by boys or girls; with new position in family or collective; with change of main activity type and need in solution the problem of professional self-determination [11, 15, 28, 31].

Prevalence of adolescents’ expressed mechanism of refusal witnesses that in stress situation children can deny the circumstances of conflict. Such circumstances are evident for surrounding people but are not recognized by a child [2]. D.A. Vasiuk studied such mechanism as “compensation” [2]. The author found correlations between personality’s indicators such as: “irritation”, “negativism” and “verbal aggression”. The author affirms that compensation can be regarded as one of form of protection from inferiority complex. In adolescents it can be asocial behavior or aggressive criminal actions directed against personality [2].

With growing life experience special system is formed in a person, which protects him/her from information. It violates internal balance: the system of protective psychological barriers. However, psychological protection mechanisms can be more complex by structure [3, 17, 22]. That is why it is quite relevant to study and explain personality’s changes, which take place in children for them to form personal protection strategy from inner conflicts and for their effective solution.

The purpose of the research is to analyze special aspects of 12-14 yrs children’s psychological protection’s manifestations.

Material and methods

Participants: the research was fulfilled in comprehensive secondary school №8 (Vasylkov). In the research children of 12-14 years age (n=25) participated. All parents gave written consent for their children’s participation if the research. The selected for research children formed one group.

Organization of the research: we used the questionnaire of Plutchik, Kellerman, Conte – Life Style Index, LSI methodic [5, 20, 25], which is intended for diagnostic of mechanisms of psychological protection of “Self”. The questionnaire consists of 97 questions, requiring answer “correct – not correct”. Eight kinds of protection mechanisms are registered: exclusion, refusal, substitution, compensation, reactive formations, projection, intellectualization (rationalization) and regression. From 10 to 14 questions, describing human personalities reactions in different situations, correspond.
to every of these protection mechanisms. On the base of answers the profile of protection structure of the tested is built. We calculated the quantity of positive answers by every of 8 scales, according to key. The points were transformed in percents [29, 30]. On the base of percent indicators we made the profile of EGO protections was created.

Statistical analysis: Student’s t-test was used for determination of statistically significant differences of mean values. The data were processed with the help of Statistika-6 program.

Results

The questionnaire permits to study hierarchy of psychological protection system and its general tension. Let us regard characteristics of psychological protection typologies. As a result we received the following results:

Psychological mechanism “exclusion” implies active, motivated removal of something from conscious. As a rule it is manifested in the form of motivated forgetting or ignoring. Such psychological mechanism was observed in 47% of children. Excluded (inhibited) impulses preserve their emotional and psycho-vegetative components. For example, typical situation: meaningful side of psycho-traumatizing situation is not realized. A child excludes the fact of bad action itself. But conflict still lives. The caused by it emotional tension subjectively is perceived as non motivated anxiety.

The next protection mechanism is “regression” (from Latin Regressus – backward movement). It means that child unconsciously starts practicing earlier, less mature and less adequate behavioral patterns. Child thinks that such behavior guarantees protection and safety. With such form of protection children undergo frustrating factors’ impact. Children change solution of more difficult tasks to more feasible and simple. Such mechanism was observed in 39.5% of children.

Psychological protection mechanism “substitution” (sublimation) was observed in 37% of children. It means that a child seeks for sub-conscious substitute of one, prohibited (or practically not feasible) aim by other, able to satisfy his/her actual demand even partially.

For example, it can be open hate to classmate or towards senior, stronger schoolboy, which can result in undesirable conflict. That is why the hate is transferred to other person, weaker one. In most of cases substitution causes emotional tension, appeared under influence of frustrating situation. Substitution does not lead to emotional release or to achievement of the set aim. In such situation a child can realize unexpected, often senseless actions. Such actions can weaken inner tension.

Protection mechanism “refusal” is observed, when a child throws away thoughts, wishes, feelings, demands or realities. On conscious level the child can not take them; he/she does not want to put up with reality. Such mechanism is observed in 50.9% of children. The action of this mechanism means refusal of external reality aspects, which are not perceived by personality. But for other people these aspects are evident. It means that conflict takes place in child’s consciousness, may be caused by information which threatens child’s self-preservation, self-respect or social prestige.

In this group of children the most expressed psychological protection mechanism is “projection” (76.7% of the tested). Projection implies the process, with the help of which not comprehended and not acceptable for personality feelings and thoughts are localized outside, being projected on other people. Thus, they become, so to say, secondary. Negative and asocial tint of the endured feelings and features is projected on surrounding people. It becomes an excuse of own aggressiveness or unfriendliness, manifested as if for protection.

Protection mechanism “compensation” takes third position among the tested (50%). It means “correction” of own, real or imaginable physical or psychic inferiority. Often such mechanism is combined with identification. It implies attempts to find appropriate substitute (other quality) of real or imaginable drawback; defect or unbearable feeling. The most often it is achieved by fantasizing or assignment of features, values, behavior characteristics or advantages of other personality.

In other case the next manifestation is possible – physically weak or fearful child is not able to meet the threat of violence. Then, he/she satisfies with humiliation of abuser with the help of fine mind or slyness. Such children often are dreamers, who seek their ideals in different life activities.

“Hyper-compensation” means substitution of real or imaginable psychological inferiority by high achievements in other spheres of activity.

This mechanism is observed in 50% of children. Probable manifestation of this mechanism is explained in the following way: children avoid unpleasant or not acceptable for them thoughts, feelings or actions by excessive development of opposite features.

The final psychological mechanism is “rationalization”. It implies logical explanation own thoughts, actions and feelings by a child. It permits for him/her to excuse and hide actual motives.

Such mechanism is observed in 49% of children. In conflict situation child weakens significance of reasons, which caused this conflict or psycho-traumatizing situation. ãîtrĕ̪.

In scale of intellectualization we also included sublimation. It is a mechanism of psychological protection, in which the excluded wishes and feelings are compensated by higher social values.

We received the following results: the greatest quantity of correlations was registered between compensation and other kinds of psychological protection (5 correlations, significance level p<0.05) and projection (4 correlations at p<0.05).

Psychological protection of personality acts as a system. Such protection acts according to age and other possible factors. Advantage of such kinds of protection is evident. It is observed more frequently than other kinds.
Discussion

As per the data of some authors [7, 11] among boys the leading protections are exclusion and rationalization. Such personality’s features and actions, which do not make personality more attractive in own eyes and in eyes of other people: envy, unfriendliness, ingratitude and etc., are excluded the most often [13, 23]. With rationalization personality creates logical grounds of own or other’s behavior, actions or feelings. It is caused by reasons, which the personality can not accept or he/she will loose self respect. Such kind of protection can result in evident attempts to weaken the value of not feasible experience.

As it was mentioned above, exclusion is a destructive kind of protection. It is used mainly by adolescents. In our study such mechanisms take fifth and sixth place.

In our work we proved the data about the most expressed psychological protection mechanism in 12-14 yrs children (projection). Unfortunately, some authors [7, 11, 34] think that projection is one of destructive forms of psychological protection. Its application reduces the risk of conflicts. In general examples and cases, when children attribute to other people own amoral whishes, are well known. For example: amoral actions are realized by classmates; home task is difficult because teacher insufficiently explained this exercise. Other kind of projection, when surrounding people are attributed with positive, socially good thoughts or action, is more seldom.

With the help of refusal personality refuses some frustrating circumstances or some internal impulses. It takes the second place in schoolchildren. Our data coincide with the data of other study [2]. Very often children do not want to perceive information, which they dislike. In the future they even can not recall that they met it. It is thrown away as unnecessary without any trace in mind.

Table. Kinds of psychological protection

<table>
<thead>
<tr>
<th>Kinds of psychological protection</th>
<th>Refusal</th>
<th>Exclusion</th>
<th>Regression</th>
<th>Compensation</th>
<th>Projection</th>
<th>Substitution</th>
<th>Rationalization</th>
<th>Reactive formations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refusal</td>
<td>1.00</td>
<td>0.49*</td>
<td>0.48*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exclusion</td>
<td></td>
<td>1.00</td>
<td></td>
<td>0.52*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regression</td>
<td>0.44*</td>
<td>1.00</td>
<td>0.52*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compensation</td>
<td>0.49*</td>
<td>0.52*</td>
<td>1.00</td>
<td>0.57*</td>
<td>0.66*</td>
<td>0.47*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Projection</td>
<td>0.48*</td>
<td>0.52*</td>
<td>0.57*</td>
<td>1.00</td>
<td>0.51*</td>
<td>1.00</td>
<td>0.53*</td>
<td></td>
</tr>
<tr>
<td>Substitution</td>
<td>0.66*</td>
<td>0.51*</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rationalization</td>
<td>0.47*</td>
<td>0.53*</td>
<td>1.00</td>
<td>0.57*</td>
<td>0.66*</td>
<td>0.47*</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Reactive formations</td>
<td>0.47*</td>
<td>0.53*</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: * – correlation coefficient is significant at r=0.41, with p<0.05 (with n = 25 persons).
Though, this kind of psychological protection has not been paid sufficient attention by many authors. But a number of other authors reasonably thinks [11, 33], that compensation can be regarded as a form of protection from inferiority complex. For example it concerns adolescents with asocial behavior, with aggressive and criminal actions against personality.

Mechanism of substitution implies release of heavy emotions (as a rule hostility and anger), which are directed to less dangerous or to more feasible objects. By our observations adolescents do not use this mechanism frequently (37%). But our data differ from the data of other scientists [2, 13, 21, 27]. Self-consciousness is still being formed in adolescents’ age. That is why plasticity of psych conditions different response to frustrating circumstances. Our data demonstrate variability in application of psychological protections and are the novelty in respect to the chosen contingent of children.

Conclusions

It was found that the most frequently children use psychological protection mechanism “projection”. It is observed in 76.7% of children. Second place is taken by “refusal” (50.9%); third place – by “compensation” (50%) and “hyper-compensation” (50%). Information about psychological protection and special aspects of personality are of great value. Children’s behavior can be regarded from the point of their emotional sphere, conscious and unconscious behavioral manifestations of this sphere. We give information about children’s “everyday psychological status” to school psychologists. In the nearest future such children will independently solve life and professional tasks. That is why the provided by us information can help to understand the reasons of de-adaptation of difficulties in solution of life problems. Besides, it will help to find appropriate means of work with problems and their correction.

Conflict of interests

The authors declare that there is no conflict of interests.

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Analysis of adaptation potentials of kick boxers’ cardio-vascular system

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2Kharkov National Medical University, Kharkov, Ukraine

Abstract

Purpose: Analysis and assessment of athletes’ adaptation potential are important components of effective selection and prediction of sports successfulness. Purpose: study and analysis of kick boxers’ cardio-vascular system’s adaptation potentials under standard physical load and in recreation.

Material: in the research kick boxers (n=17, students) participated. The athletes were divided into 2 groups, depending on reaction to physical load: 1st group – athletes with normotonic type of reaction (n=9, age 17.56±0.80 years); 2nd group – athletes with reaction different from normotonic (n=8, age 18.25±0.88 years). Indicators of cardio-vascular reaction type and tolerance to physical load were found with the help of PWC170 test.

Results: we confirmed similarity of kick boxers’ reaction to physical load. After 1st stage of physical load heart beats rate was noticeably lower in the 1st group. After 2nd stage of load systolic blood pressure was lower in the 1st group. After load, in the 1st group heart beats rate and systolic BP restored quicker. Reduction of heart beats rate under load in 1st group can serve as a proof of better adaptation mechanisms.

Conclusions: training of athletes with periodic control of electric cardiogram under physical loads permits to assess functional state of cardio-vascular system; its adaptation and correspondence to definite physical loads. Such approach permits not to admit progressing of cardio-vascular system’s pathological state.

Keywords: kick boxing, cardio-vascular system, adaptation, students, physical load.

Introduction

Analysis and assessment of athletes’ adaptation potential are important components of effective selection and prediction of their sport successfulness. Durkalec-Michalski et al. [1] confirmed that aerobic potentials of martial arts athletes’ are connected with specific weight of somatic type components. It conditions significant influence of these abilities on bio-chemical adaptation and tolerance to physical loads.

Correlation between physiological and physical profiles of young wrestlers was confirmed by Jafari et al. [2]. They offered to use physiological indicators for selection of athletes and determination of their prospects. Similar data were received by Mirzaei et al. [3]. The authors found dependence between aerobic power, somatic type components and trainability of wrestlers.

Podrigalo L.V. et al. [4] studied correlations of morphological functional indicators of martial arts athletes and their influence on sportmanship. These correlations were higher in athletes with higher sportmanship. Korobeynikov G.V. et al. [5] found interconnections between high workability and successfulness in sport dances. They proved that mobilization of junior athletes’ organism’s adaptation resources is followed by growth of sympathetic adrenaline system’s activation.

Bakhareva A.S. et al. [6] studied adaptation aspects of ski racers. Metabolic changes of athletes’ organisms at optimal level result in working muscles’ energy supply improvement; in increase of energetic systems’ power and efficiency.

Podrigalo L.V. and Volodchenko A.A. [7] fulfilled comparative analysis of bio-mechanical characteristics of different martial kinds’ athletes. They found influence of specificity of kind of sports on athletes’ functional state, which permitted to raise their adaptation potentials.

Pryshva O.B. [8] confirmed that determination of athletes’ adaptation potential and its dynamic shall be considered in trainings’ planning and assessment of training effectiveness. The similar results were received also in other works [9, 10]. These authors note demand in optimization of physical loads for increasing training effectiveness.

It is known that cardio-vascular system is and indicators of adaptation potentials. That is why study of its reaction to loads shall be regarded as a relevant task of sport science. Allen Mark S. et al. [11] confirmed importance of cardio-vascular system’s state as illustration of athletes’ tolerance to loads. The study of its parameters can be used for prediction. The same results were received in other works [12, 13].

Kotenko K.V. et al. [14] note that all kinds of functional testing in sports are based on analysis of cardio-respiratory system’s indicators obtained under significant physical loads.

Pankova N.B. et al. [15] carried out monitoring of cardio-vascular system’s reserves in junior figure skaters. They showed that in functional state monitoring analysis of indicators’ changes under sub-maximal physical loads, is the most informative.

Perkhurov A.M. [16] notes the presence of correlation between cardiologic control data and athletes’ sport efficiency in cyclic kinds of sports. The offered by the author functional index of ECG permits to improve prediction of athletes’ competition functioning.

Thus, the available literature data confirm importance
of cardio-vascular system’s study for analysis of martial arts athletes’ adaptation potential. Knowledge of mechanisms of development and main properties of physiological sport heart permits to assess functional state of cardio-vascular system, to monitor its state in training process. Correct and rational practicing of physical exercises, considering sportsman’s fitness and kind of sports results in positive changes in cardio-vascular system. It happens at the account of economizing of its work and increase of adaptation potential.

The purpose of the present research was study and analysis of kick boxers’ cardio-vascular system’s adaptation potentials under standard physical load and in recreation.

Material and methods

Participants: in the research kick boxers (n=17, students) participated. The athletes were divided into 2 groups, depending on reaction to physical load: 1st group – athletes with normotonic type of reaction (n=9, age17.56±0.80 years); 2nd group – athletes with reaction different from normotonic (n=8, age 18.25±0.88 years).

Design of the research: the research was conducted on the base of Kharkov State Academy of Physical Culture. Indicators of cardio-vascular reaction type and tolerance to physical load were found with the help of PWC170 test. The test was fulfilled on «Kettler» bike ergo meter. We used computer system CardiolabSens (production of “KhAI-Medica”, Kharkov) with continuous recording of electric cardiogram (ECG). On ergo meter athletes fulfilled two loads. The power of first was 100 W/min and the second - 150 W/min. Every work lasted 3 minutes. Speed of pedals’ rotation on ergo meter was 60 rotations per minute. At third minute of every stage of work we registered heart beats rate (HBR) for last 30 seconds. After every minute of rest (during three minutes) we registered HBR. BP was found at the end of load. After every minute of rest (during three minutes) we registered HBR for last 30 seconds. After every minute of rest (during three minutes) we registered HBR. BP was found at the end of load.

Results

The volume of the fulfilled work under first load was (2346.00±161.28) kg/m in first group and (2409.75±167.98) kg/m in second. Difference is insignificant (p>0.05). After second load results were: (3111.00±148.69) kg/m and (3155.63±236.56) kg/m. Difference was also insignificant (p>0.05).

Results of HBR, systolic BP (SBP) and diastolic BP (DBP) are dynamically presented in table 1.

The data of table 1 confirm the similarity of athletes’ reaction to load. It is also illustrated by the fact that there are no significant differences between most of the studied indicators.

But still, some differences between groups were found. For example Student’s t-test confirmed confidently less HBR indicators at 1st stage of loads in athletes with normotonic type of reaction (t=2.07, p<0.05). On 2nd stage of load indicators of systolic blood pressure (SBP) were confidently lower in 2nd group (t=2.27, p<0.05). Non parametrical criteria also confirmed some differences between groups. For example, initial DBP in 1st group was much lower (U=14, p<0.05).

After 1st stage of load HBR indicators were significantly lower in 1st group (U=17, p<0.05). After 2nd stage of load systolic blood pressure (SBP) was lower in first group (U=19, p<0.05). DBP indicators in 1st group were higher (U=12, p<0.05; r=5, p<0.05).

Some differences were found also in dynamic of recreation. In last minute of relaxation SBP was lower in

Table 1. Dynamic of cardio-vascular system’s indicators of kick boxers under load and in recreation

<table>
<thead>
<tr>
<th></th>
<th>1 group</th>
<th>2 group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HBR, min⁻¹</td>
<td>SBP, mm merc.col.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before load</td>
<td></td>
<td>80.67</td>
</tr>
<tr>
<td>±3.24</td>
<td>±3.63</td>
<td>±2.82</td>
</tr>
<tr>
<td>1 stage</td>
<td>131.44</td>
<td>128.33</td>
</tr>
<tr>
<td>±3.50</td>
<td>±5.40</td>
<td>±3.33</td>
</tr>
<tr>
<td>2 stage</td>
<td>171.33</td>
<td>148.89</td>
</tr>
<tr>
<td>±9.88</td>
<td>±4.84</td>
<td>±8.84</td>
</tr>
<tr>
<td>1 minute</td>
<td>113.11</td>
<td>128.33</td>
</tr>
<tr>
<td>±4.02</td>
<td>±3.54</td>
<td>±3.51</td>
</tr>
<tr>
<td>2 minute</td>
<td>103.75</td>
<td>120.63</td>
</tr>
<tr>
<td>±3.61</td>
<td>±5.55</td>
<td>±3.78</td>
</tr>
<tr>
<td>3 minute</td>
<td>97.38</td>
<td>108.88</td>
</tr>
<tr>
<td>±2.18</td>
<td>±3.90</td>
<td>±1.64</td>
</tr>
</tbody>
</table>

Note: 1 – difference from group 2 is confident (p<0.05). 2 – difference from previous stage is confident (p<0.05). 3 – difference from initial level is confident (p<0.05).
1st group (U=4, p<0.05), as well as DBP indicators (U=2, p<0.05).

It was interesting to observe over dynamic of the studied indicators in each group separately. The 1st stage of load in first group was characterized by noticeable increase of HBR and SBP indicators. In 2nd group first stage of load was characterized by increase of HBR and reduction of SBP. In 1st group increase of load power resulted in still higher increment of HBR and SBP indicators. There were substantial differences between them and initial level as well as previous stage of load (p<0.05). In group 2 all three indicators rather differed from initial level. Comparison with previous stage of load revealed noticeable tachycardia.

The first minute of all athletes’ rest was characterized by significant dynamic of indicators. In 1st group it was found: reductions of HBR and SBP in respect to the previous stage; preservation of increased indicators in respect to initial level. In 2nd group HBR and SBS indicators reduced. SBS indicator increased in respect to the previous stage. In respect to initial level HBR was noticeably higher, while DBP - lower (p<0.05). The second minute of relaxation proved the found tendency in indicators’ dynamic in group 1: BP indicators stabilized, HBR indicators were significantly higher in comparison with initial level. In group 2 indicators did not noticeably differ from the values in first minute of relaxation. Comparatively with initial level we confirmed substantial increase of HBR and reduction of SBP.

Finalizing stage of recreation also had its peculiarities. In group 1 SBP practically returned to initial level. DBP was significantly lower than indicators before load and HBR indicators remained to be increased.

In group 2 BP indicators did not differ from initial data and the data of previous stage.

According to commonly accepted approaches ECG analysis was fulfilled by the value of intervals (see table 2).

Applying Student’s t-test did not confirm substantial differences between groups. That is why we used non-parametrical test of Wilcoxon-Manna-Whitney. With its help we found definite differences between groups. Interval QRS in group 1 after load of 2nd stage was less (U=20, p<0.05). In first minute of recreation interval PQ in the same group was less (U=13, p<0.05). In the last minute of recreation in group 1 interval P was less (U=4, p<0.05) as well as interval PQ (U=4, p<0.05).

We proved substantial ECG intervals’ differences between groups in dynamic of load and recreation. In group 1 substantial changes of interval QT by Student’s t-test. Both load stages were characterized by its contraction in respect to initial level (accordingly, t=3.57 and t=3.73, p<0.05). The same changes were found in first and third minutes of relaxation (accordingly, t=3.03 and t=2.05, p<0.05). In second minute of relaxation higher error did not permit to confirm differences by Student’s criterion. However, criterion of Wilcoxon – Manna-Whitney witnessed about less interval (U=9, p<0.05).

In group 2 the first load resulted in significant reduction of interval (t=4.91, p<0.05). Under second load intervals PQ (t=2.97, p<0.05) and QT (t=5.51, p<0.05) reduced with simultaneous increase of QRS complex (t=2.10, p<0.05). The first minute of relaxation resulted in opposite dynamic of the mentioned intervals. In second minute of relaxation this tendency remained: interval QT was still less than initial. By the end of the last minute of relaxation in group 2 there were no significant differences between ECG intervals and initial levels and previous stage.

Results of ECG teeth analysis are presented in table 3. Analysis of differences between groups was fulfilled with the help of parametric and non parametric criteria. We found that in group 1 before load tooth R was higher (U=16, p<0.05).

After first stage of load in group 1 tooth Q (U=16, p<0.05) and tooth R (U=14, p<0.05) amplitudes were different from initial level as well as previous stage of load (p<0.05).

<table>
<thead>
<tr>
<th>Table 2. Electric cardio gram’s intervals of kick boxers under load and in recreation (msec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 group</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Before load</td>
</tr>
<tr>
<td>1 stage</td>
</tr>
<tr>
<td>2 stage</td>
</tr>
<tr>
<td>1 minute</td>
</tr>
<tr>
<td>2 minute</td>
</tr>
<tr>
<td>3 minute</td>
</tr>
</tbody>
</table>

Note: 1 — difference from previous stage is confident (p<0.05). 3 — difference from initial level is confident (p<0.05).
higher. After 2nd stage of load we did not find significant differences between teeth values in different groups.

Recreation period was also characterized by differences between groups. After 1st minute of relaxation in group 1 tooth P (r=4, p<0.05) and tooth R (U=9, p<0.05) were higher.

Further, this tendency remained. It was proved by parametric and non parametric criteria. Tooth R was higher in group 1 after 2nd stage of group of rest (U=5, p<0.05, t=2.23, p<0.05). The same result was also after 3rd minute of rest (U=3, p<0.05, t=2.01, p<0.05).

### Discussion

In scientific researches rather widely the following methodological scheme is used: division of participants, depending on sportmanship or type of cardio-vascular system’s reaction to load. Iakimova E.A. [17] studied interconnection of cardio-vascular system’s functional state and physical workability of athletes with different level of workability.

Analysis of morphological functional indicators of arm wrestling athletes of different sportmanship permitted to substantiate and work our methodic of successfullness prediction in this kind of sports [18, 19].

Choice of cardio-vascular system as the object of study was conditioned by its role in ensuring athletes’ adaptation potential and rather high load on it in training and competition processes. Cantero Ivo et al. [20] assessed dynamic of muay tai athletes’ physiological parameters during competitions. High load on cardio-vascular system was found independent on results of duels.

Ozemek Cemal et al. [21] used results of tests for load assessment of this system’s state. They confirmed possibility to predict health condition by HBR indicators.

The used methodic scheme of the research permits to assess tolerance to loads and specificities of recreation in athletes. The same results were received by Kiprych S.V. [22]. This author studied reaction to load of boxers’ cardio-vascular systems. It was noted that combined assessment of heart rhythm and breathing permits to assess the following: functional ensuring of workability, degree of functions’ mobilization in training process; activation of recreation in after-load period.

The absence of significance differences between values of work in testing permits to regard athletes’ state as similar. The found differences between cardio-vascular system’s indicators are resulted from the applied design of the researches. Division of participants by character of reaction to physical load implies assessment of just these parameters’ dynamic.

Analogous results were received in other kinds of sports. Zunzer Stefan C. et al. [23] used cardio-vascular parameters for estimation of loads and energy losses in golf. They proved informative value of HBR monitoring and calculation of metabolic equivalents for assessment of athletes’ functional state.

Fernandez-Villarino Maria A. et al. [24] used cardio-vascular parameters for assessments of adaptation to loads and successfullness prognostication in calisthenics. They confirmed connection between HBR and successfullness of performances.

Confidence of differences by HBR indicators on all stages of the research in both groups confirms sufficient athletes’ adaptation to physical load. It helps to prevent from pre-nosological health disorders. The registered HBR reduction under load in 1st group athletes can be a proof of higher adaptation mechanisms’ level.

Specificities of martial arts pre conditioned peculiarities of all athletes’ reaction to loads. 1st group athletes, mainly, react to load by changing of SBP parameters. In group 2 this parameter noticeably changed only on 2nd stage of load. More noticeably DBP parameters changed. In our opinion it reflects unfavorable reaction to loads of cyclic kinds of sports athletes (athletes, who do not train specially for this purpose).

Indicators’ changes in recreation period confirm the
made assumptions. In group 1 BP parameters restored quicker than in group 2. It was confirmed by parametric and non parametric criteria. It permits to speak about quicker stabilization of indicators in athletes with normotonic type of reaction to load.

The received results still more confirm importance of HBR and BP control in athletes. They permit to recommend them for functional state monitoring.

Application of ECG methods in sports is also widely spread. Zemcovskij E.V. [25] analyze ECG in athletes of cyclic kinds of sports. For not cyclic kinds of sports there are much less results. Assessment of any ECG changes only by indicators, registered in state of rest, is insufficient for determination of myocardium functional state. That is why it is possible to judge about myocardium adaptation to physical load only basing on ECG, recorded just in the process of loading.

Lord Rachel et al. [26] used ECG method for estimation of super marathon runners’ state. After passing distance the most informative were changes of teeth P and R, as well as segment ST. The received results are interpreted as illustration of adaptation to load of right half of heart.

Wegmann M. et al. [27] used ECG method for estimation of risks of cardio-vascular system’s disorders in football players-veterans. They confirmed effectiveness and informative value of this method in monitoring of athletes’ functional state.

The found ECG differences are one more proof of better myocardium state in 1st group athletes. Reduced value of ECG main intervals shall be regarded as witness of better myocardium tonus of athletes with normotonic type of reaction to load.

The registered shortening of QRS intervals after 2nd stage of load reflects the process of ventricles’ depolarization.

Less value of PQ interval in recreation period in 1st group can be assessed in two ways. On the one hand it confirms the absence of atrium-ventricular conductivity. Besides, it can be regarded as better adaptation of 1st group athletes’ to loads.

Less value of P interval at the end of recreation period shall be interpreted as witness of normalization of atrium activity, excitation of which is reflected by this period of ECG.

Shortening of ventricular systole in 1st group is illustrated by reduction of QT interval. In our opinion it reflects higher power of myocardium in this group athletes and possibility of more efficient adaptation to loads. Dynamic of this interval in recreation period also testifies in favor of this assumption.

In group 2 first load also resulted in shortening of ventricular systole. It permits to consider it feasible for athletes. Further increase of load caused significant changes of ECG. Besides shortening of ventricular systole, the time of atrium excitation (increase of QRS complex) also happened. It permits to consider the load to be more expressed; to assume transition from adaptation changes to adaptation-compensatory mechanisms.

Absence of expressed ECG changes witnesses about state of adaptation to physical loads. The same results were received in other works. For example Kazuto Omiya et al. [28] studied dynamic and dispersion of QT intervals in athletes of different kinds of sports and in people – not sportsmen. No statistically significant differences were found between men and women. Duration of QT interval in martial arts representatives (Judo, fencing) was comparable with results, given in table 2.

Kakhabrishvili Z. et al. [29] studied influence of durable intensive physical loads on cardio-vascular system of elite wrestlers and football players. ECG parameters proved the presence of left ventricular hypertrophy. These indicators correlated with physiological parameters, which reflect tolerance to loads.

Rising of teeth’s P, R and Q voltage in group 1 under load and in recreation period confirms ventricular hypertrophy. It is a proof of 1st group athletes’ better adaptation to physical loads. The received results in general coincide with other data [25] about ECG in athletes. The author underlines that characteristic features has athletes’ cardiogram in trainings for endurance. In non cyclic kinds of sports these properties are less expressed and conditioned by organization of training process.

**Conclusions**

The conducted research found certain differences between adaptation potentials of kick boxers’ cardio-vascular system under standard physical load and in recreation period. We confirmed similarity of reaction to athletes’ physical load. Confidentiality of HBR indicators differences on all stages of researches in both groups proves sufficient adaptation potential of athletes. The registered reduction HBR under load in 1st group proves better adaptation mechanisms. Reaction of participants to load reflect specific of martial arts. In recreation period, in group 1 VP parameters recreated quicker than in group 2. It reflects better functional state of these athletes.

The found ECG differences under load and in recreation period also prove better state of 1st group athletes’ myocardium. They characterize greater power of myocardium power in this group, possibility of more efficient adaptation to loads. High potential of adaptation mechanisms and functional state of physiological sport heart shall be regarded as long-term adaptation reaction. Trainings of kick boxers with periodic ECG control under loads permits to assess the following: functional state of cardio-vascular system; its adaptation and correspondence to certain physical loads. It permits not to admit pathologies in cardio-vascular system.

**Conflict of interests**

The authors declare that there is no conflict of interests.
References


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Somatologic characteristics of biathlon students’ body constitution in predicting of their successfulness

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Abstract
Purpose: determination of somatologic characteristics of biathlon students' body constitution in predicting of their successfulness.

Material: in the research the following students participated (n=27, age 19–21 years, boys n=17, girls n=10). Quetelet’s, Erisman’s and Piniet’s anthropometric indices were calculated as well as life index.

Results: the greatest distinctions between boys and girls were observed by the following absolute indicators: body, trunk and torso lengths; body mass. The least distinctions were by the length of upper and lower limbs, which prevail in boys. In girls we observed noticeable realization of diaphragm breathing. It permits to increase alveolar surface at the cost of lungs' stretching in longitudinal direction. With it, there was no visible change of chest excursion. Relatively high level of women's physical fitness conditions asthenia (dolymorphia). It results in approximation of girls' chest shape to men's. In boys formation of somatic type is realized at the cost of chest circumferential sizes but directly depends on the strength of hands' and back's muscles.

Conclusions: for some sport-pedagogic activities (in our case – biathlon) certain type of body constitution is intrinsic, which conditions successfulness of professional program realization. Somatic type characterizes compliance and correlation of separated body links. These criteria permit to reduce costly part of future specialist’s training and achieve high results in professional activity.

Keywords: somatology, somatic type, body constitution, body proportions, biathlon.

Introduction
Sport-pedagogic perfection is a necessary component, ensuring training of full fledged specialist. The uniqueness of this process implies applied character of tasks, which shall be solved by physical culture specialist in all kinds of his/her activity. It is an essential component of biathlon student’s, as elite sportman, practical activity [13, 16]. Professionalism of specialist depends on complex of factors, which condition the forms and content of his/her future sport-pedagogic activity. One of factors of such activity’s successfulness is sport qualification, as determining factor of high sportsmanship, education and perfection. It will permit for a specialist to use wide spectrum of means, methods and forms. With it, somatologic characteristics of body type are decisive for achievement of high sport results and success in sport-pedagogic activity.

Retrospective analysis of the studied problem points at diverse approach to its studying. It is determination of correlations between somatic type components and their influence on the type of body constitution. It conditions achievement of high sport result and determines success in sport pedagogic activity in groups of appropriate specialization.

Scientists define the type of body constitution in compliance with sport specialization. But they do not regard the degree of correlations between somatic type components and their influence on success in professional activity, for example, when studying correlations between skiers’ morphological parameters and sport results in sprint. Actually scientists regard athletes’ successfulness in definite kind of program. They point at high level of correlations between physical condition indices, flexors/
Consideration of students’ individual features [20, 21];
Finding of vertical jump’s correlations with anthropometric sizes of athletes’ bodies. Knowledge of these factors can help in identifying of talents and/or optimization of athletes’ training [19];
Improvement of physical training program for motorsport athletes. The authors found influence of main physiological parameters on predictors of motor-racing athletes’ success at elite level [22];
Finding of correlation between anthropometric profile and athletes’ maximal strength in power-lifting. These results also support the opinion that power-lifters have unique anthropometric parameters. More successful power-lifters have greater muscular mass in respect to unit of height and/or bone mass [31];
Study of detail anthropometric characteristics of elite female volleyball players. The authors found correlations between biomechanical parameters of lower limb power and jump height. These data were supplemented by anthropometric indicators of volleyball players’ bodies. This knowledge permits for coaches to individualize and determine appropriate methods of training depending on somatic bent of female volleyball players [33];
Analysis of body posture and constitution of martial arts athletes. The authors tried to create “model of champion”, whose parameters determine efficiency in Thae-quan do. The authors note that sport potential and chances for success can be found on the base of athlete’s posture and somatic type [28, 36]. Such approach permits to find the following criteria: talent for martial arts and self defense [29]; prediction of sport level at stages of Judo training [27];
Proper distribution of training means and load. The author notes that it is necessary to uniformly distribute and dose correlation of means with all indicators of general and special physical training. It will ensure rising of athlete’s sport results [23].
Of not less importance is solution of problems of students’ health improvement, including body constitution components. It can be facilitated by proper pedagogic control over health indicators. In this contest we can mention the works, which permit:
- Optimize health components in compliance with requirements of future professional activity [37];
- Find directions of students’ health improvement [32, 38, 39];
- Organize proper pedagogic control over motor indicators and somatic type components [24, 30];

In literature there are nearly no data about correlation of biathlon sportsmen’s body constitution components in respect to their type in sex-age aspect, which ensure success in professional activity. It conditions the relevance of such scientific research. Such principles envisage creation of anthropometric model characteristics of students – members of sport-pedagogic perfection groups. All these reflect the specificity of future physical culture, sports and health specialists’ professional activity.

The purpose of the research is determination of somatologic characteristics of biathlon students’ body constitution in predicting of their successfullness.

Material and methods
Material: in the research the following students participated (n=27, age19–21 years, boys n=17, girls n=10), who attend group of biathlon sport-pedagogic perfection. All students are members of National combined teams of Ukraine and Chernigov region. All they are elite athletes.

Organization of the research: total sizes of athletes’ bodies were studied by standard methodic of indicators’ registration: length of body and separate segments (torso, trunk, upper and lower limbs); body mass; chest circumference (CC) in rest, inhale and exhale; vital capacity of lungs (VCL); strength of hands and back muscles [2, 7, 14, 17]. Body length was measured with height meter. Other lengths were measured with the help of anthropometrical meter. The athlete’s initial position was upright standing on floor. In projection value (the shortest distance between anthropometrical points) we registered the position of skeletal points in respect to the floor [6, 9].

With the help of empiric equations we calculated anthropometrical indices of Quetelet, Erisman, Piniet and life index (as relation of vital capacity of lungs to body mass, ml/kg-1). Besides, we calculated relation of back and hands strength to body mass (% [14].

Statistical analysis: statistical processing of the received data was fulfilled with the help of Microsoft Office Excel program [8]. For quantitative measurements we used such statistical characteristics as: mean arithmetic (М); standard error of mean arithmetic (m). Confidence of differences was estimated with Student’s t-test for independent samples and U-test of Mann-Whitney (level of statistical significance α = 0.05). When interpreting inter-correlations’ matrixes we considered confident coefficients with diagnostic (r ≥ 0.3) and prognostic (r ≥ 0.7) value.

Results
Analysis of students’ anthropometric status showed that there are no confident dependences of the studied components on qualification and insignificant correlation (p≤0.05) with training experience. Samples are rather homogenous and reflect inter sex distinctions within one specialization. The greatest differences between boys and girls were by absolute indicators of body, trunk, torso length and body mass. These indicators vary within 6.87 – 11.89%; the least are by the length of upper and lower limbs (5.00 – 5.14%) with prevailing such characteristics in boys (see table 1).

With it VCL indicator differs to the largest extent and is 27.19%. There are insignificant distinctions of CC in relative rest (at inhale and exhale – 2.83 – 3.09%) and chest excursion (0.57%) (see table 1). It is quite logical that CC can not be the criterion for comparison in sex aspect. More confident and expressive is indicator of chest excursion, reflecting individual’s breathing function. This indicator
characterizes morphological-structural condition of chest, its mobility and breathing type. Chest excursion depends on its shape and girdle muscles’ condition. It is restricted by weakness of breathing muscles [5].

Insignificant distinction of this characteristic in boys and girls points at similarity of their chests and somatic type. It characterizes kind of sport-pedagogic activity, realized in aerobic conditions. With it, there is no necessity in high mobilization of forced breathing movements, which are intrinsic to power and speed-power kinds of sport functioning. It is quite clear that cyclic exercises form better rhythm of organism systems’ functioning. It implies breathing movements in combination with muscular efforts of upper and lower limbs. It is aerobic type of energy supply. Its purpose is; maximally quick elimination of oxygen debt, when fulfilling specific physical exercises; regulation of breathing movements on firing line (pointing and shooting). All these require athlete’s maximal control over breathing movements.

It is interesting that boys’ VCL differs significantly (27.19%) from girls’. Boys have advantage. There is insignificant difference in correlation of body area to its mass (0.88%) (see table 1). It can witness about better diaphragm breathing of girls.

We confirmed that girls have less weight-height index by Quetelet (by 5.21%) with relatively higher index of chest proportionality by Erisman (by 61.29%) (see table 2).

Boys have greater values of hands’ and back’s relative strength (19.43% and 16.20% accordingly) that characterizes specificities of physical condition. Boys’ body area significantly exceeds the girls’ one (10.93%) with insignificant (0.88%) body mass. It witnesses about similarity of biathlon boys’ and girls’ body composition.

By Piniet’s index boys and girls have similar values (19.30 – 17.91 conv.un.) Both boys and girls have normosthenic type of body constitution (mesomorphia) [6]. But, with it, girls have higher proportionality coefficient (by 4.95%). It can point at higher location of body center, comparing with boys. It is proved by the data of correlation of lower limbs’ length with body, trunk and torso lengths, i.e. girls’ lower limbs are longer in this

Table 1. Somatologic indicators of students – members of biathlon sport-pedagogic perfection group

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Boys (M±m)</th>
<th>Girls (M±m)</th>
<th>Δ,%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (months)</td>
<td>231,24±21,16</td>
<td>223,10±14,48</td>
<td>-3,52</td>
</tr>
<tr>
<td>Body area, m²</td>
<td>1,83±0.09</td>
<td>1,63±0.04</td>
<td>-10,93</td>
</tr>
<tr>
<td>Body length, cm</td>
<td>176,64±4,88</td>
<td>164,50±3,30</td>
<td>-6,87</td>
</tr>
<tr>
<td>Trunk length, cm</td>
<td>84,50±2,51</td>
<td>77,04±4,00</td>
<td>-8,83</td>
</tr>
<tr>
<td>Torso length, cm</td>
<td>59,26±2,68</td>
<td>55,12±1,16</td>
<td>-6,99</td>
</tr>
<tr>
<td>Body mass, kg</td>
<td>66,84±4,70</td>
<td>58,89±1,95</td>
<td>-11,89</td>
</tr>
<tr>
<td>Lower limb’s length, cm</td>
<td>88,43±3,89</td>
<td>84,01±3,86</td>
<td>-5,00</td>
</tr>
<tr>
<td>Upper limb’s length, cm</td>
<td>73,00±3,47</td>
<td>69,25±3,70</td>
<td>-5,14</td>
</tr>
<tr>
<td>Maximal force of hand F&lt;sub&gt;max&lt;/sub&gt; (k), kg</td>
<td>46,65±4,57</td>
<td>33,10±4,70</td>
<td>-29,05</td>
</tr>
<tr>
<td>Maximal force of back F&lt;sub&gt;max&lt;/sub&gt; (k), kg</td>
<td>123,82±12,56</td>
<td>91,50±13,10</td>
<td>-26,10</td>
</tr>
<tr>
<td>VCL, ml</td>
<td>4623,24±600,69</td>
<td>3366,00±323,20</td>
<td>-27,19</td>
</tr>
<tr>
<td>In relative rest, cm</td>
<td>93,59±3,73</td>
<td>90,75±3,35</td>
<td>-3,03</td>
</tr>
<tr>
<td>At maximal inhale, cm</td>
<td>97,56±3,42</td>
<td>94,80±3,46</td>
<td>-2,83</td>
</tr>
<tr>
<td>At maximal exhale, cm</td>
<td>90,50±3,18</td>
<td>87,70±3,50</td>
<td>-3,09</td>
</tr>
<tr>
<td>Chest excursion, cm</td>
<td>m7,06±1,78</td>
<td>7,10±1,50</td>
<td>0,57</td>
</tr>
<tr>
<td>Body mass/body area, kg·m⁻²</td>
<td>36,37±1,06</td>
<td>36,05±1,27</td>
<td>-0,88</td>
</tr>
<tr>
<td>Upper limb’s length/Lower limb’s length, %</td>
<td>82,63±3,12</td>
<td>82,86±5,30</td>
<td>0,28</td>
</tr>
<tr>
<td>Upper limb’s length/torso length, %</td>
<td>123,42±5,56</td>
<td>125,85±8,03</td>
<td>1,97</td>
</tr>
<tr>
<td>Lower limb’s length/torso length, %</td>
<td>149,64±7,62</td>
<td>152,59±8,75</td>
<td>1,97</td>
</tr>
<tr>
<td>Lower limb’s length/body length, %</td>
<td>50,05±1,42</td>
<td>51,05±2,04</td>
<td>2,00</td>
</tr>
<tr>
<td>Upper limb’s length/torso length, %</td>
<td>41,32±1,54</td>
<td>42,10±1,89</td>
<td>1,89</td>
</tr>
<tr>
<td>Lower limb’s length/trunk length, %</td>
<td>74,33±1,68</td>
<td>75,73±1,43</td>
<td>1,88</td>
</tr>
</tbody>
</table>
correlation. Alongside with it, wide chest is characteristic for girls’ body constitution. It can be a compensating factor, which neutralizes higher body center by wider chest.

Analysis of somatologic indices’ correlations with some indicators shows certain regularities of correlations of physical condition’s components. It is quite logical that with one and the same bone mass Quetelet’s index can vary at only at the accounts of greater/less mass of fat or muscular tissue. Muscular tissue is relatively “heavier” per unit of area in contrast to fat tissue. We can affirm that in sportsmen bigger/less values of index point at bigger/less level of muscular development. Higher values of index (by 5.21%) can witness about greater muscular mass in boys. This conclusion is confirmed by calculation of indices, which reflect relative strength of back and hands’ muscles. By these indices boys exceed girls by results of dead lift and hand dynamometry (accordingly by 16.20% and 19.43%) (see table 2).

### Discussion

Training of future physical education specialist is a multi-profile, specially organized process. It is facilitated by student’s sport-pedagogic perfection. Student-biathlonist shall: develop and improve special physical and psychic qualities; master certain motor skills, specific for this kind of sport-pedagogic activity. Besides, there appear the problems, connected with students’ individual features. All these shall be considered in planning and realizing training in groups of sport-pedagogic perfection [9, 20, 21]. For certain kind of sport-pedagogic activity (in our case – biathlon) definite type of body constitution is intrinsic, which conditions successfullness of professional program realization. Somatic type characterizes conformity and correlation of separate body segments. These criteria permit to reduce costly part of future specialist’s training and achieve high results in professional activity. Such affirmation is extremely relevant in applied skiing – biathlon. Biathlon combines high level of physical potentials and skills with static-dynamic function. This function is realized in shooting on firing lines, sport orientation and sport selection. Specific characteristics of posture are one of indicators, which influence on achievements in competition activities. That is why mainly athletes, who have morphological bent to definite kind of sports, win competitions [10, 27, 33]. Anthropometrical indicators, somatic type and body proportions permit to determine athlete’s sport suitability and prospects even at initial stages of many years’ training.

Distinctions in formation boys’ and girls’ Quetelet’s index mean diverse influence of somatic-metric indicators: in boys index value is influenced by body mass and length in direct proportion; in girls there is significant correlation of body mass and CC (see fig. 1). The mentioned confirms the assumption about wide chest of girls and points at prevailing of their chest circumferential sizes over cross sizes, combined with high location of body center. This index is directly connected with chest circumference (CC in different position of measurements) and hand dynamometry as well as VCL. It witnesses about location of powerful muscular groups in upper part of boys’ torsos. It conditions significant manifestation of muscular efforts of upper limbs and mobilization of chest breathing type. In girls there happens certain mobilization of diaphragm breathing type.

This conclusion confirms index of Erisman, which is the criterion of chest proportionality. The index is composed of CC parameters in rests state and body length. Body length influences on the index insignificantly. This index is formed by chest circumference with significant or insignificant negative correlation of hand and back index is formed of CC parameters in rests state and body length. This index is directly connected with chest circumference (CC in different position of measurements) and hand dynamometry as well as VCL. It witnesses about location of powerful muscular groups in upper part of boys’ torsos. It conditions significant manifestation of muscular efforts of upper limbs and mobilization of chest breathing type.

In boys this index is formed at the account of CC and body length influences on the index insignificantly. This index is formed by chest circumference with significant or insignificant negative correlation of hand and back strength (see fig. 2). It witnesses that increase of physical fitness (in particular power) results in narrowing of chest. It is a sign of biathlon girls’ morphological masculinization. Increase of girls’ muscular strength results in reduction of chest volume.

In boys this index is formed at the account of CC and body length influences on the index insignificantly. This index is formed by chest circumference with significant or insignificant negative correlation of hand and back strength (see fig. 2). It witnesses that increase of physical fitness (in particular power) results in narrowing of chest. It is a sign of biathlon girls’ morphological masculinization. Increase of girls’ muscular strength results in reduction of chest volume.

Analysis of body constitution type (by Piniet’s index) shows that CC is a determining factor in formation of

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**Table 2. Somatologic indices of students – members of biathlon sport-pedagogic perfection group**

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Boys (M±m)</th>
<th>Girls (M±m)</th>
<th>Δ,%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quetelet’s index, g·cm⁻¹</td>
<td>377,92±19,16</td>
<td>358,22±16,26</td>
<td>-5,21</td>
</tr>
<tr>
<td>Erisman’s index, conv.un.</td>
<td>5,27±3,63</td>
<td>8,50±4,50</td>
<td>61,29</td>
</tr>
<tr>
<td>Piniet’s index, conv.un.</td>
<td>19,30±5,20</td>
<td>17,91±7,11</td>
<td>-7,20</td>
</tr>
<tr>
<td>Coefficient of body proportionality, conv.un.</td>
<td>92,30±5,22</td>
<td>96,87±8,92</td>
<td>4,95</td>
</tr>
<tr>
<td>“Life index”, ml·kg⁻¹</td>
<td>69,15±6,85</td>
<td>57,20±5,77</td>
<td>-17,28</td>
</tr>
<tr>
<td>Power index,</td>
<td><em>(F max hand, kg × body mass⁻¹, kg) × 100</em></td>
<td><em>(F max back, kg × body mass⁻¹, kg) × 100</em></td>
<td></td>
</tr>
<tr>
<td>conv.un.</td>
<td>69,90±5,29</td>
<td>56,32±8,26</td>
<td>-19,43</td>
</tr>
<tr>
<td></td>
<td>185,90±21,89</td>
<td>155,78±22,58</td>
<td>-16,20</td>
</tr>
</tbody>
</table>
somatic type and influences on index in reverse proportion: the less body mass and CC are, the higher is asthenicity (dolymorphia) of students and it is quite natural (see fig. 3).

It is characteristic that in girls, body length positively \( (p \leq 0.05) \) influences on index. In boys the strength of body constitution is positively influenced by indicators of back and hands’ muscles’ power as well as VCL. Correlations are not confident. They point at certain tendency of influence on somatic type’s formation. Besides, they witness about relatively lower values of VCL, strength of back and hands in asthenic type persons. In girls this tendency has reverse character – asthenic body constitution is determined by relatively high physical fitness (power, in particular) conditions asthenicity (dolymorphia) and results in chest shape approximation to men’s chest. With it, girls’ body length is a dependent variable. In boys, longitudinal sizes of body do not substantially influence on asthenicity/normothesthenicity/hypersthenicity of body constitution. Somatic type formation is realized at the account of chest circumference \( (CC) \) in different position of measurements and chest excursion and depends on back and hands strength (see fig. 3).

Analysis of “vital index” values shows this attribute’s noticeable advantage (by 17.28%) in boys (see table 2). The character of dependences on other anthropometric indicators is rather ambiguous (see fig. 4). This index has high direct correlation with VCL \( (p \leq 0.001) \) with not confident correlation with body mass. In boys the value of this index substantially \( (p \leq 0.01) \) positively depends on chest excursion with not confident correlation with CC at inhale. This fact proves assumption about chest breathing’s prevalence in boys. In girls this tendency is absent and change of index is negatively influenced by...
Fig. 3. Interconnection of Piniet’s index with somatologic indicators of students – members of biathlon sport-pedagogic perfection group. CC_r – chest circumference in rest; CC – chest circumference at inhale; * - statistic significance of Pirson’s correlation coefficients at p ≤ 0.05; ** - statistic significance of Pirson’s correlation coefficients at p ≤ 0.01; *** - statistic significance of Pirson’s correlation coefficients at p ≤ 0.001.

Fig. 4. Interconnection of life index with somatologic indicators of students – members of biathlon sport-pedagogic perfection group. CC_in – chest circumference at inhale; * - statistic significance of Pirson’s correlation coefficients at p ≤ 0.05; ** - statistic significance of Pirson’s correlation coefficients at p ≤ 0.01; *** - statistic significance of Pirson’s correlation coefficients at p ≤ 0.001.

Fig. 5. Interconnection of power index with somatologic indicators of students – members of biathlon sport-pedagogic perfection group. CC_r – chest circumference in rest; CC_in – chest circumference at inhale; CC_exh – chest circumference at exhale; * - statistic significance of Pirson’s correlation coefficients at p ≤ 0.05; ** - statistic significance of Pirson’s correlation coefficients at p ≤ 0.01; *** - statistic significance of Pirson’s correlation coefficients at p ≤ 0.001.
hands strength (see fig. 4).

The character of dependences between students’ power potentials’ indices is proved by the following tendencies: the main combining factor is strength of back/ hand muscles with absence of confident dependence on body mass. It can be an evidence of high physical fitness level, which are phenotypically determined as a result of sport-pedagogic activity (see fig. 5).

In most of other faculties’ students (in contrast to physical education faculty) classes of sport-pedagogic, sport-mass or/and recreation activity are absent. In this students perfection of physical condition is fulfilled by means of physical culture. In these students index value has confident dependences on physical fitness (power, in particular) and on anthropometric characteristics [15, 23]. Characteristic distinction of girls’ power index is negative correlation with CC in different positions of measurements. In boys such correlations are absent. This tendency confirms our assumption about formation of masculinization in biathlon girls. It results in mobilization of diaphragm breathing.

Conclusions:

1. The highest differences between boys and girls are observed by absolute indicators of body, trunk, torso lengths and body mass. The least differences are observed by the length of upper and lower limbs and these signs prevail in boys. In girls diaphragm breathing is noticeably realized. It permits to increase alveolar area at the cost of longitudinal stretching of lungs. With it no noticeable change of chest excursion is observed.

2. In boys there are higher values of relative power of back and hands that characterize specific features of men’s physical condition. In girls we observed relatively wide chest, combined with high location of body center.

3. Relatively high physical fitness of girls (power, in particular) conditions asthenic/normosthenic/hypersthenic body constitution. Somatic type’s formation is realized at the account of chest circumference and directly depends on hands’ and back strength.

4. The received result is a peculiar model, which witnesses about opportunities for more successful sport activity.

Conflict of interests

The authors declare that there is no conflict of interests.

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Key words for the three languages: (4-6 words).

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Material and methods
Participants
Research Design
Statistical Analysis

Results
Discussion
Conclusions
Conflict of interests
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