The journal represents original scientific researches of scientists from the East-European region. The Journal welcomes articles on different aspects of physical education, sports and health of students which cover scientific researches in the related fields, such as biomechanics, kinesiology, medicine, psychology, sociology, technologies of sports equipment, research in training, selection, physical efficiency, as well as health preservation and other interdisciplinary perspectives.

In general, the editors express hope that the journal “Physical Education of Students” contributes to information exchange to combine efforts of the researchers from the East-European region to solve common problems in health promotion of students, development of physical culture and sports in higher educational institutions.
Key title: Physical education of students

Abbreviated key title: Phys. educ. stud.

ISSN 2308-7250 (English ed. online)

Founders: Iermakov Sergii Sidorovich (Ukraine); (doctor of pedagogical sciences, professor, Department of Physical Education, Kharkov National Pedagogical University).


Address of editorial office:
P.O.Box 11135, Kharkov-68, 61068, Ukraine.
Tel. +38 099 430 69 22
e-mail: sportart@gmail.com

Frequency - 6 numbers in a year.

Journal is ratified Ministry of Education and Science of Ukraine (online):
physical education and sport - № 374, 13.03.2017;

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Journal is reflected in databases:

1) Web of Science Core Collection
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   DOAJ (Directory of Open Access Journals)
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The effects of three different type of exercises on aerobic and anaerobic power

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Abstract

Purpose: The study was conducted with the aim of investigating the effects of three different types of exercise: bicycling, plyometric and weight on aerobic and anaerobic power.

Material: Sample size 30 students recreational athletes aged 23-19 years. The athletes were divided into 3 groups of 10 subjects (bicycle, plyometric, weight). The program for 6 weeks included: 3 different exercises planned for 30 minute/3 days/week. Body weight, vertical jump and 20-meter shuttle running times were measured for each group. Statistical analysis was performed by SPSS21.0: arithmetic averages and standard deviations; the Kruskal-Wallis H test was used to determine the differences between the groups; the Mann-Whitney U test was used to determine the group which result in the difference among the groups; Wilcoxon’s t test was used to determine pretest posttest differences within the groups.

Results: As a result of the research, it was determined that the increase in the aerobic power levels of the bicycle and plyometric groups was significant (p<0.05), but the increase in the weight group was not significant (p>0.05). As a result of the research, it was determined that the increase in the aerobic power and plyometric groups was high level in favor of the weight group in terms of posttest aerobic power.

Conclusions: The different exercises practiced by all three groups significantly increased anaerobic power levels. When the aerobic and anaerobic power values of the three groups in each study were examined, it was found that only the increase of weight and plyometric groups was high level in favor of the weight group in terms of posttest aerobic power.

Keywords: aerobic power, anaerobic power, bicycling, plyometric, weight.

Introduction

Motor activity provides multiple directions for research with a strong social impact, it is in direct relation to the technological development and the new scientific discoveries in related fields which determine the optimization of human motric potential [1]. Exercises not only bring physical fitness to the highest level as well as provide a longer, better quality of life, but also have many positive effects on health [2].

The effort capacity is a characteristic of the individual who performs a motor activity and is appreciated by the duration of the effort, the mechanical work and its opportunity [3]. In the field of adaptation to effort, from a conceptual point of view, the tendency is to replace the notion of homeostasis with homeorhetis, which designates a complex of progressive balancing and rebalancing, materialized in modifications: plastic, functional, biochemical and technical [3].

Scientific research in human motor field contributes to knowledge about how our bodies perform, what is the relationships between components of motor capacity related to the factors of psychic, social etc. [4]. It is necessary to raise the quality of young people’s training. Rather important are modern training methodic, permitting for teachers to use new effective forms and methods of physical education in educational process [5].

Plyometric training is a type of muscle strength exercise that can improve basic physical strength. It has been extensively studied for its ability of improving exercise performance [6]. It is thought that the plyometric exercise [7] which is defined as intense exercises performed with maximal force, that are performed to obtain physical performance changes for sportive activities, comes from word roots meaning plethysm or measure (plio) in Greek. Plyometric exercises are also defined as activities requiring maximal effort, such as high-intensity depth jumps workouts [8].

The basis of the plyometric exercises is stretch shortening cycle which allows the concentric contraction to increase during eccentric motion. Thus, the speed of the eccentric contraction movement is very significant for concentric contractions [9]. Leg pedaling exercises such as bicycling are generally preferred to increase muscle strength and endurance. Numerous studies have been conducted to understand the development of leg muscle function and coordination and the clinical impact of cycling exercise [10].

Isotonic training, that is weight trainings done with weight training machines or free weight, is highly preferred. Contrary to isometric exercises, isotonic exercise provides a constant load during a movement. Routine weight training can cause muscle tone, strength and stamina to increase. It has also been shown to develop tendon and ligament strength [2].

Anaerobic exercises are defined as studies of the highest possible oxygen borrowing capacity of the organism. In order to adequately stimulate the anaerobic energy pathways, it is necessary to apply strongly dynamic loads near the maxima. Oxygen and energy needs are raised to the highest level, aiming to operate the organism under difficult conditions [11]. Aerobic exercises are defined as the ability of the organism to receive, transport and use oxygen [11].

Aerobic exercises have no effect on strength gain (2 or 3 times a week for 20 to 30 minutes, 75% of the maximal heart rate) but can adversely affect the power increase [9].

Purpose and hypothesis

The study was conducted with the aim of investigating the effects of three different types of exercise: bicycling, plyometric and weight on aerobic and anaerobic power.
The hypothesis of the study started from the assumption that the implementation of 3 different programs bicycling exercise, plyometric exercises and weight training will have different effects on aerobic and anaerobic power on the students recreational athletes.

Material and Methods

Participants: A total of 30 male students recreational athletes, age of 21,19 years, who did not practice professional sports, actively fulfilled exercises for 3 days a week for at least 2 hours and were voluntarily participated in the study. The subjects were selected from the athletes who had not experienced any neurological, audiovisual discomfort and serious injuries in the upper and lower limbs during the past six months. At the beginning of the study, the athletes were told about the tests they would be subject to in the scope of the research and a document regarding their voluntariness was signed. The sportmen were divided into groups considering the homogeneity, and each group was consists from 10 students recreational athletes.

Procedure: The research was carried out between February - May 2016. Exercises increasing quadriceps and hamstring muscle strength were performed for 3 days per week for 6 weeks. In Table 1, we calculated the ages, size and body weight. Size: Measurements of length (Welch Allyn) were made while the athlete was standing in a upright position. On the scale, the caliper sliding on the scale is adjusted to touch the head of the athlete and the length is read with a sensitivity within 1 mm. Body Weight: Body weight measurements were made with a sensitivity within 20-gram bottle (Welch Allyn), with bare feet and shorts only.

Training Procedure

Bicycling exercise: In the (BE) exercise group, the athletes were subjected to overexercise, corresponding to 75% of their maximal heart rate for 30 minutes, 3 times a week for 6 weeks each with the BL 909D Starline brand stationary bicycle. The pulse rate of the athletes was calculated by 220 heart rate formula and the pulse interval was found and followed by the polar watch.

Plyometric exercises: Plyometric exercises (PE) was done to the sportsmen, 3 sets of 10 repetitions for the first three weeks, 3 sets of 15 repetitions for the last three weeks. 1 minute breaks between sets and 2 minutes breaks between movements were given. The plyometric exercises that are performed by the athletes during 6 weeks of exercise are: skip jumping, squat jumping, double jumping forward, single jumping forward, side jumping, depth jumping on the boxes, depth jumping performed between the boxes, split jump.

Weight training (WE): The athletes performed three sets of 10 repetitions of exercise movements. Athletes had worked with 80% of the weight they could maximal in exercises. The weights that the athletes can take up 80% each week were recalculated and worked. 1 rest between sets, 2 minutes rest between movements were given. The plyometric exercises that were performed by the athletes during the 6-week exercise period were: Leg press, hack squat machine, seated leg curl, leg extensions.

Aerobic Capacity Test - 20 meter shuttle run test (VO2max measurement) (Table 2): A shuttle run test was performed to measure the aerobicics of the athletes. The athletes were running 20 m. The test was started at a slow running speed (8 km/h), the athlete started to run in the first signal and tried to reach the line until the 2nd signal. When it hears the 2nd signal, it goes back to the starting line again. The running speed continued to increase by 0.5 km/s every minute. When the athlete heard the signal, he/she tried to adjust his/her tempo to be at the other end of the track in the second signal. In the beginning, the slow speed gradually increased every 10 seconds. The athlete continued to test if he missed a signal and reached second place. When the athlete misses two signals, the test is ended.

Calculation of Anaerobic Power - High jump test (Table 2) was applied to measure the anaerobic strength of the athletes. Athletes first stood side by side and naturally stood at the edge of the wall. The point closest to the wall is marked with the uppermost point, and then the uppermost spot reached by jumping is determined. The difference between the first point and the point reached after the jump is measured in meters. Sportsmen were asked to jump twice. Based on the vertical jump values of the anaerobic power capacities of the athletes, these data were calculated using the Lewis Formula.

\[ \text{Anaerobic power (kg.m.s.n)} = 4.9 \times \text{Body weight (kg)} \times \sqrt{\text{D}} \]

Statistical Analysis: The statistical evaluation of the findings was performed with SPSS 21.0 computer package program, and the arithmetic mean and standard deviations of all parameters were excluded. The Kruskal-Wallis H test was used to determine group differences, and the Mann-Whitney U test was used to determine the group from which the difference was derived. The Kruskal-Wallis H test was used to determine the differences between the groups and the Mann-Whitney U test was used to determine the group which result in the difference among the groups because of the low number of total data (n=30). Wilcoxon’s t test was used to determine pretest posttest differences within the groups. P<0.05 was considered as significant level.

Results

30 students recreational athletes participated in the study with the aim of investigating the effect of different types of exercise on aerobic and anaerobic power; Age, height, body weight, anaerobic and aerobic power values are given below in tabular form.

No statistically significant difference was found among age, height and body weight values between groups (p>0.05).

When the aerobic and anaerobic power values of the
cycling group were examined, a statistically significant difference was found between pretest and posttest values (p<0.05) (Table 2).

When the aerobic and anaerobic power values of the plyometric group were examined in the study, a statistically significant difference was found between pretest and posttest values (p<0.05) (Table 2).

When the anaerobic power values of the weight group were examined in the study, a statistically significant difference was found in pretest and posttest values (p<0.05) (Table 2).

When the weight group’s aerobic power values were examined, there was no statistically significant difference between pretest and posttest values, although there was a significant increase in favor of posttest (p>0.05) (Table 2).

When the aerobic and anaerobic power pretest and posttest values of the groups were examined in the study, no significant difference was found in all other measurements of the groups (p>0.05), although there was a significant increase in favor of posttest in aerobic power measurements (p<0.05) (Table 3).

**Discussions**

In this study, the effects of exercise programs performed with three different types of exercise groups performed 8 different plyometor bounce drills and four different leg weight exercises done with 80% of 1 Repetition Maximum (1RM) as well as did 30 minute bicycle exercise with 75% pulse applied for 3 days a week throughout 6 weeks, over the isokinetic strength of quadriceps and hamstring muscles were investigated.

In the study, the anaerobic forces of all three groups were measured by the vertical jump applied before and after the exercises and the aerobic power were measured by the 20 m shuttle running test (Table 2,3).

The research findings show that the anaerobic and aerobic powers of the bicycle group increased significantly in favor of the post tests, according to pretest and posttest results of force values (Table 2).

The research supports this findings of Martinmäki [12], reporting that the 6-week high intensity interval cycling training increases the jumping strength and according to the result of this research, the cycling

---

### Table 1. The statistical analysis of the age (years), size (cm) and body weight (kg) of the groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Age (x±SD)</th>
<th>Size (x±SD)</th>
<th>Body Weight (x±SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bicycle (n=10)</td>
<td>21.20±1.39</td>
<td>176.01±4.63</td>
<td>74.42±9.11</td>
</tr>
<tr>
<td>Plyometric (n=10)</td>
<td>21.50±1.90</td>
<td>176.90±6.23</td>
<td>71.59±8.34</td>
</tr>
<tr>
<td>Weight (n=10)</td>
<td>21.00±1.05</td>
<td>177.43±7.37</td>
<td>76.13±10.54</td>
</tr>
</tbody>
</table>

x - mean arithmetic; SD - standard deviation; n – number of subjects.

### Table 2. The statistical analysis of the plyometric and weight groups aerobic-anaerobic power measurements pre and posttest values (n=10).

<table>
<thead>
<tr>
<th>Group</th>
<th>Items</th>
<th>Pretest (x±SD)</th>
<th>Posttest (x±SD)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bicycle</td>
<td>Anaerobic Power (kg.m/s)</td>
<td>116.55±11.63</td>
<td>122.83±12.80</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Aerobic Power (ml.kg/min.)</td>
<td>356.31±2.29</td>
<td>385.51±2.88</td>
<td>0.004</td>
</tr>
<tr>
<td>Plyometric</td>
<td>Anaerobic Power (kg.m/s)</td>
<td>111.02±14.88</td>
<td>117.75±15.53</td>
<td>0.00*</td>
</tr>
<tr>
<td></td>
<td>Aerobic Power (ml.kg/min.)</td>
<td>382.65±3.04</td>
<td>423.61±5.43</td>
<td>0.007*</td>
</tr>
<tr>
<td>Weight</td>
<td>Anaerobic Power (kg.m/s)</td>
<td>118.07±19.55</td>
<td>124.19±18.86</td>
<td>0.003*</td>
</tr>
<tr>
<td></td>
<td>Aerobic Power (ml.kg/min.)</td>
<td>363.51±3.85</td>
<td>381.03±4.11</td>
<td>0.145</td>
</tr>
</tbody>
</table>

x - mean arithmetic; SD - standard deviation; p - level of probability; *p<0.05.

### Table 3. Comparison of aerobic and anaerobic power pretest-posttest among groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Pretest (x±SD)</th>
<th>p</th>
<th>Posttest (x±SD)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaerobic Power (kg.m/s)</td>
<td>BG-PG</td>
<td>116.54±11.63</td>
<td>0.438</td>
<td>122.82±12.80</td>
</tr>
<tr>
<td></td>
<td>BG-WG</td>
<td>111.02±14.88</td>
<td>0.830</td>
<td>117.74±15.53</td>
</tr>
<tr>
<td></td>
<td>PG-WG</td>
<td>118.07±19.55</td>
<td>0.324</td>
<td>124.19±18.86</td>
</tr>
<tr>
<td>Aerobic Power (ml.kg/min.)</td>
<td>BG-PG</td>
<td>35.63±2.29</td>
<td>0.071</td>
<td>38.55±2.88</td>
</tr>
<tr>
<td></td>
<td>BG-WG</td>
<td>38.26±3.04</td>
<td>0.611</td>
<td>42.36±5.43</td>
</tr>
<tr>
<td></td>
<td>PG-WG</td>
<td>36.35±3.85</td>
<td>0.183</td>
<td>38.10±4.11</td>
</tr>
</tbody>
</table>

x - mean arithmetic; SD - standard deviation; p - level of probability; *p<0.05; BG - Bicycle Group; PG - Plyometric Group; WG - Weight Group.
group significantly increases the anaerobic power values according to the exercise end result. Another study developed in 2017 concluded that a combined weight training and plyometric training program could represent a more efficient method for improving activities which involve acceleration, deceleration and jumps compared to WT alone [13]. Rodriguez-Rosell [14] reported that only 6 week of preseason low-volume and low-load resistance training combined with plyometrics can lead to relevant improvements in strength, jump, and sprint performance. Hellsten et al. [15] support our work by reporting that bicycle exercise has developed anaerobic power. Six male students performed exercises with VO2max 90% in cycling ergonomics for 7 weeks investigated the effects of high intensity endurance exercises on isokinetic muscle strength and at the end of training, they reported a significant increase in VO2max values [16]. Tabata et al. reported that cycling exercises significantly increased the VO2max value by performing them in medium degree of (70%) 60 min [17]. The results of these studies support our research findings.

Similar to the literature, the anaerobic and anaerobic power values of the pliometer group were significantly increased in favor of the post tests. Study of Sağroğlu et al. found that there was a significant increase in the anaerobic power values in favor of the group performing pliometer training for 3 days per week in the research in which one group trained for 3 days per week and other group trained 1 day per week In addition, it was determined that the plyometric training performed three days a week was more effective on the anaerobic power and capacity than the plyometric training performed 1 day a week. The reason for this is considered to be the effect of the plyometric training frequency on the development of anaerobic power [18]. Sağroğlu et al. [19] reported a positive increase in vertical jump performance, which was used to determine anaerobic power of 6-week plyometric exercises in their study in which they used power exercises combined with plyometric exercises performed for 3 days per week throughout 6 weeks. Ateş et al. [20] found that a 10-week plyometric training with football training, has an a positive effect over anaerobic Powers of 16-to 18-year-old footballers. Brown et al. [21] reported that depth jumping exercises performed with 10 men and 10 women significantly increased maximal oxygen use. On the one hand, while the anaerobic power group increased significantly in favor of the post test, on the other hand the aerobic power values showed an increase in favor of the post test, there was no statistical significance between the pre test and post test. Adibpour et al. [22] found that power trainings performed by 35 female basketball players for throughout 8 weeks combined with plyometric exercises performed 3 days for a week positively affect the vertical jump performances which were used to determine anaerobic power. The result of Storen et al. [23] showing that they did not achieve a significant increase in VO2max after maximal strength training for 8 weeks were in parallel with our findings. Hoff et al. [24] reported that maximal strength training with 85% of maximum 1 repetition performed for 3 times a week for 8 weeks increased aerobic endurance performance. Force training does not reduce VO2max, although it normally appears to be a disadvantage in aerobic exercises [9].

While the weighted training with these results produced a significant difference on the anaerobic power, there was no significant increase in favor of the final test, although it increased the aerobic power values.

When the aerobic and anaerobic power pretest and posttest values of the groups were examined in our study, although there was a significant increase in favor of post test values of plyometric and weight groups (p<0.05), no significant difference was found in all other measurements of the groups (p>0.05).

Conclusions
All three groups showed an increase in aerobic power levels, but the increase in cycling and plyometric exercise groups was found to be significant. Similarly, there was a significant increase in anaerobic power in all three groups.

When the values of the plyometric and weight exercises were examined between the groups, it was determined that the increase in the aerobic power value was significantly higher than the bicycle exercise group.

Conflict of interests
The authors declare that there is no conflict of interests.
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1. Badau D. Investigational approaches of the human physical potential. Publisher by International Science Culture and Sport Association; 2017.


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Cite this article as: Alpaslan Gorucu, Bekir Tokay, Adela Badau. The effects of three different type of exercises on aerobic and anaerobic power. Physical education of students, 2017;21(4):152–157. doi:10.15561/20755279.2017.0401

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Received: 08.07.2017
Accepted: 25.07.2017; Published: 10.08.2017
Study of somatic, motor and functional effects of practicing initiation programs in water gymnastics and swimming by students of physical education and sports

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Abstract

Purpose: The implementing within the academic physical education and sports curricula of a new discipline such as water gymnastics falls within the current trends of curriculum modernization. Purpose: The purpose of the study aims at evaluating the effects of driving, exercise-induced functional and somatic programs initiation of the gymnasts in the water compared to the effects specific to the initiation swimming.

Material: research duration: two semesters / 14 practical courses. In the first semester the water gymnastics initiation program was implemented and in the second semester the swimming initiation program was implemented. Research Tests: Pretest in the first practical lesson of each semester and posttest in the last lesson of each semester. Participants: 34 male students, specializing in physical education and sport. Somatic, motor and functional assessment: weight, height, BMI, basal metabolism; H2O%, fat%, 2km UKK test, VO2max, fitness index. Statistical processing SPPS 20: arithmetic mean, standard deviation, t-test, probability threshold.

Results: improvements relevant to the aqua-gymnastics group: VO2max 7.07 ml/min/kg; Test duration 2km UKK 1.049 minutes; BMI 0.255; and the group of swimming VO2max 0.43 ml/min/kg; Duration 2km UKK 0.44 minutes; BMI 0.139.

Conclusions: effects on the functional motor and exercise-induced somatic programs initiation water gymnastics are significantly superior to those of initiation in swimming. We recommend conducting further studies to assess the effects of gymnastics on water through differentiated programs on levels of physical training, age, and the use of various sporting materials.

Keywords: aqua-gymnastics, swimming, fitness index, body fat percentage, VO2max, caloric intake.

Introduction

Increasing the competitiveness of academic physical education (PE) can be achieved by implementing within the curricula of some innovative disciplines allowing the acquisition of additional professional knowledge and skills in accordance with the modern requirements and the expansion of practicing forms of physical activities [1].

The place and the role of physical education in the context of high quality integrated education are clearly defined and aimed at maximizing the human potential imposed by the dynamics of modern society [2].

The diversification of indoor aquatic activities was possible owing to the influences of modern technology that created a series of materials and installations adapted to both aquatic environment with the targeted objectives and the peculiarities of sport practitioners. Introducing water gymnastics into university curriculum to students from physical education specialization contributes to expanding and increasing the attractiveness of aquatic activities. By the curricular extension of aquatic activities we aimed at training new motor skills and teaching competences to students from physical education and sports.

Education should be directed to the needs of the knowledge society to the problems that emerge from the current modern context that applies in the future [3].

The human motor behavior appears as a complex chain of movements, attitudes, or postures whereby a man adapts to different ever changing environmental conditions [4].

The topicality of our research consists of comparing the functional and somatic adaptive effects induced by two types of activities carried out in aquatic environment: water gymnastics and swimming, addressed to students from the physical education and sports specialization, comprising modules of 14 practical lessons. The assessment was made on the ground since recent studies have shown that VO2max test in water is a complex and difficult process that involves risks [5-9].

We mention that within the curriculum of the Physical Education and Sports Specialization Program of the University of Medicine and Pharmacy of Targu Mures, there are two aquatic disciplines: swimming and water gymnastics, each with 7 theoretical courses and 14 practical lessons which are conducted in two consecutive semesters in the first year of study.

The possibilities of the aquatic environment can contribute to the active level of physical activity as a key contribution to health and aging that derives from its special features, working at functional and aesthetic levels [10].

Regarding the efficiency of the swimming methodology to physical education students, Dragan Toskić and colleagues, (2013) [11] concludes that the study has shown that some other methods and forms of organization can provide better results than those achieved within the current method of work, since, as mentioned at the beginning, the role of the university, faculty and teacher is to encourage students and enable them to realize their abilities so that they can be awarded the highest grades possible.

In 2008 Statkevičienė B. and collab., [12] conducted a study that targeted the level of performance in different swimming techniques correlated with anthropometric indices for young people aged 18 (years).
The aquatic environment presents physical properties that facilitate the diversification of movements, among which buoyancy allows three-dimensional movements and positions that can not be reproduced on the ground, stimulating the sensory area of the central nervous system. This force facilitates the possibility of multiple combinations of movement in various plans [13].

Water gymnastics is an optimal combination of: basic and aerobic gym exercises, fitness, stretching and hydro-massage, aiming mainly at improving the harmonious physical development, the posture and the motor and functional ability. Water gymnastics is an innovative activity of motor education technology, adapting to specific age and training specificities as well as to individual and group preferences, contributing to the optimal change in behaviors and physical capabilities.

Specialists in the field of motor activities consider that the innovative and attractive use of environments to carry out the activities, of the modern methods and technologies will contribute to the curricular optimization and the skills improvement of the future specialists [1,10,14].

Purpose and hypothesis

Formulating the hypothesis we started from the assumption that initiation in the exercise of water gymnastics programs has superior functional and somatic beneficial effects compared to initiation in swimming practice, during 14 practical lessons per semester, to students in the first year of study from the specialization of physical education and sport.

The study aims to determine the functional and somatic changes induced by practicing two types of aquatic physical activities: water gymnastics and swimming to students from the physical and sports education specialization, first year of study. The functional changes targeted: the vital capacity by the indicator VO2max and the fitness index which stands for the motor ability level; the somatic changes: BMI, the body fat and water percentage in relation to the differentiated caloric intake of the two physical aquatic activities- gymnastics in water and swimming.

Material and methods

Participants: The research included a number of 34 male students from Physical Education and Sports, 1st year, from the University of Medicine and Pharmacy in Targu Mures. The research subjects did not practice swimming as a performance sport, their average age 22.60 ± 1.95 years, average height 1.80 ± .07 meters. All participants in this study were volunteers.

Procedure: The research was conducted during the academic year 2015-2016 at Salus Spa per Aqua within Targu Mures University of Medicine and Pharmacy, which is equipped with a swimming pool 1.3 - 2.5 m deep, 25 m long, 6 Standard lanes. The swimming pool’s design allows practicing gymnastics in water over a third of the pool’s length where the depth is 1.3 m, and then it increases progressively.

The research was conducted during two semesters, in the first semester the students were initiated and evaluated in water gymnastics discipline, and in the second semester in swimming discipline - the initiation course. Each discipline included a total of 14 practical lessons of 90 minute duration and 7 theoretical courses.

In the study framework two tests were carried out, as follows:

- In water gymnastics discipline, the pre-test was applied in the first week of semester I, and the post-test in the 14th week of the semester;
- In swimming discipline, the pre-test was applied in the first week of the second semester, and the post-test in the 14th week of the semester.
- The operational water gymnastics programs have been differentiated all along the first semester on three value modules according to the degree of difficulty, the intensity and the complexity of the systems: beginners, intermediates and advanced ones.
- beginner level – in a four-lesson period free, simple or complex exercises were performed, aiming to familiarize with the aquatic environment and to learn the specific gymnastics motor skills; the programs’ choreography was simple;
- intermediate level- in a six-lesson period exercises with a higher complexity were included through the use of sports objects: palm, dumbbells of 1kg, a pull/ push plate , sandbags attached to the ankles; mid-level choreography;
- advanced level- in a four-lesson period exercises with a degree of difficulty, the acting intensity and complexity were higher and the choreography more complex, using materials and equipment such as: plates, dumbbells weight varying between 2 kg, palmars of greater surface, steppers etc.; elaborate choreography.

The curriculum content of the swimming discipline, conducted during the second semester, included the classic program of 12 lessons of initiation in the technical execution of swimming procedures: crawl, backstroke and breaststroke.

Tests applied: Before the start of the motor test, the anthropometric measurement of the subjects, using the magnetic impedance scale, aimed at the following parameters: height (cm), weight (kg), percentage of fat (%) and percentage of water (%). In order to evaluate the functional capacity it was applied the 2km UKK test, designed by the Finnish physician Dr. Kenneth Cooper [16], a testing component of Eurofit adult test battery, which consists of 2 km brisk walking in the open air or indoors on the treadmill with a platform’s tilt index to “0”. We opted for the 2km UKK test because it responds to the study’s objective of measuring overall functional capacity and can be applied to both aquatic activities that suppose different body positions and different types of effort. The required parameters to evaluate the 2km UKK walking test were: IMC, age, height, heart rate, and test performing duration. It starts with a slight warming up, the emphasis is on the lower limbs, and then it takes a regular cadence, about 200 meters, until it sets an individually acceptable
pace. Once the test is started, the time taken to cover the 2 km is counted and the heart rate value is recorded at the end of the test.

Based on the results of the 2 km UKK test, the fitness index (IF) was calculated according to the formula:

$$IF \text{ (men)} = 420 - (11.6 \text{ min} + 0.2 \sec + 0.56 \text{ HR} + 2.6 \text{ BMI}) + 0.2 \text{ years}$$

Where: HR - heart rate at the end of the test; Years - the age of subjects; BMI - weight (kg) / height (m) squared. Interpretation of UKK 2K test results: Depending on the correlation with UKK Institute scores, it has five levels of appreciation: <70 well below the average; 70 - 89 somewhat below average; 90 - 110 average; 110 - 130 something above average; > 130 well above average.

The maximum quantity of oxygen measured in ml / min / kg ($V_{O2\text{max}}(men)$) included the following parameters: age, BMI, the time obtained in 2 km UKK walking test (min.) and the heart rate at the end of the test, it was calculated by the formula:

$$V_{O2\text{max}}(men) = 184.9 - 4.65 \text{ time} - \text{ HR} 0.22 - 0.26 \text{ years} - 1.05 \text{ BMI}$$

Interpretation of $V_{O2\text{max}}$ for 20-29 years on assessment levels is: decreased <25 - Insufficient; 25 – 33 - Average; 34 – 42 - Good; 43 – 52 - Excellent. Where: HR = HR / HRmax X 100.

Basal metabolism (BM) reflected by the caloric transformation, specific to the UKK test, and the test time, reported at 60 min, increased by 0.435 in water gymnastics compared to 0.013 km in swimming;
- The fitness index (IF) recorded a significant improvement of 17.725 units in water gymnastics group and only 1.075 units in swimming group. The difference is justified by the required effort in water gymnastics activity during which sports teaching materials were used; they require superior/higher efforts for their handling compared to the effort needed at the initiation swimming lessons. In initial testing done at the beginning of the first semester, subjects were within an average fitness level and at the final testing they ascended to something above average level of appreciation. During the holiday period between semesters IF level fell to average which was maintained during the second semester, when the practical works of swimming discipline took place;
- The basal metabolism (BM) by the calories consumption indicator was improved by 11.092 calories after practicing gymnastics in water and by 6646 cal. in swimming, which means a body adaptation to the effort specific to both aquatic activities;
- The body water quantity whose value was calculated by a standard electronic scale recorded a decrease of 0.255 in water gymnastics compared to 0.013 km in swimming;
- The basal metabolism (BM) by the calories consumption indicator was improved by 11.092 calories after practicing gymnastics in water and by 6646 cal. in swimming, which means a body adaptation to the effort specific to both aquatic activities;
- The body weight, after practicing gymnastics in water, decreased by 0.814 kg compared to 0.483 kg after swimming lessons, the subjects having a normal weight in both tests;
- The time obtained to run the 2 km UKK test on the treadmill, declined by 1049 minutes in water gymnastics group and by 0.44 minutes in swimming group;
- The heart rate (HR) recorded at the end of the test, showed an improvement of 8.733 beats/minute for water gymnastics and only 0.5 beats per minute for swimming;
- Concerning % RH, which is an important indicator to determine the work stress, it decreased by 4.508% in water gymnastics and by only 0.258% in swimming, which is relevant for a more efficient adaptation to effort for water gymnastics compared to swimming;
- The distance resulting from the 2 km distance measured at 60 min, increased by 0.435 in water gymnastics compared to 0.013 km in swimming;
- The body fat was reduced by 0.337% after practicing gymnastics and by 0.139 in swimming group;
- There was a decrease of 0.255 in water gymnastics and 0.013 km in swimming;

The analysis of the differences between the tests
by test-t calculation (Table 2) revealed a strong statistical significance in the aqua-gymnastics group at the parameters: weight, duration of 2km, cardiac / heart rate capacity through HR indicators after effort, % HR, BMI and MB. After practicing swimming through 2km UKK test, there were statistically insignificant differences, for p <0.05, at the following parameters: the distance relative to the time, IF, the vital capacity through the indicator VO2max, the amount of water and fat in the body.
Discussions

Studies on the improvement of cardio-respiratory capacity and of body composition following gymnastics in water have been performed by numerous authors [12, 15-18].

Many authors have quantified the results of reducing the cardiac frequency in the aquatic environment between: 17 p / m while finding that the biological benefits of similar programs, compared to the aquatic environment and the ground have recorded FC values by 13% lower in the aquatic environment [19-21].

Taking into account the results obtained in numerous studies, it has been agreed by the specialists in the field that FC effort values in the aquatic environment compared to the values recorded in exercises on the ground should always be reduced by 10,17 beats / minute to work in an optimal area so as to produce the desired effects.

Studies on the dynamics of physiological indicators, VO2max, heart rate, fitness index, on people aged 20-26 years old after swimming have been performed by numerous field researchers [17, 22, 23, 24] who found out improvements in the vital and cardiac capacity.

Exercises with portable objects have the role to amplify the effects of general physical development exercises of the body, allowing a more precise control of the movements of the segments and the body as a whole [10].

Determinations of harmony and body composition through IMC, %fat, %water in the body, with direct effect on caloric consumption after practicing a physical activity, have been achieved through numerous studies showing positive effects if they are practiced systematically and under the guidance of specialists [18, 25].

A study conducted on boys practicing recreational swimming, of relatively equal age to the subjects of our research [23] revealed that the average value of $\text{VO}_2\text{max}$ is around 45.59 ± 9.32 ml / kg.min, without obtaining a significant progress after testing in consecutive days after practicing the crawl swimming procedure.

Regarding the energy consumption, it was found and it is recognized that it is inferior in water compared to the ground, due to the cardiac frequency, which for the same type of effort is inferior, by the neuromuscular activity of the postural muscles [26, 27].

In recreational aquatic motor activities, according to the existing studies, the higher the number of limbs involved in motion, the more concomitant the body’s response to effort is observed [28, 29].

The effort in water gymnastics is aerobic and depends on the objectives and materials used, so the researchers [30-31] noticed that at a heart rate of 110 beats per minute the effort self-perception is quite slight, with a $\text{VO}_2\text{max}$ of 40%, at a value of 130 beats per minute it is hard, $\text{VO}_2\text{max}$ 50%, at 150 beats / min hard, $\text{VO}_2\text{max}$ 75% and above this value the perception is very hard, and the effort is anaerobic, which is not indicated in this type of activity.

According to the Romanian Swimming Federation, six effort zones have been differentiated according to their intensity, the first four zones aiming at speed swimming, performance resistance with predominantly anaerobic and mixed, zone 5 is aimed at intensity effort between 60-85% and the sixth one refers to the lower aerobic effort zone: It is the area of the compensatory effort, the heart rate is below 120 beats / min; It has utility in learning and improving the technique, in warming up and post-effort relaxation [32].

A study of the fitness index using the same 2Km UKK test at Ukrainian students from Physical Education showed a value of 101.89, an inferior value compared to our students at the initial test, which was 103.87 [22].

The education should be changed. This change is produced under the influence of the pedagogical tradition that of the contemporary word problem and the future being aware that future order to the present [33].

Conclusions

The results of the research confirm the hypothesis, so values referring to the somatic indexes, the functional motor indexes recorded by the aqua-gymnastics group were superior compared to those in the swimming group.

The functional, motor and somatic effects induced by practicing initiation programs in water gymnastics have significantly higher effects than practicing an initiation program in swimming. Superior results recorded by the students from the physical education and sports program in the framework of this research through the exercise of water gymnastics programs are the result of the specific methodology that allows for a variation of effort and a diversification of the content higher than the one conducted for the initiation programs in swimming.

Gymnastics in water allows for the customization of programs according to the physical level of subjects, and the use of sports materials allows for an efficient and varied effort dosing, contributing to the optimization of the somatic, motor and functional capacity of the practitioners.

We recommend conducting further studies to assess the effects of gymnastics in water on other groups of students through differentiated programs by levels of physical training, age and the use of various sporting materials.

Conflict of interests

The author declares that there is no conflict of interests.
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Received: 22.05.2017
Accepted: 10.06.2017; Published: 10.08.2017
Modeling of kayak athletes’ competition activity
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Abstract
Purpose: determination of correlations between parameters of special and technical fitness of kayak athletes’ on 500 meters’ distance.
Material: in the research 29 elite athletes participated. We studied characteristics of athletes’ coordination structure in natural conditions and laboratory experiment.
Results: significant influence of specific adaptive reactions on workability dynamic and sport results is noted. Constant reduction of power is connected with lactate, pyruvate and other under-oxidation products’ accumulation in athlete’s muscles. 500 meters’ distance passing in alternative regime of motor activity permits for athletes to achieve higher level of special workability. We studied four variants of 500 meters’ competition distance passing. Most of athletes pass this distance by third variant (46% of all tested athletes) 21% - by the first variant; 14% - by second variant and 19% by the forth.
Conclusions: achievement of high sport result is facilitated by optimal structure of competition functioning, which corresponds to the following: speed power qualities and special endurance; individual features of athletes; specific of physical qualities’ manifestation, when passing definite distance.
Keywords: rowing, kayak, motor technique, bio-mechanics, lactate, blood.

Introduction
Perfection of elite athletes’ training implies improvement of their results on competition distance [17, 29]. It requires objective information about dynamic of athletes’ special and technical fitness indicators, when they pass distance [8]. High results in rowing are conditioned by psychic and physical qualities’ level; by athletes’ technical fitness [5]. Athletes’ technical fitness is regarded as a component of one, in which technical decisions are closely interconnected with athlete’s other potentials [10, 16]. Besides, it is necessary to consider environmental conditions, in which sport action is fulfilled [3, 13].

Of not less importance are the following factors:
− Optimization of physical loads [11, 12, 28];
− Consideration of athlete’s individual characteristics [6, 7, 30];
− Selection of adequate means of pedagogic control [19, 26];
− Consideration of workability dynamic in recreation processes [23, 24];
− Simulation of athletes’ training process and separate elements of movements [9, 14];
− Prediction of athlete’s successfulness in sport activity [21, 22, 27];
− Consideration of training’s didactic laws [1, 2, 4].

In practice of training there is acute demand in informative, scientifically substantiated criteria for assessment of athletes’ technical fitness. They required for operative, current and stage-by-stage control. Besides, they are important for working out and implementation of new modern means and methods of movements’ correction. Means of increase of elite rowers’ rowing technique shall also be studied.

In scientific works qualitative and quantitative changes of athletes’ technique under influence of complex of factors have been found [25, 29]. These factors determine conditions of realization of athletes’ motor potential in competition process [15]. But factors, conditioning high distance speed in the state of fatigue still remain to be not cleared [8].

Besides, working out of bio-mechanical pre-conditions for optimization of competition activity’s structure is of practical importance [31]. This problem touches wide circle of questions, connected with searching of laws of individual adaptive reactions’ manifestation in system of movements [18]. Their differentiated character depends on structure of different physical qualities’ development [32].

The purpose of the work is determination of correlations between parameters of special and technical fitness of kayak athletes’ on 500 meters’ distance.

Material and methods
Participants: in the research 29 elite athletes participated.
Organization of the research: coordination structure of athletes’ movements was studied in natural conditions and laboratory experiment.

The loads were created by row ergo-meter «Paddletlite». The athletes fulfilled the following regimes of work: 1) alternative regime at low speed of boat and power of work on start (A); 2) alternative regime at low speed of boat and power of work on finish (B); 3) alternative regime at high speed of boat and power of work on start and finish and low – in the middle of distance (C); 4) even mode of passing distance (D).

In our work we used complex method of biomechanical researches. We studied: dynamic of kinematic and dynamic forces, applied to paddle; pressure on kayak seat; goniogram of torso’s work; acceleration grams of hands’ movements in frontal and vertical axes; instant speed of boat; bio-electrical activity of arms’, torso’s, back and abdomen muscles. Amplitude and frequency of bio-potentials’ oscillations; rhythm structure of bio-electrical activity; integrative bio-electrical activity of muscles were registered. We calculated indicators of motor functioning’s effectiveness and efficiency, as well as variability of movements [9].
We also registered the following: pulse ($f_p$); oxygen consumption ($VO_2$) and release of carbon dioxide; quantity ($A$) and power ($N$) of fulfilled work. Besides, we found lactate level ($Lac$) in athlete’s blood (on 30th, 60th and 90th seconds). After finishing work we determined oxygen debt and took blood samples. After every stop and recreation the work was repeated from the start and the following was found: oxygen value of unit of work ($VO_2/A$); oxygen demand for the fulfilled work ($ZO_2$); oxygen deficit ($DO_2$).

Statistical analysis: in processing of experimental data we found: mean values of indicators and their errors ($X \pm m$); difference between mean values and confident of differences ($t, p$) as well as the value of dispersion around mean value ($\sigma, CV$). Also we found correlation between the studied indicators ($r$).

In our complex pedagogic, bio-mechanical and biological testing we followed legislation of Ukraine on health protection, Helsinki declaration 2000, directive №86/609 of European community about human participation in medical-biological researches.

**Results**

The following indicators have confident level of dependence on boat speed on all the distance:
- Power, released by athlete in stroke and in rowing cycle;
- Time of forces application in stroke; boat’s run during stroke;
- Rowing temp;

Athlete’s power is of decisive importance at the beginning of distance and in its middle. By the end of the distance effectiveness of athlete’s forces (boat’s run during stroke and time of forces application in stroke) take the first place.

Significance of rowing temp has average correlation and reduces at finish. Maximal forces, applied to paddle blade, and pulse have confident correlation with boat speed only at the beginning of distance (50-150 m from start). The quantity of work in rowing cycle and mean value of forces in strokes lose their significance on finish. Difference in maximal forces between strokes from left and right sides confidently correlates with boat speed only at the end of distance.

In the process of competition distance passing significance of different factors of athlete’s special fitness changes. The most informative indicators of special fitness are:
- on start – power; functional shifts; efficiency of work;
- On finish –effectiveness of used forces; symmetry of movements.

We found differences between correlations of dynamic of forces’ application to paddle and muscles’ characteristics activity. It depends on passing of one or another part of distance (50-150 m; 200-300 m; 400-500 m). Maximal forces at the beginning of distance are ensured by activity of abdomen oblique muscles. Distance speed is ensured by maximal forces, electrical activity of pectoralis major muscle and latissimus dorsi. On finish the role of rear beam deltoid muscle increases. With it, the role of the outer oblique muscles and pectoralis major muscles increases. But the role of latissimus dorsi reduces.

Passing of the beginning of distance by athlete is characterized by maximal usage of mass-inertia properties of torso rotation. In the middle of distance the pulling component of force is realized. It is ensured by activity of latissimus dorsi. With it, reaching of maximal rigidness of forces’ transmission from torso to arms and paddle as accented. Achievement of maximal working effect at finish is ensured by activity of frontal and rear beam deltoid muscles. The similar tendency was noted in the character of ensuring of average forces. However, at the beginning of distance their value depends on character of pectoralis major muscles’ activity.

The change of special fitness structure directly influences on the structure of athletes’ competition activity. High result directly depends on athlete’s physical qualities.

After period of training for non profile qualities, athletes demonstrated reduction of effectiveness of competition functioning distance component. Effectiveness of other components increased insignificantly. In athletes with prevalence of speed-power qualities effectiveness

<table>
<thead>
<tr>
<th>Athlete</th>
<th>Indicators</th>
<th>100 m</th>
<th>200 m</th>
<th>300 m</th>
<th>400 m</th>
<th>500 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence of special endurance</td>
<td>Boat speed, m/sec.</td>
<td>5,0</td>
<td>4,2</td>
<td>3,8</td>
<td>3,9</td>
<td>4,8</td>
</tr>
<tr>
<td></td>
<td>Released power, kgm/sec.</td>
<td>45</td>
<td>42</td>
<td>36</td>
<td>37</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>Difference in forces’ impulses on paddle blade in strikes from different sides of kayak, kg/sec</td>
<td>0,8</td>
<td>0,7</td>
<td>0,5</td>
<td>0,6</td>
<td>2,0</td>
</tr>
<tr>
<td>Prevalence of speed-power qualities</td>
<td>Boat speed, m/sec.</td>
<td>4,5</td>
<td>3,9</td>
<td>3,5</td>
<td>3,45</td>
<td>3,35</td>
</tr>
<tr>
<td></td>
<td>Released power, kgm/sec.</td>
<td>39</td>
<td>32</td>
<td>30</td>
<td>29</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Difference in forces’ impulses on paddle blade in strikes from different sides of kayak, kg/sec</td>
<td>1,2</td>
<td>1,1</td>
<td>0,2</td>
<td>0,1</td>
<td>0,2</td>
</tr>
</tbody>
</table>
of start component of competition functioning reduced. Effectiveness of finish component increased insignificantly. The same changes took place in athletes with prevalence of special endurance. After period of speed-power qualities' training effectiveness of distance finish component reduces with insignificant increase of start. Such orientation of training process does not result in rising of sport results ($r=0.73; p>0.05$).

In table 2 we present the data of two athletes: one athlete has domination of speed-power qualities and the second – has domination of endurance. With passing distance the first athlete demonstrates increase of forces application to paddle blade’s effectiveness. Than the effectiveness reduces and on finish – again increases.

The second athlete has quite opposite changes of these indicators: effectiveness of forces application to paddle blade reduces and than increases. On finish forces again reduce and motor asymmetry increases. Aptitude to development of some qualities imprints on dynamic of special fitness indicators. In the process of middle length distance passing (500 and 1000 m in kayak rowing) there are certain laws, which do not permit for athlete to fulfill all components of competition functioning at high level.

Four variants of 500 meters distance passing have been found: 1) alternative regime at low speed of boat and power of work on start ($A$); 2) alternative regime at low speed of boat and power of work on finish ($B$); 3) alternative regime at high speed of boat and power of work on start and finish and low – in the middle of distance ($C$); 4) even mode of passing distance ($D$).

Most of athletes pass this distance by third variant (46% of all tested athletes) 21% - by the first variant; 14% - by second variant and 19% by the forth.

When passing distance (in the mode of higher power at start and finish – regime $C$) we registered complete usage of creatine phosphate energy supply mechanisms. Its maximal activity is reached approximately by the $50^{th}$ meter of the distance. This energy supply prevalence is sustained during 100-120 m.

Specific features of such distance passing are as follows:
- Achievement of maximal oxygen consumption speed by the finish;
- Constant lactate concentration in blood;
- Higher oxygen demand on start and on finish;
- Constant reduction of oxygen deficit increment with approaching finish (see table).

When working in regime ($A$) after not intensive start acceleration athlete reaches maximal power of work (see table 3).

In this period, in organism maximal functional changes take place. By the middle of distance full exhaustion of creatine phosphate reserves happens as well as maximally possible accumulation of lactate in working muscles. It results in reduction of power on the next parts of distance. Reduction of power results in intensive lactate removal from working muscles (utilization with muscular contraction and diffusion in blood). On finish (see table 3) athlete can again increase the power of fulfilled work. For such regime it is characteristic the following:
- Complete usage of all athlete’s potentials;
- Accumulation of great oxygen debt;
- Accumulation of great lactate concentration in blood;
- Long period of sustaining of high special workability.

Other alternative regime ($B$) (see table 4) is a little bit worse in comparison with previous one. It is explained by demand in higher intensity of energy supply mechanisms on start and impossibility to fulfill the work with high power on finish. But from position of tactical tasks this variant can be acceptable for athletes with speed-power qualities’ prevalence.

Even passing of distance ($D$) is the most unfavorable,

### Table 2. Bio-energetic indicators of athletes, when fulfilling two minutes’ loads on row ergo-meter (regime $C$)

<table>
<thead>
<tr>
<th>Indicators</th>
<th>10 m</th>
<th>125 m</th>
<th>250 m</th>
<th>375 m</th>
<th>500 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>$N$, kgm/min</td>
<td>300</td>
<td>500</td>
<td>650</td>
<td>850</td>
<td>1150</td>
</tr>
<tr>
<td>$Z_{O_2}$, l</td>
<td>3,30</td>
<td>2,60</td>
<td>2,40</td>
<td>2,50</td>
<td>2,60</td>
</tr>
<tr>
<td>Lac, mg %</td>
<td>74</td>
<td>77</td>
<td>83</td>
<td>90</td>
<td>96</td>
</tr>
<tr>
<td>$f_h$, min$^{-1}$</td>
<td>123</td>
<td>155</td>
<td>168</td>
<td>176</td>
<td>187</td>
</tr>
<tr>
<td>$\Delta D_{O_2}$, l</td>
<td>0,62</td>
<td>0,41</td>
<td>0,25</td>
<td>0,15</td>
<td>0,01</td>
</tr>
</tbody>
</table>

Legend: $N$ – power of fulfilled work; $Z_{O_2}$ – oxygen demand for fulfilled work; $D_{O_2}$ – oxygen debt; Lac – lactate concentration in blood; $f_h$ – pulse.

### Table 3. Bio-energetic indicators of athletes, when fulfilling two minutes’ loads on row ergo-meter (regime $A$)

<table>
<thead>
<tr>
<th>Indicators</th>
<th>10 m</th>
<th>125 m</th>
<th>250 m</th>
<th>375 m</th>
<th>500 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>$N$, kgm/min</td>
<td>200</td>
<td>350</td>
<td>500</td>
<td>600</td>
<td>300</td>
</tr>
<tr>
<td>$Z_{O_2}$, l</td>
<td>1,01</td>
<td>2,52</td>
<td>2,73</td>
<td>2,22</td>
<td>2,51</td>
</tr>
<tr>
<td>Lac, mg %</td>
<td>63</td>
<td>80</td>
<td>94</td>
<td>100</td>
<td>106</td>
</tr>
<tr>
<td>$f_h$, min$^{-1}$</td>
<td>143</td>
<td>174</td>
<td>180</td>
<td>182</td>
<td>188</td>
</tr>
<tr>
<td>$\Delta D_{O_2}$, l</td>
<td>0,41</td>
<td>0,51</td>
<td>0,32</td>
<td>0,25</td>
<td>0,42</td>
</tr>
</tbody>
</table>

Legend: the same as in table 2.
because actually the power of fulfilled work constantly reduces. With it, boat speed can not have tendency to reduction on finish. That is why power reduction is compensated by increase of effectiveness of forces’ application to paddle blade and improvement of motor symmetry. For such regime it is characteristic:
- Constant accumulation of lactate in blood;
- Insignificant increase of oxygen consumption speed;
- Practically linear increasing of pulse;
- Stoppage of oxygen deficit increment by finish (see table 5).

Constant reduction of power is connected with accumulation of lactate, pyruvate and other under-oxidation products in athlete’s muscles. Distance passing in alternative regime of motor functioning permits for athletes to achieve higher level of special workability.

Discussion
High sport results are achieved by combination of rational strike technique and athlete’s high physical and functional fitness.

In the process of racing, during every stroke kayak undergoes speed oscillations at the account of athlete’s dynamic movements and different values of force impulse, applied to paddle blade. S.J. Kendal, R.H. Sanders [13] found that mean speed of kayak varies in the range 4.63-5.38 m/sec. In supporting period of stroke blade plunges in water and during the whole stroke creates propulsion force (projection on horizontal plane of paddle blade’s thrust). As a result boat speed increases, the frontal part of boat “comes out” of water. In not supporting period propulsion force is absent and boat “dives” again. Thus, mean speed of boat is a result of action of propulsion force and the forces resisting boat’s movement in water. Specialists point at the following: propulsion coefficient is very stable indicators, while strength and endurance of muscular groups can noticeably change during racing.

Specialists found duration of stroke phases [3]. For example, in supporting phase effective part is 54% and not effective - 19%; not supporting phase is 27% from total time of stroke. Between stroke power and boat speed there is no direct functional dependence. In some works it was determined that maximal force increment does not always result in boat speed increase. Stroke effectiveness to larger extent is determined by mean force, released in supporting phase.

The received by us results do not agree with conclusions of a number of authors that in racing the one and same groups of muscles work [8]. The muscles, participating in rowing on one boat’s side are not active in not supporting phase after this stroke. They are also not active during stroke from the other side [16, 31]. It is proved by our researches.

Achievement of high boat speed by athletes is conditioned by the whole complex of interactions between parameters of motor functioning. Our research confirms the opinion of specialists about change of some kinematic and dynamic characteristics of rowers’ movements.

Conclusions:
1. Sustaining of high workability level in passing all 500 meters’ distance on kayaks is impossible.
2. Dynamic of workability and sport results are significantly influenced by specific adaptive reactions.
3. High sport results’ achievement is facilitated by optimal structure of competition functioning.
4. Optimal structure of competition functioning shall correspond to the following:
   - Development of speed-power qualities and special endurance;
   - Athletes’ individual features;
   - Specificities of physical qualities’ manifestation in distance passing.

Conflict of interests
The authors declare that there is no conflict of interests.
References
Comparison of maximal oxygen uptake and anaerobic threshold in soccer and handball players
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Abstract
Purpose: The purpose of this study was to compare maximal oxygen uptake and anaerobic threshold values between soccer and handball players.

Material: 10 male professional soccer players and 10 male professional handball players took part in the study. Maximal oxygen uptake (VO2max) and anaerobic threshold (AT) were assessed using an incremental treadmill test. AT was estimated non-invasively using the V-slope method. The values of VO2 (ATVO2), heart rate (ATHR), time (ATTIME) and running speed (ATSPEED) corresponding to the AT were identified. AT was recorded as a percentage of VO2max (AT %VO2max) and HRmax (AT %HRmax). Time to exhaustion was determined as the total duration of the test.

Results: There were no significant differences between the two groups in the AT VO2 (ml kg⁻¹ min⁻¹) and relative VO2 (ml kg⁻¹ min⁻¹) of soccer and handball players compared to each other (p> 0.05). Similarly there were no significant differences between the two groups in the ATHR, ATTIME, AT %VO2max and AT %HRmax. Time to exhaustion was determined as the total duration of the test.

Conclusions: Although soccer and handball require different movement patterns, they may exhibit similar aerobic endurance capacity. Hence physiological requirements in both branches may be expected to be similar in relation to training volume and intensity.

Keywords: aerobic capacity, ventilatory threshold, team sports, football, handball, performance.

Introduction
Team sports such as soccer and handball area complex intermittent game requiring the repetition of high intensity activities with brief recovery periods [1, 2]. In soccer and handball, technical and tactical skills as well as the physical performance capacity of the player are most important factors that contribute to the success of a team in competitions. Competitive soccer and handball are a demanding sport that requires speed, agility, strength, muscular power and aerobic fitness [3, 4, 5]. Players require the ability to perform repeated maximal or near maximal intensity activities such as jumping, sprinting and changing of direction throughout the match [6, 7, 8]. The energy requirement is met by anaerobic metabolism during high intensity exercise periods while aerobic metabolism gains importance in order to supply homeostatic conditions at recovery intervals [9-11]. Improvements in aerobic capacity may not only be important for endurance performance, but also intermittent activities [9, 12].

Aerobic endurance is one of the main fitness components, important for success in soccer and handball [7, 13, 14]. VO2max and anaerobic threshold (AT) are the most important parameters used in the evaluation of aerobic endurance [6, 15, 16]. Measurements of VO2max, which is defined as the highest oxygen uptake that can be achieved during dynamic exercise with large muscle groups [17], are widely used to assess an individual’s capacity for the uptake, transport and utilization of oxygen [18]. During exercise, the oxygen consumption above which aerobic energy production is supplemented by anaerobic mechanisms, and which results in a significant increase in lactate and metabolic acidosis, is termed the AT [19]. AT can be determined from non-invasive gas exchange measurements alternative to the measurements of blood lactate concentration (lactate threshold), in this case referred to as the ventilatory threshold [20, 21]. Ventilator anaerobic threshold corresponds to the non-linear increase in carbon dioxide production (VCO2) and ventilation due to the bicarbonate buffering of hydrogen ions (H⁺) in response to the systematic increase of blood lactate above resting values [21].

Physiological measurements of VO2max and AT have commonly been used to monitor the training status of athletes and can help to determine the training regime [16, 22]. Knowing the VO2max and AT values of the athletes may be important in terms of contributing to the understanding the physiological requirements of different sport branches. The purpose of this study was to determine differences in VO2max and AT values of soccer and handball players.

Material and methods
Participants
Ten male handball players from the Second Turkish Division and ten male soccer players from the Third Turkish Division volunteered to participate in the study. The demographic characteristics of football and handball players are given in Table 1. The Erciyes University Ethics Committee approved the study (2013/693). All testing procedures were fully explained, and written informed consent was obtained for each subject. All measurements took place at the High Altitude and Sports Science Research and Implementation Center at Erciyes University. All the tests were conducted at the end of the season.

Cardiopulmonary exercise test
The VO\textsubscript{2max} and AT values of the athletes were determined from a progressive intensity and continuous effort treadmill protocol (h/p/Cosmos Quasar med, Nussdorf-Traunstein, Germany). Oxygen uptake (VO\textsubscript{2}), carbon dioxide output (VCO\textsubscript{2}), and minute ventilation were measured on-line using a breath-by-breath cardiopulmonary exercise testing system (Quark PFT Ergo, Cosmed Srl, Rome, Italy). Before each test, ambient conditions were measured and the gas analyzers and turbine flowmeter were calibrated with known certified gas concentrations (16% O\textsubscript{2}, 5% CO\textsubscript{2}, and balance N\textsubscript{2}) and a 3-litre (L) calibration syringe, respectively, following the manufacturer’s instructions. During the incremental testing period, heart rate (HR) was monitored continuously using a wireless HR monitor (Polar RS800 SD, Finland) and was synchronized to ventilatory signals. Breath-by-breath VO\textsubscript{2} was smoothed using a five-step average filter, and then reduced to 15 s stationary averages (Data Management was smoothed using a five-step average filter, and then reduced to 15 s stationary averages (Data Management Software, Cosmed, Rome, Italy) to reduce the noise so as to enhance the underlying characteristics [23].

To make sure the players were properly warmed up, prepared, and accustomed to the treadmill, each participant had to warm-up for 6 min at their own pace. Then the players were allowed to stop and stretch for about 3 min. Following the warm-up, players started running at 7 km/h (0% slope) with speed increments of 1 km/h every minute until they could no longer keep pace. The players were instructed to run until voluntary exhaustion, and given strong verbal encouragement throughout the test to elicit their best performance. The VO\textsubscript{2max} was defined as the highest 15 s VO\textsubscript{2} value reached during the incremental test. Achievement of VO\textsubscript{2max} was considered as the attainment of at least two of the following criteria: 1) a plateau in VO\textsubscript{2} despite increasing speed, 2) a respiratory exchange ratio above 1.10, and 3) a HR (heart rate) within 10 beats per minute of age-predicted maximum HR (220 – age) [24].

The VO\textsubscript{2max} values were expressed as absolute value (ml kg\textsuperscript{-1}) and relative value (milliliters per minute per body mass; ml kg\textsuperscript{-1} min\textsuperscript{-1}). Time to exhaustion was recorded as the time from the start of the run until the point of exhaustion (the time at which the subject could no longer maintain the pace of the treadmill). AT was estimated noninvasively using the V-slope method\textsuperscript{20}, which depends upon the increase in CO\textsubscript{2} output due to the excess CO\textsubscript{2} production from bicarbonate buffering of metabolic acidosis compared to the O\textsubscript{2} uptake during the incremental exercise test [21]. The values of VO\textsubscript{2} (AT\textsubscript{VO2}), heart rate (AT\textsubscript{HR}), time (AT\textsubscript{TIME}) and running speed (AT\textsubscript{SPEED}) corresponding to the AT were determined. In addition, the data related to AT were expressed as a percentage of VO\textsubscript{2max} (AT %VO\textsubscript{2max}) and HR\textsubscript{max} (AT %HR\textsubscript{max}).

### Statistical analyses

Data are reported as means ± standard deviation (SD). Statistical significance was accepted at p < 0.05. The normality of the data was examined by assessing the Shapiro-Wilk test on all measured variables. Ages, AT\textsubscript{VO2}, AT\textsubscript{HR} and AT %VO\textsubscript{2max} data were not normally distributed and so comparisons between the groups were made using the Whitney-U test. As the other data showed normal distribution, the differences in measures between groups were evaluated by unpaired t-test. The SPSS version 16 was used for all analyses (16, SPSS Inc. Chicago, IL). Linear regression analyses were performed by using the Sigma Plot program (SigmaPlot 12.0, Systat Software Inc., Chicago, USA) to determine the anaerobic thresholds of the athletes.

### Results

The physical characteristics of both groups are presented in Table 1. There were no significant differences between the age, height, body mass and sports ages of soccer players and handball players compared to each other (p > 0.05). There were no significant differences between the two groups in the time to exhaustion (min), HR\textsubscript{max} absolute VO\textsubscript{2max}, and relative VO\textsubscript{2max} (ml kg\textsuperscript{-1} min\textsuperscript{-1}) (p > 0.05; Table 2). Similarly there were no statistically significant difference between the two groups

<table>
<thead>
<tr>
<th>Table 1</th>
<th>The physical characteristics of the handball and soccer players (Mean ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Handball Players</td>
</tr>
<tr>
<td>Age (year)</td>
<td>23.1 ± 5.17</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>188.2 ± 8.92</td>
</tr>
<tr>
<td>Body Mass (kg)</td>
<td>85.9 ± 12.76</td>
</tr>
<tr>
<td>Sport age (year)</td>
<td>14 ± 6.73</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Cardiopulmonary exercise test results of handball and soccer players (Mean ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Handball Players</td>
</tr>
<tr>
<td>VO\textsubscript{2max} (ml kg\textsuperscript{-1} min\textsuperscript{-1})</td>
<td>48.72 ± 4.17</td>
</tr>
<tr>
<td>VO\textsubscript{2max} (ml min\textsuperscript{-1})</td>
<td>4138.4 ± 351.3</td>
</tr>
<tr>
<td>Time to exhaustion (min)</td>
<td>9.76 ± 1.48</td>
</tr>
<tr>
<td>HR\textsubscript{max} (beat min\textsuperscript{-1})</td>
<td>188.4 ± 10.6</td>
</tr>
<tr>
<td>Relative VO\textsubscript{2} at AT (ml kg\textsuperscript{-1} min\textsuperscript{-1})</td>
<td>37.56 ± 4.13</td>
</tr>
<tr>
<td>Absolute VO\textsubscript{2} at AT (ml min\textsuperscript{-1})</td>
<td>3215.8 ± 506</td>
</tr>
<tr>
<td>AT % VO\textsubscript{2}max</td>
<td>77.2 ± 7.1</td>
</tr>
<tr>
<td>AT % HR\textsubscript{max}</td>
<td>160.9 ± 7</td>
</tr>
<tr>
<td>Time at AT (min)</td>
<td>4.13 ± 1.5</td>
</tr>
<tr>
<td>Speed at AT (km h\textsuperscript{-1})</td>
<td>10.7 ± 1.56</td>
</tr>
</tbody>
</table>
in the AT\_SPEED \ (\text{km} \ \text{h}^{-1}), \ \text{AT\_TIME} \ (\text{min}), \ \text{AT\_HR}, \ \text{absolute AT\_VO2} \ (\text{ml} \ \text{min}^{-1}), \ \text{relative AT\_VO2} \ (\text{ml} \ \text{kg}^{-1} \ \text{min}^{-1})$, relative AT\_VO2 \ (ml kg\textsuperscript{-1} mind\textsuperscript{-1}), AT \%VO2\textsubscript{max} and AT \%HR\textsubscript{max} \ (P> 0.05).

Discussion

Athletes with high VO2\textsubscript{max} and AT can more easily tolerate high intensity exercise, and perform exercise for longer periods of time in homeostatic conditions [10, 11, 12, 25]. Physiological measurements of VO2\textsubscript{max} and AT are important for monitor the training status of athletes, and determining the optimal training intensity [16, 22]. In the present study, there were no significant differences between the two groups in the time to exhaustion, VO2\textsubscript{max} and AT, suggesting that the aerobic endurance levels of soccer and handball players may be similar. Although soccer and handball require different movement patterns, they may exhibit similar aerobic endurance capacity. Hence physiological requirements in both branches may be expected to be similar in relation to training volume and intensity.

In order to be able to comment on the aerobic capacity, it is necessary to evaluate together the whole factors that determine the rate and amount of use of oxygen at tissue level. The analysis of the respiratory gas exchange with cardiopulmonary exercise tests give the opportunity to assess the cellular, cardiovascular and pulmonary responses to metabolic stress created during exercise [17, 18]. VO2\textsubscript{max} is regarded as the best determinant of aerobic capacity and important criterion affecting aerobic endurance performance [4, 18]. There is a limited number of studies in the literature comparing aerobic capacities of soccer players and handball players with each other by cardiopulmonary exercise tests. Our findings have shown that there are no significant difference absolute VO2\textsubscript{max} (ml min\textsuperscript{-1}) and relative VO2\textsubscript{max} (ml kg\textsuperscript{-1} mind\textsuperscript{-1}) values between soccer and handball players with similar sports ages and physical characteristics. In contrast to our findings, Malacko et al. showed that the VO2\textsubscript{max} values of soccer players in the first league were higher than handball players in the first league [26]. On the other hand, it is seen that in their study VO2\textsubscript{max} values (55.32 ml kg\textsuperscript{-1} mind\textsuperscript{-1}) of soccer players are higher than handball players participating in our study [26]. This difference may be due to the fact that soccer players played in the third league and handball players played in the second league in our study. Similarly, Ferreira et al. showed that VO2\textsubscript{peak} values of young (age 17.7 years) and professional (age 23.2 years) soccer players were significantly higher than those of handball players (age 19 years) [27]. During a 90-minute soccer match, players run about 10km at an average 80–90% of maximal heart rate [28]. On the other hand, during a 60-minute handball match, players run about 4 to 6 km at a mean intensity close to 80–90% of maximal heart rate [29]. This information suggests that intensity of game in both branches similar, but that there may be differences in aerobic endurance performances of athletes when the duration of the game or the distance covered is taken into consideration.

In soccer and handball, players perform different types of physical activities requiring muscular power such as the various sprints, jumps, and quick changes of direction. The players’ success depends on ability to repeatedly these physical activities at maximal or near maximal efforts with limited recovery over the duration of a match [1, 2]. Players require well-developed aerobic capacity to maintain maximal performance throughout the match and to recover faster during the short periods of lower intensity or rest [9, 11, 12]. The handball players with a higher VO2\textsubscript{max} can run at higher speeds during a match and can sprint more [14]. In the literature, it is seen that the handball players’ VO2\textsubscript{max} values measured by the cardiopulmonary exercise tests have different results. Our findings were consistent with those of Vujkov et al. reported that professional handball players’ VO2\textsubscript{max} values are 48.4 ml kg\textsuperscript{-1} min\textsuperscript{-1} [30]. On the other hand, Sporis et al. reported that VO2\textsubscript{max} values of elite handball players are 54 ml kg\textsuperscript{-1} min\textsuperscript{-1} [31]. Similarly, Buchheit et al. reported that VO2\textsubscript{max} values of handball players 57.3ml kg\textsuperscript{-1} min\textsuperscript{-1} [32]. Previous studies have shown a significant correlation between VO2\textsubscript{max} and distance covered during a soccer match [33, 34]. Similar to our findings, Clark et al. (2008) reported that the VO2\textsubscript{max} values of professional male soccer players were 49.5 ml kg\textsuperscript{-1} min\textsuperscript{-1} [35]. On the other hand, in the literature, there are many studies showed that the VO2\textsubscript{max} values of professional soccer players are higher than our findings [26, 28, 36, 37]. It can be suggested that the differences in the VO2\textsubscript{max} values in the literature may be due to the difference in the training levels of the players.

Because of the difference in the metabolic systems in which energy is obtained during exercise, the intensity of exercise corresponding to AT must be known for the interpretation of performance and the preparation of the scientific training program. Exercise intensity corresponding to AT varies according to the physical conditioning of athlete. AT is considered an important criterion in assessing aerobic endurance [7, 16]. In the present study, there were no significant difference between the heart rate, time, running speed, absolute VO2 (ml min\textsuperscript{-1}) and relative VO2 (ml kg\textsuperscript{-1} mind\textsuperscript{-1}) values at the AT of soccer players and handball players. When AT expressed as a percentage of VO2\textsubscript{max} and HR\textsubscript{max}, it was also seen that there were no significant difference between the AT values of soccer players and handball players. Ferreira et al. showed that there was no significant difference between the running speed and heart rate at the AT of young soccer players and handball players. On the other hand, they found that the running speed and heart rate at the AT of professional soccer players were significantly higher than both groups [27]. These results suggest that the level of league played by players may be a determinant of VO2\textsubscript{max} and AT.

There are a limited number of studies examining the anaerobic threshold values of handball players. In the study by Pontaga et al. professional handball players’ AT values (41.1 ml kg\textsuperscript{-1} min\textsuperscript{-1}, 88.7 %VO2\textsubscript{max}, 91 %HR\textsubscript{max}) of determining by blood lactate measurements, were higher than our handball players [38]. The reason this may be
attributed to differences in the measurement techniques. As a matter of fact, in their study [38], VO$_{2\text{max}}$ (46.4 ml kg$^{-1}$min$^{-1}$) values of handball players in the first league seem to be similar to our study group. It is seen that in the literature, different results are revealed in the studies that determine AT with the gas exchange methods in soccer players. Similar to our research findings, Al Hazzaa et al. determined VO$_2$ values at AT of elite football players as 43.60 ml kg$^{-1}$min$^{-1}$ [39]. In the study by Clark et al. professional soccer players’ VO$_2$ values at AT (34.1 ml kg$^{-1}$min$^{-1}$) were lower than our handball players [35]. In the study by Chin et al. AT values (47.2 ml kg$^{-1}$min$^{-1}$) of the professional soccer players were higher than our soccer players [36]. In another study, Casajus et al. reported that VO$_2$ values at AT of soccer players playing in the first league of Spain were 50.2 ml kg$^{-1}$min$^{-1}$ [37]. This difference in VO$_2$ values at AT may be due to the VO$_{2\text{max}}$ values of the soccer players (59.1 and 65.5 ml kg$^{-1}$min$^{-1}$, respectively) in these studies were higher than in our study group [36, 37]. On the other hand, when AT expressed as a percentage of VO$_{2\text{max}}$ (80% and 77%, respectively) [36, 37], it is seen that the difference between the findings of our study and these studies disappears. Similarly, other studies have shown that professional soccer players’ AT occurred at 76% [39] and 80% of VO$_{2\text{max}}$ [16]. In addition, when AT of the soccer players is expressed as a percentage of HR$_{\text{max}}$, it is seen that our findings are similar to those found (85.6 – 89% HR$_{\text{max}}$) in previous studies [36, 37, 39].

Conclusions
In the present study, no significant difference was observed between VO$_{2\text{max}}$ and AT values of professional soccer players and handball players, suggesting that the aerobic endurance levels of soccer and handball players may be similar. These findings suggest that although, soccer and handball are different sports branches in terms of game rules and technical features, the players in both branches may be performing similar training loads (intensity and volume). On the other hand, considering that the duration of the soccer game is longer than the handball and the playing field is larger, it can be expected that the aerobic capacities of the soccer players are higher than handball players. The fact that the soccer and handball players in this study competing in the third and second division of the league respectively, may be a factor for their similar level of aerobic capacities. It is suggested that detailed studies related to aerobic capacity should be carried out on soccer players and handball players playing in different divisions.

Funding/support
No financial or grant support was received for this work.

Conflicts of interest
The authors have no conflicts of interest relevant to this study.

References


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Received: 13.06.2017
Accepted: 25.06.2017; Published: 10.08.2017

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Comparative analysis of effectiveness of some students’ physical culture training methodic

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Abstract

Purpose: scientific researches witness about presence of serious tendency to weakening students’ everyday motor activity and absence of motivation to physical culture and sports practicing. Some specialists offer to solve this problem by making physical culture classes more oriented on sports. At the same time there are studies, offering to use methodic of cardio-power training. Comparative analysis of effectiveness of different programs on Physical culture trainings with the help of sport oriented approach and functional-power training. The main criterion of trainings’ effectiveness was the level of physical and functional fitness of students’ organism to physical loads.

Material: in the research students (n=600: boys – n=300, girls – n=300, age – 19-20 years) participated. Selection of students was fulfilled, considering indicators of body mass. We used the methods of physical condition control and assessment (control tests) and functional fitness (functional tests). Besides, we considered indicators of busy mass by students’ regular weighing.

Results: we found some increase of body mass of students, who attended different sport specialization trainings. Boys and girls (athletic gymnastic and ping pong) demonstrated confident body mass increase in average by 3-4 kg during academic year. Students, practicing cardio-power training - HOT IRON—practically did not increase body mass. Difference in body mass indicators of such students between beginning of trainings and at the end of the researches was insignificant (±0.3 kg). Tests’ results witness about general reduction of indicators of students’ physical mass changes and targeted application of cardio-power training programs.

Conclusions: our results witness that there is a demand in corrections of students’ physical culture training methodic. Their base is programs of sport oriented physical education. With it, it is necessary to compulsory consider dynamic of body mass changes and targeted application of cardio-power training programs.

Keywords: health, motor activity, students, physical education programs, sport-oriented approach, cardio-power training, physical condition, functional fitness.

Introduction

In modern higher education students’ physical education endures rather serious changes [4]. It has been found that substantial intensification of educational process served as significant factor of students’ everyday motor activity weakening [5, 17, 21]. One more important factor of negative influence on students’ health is their excessive involvement in computer games and internet communication [3, 20, 22]. Deficit of students’ everyday motor activity results in emersion of different diseases, excessive increase of body mass and obesity [6, 25, 34, 40].

Specialists in the field of physical education offer to solve the problem of students’ insufficient motor activity by increasing the level of motivation settings to regular physical culture and sports practicing [27, 24, 46]. It is known that students’ motivation is very important in physical culture and sports [7, 2, 9, 19]. Many students consciously do not attend academic physical culture classes, thinking that they are not important for them. One more reason of low motivation is absence of proper attention of universities’ administration to sport facilities condition [26]. This problem is very urgent as far as at present time organization and methods of physical culture trainings do not meet modern requirements [23].

Specialists say that there is an acute demand in realization of students’ health improvement programs as quick as possible (both bachelor and masters students) [30, 51]. In scientists’ opinion modern physical education programs for students shall be directed at the following: increase of cultural level; preservation of psychic health; formation of steady motivations for healthy life style [8, 21, 11].

Specialists say that physical education methodic, oriented on sport oriented approach to trainings’ organization and fulfillment corresponds to the largest extent to the mentioned conditions [13, 28, 49]. Different studies show that there is noticeable positive correlation between physical culture trainings on the base of sport-oriented approach and students’ psycho-physical qualities [10, 43, 45, 47]. Increase of level of young people’s professional-applied physical fitness for future professional activity [42]. Scientific works witness that different sport mass competitions influence positively on students’ psychic health [16].

At the same time in literature there are data about use of individualized physical education of students [31]. Scientists found that boy-students’ physical activity level is higher than the same of girl-students [12]. Therefore, physical education programs, considering students’ main demands will be wanted [37]. The studies show that the main demand of girls is physical attractiveness of body:
beauty of lines, flexibility, plasticity and grace [1, 29]. Boys prefer physical qualities: strength, endurance and quickness [14]. In specialists’ opinion such demands can be satisfied completely by methodic of cardio-power training. In the base of such methodic there are power exercises, fulfilled under rhythmic music [29, 32]. Application of such exercises permitted to substantially increase students’ (boys and girls) physical fitness. Such approach will permit to successfully resist global threat – obesity of modern youth [44]. Specialists also note high students’ interest to physical training on the base of functional and power training (fitness, cross-fit, HOT IRON) [29, 48].

At present, it is admitted by specialists that students’ everyday way of life is a decisive factor of their professional longevity and health [38]. The main component of healthy life style will be optimal level of modern young people’s everyday motor activity [33, 36]. It is known that optimal level of everyday motor activity is a protective barrier against many not catching diseases [17]. In scientists’ opinion just the programs of physical culture trainings, based on sport-oriented approach and individualized functional-power training will be able to ensure optimal level of modern young people’s everyday motor activity. At the same time among scientists there no single opinion about the most effective programs of young people’s (schoolchildren and students) physical education.

Hypothesis: it is assumed that comparative analysis of recommended by specialists, practical trainings’ methodic will facilitate finding of the most effective methodic. These programs are: trainings on the base of profound practicing of a kind of sports; trainings on the base of power and functional training.

The purpose of the research: is determination of the most effective program for students’ physical and functional fitness and methodic of physical culture practical classes in universities.

Material and methods

Participants: in the research students (n=600: boys – n=300, girls – n=300, age – 19-20 years) participated. All the tested were the students of Siberian federal university. Selection of students was fulfilled, considering indicators of body mass. Mass range of boys’ bodies was 75.9 – 79.1 kg. Mean value of boys’ body mass was 77.5 kg. Mass range of girls’ bodies was 47.9 – 52.3 kg. Mean value of girl’s’ body mass was 49.8 kg. All students gave their consent for participation in the research.

Organization of the research: the researches were conducted during academic year. Students (boys and girls) were divided into two equal groups. The students attended physical culture classes of certain specialization, by their choice (trainings, based on profound practicing of definite kind of sports). For our studies we chose the most popular among students, specializations: athletic gymnastic, boxing, basketball, volleyball, ping pong. Two students’ groups (boys and girls) attended trainings, based on cardio-power training (HOT IRON) [32]. It should be noted that HOT IRON trainings at high quality are possible only through specialized training. In Russian Federation only a few HEE teachers have international certificates of HOT IRON instructors. Therefore, practicing of students’ trainings on the base of such programs contains element of scientific novelty.

At the beginning and at the end of the research all students passed a number of tests for general physical fitness. It permitted to rather objectively assess the students’ physical condition and functional fitness. It is known that main parameters of physical workability have strong correlations with human physical fitness [41]. General physical fitness is a necessary component of person’s physical health [39]. Insufficient physical fitness negatively influences on human physical health in general.

Strength was assessed by quantity of chin ups (for girls it was the quantity of pressing ups from the floor). Endurance was assessed by time of 3000 meters’ run (for girls – 2000 meters’ distance). Quickness was registered by time of 100 meters’ run. Forward bending in sitting position was the test for flexibility. Functional fitness was assessed by results of Martinet’s test. Besides, every month we regularly measured students’ body mass. The purpose of weighing was to control dynamic of body mass changes under influence of differently oriented physical exercises.

Statistical analysis was fulfilled with the help of SPSS20 program. Results of mean values in two interconnected samples were carried out with Student’s t-test.

Results

At the beginning of the researches, by results of control tests we did not find confident differences. Boys and girls demonstrated approximately equal potential of muscular strength, general endurance, flexibility and quickness. Results of functional test (Martinet’s test) also witnessed about prevalence of normosthenic type of reaction to physical load in majority of students. In average, in boys normosthenic type of reaction was found in 93% and in girls – in 86%. Body mass indicators were in average: in boys – 77.5 kg and in girls – 49.8 kg.

At the end of the researches we found distinctions in control tests’ results and, sometimes, rather substantial. Students (athletic gymnastic: boys and girls) demonstrated significant (P<0.05) increase of physical strength indicators and insignificant reduction of flexibility and quickness (boys). In girls worsening of quickness indicators was confidently significant (P<0.05). Besides, we found noticeable (P<0.05) reduction of general endurance indicators and worsening of Martinet test’s results. Mean values of students’ body mass (athletic gymnastic – boys and girls) increased confidently in average by 4 kg.

Students (boxing: boys and girls) increased physical strength and flexibility indicators insignificantly. These students demonstrated not confident worsening of quickness and general endurance indicators. Functional
fitness of organism to loads (Martinet’s test) was confidently (P<0.05) less than at the beginning of the research. Mean values of students’ body mass (boxing) increased insignificantly (within 1 kg).

In students (boys and girls – basketball) we found insignificant increase of physical strength indicators at the end of the researches. General endurance, flexibility and quickness worsened a little. Martinet test’s results point at reduction of quantity of students, having normosthenic type of reaction to physical loads. Weighing showed that body mass of the tested students increased in average by 1.7 kg. Increase of girls’ body mass was statistically significant (in average by 2.2 kg).

Young people (boys and girls – volleyball) demonstrated insignificant reduction of physical strength, general endurance, quickness and flexibility at the end of the research. We also registered worsening of positive results by type of organism’s reaction to physical load (not confident. Body mass indicators increased in average by 2 kg in boys and 1 kg in girls.

Students (boys and girls – ping pong) demonstrated insignificant reduction of flexibility and quickness indicators. Physical strength remained practically at the level, which was at the beginning of experiment. We found significant (P<0.05) weakening of general endurance and statistically significant reduction of Martinet test’s results. Body mass confidently (P<0.05) increased in average by 3 kg in boys and by 2.6 kg in girls.

Students (boys and girls - HOT IRON) demonstrated confidently significant (P<0.05) increase of physical strength, general endurance and flexibility indicators at the end of experiment. Quickness increased insignificantly. Martinet test’s results point at reduction of quantity of students (boys and girls), having normosthenic type of reaction to physical loads. Body mass indicators increased not confidently, within 0.3 kg and insignificant reduction (within 0.2 kg) in girls.

Complete results of the researches are shown in tables 1 and 2.

Table 1. Indicators of physical condition and functional fitness of the tested students (boys– n=300)

<table>
<thead>
<tr>
<th>Training programs</th>
<th>Description of indicators</th>
<th>Strength</th>
<th>Quickness</th>
<th>Endurance</th>
<th>Flexibility</th>
<th>Martinet’s test</th>
<th>Body mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athlete gymnastics (n=50)</td>
<td></td>
<td>18±4</td>
<td>23±2*</td>
<td>13±0,7</td>
<td>14±0,9</td>
<td>13,25</td>
<td>14,25*</td>
</tr>
<tr>
<td>Basketball (n=50)</td>
<td></td>
<td>11±4</td>
<td>12±4</td>
<td>12±0,6</td>
<td>13±0,4</td>
<td>13,05</td>
<td>13,20</td>
</tr>
<tr>
<td>Boxing (n=50)</td>
<td></td>
<td>13±4</td>
<td>15±3</td>
<td>12±0,9</td>
<td>13±0,5</td>
<td>13,10</td>
<td>13,22</td>
</tr>
<tr>
<td>Volleyball (n=50)</td>
<td></td>
<td>10±3</td>
<td>10±4</td>
<td>13±0,1</td>
<td>14±0,1</td>
<td>13,22</td>
<td>13,40</td>
</tr>
<tr>
<td>Ping pong (n=50)</td>
<td></td>
<td>8±2</td>
<td>8±3</td>
<td>13±0,3</td>
<td>14±0,6</td>
<td>13,16</td>
<td>14,20*</td>
</tr>
<tr>
<td>HOT IRON (n=50)</td>
<td></td>
<td>10±2</td>
<td>15±4*</td>
<td>13±0,9</td>
<td>13±0,1</td>
<td>13,35</td>
<td>12,40*</td>
</tr>
</tbody>
</table>

Notes:* - P<0.05 – level of significance

Table 2. Indicators of physical condition and functional fitness of the tested students (girls – n=300)

<table>
<thead>
<tr>
<th>Training programs</th>
<th>Description of indicators</th>
<th>Strength</th>
<th>Quickness</th>
<th>Endurance</th>
<th>Flexibility</th>
<th>Martinet’s test</th>
<th>Body mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athlete gymnastics (n=50)</td>
<td></td>
<td>15±2</td>
<td>20±2*</td>
<td>15±0,6</td>
<td>17±0,4*</td>
<td>11,15</td>
<td>12,25*</td>
</tr>
<tr>
<td>Basketball (n=50)</td>
<td></td>
<td>10±3</td>
<td>12±2</td>
<td>15±0,3</td>
<td>16±0,2</td>
<td>10,45</td>
<td>11,05</td>
</tr>
<tr>
<td>Boxing (n=50)</td>
<td></td>
<td>12±3</td>
<td>15±3</td>
<td>15±0,2</td>
<td>15±0,8</td>
<td>10,35</td>
<td>10,52</td>
</tr>
<tr>
<td>Volleyball (n=50)</td>
<td></td>
<td>10±2</td>
<td>12±3</td>
<td>15±0,4</td>
<td>16±0,3</td>
<td>10,40</td>
<td>11,10</td>
</tr>
<tr>
<td>Ping pong (n=50)</td>
<td></td>
<td>6±4</td>
<td>6±3</td>
<td>15±0,4</td>
<td>16±0,9</td>
<td>11,05</td>
<td>12,20*</td>
</tr>
<tr>
<td>HOT IRON (n=50)</td>
<td></td>
<td>10±3</td>
<td>16±2*</td>
<td>15±0,5</td>
<td>14±0,9</td>
<td>11,15</td>
<td>10,15*</td>
</tr>
</tbody>
</table>

Notes:* - P<0.05 – level of significance
Discussion

The received data can cause some questions of specialists. But our data concern with some works, devoted to studying of the most effective methodic of physical culture practicing in higher educational establishments [30, 35]. As it is known, before enrolling to definite sport specialization students are selected. Selection is fulfilled by results of tests for general physical fitness: chin ups, jumps, run and so on. Teachers enroll to specialization the most physically trained students. However, the level of fitness to technical elements of definite kind of sports in most of students is not high. Thus, most of training time is spent for training of basic technical actions. A little attention has to be paid to perfection of fulfillment of exercises and game interactions [31]. The volume of motor activity, devoted to training of new technical elements, is hot large. It explains some reduction of main indicators of students’ physical condition with the time.

It should be noted also unsatisfactory quality of sport facilities in most universities for trainings on the base of sort-oriented approach. It was found that most of students can not realize to the fullest extent their potential because of deficit of sport facilities and equipment. For example, for ping-pong training of 50 students it is necessary to have 25 tennis tables. For basketball trainings such quantity of students will require 5 sites. To play any games students have to wait their turn for long time.

That is why we offer to make some corrections of structure and methodic of such trainings. Physical culture teachers shall pay attention to opportunities for increase of students’ motor activity. It is possible at the account of noticeable increase of time for game and competition activity. In most of schools and HEES of the USA and Canada physical culture classes are conducted in the form of direct competition training and competitions in football, basketball, baseball [50].

Besides, it is necessary to introduce compulsory control over changes of students’ body mass. Significant changes of body mass shall be followed by correction of trainings’ structure and methodic.

In its turn, methodic of functional and power training (HOT IRON) demonstrated effectiveness in prevention from obesity. Mainly, this effect is achieved by high level of motor activity and power and aerobic loads’ reasonable combination. Such methodic becomes popular in different countries. For example, in China physical education programs are oriented of sport perfection with the help of fitness programs [15]. But even this methodic requires certain changes. For example specialists found need in substantial development of some professionally important for future specialist abilities: speed-power and coordination [42]. For this purpose physical culture teachers shall use at classes complexes of exercises, facilitating optimal development of such abilities.

Conclusions

1. It was found that reduction of students (boys and girls), attending sport oriented physical culture trainings, main physical condition indicators is, in a number of cases, confidently significant (P<0.05). Students of some specializations (athletic gymnastic, boxing, ping pong) demonstrated noticeable worsening of type of organism’s reaction to physical load (Martinet’s test). Students, who practiced individual cardio-power training demonstrated confident (P<0.05) increase of physical strength, endurance and flexibility. In most of students type of reaction to physical load remained to be normosthenic.

2. Our results showed negative dynamic of body mass increase in most of students, in average by 2.5 kg (boys) and 2 kg (girls) (during academic year. Increase of body mass takes place independently on specific of the chosen by students kind of sports. It permits to affirm that general level of motor activity (boys and girls – sport oriented approach) is not sufficient for prevention from body mass increase and obesity. Students (functional-power training) did not demonstrated noticeable body mass changes during academic year. It permits to recommend the methodic of cardio-power training as effective mean for prevention from obesity in students.

Conflicts of interest

The authors have no conflicts of interest relevant to this study.

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Comparative analysis of effectiveness of some students' physical culture training methodic.

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Cite this article as: Osipov A Yu, Kudryavtsev MD, Iermakov SS, Yanova MG, Lepilina TV, Plotnikova II, Dorzhieva OS. Comparative analysis of effectiveness of some students’ physical culture training methodic. Physical education of students, 2017;21(4):176–181. doi:10.15561/20755279.2017.0405

The electronic version of this article is the complete one and can be found online at: http://www.sportedu.org.ua/index.php/PES/issue/archive

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Received: 13.06.2017
Accepted: 25.06.2017; Published: 10.08.2017

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Analysis of martial arts athletes’ goniometric indicators

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Abstract

Purpose: comparative analysis of limbs’ joints goniometric indicators of martial arts athletes; study of sportsmanship level influence on kick boxers’ movements’ amplitude.

Material: martial arts athletes – students and senior pupils (n=29) participated in the research. The participants were divided into two groups. 1st group consisted of 18 kick boxers of age 17.44±0.34 years, 2nd group included 11 wrestlers of age 18.45±0.39 years. The first group was divided into two sub-groups: sub group 1a – 9 athletes of age 18.22±0.52 years and sportsmanship level; candidates and masters of sports. Sub group 1b consisted of 9 athletes, age (16.67±0.24) years and sportsmanship level from beginners to 1st sport category. We registered movements’ amplitude in wrist, shoulder, elbow, hip, knee and ankle joints.

Results: we confirmed the distinctions of goniometric indicators of martial arts athletes’ limbs joints. It was found that sportsmanship level of kick-boxers influences to certain extent on movements’ amplitude. The found distinctions reflect clearly specific of kind of sports. Wrestlers have higher amplitude of movements in wrist joints that determines reliable grip in a fight. Kick boxers have better amplitude of movements in elbow and shoulder joints. It permits to punch with higher strength. The closeness of goniometric indicators of different sportsmanship kick-boxers proves equal orientation of their training. Need in constant keeping combat stance conditions reduction of in-movement amplitude in right wrist joint and outside movement in left shoulder joint of experienced athletes.

Conclusions: increase of abduction in hip joint and reduction of bending in left knee joint illustrate specificities of punching/ kicking, optimization of their technique in experienced athletes. The higher is training experience, the more working asymmetry of joints’ movements is.

Keywords: martial arts, goniometric, indicators, successfulness, asymmetry.

Introduction

Intensive physical trainings facilitate harmony of physical condition and optimization of athletes’ functional state [3]. Rising of athletes’ efficiency is ensured by study of special aspects of special qualities’ formation and their level’s optimization. In the complex of successfulness factors important place is taken by condition of muscular skeletal apparatus. Its condition can be assessed with the help of special method – goniometry.

In review of Atwater Anne E. [2] there is a conclusion about goniometric studies’ prospects in sports and physical culture. Results of goniometry increase effectiveness of researches, devoted to kinesiology and bio-mechanics. Lees Adrian [20] analyses possibilities of bio-mechanical and goniometry methods’ application in study movements’ technique. Achievement of results is possible only with complex application of qualitative, quantitative and prognostic methods.

Application of goniometry in analysis of exercises with weights has been proved [6]. Goniometric researches of knee joint permit to assess the complex of movements’ kinematic. In its turn, it permits to optimize mastering of this technique by athletes. Ribeiro A. & Pascoal A. [32] analyzed active and passive movements of athletes and people, who do not practice sports, shoulder joints. Application of goniometry permitted to find high amplitude of outside rotation in discus throwers. Norris Beth S. & Olson Sharon L. [24] confirmed the validity of goniometry and researches with the help of 2D video analysis for studying of hip and knee joints’ movements. Rogers Kate & Gibson Ann L. [33] used goniometry as the method for assessment of Pilates trainings. They proved significant flexibility improvement resulted from 8 weeks’ training program.

Goniometric analysis of ballet movements was fulfilled by Quanbeck Amy E. et al. [31]. They found higher angle value of rotation in comparison with available results.

Goniometry is used rather widely in sport games. Morozova E.V. [23] used goniometry for study muscular skeletal apparatus’s functional state of football players. Low flexibility, by results of goniometry, witnesses about non-elasticity of shortening of muscles and ligaments. It is one of signs of muscular skeletal apparatus’s chronic over-tension.

Udokhina L.A. et al. [38] used goniometry for assessment of first maturity men – football players and those, who do not practice sports, anthropometric characteristics. They found that angle of active bending in knee joint of football players is less than in their peers. Fajzulin D.E. & Orlov A.V. [11] proved importance of elite goal keepers in mini-football special flexibility with the help of goniometry.

Mel’nicuk K.N. [21] used goniometry for assessment of functional state of juir tennis players’ muscular-ligament apparatus (upper limbs). High informative value of this method for mobility in elbow joint determination was confirmed. Panasiuk T.V. & Raspopova E.A. [25] studied functional aspects of muscular-skeletal apparatus, formed under influence of dividing. They found hypertrophy of the most loaded muscular groups, high mobility in joints and changes of posture. It is caused by specificities of divers’ muscular activity. body.

Zebzeev V.V. [41] offered goniometric research as a tool of control over biathlon skiers’ functional fitness. Similar results were obtained by Pozhidaev S.N. [29]. The author substantiated application of goniometry for testing in gymnastics. Jonsson Per et al. [17] found that different speed of thumb’s movements can be a risk factor of traumatizing. Usage of electronic goniometer for study...
of fingers’ movements permitted to substantially reduce errors, comparing with mechanical device.

Podrigalo L.V. et al. [26] analyzed results of goniometry of arm wrestlers’ and amateurs’ arm joints. They proved high movements’ amplitude in athletes, especially in wrist joints. The data were interpreted as proof of hand’s importance for efficiency in arm wrestling.

In other works the laws of bio-kinematic links of martial arts athletes were found:

- Maximal speed (result and value in every plane) of lower limbs’ segments (thigh, shin and foot) was found as well as time of reaching this speed in fulfillment of kicks in Thae-quan do. The measurements for kinematic analysis were fulfilled with the help of two three dimensional power plates and eight chambers’ motion system [9].
- Initial position of athlete as factor, influencing on Thae-quan-do technique, was determined. For measuring angle shifting of pelvis and thigh the motion system [10];
- Positions of boxers’ torso and legs, which influence on successfulness of punching, were found. For obtaining kinematic data motion system Vicon 3D was used [12];
- Parameters, which, to large extent, conditioned maximal speed of foot movement in kicking, were determined. 3D kinematic of kicks of 22 Thae-quan do athletes was recorded with the help of motion system (Vicon Motion Systems Limited, Oxford, Great Britain) [30];
- For different kinds of analysis bio-mechanical parameters, connected with range of movements, strength of punch/kick and time of punch/kick, were used. 3D technology of motion system was used [39];
- Quantitative indicators of karatekas’ movements, characterizing balance in competitions, were measured. Step width and angle articulation of athlete’s body bio-links were registered [40];

The following are important aspects in perfection of martial arts athletes’ training:

- Theoretical-methodic substantiation of sport wrestling means’ usage in physical training of cadets of lyceum with advanced military-physical training [4];
- Special aspects of special workability of elite wrestlers [37].
- Optimization of physical load in Judo wrestlers’ training [1, 13];
- Formation of Judo-wrestlers’ active attitude to sports [5];
- Increase of different kinds of Judo wrestlers’ muscular strength for formation of technical skills [8];
- Differentiation of body composition in athletes’ training for Thae-quan do competitions [16];
- Finding of criteria of athletes’ talent in combat kinds of sports and self-defense [18];
- Finding of individual aptitude of elite wrestlers to work in different regimes [36].

Analysis of researches points at possibilities to use goniometry indicators for perfection of martial arts athletes’ trainings. With such approach it is recommended to combine goniometry indicators with other characteristics of athletes’ actions.

The purpose of the research is comparative analysis of limbs’ joints goniometric indicators of martial arts athletes; study of sportsmanship level influence on kick boxers’ movements’ amplitude.

Material and methods

Participants: martial arts athletes – students and senior pupils (n=29) participated in the research. The participants were divided into two groups. 1st group consisted of 18 kick boxers of age 17.44±0.34 years. 2nd group included 11 wrestlers of age 18.45±0.39 years. The first group was divided into two sub-groups: sub group 1a – 9 athletes of age 18.22±0.52 years and sportsmanship level: candidates and masters of sports. Sub group 1b consisted of 9 athletes, age (16.67±0.24) years and sportsmanship level from beginners to 1st sport category.

Organization of the research: with the help of goniometer, produced by firm IGaging® we registered movements’ amplitude in wrist, shoulder, elbow, hip, knee and ankle joints. We fulfilled 2-3 registrations of one and the same movement, fixing maximal indicators. In wrist, shoulder and hip joints we assessed: bending (flexio), unbending (extensio), abduction (abductio), adduction (adductio). In elbow, knee and ankle joints we assessed bending and unbending.

Statistical analysis was fulfilled with the help of licensed electronic tables Excel. We determined indicators of descriptive statistics: mean arithmetic, standard deviation and error of mean arithmetic. Confidence of differences in groups was assessed with the help of parametric Student’s t-test and non-parametric tests of Wilcoxon – Manna – Whitney (U) and Wald – Wolfowitz (r).

Results

The received data are presented in tables 1-3.

We found that movements’ amplitude in wrist joints was higher in wrestlers. It is confirmed with Student’s test for abduction of both hands. Wilcoxon – Manna – Whitney test proved substantial differences between bending of right hand (U=29, p<0.05) and left hand (U=31, p<0.05), unbending of right joint (U=33, p<0.05), abduction of right (U=29, p<0.05) and left joints (U=32, p<0.05).

Bending amplitude in elbow joints also had significant differences. In right elbow joints the values were higher in kick boxers. It was proved by Student’s t-test (t=2.33) and Wilcoxon – Manna – Whitney test (U=15, p<0.05).

Movement amplitudes in shoulder joints were higher in kick boxers. For right shoulder joint, by all kinds of movements we confirmed significant difference by three movements (with Student’s t-test). For left shoulder joint we confirmed significant difference by three movements (except unbending) (with Student’s t-test). Usage of non-parametric tests confirmed the made conclusions. By three kinds of movements we confirmed significant
exceeding of amplitude in boxers. For right shoulder joint we confirmed significant difference by bending (r=2, p<0.05), отведению (U=2, p<0.05) and adduction (U=32, p<0.05). For left shoulder joint the picture is (by the same three movements) accordingly: r=4, p<0.05; U=30, p<0.05 and U=25, p<0.05).

Analysis of joint movements’ asymmetry also proved the presence of certain distinctions. In boxers we found noticeably higher abduction of left wrist joint, bending and abduction of right shoulder joint (by Student’s test). Wrestlers, by the same criterion) had higher amplitude of left shoulder joint bending.

Results (see table 2) witness about closeness of results of different sportsmanship kick boxers. It is confirmed by the presence of differences between groups (by Student’s test). At the same time usage of non parametrical criteria confirmed the presence of certain differences.

The adduction amplitude in right wrist joint of experienced athletes was less by Wald – Wolfowits criterion (r=3, p<0.05). In the same group abduction amplitude in left shoulder joint was noticeably less as per criterion of Wilcoxon-Manna-Whitney (U=19, p<0.05).

**Table 1.** Movements’ amplitudes in arms’ joints of martial arts wrestlers

<table>
<thead>
<tr>
<th>Joint movement (degrees)</th>
<th>The tested groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 group</td>
</tr>
<tr>
<td>Wrist (right)</td>
<td></td>
</tr>
<tr>
<td>Bending</td>
<td>72.65±3.26</td>
</tr>
<tr>
<td>Unbending</td>
<td>58.65±3.95</td>
</tr>
<tr>
<td>Abduction</td>
<td>36.71±1.76</td>
</tr>
<tr>
<td>Adduction</td>
<td>51.12±2.43</td>
</tr>
<tr>
<td>Bending</td>
<td>70.21±3.33</td>
</tr>
<tr>
<td>Unbending</td>
<td>62.17±2.80</td>
</tr>
<tr>
<td>Abduction</td>
<td>43.82±1.99</td>
</tr>
<tr>
<td>Adduction</td>
<td>47.12±1.92</td>
</tr>
<tr>
<td>Elbow (right)</td>
<td></td>
</tr>
<tr>
<td>Bending</td>
<td>120.69±1.65</td>
</tr>
<tr>
<td>Unbending</td>
<td>27.27±1.48</td>
</tr>
<tr>
<td>Elbow (left)</td>
<td></td>
</tr>
<tr>
<td>Bending</td>
<td>114.58±1.71</td>
</tr>
<tr>
<td>Shoulder (right)</td>
<td></td>
</tr>
<tr>
<td>Bending</td>
<td>190.22±3.15</td>
</tr>
<tr>
<td>Unbending</td>
<td>72.94±3.42</td>
</tr>
<tr>
<td>Abduction</td>
<td>194.22±3.37</td>
</tr>
<tr>
<td>Adduction</td>
<td>30.39±1.72</td>
</tr>
<tr>
<td>Bending</td>
<td>178.21±4.07</td>
</tr>
<tr>
<td>Shoulder (left)</td>
<td></td>
</tr>
<tr>
<td>Bending</td>
<td>66.74±4.38</td>
</tr>
<tr>
<td>Unbending</td>
<td>174.67±7.02</td>
</tr>
<tr>
<td>Abduction</td>
<td>32.69±1.86</td>
</tr>
</tbody>
</table>
| Notes: 1 – difference from wrestlers is confident (p<0.05). 2 – Difference from left arm is confident (p<0.05).

**Table 2.** Movements’ amplitudes in arms’ joints of kick boxers

<table>
<thead>
<tr>
<th>Joint movement (degrees)</th>
<th>The tested groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1a group</td>
</tr>
<tr>
<td>Wrist (right)</td>
<td></td>
</tr>
<tr>
<td>Bending</td>
<td>72.56±5.96</td>
</tr>
<tr>
<td>Unbending</td>
<td>60.93±3.88</td>
</tr>
<tr>
<td>Abduction</td>
<td>38.49±2.29</td>
</tr>
<tr>
<td>Adduction</td>
<td>49.89±4.46</td>
</tr>
<tr>
<td>Bending</td>
<td>71.49±5.41</td>
</tr>
<tr>
<td>Unbending</td>
<td>58.92±4.47</td>
</tr>
<tr>
<td>Elbow (right)</td>
<td></td>
</tr>
<tr>
<td>Bending</td>
<td>44.60±3.14</td>
</tr>
<tr>
<td>Adduction</td>
<td>47.01±3.01</td>
</tr>
<tr>
<td>Elbow (left)</td>
<td></td>
</tr>
<tr>
<td>Unbending</td>
<td>119.58±1.87</td>
</tr>
<tr>
<td>Shoulder (right)</td>
<td></td>
</tr>
<tr>
<td>Bending</td>
<td>28.50±1.63</td>
</tr>
<tr>
<td>Unbending</td>
<td>112.72±2.17</td>
</tr>
<tr>
<td>Bending</td>
<td>23.19±1.40</td>
</tr>
<tr>
<td>Shoulder (left)</td>
<td></td>
</tr>
<tr>
<td>Bending</td>
<td>191.80±4.43</td>
</tr>
<tr>
<td>Unbending</td>
<td>70.16±4.60</td>
</tr>
<tr>
<td>Abduction</td>
<td>190.66±3.90</td>
</tr>
<tr>
<td>Adduction</td>
<td>29.64±1.77</td>
</tr>
<tr>
<td>Bending</td>
<td>178.10±6.19</td>
</tr>
<tr>
<td>Unbending</td>
<td>67.16±5.28</td>
</tr>
<tr>
<td>Abduction</td>
<td>164.50±11.53</td>
</tr>
<tr>
<td>Adduction</td>
<td>31.63±1.80</td>
</tr>
</tbody>
</table>

Note: difference from left hand is confident (p<0.05).
Usage of Student’s test permitted to confirm asymmetry of flexibility’s development. More experienced athletes have higher amplitude of movement in right elbow joint by bending and unbending. The similar dependence was found for abduction in shoulder joint. In younger athletes we did not find movements’ asymmetry in joints.

Analysis of movements in legs’ joints confirmed made earlier assumptions about closeness of kick boxers’ flexibility indicators. We found significant increase of abduction in right hip joint in 1a sub group (by criterion of Wald – Wolfowitz: \( r=4, p<0.05 \)). Bending in left knee joint was noticeably higher in 1b sub group (by Wilcoxon-Manna-Whitney criterion: \( U=14, p<0.05 \)). In this case Student’s t-test permitted to find only tendency to confident increase (\( p<0.1 \)).

Higher asymmetry in 1a sub group was determined. We confirmed higher adduction amplitude in left hip joint and higher bending amplitude in right ankle joint (by Student’s t-test). In young athletes we found no significant differences.

**Discussion**

Efficiency of athletes’ condition analysis directly depends on informative value of the used methodic and tests. The main criterion for their selection is consideration of kind of sports’ specificity. Mirzaei B. et al. [22] determined that perfection of physical training and functional state in martial arts facilitates successfulness in fight. The authors confirmed that in junior wrestlers these factors influence on trainability.

Jafari R.A. et al. [15] studied interconnections between the following: motor activity and somatic type; anthropometric profile, body composition and physiological/physical profile of junior wrestlers. Consideration of wrestlers’ profile permits to raise their competition successfulness.

Table 3. Movements’ amplitudes in legs’ joints of kick boxers

<table>
<thead>
<tr>
<th>Joint movement (degrees)</th>
<th>The tested groups</th>
<th>2b group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1a group</td>
<td></td>
</tr>
<tr>
<td>Bending</td>
<td>33.89±9.47</td>
<td>102.64±5.31</td>
</tr>
<tr>
<td>Unbending</td>
<td>75.06±8.45</td>
<td>71.48±5.04</td>
</tr>
<tr>
<td>Abduction</td>
<td>97.69±7.16</td>
<td>86.50±6.25</td>
</tr>
<tr>
<td>Adduction</td>
<td>40.42±2.29†</td>
<td>48.14±6.15</td>
</tr>
<tr>
<td>Bending</td>
<td>99.01±8.33</td>
<td>90.16±5.52</td>
</tr>
<tr>
<td>Abduction</td>
<td>83.54±5.41</td>
<td>80.48±4.98</td>
</tr>
<tr>
<td>Adduction</td>
<td>86.50±10.30</td>
<td>71.03±5.58</td>
</tr>
<tr>
<td>Bending</td>
<td>51.03±4.13</td>
<td>56.36±5.69</td>
</tr>
<tr>
<td>Abduction</td>
<td>79.20±6.26</td>
<td>85.63±1.54</td>
</tr>
<tr>
<td>Adduction</td>
<td>49.11±4.67</td>
<td>44.81±3.41</td>
</tr>
<tr>
<td>Bending</td>
<td>77.17±5.26</td>
<td>87.81±1.31†</td>
</tr>
<tr>
<td>Abundance</td>
<td>50.74±3.76</td>
<td>47.93±1.83</td>
</tr>
<tr>
<td>Bending</td>
<td>30.26±2.05†</td>
<td>28.81±1.94</td>
</tr>
<tr>
<td>Abundance</td>
<td>43.38±2.91</td>
<td>48.36±3.63</td>
</tr>
<tr>
<td>Bending</td>
<td>23.83±2.30</td>
<td>21.78±3.52</td>
</tr>
<tr>
<td>Abundance</td>
<td>44.58±3.86</td>
<td>42.70±3.82</td>
</tr>
</tbody>
</table>

Notes: 1 – difference from left leg is confident (\( p<0.05 \)). 2 – Tendency to confidence of differences between groups (\( p<0.1 \)).

Successfulness in martial arts is in direct proportion to victory in duels. It is determined by complex of factors, which includes athlete’s physical and technical fitness. Athlete’s technical fitness to large extent depends on movements’ amplitude of limbs’ joints.

Rukosuev D.A. [34] offered include complex of tests for special flexibility in U-shu athletes (10-12 yrs age) in goniometric study. On the base of the received results the author found joints, whose mobility is always insufficient and requires additional training.


Comparison of wrestlers and impact martial arts athletes permits to consider the specificity of these kinds of sport. The similar conclusions were made by Podrigalo L.V. & Volodchenko O.A. [28] when they used bio-mechanical approaches in martial arts. Results of wrestlers and other martial arts athletes illustrate the presence of certain distinctions, depending on different techniques in wrestling and impact martial arts. The found closeness of impact martial arts’ results reflects specific aspects of these kinds of sports.

The presence of certain distinctions in wrestlers’ and impact martial arts athletes’ body constitution has been proved [14]. Increase of wrestlers’ shoulder and forearm’s circumferences as well as strength of grip in dynamic and static regimes reflects specificity of wrestling and importance of reliable grip for success.

The found differences between goniometric indicators of wrestlers and kick boxers clearly reflect specificity of kinds of sports. In wrestlers just grip takes important place in duel, as the base of effective technique’s fulfillment. Reliable grip is determined by strength of hand and movement’s amplitude in wrist joint. That is
why movement’s amplitude in wrist joint is noticeably higher in wrestlers.

Podrigalo L.V. et al. [26] confirmed importance of goniometric indicators in respect to wrist joint for successfulness in arm-wrestling.

For victory, in kick boxing min importance has kicking/punching that pre-conditioned the distinctions of goniometric indicators. Just it pre-determined increase of amplitude of right elbow joint’s bending and practically all movements in shoulder joints of kick boxers. Just they are determining in effective punching. Higher amplitude of wrestlers’ left joint’s bending reflects available in them asymmetry of development. May be it is conditioned by technical peculiarities of wrestling.

The determined asymmetry of kick boxers reflects specificity of duel. In stance left hand is in frontal position. Increase of wrist joint’s amplitude permits to expand the defended area. Increase of right shoulder joint’s abduction amplitude permits to punch with greater strength.

Analysis of different sportsmanship kick boxers’ goniometric indicators confirms similar orientation of their training. It is witnessed by closeness of the received results and absence of significant differences by most of indicators.

At the same time, the found distinctions illustrate specificity of kick boxing training. Reduction of adduction amplitude in right wrist joint and abduction in left shoulder joint in experienced athletes reflects need in sustaining of combat stance, which requires certain fixing of arms’ position. This causes joints’ mobility. Increase of training experience results in joint movements’ asymmetry. It is absent in young athletes. In kick boxing right arm’s punches are very strong. It conditions higher bending/unbending amplitude in elbow joint and abduction in shoulder joint.

Chernicyna N.V. & Sozailov U.A. [7] studied joints’ mobility of sambo and Judo wrestlers’ lower limbs joints. They found tendency to increasing mobility in hip joint of sambo and Judo wrestlers. But they did not found confident differences between these kinds of sports’ indicators.

Saenko V.G. [35] used parameters of flexibility training for analyzing karate kicking. Interconnection between results of knee kick and ann flexibility indicators was found.

Analysis of movements’ amplitude in legs’ joints confirms made earlier conclusions about influence of specificity of kind of sport on goniometric indicators. Increase of hip joint’s abduction and reduction of left knee joint’s bending illustrate specific features of kicking and their technique’s optimizing in experienced athletes. The similar dependence is confirmed by rising of goniometric indicators’ asymmetry in athletes of 1a sub group.

**Conclusions**

The fulfilled researches confirmed the following: distinctions in goniometric indicators of martial arts athletes’ limbs’ joints; certain influence of sportsmanship on kick boxers’ movements’ amplitude. The found differences between indicators of wrestlers and kick boxers clearly reflect specificity of kind of sports. For wrestlers reliable grip is very important. To large extent it depends on amplitude of wrist joint’s movements. These indicators were higher in 2nd group athletes. In impact martial arts success is determined by quality and strength of punching/kicking. It pre-conditioned increase of right elbow joint’s bending amplitude and movements in shoulder joints of kick boxers. The found kick boxers’ asymmetry reflects specificity of duel.

The closeness of different sportsmanship kick boxers’ goniometric indicators confirms equal orientation of their training. The found differences illustrate specificity of training in this kind of sports. Need in combat stance constant sustaining conditions reduction of adduction amplitude in right wrist joint and abduction in left shoulder joint of experienced athletes. Increase of right hip joint’s abduction and reduction of bending in left knee joint illustrate the following: specificities of punching/kicking, optimizing of their technique in experienced athletes. Increase of training experience results in growth of working asymmetry of movements in joints. Goniometry is a simple, informative and objective tool for control and monitoring of martial arts athletes’ functional state. It can be recommended for monitoring of athletes state.

**Conflict of interests**

The authors declare that there is no conflict of interests.
35. Saenko VG. Correlation analysis of kicking in upper area strength indicators and flexibility of elite heavy weight karatekas. Physical Education of Students 2010;3:81-83. (in Russian)

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Received: 04.05.2017
Accepted: 15.05.2017; Published: 10.08.2017
Training of motor rhythm in students, practicing football

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Abstract
Purpose: to test the methodic of students’ motor rhythm training at physical culture lessons based on application of football means.

Material: in the research full time 1st year students of main health group (n=40) participated. After short warming up (10-15 minutes) they fulfilled exercises for rhythm feeling during 15 minutes at every lesson. Assessment of rhythm feeling was carried out with the help of test “Ball pulling by foot”. Shuttle run 3x10 m was used for assessment of general coordination level. Besides, complex test for football player’s technical fitness (juggling, dribbling, dribbling around stands and kicking goal) was used.

Results: we found that it is necessary to selectively train football player’s ability for motor rhythm. It also concerns training of students’ coordination. We presented new opportunities of application of methodic of students’ motor rhythm’s development. These opportunities were realized at physical culture lessons, based on football means.

Conclusions: when mastering and practicing new and complex exercises for coordination we used the method of standard-repeated exercise. The method of variable exercise was used, when it was necessary to change the mean of movements’ fulfillment. Game and competition methods were used only, when the trained motor action became automatic.

Keywords: students, coordination abilities, rhythm, physical education, technical fitness.

Introduction
The questions, connected with coordination training and its structure’s determination are the objects of many scientific researches [1, 3, 4].

General coordination abilities are abilities to purposefully and rationally solve complex motor tasks [6, 14, 15]. Such abilities are the foundation for development of specific coordination. For achievement high results in motor activity it is necessary to have high level of specific coordination [16]. For training motor rhythm it is necessary to consider and use the following:
- Didactic laws of motor actions’ formation [25, 37];
- Individual and group models of motor actions’ construction [23, 26];
- Modern technologies of education and training [22, 31];
- Adequate forms of pedagogic control [27, 30];
- Models of successfulness prediction [24, 32];
- Correlation of anthropometric and functional indicators [21, 33];
- Criteria of motor coordination structure [19, 29, 33];
- Psychological indicators of reaction to physical load [20, 28] considering health level [35, 36].

Specific for football coordination abilities are those, which ensure optimal control of specific motor tasks’ fulfillment. Such tasks simulate separate sides of competition activity in football [16].

Among numerous specific coordination abilities we can mark out 7 the most important (basic) abilities, which influence on football player’s technical skillfulness [12, 18]:
1) motor rhythm feeling;
2) kinesthetic differentiation of motor parameters (feeling of ball);
3) orientation in space;
4) coordination (combining) of movements;
5) quick reaction;
6) adaptation and reconstruction of movements;
7) keeping balance in dynamic and static conditions.

In our opinion, from the enlisted above abilities ability to feel motor rhythm is of special importance for football player’s technical training. It implies correct and accurate reproduction of preset rhythm of motor action or its adequate varying, depending on changing conditions [12].

Thus, ability for motor rhythm is one of components of football player’s technical fitness. Importance of this task’s solution is underlined in most of works, devoted to coordination problems.

Hypothesis: it is assumed that with the help of motor rhythm training means and methods it is possible to improve coordination indicators and technical fitness of students, who practice football at physical culture lessons.

The purpose of the research is to substantiate and experimentally test the methodic of students’ motor rhythm training at physical culture lessons, based on application of football means.

Material and methods
Participants: in the research full time 1st year students of main health group (n=40), (17-18 years age) participated.

Organization of the research: the researches were conducted on the base of Vyatka State University, (Kirov, Russia).

Experimental group (EG) was completed by method of random sampling [2]. CG was trained by traditional physical education program [17]. EG trainings included exercises for rhythm. In both groups training were conducted twice a week (two academic hours each). In total we conducted 64 academic training hours in every group.

Specificities of experimental methodic of EG students:
1) After short warming up (10-15 minutes) they fulfilled exercises for rhythm feeling during 15 minutes at every lesson.
2) Load was increased gradually. Rising of intensity was at the account of increase of exercises’ quantity and shortening of rest intervals between exercises and (or) series of exercises.

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doi:10.15561/20755279.2017.0407
3) The most effective means for football players’ rhythm feeling are: dribbling with changing of temp and direction; Jumps between irregularly laid sticks; slalom dribbling; running hurdles; running with preset time of segments’ run 10, 20, 30 meters; kicking ball after rebound from wall (or after partner’s pass) [7, 9, 15].

4) When training and fulfilling new and complex coordination exercises we used the method of standard repeated exercise. The method of variable exercise was used, when there was need in changing of mean of these exercises’ fulfillment. Game and competition methods were used, when the trained action became automatic.

We also used the method of pedagogic testing and determined the following indicators: ability for rhythm, general coordination abilities; technical fitness (all tests were fulfilled on site for mini-football):

1) Assessment of rhythm feeling was carried out with the help of test “Ball pulling by foot”. Initial position is stance with both feet on floor. By signal it is necessary to pull ball backward by sole as quick as possible. After every contact with ball sole shall touch the floor (10 times). After tenth contact of sole with ball student shall touch the floor with foot. After it, stopwatch is switched off. Results: the best from two attempts is registered with accuracy up to 0.01 sec. [12].

2) Shuttle run 3x10 m was used for assessment of general coordination level. Two parallel lines are drawn on the floor at 10 meters’ distance on start and finish. Student stands behind start line. By command “Go” he runs to finish line, touches it with fingers of one hand and return to start line. Then, he repeats this exercise 3 times. Results: the best from two attempts is registered with accuracy up to 0.01 sec. [11].

3) Complex test for football player’s technical fitness implies juggling, dribbling, dribbling around stands and kicking goal.

The exercise is started with juggling (three ball touches with foot). Than – “snake” dribbling: it means dribbling around 4 stands (distance between stands – 2.5 meters) and kick goal (not entering penalty box). The time is registered from the moment of start to ball’s crossing the line of goal. If goal is not hit – exercises is failed. Result: the best from two attempts is registered with accuracy up to 0.01 sec. [17].

Statistical analysis: For determination of pedagogic experiment’s results’ confidence the data were processed with the help of mathematical statistic methods. We used parametrical criterion (Student’s t-test). Statistical processing was carried out with Microsoft Excel 2007 standard statistical programs. Results at P> 0.01 were considered to be confident.

Results:
At the beginning of experiment testing did not show confident differences between all tested indicators of EG and CG (P>0.05). After pedagogic experiment we received the following results, presented in table 1.

Analysis of table 1 showed that there happened some changes during pedagogic experiment. In test “Ball pulling by foot (sec.)” normal is result, not exceeding 4.5 sec. [4].

Before experiment both EG and CG indicators were below norm. After experiment EG indicators improved from 5.0±0.1 to 4.3±0.2 (P<0.01); in CG indicators also improved but insignificantly – by 0.1±0.1 (P>0.01): that is below norm of ability to motor rhythm.

For 1st year students in test “Shuttle run 3x10” norm is period from 7.3 sec. to 8.2 sec. 7.3 sec. means “excellent”, 8.0 – “good” and 8.2 – “satisfactory” [17].

Before experiment results of both groups were “satisfactory”. After experiment, EG indicators improved up to “good” – 7.9±0.2 (P>0.01).

Indicators of EG after experiment showed significant positive increment by 1.0±0.2 (P<0.01) that corresponded to “excellent”.

“Test passed” was put for complex test for technical fitness, if result did not exceed 8 sec. [17].

Before experiment both EG and CG students did not receive “test passed”.

After experiment EG indicators noticeably improved:

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Group</th>
<th>Before</th>
<th>After</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ball pulling by foot (sec.)</td>
<td>EG</td>
<td>5,0±0,1</td>
<td>4,3±0,2</td>
<td>P&lt;0,01</td>
</tr>
<tr>
<td></td>
<td>CG</td>
<td>4,9±0,1</td>
<td>4,8±0,1</td>
<td>P&gt;0,01</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>P&gt;0,01</td>
<td>P&lt;0,01</td>
<td>-</td>
</tr>
<tr>
<td>Shuttle run 3x10 (sec.)</td>
<td>EG</td>
<td>8,2±0,2</td>
<td>7,2±0,2</td>
<td>P&lt;0,01</td>
</tr>
<tr>
<td></td>
<td>CG</td>
<td>8,1±0,2</td>
<td>7,9±0,2</td>
<td>P&gt;0,01</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>P&gt;0,01</td>
<td>P&lt;0,01</td>
<td>-</td>
</tr>
<tr>
<td>Test for technical fitness (sec.)</td>
<td>EG</td>
<td>8,3±0,2</td>
<td>7,2±0,2</td>
<td>P&lt;0,01</td>
</tr>
<tr>
<td></td>
<td>CG</td>
<td>8,1±0,2</td>
<td>7,9±0,1</td>
<td>P&gt;0,01</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>P&gt;0,01</td>
<td>P&lt;0,01</td>
<td>-</td>
</tr>
</tbody>
</table>
Discussion

Technical fitness of football player is influenced by his coordination abilities [5, 7, 12]. The authors underline key importance of specific coordination abilities of different sportsmanship and age athletes.

Coordination abilities are rather diverse and classified in different ways [4, 10, 12]. Most of authors [4, 8, 13] recommended training equally all known abilities, including ability for motor rhythm.

Analysis of researches points at demand in selective training of football player’s motor rhythm. It relates also to development students’ coordination abilities.

The novelty of the research is that we present new opportunities for methodic of students’ motor rhythm training. These opportunities were realized at physical culture lessons, based on football means. We received positive results of this methodic application.

However, there are some prospects in studies of coordination abilities. For example, they are: influence on football players’ technical fitness, ability for quick reacting and orientation in space. Besides, it is possible to conduct complex functional and anthropometric assessment of students. Such approach will permit to monitor students’ health condition; correct training process; achieve high health related or sport results.

Conclusions:

The used means and methods of motor rhythm abilities’ development improved students’, practicing football, coordination abilities and technical fitness.

The received data are of practical interest for coaches and teachers of higher educational establishments.

Conflict of interests

The author declares that there is no conflict of interests.

References

4. Vitkovski Z, Liakh VI. Coordination abilities in football: development on different stage of students-boxers’ technical fitness, ability for quick reacting and orientation in space. Besides, it is possible to conduct complex functional and anthropometric assessment of students. Such approach will permit to monitor students’ health condition; correct training process; achieve high health related or sport results.

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The electronic version of this article is the complete one and can be found online at: http://www.sportedu.org.ua/index.php/PES/issue/archive

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Received: 16.05.2017
Accepted: 27.05.2017; Published: 10.08.2017
Risk assessment and level of physical activity of students in Poland
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\textsuperscript{3}Collegium Medicum im. Ludwika Rydygiera in Bydgoszcz, Poland

Abstract
Purpose: The aim of the study was to determine the risks of activity by using Physical Activity Readiness Questionnaire (PAR-Q) and describe the PA profile using the short-version of the International Physical Activity Questionnaire (IPAQ-SF) among selected groups of sport science students.

Material: The study covered 99 students – 61 females aged 21.08 ± 1.43 and 38 males aged 21.24 ± 1.22 y. In order to assess and stratify the risk of PA the Polish short version of the IPAQ-SF was used.

Results: The total level of physical activity of the male students was 3460.039±2502.207 MET- min/week and was higher than in the case of female students (3388.107±2204.290 MET- min/week). The dominant type physical activity of female and male students was intensive effort. Among 22 men and 39 women, risk factors for cardiac events, pulmonary and musculoskeletal injuries were reported. The relationship between PAR-Q results and the on the IPAQ-SF results was no statistically significant.

Conclusions: This study demonstrates that students achieve the level of physical activity recommended by experts for the prevention of chronic diseases. This research allows sports science students to understand their own health issues through self-assessments of personal risk factors for cardiac events, pulmonary and musculoskeletal injury.

Keywords: Health, Risk of Injury, PAR-Q+, IPAQ-SF, Physical Activity, University Students

Introduction
Globally, premature mortality from four main non-communicable disease (NCDs) decreased by 15% between 2000 and 2012. This rate of decline is insufficient to meet the 2030 target of a one third reduction (WHO, 2016). The development of new technologies associated with professional work or communication progressing in the last several years is causing social restrain from Physical Activity (PA) and decreasing health. Then the lack of trained habits healthy life style and the disappearance of the natural need of the movement causes untimely aging and at the same time deteriorates health. Nieman (1998) showed that low fitness level has become the main indicator of all the risk factors for early death.

Physical activity is a biological human need, contributing to a healthy relationship status and should be a necessary component of human’s lifestyle. Strategies to promote PA have become an important public health approach for the prevention of chronic diseases (Bonevski et al. 2014). In the past in Poland, less than 10% of all students took part in PA outside the statutory duty. In the same time in some European universities this percentage reached the limit of 50-60% (Korpak 2005).

Study of Glays Shuk-Fong Li et al. (2009), stressed that inactivity among students is prevalent. They conclude that participation in PA might be an effective way to improve the health of college students (their mental health, better social skills, higher levels of emotional intelligence). Thus, the importance of increasing exercise participation at the university level should be implemented and reinforced. The university students are considered prospective professionals with important roles in the future. For this reason, their attitudes in terms of PA level and health behaviors are of a higher importance (Varela-Mato et al. 2012). Active people live longer, are healthier and are more productive, more likely to avoid injury and illness.

The role of PA in maintaining health is undertaken for several decades (Pasek et al. 2006, Szark-Eckardt et al. 2012, Szark-Eckardt et al. 2015, Żukowska et al., 2013, Pasek et al. 2016, Busko et al. 2016, Kochanowicz et al. 2016). Studies show that PA should accompany since early childhood. PA suitable for gender, age, health and level of PF constitutes a necessary part of the health promotion.

Current recommendation of WHO, American Heart Association (AHM) and American College of Sport Medicine (ACSM) for adults 18–64 years old are that they should do at least 150 minutes of moderate-intensity aerobic PA or do at least 75 minutes of vigorous-intensity PA throughout the week or an equivalent combination of moderate- and vigorous-intensity PA. Muscle-strengthening activities should be done involving major muscle groups on 2 or more days a week, and flexibility training every day (WHO 2010, ACSM 2011). The prevalence of achieving physical activity recommendations declines rapidly between the ages of 18 and 24 when many young people are undertaking tertiary education (Grim et al. 2011).

Scientists involved in the study of the level of PA of various socio-professional groups are faced with major methodological problem according to the non-unified research tools (Wareham et al. 1998). Several methods are available to measure level of PA eg. self-reported questionnaires, direct observation, indirect calorimetry, movement sensor and heart rate telemetry (Lee, 2011). This situation has prompted researchers to develop a unified tool, resulting in the development of the International Physical Activity Questionnaire (IPAQ).

Initial pilot testing using IPAQ was performed during 1998–1999, and further method was developed resulting in the eight versions of the IPAQ, including four long and four short versions (Craig et al.,2003), and then IPAQ was used in different countries (Hagstromer et al. 2006, Biemot et al. 2007, Bauman et al. 2009). The IPAQ...
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consists of various questions including times spent on walking and moderate- and vigorous-intensity PA of at least 10 min duration. During this study assess level of PA among selected groups of sport science students was used in the short form of International Physical Activity Questionnaire (IPAQ-SF).

To ensure an optimal benefit to health ratio before performing an exercise program the risk assessment should be carried out. Widely used tool for prescreening health assessment is the PAR-Q. The PAR-Q was developed by the Canadian (British Columbia) Ministry of Health to identify the number of adults for whom the PA might be inappropriate. The pre-participation of health screening is to provide information relevant to the safety of beginning physical exercise and to identify known diseases and risk factors for NCD by self-guide methods, so the appropriate lifestyle can be initiated (Allen, 2014). PAR-Q should be a first step before initiating an exercise program or planning to increase the amount of PA.

To measure pre-participation health hazard and risk assessment several instruments are available, eg. standardized forms are PAR-Q, and AHA/ACSM Health/ Fitness Facility Pre-participation Screening Questionnaire. These questionnaires can be completed in a few minutes and identifies moderate- and high–risk individuals. The American College of Sports Medicine (ACSM) exercise pre-participation health screening recommendations stipulates that persons at moderate risk for NCD should undergo a medical examination prior to starting a vigorous. ACSM also recommends that persons at high risk for CVD should undergo a medical examination and diagnostic exercise testing before beginning either a moderate-intensity (Pescatello et al. 2014). The ACSM recommendations are not a replacement for sound clinical judgment.

The aim of this article was to identify the types of risk factors associated with the PA among sport science university students, to assess their level of PA using the IPAQ-SF and guide the future efforts to minimize the health risk and improve PA level.

Therefore, we designed that study with a twofold aims. Firstly, we verified if the use of PAR-Q reduces the barriers to physical activity participation for physical exercise sport science students and the populations, which become more physically active. Secondly, we verified if sports science students understand their own health issues through self-assessments of personal risk factors for NCD.

This was the first examination of university students which associated types of risk factors with the level of PA carried out in Poland.

**Materials and methods**

**Participants:** The study was conducted at University of Physical Education and Sport in Gdansk, Poland. The research was done on a sample of voluntary 61 women (21.08±1.43 years old) and 38 men (21.24±1.22 years old). Before training all subjects were informed and gave consent for study procedures. Anthropometric parameters of the group at the beginning of the study are presented in Table 1.

**Organization of the research:** The research method was a diagnostic survey. The study used two validated research tools: PAR-Q and IPAQ-SF. PA level was assessed by means of the Polish short IPAQ-SF. This questionnaire is currently recognized as one of the most commonly used polling tools for monitoring the level of PA (Biernat et al. 2007).

The polish version of IPAQ-SF was published as early as in 2007 (Biernat et al. 2007). In this version, there are determined separately the number of days and the time devoted to PA: intensive, moderate, and walking. The questionnaire also allows determining the overall time devoted to sitting. The measure of energy consumption during PA is the so-called MET (Metabolic Equivalent). One MET equals to consumption of one kilocalorie of energy by one kilogram of body mass during one hour of calm sitting (kcal/kg/h). PA expressed in MET-min/week is calculated by multiplying the number of days a certain effort was performed by the value of MET for this effort and by the average number of minutes the effort was performed a day (Mrozik i Stupnicki, 2015; Zuzda et al., 2015). Abu-Moghli (2014) concluded that Health education and promotion professionals can confidently use IPAQ questionnaire to assess college students’ participation in physical activity.

PAR-Q is applicable for people aged 15 to 69 years.

<p>| Table 1. Anthropometric characteristics of participants at the beginning of the study |
|------------------------------------|-------------------|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>Gender</th>
<th>Statistics</th>
<th>Age[year]</th>
<th>Height [cm]</th>
<th>Body mass [kg]</th>
<th>BMI [kg/m²]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>X</td>
<td>21.08</td>
<td>167.94</td>
<td>58.08</td>
<td>20.58</td>
</tr>
<tr>
<td>(n=61)</td>
<td>SD</td>
<td>1.43</td>
<td>3.31</td>
<td>3.67</td>
<td>1.09</td>
</tr>
<tr>
<td></td>
<td>Min</td>
<td>19.0</td>
<td>159.00</td>
<td>46.00</td>
<td>17.53</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>25.0</td>
<td>175.00</td>
<td>63.50</td>
<td>23.82</td>
</tr>
<tr>
<td></td>
<td>X</td>
<td>21.24</td>
<td>180.95</td>
<td>76.50</td>
<td>23.37</td>
</tr>
<tr>
<td>Male</td>
<td>SD</td>
<td>1.22</td>
<td>3.97</td>
<td>4.16</td>
<td>1.25</td>
</tr>
<tr>
<td>(n=38)</td>
<td>Min</td>
<td>19.0</td>
<td>173.00</td>
<td>68.00</td>
<td>20.99</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>24.0</td>
<td>190.00</td>
<td>86.00</td>
<td>26.75</td>
</tr>
</tbody>
</table>

n-number of subject; x-average; SD-standard deviation; BMI-Body Mass Index.
The purpose of preparticipation in risk assessment through the use PAR-Q is to provide information relevant to the safety of beginning exercise training, increase the intensity PA and to identify known diseases and risk factors for cardio–vascular diseases or musculoskeletal injury so that appropriate lifestyle interventions can be initiated. PAR-Q includes questions about diagnosed heart disease, stress and resting chest pain, dizziness, diseases of bones and joints, prescribed medications, elevated blood pressure or heart disease, and other causes which may be a contraindication to undertake PA.

Statistical analysis. Completed questionnaires were analyzed statistically using the package SPSS 23 (IBM, USA). It established the characteristics of distributions response based on the Shapiro-Wilk and the significance of differences on the basis of a test Chi², Mann-Whitney test and t-Student test. The probability values less than 0.05 (p<0.05) were considered as statistically significant.

Results

The IPAQ_SF allowed determining the number of days and the time devoted to intensive, moderate activity, walking, and the time spent in a sitting position during the previous 7 days among female and male sport sciences students. The distribution of vigorous, moderate and walking PA based on the number of MET–min/weeks is shown in Table 1. The total level of physical activity among the male students was 3460.039±2502.207 MET–min/weeks and was higher than among the female students (3388.107±2204.290 MET–min/weeks; p<0.05). The dominant type of activity was intense effort, for female students (4731.528±1813.091 MET–min./week). Among the male students the intense (5246.917±2524.52MET–min./week) and moderate efforts (1956.472±822.381MET–min/week) were dominant types of activity.

The male students obtained higher values in the area of moderate efforts then females (1470.250±822.381

Table 2. Level of physical activity of male (n=38) and female students (n=61)

<table>
<thead>
<tr>
<th>Activity type</th>
<th>Students</th>
<th>Average Value</th>
<th>Median</th>
<th>Lower Quartile</th>
<th>Upper Quartile</th>
<th>Standard Deviation</th>
<th>p (F vs. M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>Male (n=38)</td>
<td>3460.039</td>
<td>2821.500</td>
<td>2064.00</td>
<td>4158.00</td>
<td>2524.52</td>
<td>p&gt;0.05</td>
</tr>
<tr>
<td></td>
<td>Female (n=61)</td>
<td>3388.107</td>
<td>3066.00</td>
<td>1653.00</td>
<td>4545.00</td>
<td>2204.290</td>
<td>p&gt;0.05</td>
</tr>
<tr>
<td>Intensive</td>
<td>Male (n=18)</td>
<td>5246.917</td>
<td>4454.000</td>
<td>3631.500</td>
<td>5050.500</td>
<td>2579.278</td>
<td>p&gt;0.05</td>
</tr>
<tr>
<td></td>
<td>Female (n=36)</td>
<td>4731.528</td>
<td>4407.000</td>
<td>1039.500</td>
<td>2586.000</td>
<td>1813.091</td>
<td>p&gt;0.05</td>
</tr>
<tr>
<td>Moderate</td>
<td>Male (n=18)</td>
<td>1956.472</td>
<td>2310.000</td>
<td>1039.500</td>
<td>2586.000</td>
<td>822.381</td>
<td>p&gt;0.05</td>
</tr>
<tr>
<td></td>
<td>Female (n=17)</td>
<td>1812.971</td>
<td>1653.000</td>
<td>3156.000</td>
<td>2079.000</td>
<td>806.747</td>
<td>p&gt;0.05</td>
</tr>
<tr>
<td>Walking</td>
<td>Male (n=2)</td>
<td>910.25</td>
<td>910.25</td>
<td>758.0</td>
<td>1062.5</td>
<td>215.314</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Female (n=8)</td>
<td>689.875</td>
<td>758.500</td>
<td>490.500</td>
<td>904.500</td>
<td>309.630</td>
<td>-</td>
</tr>
<tr>
<td>Sitting</td>
<td>Male (n=38)</td>
<td>419.459</td>
<td>360.000</td>
<td>280.000</td>
<td>480.000</td>
<td>174.868</td>
<td>p&gt;0.05</td>
</tr>
<tr>
<td></td>
<td>Female (n=61)</td>
<td>364.081</td>
<td>360.000</td>
<td>240.000</td>
<td>480.000</td>
<td>174.868</td>
<td>p&gt;0.05</td>
</tr>
</tbody>
</table>

Table 3. Correlation PAR-Q test result vs. activity level

<table>
<thead>
<tr>
<th>PAR-Q</th>
<th>Level I Intensive n %</th>
<th>Level II Moderate n %</th>
<th>Level III Low n %</th>
<th>Total n %</th>
<th>Chi2</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1- Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?</td>
<td>8 100</td>
<td>35 94.6</td>
<td>50 92.6</td>
<td>54 54.5</td>
<td>0.716</td>
<td>0.699</td>
</tr>
<tr>
<td>Q2- Do you feel pain in your chest when you do PA?</td>
<td>7 87.5</td>
<td>33 89.2</td>
<td>51 94.4</td>
<td>54 54.5</td>
<td>1.045</td>
<td>0.593</td>
</tr>
<tr>
<td>Q3- In the past month, have you had chest pain when you were not doing PA?</td>
<td>6 75</td>
<td>32 86.5</td>
<td>51 94.4</td>
<td>54 54.5</td>
<td>3.659</td>
<td>0.161</td>
</tr>
<tr>
<td>Q4- Do you lose your balance because of dizziness or do you ever lose consciousness?</td>
<td>8 100</td>
<td>33 89.2</td>
<td>49 90.7</td>
<td>54 54.5</td>
<td>0.394</td>
<td>0.627</td>
</tr>
<tr>
<td>Q5- Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your PA?</td>
<td>4 50</td>
<td>21 56.8</td>
<td>39 72.2</td>
<td>54 54.5</td>
<td>3.115</td>
<td>0.211</td>
</tr>
<tr>
<td>Q6- Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?</td>
<td>8 100</td>
<td>37 100</td>
<td>54 100</td>
<td>54 54.5</td>
<td>5.184</td>
<td>0.075</td>
</tr>
<tr>
<td>Q7- Do you know of any other reason why you should not do PA?</td>
<td>8 100</td>
<td>34 91.9</td>
<td>54 100</td>
<td>54 54.5</td>
<td>5.184</td>
<td>0.075</td>
</tr>
</tbody>
</table>
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MET–min./week and $1812.971 \pm 806.747$ MET–min./week respectively; $p > 0.05$). The average declared time spent in a sitting position was $419.459 \pm 167.663$ minutes a week for the male students and $364.081 \pm 174.868$ minutes a week for the male students.

Analyzing the relationships in test results in case of the level of activity no statistically significant difference in the range of questions from 1 to 7 was found. The most frequently observed response was the answer $= 0$. In the case of Question 6 all respondents gave this reply, hence the inability to quantify the statistical dependence (Table 3).

The assessment of correlation between age, weight, height, and BMI and the level of PA showed statistically significant relationship for activity level 1 to the second level of activity with the body mass and BMI. Body mass and BMI of about 2 activity were significantly higher than respondents declaring activity level 1 (respectively: 59.2 vs. 67.7, $p=0.027$ and 20.4 vs. 22.1, $p=0.040$) (Table 4).

Table 4. Correlation of the age, weight, height, and BMI vs. level of activity

<table>
<thead>
<tr>
<th>Parameter</th>
<th>N</th>
<th>X average</th>
<th>SD</th>
<th>Median</th>
<th>Range</th>
<th>1 vs. 2</th>
<th>2 vs. 3</th>
<th>1 vs. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>99</td>
<td>21.1</td>
<td>0.1</td>
<td>21</td>
<td>19 – 25</td>
<td>0.782</td>
<td>0.549</td>
<td>0.983</td>
</tr>
<tr>
<td>Age Lev 1</td>
<td>8</td>
<td>21.1</td>
<td>0.4</td>
<td>21</td>
<td>20 – 23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age Lev 2</td>
<td>37</td>
<td>21.1</td>
<td>0.2</td>
<td>21</td>
<td>19 – 25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age Lev 3</td>
<td>54</td>
<td>21.2</td>
<td>0.2</td>
<td>21</td>
<td>19 – 25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass</td>
<td>99</td>
<td>65.1</td>
<td>1</td>
<td>62</td>
<td>46 – 86</td>
<td>0.027</td>
<td>0.123</td>
<td>0.179</td>
</tr>
<tr>
<td>Mass lev1</td>
<td>8</td>
<td>59.2</td>
<td>2.8</td>
<td>58.8</td>
<td>50 - 75.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass lev2</td>
<td>37</td>
<td>67.7</td>
<td>1.6</td>
<td>69</td>
<td>52 – 83</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass lev3</td>
<td>54</td>
<td>64.3</td>
<td>1.3</td>
<td>61</td>
<td>46 – 86</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td>99</td>
<td>172.9</td>
<td>0.7</td>
<td>171</td>
<td>159 - 190</td>
<td>0.072</td>
<td>0.113</td>
<td>0.406</td>
</tr>
<tr>
<td>Height lev1</td>
<td>8</td>
<td>169.8</td>
<td>2</td>
<td>168</td>
<td>165 - 182</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height lev2</td>
<td>37</td>
<td>174.5</td>
<td>1.2</td>
<td>173</td>
<td>162 - 186</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height lev3</td>
<td>54</td>
<td>172.3</td>
<td>1.0</td>
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<td>159 - 190</td>
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<td>21.3</td>
<td>17.5 - 26.8</td>
<td>0.040</td>
<td>0.168</td>
<td>0.147</td>
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<td>18.1 - 22.8</td>
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<tr>
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Discussion

Physical activity is a basing biological human need, contributing to a health status and should be a necessary component of human’s lifestyle. Plotnikow (2015) stressed that university students are ideal targets lifestyle interventions aimed at improving health behaviors. Universities have the potential to engage large numbers of students in health behavior change interventions (UNESCO, 2009). The number of students enrolled in higher education worldwide will reach 262 million by 2025, a marked increase from 178 million in 2010 (Davis et al., 2012).

On the other hand students wishing to change his lifestyle and to be physically active are deflected by face numerous barriers: demographic, biological, cognitive, emotional, sociocultural, and environmental factors (Pescatello et al., 2014). One of them may be health screening, which may involve a visit to a medical doctor (Warburton et al., 2011). While the benefits of PA are evident, PA may present health risks to people with NCD (Ewing et al., 2015). It is important to make sound decisions to identify which exercise interventions are chosen appropriate and safe for them (Sallis et al., 2015; Bredin et al., 2013).

Sports executives possess higher than average knowledge about the importance of risk assessment in the prevention of NCD. Unfortunately, when they became trainers and instructors, they do not implement their theoretical knowledge to the practice of everyday life in a satisfactory manner. It is important to pay more attention and scope passed in the training of student’s knowledge on risk assessment in the prevention of NCD.

The PAR-Q serves as a screening tool to quickly and easily identify adults for whom PA might not be appropriate (Pescatello et. al., 2014). PAR-Q can minimize barriers in adopting a physically active lifestyle (Balady et al., 1998; Thomas et al., 1992). The PAR-Q contains a 7-question battery designed to determine whether individuals are able to become more physically active (Allen et al, 2014, http://eparmedx.com/). When a person responds positively to 1 or more questions on the PAR-Q, he or she is advised to consult a physician for physical activity participation clearance. Risk assessment using the PAR-Q is undertaken to facilitate participation in regular physical activity by all, but should not replace sound clinical judgment.
The process is easy to complete and administer and reduce the barriers to PA participation for asymptomatic and symptomatic populations which becoming more physically active. The PAR-Q tools are evidence-based, meeting the requirements recognized by the medical community. (Bredin, 2013). They simplify the prescreening process especially when low-to moderate intensity exercise is performed. This is implemented in some countries, e.g. allows for pre-exercise screening use the PAR-Q+. This was reducing the number of individuals seeking clearance by a physician (Israeli Ministry of Health, 2015).

It is estimated that 1% of people who fill out the questionnaire PAR-Q will require a further assessment by a physician before taking the systematic exercise (Bredin et al. 2013). However, in the near future, this number may increase as the diseases of civilization are more and more common. For example prevalence of pre-diabetes status is increasing worldwide and civilizations have projected that more than 470 million people will have pre-diabetics by 2030. On the other hand for pre-diabetic individuals, lifestyle modification is the cornerstone of diabetes prevention, with evidence of a 40–70% relative-risk reduction (Tabák et al., 2012).

Declarations of our students filling the questionnaire PAR-Q indicate the incidence of symptoms memorialized at this relatively early stage of life. It should be noted, however, that the indications on individual symptoms were quite common, as concerned 22 men out of 39 tested. Among women, 60 respondents confirmed those 29 students. Efforts should be undertaken to facilitate participation in regular PA by university students and the hazards of exercise-related NCD events are likely to be reduced by careful attention to a reduce barrier and a safe and effective exercise prescription. Plotnikoff et al. (2015) stressed that the university students which are represents a significant proportion of our population are ideal targets improving health behaviors. They are still at an age where health behaviors that impact on health later in life can be improved that a variety of activities, designed to highlight PA and health factors with immediate feedback, is experience allows a hands-on approach to learning as it increases the students’ understanding of their own health issues. The results of research conducted by Snetselaar et al. among 88 medical students whose aim was a self-assessment of their personal risk factors concluded that have succeeded in providing students with a valuable educational tools, which they can use in a future work.

From international studies evaluating the level of PA residents 15 EU countries and 6 countries participating in the program CINDI WHO conducted in the late 90s it shows that the percentage of the guiding secondary amounted to between 40-80%. The largest percentage of women and men giving of a shallow PA was found in Portugal (Váró, 2003).

The Eurobarometer survey of the European Commission (http://europa.eu/rapid/press-release_IP-14-300_pl.htm) published in March 2014 indicate that 59% of European Union citizens never perform physical activity, play sport or do it only rarely, and while 41% take this kind of activity at least once a week. Residents of Northern Europe are more physically active than people in Southern and Eastern Europe. In Sweden, 70% of respondents said they practice or play sport at least once a week. Right behind Sweden the following countries are placed in the ranking: Denmark (68%) and Finland (66%), followed by the Netherlands (58%) and Luxembourg (54%). At the opposite end of the rankings were: Bulgaria (78% who never practice or play sport), followed by Malta (75%), Portugal (64%), Romania (60%) and Italy (60%). Nearly 35% of survey participants Multi-Centre Nationwide Health Survey Project - WOBASZ (37% of women and 32% men) do not perform any physical exercise lasting at least 30 minutes a day during free time from work or study. Among the people who perform this type of exercise, they do it irregularly or rarely (Dryglas et al, 2005).

Results from the Australian Bureau of Statistics of the Australian Health Survey 2011-2012 show that higher education students are more likely to meet recommended guidelines for exercise (58%) compared with 45% of non-higher education students (ABS,2012).

Hasse et al (2004) stressed that 73% of male and 79% of female university students Reduce barriers to regular PA, by eliminating unnecessary medical evaluations which replace use of the PAR-Q. All adults should be encouraged to be physically active.

University students from UK do not meet physical activity guidelines. The same is the USA where nearly half of all university students are not achieving recommended levels of PA (Weinstock, 2010).

Our study confirms the assumption that students of physical education will be characterized by increased and high physical activity resulting from lead an active lifestyle. It demonstrates that the total level of PA of the male students was 3460.039±2502.207 MET-min/week and was higher than in the case of female students (3388.107±2204.290MET-min/week). The dominant type PA activity of female students was intensive effort male students was intensive effort (5246.917±2579.27 MET-min/week) and moderate effort (1956.472±822.38MET-min/week respectively). This data were higher than that of students from Białystok Medical University where average total PA of students amounted to 3041.5 MET-min/week ± 1564.8). Most of the students presented a moderate level of physical activity.

Kościuczuk (2016) stressed that dietetics students were characterized by a higher average value of MET-min/week 1304.37 ± 1082.32 compared with students of physiotherapy (MET-min/week 1016.75 ± 715.5).

In Poland another data from study done by Starościak (2016) stressed that Physical Education students undertake PA on a high and moderate level more often than students of other pedagogical sciences. Mrozik (2015) assessed the overall performance of PA of students from College of Physical Culture and Tourism in Pruszkow (Poland) showed that the level of PA is satisfactory. Sport science
students, as future prospective coaches and instructors, should be well prepared to promote health behaviors, and after the completion of their studies stand as authority in those areas.

Conclusions:
1. This study demonstrates that sport science students achieve the level of PA recommended by experts for the prevention of NCD.
2. The indications on individual symptoms were quite common, as concerned 22 men out of 39 tested and 29 women out of 60 tested. It was found that students participating in this analysis initially did not understand their own health issues.
3. Use of the PAR-Q can reduce barriers that students encountered before taking regular physical activity

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

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Received: 06.06.2017
Accepted: 21.06.2017; Published: 10.08.2017


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Information:
Sponsors, Partners, Sponsorship:
- Olympic Academy of Ukraine
- Ukrainian Academy of Sciences.

SCIENTIFIC EDITION (journal)
Physical Education of Students, 2017;4:
Editorial to the publisher department KSPU:
certificate DK №860 20.03.2002.
________________________________________________________________________
designer - Iermakov S.
editing - Yermakova T.
administrator of sites - Iermakov S.
designer cover - Bogoslavets A.
________________________________________________________________________
passed for printing 10.08.2017.
Format A4.
PRINTHOUSE (B02 № 248 750, 13.09.2007).
61002, Kharkov, Girshman, 16a.