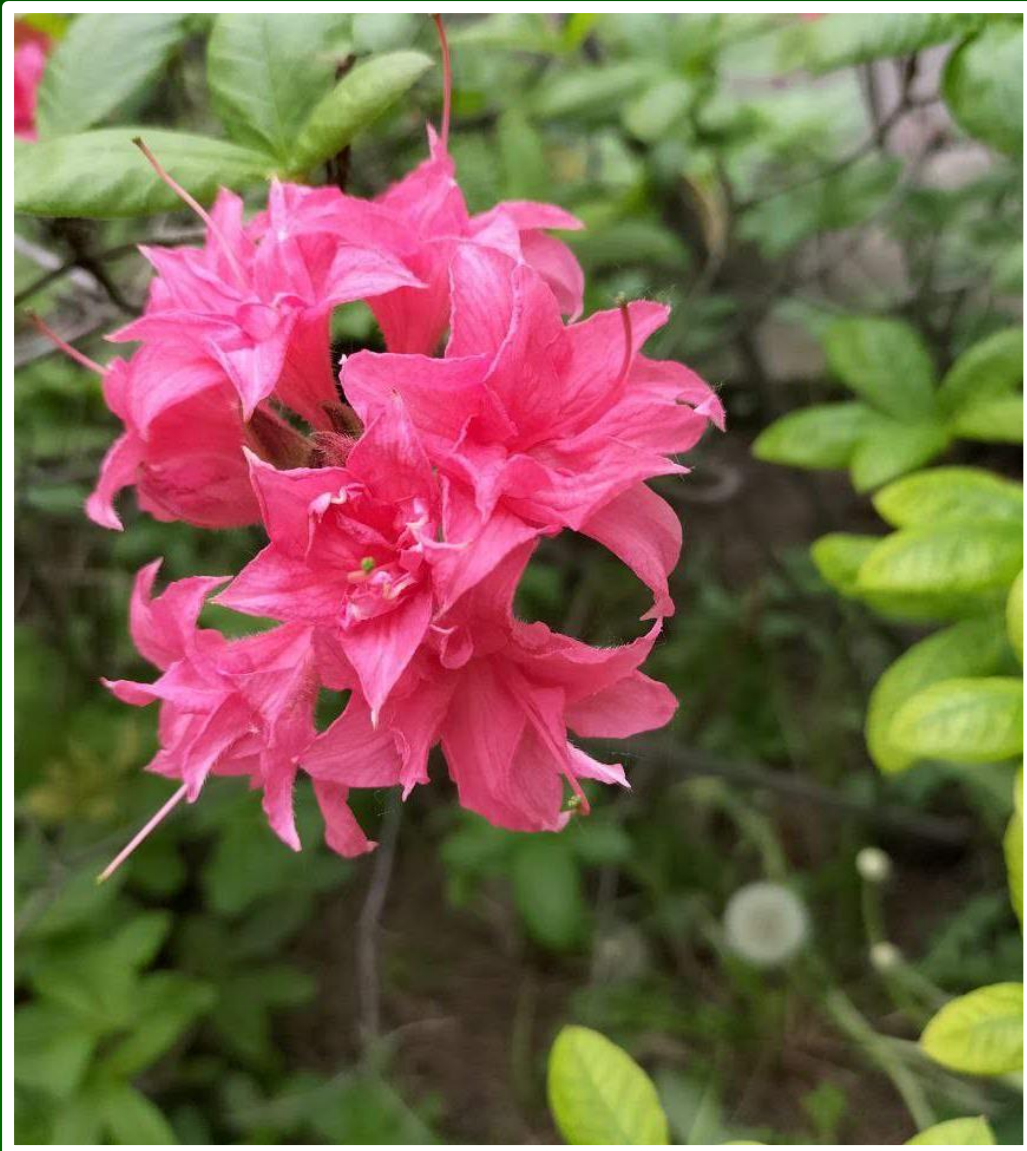




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2022 Health, sport, 8(2) rehabilitation



Scientific journal

**on problems of physical education, sports,
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Health, sport, rehabilitation

Zdorov'â, sport, reabilitaciâ

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By the order of the Ministry of Education and Science of Ukraine dated 16.07.2018 № 775 and by the order of the Ministry of Education and Science dated 02.07.2020 № 886 the journal is included in category B of professional publications of Ukraine. Specialties: physical culture and sports (017, 24.00.01, 24.00.02, 24.00.03); pedagogical sciences (011, 012, 013, 014, 015, 016, 13.00.02).

Founder:

H.S. Skovoroda Kharkiv National Pedagogical University

Certificate of state registration:

KV № 22450-12350P dated 01.12.2016

Professional scientific publication on problems of physical education, sports, formation of a healthy way of life, rehabilitation, physical therapy.

Foundation year: 2015

Branch and problems: sport, physical education, training of movements, technology of physical education, physical therapy, rehabilitation, sports medicine

The journal presents articles on topical issues of physical education and sport, as well as on the problems of the formation, restoration, strengthening and preservation of health of representatives of different groups of people, physical rehabilitation and physical therapy, rehabilitation, sports medicine.

It also reflects materials on the theory and methodology of training of sportsmen; the means of physical culture, its forms and methods, the basic principles of health-saving technologies and disease prevention.

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Здоров'я, спорт, реабілітація

Zdorov'â, sport, reabilitaciâ [Health, sport, rehabilitation]

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Наказом МОН України від 16.07.2018 № 775 та наказом МОН від 02.07.2020 № 886 журнал включено в **категорію Б фахових видань** України. Спеціальності: фізична культура і спорт (017, 24.00.01, 24.00.02, 24.00.03); педагогічні науки (011, 012, 013, 014, 015, 016, 13.00.02).

Засновник:

Харківський національний педагогічний університет імені Г.С. Сковороди.

Свідоцтво про державну реєстрацію:

КВ № 22450-12350Р від 01.12.2016

Фахове наукове видання з проблем фізичного виховання, спорту, формування здорового способу життя, реабілітації, фізичної терапії, спортивної медицини

Рік заснування: 2015

Галузь і проблематика: спорт, фізичне виховання, навчання рухам, організація фізичного виховання, рекреація, фізична терапія, спортивна медицина

У журналі представлені статті з актуальних проблем фізичного виховання і спорту, а також з проблем формування, відновлення, зміцнення і збереження здоров'я представників різних груп населення, фізичної реабілітації та фізичної терапії, спортивної медицини.

У ньому також відображені матеріали з теорії та методики підготовки спортсменів; засоби фізичної культури, її форми та методи, основні принципи здоров'язберігаючих технологій та профілактики захворювань.

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Здоровье, спорт, реабилитация

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Приказом МОН Украины от 16.07.2018 № 775 и приказом МОН от 02.07.2020 № 886 журнал включен в **категорию Б** профессиональных изданий Украины. Специальности: физическая культура и спорт (017, 24.00.01, 24.00.02, 24.00.03) педагогические науки (011, 012, 013, 014, 015, 016, 13.00.02).

Учредитель:

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Свидетельство о государственной регистрации:

КВ № 22450-12350Р от 01.12.2016

Специализированное научное издание по проблемам физического воспитания, спорта, формирования здорового образа жизни, реабилитации, физической терапии.

Год основания: 2015

Область и проблематика: спорт, физическое воспитание, обучение движениям, организация и технологии физического воспитания, физическая терапия, реабилитация, спортивная медицина

В журнале представлены статьи по актуальным проблемам физического воспитания и спорта, а также по проблемам формирования, восстановления, укрепления и сохранения здоровья представителей различных групп населения, физической терапии и спортивной медицины. В нем также отражены материалы по теории и методике подготовки спортсменов; средства физической культуры, ее формы и методы, основные принципы здоровьесберегающих технологий и профилактики заболеваний.

Журнал отражается в международных наукометрических базах данных:

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ORIGINAL ARTICLES. PHYSICAL EDUCATION

Body composition in students physical education and sport: cross-sectional pilot study

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

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Abstract

Purpose: Young people who study physical education and sport are a priori regarded as having proper body structure and body composition. It is widely presumed that young who study physical education at one of several national universities of physical education (East Sarajevo) could be characterized with proper physique and body composition. Aim of the current study was to assess and analyze the body composition of a male students Physical Education and Sport, University East Sarajevo, by bioelectric impedance analysis and determine the significance of inter correlation coefficients.

Material and methods: In study the participants consist 30 male students of Faculty of Physical Education and Sport, University of East Sarajevo, the III year of study (Body Height = 182.20 ± 6.89 cm; Body Weight = 80.06 ± 8.80 kg; Body Mass Index = 24.03 ± 2.58 kg/m²).

Results: of the study showed that the body composition is within the healthy (allowed) values recommended for this population of students (Body Fat=10.90kg or 13.62%; Body Muscle= 65.74kg or 82.40%; Body Water = 61.54%; Basal metabolic rate = 2045.07kCal; Daily calorie intake = 8436.56 kCal, etc.). Inter correlation coefficients showed inverse and significantly high correlation ($p=0.000$) between (inter correlation coefficient Fat-Muscle = -0.945), (inter correlation coefficients Fat-Water = -0.963) while direct correlation was achieved between (inter correlation coefficient Muscle-Water = 0.986).

Conclusion: The obtained results of the study defined the appropriate body composition of the students, which is a consequence of their adequate physical activity and well-designed curricula at the home faculty. In the parameters of body composition, students of physical education and sports in East Sarajevo had a higher muscle component and lower values of fat component than other students as a result of their somatotype, way of studying, teaching and extracurricular physical activities.

Key words: students of Physical Education and Sport, body composition, bioelectric impedance analysis, correlation analysis



Анотація

Ратко Павлович. Композиція тіла студентів факультетів фізичного виховання і спорту: перехресне пілотне дослідження

Мета: Молоді люди, які займаються фізкультурою та спортом, апіорі вважаються такими, що мають належну будову тіла та будову тіла. Широко припускається, що молодь, яка вивчає фізичне виховання в одному з кількох національних університетів фізичного виховання (Східне Сараєво), може мати належну статуру та композицію тіла. Метою поточного дослідження було оцінити та проаналізувати склад тіла студентів-чоловіків, студентів фізичного виховання та спорту, Університет Східного Сараєво, за біоелектричним імпедансним аналізом та визначити значення коефіцієнтів взаємозв'язку.

Матеріал і методи: У дослідженні брали участь 30 студентів-чоловіків факультету фізичного виховання та спорту Університету Східного Сараєво, III рік навчання (зріст тіла = $182,20 \pm 6,89$ см; маса тіла = $80,06 \pm 8,80$ кг; індекс маси тіла = $24,03 \pm 2,58$ кг/м²).

Результати: дослідження показало, що склад тіла знаходиться в межах здорових (дозволенних) значень, рекомендованих для цієї групи студентів (Жир = 10,90 кг або 13,62%; М'язи тіла = 65,74 кг або 82,40%; Вода в організмі = 61,54%; базальна швидкість метаболізму = 2045,07 кКал; добове споживання калорій = 8436,56 кКал тощо). Коефіцієнт взаємозв'язку показав обернену та значно високу кореляцію ($p=0,000$) між (коефіцієнт взаємозв'язку Жир-М'язи = -0,945), (коефіцієнт взаємозв'язку Жир-Вода = -0,963), тоді як пряма кореляція була досягнута між (коефіцієнт взаємозв'язку М'язи-Вода = 0,986).

Висновок: Отримані результати дослідження визначили відповідний склад тіла студентів, що є наслідком їх достатньої фізичної активності та грамотно розроблених навчальних програм на рідному факультеті. За параметрами будови тіла студенти фізкультури та спорту Східного Сараєво мали вищий м'язовий компонент і нижчі значення жирового компонента, ніж інші студенти, що вплинуло на їх соматотип, спосіб навчання, викладання та позакласної фізичної діяльності.

Ключові слова: студенти з фізичної культури і спорту, композиція тіла, біоелектричний імпедансний аналіз, кореляційний аналіз

Аннотация

Ратко Павлович. Композиция тела студентов факультетов физической культуры и спорта: профильное пилотное исследование

Цель: Молодежь, изучающая физическую культуру и спорт, априори расценивается как имеющая правильное телосложение и состав тела. Широко распространено мнение, что молодые люди, изучающие физическое воспитание в одном из нескольких национальных университетов физического воспитания (Восточное Сараево), могут характеризоваться правильным телосложением и составом тела. Цель настоящего исследования состояла в том, чтобы оценить и проанализировать состав тела студентов мужского пола по физическому воспитанию и спорту Университета Восточного Сараево с помощью биоимпедансного анализа и определить значение коэффициентов взаимосвязи.

Материал и методы: В исследовании приняли участие 30 студентов мужского пола факультета физического воспитания и спорта Университета Восточного Сараево, III курс обучения (рост = $182,20 \pm 6,89$ см; масса тела = $80,06 \pm 8,80$ кг; индекс массы тела = $24,03 \pm 2,58$ кг/м²).

Результаты: исследование показало, что состав тела находится в пределах здоровых (допустимых) значений, рекомендованных для данной популяции студентов (Жир = 10,90 кг или 13,62%; Мышцы тела = 65,74 кг или 82,40%; Вода в организме = 61,54%; базальная скорость метаболизма = 2045,07 ккал; суточная норма калорий = 8436,56 ккал и т. д.). ИСС показал обратную и значительно высокую корреляцию ($p = 0,000$) между (коэффициент взаимосвязи жир-мышцы = -0,945), (коэффициент взаимосвязи жир-вода = -0,963), в то время как прямая корреляция была достигнута между (коэффициент взаимосвязи мышца-вода = 0,986).

Заключение: Полученные результаты исследования определили соответствующий состав тела студентов, что является следствием их адекватной двигательной активности и правильно составленных учебных программ на домашнем факультете. По параметрам телосложения у студентов физкультуры и спорта Восточного Сараево более высокие значения мышечного компонента и более низкие значения жирового компонента, чем у других студентов, что обусловлено их соматотипом, способом обучения, преподавания и внеучебной физической активности.

Ключевые слова: студенты физической культуры и спорта, композиция тела, биоимпедансный анализ, корреляционный анализ



Introduction

Lack of movement (hypokinesia) reflects the time in which modern man lives and movement is one of the important factors in maintaining good health. In today's era of modern lifestyle, there is less and less physical activity (PA). As a consequence of "hypokinesia", many negative consequences for human health occur. Numerous deformities of the locomotor system occur at a younger age, while various metabolic and cardiovascular diseases are present in the older population [1-5]. Low levels of PA most often lead individuals to an increased risk of obesity and cardiovascular disease [6]. On the other hand, physical activity has been suggested as a means of reducing and controlling body fat. PA has important health benefits for adolescents and adults, and is associated with more favorable biological cardiovascular diseases (lower blood pressure, more favorable serum lipids and lipoproteins, and reduced adiposity) than less active or fit individuals, improving their ability to perform everyday tasks [7]. More generally, regular PA has been shown to effectively reduce various health risk factors, especially those related to cardiovascular disease and metabolic syndrome [8, 9]. Part of the effects of PA are thought to be through lowering blood pressure, improving lipid metabolism, and reducing body weight [10, 11]. Previous studies [12-17] confirmed that PA or aerobic exercise is inversely related to blood pressure. The American College of Sports Medicine recommends that adults engage in at least 150 min·wk⁻¹ of moderate intensity cardiovascular exercise and at least 75 min·wk⁻¹ of vigorous intensity training, in order to maintain a sufficient level of cardio-respiratory fitness. Resistance training is also suggested 2–3 day·wk⁻¹ [18].

Certain effects of increased physical activity include certain changes in the body composition of each organism [19-21]. Also, the level and magnitude of the observed changes depend on the type of physical activity or sport that the individual engages in as well as on his individual characteristics, abilities and predispositions. This usually includes gender, age, somatotype and specific dynamics of one's metabolic process in the body, which is a prerequisite for the formation of an appropriate body composition [22]. Several methods are used to analyze and measure body composition, and the most accurate measurement methods are magnetic resonance imaging and computed tomography [23]. Unfortunately, these methods are expensive and are mainly used in medical diagnostics because their wide application in population studies is difficult to justify. However, the use of bioelectrical impedance analysis

(BIA) is a relatively simple and non-invasive method for indirectly estimating overall body composition. BIA analysis is used in studies to assess body composition (e.g. total extracellular, intracellular water compartments, muscle mass, adipose tissue, body mass, resistance, basal metabolism). Its use is becoming increasingly popular because it is safe, fast, easy to use and suitable for laboratory, clinical and field assessments of the composition of the human body [24]. Due to its confirmed high repeatability, BIA is widely used in population studies as well as in replicating research [25] to enable comparative analysis of study results in different populations. The obtained information on body structure is multifunctional and can be used in different cases and with different population groups, including the student population.

With the transition to university, there are changes in the lifestyle of individuals, in terms of greater independence and increased social relations with peers, with many colleges becoming a sensitive population group in terms of diet and lifestyle [26]. Thus established new social relations and way of life most often shorten the time towards physical activity, reduce the quality of nutrition, which results in deterioration of physical composition and physical fitness of students during the school year [27, 28] show the findings of studies in several countries where poor activity, poor diet and smoking are serious health problems among students [29].

Students of physical education and sports (PES) represent a special population of healthy young people for whom PA is primary, which is in line with the specifics of their study plans and programs. Their PA is manifested through various forms of sports, most of which are included in the program of the Summer and Winter Olympic Games. In this regard, it is considered and expected that students of these faculties will have a different body composition compared to the population of the same chronological age, bearing in mind the continuity of their physical activities during their studies, also through various extracurricular activities (engagement in sports clubs and other types of recreation). A study by Grima, & Blay [30] conducted in Spain showed that students of physical education and sports have a healthier lifestyle, better cardiovascular profile and less body fat than students of other faculties, which may be due to the curriculum, which promotes active and a healthy lifestyle, in addition to having practical classes in which students participate in PA. In this regard, some research on the population of students of physical education and sports [22, 31 - 36] analyze issues of body composition, impact on motor manifestations, fitness index, correlation with



physical activity of students, differences between students of different geographical regions, correlations between body composition with physical fitness, nutritional habits, fitness and anthropometric parameters, which leads to the conclusion that physical status is a variable category and is primarily dependent on adequate PA of the individual and their lifestyle.

When enrolling at the faculty of physical education and sports, it is understood that future students have an adequate level of motor and functional potentials as well as an appropriate body composition that will, in the best possible way, enable them to realize planned PA during their studies. Almagià Flores, Lizana Arce, Rodriuez Rodriuez, et al. [31] suggest that the body composition of the student is of vital importance because it will be an excellent profit in subjects that require physical effort. It is widely believed that young people studying at the faculty of physical education and sports at one of the two national universities of Republic of Srpska (East Sarajevo) could be characterized by proper morphological structure, appropriate motor-functional potential and appropriate body composition. However, this assumption cannot be confirmed because so far there has been no research regarding the detection and analysis of physical status with students of this faculty. Due to this fact, it was considered useful to analyze and learn more about the physical development of these young people (students) who chose to study to become physical education teachers, sports coaches, instructors of recreational and sports activities or organizers of sports and recreation.

The aim of this pilot study is the detection and analysis of body composition of male students at the Faculty of Physical Education and Sports, University of East Sarajevo, using BIA. The study made it possible to identify the components of body composition that define and distinguish this physically active population (the so-called healthy population) from the physically less active population. There will also be information on the possibilities of students for the realization of practical classes at the faculty, especially in the field of aerobic and anaerobic activities.

Material and methods

Participants of study

This was a cross-sectional pilot study carried out on a total of sample 30 male students, Faculty of Physical Education and Sport, East Sarajevo (III year of study) (Body height= 182.40 ± 6.89 cm; Body

weight= 80.06 ± 8.80 kg; BMI= 24.03 ± 2.58 kg/m². A total of 19 variables were measured to assess BC:

1. Body fat (kg),
2. Body fat (%),
3. Body muscle (kg),
4. Body muscle (%),
5. Body water (%),
6. Right arm muscle (kg)
7. Left arm muscle (kg)
8. Trunk muscle (kg)
9. Right leg muscle (kg)
10. Left leg muscle (kg)
11. Right arm fat (%)
12. Left arm fat (%)
13. Trunk fat (%)
14. Right leg fat (%)
15. Left leg fat (%)
16. Viscular fat
17. Bones (kg)
18. Basal metabolic rate - BMR (kCal)
19. Daily calorie intake-DCI (kcal)

Experimental design

This study followed a cross-sectional design. The standard metric instruments were applied according to the methodology of the International Society for the Advancement of Kinanthropometry (ISAK). Body weight and Body composition (BC) were assessed with the Bioelectrical Impedance Analysis (BIA) using a body composition analyser (Tanita Inner ScanV BC-545N, Tokyo, JAPAN), in accordance with the measurement protocol. The participants were informed in about the nature of the study and investigational procedures, and all the participants have voluntarily given their consent to be the part of this study. The measurements were according to the procedures in the Helsinki declaration.

Bioelectrical Impedance Analysis (BIA)

Body composition monitor was used to assess the variables of body composition of the participants. It is a device that measures the body weight, body fat percent, visceral fat, skeletal muscle mass, and resting metabolic rate which works according to Bioelectrical Impedance Analysis (BIA) which analyzes the electrical resistance of the body tissues by sending extremely weak electrical current through the body. The following procedures were used for the measurement [37]



1. The power switch was press to turn on the machine the input button was pressed to enter each participant's age, height and sex;
2. Each participant mounted the machine bear footed placing the sole on the electrode of the machine;
3. Raise your arms horizontally and extend your elbows straight to form a 90° angle to your Body;
4. Stand with your knees and back straight and look straight ahead;
5. Hold the display unit in front of you;
6. Step on the Main Unit barefoot;
7. Make sure the heels are positioned on the heel electrodes and
8. Stand with your weight evenly distributed on the measurement platform.

Data analysis

The descriptive statistic were calculated. The statistical package Statistica, version 10.0 (STA999k347150-W) was used for data processing.

Results

The obtained results define the physical status of students of PES. More than 95% of student respondents engage in extracurricular physical activities (sports clubs, gym, fitness clubs). The presents the statistical parameters of the BC of the analyzed sample of male students (Table 1. Figure 1). The results confirmed that body fat determines $13.62 \pm 5.60\%$ (5.20-26.10%) of body composition, which is mean $10.90 \pm 4.92\text{kg}$ of fat mass (3.90-20.30kg). Of the total body mass of the sample (80.06kg), muscle mass is contained in $82.40 \pm 4.80\%$ (or 73.78-90.10%), wich is mean $65.74 \pm 5.79\text{kg}$ (56.60-81.50kg), while bones as part of the skeleton and total body mass take part with 3.42 kg (3.00-4.20kg) which is an indicator of the appropriate mineral status of the bones of the organism.

Table 1

Descriptive statistics Body composition

Body composition	Mean	Min.	Max.	SD (CI SD $\pm 95\%$)	Coef.Var.
Body fat (kg)	10,90	3,90	20,30	4,92 (3,92-6,62)	45,18
Body fat (%)	13,62	5,20	26,10	5,60 (4,46-7,53)	41,15
Body muscle (kg)	65,74	56,60	81,50	5,79 (4,61-7,79)	8,81
Body muscle (%)	82,40	73,78	90,10	4,80 (3,82-6,45)	5,83
Body water (%)	61,54	53,90	68,40	4,23 (3,37-5,68)	6,87
Right arm muscle (kg)	4,01	3,40	5,40	0,45 (0,36-0,60)	11,20
Left arm muscle (kg)	4,00	3,30	5,60	0,49 (0,39-0,66)	12,26
Trunk muscle (kg)	35,53	29,60	44,40	3,45 (2,75-4,64)	9,71
Right leg muscle (kg)	11,28	9,90	13,10	0,78 (0,62-1,05)	6,90
Left leg muscle (kg)	10,91	9,70	13,00	0,79 (0,63-1,07)	7,27
Right arm fat (%)	12,65	6,20	18,90	3,02 (2,40-4,05)	23,85
Left arm fat (%)	13,51	6,80	20,60	3,65 (2,90-4,90)	26,99
Trunk fat (%)	13,56	5,00	25,00	6,53 (5,20-8,78)	48,18
Right leg fat (%)	12,64	4,20	21,70	4,08 (3,25-5,48)	32,25
Left leg fat (%)	13,38	5,90	20,60	3,70	27,63



				(2,94-4,97)	
Visceral fat	2,25	1,00	6,00	1,72 (1,30-2,54)	64,58
Bones (kg)	3,42	3,00	4,20	0,28 (0,22-0,38)	8,18
Basal metabolic rate – BMR (kCal)	2045,07	1787,00	2592,00	188,71 (150,29-253,69)	9,23
Daily calorie intake – DCI (kCal)	8436,57	5699,00	10845,00	907,57 (722,80-1220,06)	10,76

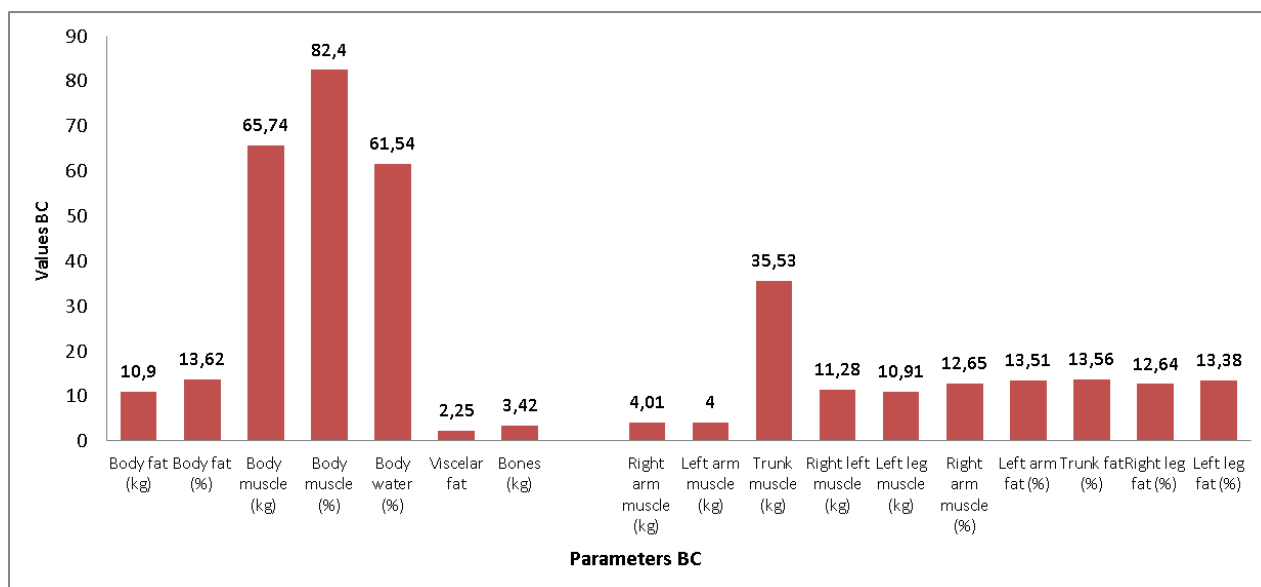


Fig. 1. Body composition of students Physical Education and Sport

It is evident that numerical analysis of segmental muscle status defines significant symmetry between the left and right sides of the cranial and caudal extremities. The right arm 4.01kg (min-max 3.40-5.40kg) contains identical mean muscle mass than the left arm 4.00kg (3.30-5.60kg). Right leg 11.28kg (9.90-13.10kg) contains slightly more in relation to the left leg 10.91kg (9.70-13.00kg). The largest muscle mass is present in the trunk muscle 35.53kg (29.60-44.40kg). Regarding the average representation of adipose tissue for trunk (13.56%), differences between the cranial and caudal extremities is evident (Table 1, Figure 1). They generally maintain an inverse relationship with muscle tissue and water values (water, 61.54%) as expected. The right arm contains an average of 12.65% adipose tissue (6.20-18.90%) and is slightly less than the fat percentage of the left arm 13.51% (6.80-20.60%). The proportion of adipose tissue in the caudal extremities recorded identical average values (right leg, 12.64% vs. left leg 13.38%) as well as ranges of min. and max. results. Carcass fat content contains close to 13.56% (5.00-25.00%), which is within healthy limits, without the possibility of amenorrhea with loss of minerals in

the bone. Body composition reflects a slight heterogeneity within the sample for body fat (kg), which may be due to poorer selection when selecting, biological differences, training process, extracurricular physical activities, acceleration growth, physical fitness, etc.

Out of a total of six inter correlation coefficients (ICC) between anthropometric parameters (height, weight) with the amount of fat, muscle component and water content in the body, four showed a high statistical correlation (Figures 2,3,4,5). Body height records a positive correlation only with muscle mass ($r = 0.550$; $p=0.000$), while there are insignificant correlations with the amount of fat and water in the body. It turns out that students with higher body weight also had a larger muscle component. In contrast to height, body mass is in a significant linear relationship with the amount of fat in the body ($r = 0.748$; $p = 0.000$) and muscle component ($r = 0.843$; $p = 0.000$) while inversely related to the amount of water in the body = -0.605 ; $p = 0.000$). ICC body composition, ie muscle mass and water content showed a very high and statistically significant direct ratio ($r = 0.986$; $p = 0.000$), in contrast to ICC body



fat and muscle component content ($r = -0.945$; $p = 0.000$), that is, fat and water content ($r = -0.963$; $p = 0.000$) that maintained a strong inverse relationship (Figures 6, 7, 8). This points to the fact that students who had a pronounced muscle component have more

water and less fat in the body. Similar results also refer to the inverse correlation of the fat component with the amount of water in the body ($r = -0.944$; $p = 0.000$).

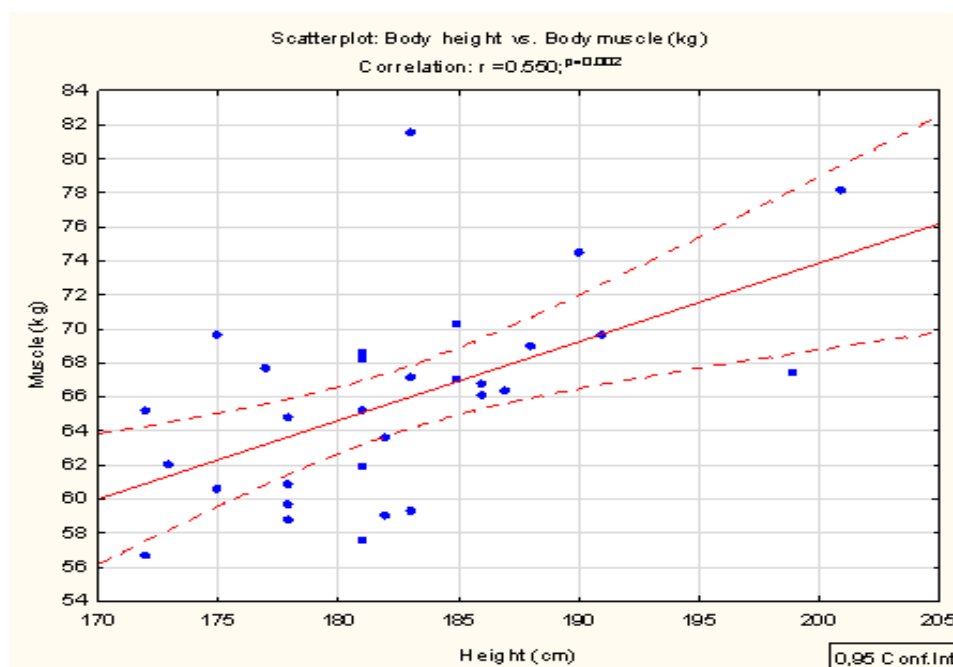


Fig. 2. Correlation Body height (cm) vs. Body muscle (kg)

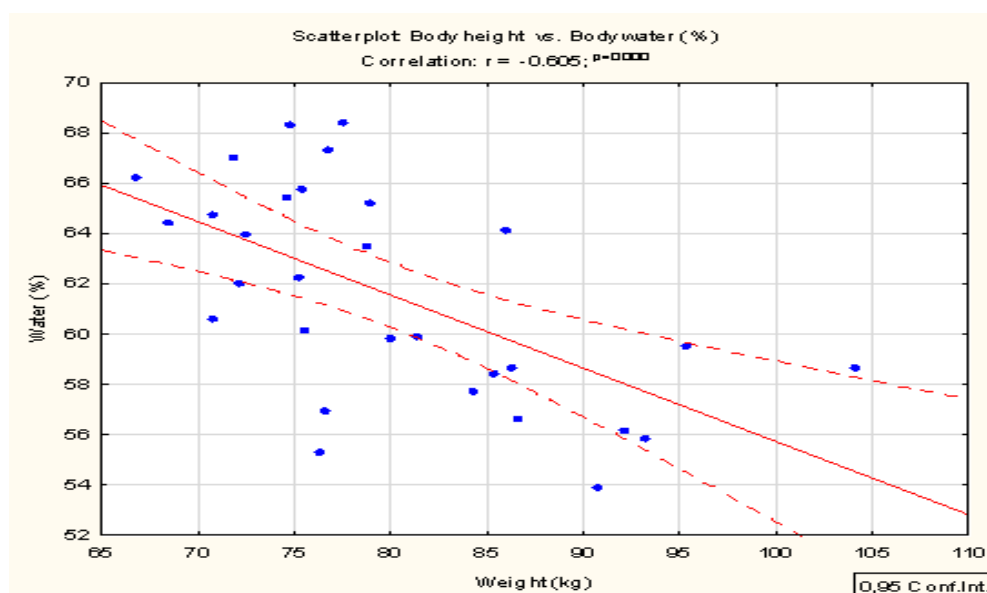


Fig. 3. Correlation Body weight (kg) vs. Body water (%)

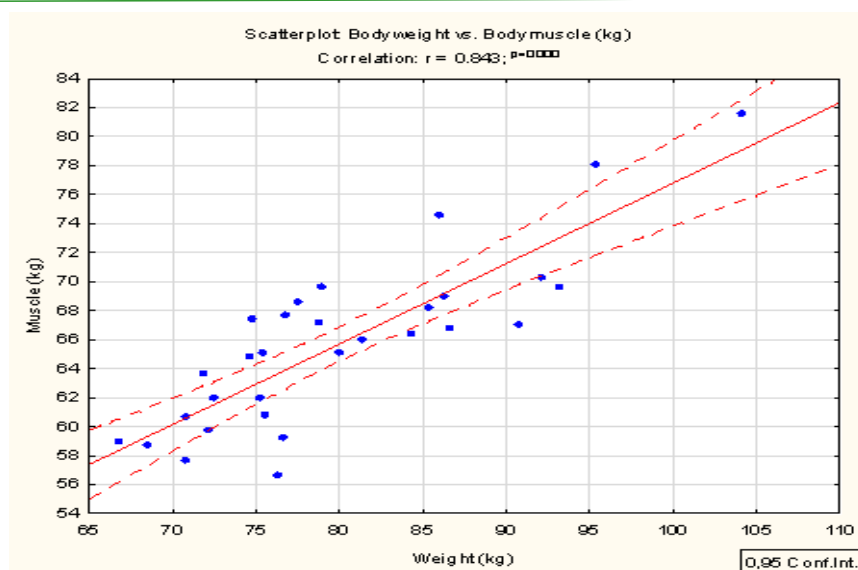


Fig. 4. Correlation Body weight (kg) vs. Body muscle (kg)

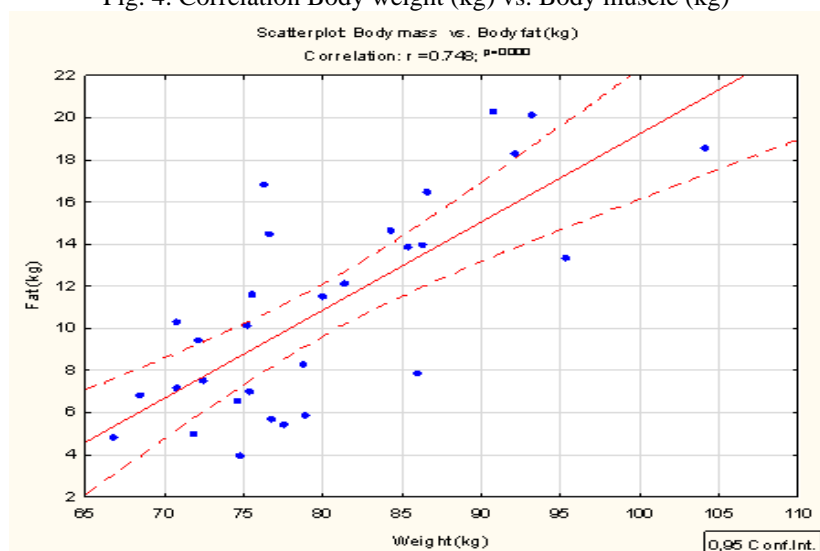


Fig. 5. Correlation Body weight (kg) vs. Body fat (kg)

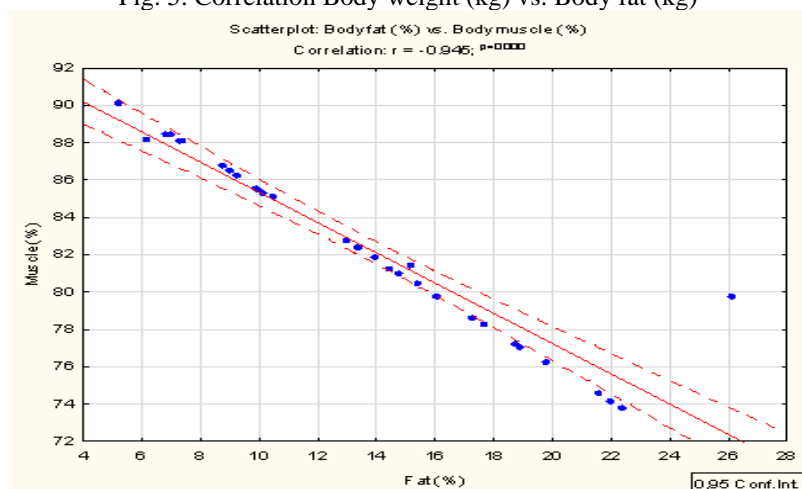


Fig. 6. Correlation Body fat (%) vs. Body muscle (%)

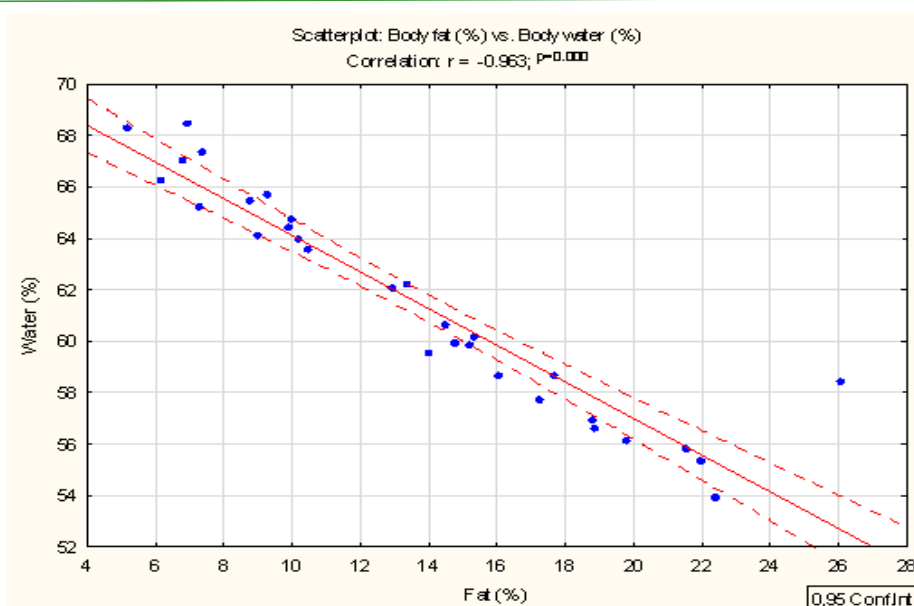


Fig. 7. Correlation Body fat (%) vs. Body water (%)

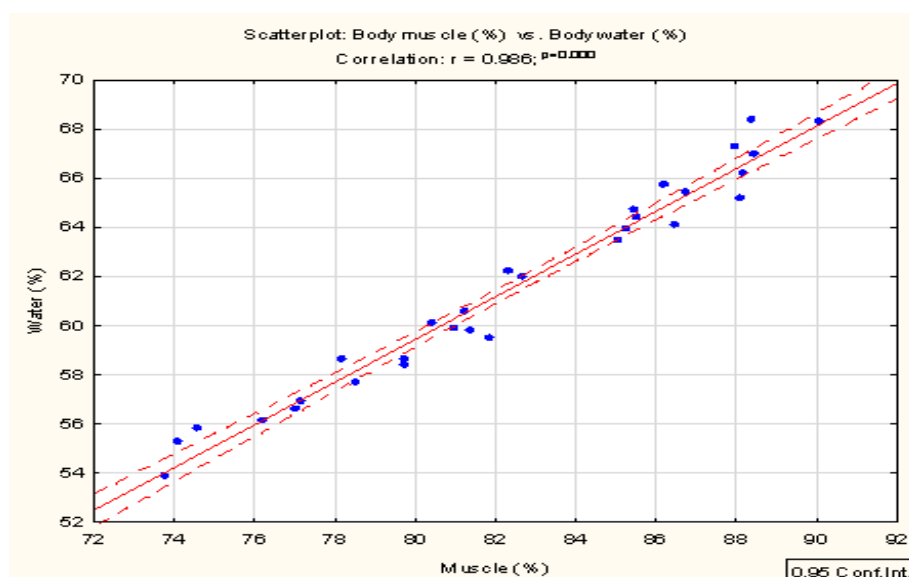


Fig. 8. Correlation Body muscle (%) vs. Body water (%)

Discussion

The aim of the study was to detect and analyze the body composition of a group of 30 male students of Faculty PES at the University of East Sarajevo. The analysis assessed 19 body composition parameters and determined ICC. The obtained results confirm the positive numerical values of all parameters of body composition. From the health aspect, i.e. possible negative consequences for the health of our sample, these are good results. The values of body fat (13, 62%) and visceral fat (2.25) are healthy norms so that their values were not detected as risk factors for some diseases and a negative factor in PA.

According to Vehrs & Hager [38] most body fat is deposited in fat cells (adipocytes) under the skin (subcutaneous fat) and around organs (visceral fat). Some fat (3-5% in men; 8-12% in women) is necessary for normal bodily functions, such as fat that is part of the nervous system or surrounding visceral organs in women [39]. Body fat has three important functions in the human body (serves as an insulator to preserve body heat, is a source of fuel for metabolic energy and as a basis for protection) but excess increases the risk of cardiovascular disease, type 2 diabetes, hypertension, hyperlipidemia, metabolic syndrome, coronary artery disease, intermittent claudication, stroke [40]

In the current study, significantly high ICC of anthropometric and body composition parameters



of students are evident. Body height is directly related only to muscle mass, while body weight is directly related to the amount of fat and muscle in the body, and inversely related to the amount of water in the body. And the measured impedance is related to the size and shape of the body and the amount of water in the body. Since a large part of skeletal muscle is only water, the measured impedance is used to estimate the total water content in the body (%), which in turn can be used to estimate FFM. Factors affecting the water content in FFM will affect the accuracy of predicting body fat percentage (% BF). The higher presence of fat in the body prevents the presence of water, especially in muscles [38]. These changes are due to the positive effects of student physical activity during studies and the faculty curriculum which supports the findings of some earlier studies [19, 21, 22].

The muscular component of our sample is dominant with more than 82% participation (66kg) which is a good result and an indicator of a significant presence of student physical activity. Increased calorie intake can be explained by the fact that in this population a better metabolic product is necessary, i.e. higher caloric consumption as a result of consumption in physical activity, which is in line with a study [41] that defines a negative correlation between physical activity, energy expenditure, and fat percentage in men. Men are more likely to engage in team sports (football, basketball, volleyball, handball) or in strength-related activities, e.g. body building, fitness, martial arts, athletics involving intense repetitive efforts, which are positively correlated with fat loss [42]. It turns out that different adaptations of the organism can be related to the type of sport. Considering that they are students of physical education and sports, these results are therefore expected. The results of our sample of students in terms of height, body weight and BMI are higher average values than the Italian sample of sports science students [33] for values of height (182.40cm vs. 177.60cm), body weight (80.06kg vs. 75.60 kg), while the parameters of body composition are lower (Body Fat 13.62% or 0.90kg vs. 17.3% or 13.3kg) and muscle components (65.74kg vs. 62.4kg). There are also significantly higher anthropometric measures compared to Japanese students [43] while body composition is slightly lower in Japanese students (Body Fat 12,3% or 7.9kg, Body Muscle 55.4kg).

Authors López-Sánchez, Radziminski, Skalska, et al. [36] analyze differences in body composition, physical activity, and diet between Polish and Spanish male sports science students. The results show that Polish students have better values of physical composition and physical activity, while

Spanish students are defined by a healthier lifestyle. To avoid future risks of diseases such as obesity or diabetes, Polish physical education and sports curricula should include more lessons that promote an active and healthy lifestyle, while Spanish curricula require more physical activity and sport. Faculties of sports sciences should include more active practical classes in which students could improve their physical status and physical fitness through physical exercise. Compared to Polish sports students from Gdańsk (180cm-78.80kg) our sample defines higher values of anthropometric parameters, body height and body weight, but also lower numerical values of the fat component which is more pronounced in Polish students (Body Fat 14,28%-11.69kg). The percentage of water content is almost identical with a slight increase in the field sample (62,67% vs. 61.54%). The muscle component recorded a higher value of Polish students (67.11 kg-85.71%) compared to our sample (65.74 kg-82.40%) but also an average lower BMR (1995.03 vs. 2045.07). Our sample of students compared to Spanish sports students from Murcia is primarily defined by bigger height (182.40cm vs. 178cm) and body weight (80.06kg vs. 75.31kg). They also have less isolated adipose tissue in the body compared to the Spanish (Body fat 13,62%-10.90kg vs. 14.73%-11.41kg). The water content in the body is slightly higher in the Spanish sample (62,82%) compared to students in East Sarajevo (61,54%). When it comes to the muscle component, it is more dominant in the sample of our students compared to the Spanish (65,74kg -82.40% vs. 63.92kg 85.26%) who also recorded a lower BMR (1895.60).

The lower fat content by 2 kg (2%) in physically active students compared to less active students is confirmed by the research of [22]. Adipose tissue participates from 15-17% while the muscle component occupies 44 kg of total body weight with 45% water. The results confirm that the level of physical activity is not related to body height, body weight and absolute amounts of other studied components of body composition. Compared to the previous research, our sample defines a lower fat content (by about 3%), a more dominant muscle component by almost 20kg and more water by 21%. The results of this study do not support the results of previous research, but are consistent with the results of [30] supporting the thesis on the impact of physical activity through the practical teaching of sports faculties on lower fats in the body of individuals. The results of the current study are in line with the conclusions of the research [31] which imply the negative impact of adipose tissue on the manifestations of motor skills from space speed, strength and aerobic endurance.



It can be assumed that the physical adaptation of students in East Sarajevo is a positive response to the programmed physical activity that is associated with increasing muscle mass, reducing body fat and vice versa. Physical adaptation in response to a large amount of weekly physical activity through practical lectures and exercises can be correlated with a reduced percentage of fat and an increase in muscle mass and at the same time with the general health of the student sample.

Conclusions

The obtained results of the study defined the appropriate body composition of students of PES (Fat-13,62%; Muscle-82,49%; Water-61,54%; Visceral Fat-2,25; BMR = 2045,07kCal; DCI = 8436,56 kCal ...) which is a consequence of their adequate PA and well-designed curricula at the home faculty. Good body composition of individuals is a prerequisite for good realization of both motor and functional abilities. The ICC results confirmed a highly inverse and statistically significant relationship between the amounts of fat in the body on the one hand and muscle mass and water content

on the other. Students who had more muscle mass and more water also had less fat in their bodies. Compared to students from other countries, our sample of students in terms of anthropometric parameters (height, mass) is superior. In terms of body composition, students of PES in East Sarajevo had a higher muscle component and lower values of fat component, than students from other countries, which is a consequence of their somatotype, way of studying, curricular and extracurricular physical activities. The physical status defined in this way will enable more adequate performance of certain aerobic and anaerobic activities of students. As a recommendation for future research would go in the direction of involving significantly more students, e.g. all four years of study.

Conflict of interest

The authors declare that there is no conflict of interest.

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ORIGINAL ARTICLES. PHYSICAL EDUCATION

Functional condition of students with different types of posture

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Abstract

Purpose: The purpose of the work is to conduct a comparative analysis of the functional state of students with different types of posture.

Material and methods. The study surveyed 222 students (108 boys and 114 girls). The analysis of the obtained data indicates that only 19.4% of boys and 12.3% of girls have a normal posture.

Results. Among students with postural disorders, scoliotic (asymmetric) posture is most common (34.3% of boys and 43.8% of girls), less with stooped (22.2% and 23.7%, respectively), less common with round posture (24.1% and 20.2%). Female students have a lower level of biogeometric posture than boys. The functional state of the level of aerobic productivity, girls, regardless of posture, is higher than boys. Among boys, the level of aerobic performance was not rated higher than "below average", and among girls below "excellent" or "good". According to the standards for assessing the functional readiness of people of different ages in Podilsk region, the "average" level of aerobic productivity of women 20-22 years is much higher than established by GL Apanasenko "safe level of health", and the value of 38 ml min⁻¹ kg⁻¹ corresponds only "average" level, regardless of posture. It was found that in students with a low level of biogeometric posture profile, the level of aerobic productivity, regardless of gender, is lower than in people with normal posture. Thus, the relationship between the level of biogeometric profile and the level of aerobic productivity, regardless of the type of posture.

Conclusions. The functional state of the level of aerobic productivity, girls, regardless of posture, is higher than boys. Among boys, the level of aerobic performance was not rated higher than "below average", and among girls below "excellent" or "good".

Key words: physical performance, posture disorders, biogeometric profile, assessment standards



Анотація

Городецкая О.О., Куц Б.О. Функциональный стан студентов с разными типами постанки.

Мета роботи: провести порівняльний аналіз функціонального стану студентів з різними типами постанки.

Матеріал і методи. В ході дослідження обстежено 222 студенти (108 юнаків та 114 дівчат). Для визначення функціонального стану використовували метод викопіювання з медичних карт, велоергометрію. Для визначення типу постанки використовували удосконалену карту експрес-контролю біогеометричного профілю постанки. Обрахунок проводили за допомогою t-критерію Стьюдента.

Результати. Аналіз отриманих даних вказує на те, що лише 19,4 % юнаків та 12,3 % дівчат мають нормальну постанку. Серед студентів з порушенням постанки, найбільше зустрічається зі сколіотичною (асиметричною) поставою (34,3% юнаків та 43,8% дівчат), менше із сутулою (22,2% і 23,7% відповідно), рідше із круглою поставою (24,1% та 20,2%). У студенток-дівчат рівень стану біогеометричного профілю постанки нижчий, ніж у студентів-юнаків. Функціональний стан за рівнем аеробної продуктивності, дівчат, незалежно від типу постанки, вищий, ніж у юнаків. Серед юнаків рівень аеробної продуктивності у жодного не був оцінений вище ніж «нижче посереднього», а серед дівчат нижче «відмінно» чи «добре». Відповідно до стандартів оцінки функціональної підготовленості осіб різного віку Подільського регіону «середній» рівень аеробної продуктивності жінок 20-22 років перебуває значно вище від встановленого Г. Л. Апанасенком «безпечного рівня здоров'я», а величина $38 \text{ мл} \cdot \text{хв}^{-1} \cdot \text{кг}^{-1}$ відповідає лише «середньому» рівню, незалежно від стану постанки. Встановлено, що у студентів із низьким рівнем біогеометричного профілю постанки, рівень аеробної продуктивності, незалежно від статі, нижчий, ніж у осіб з нормальною поставою. Таким чином, встановлено взаємозв'язок між рівнем біогеометричного профілю та рівнем аеробної продуктивності, незалежно від типу постанки.

Висновки. Функціональний стан за рівнем аеробної продуктивності, дівчат, незалежно від типу постанки, вищий, ніж у юнаків. Серед юнаків рівень аеробної продуктивності у жодного не був оцінений вище ніж «нижче посереднього», а серед дівчат нижче «відмінно» чи «добре».

Ключові слова: фізична працездатність, порушення постанки, біогеометричний профіль, стандарти оцінки

Аннотация

Городецкая А.А., Куц Б.А. Функциональное состояние студентов с различными типами осанки.

Цель работы - провести сравнительный анализ функционального состояния студентов с различными типами осанки. Для решения поставленных задач были применены следующие методы исследования: анализ научно-методической литературы, метод выкопировки из медицинских карт, велоэргометрия, для определения типа осанки использовали усовершенствованную карту экспресс-контроля биометрического профиля осанки.

Материал и методы. В ходе исследования обследовано 222 студента (108 юношей и 114 девушек). Для определения функционального состояния использовали метод выкопировки из медицинских карт, велоэргометрия. Для определения типа осанки использовали усовершенствованную карту экспресс-контроля биометрического профиля осанки. Расчет производили с помощью t-критерия Стьюдента.

Результаты. Анализ полученных данных указывает на то, что лишь 19,4% юношей и 12,3% девушек имеют нормальную осанку. Среди студентов с нарушением осанки, чаще всего встречается сколиотическая (асимметричная) осанка (34,3% юношей и 43,8% девушек), меньше с сутулая (22,2% и 23,7% соответственно), реже круглая спина (24,1% и 20,2%). В студентов-девушек уровень состояния биометрического профиля осанки ниже, чем у студентов-юношей. Функциональное состояние по уровню аэробной продуктивности, девушек, независимо от типа осанки, выше, чем у юношей. Среди юношей уровень аэробной производительности ни у одного не был оценен выше «ниже среднего», а среди девушек ниже «отлично» или «хорошо». Согласно стандартам оценки функциональной подготовленности лиц всех возрастов Подольского региона «средний» уровень аэробной продуктивности женщин 20-22 лет находится значительно выше установленного Г. Л. Апанасенко «безопасного уровня здоровья», а величина $38 \text{ мл} \cdot \text{мин}^{-1} \cdot \text{кг}^{-1}$ соответствует только «среднему» уровню, независимо от состояния осанки. Установлено, что у студентов с низким уровнем биометрического профиля осанки уровень аэробной продуктивности, независимо от пола, ниже, чем у лиц с нормальной осанкой. Таким образом, установлена взаимосвязь между уровнем биометрического профиля и уровнем аэробной производительности независимо от типа осанки.

Выводы. Функциональное состояние по уровню аэробной продуктивности, девушек, независимо от типа осанки, выше, чем у юношей. Среди юношей уровень аэробной производительности ни у одного не был оценен выше «ниже среднего», а среди девушек ниже «отлично» или «хорошо».

Ключевые слова: физическая работоспособность, нарушение осанки, биометрический профиль, стандарты оценки



Introduction

Much attention has recently been paid to the student health. Health depends of many factors and is determined by a set of interrelated features: primarily physical performance, functional status of organs and systems of the body, physical development, physical fitness of students. An integral indicator of health is considered to be a functional state, which is defined as the level of the resistance of the organism to the action of adverse environmental factors and is determined by physical performance [1-3].

Physical and functional fitness is considered as a result of physical training, which is achieved in the process of mastering motor skills and improving physical qualities while increasing the level of activity of the main functional systems of the body. Moreover, functional fitness is the basic basis for improving physical qualities, the manifestation of which determines physical fitness.

Posture is one of the factors that negatively affect the functional capabilities of the body, and also contributes to the emergence of some chronic diseases [4]. The high prevalence of postural disorders among students is due to many factors, including the complexity of work organization, low motivation of young people to engage in physical education and the lack of optimal methods of physical education in higher education.

It should be noted that the manifestation of certain physical qualities of persons with posture defects depends on the type of posture disorder. Thus, a decrease in general strength qualities is observed most often in young people with asymmetrical posture, and a decrease in flexibility - in people with postural disorders in the sagittal plane with a decrease and increase in curvature of the spine [5].

It has been established that posture disorders affect the activity of the cardiovascular and respiratory systems. Thus, according to some authors, people with postural disorders have significantly reduced Robinson and Ruffier indices, which is confirmed by violations of regulation and insufficient level of adaptive reserves of the cardiovascular system [6]. Students with postural impairment after dosed exercise have significantly higher heart rate and blood pressure, and the recovery time is longer compared to students with normal posture.

Postural disorders are a common musculoskeletal disorder among young people. Middle and high school students have more postural disorders than preschool children. There is a lack of consensus among scholars on the prevalence and

type of postural disorders in students. However, there is evidence that the prevalence of postural disorders among students ranges from 60 to 80%

According to scientific literature sources, posture disorders are accompanied by a decrease in physical and functional fitness of the body. In children, adolescents and students found posture disorders have a negative impact on the development and improvement of physical qualities: strength, endurance, flexibility, static-strength endurance of the muscles of the back and legs. However, in students, posture disorders are often combined with decreased activity of the cardiovascular and respiratory systems. There are data that indicate a negative impact of posture disorders on energy supply and physical performance.

The relevance of the study is due to the increase in the number of students with postural disorders and persons classified by health status to a special medical group, which is also due to the lack of optimal methods of training [7-9].

Purpose: The purpose of the work is to conduct a comparative analysis of the functional state of students with different types of posture.

Material and methods

Participants

The study involved 222 students (108 boys and 114 girls) 2-4 years of study of Vinnytsia Institute of University 'Ukraine'. All students attended the main medical group and did not play sports.

All participants were aware of the objectives of the study and agreed to participate.

Procedure

For the determination of the posture type used the improved map of rapid control of the biogeometric profile of posture [10].

Initially, the presence of postural disorders in the frontal and sagittal planes was determined in all subjects. Students were divided into groups with and without violation of posture. They studied the level of functional performance. In addition, the level of functional performance of people with posture disorders was determined depending on the plane in which the posture disorder was detected.

The functional state was studied in terms of physical performance (PWC_{170}), maximum oxygen consumption (VO_{2max}). For this purpose, the methods of bicycle ergometry, and heart rate monitor were used. The maximum measure of oxygen consumption (VO_{2max}) was determined by the



Karpman method. Investigated person performed two loads on bicycle ergometer by 5 min. The frequency of pedaling was 60 rpm^{-1} with 3 min interval of rest. Power of the first load was 1 W on 1 kg of body weight. Power of the second load was 2 W on 1 kg of body weight. The heart rate was registered at the end of each load. The value of VO_2 max was calculated. The value of VO_2 max is calculated in $\text{ml} \cdot \text{min}^{-1}$ [11-13]

Indicators of aerobic productivity of the organism were evaluated by the relative value of maximum oxygen consumption using the criteria of J. Piarnat [11] and standards of aerobic productivity students of aged 20-22 years old in Podilsk region [11-14]. The relative health of students was also assessed by the relative value of $\text{VO}_{2\text{max}}$. Thus, 'safe level of health' for men is characterized by the relative value of maximum oxygen consumption and is not less than $42 \text{ ml min}^{-1} \text{ kg}^{-1}$, and for women - $35 \text{ ml min}^{-1} \text{ kg}^{-1}$.

The work was performed in accordance with generally accepted bioethical norms in compliance with the relevant principles of Declaration of Helsinki, Council of Europe Convention on Human Rights and Biomedicine and the relevant laws of Ukraine on experimental and clinical research.

Statistical analysis

Systematization of the material and primary mathematical processing were performed using a spreadsheet Microsoft® Excel 2010.

Statistical processing was performed applying Student's t-criterion. It was defined as an average mean (\bar{X}), Student's t-criterion (t), standard error of the mean ($\pm m$), number of degrees of freedom (f), significance value (p). The difference was considered significant at $p < 0,05$ [10]

Results

Copying data from medical records of students, photography with the participation of a doctor - vertebral neurologist allowed to establish that only about 19.4% of men and 12.3% of female students have a normal posture (Table 1). Thus, among students the types of posture disorders were distributed as follows: scoliotic posture in 34.3%, stooped back in 22.2%, round in 24.1%. In female students, scoliotic posture was observed in 43.8%, stooped back in 23.7%, round in 20.2%.

Analyzing the data obtained to determine the state of the biogeometric profile of students' posture, it was found that 61.9% of students with normal posture have an average level of biogeometric profile of posture and only 38.1% high. The average biogeometric profile of female students was 9.5% more common than that of male students. No students with a low level of biogeometric profile were found among students with normal posture.

Table 1

Distribution of students by levels of biogeometric posture profile,
% (n = 222)

Posture type	Sex	Levels of biogeometric posture profile condition, %		
		Low	Average	High
Normal posture	Boys n=21	0	61.9	38.1
	Girls n=14	0	71.4	28.6
Scoliotic posture	Boys n=37	48,6	51.4	0
	Girls n=50	52,0	48.0	0
Stooped back	Boys n=21	25,0	75.0	0
	Girls n=27	33,3	66.7	0
Round back	Boys n=21	26,9	73.1	0
	Girls n=23	30,4	69.6	0



As a result of the study, we found that students with normal posture have a high level of biogeometric profile is 9.5% more common than female students. Male students with scoliotic posture have a low level of biogeometric profile is 4.6% more often than female students. Low-level biogeometric profile is more common in female students with a round and stooped back, 3.5% and 8.3%, respectively, than in female students. Students with a normal posture did not have individuals with a low level of biogeometric posture profile, and students with scoliotic, round and stooped backs did not show individuals with a high level of biogeometric profile.

Comparative analysis of the data showed that the state of the biogeometric profile of the posture of female students is lower in comparison to boys. According to the results of the study, scoliotic

posture is the most common posture disorder regardless of gender.

The study of physical performance and maximum oxygen consumption of students convincingly showed that there are probable differences in aerobic productivity of the body in absolute and relative values of such indicators as PWC_{170} and VO_{2max} in students with different types of posture. Evaluating the aerobic productivity of the body by the relative value of VO_{2max} , in students with different types of posture, using the criteria of Ya. Piarnat (1983) we found gender differences in the distribution of the surveyed by the level of aerobic productivity (Table 2-3).

The level of aerobic productivity of female students was much better than the same for young men, regardless of the presence or absence of posture disorders.

Table 2

Aerobic productivity of boys with different types of posture (n=108)

Measures	Normal posture n=21	Postural disorders n=87	Significance of differences	
	$\bar{X} \pm m$	$\bar{X} \pm m$	p	t
PWC_{170} , kgm min ⁻¹	949.65±17.70	791.72±12.01	<0.001	-7.39
PWC_{170} , kgm min ⁻¹ kg ⁻¹	13.56±0.18	10.56±0.17	<0.001	-12.50
VO_{2max} , ml min ⁻¹	2854.4±30.08	2585.48±20.41	<0.001	-7.39
VO_{2max} , ml min ⁻¹ kg ⁻¹	40.87±0.41	34.49±0.52	<0.001	-12.50

Note: *** -significance level p <0.001

Table 3

Aerobic productivity of girls with different types of posture (n=114)

Measures	Normal posture n=14	Postural disorders n=100	Significance of differences	
	$\bar{X} \pm m$	$\bar{X} \pm m$	p	t
PWC_{170} , kgm min ⁻¹	697.55±21.72	644.87±11.23	<0.05	-2.15
PWC_{170} , kgm min ⁻¹ kg ⁻¹	12.41±0.26	10.58±0.09	<0.01	-6.78
VO_{2max} , ml min ⁻¹	2425.97±36.92	2336.2±19.09	<0.05	-2.15
VO_{2max} , ml min ⁻¹ kg ⁻¹	43.33±0.84	38.52±0.30	<0.01	-6.78

Note: * -significance level p <0.05; ** -significance level p <0.01

In boys with impaired posture (scoliotic posture, stooped and round back), the absolute value of PWC_{170} was significantly lower by 16.63% (P <0.01) than in students with normal posture. In terms of relative indicators PWC_{170} , this difference was 22.12% (P <0.01). The absolute and relative VO_{2max} values in young men with postural disorders were also lower than in their yearling with normal posture,

respectively, by 9.42% (P <0.01) and 15.61% (P <0.01).

Therefore, significant differences in the aerobic performance of the body in terms of absolute and relative values of indicators such as PWC_{170} and VO_{2max} of students with different types of posture.

The results of the study of physical performance and maximum oxygen consumption of students.



In girls who had postural disorders, the absolute value of PWC_{170} turned out to be significantly less than in girls with normal posture by 7.55% ($P < 0.05$), and the relative value by 15.55% ($P < 0.01$). The absolute value of the VO_{2max} indicator

was recorded among students with postural disorders less than among students without posture disorders, by 3.7% ($P < 0.05$). At the same time, the relative value of VO_{2max} differed more - by 11.15% ($P < 0.01$).

Table 4

Estimation of aerobic performance of students with different types of posture (n = 222)

Posture type	Sex	VO_{2max} , $ml \cdot min^{-1} \cdot kg^{-1}$, $\bar{X} \pm m$	Standards of aerobic productivity students' of aged 20- 22 years old in Podilsk region	Exception is the evaluation criteria of Piarnat Ia.P.
Normal posture,	Boys n=21	40.87±0.41	Average 43.00 – 38.60	Below average 35-42
	Girls n=14	43.33±0.84	Good 42.10-44.20	Excellent >36
Scoliotic posture	Boys n=37	34.31±0.51	Low 36.20-31.80	Low <35
	Girls n=50	40.72±0.40	Average 42.00-37.60	Excellent >36
Stooped posture,	Boys n=21	34.42±0.52	Low 36.2-31.8	Low <35
	Girls n=27	39.12±0.30	Average 42.0—37.6	Excellent >36
Round back,	Boys n=21	34.49±0.52	Low 36.20-31.80	Low <35
	Girls n=23	40.43±0.30	Average 42.00 -37.60	Excellent >36

As noted by the authors Furman, Yu., Miroshnichenko V, Brezdeniuk O [16]. There are no generally accepted criteria for assessing human aerobic capacity. The data by different authors published are somewhat different. The most commonly used evaluation criteria are Piarnat Ia.P. [11]. They cover a wide age range (from 10 to 50 years), but do not take into account the peculiarities of the region

Therefore, to assess the aerobic capacity of young people with and without postural disorders used "Standards of functional fitness of young people 20-22 years of the Podilsk region," because they are based on modern data, take into account the features.

The data obtained by us confirmed the data that the "average" level of aerobic productivity of women aged 20-22 (see Table 1) is much higher than the "safe level of health" established by GL Apanasenko. According to JP Pernat[11], the "excellent" level of aerobic productivity corresponds to values > 38 $ml \cdot min^{-1} \cdot kg$ [13-18]. According to

Furman Yu, Brezdenyuk O, Miroshnichenko V (2021). Standards for assessing the functional readiness of persons of different ages., Given in table. 1, the value of 38 $ml \cdot min^{-1} \cdot kg$ corresponds only to the "average" level

According to scientists of the Podilsk region, the level of aerobic productivity in young people with a normal posture corresponds to the «average», and according to the criteria of the spot «below the average». The girls are respectively above «average» and «excellent».

Students with a normal posture - the majority (72.97%) had a level of aerobic performance «below average», and the rest (27.03%) «average». Among the students of this group, none with «good» and «excellent», as well as «low» levels of aerobic performance. Students with postural and «excellent» levels of aerobic performance were also not found in students with postural disorders (scoliotic, stooped, round back).



Table 5

The ratio of the number of students (%) with different levels of aerobic performance
(n = 222)

Contingent of students		Quantity of people with different LAP				
		Low	Below average	Average	Good	Excellent
Boys	Normal posture, n=21	-	72.97	27.03	-	-
	Scoliotic posture, n=37	48.61	32.43	18.96	-	-
	Stooped posture, n=24	45.83	33.33	20.84	-	-
	Round back, n=26	57.70	26.92	15.38	-	-
Girls	Normal posture, n=14	-	-	-	3.85	96.15
	Scoliotic posture, n=50	-	-	-	16.00	84.00
	Stooped posture, n=27	-	-	-	18.52	87.48
	Round posture, n=23	-	-	-	78.26	21.74

It should be noted that most of the young students with a «low» level of aerobic productivity were found people with round (57.70%), scoliotic (48.61%), stooped (45.83%) back. The least among students with «average» level of aerobic productivity were found people with round back (15.38%), scoliotic (18.96%), and stooped back (20.84%).

Among the surveyed girls with normal posture, the majority (96.15%) had an «excellent» level of aerobic performance and only 3.85% «good». Among female students with a stooped back, the most identified (87.48%) were people with an «excellent» level of aerobic performance, with a scoliotic posture - 84.00%, with round one - 21.74%. Girls with round back - 78.26% of people had a «good» level of aerobic performance.

It should be noted that among the students there were no people with «average», «below average» and «low» levels of aerobic performance, regardless of posture.

Discussion

Posture disorders among students are a fairly common spinal defect that is more common in girls than in boys, due not only to the lower presence of a muscular component in the body weight of girls

compared to boys, but also in our opinion insufficient motivation to exercise.

The study of physical performance and maximum oxygen consumption of young men convincingly showed that there are probable differences in aerobic productivity of the body in absolute and relative values of such indicators as PWC_{170} , and VO_{2max} in persons with and without postural disorders.

Despite the fact that the average value of the absolute VO_{2max} in boys with posture disorders significantly exceeds the average value of this indicator in girls, the average values of the relative VO_{2max} in males and females are almost the same ($P < 0.05$). This phenomenon is explained by a significant difference in body weight in boys and girls, which in students was much smaller.

Evaluating the aerobic productivity of the body by the relative value of VO_{2max} , in students with and without impaired posture, using the criteria of Ya.P. Pjrnata and Standards for assessing the functional readiness of persons of different ages by Furman Yu, we found gender differences in the distribution of the surveyed by the level of aerobic productivity.

Such differences in the level of aerobic productivity of the body relative to the "critical level of health" according to GL Apanasenko in girls and boys coincide with the results of a study by a number of scientists Yu.M. Furman, V.M. Miroshnichenko,



SP Drachuk[18-20].. This suggests that boys should pay more attention to improving the aerobic productivity of the body than girls using the means of physical education.

The study found that the type of posture, in particular posture disorders, determines the functionality of student youth. Students with a low level of biogeometric profile, regardless of gender, had a lower level of aerobic performance than those with a normal posture. Thus, a correlation was established between the level of biogeometric profile and the level of aerobic productivity regardless of the type of posture.

According to research, the level of aerobic productivity in students was lower than the 'safe level of health'. In girls, regardless of the presence of postural disorders, the level of aerobic productivity of the body corresponded to «high».

As a result of the research, it was established that the type of posture, in particular posture disorders, determines the functional capabilities of student youth. Students with a low level of biogeometric profile, regardless of gender, had a lower level of aerobic productivity than those with normal posture. Thus, the correlation between the level of biogeometric profile and the level of aerobic productivity, regardless of the type of posture was established.

Conclusions

1. Functional posture disorders are a fairly common pathology that occurs in students and adversely affects their functionality.

2. Posture disorders in students cause more significant changes than in female students.

Assessing the level of aerobic productivity of students with and without postural disorders, it was found that the level of aerobic productivity in girls is higher than in boys. Such differences in the level of aerobic productivity of the body relative to the "safe level of health" in girls and boys coincide with the results of a study by a number of scientists. This suggests that young men should pay more attention to improving the aerobic productivity of the body than girls using the means of physical education. It should be noted that timely control and assessment of preparedness allows you to rationally build the learning process and determine its effectiveness.

Conflict of interest

The authors declare that there is no conflict of interest.

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ORIGINAL ARTICLES. SPORT

Interactive tools for theoretical training of kayakers and canoeists aged 13-16

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Abstract

Purpose: substantiation and development of the structure and content of theoretical training of kayakers and canoeists at the stage of preliminary basic training and determining the effectiveness of classes using traditional and author's (interactive) means of theoretical training of athletes.

Material and methods. In the second stage, an experiment was conducted to establish the effectiveness of traditional and interactive means of theoretical training. The study involved trainers-teachers, a total of 82 people. Among the respondents were 41 coaches of the highest category (21 of them - Honored Coach of Ukraine), 19 people - coaches of the first category, 22 people - coaches of the second category. In the second stage, an experiment was conducted to establish the effectiveness of traditional and interactive means of theoretical training. The experiment involved kayakers and canoeists aged 13-16, who were engaged in the stage of preliminary basic training. The total number of athletes was 42 people. Two experimental groups were formed, in the preparation of which different methods and means of theoretical training were used. Comparison of data obtained during the survey of trainers-teachers was tested for the normality of the distribution using the criterion of agreement χ^2 Pearson. To determine the reliability of the differences between the indicators of the level of theoretical training of rowers before and after the pedagogical experiment, the criterion of signs (Signtest) was used.

Results. Training sessions on the developed program with the use of author's interactive means of theoretical training contributed to a significant ($p < 0.05$) increase in the overall level of theoretical training of rowers at the stage of preliminary basic training by 29.56%. At the same time, training sessions with the use of theoretical training provided by the state curriculum were less effective and contributed to increasing the overall level of theoretical training of young rowers by only 7.2% ($p < 0.05$).

Conclusions. Theoretical training is an important component in the system of training kayakers and canoeists. The use of interactive theoretical training tools using the game method (computer games) in the process of theoretical training significantly increases its effectiveness, in contrast to classes that used only traditional tools and methods (study of methodological literature, conversations, demonstration of posters, stands, educational films). This innovative approach makes the process of theoretical training much more effective by providing a higher level of theoretical training of athletes.

Keywords: structure and content, interactive tools, game method



Анотація

Вікторія Богуславська, Вячеслав Мірошніченко, Сергій Драчук, Володимир Яковлів, Тамара Чернишенко. Інтерактивні засоби для теоретичної підготовки байдарочників та каноїстів 13-16 років.

Мета: обґрунтування та розробка структури та змісту теоретичної підготовки веслувальників на байдарках і каное на етапі попередньої базової підготовки та визначення ефективності занять із застосуванням традиційних та авторських (інтерактивних) засобів теоретичної підготовки спортсменів.

Матеріал і методи. На другому етапі з метою встановлення ефективності традиційних та інтерактивних засобів теоретичної підготовки проведено експеримент. В дослідженні взяли участь тренери-викладачі, загальною кількістю 82 особи. Серед опитаних було 41 тренер вищої категорії (з них – 21 заслужений тренер України), 19 осіб – тренери першої категорії, 22 особи – тренери другої категорії. На другому етапі з метою встановлення ефективності традиційних та інтерактивних засобів теоретичної підготовки проведено експеримент. У експерименті взяли участь веслувальники на байдарках і каное віком 13–16 років, які займалися на етапі попередньої базової підготовки. Загальна кількість спортсменів становила 42 особи. Було сформовано дві експериментальні групи, у підготовці яких застосовували різні методи і засоби теоретичної підготовки. Порівняння даних, отриманих під час анкетування тренерів-викладачів, перевірено на нормальність розподілу за допомогою критерію згоди χ^2 Пірсона. Для визначення достовірності відмінностей між показниками рівня теоретичної підготовленості веслувальників до і після педагогічного експерименту використовувався критерій знаків (Signtest).

Результати. Навчально-тренувальні заняття за розробленою програмою із застосуванням авторських інтерактивних засобів теоретичної підготовки сприяли достовірному ($p < 0,05$) підвищенню загального рівня теоретичної підготовленості веслувальників на етапі попередньої базової підготовки на 29,56 %. Водночас навчально-тренувальні заняття із застосуванням засобів теоретичної підготовки, що передбачені державною навчальною програмою, виявилися менш ефективними та сприяли підвищенню загального рівня теоретичної підготовленості юних веслувальників лише на 7,2 % ($p < 0,05$).

Висновки. Теоретична підготовка є важливим компонентом у системі підготовки веслувальників на байдарках і каное. Використання інтерактивних засобів теоретичної підготовки із застосуванням ігрового методу (комп'ютерних ігор) у процесі теоретичної підготовки значно підвищує її ефективність, на відміну від занять на яких застосовували лише традиційні засоби і методи (вивчення методичної літератури, бесіди, демонстрація плакатів, стендів, навчальних фільмів). Такий інноваційний підхід робить процес теоретичної підготовки значно ефективнішим забезпечуючи більш високий рівень теоретичної підготовленості спортсменів.

Ключові слова: структура і зміст, інтерактивні засоби, ігровий метод

Аннотация

Виктория Богуславская, Вячеслав Мирошниченко, Сергей Драчук, Владимир Яковлев, Тамара Чернышенко. Интерактивные средства для теоретической подготовки байдарочников и каноистов 13-16 лет.

Цель: обоснование и разработка структуры и содержания теоретической подготовки гребцов на байдарках и каное на этапе предварительной базовой подготовки и определения эффективности занятий с применением традиционных и авторских (интерактивных) средств теоретической подготовки спортсменов.

Материал и методы. На втором этапе для установления эффективности традиционных и интерактивных средств теоретической подготовки проведен эксперимент. В исследовании приняли участие тренеры-преподаватели, общим количеством 82 человека. Среди опрошенных был 41 тренер высшей категории (из них – 21 заслуженный тренер Украины), 19 – тренеры первой категории, 22 – тренеры второй категории. На втором этапе для установления эффективности традиционных и интерактивных средств теоретической подготовки проведен эксперимент. В эксперименте приняли участие гребцы на байдарках и каное в возрасте 13–16 лет, которые занимались на этапе предварительной базовой подготовки. Общее количество спортсменов составило 42 человека. Были сформированы две экспериментальные группы, в подготовке которых применяли различные методы и средства теоретической подготовки.

Сравнение данных, полученных при анкетировании тренеров-преподавателей, проверено на нормальность распределения с помощью критерия согласия χ^2 Пирсона. Для определения достоверности отличий между показателями уровня теоретической подготовленности гребцов до и после педагогического эксперимента использовался критерий знаков (Signtest).

Результаты. Учебно-тренировочные занятия по разработанной программе с применением авторских интерактивных средств теоретической подготовки способствовали достоверному ($p < 0,05$) повышению общего уровня теоретической подготовленности гребцов на этапе предварительной базовой подготовки на 29,56%. В то же время учебно-тренировочные занятия с применением средств теоретической подготовки, предусмотренные государственной учебной программой, оказали менее эффективными и способствовали повышению общего уровня теоретической подготовленности юных гребцов только на 7,2% ($p < 0,05$).

Выводы. Теоретическая подготовка является важным компонентом в системе подготовки гребцов на байдарках и каное. Использование интерактивных средств теоретической подготовки с применением игрового метода (компьютерных игр) в процессе теоретической подготовки значительно повышает ее эффективность, в отличие от занятий, на которых применяли только традиционные средства и методы (изучение методической литературы, беседы, демонстрация плакатов, стендов, обучающих фильмов). Такой инновационный подход делает процесс теоретической подготовки более эффективным, обеспечивая более высокий уровень теоретической подготовленности спортсменов.

Ключевые слова: структура и содержание, интерактивные средства, игровой метод



Introduction

Today, theoretical training is an integral part of the system of training athletes at all stages of long-term sports development [1, 2, 3].

The need to improve theoretical training is due to the growing globalization and professionalization of various groups of sports. This causes the need for athletes to understand the essence of sports, its role in influencing socio-economic and political relations in society, which significantly increases motivation for sports and inevitably leads to increased skills of athletes [4].

However, only some issues of theoretical training of athletes are considered in some works [5]. In addition, there are no disciplines in the curricula of higher education institutions, the purpose of which would be to create a future idea of the system of knowledge of athletes of different qualifications [6, 7, 8, 9, 10].

The substantiation of the general concept of theoretical training in sports revealed by the literary sources of MP Pitin (2015) did not provide for the specification according to the groups of sports [2, 11].

We believe that the theoretical training in kayaking and canoeing should be modern, in accordance with the trends of the sport, to meet the characteristics of the structure and content of training and competitive activities.

Thus, we have identified a scientific and applied problem of theoretical training in kayaking and canoeing, determined by the contradictions between:

- proven need for theoretical training and the lack of relevant components in the software and regulations.
- general requirements for monitoring the level of training of athletes and the lack of objective criteria for theoretical training of rowers.

Hypothesis. We suggested that the use of interactive theoretical training tools using the game method will effectively affect the level of theoretical training of kayakers and canoeists at the stage of preliminary basic training.

The purpose of the work is to substantiate and develop the structure and content of theoretical training of kayakers and canoeists at the stage of preliminary basic training and determine the effectiveness of classes using traditional and author's (interactive) means of theoretical training of athletes.

Material and methods

Participants

At the first stage, in order to determine topical issues of theoretical training of athletes, a survey of coaches was conducted. Coaches-teachers took part in the survey. The total number of respondents is 82 people. Among the respondents are 41 coaches of the highest category, including 21 honored coaches of Ukraine, 19 people - coaches of the first category and 22 people - coaches of the second category.

In the second stage, an experiment was conducted to establish the effectiveness of traditional and interactive means of theoretical training. It was attended by kayakers and canoeists aged 13-16, who were engaged in the stage of preliminary basic training. The total number of athletes was 42 people. They formed two groups. The first group consisted of 20 people, and the second - 22 people. All participants voluntarily agreed to participate in the study.

Procedure (organization of research)

The analysis and generalization of data from scientific and methodological literature and Internet content was aimed at identifying problems and contradictions related to the theoretical training in kayaking and canoeing. The integration of the latest scientific achievements into the system of training athletes was clarified.

The analysis of documentary materials (training programs for athletes) determined the existing structure and content of theoretical training in rowing and made it possible to determine the extent to which theoretical training is provided at the legislative level.

A sociological survey was conducted among trainers to determine the priority of information sources in providing athletes with information, the feasibility of using various tools and methods of theoretical training, the importance of sections and topics of theoretical training, the effectiveness of forms of training and control over the level of theoretical training of athletes. basic training.

According to the results of the questionnaire, an author's program for theoretical training of kayakers and canoeists for the stage of preliminary basic training with an improved structure and content was created. Author's interactive means of theoretical training have been developed. Namely, sixteen computer games: "Quiz on the history of rowing as a sport", "Who is depicted in the photo?", "Sports

terminology", "Major errors in rowing technique", "Features of physical training of rowers", "If tired - rest ", " Victory lies in the rules ", " Medical control and self-control ", " The impact of exercise on the athlete's body ", " Do you want to be healthy - harden ", " Do you know how to eat? ", " Friends with your

boat ", "Be careful on the water!", "When do injuries occur?", "Rules of conduct during competitions", "Assistance to the victim" (<http://bohoslavska.com>) (Fig. 2) [12].



Fig. 1. Interactive means of theoretical training of kayakers and canoeists at the stage of preliminary basic training

The program was implemented in the training process during the preparatory period of the annual macrocycle (only 30 hours). At the stage of preliminary basic training it lasts seven months (from October to April).

At the stage of the observational experiment, before the beginning of classes according to the author's program, the level of theoretical readiness of athletes was determined by testing.

At the stage of the formative experiment the influence of the developed program and author's interactive means on the level of theoretical readiness of the same contingent of rowers was studied. For this purpose, at the end of the stage, the final control testing of the level of theoretical training of athletes was carried out.

The program of theoretical training in a pedagogical experiment consisted of eight sections. Thus, the section "History of the sport" includes three topics: "Rowing at the Olympic Games", "Performances of Ukrainian rowers at the Olympic Games", "Outstanding athletes and coaches". The section "Humanitarian and socializing knowledge in the training of athletes" is presented by the topic:

"Sports terminology". According to the section "Content of sports training" the most popular topics were: "Formation of knowledge about the technique of sport" and "Formation of knowledge about the features of physical training of athletes." The section "General basics of training athletes" is presented on the topic: "Fatigue and recovery". The section "Competitive activity" is presented by the theme: "Rules and refereeing of sports competitions". The section "Medical and biological bases of sports training" is presented by four topics: "Medical control and self-control", "Hygiene, hardening, mode", "Influence of physical exercises on the athlete's body", "Features of athletes' nutrition". The section "Logistics" offers three topics for study: "Sports equipment. Rules of storage and operation ", "Requirements for training venues and competitions "and" Athlete's equipment ". The section "Safety rules" is presented by four topics: "Rules of conduct during training and competitions", "First aid", "Safety and emergency procedures" and "Injuries in sports". Causes and prevention "(Fig. 2).

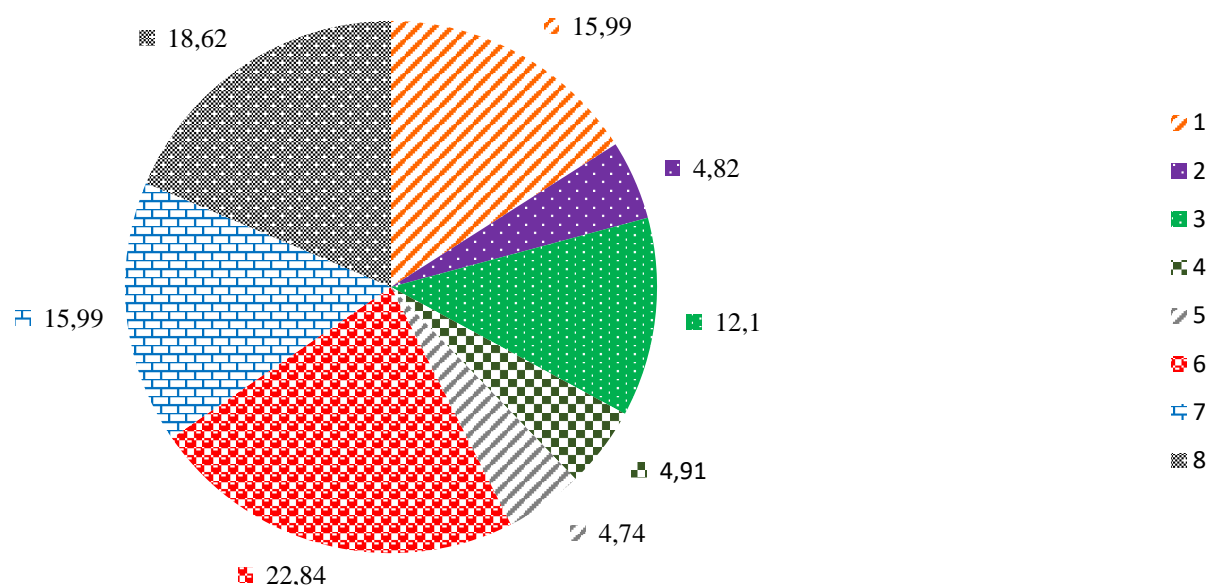


Fig. 2. Percentage of hours allocated for consideration of separate sections of theoretical training at the stage of preliminary basic training (according to the results of the survey of trainers-teachers, n = 82):

- 1 – History of your sport
- 2 – Humanitarian and socializing knowledge in the training of athletes
- 3 – The content of sports training
- 4 – General basics of training athletes
- 5 – General activities
- 6 – Medical and biological bases of sports training
- 7 – Logistics
- 8 – Safety rules

For athletes of both experimental groups, the content of theoretical classes was the same. The difference between the groups was the use of tools and methods. The first group used only those tools and methods that are recommended by the state curriculum (study of methodological literature, conversations, demonstration of posters, stands, educational films) [13]. While in the educational and training process of the athletes of the second group, the author's interactive tools were introduced, namely sixteen computer games on the topics of the sections of theoretical training.

The use of author's interactive tools took place according to the following algorithm:

- 1) preliminary conversation (story) with athletes on the topic of the lesson;
- 2) acquaintance of athletes with the content of the game;
- 3) placement of each of the players on a separate PC (laptop);
- 4) providing assistance (if necessary) to athletes during the game;
- 5) determining the winner by a set of factors (speed of solving the problem, the number of mistakes);

6) analysis and discussion of the results of the game, indicating the advantages and disadvantages of the participants.

For both groups, the duration of the theoretical training load was one academic hour per week. The total duration of theoretical training was 30 weeks.

Statistical analysis:

The comparison of data obtained during the survey of trainers-teachers was tested for the normality of the distribution using the criterion of agreement χ^2 (chi-square) Pearson.

Determination of the level of theoretical training of rowers was carried out in points (from 0 to 30).

Establishing the reliability of differences between indicators of the level of theoretical readiness of rowers before and after the pedagogical experiment (1st and 2nd sections of testing) was implemented using the criterion of signs (Signtest). This non-parametric criterion was used because the results obtained during the study are not subject to the law of normal distribution. Statistica 13 was used to process the results of the study.

Results.

Analysis of the state curriculum for kayaking and canoeing [13] revealed some inconsistencies.



Thus, with each subsequent year of training of rowers there is a decrease in the load of theoretical training (from 4.81% to 3.21%) relative to the total number of hours devoted to the training process in the macrocycle.

In addition, the curricula revealed duplication of many topics of information material at different stages of long-term improvement of athletes.

In our opinion, this impoverishes the information material and unilaterally forms the special knowledge of rowers.

In order to solve the established problems, the attitude of coaches-teachers to the topical issues of theoretical training of athletes was clarified. For this purpose, a survey of specialists ($n = 82$) was conducted through questionnaires.

According to the results of the questionnaire, it was established which topics coaches-teachers recommend to include in the program material for training athletes at each stage of long-term improvement. The verification of the answers to the questionnaires on the normality of the distribution using the Pearson consistency criterion found that the level of reliability from $p = 0.027$ ($p < 0.05$) to $p = 6.61 \cdot 10^{-25}$ ($p < 0.05$).

According to the trainers, at the stage of preliminary basic training it is unanimous to give priority in the application of the game method of theoretical training (96.34%). The level of reliability of the obtained data on the normality of the distribution using the Pearson consistency criterion ranges from $p = 0.13$ ($p < 0.05$) to $p = 1.18 \cdot 10^{-29}$ ($p < 0.05$).

The generalization of the results of the answers of trainers-teachers regarding the expediency of using various means of theoretical training at the stage of preliminary basic training

showed the need to use technical teaching aids (81.71%). The established level of reliability of the study results is in the range from $p = 0.019$ ($p < 0.05$) to $p = 2.32 \cdot 10^{-29}$ ($p < 0.05$).

The survey provided an opportunity to identify the topics of theoretical training of kayakers and canoeists who train at the stage of preliminary basic training, to fill in the content of each topic, to develop and implement a program of formative experiment.

As a result of the conducted pedagogical experiment the insufficient efficiency of assimilation of information by rowers on all sections of theoretical preparation where only the means recommended by the state educational program were applied is established. Although a tendency to its growth has been established, which has contributed to a statistically significant increase in the general level of theoretical training. Thus, at the beginning of the study, the average assessment of the level of knowledge of athletes was 8.7 ± 0.61 points, at the end - 10.85 ± 0.61 points (maximum number of points - 30). At the same time, in percentage terms, this indicator improved by 7.2% ($p < 0.05$).

In contrast, classes in which, in addition to the curriculum provided, interactive theoretical training tools were used using game and competitive methods, contributed to a likely increase in the average assessment of the level of theoretical training of athletes in each section of the program. This is evidenced by a much higher degree of growth of average scores from 9.27 ± 0.51 points at the beginning of the experiment and up to 18.14 ± 0.8 points (maximum number of points - 30) in the final testing. This percentage difference is equal to 29.56% ($p < 0.05$) (Table 1).

Table 1

The level of education of kayakers and canoeists in theoretical training at the stage of preliminary basic training in the preparatory period of the annual macrocycle

Knowledge section	Experimental group, during the preparation of which only the means recommended by the state curriculum were used.				Experimental group, during the preparation of which interactive means of theoretical training with the use of game and competitive methods were used			
	Before classes	In 30 weeks	Significance level		Before classes	In 30 weeks	Significance level	
	$X \pm S$	$X \pm S$	Z	p-level	$X \pm S$	$X \pm S$	Z	p-level
History of kayaking and canoeing as a sport	1.30±0.184	1.75±0.184	1.581	0.114	1.45±0.171	2.41±0.171	2.750	0.005*
Humanitarian and socializing knowledge in the training of athletes	1.15±0.123	1.30±0.123	1.500	0.134	0.91±0.114	1.73±0.171	3.328	0.000*



The content of sports training	0.85±0.123	1.00±0.123	0.316	0.752	1.00±0.114	2.18±0.114	3.474	0.000*
General basics of training athletes	0.40±0.062	0.65±0.123	0.756	0.450	0.55±0.057	1.36±0.057	3.328	0.000*
Competitive activity	0.75±0.062	1.00±0.123	1.512	0.131	0.68±0.114	1.36±0.057	2.774	0.005*
Medical and biological bases of sports training	1.65±0.184	2.00±0.246	1.443	0.149	1.77±0.114	3.63±0.229	3.750	0.000*
Logistics	0.60±0.062	0.65±0.123	0.289	0.773	0.55±0.057	1.45±0.057	3.175	0.001*
Safety rules	2.00±0.123	2.50±0.246	1.443	0.149	2.14±0.114	4.59±0.229	3.881	0.000*

Note. Probability of difference of indicators concerning initial data: * - $p < 0.05$

Discussion

The results of our research confirm the data of other authors, who emphasize that theoretical training in cyclical sports is given insufficient attention [2, 14, 15, 16].

In addition, the coaches we interviewed confirm the opinion of a large number of scientists who point out the inconsistency of software and methodological support of the training process of young athletes to modern requirements for sports training [1, 17].

Thus, as a result of our research, we further developed information about the importance of theoretical training in sports as a factor in the socialization of the athlete and the indirect conditions for achieving results in training and competitive activities in kayaking and canoeing [3, 4, 18].

The content of implementation provisions of theoretical training in sports has been improved.

We rely on available scientific approaches to methods, tools and forms of control. They are specified in accordance with the requirements of theoretical training of kayakers and canoeists at the stage of preliminary basic training.

In this regard, the game method chosen by the coaches-teachers for this stage of preparation was borrowed by M.P. Pitin (2015) [2, 11] on practical activities in sports. This method makes it possible to simultaneously affect several senses, ie able to develop polysensitivity in athletes. And the interactive methods of theoretical training substantiated by the author stimulate the athlete's desire to find answers to questions or ways to solve problems that arise in the process of sports training.

The use of theoretical training methods in the educational process is possible due to specific means of theoretical training.

However, we did not find any information on testing the effectiveness of theoretical training on the example of kayaking and canoeing. However, the effectiveness of some theoretical training tools has been experimentally tested and proven on the example of such sports (groups of sports) as martial

arts [5, 20, 21], athletics (16), cycling [15], sports games [6, 19].

The expediency and effectiveness of the use of tools and methods of theoretical training in the training process is carried out by checking the level of knowledge of athletes.

We have improved the requirements for the knowledge system of kayakers and canoeists at the stage of preliminary basic training. To this end, the opinions of the trainer-teachers were clarified. Among them, most respondents insist on testing as a form of staged control of the level of theoretical training of rowers at this stage of long-term sports improvement. This confirms the opinion of other authors who consider pedagogical testing to be the most standardized method of control and evaluation of knowledge, skills and abilities of the subjects [2, 5].

As a result of the study, the structure and content of the system of theoretical training of rowers at the stage of preliminary basic training were substantiated for the first time. This was done taking into account the fundamental scientific principles of the general theory of training athletes [3] and the results of a previous survey of trainers-teachers [1, 17].

Thirteen topics are proposed for consideration at this stage of preparation by the state curriculum, the effectiveness of seven of which is confirmed by the results of a survey of trainers-teachers. At the same time, the necessity of introducing eleven topics that are not presented in the curriculum into the theoretical training of athletes was confirmed.

Conclusions

Theoretical training is an important component in the system of training kayakers and canoeists. The use of interactive theoretical training tools using the game method (computer games) in the process of theoretical training significantly increases its effectiveness, in contrast to classes that used only



traditional tools and methods (study of methodological literature, conversations, demonstration of posters, stands, educational films). This innovative approach makes the process of theoretical training much more effective by providing a higher level of theoretical training of athletes.

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Conflict of interest

The authors state that there is no conflict of interest that could harm the impartiality of the article.

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ORIGINAL ARTICLES. SPORT

The effect of water exercise and sand exercise training methods on agility in basketball athletes

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

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Abstract

Purpose: to examine the water and sand exercise models to maximize athletes' training ability as exercise media.

Material and Methods: This research is experimental research with a "Two Groups Pretest-Posttest" design that includes a pre-test before the subjects are given treatment and a post-test after the treatment. The research populations were twenty male athletes from a basketball club in Yogyakarta, selected using a random sampling technique. All samples were subjected to a pre-test to determine the treatment group, ranked by their pre-test scores, then matched with the A-B-B-A pattern in two groups with ten athletes each. The sampling technique used in this dividing step was ordinal pairing. This research was conducted 18 times in treatment. The instrument used was an agility test using the Lane agility test. The movements for each number are as follows, (1) Sprint, stunt step, (2) Right slide (running with a guard position to the right side), (3) Run backwards, (4) Left slide, (5) Right slide, (6) Sprint, stunt step, pivot, (7) Right slide, (8) Sprint.

Results: The research used normality, homogeneity, and hypothesis testing. To test the hypothesis, the researchers used the two types of t-tests, namely paired sample test and the independent sample test. The T-test is a statistical analysis technique that can be used to determine whether there is a significant difference between two sample means or not. The results revealed that the t count was 2,335 with a p significance value of 0.031. Because the t-count was 2.335 and the significance value was <0.05, these results indicated a significant difference.

Conclusions: There was a significant difference in the effect of the exercise methods (water exercise and sand exercise) on agility. The sand exercise training method was higher (better) than the water exercise training method on the agility of basketball athletes.

Keywords: water exercise, sand exercise, agility, basketball



Анотація

Мухаммад Насіхул Ваффак, Памуджі Сукоко, FX. Сугіянто. Вплив вправ у воді та методів тренування вправ на піску на спритність у баскетболістів

Мета. Автор спробував дослідити моделі вправ у воді та піску, щоб максимізувати тренувальні здібності спортсменів як засоби вправ.

Матеріал та методи. Це дослідження є експериментальним дослідженням із задумом «Дві групи попереднього тесту-посттесту», який включає попереднє тестування до того, як суб'єктам буде призначено лікування, і пост-тест після лікування. Дослідницькі популяції складали двадцять спортсменів-чоловіків з баскетбольного клубу в Джок'якарті, відібраних за допомогою техніки випадкової вибірки. Усі зразки були піддані попередньому тестуванню для визначення групи лікування, ранжованих за результатами попереднього тестування, а потім зіставлялися за зразком A-B-B-A у двох групах по десять спортсменів у кожній. Методом вибірки, використаним на цьому етапі поділу, було порядкове парування. Це дослідження проводилося 18 разів під час лікування. Використовуваним інструментом був тест на спритність за допомогою тесту на спритність Лейна. Рухи для кожного номера такі: (1) Спринт, крок трюка, (2) Праве ковзання (біг із позицією захисника з правого боку), (3) Біг назад, (4) Ліворуч, (5) Праворуч слайд, (6) Спринт, трюковий крок, поворот, (7) Правий ковзання, (8) Спринт.

Результати. У дослідженні використовувалися перевірка нормальності, однорідності та гіпотези. Щоб перевірити гіпотезу, дослідники використали два типи t-тестів, а саме парний вибірковий тест і незалежний вибірковий тест. T-тест – це метод статистичного аналізу, який можна використовувати, щоб визначити, чи існує значна різниця між двома середніми вибірками чи ні. Результати показали, що кількість t становила 2335 із значенням значущості p 0,031. Оскільки число t становило 2,335, а значення значущості було <0,05, ці результати вказували на значну різницю.

Висновки. Була суттєва різниця у впливі методів вправ (вправи у воді та вправи на піску) на спритність. Метод тренувань на піску був вищим (кращим), ніж метод тренувань у воді на спритність баскетболістів.

Ключові слова: вправи на воді, вправи з піску, аджилити, баскетбол

Аннотация

Мухаммад Насихул Ваффак, Памуджі Сукоко, FX. Сугиянто. Влияние упражнений в воде и методов тренировки упражнений на песке на ловкость у баскетболистов

Цель. Автор попытался исследовать модели упражнений в воде и песке, чтобы максимизировать тренировочные способности спортсменов как средства упражнений.

Материал и методы. Это исследование является экспериментальным исследованием с замыслом «Две группы предварительного теста-посттеста», который включает предварительное тестирование до того, как субъектам будет назначено лечение и пост-тест после лечения. Исследовательские популяции составляли двадцать спортсменов-мужчин из баскетбольного клуба в Джокьякарте, отобранных с помощью техники случайной выборки. Все образцы были подвергнуты предварительному тестированию для определения группы лечения, ранжированных по результатам предварительного тестирования, а затем сопоставлялись по образцу A-B-B-A в двух группах по десять спортсменов в каждой. Методом выборки, использованным на этом этапе разделения, было порядковое спаривание. Это исследование проводилось 18 раз во время лечения. Используемым инструментом был тест на ловкость с помощью теста на ловкость Лейна. Движения для каждого номера следующие: (1) Спринт, шаг трюка, (2) Правое скольжение (бег с позицией защитника с правой стороны), (3) Бег назад, (4) Слева, (5) Справа слайд, (6) Спринт, трюковой шаг, поворот, (7) Правый скольжение, (8) Спринт.

Результаты. В исследовании использовались проверка нормальности, однородности и гипотезы. Чтобы проверить гипотезу, исследователи использовали два типа t-тестов, а именно четный выборочный тест и независимый выборочный тест. T-тест – это метод статистического анализа, который можно использовать, чтобы определить, существует ли разница между двумя средними выборками или нет. Результаты показали, что количество t составило 2335 со значением значимости p 0,031. Поскольку число t составляло 2,335, а значение значимости было <0,05, эти результаты указывали на значительную разницу.

Выводы. Была существенная разница во влиянии методов упражнений (упражнения в воде и упражнения на песке) на ловкость. Метод тренировок на песке был выше (лучше), чем метод тренировок в воде на ловкость баскетболистов.

Ключевые слова: упражнения на воде, упражнения из песка, аджилити, баскетбол



Introduction

Today basketball is developing rapidly, proven by the more clubs and activities being established in the school environment and the holding of regional, national and international basketball championships [1, 2]. Basketball is a fast-paced game where the objective is to put the ball into the basket. Although the concept is simple, the game's specific offensive and defensive aspects are executed differently based on the level of play and the game situation [3, 4].

Perfect abilities must support today's basketball game. A good player is a player who can display a consistent performance from start to finish in every half [5, 6]. The good physical quality is needed through training and loading, so that muscle fitness will be created to support every biomotor component in the athlete [7, 8]. The biomotor components of athletes include speed, strength, endurance, and flexibility. [9] Stating that "The results of the combination of these biomotor components will produce derivatives of other biomotor components, for example, the results of the combination of speed and strength will produce power, the combination of strength and endurance will produce strength endurance or stamina, while the combination of speed, flexibility and coordination will produce agility.

One of the most important physical components in achieving optimal performance is leg muscle power and good agility to develop basketball achievements. For example, a basketball player must be able to change movements from dribble quickly and then jump to jump shoot, rebound both offensive rebounds and defensive rebounds, free himself from the guard of the opponent without the ball or with the ball, and vice versa do good guarding with the opponent without or with the ball [10, 11]. This component means that the working muscles must be able to contract maximally in a short time. The provision of training must be specific, according to the characteristics of the physical condition to be developed.

The players in the game of basketball require a very high level of agility. Some forms of activity on the field require agility when dribbling the ball quickly towards the basketball hoop and passing several opponents who are guarding around the ring with a particular formation [1]. This aspect is reinforced by [12] saying that "agility is the ability which makes it possible for an athlete to change direction, make quick stops and perform fast, smooth, efficient and repetitive movements." Therefore, it can be said that an athlete must have

good agility in a basketball game. Agility is instrumental when doing rebounds, driving jump shots, and changing speed (sudden speed changes).

When athletes have good agility, their skills, both basic techniques and basic movements, will increase because the basketball game is closely related to changes in speed. For example, a defender must always be as fast as possible to follow the attacking player's movements when doing defense. On the other hand, when attacking, it is helpful to do a v-cut (cutting/ability to change direction suddenly) to free himself from the opponent's guard. Applying several different training methods to provide a variety of exercises and avoid athlete saturation can be done to improve and develop an athlete's agility [13, 14, 15]. An athlete is expected to achieve optimal performance with excellent and varied training methods.

So far in practice, athletes aged 16-18 years, especially in basketball clubs in Sleman, Yogyakarta, still have low agility, evidenced by the many traveling violations caused by lack of control when changing speed, the number of fouls due to the slow-motion of the slide defense and many more. This fact is strengthened by data that researchers will display during fact observations in the field during the KONI Cup inter-club competition in Yogyakarta City.

Perbakas Kalasan and Ayaba are clubs located in the city of Yogyakarta. Both clubs have a whole age group, including KU 14 boys and girls, KU 16-18 boys and girls, and KU Senior boys and girls. In initial observations, on April 9, 2016, Saturday at 15.30 in Ayaba, and on April 10, 2016, Sunday in Perbakas Kalasan, it could be seen that many athletes ignored the basic movements of basketball athletes, especially the 16-18-year-old age group. Their stances defense was too high, rebounds were still careless, cutting movements and change of direction were still broken, resulting in athletes quickly passing by opponents who only have ordinary dribbling abilities and much loose dribbling, one of which was due to the level of inadequate agility.

Based on the match statistics data above, it shows that the turnover rate by athletes is very high, more than 30 times in one match. Turnover itself consists of several elements: improper passing, traveling violation, and being hit by stealing [16]. The dominant thing that occurs is traveling violation or being hit by steals due to the athlete's inability to pass the opponent so that the athlete tends to make mistakes [17]. This means that athletes often do fouling due to stances/foot stances when the defense is not strong enough, thus forcing them to use their hands to stop the opponent's pace, which is



prohibited in basketball. Moreover, the number of rebounds is small, resulting in the gap between the coach's instructions against the intended target and the athletes' execution results on the field.

Agility is essential in all activities and sports [18]. Individual and team sports involve quick starts and stops, rapid change of directions, efficient footwork, and quick adjustment of the body or body parts [2,19]. Agility is the ability to maintain control body position while quickly changing direction during a series of movements [20]. Agility is one of the elements of physical condition that plays an important role, especially in sports, including basketball, when being guarded by an opponent. A player must be able to move quickly to change direction or to escape [21]. Thus, explosive movements will extensively allow players to control the ball, pass the opponent's obstacles, and breakthrough the tight opponent's defense.

Based on observations during his time as a trainer, he only used a field with a hard texture during training, and there was still a lack of use of other training models for training. The more diverse training models offered to athletes, the more stimulating athletes will not feel bored while practicing. The use of the exercise model must also be adjusted to the training media used so that the exercise results will be more optimal. Therefore, the author will examine the water and sand exercise model to maximize the athlete's ability to train as an exercise medium.

Water has different pressures depending on the formation compound and depth or volume [22]. The pressure contained in the water can be used to provide a load during exercise [23]. In addition to using water pressure as a training load, exercising in the water is also easier and safer from injury to muscles or joints because, in the water, the players are better able to control the given load [24]. It also provides freedom of movement of muscles and joints, reducing pressure (resistance) caused by hard steps such as when exercising on land.

Exercise using water media is not only used for various swimming techniques (crawl, backstroke, breaststroke, or butterfly) but also exercises with water media offer many other movement possibilities such as walking, jogging, or jumping [25,26]. This will make it possible to stimulate the metabolic and neuromuscular systems, followed by physiological adaptation processes. Some studies have shown that a program of jumps in water increases power, peak concentric torque, vertical jump height, and speed. These performance improvements may be due to the forces resisting forward movement (increased load) generated during water jumps [27]. Buoyancy

reduces the effect of weight-bearing on skeletal joints and reduces compressive joint forces the more significant density of water (compared to air), and the drag force provides loading during all movements [28].

Likewise, in sand exercise, sand can also function to reduce the pressure (resistance) caused by a tricky footing, such as when exercising on a hard textured field [29, 30]. Exercise in the sand can also be a medium for implementing strength, speed, endurance, or power training [31, 32]. Compared to regular handball training, supplemental jump and sprint exercise training on sand substantially improved sprinting, agility, jumping, repeated sprinting, and balance in male handball players. Weak foundations such as those found in sand or water have properties as resistance so that apart from helping reduce pressure, they also have an effect as a burden so that they will be helpful in the practice process. Sand also drives athletes to test the limits of their anaerobic thresholds [33]. Running and jumping activities on the sand make the result faster than the same activities on any other surface. The leg and hip muscles are forced to work much harder when planting and pushing off in the sand [34].

Research by [35,36] shows that "10 weeks of agility training on a sand surface resulted in significant improvements in agility tests conducted on both sand and firm ground surfaces, suggesting that the physiological and biomechanical adaptations unique to sand training can also have a positive effect on firm-ground agility performance". That is, ten weeks of agility training performed on the surface of the sand showed a significant improvement.

Therefore, there was a need for research using water exercise and sand exercises influenced by leg muscle power on agility which would then be developed with the title "The effect of water exercise and sand exercise training methods on agility in basketball athletes."

Material and methods

This study is included in experimental research, examining the relationship between the cause-and-effect variables. The design used in this study was "Two Groups Pretest-Posttest," which contained a pre-test for the subjects before they were given treatment and a post-test after the treatment. In this study, 18 meetings were conducted. After being given treatment, more accurate results are gained because they can be compared with what was held before being treated.

The research population was all-male athletes from a basketball club in Yogyakarta,

determined using a random sampling technique. All samples were subjected to a pre-test to determine the treatment group, ranked by their pre-test scores, then matched with the A-B-B-A pattern in two groups with ten athletes each. The sampling technique used in this study was ordinal pairing.

In addition to the racetrack's start and finish transition gates, a third gate was also placed at the

initial point of slaloms (Figure 1). Participants were assessed for initial sprint-reverse ratings, slalom ratings, second sprint-reverse ratings, and the total Illinois agility test ratings [37].

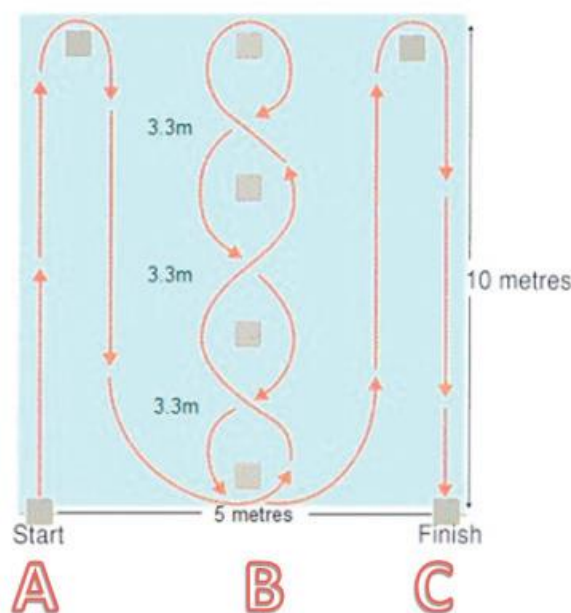


Fig. 1. Transition gate locations in the Illinois agility test (A–B–C)

The analysis techniques used were normality, homogeneity, and hypothesis testing. The hypothesis was tested using the t-test, a statistical analysis technique that can be used to determine

whether there is a significant difference between two sample means. The t-tests used were the paired sample test and the independent sample test (two groups of unpaired samples).

Results

Statistical descriptions of the agility test result on male athletes of basketball clubs in Yogyakarta are presented in Table 1.

Based on Table 1, the mean pre-test and post-test of water exercise decreased, which means

that the data/research group experienced an increase in speed. The mean pre-test and post-test sand exercise data also decreased, which means that the data/group also experienced an increase in speed.

Table 1

Descriptive Table of Agility Test Results Statistics

Statistics				
Statistics indicators	Pretest Water Exercise	Posttest Water Exercise	Pretest Sand Exercise	Posttest Sand Exercise
Valid	10	10	10	10
Mean	19,04	17,71	19,00	16,77
Median	19,10	17,54	19,12	16,87
Mode	18,47 ^a	16,46 ^a	19,12	15,25 ^a
Std, Deviation	0,33	0,71	0,39	0,75



Minimum	18,47	16,46	18,53	15,25
Maximum	19,45	18,58	19,54	17,59
Sum	190,43	177,13	190,02	167,73
Multiple modes exist, The smallest value is shown				

Table 2

Normality test calculation

Data		Significance	Explanation
Water Exercise	Pretest	0,354	Normal
	Posttest	0,391	Normal
Sand Exercise	Pretest	0,123	Normal
	Posttest	0,164	Normal

The results of the normality test used the Shapiro-Wilk test. From the results of the Table above, it can be seen that the pre-test and post-test

data have a p-value (sig.) > 0.05., and then the variable is normally distributed.

Table 3

Homogeneity Test

Data	Homogeneity test	Homogeneity test
Pretest-Posttest Water Exercise	0,655	Homogen
Pretest-Posttest Sand Exercise	0,246	Homogen

Useful for testing the similarity of the sample that is uniform or not the variance of the sample taken from the population. The results of the homogeneity test of this study can be seen in Table 3

as follows: From table 3 above, it can be seen that the value of sig. Pre-test and post-test significance > 0.05, so the data is homogeneous.

Table 4

Pre-test and Posttest Hypothesis Testing of Agility after Water Exercise is as follows:

Agility	Average	t _{count}	sig
Pretest	19,04	6,593	0,000
Posttest	17,71		

Based on the analysis results in Table 3 above, it can be seen that the t_{count} is 6,593 with the p significance value of 0,000. Because the t_{count} is 6,593 and the significance value is 0,000 < 0,05, this

result shows a significant difference. Thus the alternative hypothesis (Ha), "There is a significant effect of Water Exercise on agility," is accepted.

Tabel 5

Pre-test and Posttest Hypothesis Testing of Agility after Sand Exercise

Agility	Average	t _{count}	sig
Pretest	19,00	11,132	0,000
Posttest	16,77		

Based on the analysis results in Table 3 above, it can be seen that the t_{count} is 11,132 with the p significance value of 0.000. Because the t count is 11,132 and the significance value is 0.000 < 0.05,

this result shows a significant difference. Thus the alternative hypothesis (Ha), "There is a significant effect of sand exercise on agility," is accepted.



Tabel 5

The hypothesis of Differences in the Water Exercise and Sand Exercise Effect on Agility will be Explained in Detail in the Table below

Groups	Mean Gain	t _{count}	sig
Water Exercise	1,33	3,163	0,005
Sand Exercise	2,23		

Based on the analysis results in Table 3 above, it can be seen that the t_{count} is 3.163 with a p significance value of 0.005. Because the t_{count} is 3.163 and the significance value is $0.005 < 0.05$, this result shows a significant difference. Thus the alternative hypothesis (H_a), "There is a significant difference between Water Exercise and Sand Exercise on agility," is accepted. The Sand Exercise group is better than the Water Exercise for basketball agility.

Discussion

Based on the hypothesis testing, it is known that the water exercise and sand exercise have a significantly different effects on agility. The analysis results show that the sand exercise method is better than the water exercise method. Sand exercise is another method to improve the leg muscles' ability [38]. Training on sand can reduce the stress placed on the skeletal muscle system during exercise, limit the degree of exercise-induced muscle damage, and associated negative side effects such as increased muscle soreness and reduced performance capacity [39, 40, 41, 43]. When the footsteps are on the sand, the athlete will receive a more significant stimulus through the resistance pressure generated during training.

Exercise in the sand can also be a medium for implementing strength, speed, endurance, or power training [29]. Training in the sand also puts pressure and weight on it to feel heavier than training on a regular field [31]. The plant foot (front) sinks into the sand instead of regular ground reaction forces to stabilize the body and provide efficient forward propulsion when sprinting through the sand. [30, 32].

Sand sprinting is another common training method used to develop sprint speed [44]. Soviet research on Olympic sprinters theorized that sprinting in the sand was one of the best ways to develop the hamstrings [45, 46]. The sand surface is also expected to reduce stride frequency slightly, as athletes maintain almost the same movement pattern and range of motion during stride [47]. The lower horizontal speed on the sand surface means the athlete takes longer to make a move, hence having a

longer time in contact with the sand surface [48]. The high shock absorptive qualities of sand can also limit maximal movement speed in sprint training and jumping performance [49]. This means that sand therapy can also reduce the pressure (resistance) caused by a hard footing, such as when exercising on a hard-textured court here, where the sand absorbs more pressure on the joints which usually occurs in hard-textured courts.

Research by Gortsila et al. in [50] shows that "10 weeks of agility training on a sand surface resulted in significant improvements in agility tests conducted on both sand and firm ground surfaces, suggesting that the physiological and biomechanical adaptations unique to sand training can also have a positive effect on firm-ground agility performance". Furthermore, [51] adds, "soft sand running has provided the most conclusive evidence to date, by identifying a significantly greater contribution of the lower leg muscles to the exercise bout when compared to the firm ground running."

Agility is needed in sports that are games, as it is related to body movements involving footwork and rapid body position changes. Agility, in principle, plays a role in activities that involve changing body movements while maintaining balance. An athlete or player who has good agility will be able to perform movements more effectively and efficiently.

Prospects for further research. For trainers, the results of this study can add to the existing knowledge and training methods. This research is expected to contribute to science, especially in the sport of basketball, and explain scientifically the influence of the training methods given.

Conclusions

Based on the results of the research and the results of data analysis, there is a significant difference in the effect of the water exercise with sand exercise methods on agility. The sand exercise training method is higher (better) than the water exercise training method on the agility of basketball athletes.



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Conflict of interest

The authors declared no conflicts of interest in preparing this article. The result of this study was not affected by any parties or sponsors.

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ORIGINAL ARTICLES. SPORT

Forecast the accuracy of spike and blocking skills in terms of some physical measurements and physical and motor abilities of volleyball players

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Abstract

Purpose: to find an equation for accurately predicting the skills of spike skill beating (straight and diagonal), and the blocking skills about specific physical measures physical and kinetic skills of volleyball players. The skill of spike and skill blocking is one of the basic skills in volleyball, whose performance requires high compatibility and balance between physical measurements and physical skills

Material and Methods. Moreover, monitoring shows that no statistical equation predicts the punch and squeezes talents that hinder the volleyball sector for the age group (14-16). In the youth volleyballers centers in Erbil, the number of players was (75) out of (106) participants (76% of the total population). 25 Players were excluded because they did not complete the test requirements.

Results. The manuscript reached the following results: It was possible to identify the values of some physical measurements and physical and motor abilities affecting the level of accuracy test performance of the skill of spike (straight and diagonal). And through the logical analysis of the regression of anthropometric indicators and physical and motor abilities. The regression equation for the first indicator was: $\hat{Y} = a + b x$. The second indicator is: $\hat{Y} = a + b_1 x_1 + b_2 x_2$. As for that, the compatibility index is the most contributing variable to the accuracy of the performance of the blocking skill, as its contribution rate was for the first indicator: $\hat{Y} = a + b x$. And the second indicator: $\hat{Y} = a + b_1 x_1 + b_2 x_2$

Conclusions: were a statistically significant correlation between some physical measurements, physical and motor abilities, and the accuracy of the spike skill and the blocking skill (Straight and diagonal) of the research sample. Regression equations were obtained to predict the accuracy of the hit performance (Straight and diagonal) in terms of physical measurements, physical abilities, and kinetics.

Keywords: spike and block, measurements, accuracy, volleyball, predict



Анотація

Навазад Хуссієн Дарвеш, Ніхад Аюб Кадір, Твана Вахбі Гафур Шаріф. Прогнозування точності виконання нападаючих ударів і блоків за деякими фізичними показниками та фізико-руховими можливостями волейболістів.

Мета. Це дослідження має на меті знайти рівняння для точного прогнозування навичок нападаючих ударів (прямі та діагональні), а також навичок блокування щодо конкретних фізичних показників фізичних та кінетичних навичок волейболістів. Навичка виконання нападаючих ударів і блокування є одним з основних навичок у волейболі, виконання якого вимагає високої сумісності та балансу між фізичними вимірами та фізичними навичками.

Матеріал і методи. Більше того, моніторинг показує, що жодне статистичне рівняння не прогнозує ударів і витискає таланти, які заважають у волейбольному секторі для вікової групи (14-16). У центрах молодіжних волейболістів Ербіля кількість гравців становила (75) з (106) учасників (76% від загальної кількості населення). 25 гравців було виключено, оскільки вони не виконали вимоги тесту.

Результати. Вдалось виявити значення деяких фізичних вимірів і фізичних і рухових здібностей, що впливають на рівень виконання тесту точності навичку нападаючих ударів (прямий і діагональний). А через логічний аналіз відбувається регресія антропометричних показників і фізичних і рухових здібностей. Рівняння регресії для першого показника було таким: $\hat{Y} = a + b x$. Другий показник: $\hat{Y} = a + b_1 x_1 + b_2 x_2$. Що стосується цього, то індекс сумісності є найбільшою змінною, яка сприяє точності виконання навичку блокування, оскільки його коефіцієнт внеску був для першого показника: $\hat{Y} = a + b x$. І другий показник: $\hat{Y} = a + b_1 x_1 + b_2 x_2$.

Висновки: була статистично значуща кореляція між деякими фізичними вимірами, фізичними та руховими здібностями, а також точністю навичок нападаючих ударів і навичок блокування (прямий і діагональний) досліджуваної вибірки. Рівняння регресії були отримані для прогнозування точності виконання удару (прямий і діагональний) з точки зору фізичних вимірювань, фізичних здібностей та кінетики.

Ключові слова: нападаючий удар і блок, вимірювання, точність, волейбол, прогноз

Аннотация

Навазад Хуссейн Дарвеш, Нилад Аюб Кадир, Твана Вахби Гафур Шариф. Прогнозирование точности выполнения нападающих ударов и блоков по некоторым физическим показателям и физико-двигательным возможностям волейболистов.

Цель. Это исследование направлено на поиск уравнения для точного прогнозирования навыков выполнения нападающих ударов (прямых и диагональных) и навыков блокирования конкретных физических показателей физических и кинетических навыков волейболистов. Навык выполнения нападающего удара и навык блокировки - один из базовых навыков в волейболе, выполнение которого требует высокой совместимости и баланса между физическими размерами и физическими навыками.

Материал и методы. Более того, мониторинг показывает, что ни одно статистическое уравнение не прогнозирует ударов и вытесняет таланты, которые мешают волейбольному сектору для возрастной группы (14-16). В молодежных волейбольных центрах в Эрбиле количество игроков составляло (75) из (106) участников (76% от общей численности населения). 25 игроков были исключены из-за того, что они не выполнили требования теста.

Результаты. Удалось выявить значения некоторых физических измерений и физико-двигательных способностей, влияющих на уровень точности выполнения теста навыка нападающего удара (прямого и диагонального). А через логический анализ регрессии антропометрических показателей и физических и двигательных способностей. Уравнение регрессии для первого индикатора было следующим: $\hat{Y} = a + b x$. Второй показатель: $\hat{Y} = a + b_1 x_1 + b_2 x_2$. Что касается этого, индекс совместимости является переменной, в наибольшей степени влияющей на точность выполнения блокирующего навыка, так как его коэффициент вклада был для первого индикатора: $\hat{Y} = a + b x$. И второй показатель: $\hat{Y} = a + b_1 x_1 + b_2 x_2$.

Выводы: выявлена статистически значимая корреляция между некоторыми физическими показателями, физическими и двигательными способностями и точностью навыка спайка и навыка блокировки (прямого и диагонального) исследуемой выборки. Были получены уравнения регрессии для прогнозирования точности выполнения ударов (прямых и диагональных) с точки зрения физических измерений, физических способностей и кинетики.

Ключевые слова: нападающий удар и блок, измерения, точность, волейбол, прогноз



Introduction

Volleyball is one of the most successful and Villette most competitive games globally, characterized by excitement because of the abundance of motor skills and performance volleyball enjoys worldwide popularity, with only soccer attracting more global participation [1]. A volleyball player must have the physical measurements and physical and motor abilities appropriate to the game's requirements for the skillful performance of the players. (Morphological characteristics in human beings are affected by ecological, biological, geographical, racial, gender, and age factors [2]. This game has taken a large share of the increasing interest by increasing the number of world championships throughout the year.

This is what called on the International Federation of Volleyball to legislate several game rules to make it more exciting and exciting. Volleyball is one of the sports activities that reached a sophisticated level. As a result of the entry of the scientific side, all aspects, including these aspects (physical, body, and kinetics) of the players, for example, the length of the body, plays an essential role in the performance of the skill beating to the crushing and can be used by the team to penetrate and break the wall of the opponent's opponent and get points. Anthropometric measurements are essential in that they are often used as a basis for success or failure in a particular activity; this is confirmed by the studies of both Kohler and others [3, 4, 5].

However, this also requires consistency between other parts of the body and body mass. The rapid pace of this game requires both functional and physical adaptation to provide the energy needed to perform the performance of a high-precision skill. "The performance in sport depends on a pack of tactical, physical, skill and even psychological aspects, and anthropometric factors" [6, 7]. Reaching the jump is necessary for the spike and blocking. One of the most important aspects of volleyball is the increase in human, material, and technical aspects because of the spike, both for the men's and women's game, and the blocking, in men's game, are the most correlated actions with winning. [8, 9].

The physical measurements occupy a special place in the volleyball game; they offer the opportunity to study the relationship between skill performance and body specifications. As indicated (carter). "The morphological characteristics of an athlete play a significant role in the success of a high-level sports career. And therefore, they form a basic criterion for the chosen female volleyball athletes" [10]. There are many physical capabilities in volleyball, including vertical jump capabilities. Jumping a volleyball player requires fast and synchronized coordination of body movements. The body needs to overcome inertia (Newton's First Law), by having a force applied to the player (Newton's Second Law) by using power against the ground that provides an equal and opposite force back (Newton's Third Law) [11].

Therefore, the prediction is significant in the process of selection and selection of players through the use of scientific means, which in turn contributes to the selection of the best athletes. This, in turn, reflects positively on the training process in terms of shortening and reducing time. The accuracy requires full control of the muscles of the human will to be directed towards the specific target, and is the prediction of the branches of science, which is interested in the study of the future of what will happen in the future according to statistical methods (linear regression and multiple), and thus provides advance data will be reached. The importance of the research is to predict the accuracy of the performance of the spike skill (rectal and diagonal) and the wall of the shock in terms of some physical measurements and physical and motor abilities of the volleyball players to achieve good results in the future.

Material and Methods

Participants

In the youth volleyball centres in Erbil, the number of players was (75) out of (106) participants (70% of the total population). 25 Players were excluded because they did not complete the test requirements (Tabl. 1).

Table 1

Details of the research sample

Youth Community	Search community	Sample Final Experience
Youth Center- A	18	12
Youth Center- B	18	12
Youth Center- C	16	12
Youth Center- D	14	10
Youth Center- E	14	10



Youth Center- F	14	10
Youth Center- G	14	9
Total	106	75

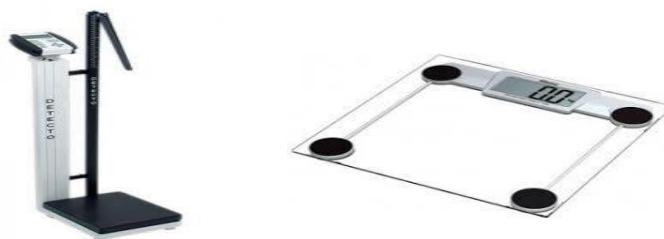


Fig. 1. Measuring device Length and body weight measuring device



Fig. 2. Jump Mat Device

Equipment

Measuring tape length (20 m), medical Ball, (plastic cones) number (5), and platform electronic jumping device (type Axuo)

Applied tests

Physical measurements

1 - Body length: Detecto was used to measure the size of the body, noting that the distance measured from the ground and the highest point in the skull head [12].

2. Body mass: Measurement is performed through the medical balance of the nearest half kilogram. The laboratory stands in the middle of the base of the balance so that the body's weight is distributed on the feet.

Physical and kinetic tests applied

- 1- Zigzag test running in a barrow manner [13].
2. Extend extension test [14].
- 3 - Test the explosive power of the two legs

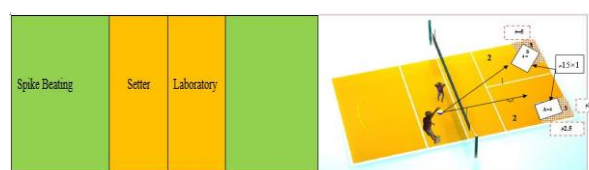


Fig. 3. Test the accuracy of the performance of the spike skill (Straight and diagonal) and blocking

A particular device (jump mat) number (1) with dimensions (50 x 110 cm) was used to measure kinetic variables directly in the course of performance. Among these variables is a vertical jump in centimeters. The experiment was carried out on the jumping mat competence of the mechanics/volleyball.

Technical tests used

- 1 - Test the accuracy of the spike Beating skill (Straight and diagonal)
- 2 - Test the accuracy of the blocking skill: [15].

Tests conducting process

The tests were carried out in two days for each youth centre according to the scheduled schedule from 2/8/2021 until 21/10/2021. First, physical measurements (total body length, body mass) were carried out. Then, the second day was conducted to test the accuracy of the overwhelming beating in the directions (rectal and catheter) and the barrier wall.

Statistical means

The researchers used the statistical SPSS version 18 for data processing.



Results

Three variables are not significant in the correlation.

He points out (El-Meligy) Quoting (Paul J). that the relationship between two or more variables is usually studied in the hope of using the derived relationship in helping to estimate, guide, or predict the regression methods [16]. and that this problem of

linear prediction leads to the problem of straight-line alignment of a set of points. This equation can be written in the following picture:

$$\hat{Y} = a + b x$$

As a = constant amount

And b = regression coefficient

And x = the measurement value of the contributing variables.

Table 2

Computational circles, standard deviations, and torsion coefficients

NO	Variables	Arithmetic mean	standard deviation	Torsion coefficient
1	Body length	173.240	6.372	-0.230
2	Body mass	62.209	7.777	0.250
3	The explosive force of the two legs	41.68	7.046	-0.221
4	Trunk flexibility	30.0267	7.068	0.759
5	The power of speed	11.554	1.337	-0.416
6	Kinetic compatibility	13.280	2.339	0.367
7	Fitness	7.724	0.595	-0.566
8	The overwhelming beating (rectal and diagonal)	26.040	6.143	-0.084
8	Blocking	28.400	3.158	0.449

Table 3

Crosslink parameters for search variables

Research Variables and Probability Ratio	The value of the correlation with the accuracy of the spike skill (straight and diagonal)
Body length	0.476*
Sig. (2-tailed)	0.0001
Mass	0.195
Sig. (2-tailed)	0.047
The explosive force of the legs	0.442*
Sig. (2-tailed)	0.0001
Flexible trunk	-0.022
Sig. (2-tailed)	0.425
The power of speed	0.302**
Sig. (2-tailed)	0.004
Kinetic compatibility	-0.015*
Sig. (2-tailed)	0.450
Fitness	0.140
Sig. (2-tailed)	0.116

Therefore, the researcher performed the steps of the logical analysis of the regression of the physical, physical, and motor abilities, which achieved the highest correlation with the skill

performance accuracy test to determine the percentage of the contribution of these variables in the precision accuracy of the performance of the spike skill.



Table 4

Multivariate analysis of physical somatic, physical abilities, skill performance and contribution rates in the accuracy of the performance of the spike skill

No	Variables	Fixed Amount	Parameter	Calculate	Error Probability Ratio	The degree of freedom	Link value	Contribution Ratio
1	Body length	53.443	0.459	21.376	0.000	73	0.476	0.226
2	Body length of the explosive power of the legs	71.534	0.468 0.394	27.270	0.000	72	0.657	0.431

Table 4 shows that the variables of research and contribution to the accuracy of skill performance have reached three variables, respectively:

The first indicator

Table 4 shows that the body length index is the most contributing variable to the accuracy of the performance of the spiking skill, as its contribution rate reached (0.226). Thus, the equation of the predictive slope line with the accuracy of the skill of the overwhelming beating of the movement in terms of body height is: $\hat{Y} = a + b x$

The second indicator

Table 4 shows that the index of the explosive power of the legs is the second contributor to the accuracy of the skill's performance of the crushing

strike. It raised the contribution ratio from (0.226) to (0.431) by (0.205) from the contribution of the first indicator.

Accordingly, the equation of the predictive slope line is:

$$\hat{Y} = a + b_1 x_1 + b_2 x_2$$

As b_1 = the regression coefficient value of the first contributor.

And x_1 = the measurement value of the first contributing indicator.

And b_2 = the regression coefficient value of the second contributor.

And x_2 = the measured value of the second contributor.

Table 5

Crosslink parameters for search variables

Research Variables	The accuracy skill of the barrier wall
Body length	-0.236*
Sig. (2-tailed)	0.021
Mass	-0.014
Sig. (2-tailed)	0.454
The explosive force of the legs	-0.126
Sig. (2-tailed)	0.141
Flexible trunk	-0.025
Sig. (2-tailed)	0.415
The power of speed	0.049
Sig. (2-tailed)	0.338
Kinetic compatibility	0.264*
Sig. (2-tailed)	0.011
Fitness	-0.064
Sig. (2-tailed)	0.292

Three variables are not significant in the correlation.

The relationship between two or more variables is usually studied in the hope of using the derived relationship in helping to estimate, guide or predict the regression methods. This problem of linear

prediction leads to the problem of the straight-line alignment of a set of points. This equation can be written in the following picture:

$$\hat{Y} = a + b x$$

As a = constant amount

And b = regression coefficient



And x = the measurement value of the contributing variables.

Accordingly, the researcher performed the logical analysis of the regression of the physical bases and physical and motor abilities, which achieved the

highest correlation with the test accuracy of the skill performance to determine the contribution of these variables in the blocking.

Table 6

Multiple regression analysis of physical bases, physical and motor abilities, skill performance, and contribution rates in wall barrier performance accuracy

No	Variables	Fixed Amount	Parameter	Calculated	Error Probability Ratio	The degree of freedom	Link value	Contribution Ratio
1	Kinetic compatibility	23.660	0.357	5.489	0.022	73	0.264	0.070
2	Kinetic compatibility Body length	43.244	0.345 0.112-	4.959	0.010	72	0.348	0.121

Table 6 shows that the compatibility index is the most contributing variable to the accuracy of the performance of the blocking skill, as its contribution rate was (0.070).

The first indicator

Accordingly, the equation of the regression line predictive of the accuracy of the performance of the block skill of movement in terms of body length is:

$$\hat{Y} = a + b x$$

The second indicator

Table 6 shows that the body length index is the second contributor to the accuracy of the performance of the blocking skills, as it raised the contribution percentage from (0.070) to (0.121) by (0.051) from the contribution of the first indicator.

Accordingly, the predictive slope equation is:

$$\hat{Y} = a + b_1 x_1 + b_2 x_2$$

B_1 = the regression coefficient value of the first contributor index.

And x_1 = the index value of the first shareholder.

And b_2 = the regression coefficient value of the second contributor index.

And x_2 = the measured value of the second contributor.

Discussion

When watching table 4. The researcher attributed this result to the fact that the length of great importance in volleyball reduces the distance between the player and the height of the network. It contributes significantly to the performance of the spiking skill

beating because the length of the body has an essential role in achieving the results, size and its relation to the accuracy of the performance of the spike skill. As a result, accuracy is dependent on the individual's ability to estimate the distance and coordination between the movements of the body parts when working together at a very high speed, so it is necessary for a player to fully understand the distance from which the power is sent to them with this distance in the case of skill performance. In addition, the importance of precision in sporting events on which the Hit a target. Moreover, the point is recorded. As for the second indicator, the explosive force of the two legs is to remove the maximum force as soon as possible, as [17] defined it as "the maximum muscle strain that can be achieved in one muscle contraction." As he climbs up to raise his body over the upper edge of the net to overcome the rebound wall and properly complete the crushing bat, the volleyball player needs this aspect." While hitting the ball, the player must utilize his complete body to provide strength to his arms, extend the knee, and raise the hip." [18].

When watching table 6, the attributes this result to the fact that height is of great importance in volleyball, which reduces the distance between the player and the height of the network. It contributes to reaching the network quickly to perform the skill of the wall of the resistance. Size is significant in many sports, as it is the total length or length of the arms and legs. And the consistency of the length of the limbs with each other is essential in acquiring the individual muscle and nervous in most sports activities. Motor coordination is the complex set of



interactions between neural processes involved in moving a limb and the actual stem in movement [19]. Hence, the compatibility between the eye, the hand, the eye, and the man are one of the most important factors for the performance of the skill of the wall of resistance, because through the performance movements there is a transmission of nerve signals from the nervous system to the muscular, so the more coordination between the physical and the technical skills is increased, which in turn helps to increase the compatibility between the performance and the goal, which is accuracy. Accuracy is defined as the ability to speed learning and master motor skills by directing the player's voluntary movements towards a specific purpose [20]. In volleyball, physical abilities are not necessary if they lack the motor precision in performing the performance of skills and directing the movements to the opponent's court, as well as have great importance in resolving the points if the player is good, especially during the performance of the blocking skill. As for the second indicator, Height The body is different from other elements of force. It requires the output of maximum strength as low as possible and requires the player to this element in the jump to the top to overcome the overwhelming beating of the opposing team. Therefore, the level of performance of the crushing defeat and the wall of resistance depends on the availability of the explosive power of the muscles of the two legs [21].

Based on the previous review of tables (2), (3), (4), (5), (6) and based on the results obtained from them, the researcher has reached some physical measurements and physical and motor abilities affecting the accuracy of the spike skill The correlation between these indicators and the percentage of their contribution to the accuracy of the spike skill and the resistor wall were also determined, as well as the determination of the predictive regression equations in terms of the values of the physical measurements and the physical and motor abilities. All the hypotheses in question have been answered.

Conclusions

1. It is possible to identify some physical measurements and physical and motor abilities affecting the level of accuracy of the performance of the skill spike and blocking in the sample research. Furthermore, there is a statistical correlation between some physical measurements and physical and motor abilities and the accuracy of the skill spike and blocking performance in the research sample. Through the logical analysis of the regression of the indicator physical measurements and physical and motor abilities, it was possible to determine the variables of physical measures. Physical skills of the performance skill contribute to improving the accuracy of the skill of skill spike and blocking are as follows: (Body length, and the explosive power of the legs).

2. Equations of the regression line to predict the accuracy of the performance of the skill spike and blocking in the research sample. In terms of some physical measurements and physical abilities, and kinetics. As there through the logical analysis of the regression of the indicator's physical measures and physical and motor abilities, it was possible to determine the variables of physical measurements and the physical and motor abilities of the performance skill contribute to improving the accuracy of the performance of the wall, respectively: (Kinetic compatibility and Body length).

3. Equations of the regression line to predict the accuracy of the blocking skill's performance in the search are a function of some physical measurements and physical and motor abilities.

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Conflict of interest

The authors declare that there is no conflict of interest.

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ORIGINAL ARTICLES. PHYSICAL THERAPY

Physical therapy graduate students' and examiners' perception of objective structured clinical examination: a feedback for process improvement

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Abstract

Purpose: to analyze the first experience of administering Objective Structured Clinical Examination (OSCE) for the students (studs) enrolled in the master's degree program majoring in physical therapy at National University of Ukraine on Physical Education and Sport.

Material and methods. The survey included 21 examiners (examrs) and 46 studs involved in OSCE administering. The questionnaire consisted of the questions assessing the quality of station equipment, clarity of the exam format, other aspects.

Results. All the examrs informed of total clarity of the examination format, but only 13 (61.9%) of them noted a similar level of clarity for the studs. The examrs identified 3 main reasons for unsuccessful attempts to perform a skill/task: insufficient training, new format of checking knowledge/examination, slightly different focus of training. The distribution of answers concerning the clarity of the format of the examination and its tasks provided by the studs did not differ statistically from those provided by the teachers. The vast majority of the examrs indicated that the skills were of sufficient difficulty for the purpose of the examination. 5 examrs had significant difficulties assessing skill performance according to the provided form, while 7 of them had slight difficulties and the rest had no difficulties. The majority of the studs noted that the number of stations and equipment was sufficient (no statistical differences were determined between the answers of the studs and the examrs).

Conclusions. The survey revealed the need for introducing certain changes in OSCE assessment form, in the educational program, conducting special preparatory classes for studs. The obtained results can be used to improve the development of OSCE in physical therapy in Ukraine.

Key words: first experience of administering, clinical and practical skills, competencies, students, surveys



Анотація

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Сприйняття студентами магістратури фізичної терапії та екзаменаторами об'єктивного структурованого клінічного екзамену: зворотний зв'язок для покращення процесу.

Мета: провести аналіз першого досвіду проведення об'єктивного структурованого клінічного іспиту (ОСКІ) у випускників магістерської програми з фізичної терапії у Національному університеті фізичного виховання і спорту України.

Матеріал та методи. У опитуванні прийняли участь 21 екзаменатор та 46 студентів. Анкета складалась з запитань, котрі оцінювали якість оснащення станцій, зрозумілість формату екзамену, а також інші аспекти.

Результати. Усі викладачі повідомили про повну зрозумілість формату екзамену, але лише 13 (61,9%) з них відзначили аналогічний рівень зрозумілості для студентів. Екзаменатори виділили три основні причини невдалих спроб виконати навичку/завдання: недостатня підготовка, новий формат перевірки знань/екзамену, дещо інша спрямованість підготовки при навчанні. Розподіл відповідей щодо зрозумілості формату екзамену та завдань студентами статистично не відрізнялася у опитуванні студентів та викладачів. Переважна більшість викладачів вказала, що навички були достатньої важкості для мети екзамену. П'ять викладачів мали значні складності з оцінюванням виконання навички за наданим бланком, сім – у незначній мірі, інші не мали складнощів. Більшість студентів відзначила, що кількість станцій і обладнання були достатніми (статистичних відмінностей між відповідями студентів та викладачів не встановлено).

Висновки. Проведене опитування виявило необхідність певних змін бланку оцінювання, освітньої програми, проведення спеціальних підготовчих занять для студентів. Отримані результати можуть бути використані для покращення розробки ОСКІ у галузі фізичної терапії в Україні.

Ключові слова: перший досвід адміністрування, клінічні та практичні навички, компетенції, студенти, опитування

Аннотация

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Восприятие студентами магистратуры физической терапии и экзаменаторами объективного структурированного клинического экзамена: обратная связь для улучшения процесса.

Цель: провести анализ первого опыта проведения объективного структурированного клинического экзамена (ОСКЭ) у выпускников магистерской программы по физической терапии в Национальном университете физического воспитания и спорта Украины.

Материал и методы. В опросе приняли участие 21 экзаменатор и 46 студентов. Анкета включала в себя вопросы, оценивающие качество оснащения станций, понимание формата экзамена, а также другие аспекты.

Результаты. Все преподаватели сообщили о полном понимании формата экзамена, но только 13 (61,9%) из них отметили аналогичный уровень понимания для студентов. Экзаменаторы выделили три основные причины неудачных попыток продемонстрировать навыки: недостаточная подготовка, новый формат проверки знаний/экзамена, несколько иная направленность подготовки при обучении. Распределение ответов по пониманию формата экзамена и задач студентами статистически не отличалось в опросе студентов и преподавателей. Подавляющее большинство преподавателей указали, что навыки были достаточно сложными для целей экзамена. Пять преподавателей имели значительные сложности с оценкой выполнения навыка по предоставленному бланку, семь – в незначительной степени, другие со сложностями не столкнулись. Большинство студентов отметило, что количество станций и оборудования было достаточными (статистические отличия между ответами студентов и преподавателей не установлены).

Выводы. Проведенный опрос указал на необходимость определенных изменений бланка оценивания, образовательной программы, проведения специальных подготовительных занятий для студентов. Полученные результаты могут использоваться для улучшения разработки ОСКИ в области физической терапии в Украине.

Ключевые слова: первый опыт администрирования, клинические и практические навыки, компетенции, студенты, опросы



Introduction

Ukraine is currently implementing a healthcare reform, which includes developing a strategy to change the medical education system. The latter involves, among other things, adjusting of educational and professional training programs for physical therapists to European practice. Ukraine has been providing educational programs in physical therapy since 2017. However, they do not meet the requirements of the European Region of the World Confederation for Physical Therapy [1]. Improving training quality is a very important issue since physical therapy involves a wide range of patients with various disorders of the nervous [2,3], musculoskeletal [4,5] and cardiovascular systems [6-9], as well as congenital pathologies [10].

One of the fitting criteria is a mandatory certification of the students enrolled in the master's academic program and majoring in "22 Health care" branch of knowledge, carried out in the form of a unified state qualification exam (USQU). It consists of an integrated test-based exam "KROK"; Objective Structured Clinical Examination (OSCE); International Foundations of Medicine Examination; the English Language Proficiency Test [11]. The procedure of administering the unified state qualification examination for the students enrolled in the master's academic program and majoring in "22 Health care" branch of knowledge was approved by Resolution of the Cabinet of Ministers of Ukraine of March 28, 2018 No. 334 [11]. The Ministry of Health of Ukraine developed the Procedure, terms and timeframe for USQU development and administration as well as result assessment criteria for the USQE components [Ошибка! Источник ссылки не найден.2].

OSCE was hypothesized by Harden in the 1960s, first reported in the British Medical Journal [13] and introduced in 1975 [14]. Thereafter, it has been used as a valuable tool to assess students' clinical skills in medical, dentistry, nursing and pharmacology schools around the world [13]. Being the model for assessing results in a number of medical professions OSCE is a type of examination that provides students with a series of scenarios or stages, each including a standardized task which should be performed within a specific timeframe, often involving interaction with a standardized patient or other types of models [15].

Students rotate round the stations where they perform certain practical tasks, being observed and scored by the examiners according to the checklist. The examination is more objective, and grading strategy is determined in advance. The examination

results in improved feedback to students and staff [16].

The main concerns that this exam should address are validity for clinical skills, not just for knowledge; high reliability; fairness to students; compliance with learning objectives; possibility to create in medical universities using existing or available technologies [15].

The aim of the examination is to conduct an observational pseudo-quantitative assessment of students' clinical skills and competencies in a standardized, simulated environment before they proceed to a clinical internship. The standardized nature of OSCE is aimed to provide a possibility to determine whether a trainee has reached the threshold level of competence that will ideally ensure safe and effective practice in real-life environment. However, students describe OSCE as one of the aspects of their physical therapy training that is of most anxiety [17].

In September 2019, the National University of Ukraine on Physical Education and Sport (NUUPES) started implementation of a pilot master's degree program in specialization 227.1 "Physical Therapy" for the second (master's) level of higher education within the project "Innovative Rehabilitation Education – Introduction of new master's degree programs in Ukraine" (REHAB) No. 598938-EPP-1-2018-1-LV-EPPKA2-CBHE-JP of the Erasmus+ program, funded by the European Union. During May 20-25, 2021, its graduates (77 students) passed the pre-pilot version of OSCE.

Six testing stations were equipped (physical therapy for the diseases of the nervous system, physical therapy for the diseases of the musculoskeletal system, assessment methods in neurology and orthopedics). The duration of one station was 6 minutes; transition time was 30 seconds. Six students were evaluated within one station. Twenty-one examiners and 18 standardized patients were trained and involved in the evaluation process. Task performance was assessed according to the developed checklist and 24 competencies, grouped into the following categories: communication skills – 4, ethic skills – 4, demonstration of knowledge and skills – 10, ability to interpret collected data correctly – 6. Each of the competencies was graded according to the developed checklist. Maximum score for demonstrating one skill was 20 points.

Purpose: to analyze the first experience of administering OSCE for the students enrolled in the master's degree program majoring in physical therapy at NUUPES.



Material and Methods

Participants

The survey included 21 examiners (six examiners were PhD and one was a Doctor of Science; two examiners were Associate Professors and one was a Professor) and 46 students involved in OSCE administering. Participants of the research signed an informed consent form. The research was approved by the University Ethics Committee (№ 2/2020).

Procedure

The survey was conducted with the help of online service "Google Forms". The questionnaire consisted of the questions assessing the quality of station equipment, clarity of the exam format, compliance of the behavior of standardized patients with the tasks, as well as other aspects of the exam administration.

Statistical Analysis

The obtained results were processed by means of mathematical statistics using IBM SPSS Statistics 21 application. Since the results did not correspond to the law of normal distribution, calculations included measuring median value (Me) and upper and lower quartiles (25%; 75%), as well as mean value and standard deviation ($M \pm SD$). Taking into account its specifics, the survey included frequency analysis and determining proportions of the patients according to their answers to the questions. Chi-square test (χ^2 ; nominal and ordinal variables) and Mann-Whitney U test (quantitative indicators) were used to compare the groups' answers to similar questions.

Results

Consider the results of surveying the examiners. Their academic experience varied from one to 22 years. $M \pm SD$ values comprised 7 ± 6.39 years, Me (25%; 75%) indicators were 4 (2; 11) years, which indicates that both young and

experienced specialists were involved in the study. It should be noted that apart from academic activities all the young specialists dealt with practical activities of physical therapy with patients of different nosological groups. Examination administration received 8.85 ± 1.33 points on a ten-point scale from the examiners, with Me (25%; 75%) indicators being 9 (8; 10) points.

The vast majority of the examiners noted that the video camera did not distract them (90.5%) and the students (85.7%). Other examiners chose the answer "partially". The largest share of the examiners (71.4%) noted that the room where the examination was conducted met the necessary requirements. Four respondents informed of partial compliance with the requirements, whereas two of them denied any compliance.

All the examiners informed of total clarity of the examination format, but only 13 (61.9%) of them noted a similar level of clarity for the students. Eight examiners (38.1%) noted partial clarity of the format for the students.

Nineteen examiners (90.5%) reported that the format of the tasks was totally clear to them, while the others noted that it was partially clear. Eleven respondents (52.4%) thought that the format of the tasks was completely clear to the students, nine examiners (42.9%) noted that it was partially clear and one of them stated that the format was not clear.

The same shares of the examiners rated the attitude of the students to the examination as good/with interest and uncertain (47.6%), and only one respondent chose a negative attitude.

The vast majority of the examiners (71.4%) reported that they were not distracted by extraneous noise or interference, while others indicated that this was rare. A similar question, but concerning the students, received similar answers – 71.4% and 28.6% of the respondents, respectively. The answer options "often" and "constantly" were not chosen by any of the respondents.

The average score of tasks/skills performance by all the students was evaluated by the examiners at the level of 60.71 ± 21.05 points on 100-point scale; Me (25%; 75%) indicators comprised 65 (40; 75) points. At the same time, the examiners identified three main reasons for unsuccessful attempts to perform a skill/task (Fig. 1).

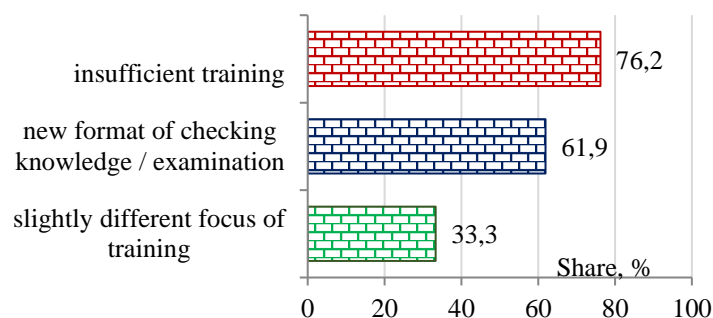


Fig. 1. Main reasons for unsuccessful attempts to perform a skill/task by the students in the opinion of the examiners

Almost a quarter (23.8%) of the respondents noted that the number of stations (examination tasks) should be increased, while the others considered it sufficient. All the examiners informed of the relevance of the skills that were selected for the examination.

Eleven respondents noted that the equipment of the stations was sufficient to perform the skill, while the other ten considered it necessary to increase its number.

A number of questions concerned the patient model. Sixteen (76.2%) examiners considered it totally possible for a student to perform the skill on a standardized patient, while the others chose the answer "partially".

The examiners noted that the standardized patient should be given better and more specific instructions on complaints and medical history (including their absence) – 90.5% of responses, the need to indicate in the medical history counterindications to perform the skill – 66.7%, testing conditions (inpatient, outpatient admission) – 57.1%, following only student's instructions (because the standardized patient could perform the skill correctly, although the student provided vague explanations) – 76.2%.

Ten examiners indicated that the assigned time was sufficient to perform all the skills. A similar proportion of the respondents answered "enough time for most of the skills", only one respondent chose "enough time for half of the skills".

The vast majority of the respondents (81%) indicated that the skills were of sufficient difficulty for the purpose of the examination. The answers "not difficult enough" and "too easy" considering the purpose of the examination were chosen with the same frequency (9.5%).

Almost all the examiners noted that they were not biased against the students during the

examination (90.5%). Only two teachers chose the answer "biased to a certain extent".

Five examiners had significant difficulties assessing skill performance according to the provided form, while seven of them had slight difficulties and the rest had no difficulties.

In addition, the examiners were inquired about the need for additional instructions on assessing skill performance according to the provided form in a specific situation. Thirteen respondents (61.9%) confirmed the need for additional instructions in a situation where the student performed a skill not specified in the task, but did it properly and in accordance with the assessment purpose (e.g. assessment of strength, stamina, range of motion, pain); 38.1% of the respondents – in a situation where the student performed a skill not specified in the task and not in accordance with the assessment purpose, but did it properly; 47.6% – when the student performed a specified skill, but partially (only on one side or limb, during insufficient amount of time); 33.3% – when the student explained how to perform the skill, but was distracted by talking to the patient and did not perform it.

Besides, the examiners were inquired about the need to change the form of skill assessment. The majority of the respondents (57.1%) confirmed that the first assessment unit (communication skills) should be left unchanged. Other respondents chose the answers "to reduce the number of grades from 4 to 2" (14.3%), "to reduce the number of grades from 4 to 1" (14.3%), "to reduce the number of grades and change the form" (14.3%). None of the respondents chose the options "to increase the number of grades" and "to delete the unit". Open-ended questions in the first assessment unit included recommendations and comments concerning the fact that the form should include only those communication skills that are necessary



to perform the skill; these skills should be taught and assessment points should be explained to the students; the purpose of the examination is to assess students' practical skills, therefore this unit is not a key one.

The majority of the respondents (57.1%) confirmed that the second assessment unit (ethic skills) should be left unchanged. Other respondents chose the answers "to reduce the number of grades from 4 to 2" (19%), "to reduce the number of grades and change the form" (14.3%), "to delete the unit" (4.8%), "task format does not always enable to assess ethic skills" (4.8%). None of the respondents chose the options "to reduce the number of grades from 4 to 1", "to increase the number of grades" and "to combine the unit with the first one".

Open-ended questions in the second assessment unit included recommendations and comments concerning the fact that the form should include only those ethic skills that are necessary to perform the skill; ethic skills should be taught and assessment points should be explained to the students; this unit should be assessed directly in a medical institution, rather than automatically completed at the examination.

The majority of the respondents (61.9%) confirmed that the third assessment unit

(demonstration of knowledge and skills) should be left unchanged. Other respondents chose the answers "to reduce the number of grades" (9.5%), "to reduce the number of grades and change the form" (14.3%), "to increase the number of grades" (9.5%), "to change the content of grades to make them more objective" (4.8%).

Concerning the fourth unit (the ability to correctly interpret the collected data), the same shares of the respondents (33.3%) chose the answers "to leave the unit unchanged" and "to reduce the number of grades and change the form". Other respondents chose the answers "to reduce the number of grades" (19%), "to increase the number of grades" (4.8%), "to delete the unit" (9.5%). Sixteen examiners noted they did not interfere with the skill performance.

Consider the results of surveying the students. The group involved 54.3% of males. The age of the students ranged from 21 to 43 years. $M \pm SD$ indicators comprised 26.8 ± 6.25 years, and Me (25%; 75%) indicators were 24 (23; 27.5) years. The distribution of answers concerning the clarity of the format ($\chi^2=2.243$, $p=0.326$) of the examination and its tasks ($\chi^2=1.411$, $p=0.494$) provided by the students did not differ statistically from those provided by the teachers (Fig. 2).

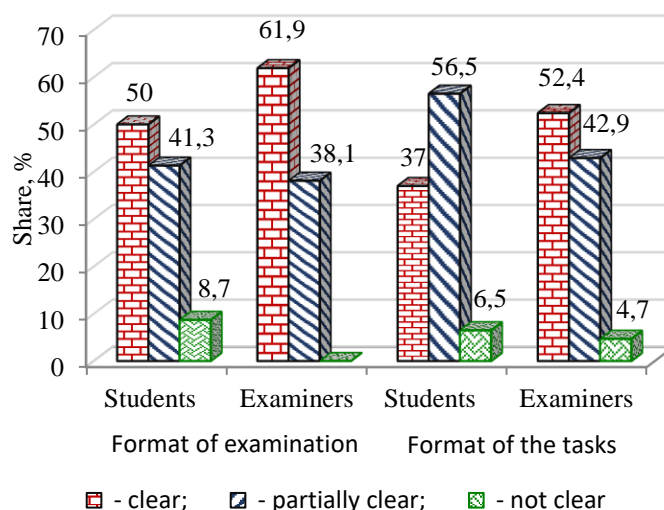


Fig. 2. Distribution of students' and examiners' answers concerning the clarity of the formats of the examination and the tasks to the students

The students rated the performance of tasks/skills at the level of 79.57 ± 13.24 points on 100-point scale; Me (25%; 75%) indicators comprised 80 (70; 90) points. The assessment of the students was

statistically higher than that of the examiners ($Z=-3.479$, $p=0.001$).

The majority of the students (69.6%) noted that the number of stations was sufficient. The same shares of the students indicated that the number of



stations should be increased (15.2%) and decreased (15.2%). No statistical differences were determined

between the answers of the students and the examiners (Table 1).

Table 1

Comparison of answers to question about the number of stations

Answers	Groups		Total	χ^2	p
	students	examiners			
need to reduce	7	0	7	0.144	0.052
enough	32	16	48		
need to increase	7	5	12		
Total	46	21	67		

The largest share of the students (58.7%) noted that the equipment of the stations was sufficient to perform the skill. The need to increase the amount of the equipment was chosen by 39.1% of the students, while the rest of them considered it

necessary to reduce its amount. No statistical differences were determined between the answers of the students and the examiners (Table 2).

Table 2

Comparison of answers to question about the amount of equipment in stations

Answers	Groups		Total	χ^2	p
	students	examiners			
need to reduce	1	0		0.806	0.668
enough	27	11	38		
need to increase	18	10	28		
Total	46	21	67		

Sixteen students (34.8%) considered it possible to perform the skill on a standardized patient. The answer "partially" was chosen by 45.7% of the students, "impossible" – by 4.3%, while the other 15.2% confirmed that the patient distracted/prevented them from demonstrating the skill.

Almost half (47.8%) of the students noted that the assigned time was enough to perform all the

skills; 21.7% of them chose the answer "enough to perform most of the skills"; 17.4% – "enough to perform half of the skills"; 6.5% – "not enough to perform most of the skills"; 6.5% – "not enough to perform all the skills". No statistical differences were determined between the answers of the students and the examiners (Table 3).

Table 3

Comparison of answers to question about the amount of time to complete tasks

Answers	Groups		Total	χ^2	p
	students	examiners			
enough to perform all the skills	22	10	32	7.686	0.104
enough to perform most of the skills	10	10	20		
enough to perform half of the skills	8	1	9		
not enough to perform most of the skills	3	0	3		
not enough to perform all the skills	3	0	3		
Total	46	21	67		

Concerning the performed skills, 19.6% of the students informed of the absence of skills that were not taught within their bachelor's and master's degree programs. 37% of the students chose the

answer "a small number of the skills"; 19.6% – "a half of the skills"; 19.6% – "majority of the skills"; 4.3% – "all the skills were not taught".



The vast majority of the students (71.7%) noted that the skills were difficult enough for the purpose of the exam. The answer "not difficult enough" was chosen by 21.7% of the respondents, and "too easy" – only by one student. Two students

(4.3%) considered the skills too difficult to perform. No statistical differences were determined between the answers of the students and the examiners (Table 4).

Table 4

Comparison of answers to questions about the complexity of exam tasks

Answers	Groups		Total	χ^2	p
	students	examiners			
difficult enough	33	17	40	4.018	0.206
not difficult enough	10	2	12		
too easy	1	2	3		
too difficult to perform	2	0	2		
Total	46	21	67		

The majority of the students noted that they were not biased during the exam (54.3%). 39.1% of the students were biased to some extent, while the others were strongly biased.

Discussion

The obtained results can be used to improve the development of a standardized OSCE in physical therapy in Ukraine and to elevate the integrity of future surveys of students and teachers. The study was limited by the amount of samples that can be increased in further studies to improve generalizability of the results.

It was previously reported that feedbacks from students and teachers are invaluable and contribute to a critical review and modification of the content of OSCE stations and carrying out expert examination [14]. According to the surveys, OSCE is positively perceived by most students [18-20]. One of the previous studies showed that OSCE is perceived as a fair assessment tool by both students and teachers [13].

The results of the survey confirmed the need to improve the format of assessing students' skill performance. The difference between assessment results of the examiners and the students, as well as the level of understanding of the format of the examination and the tasks emphasize the need for administering special training courses or classes for students, implementing changes in the educational curricula. On the other hand, this difference can be explained by the results of the previous studies where students reported that OSCE is more difficult [14,21] and more honest [14] than the usual teacher assessment (Clerkship ratings).

In terms of simplifying the assessment, we should note its specifics in one of the studies: the results of students' performance were assessed

according to the criteria for each station (the validity and content of each checklist were established by a group of senior pediatricians through conducting a review and reaching a consensus); criteria-based scoring was used, with each checklist item being rated as 0 (omitted, incorrect or inadequate) or 1-2 (correct or adequate) [14].

The presented results confirm that the majority of the examiners and the students believed that there was enough time to perform all or most of the skills. Only a few students noted that there was not enough time to perform all or most of the skills. One of the previous studies [14] stated that faculty members considered that students' concerns about the distribution of time at the station and the degree of stress were caused by insufficient preparation for the exam, especially in competencies that were not previously assessed at the "traditional" examination.

At the same time, the obtained results actualize the issues of task design, clarity of instructions, and the problem of individual variability among examiners. In order to make OSCE reliable, it is necessary to conduct a thorough review of the content and design of the tests, training of examiners and implementation conditions.

A survey conducted in Nigeria confirmed that 40.4% of the students easily understood written instructions at OSCE stations; 70.2% of the students believed that the time allocated to each station was sufficient. Besides, 56.3% informed that OSCE enhanced their communication skills; 53% informed of nervousness caused by OSCE; and 48.3% expressed concerns about the change of examiners at the stations. At the same time, only 37.1% of the students believed that OSCE should be used more often than other forms of assessment [19].

Conducted in Jamaica among medical students, OSCE (13 stations) received overwhelming acceptance in child health with respect to the comprehensiveness (90%), transparency (87%),



fairness (70%) and authenticity of the required tasks (58-78%). However, students felt a strong anxiety and expressed concerns regarding the ambiguity of some questions and lack of time to perform a task [14].

A survey of the teachers who conducted OSCE for the students of the Department of Internal Medicine revealed that 80% of the students perceived OSCE as a better assessment tool than traditional long/short case exams. A large number of stations and areas of tasks (nosologies) allowed to identify weaknesses and explain them by the peculiarities of training and the prevalence of pathology. It should be noted that communication skills were assessed at one of 21 stations (10 history-taking stations, 6 physical examination stations and 5 data interpretation stations) [13]. Taking into account the obtained results and teachers' comments, the organization of a specific station for the assessment of communication skills can result in improving the organization of the examination on the whole.

One of the studies grouped medical competencies into six categories: medical knowledge, patient care, professionalism, interpersonal and communication skills, system-based practice, practice-based learning and improvement [22]. OSCE is considered an important tool for assessing patient care, interpersonal and communication skills, and professionalism. It is also a reliable method of assessing practice-based learning and improvement, system-based practice, but not medical knowledge [22, 23]. These data can

also be used to improve examination structure, namely the number of stations and their content.

Conclusions

Students' feedbacks on the use of tools to assess their knowledge and skills are of great importance, being thus an effective method to improve education system. The survey revealed the need for introducing certain changes in OSCE assessment form, conducting special preparatory classes for students, providing changes in the educational program. The obtained results can be used to improve the development of OSCE in physical therapy in Ukraine, to enhance master's degree program in specialization 227.1 "Physical Therapy" at NUUPES and advance its acceptance by the European Region of the World Confederation for Physical Therapy.

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Conflict of interest

The authors declare that there is no conflict of interest.

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ORIGINAL ARTICLES. PHYSICAL THERAPY

Condition of membranes of erythrocytes of peripheral blood of elderly people with chronic tiredness and low level of tolerance to physical load

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Abstract

Purpose: The aim of the work is to study the osmotic stability and morpho-functional features of peripheral blood erythrocytes of patients with chronic fatigue syndrome depending on the level of exercise tolerance and associated risk factors. groups of factors that may be the cause, so the development of measures to eliminate them is an urgent problem today, which requires the development of effective ways to correct chronic fatigue syndrome. It is known that the peripheral part of erythron actively responds to changes that occur in the whole body after the action of various factors, including those factors that lead to chronic fatigue syndrome.

Material and methods of research. The examination was performed on the basis of the Department of Vascular Neurology of the Central Clinical Hospital of Ivano-Frankivsk. The study involved 30 patients aged 55-65 years (mean age 60.6 ± 1.2 years), who were divided into 3 groups: 1 gr. included 10 patients with chronic fatigue syndrome and a high level of exercise tolerance. The 2nd group included 10 patients with chronic fatigue syndrome and the average level of exercise tolerance, the composition of 3 gr. included 10 patients with chronic fatigue syndrome associated cardiovascular pathology (angina pectoris, hypertension) and low exercise tolerance (3 gr.).

Results. It is established that chronic fatigue syndrome proceeds in 3 phases and has natural stages of development which are characterized by three groups of etiological factors and the corresponding levels of teletransitivity to physical activity, each of which corresponds to a certain erythrocyte profile and level of osmotic stability of erythrocytes which are offered to use as prognostic and diagnostic characteristics. chronic fatigue syndrome.

Conclusions. The study of the quantitative composition of peripheral blood erythrocytes and hemoglobin, as well as their ratio (color index) in patients with chronic fatigue syndrome on the background of low levels of exercise tolerance revealed a decrease in erythrocytes and hemoglobin by 42% and 25%, respectively, indicating the presence of anemic hypoxia. 2. In conditions of chronic fatigue there is a decrease in osmotic resistance of erythrocytes, as evidenced by a decrease in the number of osmotically stable erythrocytes with a gradual decrease in the concentration of NaCl solution (3.0%; 0.5%; 0.46%; 0.3%).

Key words: chronic fatigue syndrome, exercise tolerance, peripheral blood erythrocytes, osmotic resistance of erythrocytes



Анотація

Сергій Л. Попель. Стан мембран еритроцитів периферичної крові людей похилого віку при хронічній втоми і низькому рівні толерантності до фізичного навантаження

Мета: - вивчити осмотичну стійкість і морфо-функціональні особливості еритроцитів периферичної крові пацієнтів з синдромом хронічної втоми в залежності від рівня толерантності до фізичного навантаження та асоційованих з синдромом хронічної втоми факторів ризику. Для синдрому хронічної втоми характерним є наявність декількох фаз перебігу і трьох груп факторів, які можуть бути його причиною, тому розробка заходів для їх нівелювання є актуальною проблемою сьогодення, яка потребує розробки ефективних шляхів корекції синдрому хронічної втоми. Відомо, що периферична частина еритроциту активно реагує на зміни, які відбуваються в цілісному організмі після дії різних факторів, в тому числі і тих факторів, які ведуть до синдрому хронічної втоми.

Матеріал і методи. Обстеження проводили на базі відділення судинної неврології Центральної клінічної лікарні м. Івано-Франківська. В дослідженні приймали участь 30 пацієнтів віком 55-65 років (середній вік $60,6 \pm 1,2$ роки), яких поділили на 3 групи: до складу 1 гр. увійшли 10 пацієнтів з СХВ і високим рівнем толерантності до фізичного навантаження. До складу 2-ої групи увійшли 10 пацієнтів з синдромом хронічної втоми і середнім рівнем толерантності до фізичного навантаження, до складу 3 гр. увійшли 10 пацієнтів з асоційованою з синдромом хронічної втоми серцево-судинною патологією (стенокардія напруження, артеріальна гіпертонія) і низьким рівнем толерантності до фізичного навантаження (3 гр.).

Результати. Встановлено, що синдром хронічної втоми перебігає у 3 фази і має закономірні етапи розвитку, які характеризуються трьома групами етіологічних факторів і відповідними рівнями толерантності до фізичного навантаження, кожен з яких відповідає певному еритроцитарному профілю і рівню осмотичної стійкості еритроцитів, які пропонується використовувати в якості прогностично-діагностичних характеристик синдрому хронічної втоми.

Висновки. Дослідження кількісного складу еритроцитів периферичної крові і гемоглобін, а також їх співвідношення (кольоровий показник) у пацієнтів при синдромі хронічної втоми на фоні низького рівня толерантності до фізичного навантаження виявило зменшення кількості еритроцитів периферичної крові і гемоглобін відповідно на 42 % і 25 %, що свідчить про наявність анемічної гіпоксії. 2. В умовах хронічної втоми спостерігається зниження осмотичної резистентності еритроцитів, про що свідчить зменшення кількості осмотично стійких еритроцитів при поступовому зменшенні концентрації розчину NaCl (3,0 %; 0,5 %; 0,46 %; 0,3 %).

Ключові слова: синдром хронічної втоми, толерантність до фізичного навантаження, еритроцити периферичної крові, осмотична резистентність еритроцитів

Аннотация

Сергей Л. Попель. Состояние мембран эритроцитов периферической крови у людей пожилого возраста с хронической усталостью и низким уровнем толерантности к физической нагрузке

Цель: изучение осмотической стабильности и морфофункциональных особенностей эритроцитов периферической крови больных с синдромом хронической усталости в зависимости от уровня толерантности к физической нагрузке и сопутствующих факторов риска. группы факторов, которые могут быть причиной, поэтому разработка мероприятий по их устранению является актуальной проблемой на сегодняшний день, что требует разработки эффективных способов коррекции синдрома хронической усталости. Известно, что периферическая часть эритрона активно реагирует на изменения, возникающие во всем организме после действия различных факторов, в том числе тех, которые приводят к синдрому хронической усталости.

Материал и методы исследования. Обследование проводилось на базе отделения сосудистой неврологии ЦКБ г. Ивано-Франковска. В исследовании приняли участие 30 больных в возрасте 55-65 лет (средний возраст $60,6 \pm 1,2$ года), которые были разделены на 3 группы: 1 гр. включены 10 пациентов с синдромом хронической усталости и высоким уровнем толерантности к физической нагрузке. Во 2-ю группу вошли 10 больных с синдромом хронической усталости и средним уровнем толерантности к физической нагрузке, состав 3 гр. включено 10 больных с синдромом хронической усталости на фоне сердечно-сосудистой патологии (стенокардия, гипертоническая болезнь) и низкой толерантностью к физической нагрузке (3 гр.).

Результаты. Установлено, что синдром хронической усталости протекает в 3 фазы и имеет закономерные этапы развития, которые характеризуются тремя группами этиологических факторов и соответствующими уровнями толерантности к физической нагрузке, каждая из которых соответствует определенному эритроцитарному профилю и уровню осмотической устойчивости эритроцитов, которые предлагается использовать в качестве прогностически-диагностических признаков синдрома хронической усталости.

Выводы. Изучение количественного состава эритроцитов и гемоглобина периферической крови, а также их соотношения (цветовой показатель) у больных с синдромом хронической усталости на фоне низкого уровня толерантности к физической нагрузке выявило снижение эритроцитов и гемоглобина на 42% и 25%. соответственно, что свидетельствует о наличии анемической гипоксии. 2. В условиях хронического утомления происходит снижение осмотической резистентности эритроцитов, о чем свидетельствует уменьшение количества осмотически стабильных эритроцитов при постепенном снижении концентрации раствора NaCl (3,0%; 0,5%; 0,46%; 0,3 %).

Ключевые слова: синдром хронической усталости, толерантность к физической нагрузке, эритроциты периферической крови, осмотическая резистентность эритроцитов



Introduction

At present, the problem of chronic fatigue and low tolerance to physical activity is acute all over the world. This is facilitated by the instability of the social situation, the economic crisis, changes in the system of personal values, and environmental factors (global warming). The total number of people with chronic fatigue syndrome reaches 200 million or 5% of the world's population [1]. The main "risk group" of people with low tolerance to physical activity includes young people and adolescents with chronic fatigue syndrome [2]. The constant accumulation of deoxidized substances in the body due to lipid peroxidation in chronic fatigue syndrome stimulates the launch of various pathological reactions affecting metabolic processes, leading to the development of cardiovascular disease and causing low tolerance to exercise. According to the World Health Organization (WHO), the clinical manifestations of chronic fatigue syndrome are: muscle and joint pain; fatigue after waking up, which indicates the lack of regenerative properties of sleep; constant headache; deterioration of health, which lasts for 24 hours after exercise, impaired concentration and memory; "Blurring" of vision; problems with the vestibular apparatus. The multifunctional role of peripheral blood erythrocytes in the mechanisms of adaptation to physical activity and compensation of negative consequences in hypoxia, gas transport processes and other vital functions explains the high informativeness of the results of studying structural and functional changes in these cells in various human conditions. At the same time, the enzyme regulation of the processes of formation and destruction of hydrogen peroxide (H_2O_2) in peripheral blood erythrocytes is an insufficiently studied aspect of hypoxia. Taking into account the data on the direct participation of reactive oxygen species and hydrogen peroxide (O_2 , H_2O_2) and enzymes of the antioxidant defense system: superoxide dismutase (SOD) and catalase (CAT) in the oxygenation of hemoglobin [3, 4], is of interest changes in the activity of these enzymes, aimed at improving the structural and functional value of erythrocytes of peripheral blood, necessary for adequate transport of oxygen during exercise in chronic fatigue syndrome.

Chronic fatigue syndrome is diagnosed after 6 months of clinical signs. The disease is divided into 3 phases:

- Prodromal phase: which is characterized by symptoms of chronic fatigue, manifested by physical and mental exhaustion. At this stage, the patient can

get rid of chronic fatigue syndrome by changing their lifestyle.

- Acute phase: characterized as a disease of systemic intolerance to physical activity or low tolerance to physical activity. The inability to get out of bed is compounded by impaired thinking and concentration. Characteristic attacks of panic and depression.

- Recovery phase: during which the patient tries to return to normal life, feeling tired and weak.

Etiology of the disease. The causes of chronic fatigue syndrome are classified into three groups: the first group includes psychological problems. These are stressful situations, outbursts of strong negative emotions and depression. The second group includes somatic health problems, such as: anemia; malnutrition; hypothyroidism; sleep apnea; diabetes; adiposity. The third group includes lifestyle problems: alcohol abuse; hypokinesia; caffeine abuse; irregular diet. Among the causes of chronic fatigue syndrome is not the last place overload at work and work at night. All these factors are characteristic of the daily professional activities of a teacher in higher education.

Pathogenesis

At present, the pathogenesis of chronic fatigue syndrome has not been fully elucidated. The disease is based on an abnormal level of chemicals synthesized in the system "hypothalamus - pituitary - adrenal glands". This system is responsible for controlling many physiological functions: sleep, vitality and stress reactions. At the same time, patients with chronic fatigue syndrome have low levels of serotonin and dopamine in the body. Signs of chronic fatigue syndrome often develop after a violation of the immune system. In general, the prognosis for recovery is favorable with timely medical attention. However, in the scientific literature there are no criteria for this timeliness.

Therefore, there is an urgent need to establish objective criteria for the course and predict the treatment of a patient with chronic fatigue syndrome with professional help. At long action of stress factors there is a steady disturbance of a metabolism in an organism which are the reason of many comorbid diseases and, as a consequence of decrease in level of protective forces of an organism; the level of human social activity, his ability to work and the adequacy of behavior decreases [5].

Under the action of toxic substances, conditions are created for the intensive formation of products of lipid peroxidation, which leads to the development of oxidative stress and, accordingly, to the peroxide destruction of cell membranes.



Activation of free radical oxidation processes is the basis of many pathological processes, and in particular low tolerance to exercise. It is known that hypokinesia and hypoxia as constant companions of chronic fatigue syndrome affect the key stages of intracellular metabolism and, above all, the processes of energy metabolism, which relate mainly to aerobic oxidation of fatty acids and glucose [6]. As a result of lipophilic effects of lipid peroxidation on cell structures, the properties of cell membranes, their liquid crystal structure, viscosity and stability change, which is especially evident in cells with low adaptive capacity, such as peripheral blood erythrocytes. This is accompanied by suppression of all functions and premature aging of the body.

Erythrocytes of peripheral blood, in close contact with all tissues and entering into morphological functional relationships with them, their own qualitative and quantitative adjustment reflect the physiological and pathological changes that occur throughout the body, thus causing the so-called "exquisite" (reflected) reactions as prognostic markers for a number of chronic diseases [7].

The aim of the study was to study the osmotic stability and morpho functional features of peripheral blood erythrocytes of patients with chronic fatigue syndrome depending on the level of tolerance to exercise and risk factors associated with chronic fatigue syndrome.

Material and methods

Participants

The examinations were performed on the basis of the neurological department of the Central Clinical Hospital in Ivano-Frankivsk. The study involved 30 patients aged 55-65 years (mean age 60.6 ± 1.2 years), who were divided into 3 groups: 1 g. included 10 patients with chronic fatigue syndrome and a high level of tolerance to exercise. The 2nd group included 10 patients with chronic fatigue syndrome and moderate tolerance to exercise, the 3rd group included 10 patients with associated with chronic fatigue syndrome cardiovascular disease (stress angina, hypertension) and low physical tolerance. load (3 group). Among the patients were 15 teachers of higher education institutions with at least 15 years of teaching experience.

All participants were informed about the purpose of the study and gave written consent to participate in the study, which was conducted in accordance with the Helsinki Declaration of the

WMA - Ethical Principles of Medical Research for Human Subjects, 2013.

Morpho-biochemical methods of erythrocyte analysis

Morphological studies of erythrocytes were performed in a scanning electron microscope "JEOL-25M-T220A" (Japan) according to the generally accepted method [3]. Used, where A is the total number of erythrocytes, B is the number of irreversibly altered forms of erythrocytes, B is the number of inversely altered forms of erythrocytes. The low level of conformational ability of erythrocytes is determined at values of erythrocyte deformation index from 1.6 to 2.5, medium - in the range of 2.6-3.9, high - at 4.0-6.0. To determine the electrolyte composition of erythrocytes in a muffle furnace at a temperature of 800 Co ash was 2 ml of erythrocyte mass. The ash was pressed, after which the surface of the mold was sprayed with carbon (≈ 10 nm). Determination of erythrocyte concentration of macronutrients such as sodium (Na), potassium (K), iron (Fe), magnesium (Mg) and calcium (Ca) was performed using a computer program "SELM" and a prefix for energy-dispersive X-ray microanalysis EDAR "On the REMMA-102E scanning electron microscope (SELM, Ukraine) with an accelerating voltage of 20 kV in the energy range from 960 to 19600 kiloelectron-volts (keV). Morpho functional parameters and osmotic resistance of erythrocytes (WEM) were studied in the blood, which was determined by the Janowski microscopic method using descending (3%, 0.5%, 0.46%, 0.3%) concentrations of NaCl solution. The number of peripheral blood erythrocytes was determined in Goryaev's chamber. The hemoglobin concentration was determined with a hemometer. Erythrocyte sedimentation rate was determined by the unified Panchenkov micromethod [5].

The level of tolerance to physical activity was determined by cycling ergometry (cycling ergometer "Kettler" Germany) according to the PWC100 protocol.

The surface architecture of peripheral blood erythrocytes was studied using scanning electron microscopy (SEM) (electron microscope "JEOL 25A T3225"; Japan) with the preparation of samples according to the method of Romashchenko O.V., V.F. Kamenev [7] and GI Kozynets and co-authors [3]. The calculation of different morphological forms of EPA was performed according to the classification of GI Kozynets and co-authors [3]. Some of the studies were performed on a hemoanalyzer (Lab Analyt30000Plus) (Finland).



Determination of the microelement composition of EPA (nitrogen, calcium, magnesium) was performed using energy-dispersed X-ray structural scanning on the attachment for microanalysis "EDAR" to the scanning electron microscope "REMMA 202E" (Sumy, Ukraine)

Determination of erythrocyte deformability index was performed by the method of C. Tannert, V. Lux in modification Z.D. Федоровой, М.О. Kotovschikova [8]. Oxygen saturation was determined by pulse oximetry on a Jziki-Fingertip oximeter. For the clinical characteristics of patients with CFS determined the level of overall morbidity, health self-assessment index; Heart rate at rest and at FN; double product; stress index (IN); adaptive potential according to Baevsky [9]; percentage of excess body weight.

Statistical analysis

Statistical analysis was performed using the standard software package SAS 8.0 (SAS Inc., USA). Criteria t and χ^2 were used. Statistical processing of quantitative indicators was performed using the computer software package "Statistica 6.0" [10]. Data are presented as arithmetic mean \pm standard deviation ($M \pm SD$). The obtained results were not subject to the law of normal distribution according to the Kolmogorov-Smirnov criterion, therefore the statistical significance of the intergroup difference was estimated using the Mann-Whitney test and the nonparametric Kruskal-Wallis test using the nonparametric Spearman correlation coefficient. The difference was considered statistically significant at a bilateral level of $p < 0.05$.

To determine the significance of the influence of qualitative value of the erythrocyte deformation index on the functional state of the cardioregulation system, a nonparametric analysis of variance of heart rate variability was performed [9] both before and after exercise at maximum aerobic capacity. The obtained data were subject to variational-statistical processing by the method of small sampling [10]. The difference was considered statistically significant at $p < 0.05$ and below.

Results

The main complaints of patients with CFS are presented in table. 1

Table 1

The structure of complaints in groups of teachers with chronic fatigue syndrome (%)

Clinical manifestations	Groups	
	Women, n = 20	Men, n = 10
Sleep disorders	85.0	14.2*
Impaired short-term memory and ability to concentrate	65.0	35.7*
Feeling of constant unexplained fatigue for 6 months or more	100	100
Depression	65.0	28.6*
Prolonged subfibrillation (37,2–37,4°C)	85.0	50.0*
Headache, muscle and joint pain	70.0	28.6*

Note: * - the difference is probable at $p < 0.05$.

The state of the membrane of destabilizing processes is characterized by various criteria. This is primarily the level of functional activity of endogenous phospholipases and the dynamics of lipoperoxide accumulation. According to our results, the severity of membrane destabilizing processes increases from the minimum values in patients 1 gr. with a more favorable form of chronic fatigue syndrome and a high level of tolerance to physical activity to the maximum level in patients 2 gr. and patients 3 gr. (with a low level of tolerance to physical activity on the background of cardiovascular disease), which is manifested by the expansion of the hemogram and its change from normal, unimodal type of hemogram (Fig. 1, A) to bipolar type of peripheral blood erythrocytes (Fig. 1, B) by their corpuscular volume, with a significant shift of the distribution peak to the left (Fig. 1 B). This is closely correlated ($r = 0.93$) with the appearance of cells with irreversibly altered shape among erythrocytes (Fig. 1, A, B).

It was found that the level of tolerance to exercise 82% of patients with chronic fatigue syndrome had low physical performance, which averaged 0.87 ± 0.02 W / kg, which is 25% less than the reference values. The number of peripheral blood erythrocytes depends on many factors, the general mechanism of action of which is expressed in a hypoxic state. Toxic substances (eg, lipid peroxidation products) may also be such factors [11, 12].

The results of the studies revealed significant changes in blood parameters in patients with chronic fatigue syndrome with a low level of exercise tolerance (Table 1). There is a decrease in

the number of peripheral blood erythrocytes by 42% compared to the reference values of physiological norm. Erythropenia accompanies the syndrome of chronic fatigue and is closely correlated ($r = 0.87$)

with a decrease in hemoglobin to 90 ± 8.2 g / l (Table 1) and with hemogram (Fig. 1).

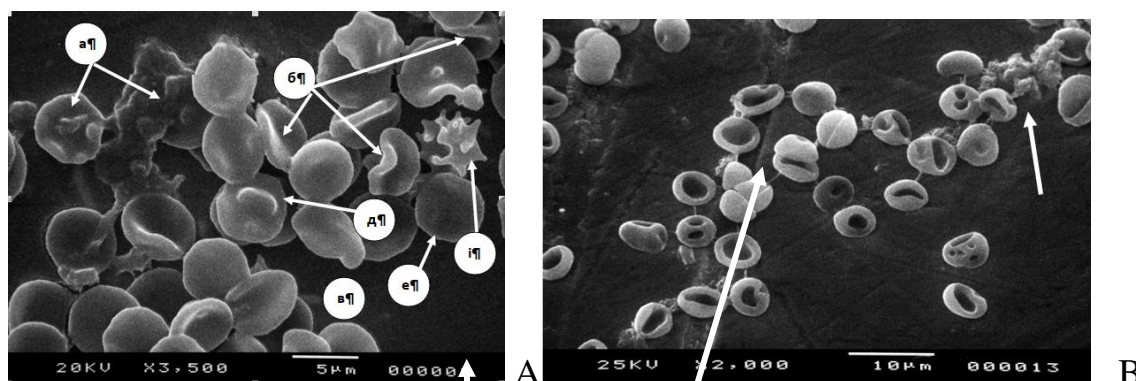


Fig. 1. A: Acanthocyte (a), erythrocyte with crest (b), erythrocyte with one outgrowth (c), erythrocyte with dome (e), spherocyte (e) echinocyte (i) in patients 3 gr.
B: the arrow shows the "shadows" of erythrocytes

Table 2

Blood parameters in chronic fatigue syndrome with low tolerance to exercise compared with reference data ($M \pm m$, $n = 10$)

Indexes	Physiological norm	Chronic fatigue syndrome
Erythrocytes ($\times 10^{12}/l$)	4.5 ± 0.7	2.6 ± 0.43 $P < 0.001$
Hemoglobin (g / l)	120.0 ± 13.2	90.0 ± 10.4 $P < 0.001$
Erythrocyte sedimentation rate (mm / hour)	11.4 ± 1.0	9.6 ± 0.4 $P < 0.001$
Color indicator	0.8 ± 0.01	0.89 ± 0.002 $P < 0.001$

Note: P is the degree of probability of the results in relation to the control

In order to maintain homeostasis, the blood system responds not only to quantitative but also qualitative changes in its composition to any exogenous or endogenous factors [12].

As a result of the study in patients of group 3 with chronic fatigue syndrome with a low level of tolerance to exercise, specific features of the indicators of osmotic resistance of erythrocytes were established. Compared with the physiological norm with a low level of tolerance to exercise, there is a decrease in the number of erythrocytes at a concentration of NaCl 3% by 42.2%, at a concentration of 0.5% by 28.6%, at a concentration of NaCl 0.46% - by 46.2% and at a concentration of NaCl solution of 0.3% by 54.5% (Table 2).

Table 3

Indicators of osmotic resistance in different states of the body
($n = 10$)

Concentration NaCl	Physiological norm (the number of erythrocytes) \bar{x}	Chronic fatigue syndrome	Tolerance to physical activity, W / kg body weight
3%	4.5 ± 0.9	2.6 ± 0.04	3.0 ± 0.04
0.5 %	2.1 ± 0.6	1.5 ± 0.8	1.2 ± 0.8
0.46 %	1.3 ± 0.1	0.7 ± 0.03	0.5 ± 0.03
0.3 %	1.1 ± 0.2	0.5 ± 0.1	0.5 ± 0.1

Our data on the decrease in the resistance of peripheral blood erythrocytes in chronic fatigue syndrome with low tolerance to exercise can be explained by the fact that the products of lipid peroxidation are included in the lipid layer of membranes, increasing the surface area of cytoplasmic membrane in erythrocytes. Therefore, the condition of peripheral blood erythrocytes is a sensitive indicator of changes in the normal course of physiological, biochemical and biophysical processes in the body, which are due to the influence

of external or internal factors, including physical factors, which is exercise. Determination of osmotic resistance of erythrocytes is an important research method for diagnosis in sports medicine, used to study the mechanism of pathological processes and the impact of certain types of exercise [13]. This changes the biochemical parameters of peripheral blood erythrocytes (table 1), which is especially evident when comparing the indicators obtained in patients with low and high levels of tolerance to exercise (table 3).

Table 4

Indicators of phospholipase activity α_2 and the content of lipid peroxidation products in the erythrocytes of peripheral blood of patients of group I depending on the level of tolerance to exercise ($M \pm m$)

Indicators	High level of tolerance to physical activity, control group (n=5)	Patients with chronic fatigue syndrome, n=10	
		Low level of tolerance to physical activity (n=5)	Average level of tolerance to physical activity (n=5)
Phospholipases - α_2 , % hemolysis	4.44 \pm 0.22	21.9 \pm 1.73*/**	15.1 \pm 0.71*
diene conjugates, nmol · ml	47.9 \pm 1.51	155.77 \pm 5.5*/**	121.1 \pm 2.33*
Schiff compounds, conventional units	17.89 \pm 1.03	29.33 \pm 1.11*/**	22.3 \pm 1.71*

Примітка: * – вірогідність статистичної різниці між показниками з високим і низьким рівнем толерантності до фізичного навантаження ($p < 0,05$);

** – вірогідність статистичної різниці між показниками з високим і середнім рівнем толерантності до фізичного навантаження ($p < 0,05$).

Thus, in patients with chronic fatigue syndrome, regardless of the level of tolerance to exercise, there was a multiple increase in the content of lipid peroxidation products (diene conjugates and Schiff compounds) and phospholipase- α_2 activity

relative to the control group ($p < 0.05$) with a high level of tolerance to physical activity, the appearance of erythrocyte sludges in the form of "coin" columns and fibrin threads between individual erythrocytes after exercise (Fig. 2).

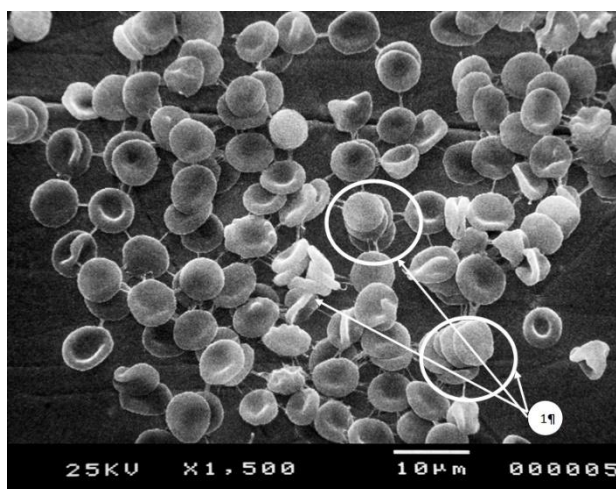


Fig. 2. Formation of local aggregates in the form of "coin columns" (1) and fibrin threads between individual erythrocytes in patients of the 3rd group with chronic fatigue syndrome, after bicycle ergometric testing according to the PWC₁₀₀ protocol



At the same time, as the level of exercise tolerance decreases, the content of lipid peroxidation products (diene conjugates, Schiff compounds) naturally increases ($p < 0.05$) and closely correlates ($r = 0.93$) with an increase in the number of peripheral erythrocytes. blood irreversibly changed shape (Fig. 1, B), which can be a prognostically unfavorable indicator, a reason to see a doctor and a more thorough examination by a specialist.

Discussion

The idea that the level of physical performance is related to the main indicators of health [6, 7, 9], is more confirmed in patients 56-60 years (the correlation coefficient between the level of physical performance and the overall incidence is 0.345; index self-assessment of health $r = -0.399$, heart rate at rest -0.382 , double product 0.371, stress index $r = -0.333$, $p = 0.001$ adaptive potential $+0.319$, % overweight $r = -0.539$, $p = 0.001$). In younger patients 40 to 55 years of age, such a dependence is absent, except for the relationship between the level of physical performance and the degree of risk of cardiovascular disease ($r = -0.356$, $p = 0.006$).

The degree of risk in patients aged 50-65 years is associated with overall morbidity ($r = 0.311$),

health self-esteem index ($r = 0.318$; $p = 0.006$), blood pressure ($r = -0.388$), double product ($r = 0.322$), adaptive potential ($r = -0.462$), the amount of excess body weight ($r = 0.463$, volumetric size of the waist ($r = 0.311$) and pelvis ($r = 0.341$), as well as the level of daily motor activity ($r = -0.486$) ($p < 0.01$). This explains the interdependence of the PWC test with the level of exercise tolerance in people aged 50-65 years with chronic fatigue syndrome, as in most of them in the absence of physical activity, when performing PWC100 loads, active and subjective signs of inadequate response of the body (hypertension, incoordination of the cardio-respiratory system [8], feeling of tension, headache, dizziness, nausea, discomfort, etc.), which is closely correlated ($r = 0.93$; $p = 0.006$) with increasing number of irreversibly altered peripheral erythrocytes blood.

Ignorance of such patterns can lead to incorrect calculation of maximum physical performance, its ergometric and metabolic parameters. This is confirmed by statistical differences in the main indicators of morpho-functional status, physical performance and morbidity in patients of different risk groups for the development of chronic fatigue syndrome and comorbid diseases [14, 15, 16] (Table 4).

Table 5

Indicators of morpho-functional status of patients 50 to 65 years with varying degrees of risk of cardiovascular disease ($M \pm m$, $n = 134$)

Indexes	Degree of risk			P_{1-2}	P_{1-3}	P_{2-3}
	low	average	high			
Body weight, kg	67.2 \pm 2.14	71.4 \pm 3.06	98.3 \pm 3.17	<0.05	<0.05	<0.05
Body fat, %	15.2 \pm 0.28	18.0 \pm 0.93	22.5 \pm 1.11	<0.05	<0.05	<0.05
Kettle Index, conventional units	24.9 \pm 1.23	28.4 \pm 1.46	30.5 \pm 1.61	<0.05	<0.05	<0.05
Heart rate, beats / min	71.6 \pm 3.22	72.1 \pm 3.35	89.1 \pm 5.19	>0.05	>0.05	>0.05
Systolic blood pressure, mm Hg	123.7 \pm 4.53	124.6 \pm 3.72	131.6 \pm 9.22	>0.05	<0.05	<0.05
Diastolic blood pressure, mm Hg	76.2 \pm 3.16	79.1 \pm 3.31	84.7 \pm 3.63	<0.05	<0.05	<0.05
voltage index, conventional units	111.5 \pm 8.17	123.4 \pm 9.02	149.9 \pm 9.85	<0.05	<0.05	<0.05
Adaptive potential of the circulatory system to environmental factors, conventional units	1.5 \pm 0.09	1.6 \pm 0.12	1.7 \pm 0.15	>0.05	<0.05	<0.05
Tolerable level of physical activity, W / kg	1.3 \pm 0.05	1.1 \pm 0.03	0.84 \pm 0.02	<0.05	<0.05	<0.05
Oxygen uptake at a tolerable level of exercise, ml / min / kg ⁻¹	35.1 \pm 2.03	31.4 \pm 1.82	27.7 \pm 1.53	<0.05	<0.05	<0.05
Morbidity: number of days of temporary incapacity for work	7.8 \pm 1.96	9.2 \pm 1.44	12.2 \pm 2.42	>0.05	<0.05	<0.05



Using data on morphological changes of peripheral blood erythrocytes, we propose to create an erythrocyte profile of patients to predict the risk of developing complications associated with chronic fatigue syndrome, in which the main indicators should be the level of exercise tolerance based on erythrocyte deformability index [17–22]. The main risk factors must also be taken into account (Fig. 5).

Prospects for further research

Further research may be aimed at finding ways to improve the system of cardiohemodynamic control of people with chronic fatigue syndrome, and find measures to prevent and reduce the impact of the main factors of CFS in people of all ages.

Limitation

The study was conducted among older teachers, so the data obtained relate only to the studied contingent. Additional research is needed to disseminate the data among people of other ages and social groups, as well as among representatives of other specialties.

Conclusions

1. The study of the quantitative composition of erythrocytes of peripheral blood and hemoglobin, as well as their ratio (color index) in patients with chronic fatigue syndrome on the background of low tolerance to physical fatigue revealed a decrease in erythrocytes and hemoglobin by 42% and 25%, respectively. the presence of anemic hypoxia.

2. In conditions of chronic fatigue there is a decrease in osmotic resistance of erythrocytes, as evidenced by a decrease in the number of osmotically stable erythrocytes with a gradual decrease in the concentration of NaCl solution (3.0%; 0.5%; 0.46%; 0.3%).

3. With chronic fatigue there is a deterioration of membranes in erythrocytes of peripheral blood, as evidenced by a decrease in their osmotic stability and increase in the number of irreversibly altered forms of erythrocytes of peripheral blood, as well as a decrease in erythrocytes of peripheral blood, which is closely correlated with

It should be noted that in different risk groups of chronic fatigue syndrome differ leading factors, as well as major comorbid chronic diseases.

1. In the high-risk group, the main factors are hypokinesia, overweight, hypertension, hereditary factors; along with diseases of the cardiovascular system in this risk group revealed chronic fatigue syndrome associated with chronic diseases of the endocrine, musculoskeletal and respiratory systems, which corresponds to the data of other authors.

2. In the group of medium risk the main factors are: hypokinesia, overweight, nervous and emotional overload; chronic diseases of the cardiovascular, nervous system, musculoskeletal system and senses, combined with a decrease in disc-shaped erythrocytes of peripheral blood by 35%.

3. Patients in the low-risk group have virtually no pathogenetic factors in the development of chronic diseases. Exceptions are only patients with severe hypokinesia and nervous and emotional overload, as well as diseases of the digestive system.

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Conflict of interest

The authors declare that there is no conflict of interest.

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