

- The investigation of the living world using specific methods and means to improve the quality of life and the environment.
- The involvement in activities to maintain their own health and the health of others by applying interactive methods in order to form a healthy behavior.

The participation in the biodiversity protection actions through partnership in order to solve ecological problems at individual, local and global levels.

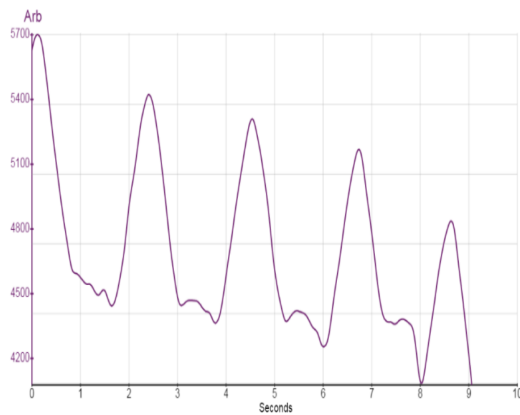


Fig. 9. The graph with the results of measuring the abdominal respiratory rate after physical effort, at the 17-year-old male pupil

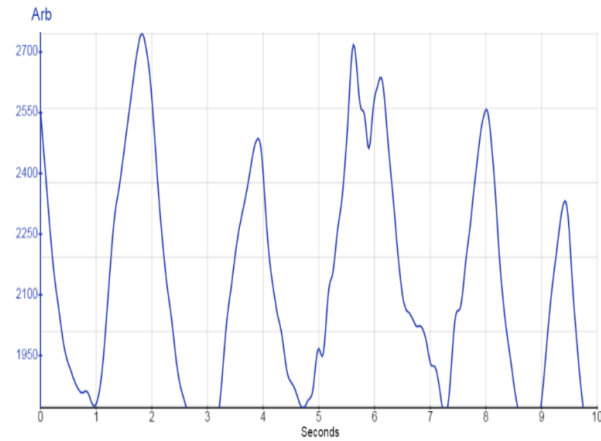


Fig. 10. The graph with the results of measuring the abdominal respiratory rate after physical effort, at the 17-year-old female pupil

Conclusions. Improving the material supplies of high-performance laboratories will ensure the pupils' motivation to investigate as they are required to have digital skills. An ICT teacher plans an investigative activity with specific and appropriate objectives. Using different pedagogical approaches, the same practical activity can be used to achieve special educational goals. The use of ICT tools in the development of the investigative competence becomes effective when: the intended objectives are clear; the task design highlights the main objectives; a strategy is used to stimulate pupils' thinking, so that the practical task answers a question that the pupil is already thinking about, and the degree of autonomy with which pupils communicate and collaborate productively leads to the achievement of the expected goals. Practical activities with the use of digital laboratory sensors offer the possibility to improve the application and investigative component forming the basis of research training [2].

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MORPHOFUNCTIONAL FEATURES OF THE MANIFESTATION OF SEXUAL DIMORPHISM IN HIGHLY QUALIFIED ATHLETES SPECIALIZING IN MODERN PENTATHLON

The purpose of the study is to establish the degree of manifestation of sexual dimorphism in highly qualified athletes specializing in modern pentathlon in terms of morphological and functional indicators. It has been revealed that according to anthropometric indicators, the severity of sexual dimorphism in highly skilled pentathletes is within the limits of light (body length, hip circumference, waist/hip ratio, body mass index) and medium (body weight, waist circumference) degree. In terms of the component composition of the body, a high (musculoskeletal mass, intracellular fluid, total fluid, active cell mass), medium (extracellular fluid, fat mass) and light (share of active cell mass and skeletal muscle mass) degree of sexual dimorphism have been determined. When assessing functional readiness, the most significant sex differences were revealed in terms of the functional capabilities of the respiratory system, light in terms of maximum heart rate, heart rate at the level of anaerobic metabolism threshold, maximum oxygen consumption. The absence of sex differences was established in terms of heart rate at rest. To reduce the severity of sexual dimorphism, attention should be paid to the selection of female athletes. The training process of qualified athletes must be carried out on the basis of a thorough study of the functioning of the body of women in difficult conditions of physical activity. Sexual dimorphism and the associated physiological characteristics of the female body predetermine the need for the specifics of building the training process of highly qualified athletes.

Key words: *highly qualified athletes, modern pentathlon, morphological features, functional indicators, sexual dimorphism.*

Севдалев С.В., Врублевський Є.П., Аленік Є.А. Морфофункціональні особливості прояву статевого диморфізму у висококваліфікованих спортсменів, що спеціалізуються на сучасному п'ятиборстві. Метою дослідження є встановлення ступеня прояву статевого диморфізму у висококваліфікованих спортсменів, що спеціалізуються на сучасному п'ятиборстві з точки зору морфофункціональних показників. Виявлено, що за антропометричними показниками тяжкість статевого диморфізму у висококваліфікованих спортсменів-пятидесятників знаходиться в межах слабкого (довжина тіла, окружність стегна, співвідношення талії/стегна, індекс маси тіла) і середнього (маса тіла, окружність талії). У показниках компонентного складу організму визначається високий (опорно-рухова маса, внутрішньоклітинна рідина, загальна рідина, активна клітинна маса), середня (позаклітинна рідина, жирова маса) і слабкий (частка активної клітинної маси і опорно-рухової маси) ступінь тяжкості статевого диморфізму. При оцінці функціональної придатності були виявлені найбільш значні статеві відмінності в показниках функціональних можливостей дихальної системи, слабких з точки зору максимальної частоти серцевих скорочень, частоти серцевих скорочень на рівні порогу анаеробного обміну, максимального споживання кисню. Відсутність статевих відмінностей встановлюється в показниках частоти серцевих скорочень в стані спокою. Щоб зменшити вираженість статевого диморфізму, слід звернути увагу на відбір спортсменів. Тренувальний процес кваліфікованих спортсменів повинен проводитися на основі ретельного вивчення особливостей функціонування організму жінок в складних умовах фізичних навантажень. Статевий диморфізм і пов'язані з ним фізіологічні особливості жіночого організму зумовлюють необхідність специфіки побудови тренувального процесу висококваліфікованих спортсменів.

Ключові слова: *висококваліфіковані спортсмени, сучасний п'ятиборство, морфологічні особливості, функціональні показники, статевий диморфізм.*

Introduction. In the 21st century, there are practically no "male" sports left. The girls are actively engaged in martial arts, power sports, mastered the original men's track and field athletics. The unbridled desire of women to achieve high sports results in all sports requires complex scientific research, primarily related to the study of the impact on the female body of intense training and competitive loads inherent in modern sports activities.

Currently in the system of sports training in addition to general provisions for men and women, there are two dominant approaches regarding the peculiarities of women's training. In one case, the authors emphasize the existence of features that are characteristic only of women's sports. In their opinion, first of all, the features and specific requirements characteristic of individual sports entail differences in the course of adaptive processes in the female body, and when organizing training effects, the cyclicity of the female body must be taken into account [1, 5, 10, 11].

On the other hand, the group of authors is convinced that in most sports women are represented mainly by an androgenic hormonal profile, and when planning the training process, one should adhere to generally accepted approaches used in men's sports (except a slight decrease in the amount of load), linking this to the fact that an increased level of natural androgens (congenital hyperandrogenism), often supplemented with illegal drugs, allows female athletes to be competitive [8].

It is noted that one of the main shortcomings of a number of modern studies in the field of sports theory is the lack of consideration of the characteristics of sexual dimorphism, only this approach will reveal the objective causes of the problems of women's sports [9].

Works on the problem of sexual dimorphism make it possible to reveal a clear pattern of convergence of sports results in highly qualified athletes of both sexes who specialize in one sport. As their physiological and morphological and functional indicators converge, the possibility of achieving a high sports result is predetermined [10].

Basically, studies of the features of the manifestation of sexual dimorphism in athletes are devoted to power sports, martial arts, less often sports games, acrobatics, and gymnastics. Scientific works concerning multiathlon sports are extremely rare. Sports all-around events are characterized by high specificity of requirements to the morphological and functional systems of the body, which provide the possibility of achieving a high result. At the same time, mutual parallels were established between the morphological data and the performance of female athletes [2, 4, 7].

Modern pentathlon is one of the applied types of multiathlon sports, which includes fencing as a masculine sport, swimming as a neutral sport, a combined sport (including running and shooting), and equestrian sports. Thus, scientific studies devoted to determining the features of the manifestation of sexual dimorphism in qualified athletes involved in modern pentathlon in the available literature are not enough. For this reason, this study was undertaken.

Purpose of the study: to establish the degree of manifestation of sexual dimorphism in highly qualified athletes specializing in modern pentathlon in terms of morphological and functional indicators.

Organization and research methods. The study involved 18 highly qualified athletes (masters of sports and masters of sports of international class) involved in modern pentathlon.

To solve the tasks set, somatometry methods generally accepted in sports morphology were used. In addition, the method of bioimpedance analysis of body composition was used using the measuring device ABC-1 "Medass". Evaluation of functional indicators was carried out in the conditions of performing a competitive exercise (combined relay race) using a portable ergospirometer "Cortex MetaMax 3B". We recorded the following indicators: vital lung capacity (VC), heart rate at rest (HR, beats/min), heart rate at the level of anaerobic metabolism threshold (HR (AT), beats/min), maximum oxygen consumption (VO₂ max, ml / kg / min), as well as the maximum heart rate (HR max, beats / min). Also, lactate concentration was determined (La max, mmol/l).

The severity of sexual dimorphism was determined according to five categories. The absence of sex differences was established when the compared values converged ± 1%; light expressiveness – at their divergence in the range of ± 10%; medium - with a discrepancy of at least ± 10% and not more than ± 30%; high - respectively, within ± 50%; very high - with a discrepancy of values more than ± 50%.

To quantify the severity of sexual dimorphism, in addition to the generally accepted statistical indicators (X; S; V%), the Mollison test (kM) was used [11].

$$kM = \frac{\bar{x}_w - \bar{x}_m}{S_m}$$

Where \bar{x}_w – is the arithmetic mean of this trait in women; \bar{x}_m – the arithmetic mean of this trait in men; S_m – is the quadratic deviation of this trait in men. The higher the numerical values of the criterion, the greater the degree of sexual dimorphism.

Research results. Comparison data of morphological parameters of athletes specializing in modern pentathlon (men and women) are presented in

Table 1

Morphological indicators of highly qualified athletes specializing in modern pentathlon (n = 18)

Indicators	Men			Women			%	kM
	\bar{X}	S	V%	\bar{X}	S	V%		
Body length, cm	182,8	6,14	3,35	167,25	8,34	4,98	9,29	6,52
Body weight, kg	73,04	7,24	9,91	59,6	8,27	13,87	22,55	5,40
Body mass index, units	21,86	1,55	7,09	21,25	1,23	5,78	2,87	1,41
Waist circumference, cm	76,4	3,97	5,19	67,25	3,40	5,05	13,61	7,95
Hip circumference, cm	95,4	4,21	4,41	92,5	5,25	5,67	3,13	1,89
Waist/Hip Ratio	0,79	0,86	5,12	0,72	0,02	3,95	9,72	0,41

According to anthropometric (morphological) indicators, the severity of sexual dimorphism in highly qualified athletes is within the limits of a light and medium degree. In body length (9.29%), hip circumference (3.13%), waist/thigh ratio (9.72%), body mass index (2.87%), a light degree of sexual

dimorphism was found. Body mass index (22.55%), waist circumference (13.61%) have a medium degree of sexual dimorphism.

Studies of the component composition of the body (Table 2) revealed a high degree of sexual dimorphism in terms of: skeletal muscle mass (44.22%), intracellular fluid (39.49%), total fluid (32.90%), active cell mass (38.07%).

Table 2

Indicators of the body composition of highly qualified athletes specializing in modern pentathlon (n = 12)

Indicators	Men			Women			%	kM
	X	S	V%	X	S	V%		
Share of active cell mass, %	62,24	2,62	4,20	60,1	1,23	2,04	3,56	1,91
Skeletal muscle mass, kg	34,54	2,32	6,71	23,95	2,93	12,23	44,22	2,44
Share of skeletal muscle mass, %	55,76	1,48	2,65	51,3	1,26	2,45	8,69	10,43
Fat mass, %	14,96	1,85	12,36	21,15	4,33	20,47	-29,26	-5,51
Intracellular fluid, kg	27,62	2,58	9,36	19,8	1,73	8,76	39,49	11,71
Extracellular fluid, kg	17,76	1,29	7,26	14,35	1,78	12,42	23,76	6,73
Total fluid, kg	45,4	3,84	8,46	34,17	3,46	10,12	32,90	9,82
Active cell mass, kg	38,66	4,12	10,65	28,0	2,63	9,39	38,07	10,19

The medium degree was revealed in the following indicators – extracellular fluid (23.76%), fat mass (29.26%). Low – the proportion of active cell mass (3.56), the proportion of skeletal muscle mass (8.69%).

Analyzing the variability (V%) of the studied indicators, it is possible to identify indicators – fat mass (20.47% for women and 12.36% for men), body weight (13.87% for women and 9.91% for men), active cell mass (9.39% in women and 10.65% in men) having the highest significant coefficient of variation. The smallest coefficient of variation was found in such indicators as body mass index, body length and percentage of skeletal muscle mass. In general, the variability of the studied indicators is higher in female pentathletes.

Studies of functional indicators (Table 3) revealed a high degree of sexual dimorphism in terms of the functional capabilities of the respiratory system (vital capacity of the lungs – 43.29%).

Table 3

Functional indicators of highly qualified athletes specializing in modern pentathlon (n = 12)

Indicators	Men			Women			%	kM
	X	S	V%	X	S	V%		
VC, ml	5885	304,3	5,17	4107	245,66	5,98	43,29	5,84
HR, beats/min	57,57	3,02	5,25	57,71	3,61	6,26	0,24	0,04
HR max, beats/min	195,86	5,54	2,83	191,4	8,55	4,47	2,33	0,80
HR (AT)	175,57	9,75	5,55	180,0	5,25	2,92	2,52	0,45
VO2 max, ml/kg/min	59.33	2,56	4,31	55,25	5,27	9,54	7,38	1,59

A light degree was revealed in the following indicators – the maximum heart rate (2.33%), the heart rate at the level of the anaerobic metabolism threshold (2.92%), the maximum oxygen consumption (7.38%). The absence of sex differences was established in terms of heart rate at rest (0.24).

The highest variability (V%) of the studied indicators was found in pentathletes in terms of maximum oxygen consumption (9.54). In other indicators of functional readiness, the coefficient of variation is not significant. The highest severity of the degree of sexual dimorphism according to the Mollison criterion (kM) was determined in the following morphological and functional indicators: intracellular fluid – 11.71; proportion of skeletal muscle mass – 10.43; active cell mass – 10.19.

Conclusion. It has been determined that according to anthropometric indicators, the severity of sexual dimorphism in highly qualified athletes specializing in modern pentathlon is within the limits of light (body length, hip circumference, waist/hip ratio, body mass index) and medium (body weight, waist circumference) severity of sexual dimorphism.

In terms of the component composition of the body, a high (musculoskeletal mass, intracellular fluid, total fluid, active cell mass), medium (extracellular fluid, fat mass) and light (share of active cell mass, share of skeletal muscle mass) degree of sexual dimorphism were determined. In almost all studied indicators, men are ahead of women, with the exception of the indicator of fat mass.

The study of functional indicators revealed a high degree of sexual dimorphism in terms of the

functional capabilities of the respiratory system, light in terms of maximum heart rate, heart rate at the level of anaerobic metabolism threshold, maximum oxygen consumption. The absence of sex differences was established in terms of heart rate at rest.

Light and medium severity of sexual dimorphism according to the studied parameters can be explained by adaptation to specific training and competitive influences. This fact is also confirmed by the evaluation of the results of the severity of the degree of sexual dimorphism according to the Mollison criterion (kM).

To reduce the severity of sexual dimorphism, attention should be paid to the selection of female athletes. At present, as a rule, athletes who have gone in for swimming in the past and have not shown high results in this type of sport come to the modern pentathlon. When selecting for the modern pentathlon, attention should be paid to athletes who are the most adapted in terms of total body size, motor potential and functional abilities for speed-strength loads and the manifestation of special endurance.

At the same time, according to the authors [3, 6], in connection with the next changes in the rules of competitions in the modern pentathlon in the preparation of athletes, special attention should be paid to fencing and increasing the effectiveness of running training. It becomes obvious that the training process of qualified athletes must be carried out on the basis of a thorough study of the functioning of the body of women in difficult conditions of physical activity. Sexual dimorphism and the associated physiological characteristics of the female body predetermine the need for the specifics of building the training process of highly qualified female athletes.

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BIEGI DŁUGODYSTANSOWE JAKO FORMA AKTYWNEGO SPĘDZANIA CZASU WOLNEGO

Zhuravski A. Long-distance runs as a form of active spending of free time. Purpose of research. Research on how long-distance running affects the functioning of the body and determining the factors that hinder and facilitate long-distance running. *Subject of study.* Opinion on long-distance running among the respondents. **Research questions:** 1. What are the main reasons why people start running? 2. What is the awareness of the role of physical activity among the respondents? 3. What is the attitude towards long-distance running among the respondents? 4. What are the benefits for the functioning of the body from long-distance running? 5. Does running as a form of athletics occupy an important place among the respondents? 6. How do the respondents spend their free time? **Methods, techniques, research tools. The method of diagnostic survey was used in the work.** The research used the questionnaire technique consisting in "filling, most often, independently by the respondent, of special questionnaires, usually with a high degree of standardization, in the presence or more often without the presence of an interviewer". A research tool in a general sense is "the object by which information is collected". The research tool used was a questionnaire. **Organization and course of research.** The research was conducted at the turn of February and March 2021. The subjects of the study were people who participate in long-distance runs. The selection for the study was deliberate. The research was carried out with the help of the survey method, with the use of a tool, in this case, a questionnaire. Each questionnaire was completed correctly and all copies were returned to the researcher. All respondents were informed of complete anonymity and the purpose of the study was presented to them. The survey was sent by e-mail or via a social networking site. None of the respondents refused to participate in the study. The study was not limited to one voivodeship, but covered the entire territory of Poland. 40 people participated in the study, 16 of whom are women and 24 are men.

Key words: long-distance running, outdoor activities, free time

Журавський О. Біг на довгі дистанції як форма активного проведення вільного часу. Мета дослідження. Дослідження того, як біг на довгі дистанції впливає на функціонування організму та визначення факторів, які перешкоджають та полегшують біг на довгі дистанції. **Предмет вивчення.** Думка респондентів щодо бігу на довгі дистанції. **Дослідницькі питання:** 1. Які основні причини, чому люди починають бігати? 2. Яке усвідомлення ролі фізичної активності серед респондентів? 3. Яке ставлення до бігу на довгі дистанції серед респондентів? 4. Чим корисний біг на довгі дистанції для функціонування організму? 5. Чи посідає важливе місце серед респондентів біг як вид легкої атлетики? 6. Як проводять вільний час респонденти? **Методи, прийоми, засоби дослідження.** У роботі використано метод діагностичного опитування. У дослідженні використовувалася методика анкетування, яка полягала в тому, що «респондент найчастіше заповнював спеціальні анкети, як правило, з високим ступенем стандартизації, у присутності або частіше без присутності інтерв'юера» Засобом дослідження в загальному розумінні є «об'єкт, за допомогою якого збирається інформація». Інструментом дослідження, використаним у