THE CORRELATION BETWEEN BODY COMPOSITION AND AEROBIC ENDURANCE AS A PREDICTOR OF SPORTS PERFORMANCE IN 16–18-YEAR-OLD SWIMMERS

КОРЕЛЯЦІЯ МІЖ СКЛАДОМ ТІЛА ТА АЕРОБНОЮ ВИТРИВАЛІСТЮ ЯК ПРЕДИКТОР СПОРТИВНИХ РЕЗУЛЬТАТІВ У 16–18-РІЧНИХ ПЛАВЦІВ

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Abstracts

In the presented article, the components of body composition and working capacity factors were analyzed. The obtained data were correlated with the volume of training and athletic performance. The research was conducted on eight swimmers from the MUKS Astoria club in Bydgoszcz. In relation to the discussed issues, four hypotheses were put forward. The first two suggest that due to the applied training volume, differences in the components of body composition and aerobic capacity will be noticeable. The next hypothesis concerns the influence of the components of body composition on performance. The fourth includes the statement that the applied training volume, performance, and the components of body composition will affect the athletic outcome.

The research showed minor changes in the components of body composition due to the training volume used. The performance was improved, both of the oxygen threshold, power, and AT threshold. Performance did not correlate with the training volume. It is possible to assume that the decisive factor in improving performance is the qualitative component of training loads, i.e., intensity. A statistically significant correlation between performance and the components of body composition was noted. Swimmers with less fat (FAT) and more water and muscle mass (SMM) had better performance. In the group under research, the FAT and SMM values were in line with the reference values.

Correlating performance and the components of body composition with athletic results, depending on the distance and swimming style, a statistically significant correlation was observed. In the backstroke style, it was shown that Vo2 max and power do not play such a crucial role since it is a technical style. Moreover, backstroke athletes characterized by lower SMM, water content and higher FAT achieved better sports results. In the classical style, swimmers with a higher oxygen threshold and maximum power, as well as higher water and SMM content and less FAT, achieved better athletic performance. In butterfly, great power indicated a better athletic result. Both styles require high physical fitness and significant energy expenditure. For the 100-meter distance, a higher FAT content allowed swimmers to float higher in the water and achieve a better athletic outcome. A similar correlation was found when analyzing the 50-meter distance, confirming that for sprinters, higher FAT and lower SMM contribute to improved sports performance.

Key words: composition, performance, swimmers, correlation, distance, results.

У представленій статті проаналізовано складники будови тіла та фактори працездатності. Отримані дані корелювали з обсягом тренувань і спортивними результатами. Дослідження проводилося на восьми плавцях клубу MUKS Astoria в Бидгощі. Стосовно обговорюваних питань було висунуто чотири гіпотези. Перші дві припускають, що завдяки застосованому тренувальному обсягу будуть помітні відмінності в компонентах будови тіла та аеробних можливостях. Наступна гіпотеза стосується впливу компонентів будови тіла на працездатність. Четверта включає твердження про те, що застосовуваний обсяг тренування, продуктивність і компоненти будови тіла впливатимуть на спортивний результат.

Дослідження показало незначні зміни в компонентах будови тіла через використовуваний обсяг тренувань. Покращено продуктивність кисневого порогу, потужності та порогу АТ. Результативність не корелювала з обсягом тренувань. Можна вважати, що вирішальним чинником підвищення працездатності є якісний складник тренувальних навантажень, тобто інтенсивність. Була відзначена статистично значуща кореляція між продуктивністю та компонентами складу тіла. Плавці з меншою кількістю жиру (FAT) і більшою кількістю води та м'язової маси (SMM) мали кращі результати. У досліджуваній групі показники FAT і SMM відповідали референтним значенням.

Співвідносячи працездатність і компоненти будови тіла зі спортивними результатами, залежно від дистанції та стилю плавання, спостерігався статистично значущий кореляційний зв'язок. У стилі плавання на спині було показано, що Vo2 max і сила не відіграють такої вирішальної ролі, оскільки це технічний стиль. Більше того, спортсмени, які плавали на спині, характеризуються нижчими SMM, вмістом води та вищим FAT, досягли кращих спортивних результатів. У класичному стилі плавці з вищим кисневим порогом і максимальною потужністю, а також вищим вмістом води і SMM і меншим FAT досягли кращих спортивних результатів. У батерфляї велика сила вказувала на кращий спортивний результат. Обидва стилі вимагають високої фізичної підготовки та значних енергетичних витрат. На 100-метровій дистанції вищий вміст FAT дозволяв плавцям плавати вище у воді та досягати кращих спортивних результатів. Подібна кореляція була виявлена під час аналізу 50-метрової дистанції, підтверджуючи, що для спринтерів вищий FAT і нижчий SMM сприяють покращенню спортивних результатів.

Ключові слова: склад, виступ, плавці, співвідношення, дистанція, результати.

Introduction. Constant shifting of record boundaries, as well as intensified athletic competition, require ongoing scientific research and refinement of the training process [16; 20].

Nowadays, due to technological advancements and the continuous growth of knowledge in various sports fields [1; 8; 22], it is possible to consciously guide an athlete [3; 10; 13] to reach their maximum potential [20; 27]. This constitutes the essence and primary goal of their sports career [2; 7].

In the presented research, components of body composition and aerobic endurance of swimmers were analyzed under the influence of the applied training volume [4; 8], as well as their correlation with sports results [3; 17; 28].

The research was carried out on a group of eight swimmers from the MUKS Astoria Bydgoszcz club.

Research Object. The research object of this study is the analysis of the components of body composition and aerobic endurance, as well as their influence on the athletic results of swimmers aged 16–18 from the MUKS Astoria Bydgoszcz club [5; 11]. The research project's issues arise from the interest in the physiology of athletes and the body's properties that influence sports results, which is the culmination of the athletes' diligent work [18; 25]. The particular interest lies in endurance research and analysis of the components of body composition, which were used in the work [14; 19; 24]. The chosen topic is important due to the increasing athletic level [10; 20; 21]. Therefore, there is a need to expand knowledge in the field of human physiology. By studying the human body and simultaneously analyzing sports results, many conclusions can be drawn about the future direction of the training process [6; 12; 15].

Research Methodology. Information aimed at deepening knowledge related to the analysis of the components of body composition and swimmers' endurance, as well as the dependence of these properties on athletic performance, was presented in the form of an analysis of the research results [23; 26].

Before the start of the research, a conversation was held with the coach regarding the course and timing of the planned studies. After obtaining the coach's consent, swimmers were invited to participate in the research, and they were informed that all collected data would be used exclusively for research purposes. The study involved 8 swimmer athletes from the MUKS Astoria sports club in Bydgoszcz. Both the female and male groups consisted of four individuals each. Trainings took place from Monday to Friday twice a day and on Saturdays in the morning.

The group included athletes who were trained by three different coaches, designated by the letters: A, B, C. The characteristics of the swimmers are presented in the table 1.

The group consisted of athletes aged between 16 and 19. The youngest among the athletes was a 16-year-old boy. The oldest athlete was a 20-year-old girl. Starting the study, the girls' weight ranged from 62.1 to 67.7 kg, while the boys weighed between 70.5 and 77.5 kg. The swimmer with the lowest weight weighed 62.1 kg, while the heaviest swimmer weighed 77.5 kg. The average height of the female athletes was 169 cm, and for the male athletes, it was 186 cm. The two tallest female athletes were 170 cm tall, while the shortest was 167 cm. In the group of boys, two were the tallest – 189 cm, whereas the shortest was 180 cm. The training experience of 7 athletes ranged from 9 to 13 years. One of the swimmers has been training for only one year and a half. The swimmers specialize in various swimming styles and at different distances.

Research Procedure. The scope of the research included analysis of the components of body composition, aerobic endurance, and performance times in various swimming styles over different distances [3; 9].

Attendance at training sessions and the number of kilometers of swum were also taken into account. The components of body composition were measured by means of bioelectrical impedance with the Biospace in Body 720 – Body Composition Analyzer. The Bioelectrical Impedance Analysis (BIA) measures fat tissue based on body density. To assess aerobic endurance (Vo2 max), the Meta Max 3B respiratory gas analyzer from Cortex was used. The test was conducted on a cycle ergometer and measured how much oxygen the body consumes during increasing-intensity exercise. For this purpose, measurements were made with an open gas cycle since the subjects breathed atmospheric air. The test began by recording data at rest for 2 minutes, after which the participant did a warm-up with an initial load for 5 minutes. Then the intensity increased every minute, adding a load of 0.5 kg each time. The test ended at the moment of refusal when the athlete could not continue performing the task.

Research. The research began on September 22, 2022, and continued until November 16, 2022. Athletes underwent two identical tests on the first and last days. Between the tests, they trained according to their training plan. Both the training sessions and the research were conducted at the Astoria swimming pool in Bydgoszcz.

Research Results. The second research demonstrated a 1% decrease in the average content of intracellular water (Table 2).

In Research II, in the area of average extracellular water content, there was a 1% decrease (Table 3).

In the second research, an increase of 6% in the average adipose tissue mass was calculated (Table 4).

In the second research, there was a 1% decrease in the area of average skeletal muscle mass (Table 5).

Significant statistical changes in the value of Vo2max [ml/kg/min] have been observed between the conducted investigations. The graph indicates an increase in the level of oxygen con-

Table 1

General characteristics of the research group

№	Participants (initials)	Gender	Age [years]	Body Height [cm]	Body Weight [kg]	Training Tenure [years]	Coach
1	J.Ch.	K	18	170	65.5	13	A
2	K.K.	M	18	180	74.9	12	A
3	D.K.	M	17	189	77.5	9	A
4	N.G.	K	18	169	65	10	A
5	B.Ch.	M	16	189	70.5	9	A
6	M.S.	K	17	170	62.1	11	B
7	T.M.	M	17	187	75.3	1,5	B
8	K.L.	K	20	167	67.7	13	C

Table 2

Changes in intracellular water content (ICW)

Research period	Descriptive statistics			
	Average	Min	Max	SD
Research I	27.1	22.4	33.9	4.3
Research II	26.9	22.0	31.7	4.0

N=8, no statistically significant differences

Table 3

Changes in the content of extracellular water (ECW)

Research period	Descriptive statistics			
	Average	Min	Max	SD
Research I	16.3	13.3	21.0	2.8
Research II	16.2	13.4	19.6	2.5

N=8, no statistically significant differences

Table 4

Changes in the content of adipose tissue mass

Research period	Descriptive statistics			
	Average	Min	Max	SD
Research I	10.7	3.1	16.0	4.9
Research II	11.3	6.0	16.3	3.8

N=8, no statistically significant differences

Table 5

Changes in the content of skeletal muscle mass (SMM)

Research period	Descriptive statistics			
	Average	Min	Max	SD
Research I	33.4	27.2	42.3	5.6
Research II	33.1	26.7	39.3	5.2

N=8, no statistically significant differences

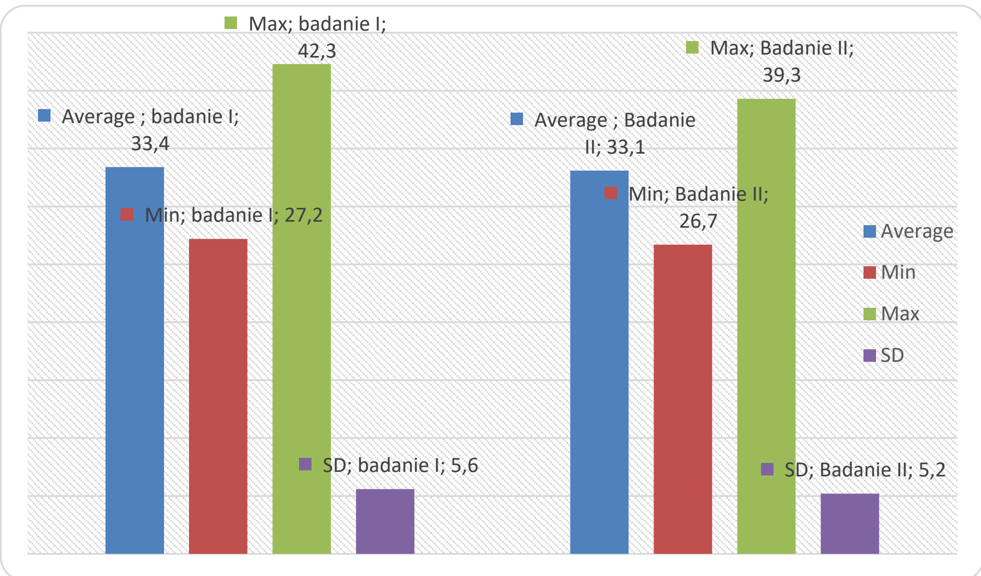

Fig. 1. Changes in the content of muscle tissue mass

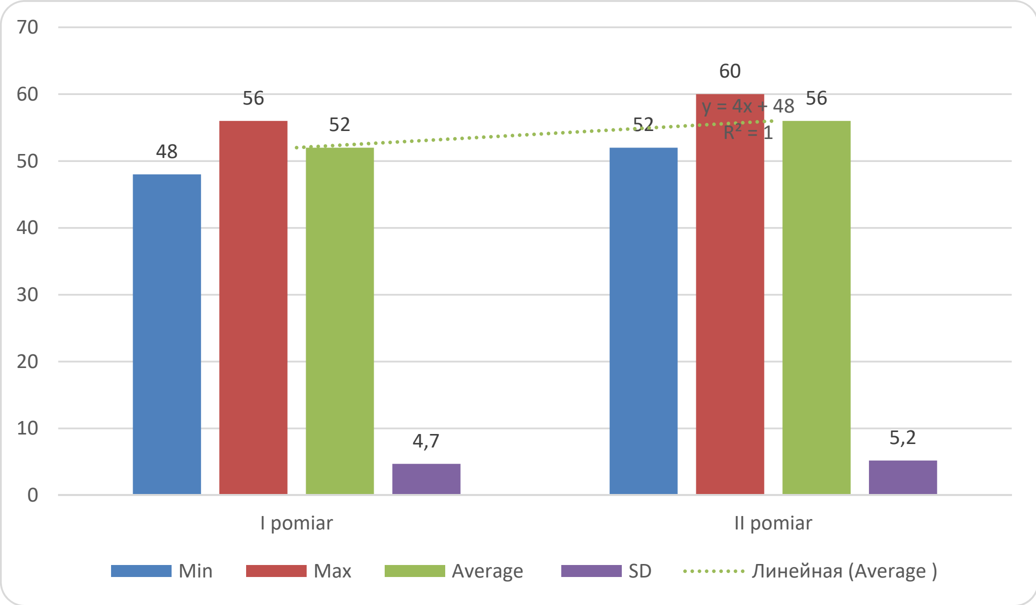

Figure 2. Changes in Vo2max [ml/kg/min]

(* statistically significant differences)

sumption. In both the female and male groups, a statistically significant increase in the value of Vo2max [ml/kg/min] was observed. The increase was independent of gender.

Correlation of body composition components with performance. In both researches, the intracellular and extracellular water content significantly correlates with physical endurance. Adequate hydration is associated with physical endurance. The first research showed a statistically significant relationship between body composition and sports performance in a 100-meter distance. The more fatty-tissue athletes had and the lower the water content in the body and muscle mass was, the better sports performance they achieved in competitions. The second research had a reverse correlation for the 50-meter distance. The less water content and muscle mass athletes had, the better sports performance they achieved. For the remaining distances, the results were not statistically significant.

Conclusions. Analyzing the results regarding the influence of the volume of training on changes in swimmers' aerobic endurance, it is possible to note an improvement in endurance, including

Table 6

Correlation of water content with performance – Research I

Variables	Correlation p< 0,5			
	1 AT power [w]	1 VO2 max	1 power max	Power w/kg
ICW I	0.54*	0.91*	0.94*	0.72*
ECW I	0.51*	0.94*	0.93*	0.72*

N=8, * statistically significant differences

Table 7

Correlation of water content with performance – Research 2

Variables	Correlation p <0,5			
	2 AT power [w]	2 VO2 max	2 power max	II power w/kg
ICW II	0.56*	0.79*	0.84*	0.42
ECW II	0.56*	0.82*	0.88*	0.49

N=8, * statistically significant differences aerobic capacity, strength, and anaerobic threshold. The increase was independent of gender and statistically significant. Thus, endurance has improved. Furthermore, the increase in strength may indicate an enhancement in muscular strength and could impact swimming speed. Nevertheless, available literature clarifies that achieving high sports performance in swimming is closely related to the proportions of exercises in different intensity ranges. Appropriately selected training loads, encompassing both volume and intensity, significantly affect sports performance.

When analyzing the relationship between the components of body composition and sports performance in the conducted research, statistically significant correlations were not observed. However, statistically significant correlations were revealed when sports results were divided into subgroups based on distance and style. Valuable insights could be obtained from studies conducted during various phases of the training macrocycle. A detailed analysis of the tested properties during specific periods made it possible to accurately determine how training influenced the athlete and how to direct the training process to achieve the athlete's maximum potential during key sporting events.

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