THE RELATIONSHIP BETWEEN PHYSICAL DEVELOPMENT INDICATORS AND THE POWER OF ANAEROBIC ENERGY SUPPLY PROCESSES IN WOMEN OF DIFFERENT SOMATOTYPES

ЗВ'ЯЗОК ПОКАЗНИКІВ ФІЗИЧНОГО РОЗВИТКУ ІЗ ПОТУЖНІСТЮ АНАЕРОБНИХ ПРОЦЕСІВ ЕНЕРГОЗАБЕЗПЕЧЕННЯ У ЖІНОК РІЗНИХ СОМАТОТИПІВ

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Abstracts

Anaerobic energy supply plays a key role during physical efforts of maximal and submaximal intensity. Therefore, studying the factors that influence the ability to perform physical activity through anaerobic metabolism is relevant. It has been proven that individuals of different morphological types differ in both aerobic and anaerobic performance of the body, as well as in the manifestation of physical qualities. Active research is being conducted to identify relationships between physical development indicators and functional fitness parameters in athletes. We did not find data in the literature regarding the correlations between physical development indicators and anaerobic performance indicators in women aged 25–35 with different somatotypes. **The aim of this study is** to establish the specifics influence of body weight, height, fat and muscle components on anaerobic performance in women aged 25–35 with different somatotypes. The power of anaerobic alactic energy supply processes was determined using the 10-second Wingate test. The power of anaerobic lactic energy supply processes was determined by using the 30-second Wingate test. It was established that the degree of correlation between indicators of physical development and indicators of anaerobic performance of the body in representatives of different somatotypes differs significantly. A high degree of correlation was found between the absolute values of WAnT 10, WAnT 30, and body mass, height, and BMI in women with ectomorphic and balanced somatotypes. For relative values, a high correlation was found only in women with a balanced somatotype – between WAnT 30 and body mass. **Conclusions.** Anaerobic performance indicators in women with endomorphic and endo-mesomorphic somatotypes show significantly weaker correlations with physical development indicators compared to women with ectomorphic and balanced somatotypes. Body mass, height, and BMI may serve as predictors of high anaerobic performance in women with balanced and ectomorphic somatotypes. The percentages of body fat and muscle do not have a significant impact on the anaerobic capacity of women across all somatotypes.

Key words: anaerobic performance, fat, muscle, early adulthood, women.

Під час виконання роботи максимальної та субмаксимальної інтенсивності анаеробне енергозабезпечення відіграє провідну роль. Тому дослідження факторів, які мають вплив на здатність виконувати фізичні навантаження за рахунок анаеробного режиму енергозабезпечення, є актуальним. Доведено, що особи різних морфологічних типів відрізняються як за показниками аеробної, так і анаеробної продуктивності організму та мають відмінності у прояві фізичних якостей. Активно ведуться пошуки зв'язків між показниками фізичного розвитку та показниками функціональної підготовленості у спортсменів. У осіб, які не займаються спортом, такі зв'язки досліджено фрагментарно. Даних про особливості кореляції показників фізичного розвитку із показниками анаеробної продуктивності організму у жінок 25–35 років різних соматотипів у літературі ми не виявили. **Мета цієї роботи** – встановити особливості впливу маси тіла, зросту, жирового та м'язового компонентів

на анаеробну продуктивність у жінок віком 25–35 років різних соматотипів. Соматотип досліджуваних визначали за методом Хіт-Картера. Потужність анаеробних алактатних процесів енергозабезпечення визначали за 10-секундним Вінгатським тестом. Потужність анаеробних лактатних процесів енергозабезпечення визначали за 30-секундним Вінгатським тестом. Встановлено, що ступінь кореляції між показниками фізичного розвитку та показниками анаеробної продуктивності організму у представниць різних соматотипів істотно відрізняється. Високий ступінь кореляції виявлено між абсолютними показниками VAnT 10, VAnT 30 і масою тіла, зростом, BMI у жінок ектоморфного і збалансованого соматотипу. За відносними показниками кореляцію високого ступеня виявлено лише у жінок збалансованого соматотипу між VAnT 30 і масою тіла. **Висновки.** Показники функціональної підготовленості представниць ендоморфного та ендоморфно-мезоморфного соматотипів значно менше корелюють із показниками фізичного розвитку, порівняно із представницями ектоморфного та збалансованого соматотипів. Маса тіла, зріст та індекс маси тіла можуть бути предиктором високого рівня анаеробної продуктивності у жінок збалансованого та ектоморфного соматотипів. Відсотковий вміст жиру і м'язів в організмі не має вагомого впливу на анаеробні можливості організму жінок усіх соматотипів.

Ключові слова: анаеробна продуктивність, жир, м'язи, перший зрілий вік, жінки.

Introduction. A person's functional fitness is determined by their energy potential, namely, the degree of development of the aerobic and anaerobic energy supply systems of muscular activity. The anaerobic portion of a person's total energy potential is significantly smaller than the aerobic portion. However, during maximal and submaximal intensity exercise, anaerobic energy supply plays a leading role [9]. Therefore, research into factors that influence the ability to perform physical activity through the anaerobic energy supply mode is relevant.

It has been proven that individuals of different morphological types differ in both aerobic and anaerobic performance of the organism [6]. In addition, there is evidence that representatives of different morphological types have different adaptive changes to physical exertions [9]. Therefore, the problem of taking into account morphological features in sports has been studied quite thoroughly.

Regarding the study of anaerobic performance in individuals of different morphological types who do not engage in sports, this problem has been studied fragmentarily, only with certain categories of individuals. Thus, R. Dotan et al. [з], using correlation analysis, established that higher body mass values in children aged 10–12 years determine a higher level of anaerobic lactic performance power according to the 30-second Wingate test.

There is ongoing research into the relationship between physical development indicators (fat and muscle body composition, body mass, height, BMI) and functional fitness indicators in athletes. It has been proven that higher body fat percentage in female handball players negatively affects both peak and mean power in the VAnT 30 test [8]. It has been found that female swimmers who have higher lean mass achieve better results on the VAnT 30 test [15]. These findings can be interpreted as a positive influence of the muscle component and a negative influence of the fat component on anaerobic lactic performance.

The correlation between physical development indicators and anaerobic capabilities in individuals who do not engage in sports has been studied fragmentarily. There is evidence that the fat component has a smaller negative impact on the anaerobic capacity of women, and a greater impact on men [4]. Other researchers have not found a relationship between relative muscle fiber area and anaerobic lactic performance as determined by the VAnT 30 test in non-athletic women [5]. In previous publications, we investigated the correlation between indicators of physical development and anaerobic performance in early adulthood women, without taking into account somatotype [12]. We did not find any results of a study of the correlation between indicators of physical development and indicators of anaerobic productivity in early adulthood women of different somatotypes in the literature available to us. Therefore, this problem has not been investigated.

The aim of this study is to establish the specifics influence of body weight, height, fat and

muscle components on anaerobic performance in women aged 25–35 with different somatotypes.

Materials and methods of research.

A total of 392 early adulthood women (25–35 years old) were studied. In the process of recruiting the contingent of subjects, the exclusion criteria were: experience in sports or systematic training in recreational types of physical activity; the presence of medical restrictions on physical activity. All participants were informed about the study procedure and provided written consent to participate.

The somatotype of the subjects was determined using the Heath-Carter method [2]. According to this method, the components of the somatotype were expressed in points: endomorphy – relative obesity; mesomorphy – relative development of the musculoskeletal system; ectomorphy – relative body elongation. Belonging to a somatotype was determined by the predominance of one (or several) components. All subjects were conditionally divided into groups based on their somatotype.

The body composition was determined by the bioelectrical impedance method using a device OMRON BF-511 (OMRON, Japan). The device's indicators determined fat content (%), muscle content (%), visceral fat content (scores), body mass, and body mass index (BMI).

The power of anaerobic alactic processes of energy supply of muscular activity was determined by 10-second Wingate anaerobic test (WAnT 10). The power of anaerobic lactic processes of energy supply of muscular activity was determined by 30-seconds Wingate anaerobic test (WAnT 30) [3]. Absolute and relative indicators were calculated for each test.

Statistical processing was carried out using the licensed program Statistica 13. Initially, the data sets were checked for normality using the Shapiro-Wilk and Kolmogorov-Smirnov tests. If at least one of the two data sets did not follow a normal distribution, the correlation analysis was performed using Spearman's rank correlation coefficient ($r_{x\gamma}$). The relationship was considered statistically significant at $p < 0.05$. The strength of the correlation was evaluated according to Chaddock's scale: very high – $0,9 \leq r_{x\gamma} \leq 0,99$; high – $0,7 \leq r_{x\gamma} < 0,9$; noticeable – $0,5 \leq r_{x\gamma} < 0,7$; moderate – $0,3 \leq r_{x\gamma} < 0,5$; weak – $0,1 \leq r_{x\gamma} < 0,3$.

Research results. After conducting a correlation analysis in groups of women categorized by somatotype, we found that the degree of correlation between indicators of physical development and anaerobic performance significantly differed across somatotypes.

The data in Table 1 show that representatives of the ectomorphic somatotype have the highest degree of correlation between the absolute value of WAnT 10 and body mass, height, BMI. Such a correlation is characterized as positive of high degree. The absolute WAnT 30 value also showed a high degree of positive correlation with body mass. It should be noted that the correlation between anaerobic performance indicators and both body fat percentage and visceral fat content was not statistically significant ($p > 0.05$). Thus, in women with the ectomorphic somatotype, higher values of height, body mass, and BMI are predictors of a higher level of anaerobic alactic performance. Body mass is the sole predictor of a higher level of anaerobic lactic performance.

Table 1

The relationship between indicators of anaerobic performance and indicators of physical development in women of the ectomorphic somatotype (n = 94)

Indicators of physical development	WAnT10 $_{abs.}$		WAnT10 $_{rel.}$		WAnT30 $_{abs.}$		WAnT30 $_{rel.}$	
	r_{xy}	p	r_{xy}	p	r_{xy}	p	r_{xy}	p
Body mass, kg	0.810	< 0.05	0.581	< 0.05	0.743	< 0.05	0.568	< 0.05
Height, cm	0.707	< 0.05	0.534	< 0.05	0.657	< 0.05	0.512	< 0.05
Body mass index, units	0.709	< 0.05	0.492	< 0.05	0.642	< 0.05	0.450	< 0.05
Fat content in the body, %	-0.182	> 0.05	-0.176	> 0.05	-0.109	> 0.05	-0.041	> 0.05
Muscle content in the body, %	0.311	< 0.05	0.305	< 0.05	0.316	< 0.05	0.271	< 0.05
Content of visceral fat, units	0.125	> 0.05	0.071	> 0.05	0.085	> 0.05	0.082	> 0.05

Notes: r_{xy} – Spearman's correlation coefficient; the correlations marked in red are significant.

In women with the endomorphic somatotype, no high-degree correlations were found (Table 2). The highest correlation of WAnT $10_{abs.}$ and WAnT $30_{abs.}$ values was found with body weight and between WAnT $10_{abs.}$ values and BMI. However, these correlations are characterized as positive of noticeable strength. It is noteworthy that there is no significant relationship between the relative WAnT 10, WAnT 30 values and body weight, height, and BMI.

In women with the endo-mesomorphic somatotype, a high degree of positive correlation was found only between the absolute values of WAnT 10 and body mass (Table 3). In addition, a noticeable and moderate positive correlation was observed between the absolute values of WAnT 10 and WAnT 30 and both height and BMI, while for the relative indicators, the correlation was either non-significant ($p > 0.05$) or weak. Of note is the presence of a negative correlation between body fat percentage and the relative WAnT 10 and WAnT 30 indicators, although the strength of these correlations is considered weak. Thus, in women with the endo-mesomorphic somatotype, body mass serves as a predictor of a higher level of anaerobic alactic performance.

In women with a balanced somatotype, the absolute values of WAnT 10 and WAnT 30 showed a high degree of positive correlation with body mass, height, and BMI (Table 4). These findings indicate that, in women with a balanced somatotype, higher values of body mass, height, and BMI serve as predictors of a higher level of anaerobic alactic and lactic performance. The percentage of body fat has the least influence on anaerobic performance, as evidenced by the weak or non-significant correlation ($p > 0.05$).

Discussion. A general analysis of the data obtained revealed that the relationship between physical development indicators and anaerobic performance indicators in women aged 25–35 of different somatotypes has differences. A high

Table 2

The relationship between indicators of anaerobic performance of the body and indicators of physical development in women endomorphic somatotype (n = 92)

Indicators of physical development	WAnT10 $_{abs.}$		WanT10 $_{rel.}$		WanT30 $_{abs.}$		WanT30 $_{rel.}$	
	r_{xy}	p	r_{xy}	p	r_{xy}	p	r_{xy}	p
Body mass, kg	0.638	< 0.05	0.019	> 0.05	0.656	< 0.05	0.015	> 0.05
Height, cm	0.184	> 0.05	-0.121	> 0.05	0.415	< 0.05	0.064	> 0.05
Body mass index, units	0.588	< 0.05	0.119	> 0.05	0.475	< 0.05	-0.019	> 0.05
Fat content in the body, %	0.364	< 0.05	0.233	< 0.05	0.215	< 0.05	0.124	> 0.05
Muscle content in the body, %	0.028	> 0.05	0.349	< 0.05	0.015	> 0.05	0.348	< 0.05
Content of visceral fat, units	0.305	< 0.05	0.348	< 0.05	0.165	> 0.05	0.251	< 0.05

Notes: r_{xy} – Spearman's correlation coefficient; the correlations marked in red are significant.

Table 3

The relationship between indicators of anaerobic performance of the body and indicators of physical development in women endo-mesomorphic somatotype (n = 104)

Indicators	WAnT 10 $_{abs.}$		WAnT 10 $_{rel.}$		WAnT 30 $_{abs.}$		WAnT 30 $_{rel.}$	
	r_{xy}	p	r_{xy}	p	r_{xy}	p	r_{xy}	p
Body mass, kg	0.780	< 0.05	0.097	> 0.05	0.653	< 0.05	0.026	> 0.05
Height, cm	0.592	< 0.05	0.111	> 0.05	0.661	< 0.05	0.233	< 0.05
Body mass index, units	0.628	< 0.05	0.122	> 0.05	0.367	< 0.05	-0.140	> 0.05
Fat content in the body, %	-0.052	> 0.05	-0.284	< 0.05	-0.120	> 0.05	-0.267	< 0.05
Muscle content in the body, %	-0.006	> 0.05	0.205	< 0,05	0,078	> 0.05	0.270	< 0.05
Content of visceral fat, units	0.328	< 0.05	0.028	> 0.05	0.124	> 0.05	-0.190	> 0.05

Notes: r_{xy} – Spearman's correlation coefficient; the correlations marked in red are significant.

degree of correlation in women of different somatotypes was found only for absolute indicators of anaerobic performance. Only in women with a balanced somatotype was a high correlation observed between the relative WAnT 30 indicator and body mass. The relationships between relative anaerobic performance indicators and body mass, height, and BMI in women of endomorphic and endo-mesomorphic somatotypes is significantly weaker than in women of ectomorphic and balanced somatotypes. In our previous studies we established that women with endomorphic and endo-mesomorphic somatotypes are characterized by significantly higher body mass and a higher percentage of body fat [11]. Therefore, these factors could potentially account for the lower degree of correlation. Additional studies are needed to confirm this hypothesis.

In women with ectomorphic and balanced somatotypes, no correlation was found between body fat percentage and anaerobic performance indicators. In contrast, women with an endomorphic somatotype showed a weak to moderate positive correlation, while women with an endo-mesomorphic somatotype exhibited a weak negative correlation. Additional research is needed to clarify the reasons for such discrepancies.

It is worth noting the presence of a positive correlation between visceral fat level and most indicators of anaerobic performance in women with balanced and endomorphic somatotypes. However, the strength of this correlation is moderate or weak.

The correlation between the percentage of muscle in the body and anaerobic performance indicators does not exceed a moderate level in representatives of all somatotypes, except for those with a balanced somatotype, in whom a noticeable positive correlation was found with the WAnT $10_{rel.}$ indicator.

The data we obtained are consistent with our previous studies, in which the strongest correlation between anaerobic performance indicators and body mass and BMI was found in women aged 25–35, regardless of somatotype [12].

We did not find any data in the scientific literature regarding the relationships between physical development indicators and functional fitness indicators such as WAnT 10 and WAnT 30 in women of different somatotypes. Therefore, we can compare our results only with studies that are partially related to this issue. Our data, which demonstrate a high and noticeable degree of positive correlation between anaerobic performance indicators and height in representatives of most somatotypes, are in partial agreement with the findings of Zh. Kozina [10], who identified differences in functional fitness levels among individuals of varying heights. J. Alkandari and B. Nieto [1] showed that among physical development indicators in men and women, height had the strongest association with handgrip strength. Since handgrip strength is determined by the level of anaerobic alactic performance, these findings can be extrapolated to the WAnT 10 indicator. Similar data were obtained by Neha

Table 4

The relationship between indicators of anaerobic performance of the body and indicators of physical development in women balanced somatotype (n = 102)

Indicators	WAnT $10_{abs.}$		WAnT $10_{rel.}$		WAnT $30_{abs.}$		WAnT $30_{rel.}$	
	r_{xy}	p	r_{xy}	p	r_{xy}	p	r_{xy}	p
Body mass, kg	0.837	< 0.05	0.572	< 0.05	0.878	< 0.05	0.703	< 0.05
Height, cm	0.792	< 0.05	0.547	< 0.05	0.814	< 0.05	0.635	< 0.05
Body mass index, units	0.724	< 0.05	0.477	< 0.05	0.779	< 0.05	0.635	< 0.05
Fat content in the body, %	0.202	< 0.05	0.105	> 0.05	0.154	> 0.05	0.096	> 0.05
Muscle content in the body, %	0.434	< 0.05	0.502	< 0.05	0.344	< 0.05	0.380	< 0.05
Content of visceral fat, units	0.442	< 0.05	0.295	< 0.05	0.491	< 0.05	0.416	< 0.05

Notes: r_{xy} – Spearman's correlation coefficient; the correlations marked in red are significant.

Parve et al. [13] regarding the relationship with body mass. They found a correlation between handgrip strength and body mass in women aged 35–45 at the level of r_{xy} = 0,6.

Sarifin Hasmyati et al. [7] argue that BMI is a reliable predictor of anaerobic performance only when it falls within the normal range. An increase in BMI to the level of obesity changes the correlation to a negative one. Since, in our study, women with obesity were excluded based on exclusion criteria, the data we obtained are consistent with this assertion.

Data regarding the influence of the fat component on anaerobic performance are somewhat contradictory. Pei Yang et al. [14] reported a strong positive correlation between visceral fat content and handgrip strength, and a negative correlation with total body fat percentage. This relationship can be tentatively extrapolated to anaerobic alactic performance, since strength abilities are determined by the level of development of the anaerobic alactic energy supply system of muscular activity. Mehmet Kale and Erkan Akdoğan [8] found a weak negative correlation (r_{xy} = -0,3) between body fat percentage and peak power output in the WAnT 30 test, and a moderate negative correlation (r_{xy} = -0,6) with anaerobic capacity in the WAnT 30 test among women aged 19 ± 2,6 years who play volleyball. It should be emphasized that such trends can only be considered with caution, as the data obtained from athletic women are not directly comparable to those of untrained individuals.

We did not find data in the scientific literature on the correlation between muscle mass content and anaerobic performance in women who do not engage in sports. In our previous studies, we found no correlation of the muscle component with either absolute or relative WAnT 30 indicators and only a weak positive relationship with the relative WAnT 10 indicator in women aged 25–35 without taking into account somatotype [11]. The lack of a significant association between fat-free body mass and performance in anaerobic tests may partly indicate the absence of a substantial influence of the muscle component on anaerobic capacity [8]. This trend is also confirmed by the lack of a connection between mesomorphy and anaerobic power [1].

Conclusions. Anaerobic performance indicators in women with endomorphic and endo-mesomorphic somatotypes show significantly weaker correlations with physical development indicators compared to women with ectomorphic and balanced somatotypes. Body mass, height, and BMI may serve as predictors of high anaerobic performance in women with balanced and ectomorphic somatotypes. The percentages of body fat and muscle do not have a significant impact on the anaerobic capacity of women across all somatotypes.

Conflicts of interest. The authors declare no conflict of interest.

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