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# PHYSICAL HEALTH OF FEMALES FROM THE MOUNTAIN DISTRICTS OF ZAKARPATTIA ACCORDING TO THE METABOLIC LEVEL OF AEROBIC AND ANAEROBIC ENERGY SUPPLY DEPENDING ON THE COMPONENT BODY COMPOSITION

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## ABSTRACT

**Aim:** To determine the aerobic and anaerobic productivity of females from the mountain districts of Zakarpattia region, depending on the component composition of body weight.

**Materials and Methods:** A comparative analysis of physical health status of females in the post-pubertal period of ontogenesis, was carried out. Physical health status was assessed by indicators of aerobic and anaerobic productivity depending on the component composition of the body, which was determined by impedance measurement.

**Results:** Physical health of females from the mountain districts depends on the component composition of the body, namely: an excellent level of aerobic productivity is observed in females who have a insufficient body weight with a normal relative fat content and a high relative content of skeletal muscles, $VO_{2\ max\ rel} > 38\ ml \cdot min^{-1} \cdot kg^{-1}$; as a result, their physical health exceeds the "critical level" according to H.L. Apanasenko and corresponds to "excellent" according to Ya.P. Pyarnat's criteria. Females from the mountain districts with normal body weight, high relative fat and normal relative skeletal muscle have average level of aerobic performance., i.e., $VO_{2\ max\ rel.}$ is within 28-33 $ml \cdot min^{-1} \cdot kg^{-1}$. As a result, their physical health is below the "critical level".

**Conclusions:** "Excellent" and "good" level of aerobic productivity of females from the mountain districts of the Zakarpattia region guarantees "safe health level". Females from mountain districts with a high content of fat component have an "average" level of aerobic performance, which does not provide a "safe health level".

**KEY WORDS:** body mass, fat, skeletal muscles, post-pubertal age

## INTRODUCTION

According to existing concepts about physical health [1], its level is determined by a person's ability to adapt to the influence of various factors, that is, to maintain normal life activities in inadequate situations [2]. Moreover, the individualization of a person's adaptive capacity is determined by a number of factors, namely: age, gender, constitutional characteristics of body composition, functional state of the body, etc. [3]. It should be noted that the ability to effectively perform physical work in aerobic and anaerobic (alactic and lactic) modes of energy supply can serve as an indicator of the level of adaptive capacity [4]. Because there is scientific information about the dependence of the level of physical health on the efficiency of aerobic and anaerobic metabolic processes that ensure physical activity [5].

A whole series of scientific works testify that a person's ability to adapt to aerobic and anaerobic physical work depends on the somatotype [6-8]. Recently, scientists have also focused their attention on the dependence of the individual's capacity to adapt to work in aerobic and anaerobic modes of energy supply on the component composition of body weight, namely on the ratio of fat and muscle components [9].

The physical health of certain population groups is formed as a result of many years of living in a certain territory due to the influence of exogenous (meteogeographic) factors on the human genetic apparatus [10, 11].

## AIM

The aim is to determine the aerobic and anaerobic productivity of females from the mountain districts

of Zakarpattia region, depending on the component composition of body weight.

## MATERIALS AND METHODS

A comparative analysis of physical health status of 102 post-puberty females aged 16 to 20, residents of the mountain districts of Zakarpattia region, was carried out. Physical health status was assessed by indicators of the aerobic productivity of the body, namely, the maximum oxygen consumption was measured ($VO_{2\ max}$) using the bicycle ergometry method. To evaluate the level of aerobic productivity, the Ya.P. Pyarnat's rating scale was used [12]. Indicators of anaerobic productivity of the body were studied by: measuring the power of anaerobic alactic energy supply processes by the Peak Power Output in 10 s ($WAnT_{10}$); the power of anaerobic lactic energy supply processes by the Peak Power Output in 30 s ($WAnT_{30}$), using the Wingate anaerobic test described by Yu.M. Furman et al [13]. The anaerobic lactic productivity of the organism was measured by the Peak Power Output (PPO) in 1 min using A. Shogy and G. Cherebetin's method [14]. The component body mass composition was determined using the impedance method with the application of Omron BF511 Body Composition Monitor to estimate the percentage of fat mass (subcutaneous and visceral fat) and the percentage of skeletal muscle [15]. The statistical processing of the material was carried out in Excel 7.0 and SPSS version 10.0 using Student's t-test to find out the reliability of the difference between the average values.

## RESULTS

As a result of determining the component composition of body weight, the females studied were divided into three groups depending on the relative content of fat and into three groups depending on the relative content of skeletal muscles. The number of females with a normal relative fat content (21.0-32.9%) was the largest – 52 individuals (51.0%), while the number of females with a high relative fat content (33.0 -38.9%) was the smallest – 11 (10.8%). There were no individuals with a very high relative fat content (> 39.0%) among those studied. The representatives of the mountain districts were almost equally distributed regarding relative content of skeletal muscles, namely: there were 59 females (57.8%) with normal and 40 females (39.2%) with high relative content of skeletal muscles. We also recorded 3 individuals (3%) with a very high relative content of skeletal muscles (>35.3%). There were no females with a low relative content of skeletal muscles (<24.3%) among the studied individuals (Table 1).

The value of the absolute $VO_{2\ max}$ index in females with low relative fat content is 14.0% significantly lower than the value in females with normal relative fat content. The average value of $VO_{2\ max\ rel.}$ in females with a high relative fat content is 33.8±1.76 $ml \cdot min^{-1} \cdot kg^{-1}$, which is1.23 times lower than the average value in females with a normal relative fat content ($p<0.05$) and does not reach the "safe health level". The average value of the relative indicator of maximal oxygen consumption in females from the mountain districts with a normal relative fat content exceeds the "safe health level" by 18.9%. The results of the study of the power of anaerobic lactic energy supply processes according to the relative value of $WAnT_{10\ rel.}$ in females from the mountain districts, show a significant prevalence of this indicator in females with a normal relative content of the fat component compared to persons with a high content by 9.1%. Peculiarities of the manifestation of anaerobic productivity in representatives of the mountain districts with different component composition of body weight were also revealed when determining the relative power of anaerobic lactic energy supply processes. It should be noted that the lowest average values of $WAnT_{30\ rel.}$ are observed in representatives of the mountain districts with both high and low relative fat content, while in females with normal relative fat content, the average value of the absolute indicator of the capacity of anaerobic lactic energy supply processes is higher compared to representatives of the mountain districts with low and high relative fat the content of the fat component by 17.8% and 18%, respectively. However, females from the mountain districts with different relative fat content probably do not differ from each other in terms of the

**Table 1.** Distribution of females from the mountain districts of Zakarpattia by component composition of body weight, n=102

| Relative fat content (%) | | | | | | | |
|---|---|---|---|---|---|---|---|
| < 21,0 (-) low | | 21,0 – 32,9 (0) normal | | 33,0 – 38,9 (+) high | | >39,0 (++) very high | |
| number of persons | % | number of persons | % | number of persons | % | number of persons | % |
| 39 | 38,2 | 52 | 51,0 | 11 | 10,8 | - | - |
| **Relative content of skeletal muscles (%)** | | | | | | | |
| < 24,3 (-) low | | 24,3 – 30,3 (0) normal | | 30,4 – 35,3 (+) high | | > 35,3 (++) very high | |
| number of persons | % | number of persons | % | number of persons | % | number of persons | % |
| - | - | 59 | 57,8 | 40 | 39,2 | 3 | 3,0 |

**Table 2.** Average values of indicators of aerobic and anaerobic productivity of the body (M±m) of females from the mountain districts of Zakarpattia, depending on the relative fat content, n=102

| Indicators | Aerobic productivity | | | | Anaerobic productivity | | | |
|---|---|---|---|---|---|---|---|---|
| | Maximum oxygen consumption | | power of alactic energy supply processes | | power of lactic energy supply processes | | capacity of lactic energy supply processes | |
| Relative fat content (%) | $VO_{2\,max}$ $ml \cdot min^{-1}$ | $VO_{2\,max\,rel.}$ $ml \cdot min^{-1} \cdot kg^{-1}$ | $WAnT_{10'}$ $kgm \cdot min^{-1}$ | $WAnT_{10\,rel}$•, $kgm \cdot min^{-1} \cdot kg^{-1}$ | $WAnT_{30.}$ $kgm \cdot min^{-1}$ | $WAnT_{30\,rel}$•, $kgm \cdot min^{-1} \cdot kg^{-1}$ | PPO, $kgm \cdot min^{-1}$ | $PPO_{rel.}$, $kgm \cdot min^{-1} \cdot kg^{-1}$ |
| < 21,0 (-) low (n=39) | 2032,6 ± 53,4 · | 38,5 ± 1,67 | 2063,0 ±59,2 | 39,3 ± 0,9 | 1983,4 ± 56,5 " | 37,2 ± 0,68 · | 1121,6 ± 31,3 · | 20,6 ± 0,7 |
| 21,0 – 32,9 (0) normal (n= 52) | 2364,8 ± 64,6 | 41,6 ± 1,93 | 2202,1 ± 62,7 | 42,1 ±1,18 | 2128,3 ± 62,4 | 40,5 ± 1,07 | 1286,2 ± 40,8 | 21,2 ± 0,9 |
| 33,0 – 38,9 (+) high (n=11) | 2101,4 ± 58,6 · | 33,8 ± 1,76 · | 2122,4 ± 61,1 | 38,6 ± 0,8 | 2218,4 ± 61,3 | 36,8 ± 0,66 * | 1206,3 ± 40,4 | 19,9 ± 0,8 |

*Note: the probability of a difference in mean values (p<0.05):*
** - relatively low fat content;*
*• - relatively normal fat content;*
*" - relatively high fat content.*

relative value of the capacity of anaerobic lactic energy supply processes (p>0, 05) (Table 2).

The dependence of the level of aerobic productivity on the content of the muscle component of body weight was established. The value of the absolute $VO_{2\,max}$ index in females with normal and high relative content of skeletal muscles is significantly lower than the value in females with very high relative content of skeletal muscles (p<0.05) by 19.9% and 13.2%, respectively. The average value of the relative indicator of maximum oxygen consumption $VO_{2\,max\,rel}$• in females from the mountain districts with normal, high, and very high relative skeletal muscle mass is significantly higher than the "safe health level" and corresponds to an excellent level of aerobic performance. The results of studies of the power of anaerobic lactic energy supply processes of the body in terms of the absolute value of $WAnT_{10}$ in females from the mountain districts revealed a significant prevalence of this indicator in females with a very high relative content of skeletal muscles by 23.7% compared to individuals with a normal relative content of this body mass component. Peculiarities of anaerobic productivity manifestation in representatives of the mountain districts with different component composition of body weight were also revealed when determining the absolute value of the power of anaerobic lactic energy supply processes. However, the lowest absolute average values of $WAnT_{30}$ are observed in females from the mountain districts with normal and high relative content of skeletal muscles. In females with a normal relative content of skeletal muscles, the average value of the absolute indicator of the capacity of anaerobic lactic energy supply processes is reliably the lowest by 19.1% and 21.7% compared to representatives of the mountain districts with high and very high relative content of skeletal muscles, respectively (p<0.05). At the same time, according to the relative indicator of the capacity of anaerobic lactic energy supply processes, females from the mountain districts with different relative content of skeletal muscles probably do not differ among themselves, p>0,05 (Table 3).

Thus, according to the results of the research of aerobic and anaerobic processes of energy supply in females from mountain districts, we came to the conclusion that females with a normal relative fat content (21.0-32.9%) and a high relative content of skeletal muscles (30.4-35.3%) with insufficient body weight (BMI<18.5 $kg/m^2$) have an excellent level of aerobic productivity, i.e. $VO_2$ max rel. > 38 $ml \cdot min^{-1} \cdot kg^{-1}$. Females with a normal relative fat content and a normal relative skeletal muscle content (24.3-30.3%) with normal body weight (18.5 ≤ BMI < 25 $kg/m^2$) have a good level of aerobic productivity, i.e. $VO_2$ max rel. > 34 to 38 $ml \cdot min^{-1} \cdot kg^{-1}$. Females with a high relative fat content and a normal relative skeletal muscle content with normal body weight have an intermediate level of aerobic productivity, i.e. $VO_2$ max rel. 28-33 $ml \cdot min^{-1} \cdot kg^{-1}$. At the same time, all the individuals studied have a normal level of visceral fat, in the range from 1 to 9% (Fig.1).

## DISCUSSION

The issues of physique are in the field of interests of both theoretical and clinical medicine. Traditional anthropometric approaches are now successfully complemented by high-tech and effective research methods (bioimpedancemetry, etc.), which provide an objective assessment of the component composition of the human body and other morphological features. The expediency of conducting such studies with a clinical purpose is determined by the repeatedly proven fact of constitutional predisposition to the development of a number of diseases, as well as by the fact that belonging to a certain constitutional type can be considered as a factor of well-being, indicating the optimal adaptation potential and low probability of the development of certain nosological forms. This allows for individualization of approaches to disease prevention, selection of treatment tactics, and prediction of treatment

**Table 3.** Average values of indicators of aerobic and anaerobic body productivity (M±m) of girls from the mountain districts of Zakarpattia depending on the relative content of skeletal muscles, n=102

| Indicators | Aerobic productivity | | | | Anaerobic productivity | | | |
|---|---|---|---|---|---|---|---|---|
| | Maximum oxygen consumption | | power of alactic energy supply processes | | power of lactic energy supply processes | | capacity of lactic energy supply processes | |
| Relative skeletal muscle content (%) | $VO_{2\ max}$ $ml \cdot min^{-1}$ | $VO_{2\ max\ rel.}$ $ml \cdot min^{-1} \cdot kg^{-1}$ | $WAnT_{10'}$ $kgm \cdot min^{-1}$ | $WAnT_{10\ rel'}$ $kgm \cdot min^{-1} \cdot kg^{-1}$ | $WAnT_{30.}$ $kgm \cdot min^{-1}$ | $WAnT_{30\ rel'}$ $kgm \cdot min^{-1} \cdot kg^{-1}$ | PPO, $kgm \cdot min^{-1}$ | $PPO_{rel.'}$ $kgm \cdot min^{-1} \cdot kg^{-1}$ |
| 24,3 – 30,3 (0) normal (n=59) | 2098,3 ± 48,6" | 43,7 ± 0,61 | 2006,8 ± 54,5" | 41,7 ± 1,04 | 2014,7 ± 67,8" | 41,8 ± 2,01 | 1208,4 ± 28,3"' | 25,1 ± 1,02 |
| 30,4 – 35,3 (+) high (n=40) | 2273,4 ± 63,8" | 40,5 ± 0,48* | 2311,4 ± 70,4 | 40,0 ± 1,7 | 2291,1 ± 43,2 | 40,4 ± 1,92 | 1494,6 ± 31,2 | 26,3 ± 0,9 |
| > 35,3 (++) very high (n=3) | 2618,3 ± 59,66 | 41,69 ± 0,46 | 2482,7 ± 62,7 | 40,17 ± 1,4 | 2447,7 ± 50,4 | 40,2 ± 1,68 | 1543,7 ± 40,1 | 25,3 ± 1,4 |

*Note: the probability of a difference in mean values ($p<0.05$):*
** - relatively low fat content;*
*" - relatively normal fat content;*
*' - relatively high fat content.*

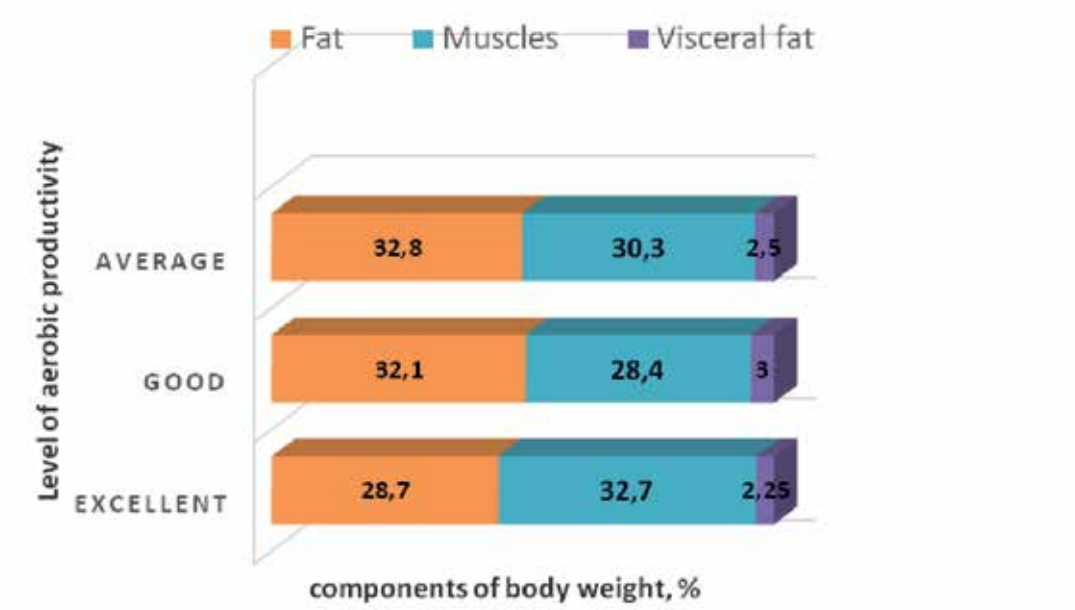


**Fig. 1.** Graphic representation of the dependence of the level of aerobic productivity of females from the mountain districts of Zakarpattia on the ratio of the component composition of body weight (n=102).

effectiveness [16]. M. I. Nemesh's study of the relationship between indicators of the component composition of the body and central hemodynamics in females with excessive body weight, proves that an increase in body weight due to adipose tissue, first of all, serves as a load for the heart muscle, which leads to increase the minute blood volume. Another mechanism that occurs in parallel is characterized by the production of hormones by visceral fat: tumor necrosis factor-α, resistin, visphantin reduce the production of nitric oxide by the vascular endothelium, which negatively affects the vasodilatation of peripheral arteries and leads to hardening of the arterial walls, and eventually to the appearance of arterial hypertension [17-19]. However, with physical exertion, training of the skeletal muscles increases, and this will correct the indicators of central hemodynamics.

A. S. Shklyar's research shows the importance of studying the component composition of the body at various stages of postnatal ontogenesis, which makes it possible to explain age and gender differences in the frequency of formation of functional disorders, pre-nosological, as well as nosologically defined pathological conditions as manifestations of the general process of growth and development in postnatal ontogeny. After all, the fat component of a person's body weight is one of the indicators of a person's physique and of their nutritional (alimentary) status. It can change dynamically under the influence of various factors [20]. The muscle component of a person's body weight is one

of the indicators of body structure and an indicator of its structural and functional state at various stages of ontogenesis. Changes in the muscle component of body weight can be transitory or permanent, which is determined by the state of metabolic processes in the corresponding period of ontogenesis, the nutritional support of nutrient homeostasis, the mode of motor activity and the state of the person's somatic health [21].

Yu.I. Huminskiy et al. conducted a longitudinal study for the first time on the territory of Ukraine. The study determined changes in the component composition of the body mass of young cadets of the 1st, 2nd, and 3rd years of study in the academic setting as an exogenous factor, which, together with the daily regime, way of eating, motor activity and emotional load affect the body. It was found that the indicators of the muscle and bone components of the body weight of the cadets increased during training, while the indicator of the fat component reduced. Significant differences were found when comparing annual changes in muscle and fat components of body weight. In addition, annual changes in the fat component were more significant in the second year of study than in the first, while indicators of the muscle and bone components prevailed in the first year of study [22]. Identifying patterns of individual typological variability of the body structure and its parts is ideal for monitoring health and physical status, and can be used in personalized approaches of clinical and preventive medicine.

## CONCLUSIONS

In females from the mountain districts with a high fat content, the average value of the power of anaerobic lactic energy supply processes based on the relative value of $WAnT_{10}$ and the power of lactic processes based on the relative value of $WAnT_{30}$ is probably lower than that of peers with a normal content of the fat component by 9.1% and 18.0%, correspondingly. The capacity of anaerobic lactic processes of energy supply in females with a high fat content in terms of the relative value of PPO in 1 min is probably 11.5% lower than in females with a normal fat content. "Excellent" and "good" level of aerobic productivity in females from the mountain districts of Zakarpattia region guarantees "safe health level". Females from the mountain districts with a high content of fat component have an "average" level of aerobic performance, which does not provide "safe health level".

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**CONFLICT OF INTEREST**
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