Physical Health of Males Residents from the Lowland Districts of Ukrainian Transcarpathia During the Post-Pubertal Period Depending on the Component Body Composition

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Abstract

Objective of the research was to determine the aerobic and anaerobic productivity of males from the lowland districts of Ukrainian Transcarpathia during the post-pubertal period, depending on the component composition of body weight.

Physical health status of 112 subjects was assessed by indicators of aerobic and anaerobic productivity depending on the component composition of the body, which was determined by impedance measurements. Physical health status was assessed by indicators of the aerobic productivity of the body, namely, the maximum oxygen consumption was measured (VO2 max) using the bicycle ergometry method. To evaluate the level of aerobic productivity, the Pyarnat's rating scale was used. Indicators of anaerobic productivity of the body were studied by: the power of anaerobic alactic energy supply processes by the Peak Power Output in 10 s (WAnT10); the power of anaerobic lactic energy supply processes by the Peak Power Output in 30 s (WAnT30), using the Wingate anaerobic test described by Yu.M. Furman et al.

The highest level of aerobic productivity in terms of the relative value of maximal oxygen consumption was found in young males who have normal body weight with a very high relative content of skeletal muscle, a low relative content of fat, and a normal level of visceral fat. An increase in the fat component has a negative effect on the body's aerobic energy supply among young males from lowland districts of Ukrainian Transcarpathian region. On the contrary, the growth of the muscle component of the body weight helps to increase the aerobic capacity of the body. Among all examined males, no individuals with «excellent» or «good» level of aerobic productivity of the body were found.

Clinical article (J Int Dent Med Res 2023; 16(4): 1632-1637)

Keywords: Physical Health, Post-Pubertal Period, Body Composition.

Received date: 09 October 2023 **Accept date: 10 December 2023**

Introduction

Human physical health depends on the body's ability to adapt to the conditions of the external environment, while maintaining normal functional parameters of all physiological systems.[1,2,3] The urgent mechanism of such adaptation is carried out by neural and humoral pathways;[2] however this process is personified by the human somatotype.[3,4] Moreover, there are gender differences in such «personification», namely, when functional capabilities of individual systems of males and females with the same somatotype do not match.[4,5,6] A number of scientists point out that the set of various morphological factors, on which the somatotype depends (in particular, the component composition of body weight), affect both the functional capabilities of the body and the susceptibility to certain diseases.[5,6,7] Therefore, determining the component composition of the body and somatotype is expedient as it allows to individualize disease prevention, and to choose effective treatment tactics, as well as to predict the effectiveness of the treatment.[7,8,9]

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According to the existing concepts about physical health, aerobic and anaerobic processes of energy supply play a significant role in somatotype formation. Also somatic type of a person largely depends on the ethno-territorial factor of residence, therefore, the somatotype may be considered a morphological passport of the constitution.[9,10,11,12,13,14]

In Ukraine, there are territories with ecological features that determine the hormonal status of residents of these regions, somatometric parameters, individual components of the somatotype, component composition of body weight, and functional state; and Ukrainian Transcarpathian is one of these regions.[13,14]

Therefore, in order to carry out an objective analysis of physical health status of people of different ages and genders, it is necessary to clearly determine the values and limits of physiological fluctuations among indicators of aerobic and anaerobic productivity of the body, depending on the component composition of body weight, in the healthy population of the Ukrainian Transcarpathia.

Objective of the research was to determine the aerobic and anaerobic productivity of males from the lowland districts of Ukrainian Transcarpathia during the post-pubertal period, depending on the component composition of body weight.

Materials and methods

112 post-puberty male residents of the lowland districts of Ukrainian Transcarpathia aged 17 to 21 years were recruited for the comparative analysis of physical health status. Sample size was calculated considering 4-type categorization approach applied for relative fat content and relative muscle content, while also recommendations provided by Lenthÿ R.[15] and Friston K.[16] for effective sample size determination due to which optimal number of participants for each category should be in the range of 16-32 subjects.

Inclusion criteria for participants involvement was the following: 1) age range 17-21 years (corresponding to post-pubertal period); 2) male gender; 3) permanent living within lowland district of Ukrainian Transcarpathian region; 4) absence of any clinically-prominent or already diagnosed chronic or acute disease during the study; 5) absence of any significantly influential behavioral habits; 6) agreement of person to take part within provided research approved by the signed informed consent form. Next parameters were used as exclusion criteria: 1) age out of 17-21 years range; 2) non-male gender of the person; 3) non-consistent residence within lowland district of Ukrainian Transcarpathian region; 4) presence of any already diagnosed chronical diseases; 5) diagnosis of any acute diseases' signs and symptoms during provided research; 6) presence of any bad habits (smoking, tobacco chewing, alcohol consumption etc.); 7) person's refusal to sign informed consent form and follow diagnostic procedures during the study.

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 Pyarnat's rating scale was used.[13, 14] Indicators of anaerobic productivity of the body were studied by: 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.[17] 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.[18] 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.[19] Following categorization of relative fat content was used in means of percentage: < 8.0% – low (-), 8.0 – 19.9% – normal (0), 19.9 – 24.9% – high (+), >24.9% – relatively high (++). Results of relative content of skeletal muscles evaluation were interpreted in following manner: < 33.3% - low (-), 33.3 – 39.3% - normal (0), 39.4 – 44.0 – high (+), > 44.0 – very high (++).[13, 14]

Evaluation of different parameters correspondence to the «safe health level» criterion was held due to the approach proposed by Apanasenko G.L. [20]

Ethical aspects

Research design and its full correspondence with principals of human rights and human dignity, moral and ethical standards and with the principles of the Declaration of Human Rights of Helsinki, the Council of Europe Convention on Human Rights and Biomedicine ethical standards was approved by Institutional Review Board of Faculty of Dentistry at Uzhhorod National University (Ukraine) with positive resolution assigned by protocol № 11 (15/06/2022). All participants recruited for present research agreed to take part in all diagnostic procedures on the voluntarily basis after detalized explanation of all aspects of research design, which was approved confirmed by signed informed consent form.

Statistical analysis

The significance of the differences (p) registered among parameters of aerobic and anaerobic productivity among persons with various relative fat content and relative muscle content levels was assessed due to the generally accepted statistical principles with the use of Student's t-tests for parametrical variables and Wilcoxon–Mann–Whitney test for nonparametric variables. Statistical validity of obtained outcomes was confirmed only under condition of $p<0.05$ (significance level of 0.95). Data categorization, tabulation and processing was held within Microsoft Excel software (Microsoft Office 2019, Microsoft Corp., USA) with the additional use of XLSTAT (Addinsoft Inc., Long Island, NY, USA) statistical add-ins for inferential statistics manipulations.

Results

Examined males residents were divided into three groups depending on the relative content of fat and the relative content of skeletal muscles based on obtained results. The number of males with a normal relative fat content (8.0 – 19.9%) was the largest – 82 individuals (73.2%). There were no individuals with a very high relative fat content (>24,9%) among those studied. The number of males with very high and high relative content of skeletal muscles was the largest – 52 (46.4%) and 45 individuals (40.2%), respectively. There were no males with a low (< 33.3%) relative content of skeletal muscles among those studied (Table 1).

The value of the absolute $VO_{2\ max}$ indicator in individuals with a high relative fat content does not differ from the same value of individuals with a normal and low relative fat content ($p > 0.05$). At the same time, the average value of $VO_{2\ max\ rel.}$ of individuals with a high relative fat content is 13.7% lower than the average value of individuals with a low fat content; and 5.3% lower than the average value of individuals with a normal relative fat content ($p < 0.05$), and does not reach a «safe health level» («safe health level» is at the limit of 42.0 $ml·min^{-1}·kg^{-1}$).

Relative fat content (%)							
< 8.0 (-) low		8.0 – 19.9 (0) normal		19.9 – 24.9 (+) high		>24.9 (++) very high	
number of persons	%	number of persons	%	number of persons	%	number of persons	%
15	13.4	82	73.2	15	13.4	-	-
Relative content of skeletal muscles (%)							
< 33.3 (-) low		33.3 – 39.3 (0) normal		39.4 – 44.0 (+) high		> 44.0 (++) very high	
number of persons	%	number of persons	%	number of persons	%	number of persons	%
-	-	15	13.4	45	40.2	52	46.4

Table 1. Distribution of males from the lowland districts of Ukrainian Transcarpathia by component composition of body weight, n=112.

Males from the lowland districts of Ukrainian Transcarpathia with a high fat component have significantly lower alactic productivity by 24.9% compared to individuals with a normal fat content ($p < 0.05$). The decrease of the fat component of body weight in males contributes to a more effective increase in the power and capacity of the anaerobic energy supply system. In lowland males with a low fat content, the power of anaerobic alactic processes of energy supply is 24.3% higher compared to their peers who have a high fat content ($p < 0.05$); the power of anaerobic lactic processes is 20.1% higher; the capacity of anaerobic lactic processes is 19.6% higher ($p < 0.05$) (Table 2).

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·min⁻¹	$VO_{2max\ rel.}$ ml·min⁻¹·kg⁻¹	$WAnT_{10}$, kgm·min⁻¹	$WAnT_{10\ rel.}$, kgm·min⁻¹·kg⁻¹	$WAnT_{30}$, kgm·min⁻¹	$WAnT_{30\ rel.}$, kgm·min⁻¹·kg⁻¹	PPO, kgm·min⁻¹	$PPO_{rel.}$, kgm·min⁻¹·kg⁻¹
< 8.0 (-) low (n=15)	3363.6 ±74.8	43.8 ± 1.4	4392.1 ± 61.7	57.8 ± 3.8	3801.4 ± 81.3	50.0 ± 3.6	2304.1 ± 46.7	29.8 ± 0.96
8.0 – 19.9 (0) normal (n= 82)	3361.4 ±63.2	39.9 ± 0.94	4278.6±8 1.1	58.1 ± 3.6	3733.2 ± 78.2	45.2 ± 3.3	2202.4 ± 52.4	26.8 ± 1.2
19.9 –24.9 (+) high (n=15)	3512.7 ±73.2	37.8 ± 0.86 •*	46.5±3.1 •*	37.1 ± 0.92 •*	3824.7 ± 52.1	41.6 ± 3.4	2312.1 ± 56.3	24.9 ± 2.3 *

Table 2. Average values of indicators of aerobic and anaerobic productivity of the body (M±m) of

males from the lowland districts of Ukrainian Transcarpathia, depending on the relative fat content, n=112.
Note: the significance of a differences in mean values ($p<0.05$):
* - relatively low fat content;
• - relatively normal fat content;
• - relatively high fat content.

The values of the absolute $VO_{2\ max}$ index in males from lowland districts with different relative content of skeletal muscles do not reliably differ from each other ($p > 0.05$). The average value of $VO_{2max\ rel.}$ in males with normal and high relative content of skeletal muscles is significantly below the «safe health level», corresponds to the level of aerobic productivity «below average» and is 37,8±0,81 $ml{\cdot}min^{-1}{\cdot}kg^{-1}$ and 39,2±0,68 $ml{\cdot}min^{-1}{\cdot}kg^{-1}$, respectively, although the indicators do not differ significantly ($p > 0.05$). At the same time, in males with a very high relative content of skeletal muscles, the indicator of maximum oxygen consumption $VO_{2max\ rel.}$ is significantly above the «safe health level», which corresponds to the «average» level of aerobic productivity and is 42,9±1,02 $ml{\cdot}min^{-1}{\cdot}kg^{-1}$.

The results of anaerobic alactic energy supply processes assessment by the absolute value of $WAnT_{10\ abs}$. in males from lowland districts, demonstrated significant higher values of of this indicator in individuals with a very high relative content of skeletal muscles, which was 7.6% higher compared to individuals with normal and 6.7% higher compared to individuals with high relative content of skeletal muscles, respectively (Table 3).

The power of anaerobic alactic processes of energy supply of the body according to the relative value of $WAnT_{10\ rel.}$ among males from lowland districts was significantly higher by 20.5% in individuals with a very high relative content of skeletal muscles than in those with a normal content of skeletal muscles ($p < 0.05$). It is worth noting that the lowest average values of $WAnT_{30\ rel.}$ were observed in individuals from lowland districts with normal relative content of skeletal muscle compared to those with very high relative content of skeletal muscle. At the same time, the indicators of the capacity of anaerobic lactic energy supply processes of the body in males from lowland districts with different relative content of skeletal muscles do not differ between themselves in absolute and relative values ($p > 0.05$).

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, $kgm{\cdot}min^{-1}$	$PPO_{rel.}$, $kgm{\cdot}min^{-1}{\cdot}kg^{-1}$
33.3 – 39.3 (0) normal (n=15)	3250.4 ± 84.2	37.8 ± 0.81•	4264.8 ± 90.6 •	50.8 ± 2.01•	3720.3 ± 91.1	45.2 ± 2.3•	2128.0 ± 56.1	25.3 ± 3.1
39.4 – 44.0 (+) high (n=45)	3279.1 ± 69.4	39.2 ± 0.68	4299.9 ± 78.6 •	54.4 ± 1.87	3989.6 ± 87.3	50.3 ± 1.8	2233.4 ± 46.7	27.9 ± 1.9
> 44.0 (++) very high (n=52)	3296.4 ± 83.1	42.9 ± 1.02	4587.9 ± 63.8	61.2 ± 1.36	4981.3 ± 72.8	56.2 ± 2.2	2179.8 ± 60.2	28.6 ± 2.3

Table 3. Average values of indicators of aerobic and anaerobic body productivity (M±m) of males from the lowland districts of Ukrainian Transcarpathia depending on the relative content of skeletal muscles, n=112.

Discussion

Recent systematic review revealed that associations noted between motor competence and health related physical fitness parameters among adolescents may be used as ground base for the health outcomes improvements through the corrections provided over targeted links between various derivatives, especially such potential was noted within relationship of motor competence and body weight status.[21] On the other hand it has been proven that people with various somatotypes differ not only in body features, but also in reactivity, metabolism, endocrine indicators, and individual psychological qualities.[22,23,24] This convinces the need to create such a research direction in medicine as «constitutional diagnostics».[22,23,24] Meanwhile, not the somatic type itself but component parameters of such, including component body composition, have previously shown significant inter-relations with level of physical health.[13,14] Moreover body composition profiling based on quantitative non-invasive assessment seems to be perspective for individualized physical training and personalized treatment strategies, taking into consideration agreements that were established among principal and compartmental measurements.[25]

Specific trend regarding higher level of aerobic productivity among females compare to males regardless of territory of residence was discovered in previous research, which also revealed that anaerobic productivity of females was contrary lower than in males.[14] Previously it was also found that higher values of fat component within general body composition was associated with decreased tendency of aerobic and anaerobic energy supply.[14] In present research it was found that not just increase of fat component itself, but disbalance of fat-muscle components with the domination of fat has negative effect on the power of anaerobic alactic and lactic processes of energy supply, as well as on the capacity of anaerobic lactic metabolism. On the other hand in males from the lowland districts of Ukrainian Transcarpathia, the increase in the level of the muscle component contributes to the increase in the power of alactic and lactic processes of energy supply.

Analysis of links between somatotype and anaerobic performances revealed that at least one third of strength performance may be predicted by one or few derivatives of somatotypes.[11, 26] In present research we have not proposed any regression model, nevertheless our results is somewhere similar to the Stewart's et al.,[11] since it was found that ratio of fat-muscle components as one of the somatotype criteria impact the aerobic and anaerobic productivity of males from the lowland districts of Ukrainian Transcarpathia.

Based on the above-mentioned facts it may be resumed that pattern of inter-relations between somatotype parameters and physical health derivatives should be differentiated for persons of different gender, even if such share the same territory of residence. Previously it was also mentioned that correlation level between physical qualities and aerobic and anaerobic body productivity values is influenced not only by gender, age and chosen type of motor activity, but also by methods used to verity physical parameters ifself.[27]

Considering results of the study it may be resumed that males from lowland districts with a low content of fat component, as well as with a very high content of muscle component, have an «average» level of aerobic productivity. Such links between somatic type parameters and energy expenditure values may be further used for the prediction of daily living and functional capacity profiles considering changes taking place within the function of age as determinant. Environmental conditions of residential area and person-oriented factors should also be taken into account while forming prediction profiling model of changes withing physical activity or risk of different diseases development.[28]

Limitations of present study associated with disproportional distribution of study sample among different categories of relative skeletal muscle content and relative fat content, since there was no subjects with very high fat content and low muscle content. Proportional filling of subgroups with various relative skeletal muscle and fat content may support better statistical argumentation of differences registered among groups, while also enhance possibilities for further regression analysis to clear out dependencies of aerobic and anaerobic productivity levels on the different somatotype parameters as principal regressors. Nevertherless, obtained distribution represents real-life allocation pattern typical for male residents of lowland Ukrainian Transcarpathian region. Another limitation is associated with the fact that present research was focused just on the examination of males with specific territory of residence, but no comparison with general Ukrainian male sample was carried out, which would be beneficial to highlight the potential impact of residence area's conditions on the inter-relations between physical health parameters and component composition of body. This limitation would be considered during the formulation of future studies' design aimed at further in-depth analysis of associations observed between somatic type' derivatives and aerobic and anaerobic productivity. Also, statistical modeling approach would be beneficial to discriminate role of different somatotype parameters on the physical productivity level, while also considering possibility to apply thresholding (cut-off) manipulation for minor influential factors and confounders.

Conclusions

Increase in the fat component has a negative effect on the body's aerobic energy supply among males from the lowland districts of Ukrainian Transcarpathia during the post-pubertal period. On the contrary, the growth of the muscle component of the body weight helps to increase the aerobic capacity of the body. Reducing the fat component of body weight in young males contributes to a more effective increase in the power and capacity of the anaerobic energy supply system. Among all examined young males, no individuals with «excellent» and «good» level of aerobic productivity of the body were found.

Declaration of interest

The authors report no conflict of interest, and the article was not funded or supported by any research grant.

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