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An estimation of aerobic and anaerobic productivity of an organism of youth aged 17-19 years old of Podilsk region

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Abstract

Purpose: to establish standards for the assessment of the aerobic and anaerobic productivity of the body of youth aged 17-19 years old of the Podilsk region.

Material: The study involved students (n = 799 - girls, n = 668 - boys). All students study at Higher Education Institutions of Vinnytsia (Ukraine) and live within Podilsk region. Students belong to the main medical group and have not been engaged in sports for the last 5 years.

Results: the criteria for evaluating the aerobic and anaerobic productivity of the organism of the youth of Podilsk region have been developed. The comparison of the individual values of students of Podilsk region with the standards of functional preparedness is carried out. The approaches to constructing an individual profile of students' functional readiness are determined. The profile visually distinguishes the sides of functional readiness, which require correction.

Conclusions: Standards for functional readiness need to be updated. New standards should be developed on the basis of the average of the indicator obtained as a result of the survey of a large number of persons of a uniform contingent. The gradation of standards is set within the range of the mean square deviation.

Keywords: functional preparedness, standards, youths, girls.

Introduction

The vast majority of scientific publications on the physiology of motor activity in recent decades indicate an inadequate level of functional preparedness of the population of Ukraine [1, 2].

There are no clearly defined recommendations for assessing the level of human functional preparedness. Apanasenko G.L. [3], Piarnat Ia.P. [4], Furman Y. [5] suggests to use an energy supply aerobic power process (VO2 max) for this purpose. This is due to the fact that in the total amount of energy potential of an organism, aerobic energy formation is largely anaerobic [6, 7]. Anaerobic processes of metabolism play an essential role in the formation of energy potential. With an increase in the level of anaerobic lactic productivity: the protection of the myocardium from hypoxia increases; lower plasma cholesterol and low density lipoprotein; increases the content of high density lipoprotein; the coefficient of atherogeny increases [8, 9]. The study of the relationship between aerobic and anaerobic (lactate) productivity of the organism allowed to establish a strong correlation. Such a phenomenon is manifested only if: the factor is anaerobic productivity; the effective indicator is aerobic performance [10, 11]. Therefore, the assessment of functional preparedness should be based on the aerobic and anaerobic potential of the organism.

There are no generally accepted criteria for evaluating human aerobic capacity. The data published by different authors is somewhat different. And most of the evaluation criteria apply to people over the age of 20. Exception is the evaluation criteria of Piarnat Ia.P. [4]. These criteria cover a wide age range (10 to 50 years). Such criteria do not take into account the features of the region.

Apanasenko G.L. [12] suggests evaluating aerobic performance at a "safe level of health", which is determined by the relative magnitude of $VO_{2\ max}$ (maximum oxygen consumption). For men, this level is 42.0 $ml \times min^{-1} \times kg^{-1}$. For women, this level is 35.0 $ml \times min^{-1} \times kg^{-1}$. Other studies indicate an excess of mean group values of the relative $VO_{2\ max}$ at girls aged 17-19 years old [13, 14]. The average group of men the values of $VO_{2\ max}$ are below the "safe level of health" [11, 15]. The criteria for the "safe level of health" require clarification on the current state of health of the population of Ukraine.

To assess the aerobic capacity of the organism it is used a modified Kuper K. test [16]. The disadvantage of this technique is the lack of evaluation criteria that take into account the age of a person. Also, this technique does not take into account the differences in the region.

In addition to the power of aerobic energy supply, an important indicator of functional readiness is the threshold of anaerobic metabolism (TAM). This indicator reflects the capacity of aerobic energy supply processes [2]. Generally accepted standards for TAM evaluation do not exist. The TAM is evaluated by comparing the value of different individuals of the same sex and age group. Also, TAM estimates the dynamics of the values obtained from one person or group of individuals.

To determine the anaerobic performance of the organism there are $WAnT_{10}$ (Wingate anaerobic test for 10 seconds), $WAnT_{30}$ (Wingate anaerobic test for 30 seconds),

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MQMK (maximum quantity of mechanical work for 1 minute) tests [17]. We did not meet the evaluation criteria of anaerobic productivity in scientific sources. Therefore, anaerobic performance is evaluated in the same way as the capacity of aerobic performance.

Dulo O.A. and Furman Yu.M. [1] found the difference between the mean values of the aerobic and anaerobic productivity of the body of young people of all ages and sex in different regions of Ukraine. Therefore, there is a need to develop criteria that take into account the above-mentioned factors.

All existing criteria for assessing the aerobic performance of an organism need to be updated taking into account the specifics of the region. In the absence of criteria for evaluating anaerobic productivity, there is a need for their development.

The developed criteria for assessing functional preparedness will become an objective benchmark for assessing the aerobic and anaerobic capabilities of the youth. Such criteria are based on modern data. They take into account the features of the region and reflect the entire spectrum of energy potential of the organism.

The purpose of the study is to establish standards for assessing the aerobic and anaerobic productivity of the body of youth in the age of 17-19 years of Podilsk region.

Material and methods.

Participants. The study involved students (n = 799 - girls, n = 668 - boys). All students study at Higher Education Institutions of Vinnytsia (Ukraine) and live within Podilsk region. Students belong to the main medical group and have not been engaged in sports for the last 5 years.

Organization of research. At first, the students determined the indicators of functional preparedness.

The power of aerobic energy supply processes was determined by Karpman V.L. et al [18]. The student performed two loads on a bicycle ergometer for 5 minutes each (interval of rest – 3 minutes). The pedaling speed was 60 revolutions per min.$^{-1}$. The power of the first load was 1 W per 1 kg of body weight. The power of the second load was 2 W per 1 kg of body weight. At the end of each load, the heart rate (heart rate) was recorded. The calculations were based on the value of $VO_{2\ max}$. $VO_{2\ max}$ was displayed in ml min^{-1}.

TAM was determined by the test Yu.M. Furman [9]. The student performed work on a bicycle with a gradually increasing power. The duration of operation and the frequency of pedaling at each level did not change: the duration was 40 s; the frequency was 60 revolutions per min.$^{-1}$. The power of work was gradually increased. Work began at a power of 60 W. 10 W were added per each degree. Every 40 s were determined by heart rate. The threshold of anaerobic exchange corresponded to the load capacity, which recorded the loss of linear growth of heart rate.

The capacity of anaerobic alactic productivity was determined by Wingate anaerobic test (Wingate anaerobic test for 10 seconds – $WAnT_{10}$). The capacity of anaerobic lactic productivity was determined by Wingate anaerobic test (Wingate anaerobic test for 30 seconds – $WAnT_{30}$) [17]. These tests assume the performance of veloergometric load with the maximum possible frequency of pedaling: during 10 s; within 30 s. The magnitude of the capacity of anaerobic alactic productivity and anaerobic lactic productivity was reflected in W [17].

The capacity of anaerobic lactic energy supply processes was determined by the method of Shogy A., Cherebetin G [19]. This technique involves determining the maximum amount of external mechanical work for 1 min (maximum quantity of mechanical work for 1 minute – MQMK) when working on a bicycle. The magnitude of the capacity of anaerobic lactic energy supply processes was reflected in W.

On the basis of the obtained data, the criteria for evaluation were developed.

The statistical analysis of the data was carried out using the Excel 2010 program.

The standards of functional readiness were developed on the basis of the arithmetic mean ($\overline{X}$) of $VO_{2\ max}$, TAM, $WAnT_{10}$, $WAnT_{30}$, MQMK and the range of mean square deviations (σ).

Results

Tables 2-5 show the standards of aerobic and anaerobic performance of the organism developed by us for the youth of 17-19 years old living in Podilsk region.

The data obtained by us confirmed the hypothesis that the "average' level of aerobic productivity of girls (see Table 1) is significantly higher than the established "safe level of health" [12]. For Piarnat Ia.P. [4] the "excellent" level of aerobic performance corresponds to a value >38 ml×mil^{-1}×kg $^{-1}$. According to our data, the value of 38 ml×min^{-1}×kg $^{-1}$corresponds only to the "average" level (Table 1).

The standards of anaerobic body productivity of girls aged 17-19 years old do not have analogues in the literature, therefore it is impossible to compare them (Table 2).

The data in Table 3 indicates that the "average" level of aerobic productivity of 17-19 years old boys coincides with the "safe level of health" [12]. The data obtained are somewhat lower than the well-known standards for boys [4].

The standards of anaerobic productivity of the body of boys of 17-19 years old do not have analogues in the literature, therefore it is impossible to compare them (Table 2).

Discussion.

Dembo A.G. [20], Karpman V.L. [21] developed anthropometric standards. The authors, for an average level, took a range of ± 1σ from the arithmetic mean for a large number of homogeneous contingents. Chogovadze A.V. [22] for the average level of the feature took the range ± 0,67 σ. It is known that the value of ± 1 σ from $\overline{X}$ - is a fairly wide range. This range includes 68.27% of the total sample [23]. Therefore, we recommend a range of ± 0,5σ

Table 1. Standards of aerobic productivity of girls aged 17-19 years old in Podilsk region by indicators of VO_2 and TAM, (n=799)

Sigma	Level of functional preparation	Aerobic productivity $VO_{2\ max}$, ml·min $^{-1}$	$VO_{2\ max}$, ml·min^{-1}·kg^{-1}	TAM, W	TAM, W·kg^{-1}
> 2,0 σ	Very high	> 2892,6	> 49,5	> 171,6	> 3,3
1,1 – 2,0 σ	high	2658,6 – 2892,6	44,9 – 49,5	155,8 –171,6	2,8 – 3,3
0,6 – 1,0 σ	Above the average	2541,7 – 2658,6	42,46 – 44,8	147,9 – 155,7	2,7 – 2,8
$\overline{X}$ + 0,5 σ – ($\overline{X}$ ± 0,5 σ) – $\overline{X}$ - 0,5 σ	average	2541,6 – (2424,6 ± 117,00) – 2307,6	42,5 – (40,1 ± 2,35) – 37,8	147,8 – (139,8 ±7,96) – 131,8	2,6 – (2,5 ± 0,22) – 2,2
-0,6 – -1,0 σ	Below the average	2307,5 – 2190,6	37,74 – 35,4	131,7 – 123,9	2,1 – 2,0
-1,1 – -2,0 σ	low	2190,5 – 1956.6	35,3 – 30,7	123,8 – 107,9	1,8 – 1,5
< -2,0 σ	Very low	< 1956.6	< 30,7	< 107,9	< 1,5

Note. ▭ – average level of functional preparedness.

Table 2. Standards of anaerobic productivity of girls aged 17-19 years old in Podilsk region by $WAnT_{10}$ (n = 165), $WAnT_{30}$ (n = 165) and MQMK (n = 633)

Sigma	Level of functional preparation	Anaerobic productivity $WAnT_{10}$, kgm·min^{-1}	$WAnT_{10}$, kgm·min^{-1}·kg^{-1}	$WAnT_{30}$, kgm·min^{-1}	$WAnT_{30}$, kgm·min^{-1}·kg^{-1}	MQMK, kgm·min^{-1}	MQMK, kgm·min^{-1}·kg^{-1}
> 2,0 σ	Very high	> 3398,8	> 49,42	>2509,3	> 41,72	> 2171,2	> 34,5
1,1 – 2,0 σ	high	2845,2 – 3398,8	43,2 – 49,42	2110,7 – 2509,3	36,32 – 41,72	1947,3 – 2171,2	31,4 – 34,5
0,6 – 1,0 σ	Above the average	2568,3 – 2845,1	40,0 – 43,1	2110,6 – 2309,8	33,7 – 36,31	1836,2 – 1947,2	29,8 –31,3
$\overline{X}$ + 0,5 σ - ($\overline{X}$ ± 0,5 σ) - $\overline{X}$ - 0,5 σ	average	2568,2 – (2291,3 ± 276,87) – 2014,4	39,9 – (36,8 ± 3,11) – 33,7	2110,5 – (1911,1 ± 199,35) – 1711,8	33,6 – (30,9 ± 2,71) – 28,2	1835,2 – (1723,2 ± 112,01) – 1611,2	29,7 – (28,1 ± 1,55) – 26,6
-0,6 – -1,0 σ	Below the average	2014,3 – 1737,5	33,6 – 30,5	1711,7 – 1512,4	28,1 – 25,5	1611,1 – 1499,2	26,5 – 25,1
-1,1 – -2,0 σ	low	1737,4 – 1183,8	30,4 – 24,3	1512,3 – 1113,7	25,4 – 20,1	1499,1 – 1275,2	25,0 – 22,0
< -2,0 σ	Very low	< 1183,7	< 24,3	< 1113,7	< 20,1	< 1275,2	< 22,0

Note. ▭ – average level of functional preparedness.

to determine the average level of aerobic and anaerobic performance of an organism. The level "above average" or "below average" is recommended to be determined within the range 0,6σ - 1σ or (-0,6σ) - (-1σ). The "high" and "low" levels can be found within the range 1.1σ-2σ or (-1.1σ) - (-2σ). The "very high" level should be found within> 2.0 σ. The "very low" level should be found within the range of <-2.0 σ.

According to this concept: the standards of functional preparedness - this range of deviation from the average values of indicators of aerobic and anaerobic productivity of the organism. This range is expressed in σ. Such a range is obtained by statistical processing of a large number of measurements of a homogeneous composition of the contingent of people. This contingent does not differ by age, gender, social status, physical activity, or residence in a particular area.

We have compared the individual values of the students of Podilsk region with the standards of functional readiness (Fig. 1). In this way, we get an individual profile of functional preparadness. The profile visually distinguishes those aspects of functional

Table 3. Standards of aerobic productivity of boys of the 17-19 years of the Podilsk region in terms of indicators VO_2 (n = 668) and TAM (n = 482)

Sigma	Level of functional preparation	Aerobic productivity			
		$VO_{2\ max}$, ml min $^{-1}$	$VO_{2\ max}$, ml·min^{-1}·kg^{-1}	TAM, W	TAM, W kg^{-1}
> 2,0 σ	Very high	> 3512,4	> 50,0	> 229,0	> 3,4
1,1 – 2,0 σ	high	3263,9 – 3512,4	45,9 – 50,0	211,3 – 229,0	3,1 – 3,4
0,6 – 1,0 σ	Above the average	3139,5 – 3263,8	43,8 – 45,8	202,4 – 211,2	2,74 – 3,0
$\overline{X}$ + 0,5 σ - ($\overline{X}$ ± 0,5 σ)- $\overline{X}$ - 0,5 σ	average	3139,4 – (3015,1± 124,3) – 2890,8	43,7 – (41,6 ± 2,10) – 39,5	202,3 – (193,4 ± 8,9) – 184,5	2,7 – (2,5 ± 0,23) – 2,3
-0,6 – -1,0 σ	Below the average	2890,7 – 2766,4	39,4 – 37,4	184,4 – 175,6	2,26 – 2,05
-1,1 – -2,0 σ	low	2766,3 – 2517,8	37,3 – 33,2	175,5 – 157,8	2,04 – 1,6
< -2,0 σ	Very low	< 2517,8	< 33,2	< 157,8	< 1,6

Note. – average level of functional preparedness.

Table 4. Standards of anaerobic productivity of boys aged 17-19 years old in Podilsk region according to the indices of $WAnT_{10}$ (n = 124), $WAnT_{30}$ (n = 124) and MQMK (n = 548).

Sigma	Level of functional preparation	Anaerobic productivity					
		$WAnT_{10}$, kgm·min^{-1}	$WAnT_{10}$, kgm·min^{-1}·kg^{-1}	$WAnT_{30}$, kgm·min^{-1}	$WAnT_{30}$, kgm·min^{-1}·kg^{-1}	MQMK, kgm·min^{-1}	MQMK, kgm·min^{-1}·kg^{-1}
> 2,0 σ	Very high	> 5064,8	> 68,3	> 4891,9	> 63,72	> 2853,2	> 42,2
1,1 – 2,0 σ	high	4510,8 – 5064,8	61,6 – 68,3	4246,7 – 4891,9	56,8 – 63,72	2582,2 – 2853,2	37,3 – 42,2
0,6 – 1,0 σ	Above the average	4233,8 – 4510,7	58,2 – 61,5	3924,0 – 4246,6	53,4 – 56,7	2446,7 – 2582,1	34,9 – 37,2
$\overline{X}$ + 0,5 σ - ($\overline{X}$ ± 0,5 σ)- $\overline{X}$ - 0,5 σ	average	4233,7 – (3956,6 ± 277,05) – 3679,6	58,1 – (54,7 ± 3,40) – 51,3	3923,9 – (3601,2 ± 322,69) – 3278,5	53,3 – (49,8 ± 3,48) – 46,3	2446,6 – (2311,0 ± 135,56) – 2175,4	34,8 – (32,3 ± 2,47) – 29,8
-0,6 – -1,0 σ	Below the average	3679,5 – 3402,5	51,2 – 47,9	3278,5 – 2955,8	46,2 – 42,8	2175,3 – 2039,9	29,8 – 27,4
-1,1 – -2,0 σ	low	3402,4 – 2848,4	47,8 – 41,1	2955,7 – 2310,5	42,7 – 35,9	2039,8 – 1768,8	27,3 – 22,4
< -2,0 σ	Very low	< 2848,4	< 41,1	< 2310,5	< 35,9	< 1768,8	< 22,4

Note. – average level of functional preparedness.

readiness that require correction. As an example of the functional readiness of student N. The level of functional preparedness is within the range or exceeds it. According to the level of functional readiness of the student, one can conclude that the means of physical education should be directed to maintain its level of functional readiness.

Conclusions.

It is known that over time the standards of functional readiness lose their objectivity. Therefore, such standards need to be updated. In literary sources, there are no standards for functional preparedness in terms of TAM, anaerobic lactic and anaerobic alactic productivity of the organism. We have found that new standards are developed by the average of the indicator. For this purpose, a survey of a large number of people of a uniform contingent is conducted. The gradation of standards is set within the range of the mean square deviation - σ. The developed standards cover the entire spectrum of aerobic and anaerobic productivity indicators of youth aged 17-19

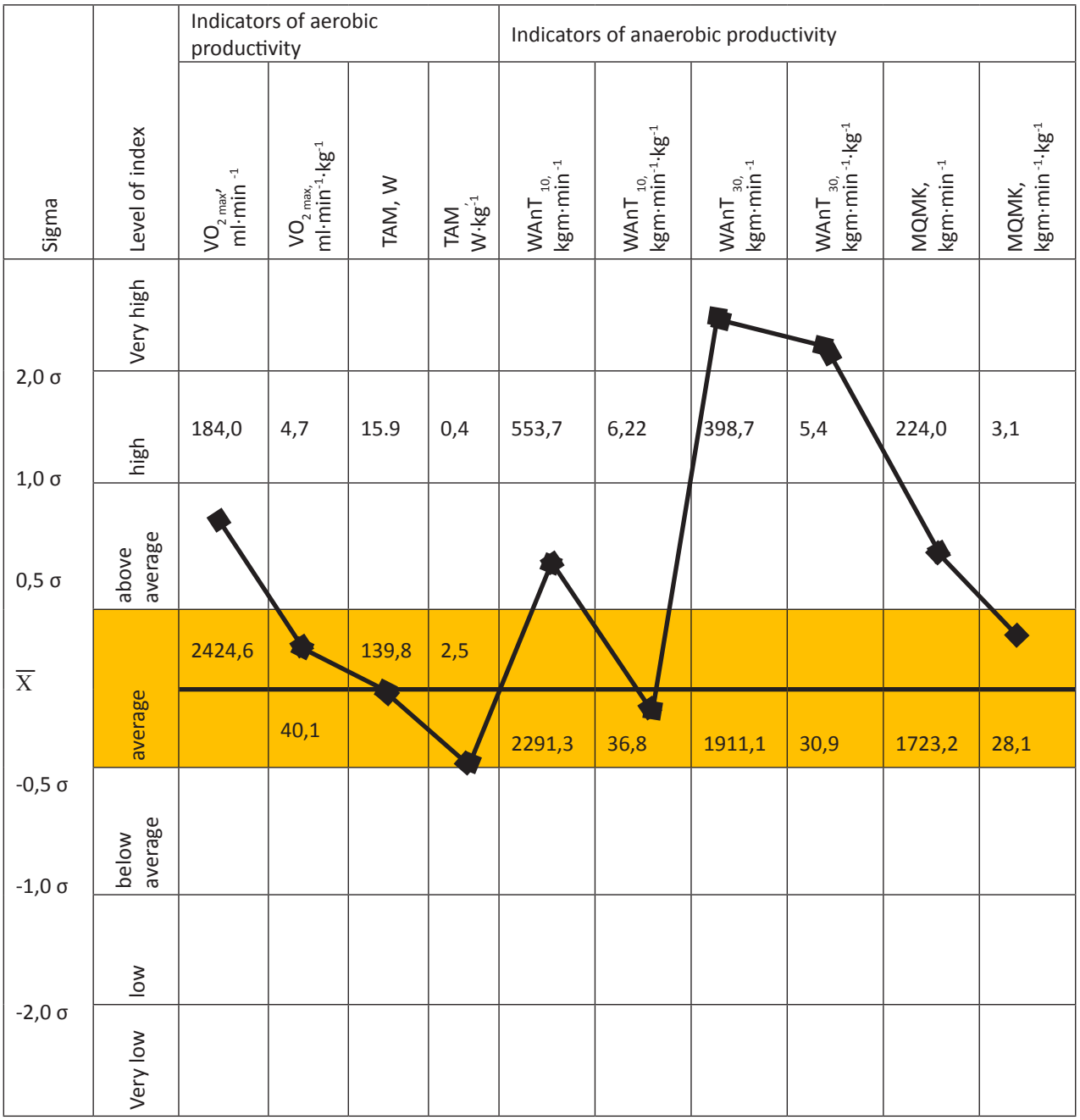

Fig. 1. Graphic representation of functional preparadness (individual profile) of examined N:

2424.6 - average value of index ($\overline{X}$);

184.0 – average level of index;

- value σ.

years old in Podilsk region.

Further research should be directed to the development of a computer program that evaluates individual student data on the basis of standards developed by us.

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Conflict of interest.

The authors state that there is no conflict of interest.

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