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CONTENT

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EXPRESS METHOD OF ASSESSMENT OF SOMATIC HEALTH OF PERSONS WITH DISORDERS IN MUSCULOSKELETAL SYSTEM ON RESERVES OF BIOENERGY (PROBLEM OF THE ATHLETES' HEALTH ASSESSMENT)

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Author contribution: A – study concept and design; B – data collection; C – data analysis and interpretation; D – paper writing; E – paper editing; F – paper final adoption.

Abstract

Introduction. It is known that the express method of quantitative assessment of the level of somatic health by bioenergy reserves (by G. Apanasenko) cannot be used when testing persons with musculoskeletal disorders. It is also known that this method cannot be used to assess the health of athletes. However, the problem of quantifying the somatic health of athletes with disabilities remains little studied.

Aim is to identify and scientifically substantiate the feasibility / inexpediency of using the express method in assessing the level of physical health of athletes with physical disabilities.

Material and methods: 1) theoretical (analysis of the scientific literature on the problems of health diagnostics), 2) empirical (pedagogical questionnaire, observation, pedagogical experiment), 3) analytical (statistical methods).

Results. Studies have established the fact of the specificity of the impact of training loads of different orientations on the indicators of rapid assessment of somatic health of athletes with physical disabilities.

Conclusions. It has identified that the main factor that makes it impossible to use the express method in assessing the level of physical health of athletes with special needs is the phenomenon of "loss" of functional abilities in the process of sports.

Key words: health, assessment, student-athletes with physical disabilities.

Introduction.

It was not accidentally that a well-known American scientist, a theorist of medicine Henry Sigerist noted that even the ancient philosophers valued health greatly and considered it one of the greater goods (for example, Socrates believed that health is not that everything, but everything is nothing without health) [29, 30, 31].

It is also known that one of the necessary conditions of focused impact on human health as hardest and multifaceted (from the view of holism or

integrated approach) [26, 28] bioenergetic, informational and social system able to self-organize and characterized by energy supply reserves of an organism is getting quantitative information about functional reserves of an organism constituting the basis of somatic health [1, 2, 4, 5, 9, 12, 21].

One of the methods for solving the problem of quantitative assessment of human somatic health is a screening-test developed by H. Apanasenko based on the fact of relationship of somatic (physical) health, general endurance (mechanisms of aerobic energy supply of functions), amount of physical reserves, and manifestation of economization of cardiorespiratory system's function [3, 4].

Though as exceptional the mentioned method cannot be fully used while testing people with locomotor system disorders, in spite of its informativeness, simplicity and availability.

To solve the problem of quantitative assessment of somatic health of people with disabilities (mainly because of locomotor system disorders after severe traumatic injuries and diseases of different nature, etc.) we developed and patented the way of assessment of somatic health of people with locomotor system disorders (based on multi-year research) [14].

From the study results of recent years we find out that H. Apanasenko's express method based on assessment of such indicators of organism viability as strength and efficiency of aerobic energy supply can be used only for those who do not do sports [7, 23], while it is not advisable to be used with highly trained adult athletes (sports excellence stage) [6, 8], or young athletes of teen age (special basic sports training stage) [16, 20]. The reason is considerable differences in the structure of energy metabolism during muscle action caused by the specificity of impact of training workloads of different orientation on human organism [10, 9, 17, 27].

Moreover, some authors [22, 24, 25] consider that energy potential amount not always can be as a measure of health as well as integral indicator of organism energy potential – maximal oxygen consumption is a measure of physical performance but it is not a measure of physical health and duration of human life.

In that regard, the question of advisability or inadvisability of using the mentioned above express method of assessment of somatic health level among athletes with locomotor system functional disorders is up-to-date.

The **aim of the research** was to identify and scientifically substantiate the question of advisability / inadvisability of using the express method of assessment of somatic health level among athletes with locomotor system disorders (LMS) on bioenergy reserves.

Material and methods of study: *theoretical*: – analysis of the scientific literature in problems of health diagnostics; *empirical*: 1) pedagogical questionnaire and observation; 2) pedagogical experiment: conducting express methods of assessment of *somatic health level* (SHL) among people with physical disabilities on organism's bioenergy reserves; *analytical:* – statistical methods.

Under our observation there were approximately 700 people (male and female) aged from 18 to 35 years old among which: the students of Institute of

Social Technologies of University «Ukraine» (Kyiv) and Brovary branch campus of University «Ukraine» (n=606) (of primary medical group not doing any sports, and 28 student-athletes of the mentioned educational institutions having locomotor system functional disorders and adults (male and female) not doing any sports (n=57).

Student-athletes aged from 18 to 23 years old (experimental group) were divided (according to A. Dembo's classification of kinds of sports [10]) into two groups: *group A* (n=13) – speed and strength sports (weightlifting, Greco-Roman and freestyle wrestling, powerlifting); *group B* (n=15) – endurance sports (swimming: 200, 400 and 1500 m, athletics: 800, 1500, 3000 and 5000 m run; paratriathlon).

The *control group* included 35 students of the mentioned above educational institutions of primary medical group not doing any sports.

The study was conducted based on University «Ukraine» and Brovary branch campus of University «Ukraine» in the first half of the day from 9 a.m. till 1 p.m. and in the second half of the day from 4 till 7 p.m., which means during the periods of more productive organism functionality. The day before the study the athletes did not exercise in the second half of the day. They ate not earlier than two hours before the trainings started. The air temperature during the conducting of laboratory testing was between + 18 °C and + 24 °C.

For the period of conducting the studies all the examined were not sick, informed of the tests' content and gave their consent on taking part in the studies (as demanded by the legislation of Ukraine on healthcare [13] and Helsinki declaration on participation of the examined in medical and biological studies [32]).

Table 1. **Express assessment of somatic health level (by H. Apanasenko)** [4]

Indicators	Health level									
	Low		Lower than average		Average		Higher than average		High	
	M	F	M	F	M	F	M	F	M	F
Body mass index ($kg \cdot m^{-2}$)	≤18.9 (-2)	≤16.9 (-2)	19.0-20,0 (-1)	17.0-18,6 (-1)	20.1-25.0 (0)	18.7-23.8 (0)	25.1-28.0 (-1)	23.9-26.0 (-1)	≥28.1 (-2)	≥26.1 (-2)
Birth-death ratio ($ml \cdot kg^{-1}$)	< 50 (-1)	< 40 (-1)	51-55 (0)	41-45 (0)	56-60 (1)	46-50 (1)	61-65 (2)	51-56 (2)	> 66 (3)	> 56 (3)
Force index (%)	< 60 (-1)	< 40 (-1)	61-65 (0)	41-50 (0)	66-70 (1)	51-55 (1)	71-78 (2)	56-60 (2)	> 80 (3)	> 61 (3)
Robinson index (relat. un.)	>111 (-2)	>111 (-2)	95-110 (-1)	95-110 (-1)	85-94 (0)	85-94 (0)	70-84 (3)	70-84 (0)	< 69 (5)	< 69 (5)
Time for HR recovery after 20 squats in 30 s	≥ 3[1] (-2)	≥ 3[1] (-2)	2-3[1] (1)	2-3[1] (1)	1.30-1.59[1] (3)	1.30-1.59[1] (3)	1.0-1.29[1] (5)	1.0-1.29[1] (5)	≤59[11] (7)	≤59[11] (7)
General assessment of health level (points)	< 3	< 3	4-6	4-6	7-11	7-11	12-15	12-15	16-18	16-18

Results of the research and discussion.

By the results of multi-year studies conducted by us [18] three variants of assessment scales for somatic health level among people with physical disabilities mainly caused by disability itself not able to complete the testing moves comprising express method of assessment of somatic health level actually healthy people with no LMS functional disorders (*table 1*).

Not to break the system of general SHL assessment (in points) whose author is H. Apanasenko we decided to evaluate our proposed indicators:

1) time value for HR recovery after 10 pushups in 30 s;

2) force index of shoulder dynamometry;

3) maximal pause of holding breath when breathing out (see further) by the same scale as time value for HR recovery after 20 squats in 30 s and force index value of wrist dynamometry.

The first variant: for people with paralysis in the upper limbs (upper paraplegia) and with amputated upper limbs – shoulder dynamometry was implemented instead of wrist dynamometry equivalent to it in determination of force index (*table 2*).

Table 2. **Express assessment of somatic health level among people with locomotor system disorders (by M. Khoroshukha: 1st variant)** [15]

Indicators	Health level									
	Low		Lower than average		Average		Higher than average		High	
	M	F	M	F	M	F	M	F	M	F
Body mass index ($kg \cdot m^{-2}$)	≤18.9 (-2)	≤16.9 (-2)	19.0-20.0 (-1)	17.0-18.6 (-1)	20,1-25.0 (0)	18.7-23.8 (0)	25.1-28.0 (-1)	23.9-26.0 (-1)	≥28.1 (-2)	≥26.1 (-2)
Birth-death ratio ($ml \cdot kg^{-1}$)	< 50 (-1)	< 40 (-1)	51-55 (0)	41-45 (0)	56-60 (1)	46-50 (1)	61-65 (2)	51-56 (2)	> 66 (3)	> 56 (3)
Force index (%)	< 45 (-1)	< 30 (-1)	46-50 (0)	31-35 (0)	51-65 (1)	36-40 (1)	56-60 (2)	41-45 (2)	> 60 (3)	> 45 (3)
Robinson index (relat. un.)	> 111 (-2)	> 111 (-2)	95-110 (-1)	95-110 (-1)	85-94 (0)	85-94 (0)	70-84 (3)	70-84 (0)	< 69 (5)	< 69 (5)
Time for HR recovery after 20 squats in 30 s	≥ 3[1] (-2)	≥ 3[1] (-2)	2-3[1] (1)	2-3[1] (1)	1,30-1,59[1] (3)	1,30-1,59[1] (3)	1,0-1,29[1] (5)	1,0-1,29[1] (5)	≤59[11] (7)	≤59[11] (7)
General assessment of health level (points)	< 3	< 3	4-6	4-6	7-11	7-11	12-15	12-15	16-18	16-18

The second variant: for people with paralysis in the lower limbs (lower paraplegia) and with amputated lower limbs – instead of the test of 20 squats in 30 seconds and determination of time for heart rate (HR) recovery after completed physical workload, respectively, the equivalent tests of 10 pushups in 30 seconds (for men) and 15 sit-ups with hands clasped behind the neck in 30 seconds (for women) analogous to them were implemented (*table 3*).

Table 3. **Express assessment of somatic health level among people with locomotor system disorders (by M. Khoroshukha: 2nd variant)** [15]

Indicators	Health level									
	Low		Lower than average		Average		Higher than average		High	
	M	F	M	F	M	F	M	F	M	F
Body mass index ($kg \cdot m^{-2}$)	≤18,9 (-2)	≤16,9 (-2)	19,0-20,0 (-1)	17,0-18,6 (-1)	20,1-25,0 (0)	18,7-23,8 (0)	25,1-28,0 (-1)	23,9-26,0 (-1)	≥28,1 (-2)	≥26,1 (-2)
Birth-death ratio ($ml \cdot kg^{-1}$)	< 50 (-1)	< 40 (-1)	51-55 (0)	41-45 (0)	56-60 (1)	46-50 (1)	61-65 (2)	51-56 (2)	> 66 (3)	> 56 (3)
Force index (%)	< 60 (-1)	< 40 (-1)	61-65 (0)	41-50 (0)	66-70 (1)	51-55 (1)	71-78 (2)	56-60 (2)	> 80 (3)	> 61 (3)
Robinson index (relat. un.)	> 111 (-2)	> 111 (-2)	95-110 (-1)	95-110 (-1)	85-94 (0)	85-94 (0)	70-84 (3)	70-84 (0)	< 69 (5)	< 69 (5)
Time for HR recovery after 10 pushups in 30 s	≥ 3[1] (-2)	≥ 3[1] (-2)	2-3[1] (1)	2-3[1] (1)	1,30-1,59[1] (3)	1,30-1,59[1] (3)	1,0-1,29[1] (5)	1,0-1,29[1] (5)	≤59[11] (7)	≤59[11] (7)
General assessment of health level (points)	< 3	< 3	4-6	4-6	7-11	7-11	12-15	12-15	16-18	16-18

The third variant: for people with paralysis in the upper and lower limbs (quadriplegia) and with amputated limbs, respectively, instead of wrist dynamometry shoulder dynamometry was used, and instead of testing moves related to squats and pushups the test of holding breath when breathing out (determination of maximal pause by K. Buteiko's method [11]) (*table 4).*

Table 4. **Express assessment of somatic health level among people with locomotor system disorders (by M. Khoroshukha: 3rd variant))** [15]

Indicators	Health level									
	Low		Lower than average		Average		Higher than average		High	
	M	F	M	F	M	F	M	F	M	F
Body mass index ($kg \cdot m^{-2}$)	≤18.9 (-2)	≤16.9 (-2)	19.0-20.0 (-1)	17.0-18.6 (-1)	20.1-25.0 (0)	18.7-23.8 (0)	25.1-28.0 (-1)	23.9-26.0 (-1)	≥28.1 (-2)	≥26.1 (-2)
Birth-death ratio ($ml \cdot kg^{-1}$)	< 50 (-1)	< 40 (-1)	51-55 (0)	41-45 (0)	56-60 (1)	46-50 (1)	61-65 (2)	51-56 (2)	> 66 (3)	> 56 (3)
Force index (%)	< 45 (-1)	< 30 (-1)	46-50 (0)	31-35 (0)	51-65 (1)	36-40 (1)	56-60 (2)	41-45 (2)	> 60 (3)	> 45 (3)
Robinson index (relat. un.)	> 111 (-2)	> 111 (-2)	95-110 (-1)	95-110 (-1)	85-94 (0)	85-94 (0)	70-84 (3)	70-84 (0)	< 69 (5)	< 69 (5)
Maximal pause (s)	≤ 35 (-2)	≤ 35 (-2)	40-55 (1)	40-55 (1)	60-75 (3)	60-75 (3)	80-95 (5)	80-95 (5)	≥ 100 (7)	≥ 100 (7)
General assessment of health level (points)	< 3	< 3	4-6	4-6	7-11	7-11	12-15	12-15	16-18	16-18

The developed methodology was tested (in dynamics) on three patients with LMS functional disorders. Diagnosis: traumatic paraplegia of lower limbs affected by dorsal spine injury. Instead of the test of 20 squats in 30 s the test of 10 pushups in the same period of time equivalent to it was conducted (*table 5*).

Table 5. **The dynamics of indicators of somatic health among people with locomotor system disorders (by the author's development)** [18]

The examined	*Studies*	*Indicators*					
		Body mass index ($kg \cdot m^{-2}$)	Birth-death ratio ($ml \cdot kg^{-1}$)	Force index (%)	Robinson index (relat. un.)	Time for HR recovery after 10 pushups in 30 s	Somatic health level (points)
V-yi	1	24.3 (0)	53.2 (0)	67.3 (1)	77.4 (3)	2.50' (1)	5
	2	24.3 (0)	51.4 (0)	68.7 (1)	75.2 (3)	2.50' (1)	5
	3	24.3 (0)	53.0 (0)	70.1 (1)	76.8 (3)	2.40' (1)	5
	4	24.4 (0)	52.7 (0)	69.4 (1)	73.3 (3)	2.50' (1)	5
S-ko	1	26.7 (-1)	51.7 (0)	65.2 (1)	72.0 (3)	2.45' (1)	4
	2	26.7 (-1)	54.2 (0)	66.8 (1)	74.7 (3)	2.50' (1)	4
	3	26.7 (-1)	53.6 (0)	67.4 (1)	72.6 (3)	2.40' (1)	4
	4	26.2 (-1)	54.4 (0)	68.8 (1)	75.7 (3)	2.50' (1)	4
F-ko	1	22.4 (0)	63.7 (2)	74.7 (2)	68.2 (5)	1.40' (3)	12
	2	22.4 (0)	61.8 (2)	78.2 (2)	67.0 (5)	1.50' (3)	12
	3	22.4 (0)	64.1 (2)	79.0 (2)	68.5 (5)	1.50' (3)	12
	4	21.0 (0)	64.6 (2)	79.3 (2)	65.3 (5)	1.35' (3)	12

As we can see from the data of this table, the SHL of the three examined people during subsequent tests (the first three studies were conducted every second day, and the fourth – in 30 days) conducted by us under the same conditions match. Thus, among the first two people not doing any sports, the SHLs are evaluated as lower than average (5 and 4 points, respectively).

The somatic health level of the individual F-ko – a Paralympian doing tennis professionally, was higher than average (12 points) as was expected. So, the highlighted above indicates reliability (stability) and objectivity of the test in determination of somatic health among people with physical

disabilities. Yet, due to little amount of people with mentioned pathology directly taking part in examination of efficiency of the mentioned method (in possibilities of using which we have no doubt) we consider conducting additional studies in this respect advisable.

And finally, to solve the issue of advisability or inadvisability of using the express method of assessment of somatic health level among athletes with LMS disorders suggested by us, we conducted analogous studies in which student-athletes with special needs took part. Thus, based on our conducted studies it was established that among student-athletes with physical disabilities aged 18-23 years old (regardless of training process orientation) the SHLs higher than average are recorded (from 12 to 14 points), whilst among their agemates – students not doing any sports – mostly average levels (from 7 to 12 points, respectively).

The way of BDR changes in the three groups of the examined by data of the first and second (in a year) periods of the study are given in the *fig. 1* and *2*.

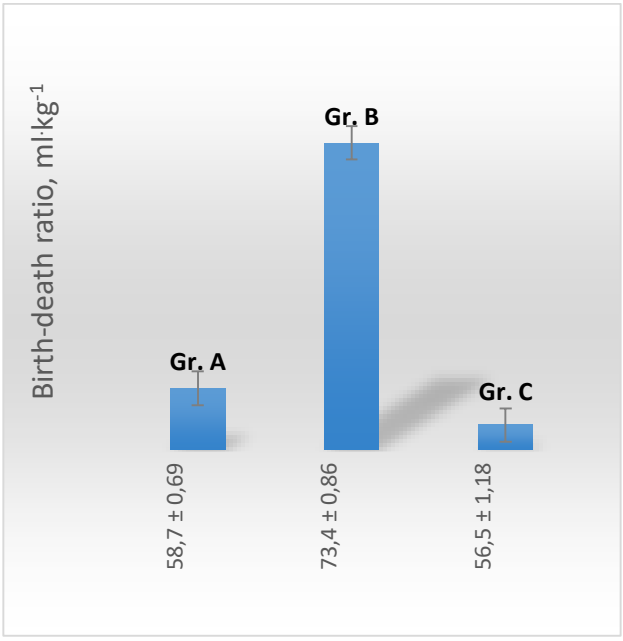

Fig. 1. Characteristics of birth-death ratio among athletes with special needs aged 18-23 while speed and strength oriented sports (group A), endurance sports (group B) and their agemates – students not doing any sports (group C), by data of the first period of studies

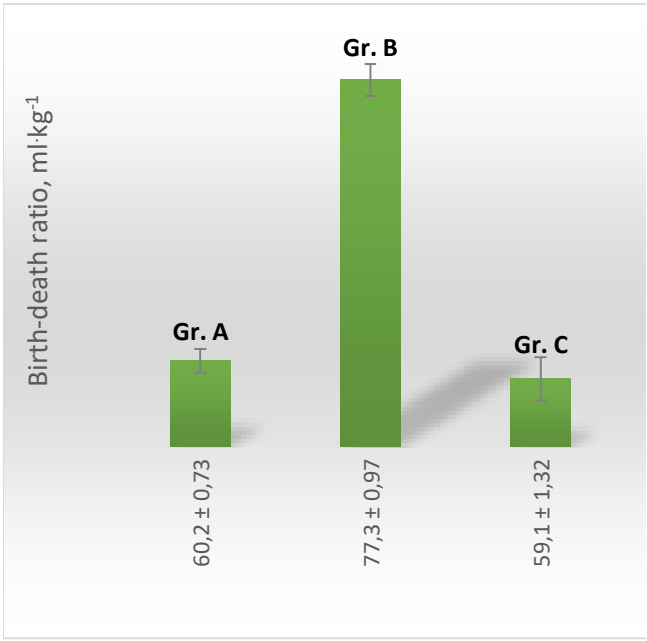

Fig. 2. Characteristics of birth-death ratio among athletes with special needs aged 18-23 while speed and strength oriented sports (group A), endurance sports (group B) and their agemates – students not doing any sports (group C), by data of the second period of studies

Though, it is worth noting that equally high SHLs among representatives of different training-oriented sports are gained by different ways, namely: in speed and strength sports (weightlifting, Greco-Roman

and freestyle wrestling, powerlifting) dependable ($p<0.001$) growth of force index (FI) and incident ($p>0.05$) growth of birth-death ratio (BDR) were recorded, whilst in endurance sports (swimming, athletics and paratriathlon), in contrast, probable ($p<0.001$) BDR growth and weak FI changes were recorded.

We note also that among the students representing the control group no growth of BDRs or SIs was recorded ($p>0.05$ in both cases).

As we can see, the highest values of this indicator are observed among the representatives of endurance sports compared to the athletes mostly developing speed and strength qualities both in the first ($t = 13.33$; $p < 0.001$) and second ($t = 14.09$; $p < 0.001$) periods of the study. Consequently, among the athletes of the group B the BDR value is dependably higher than among not athletes ($t = 11.57$; $p < 0.001$ – in the first period of the study and $t = 11.11$; $p < 0.001$ – in the second).

We can note the fact that the changes of the given indicator among the athletes of the groups A and control (C) did not have any statistically significant difference both in the first period of the studies ($t = 1.61$; $p>0.05$) and in the second one (respectively, $t = 1.39$; $p>0.05$).

Analyzing the dynamics of changes of the sequent indicator – force index (*fig. 3* and *4*), we can note the fact that the changes of this indicator are alternative to the way of changes of the previous indicator – birth-death ratio.

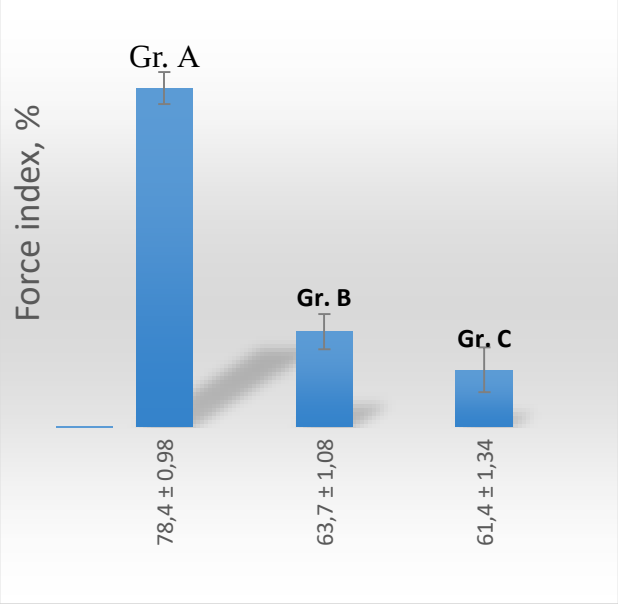

Fig. 3. Characteristics of force index among athletes with special needs aged 18-23 while speed and strength oriented sports (group A), endurance sports (group B) and their agemates – students not doing any sports (group C), by data of the first period of studies

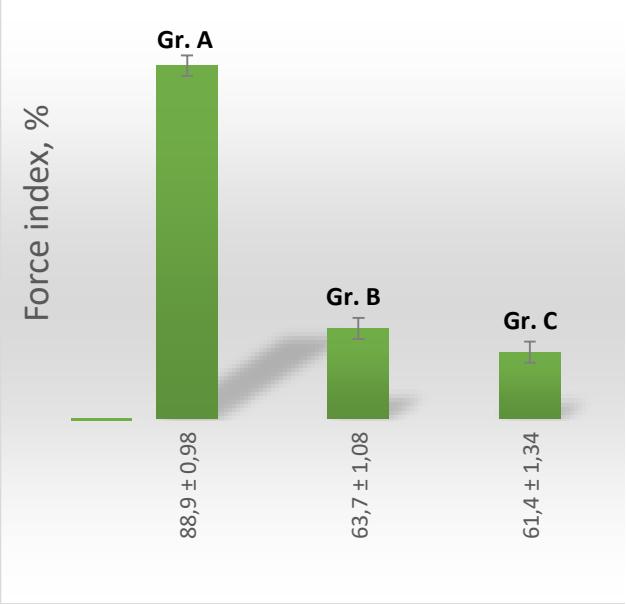

Fig. 4. Characteristics of force index among athletes with special needs aged 18-23 while speed and strength oriented sports (group A), endurance sports (group B) and their agemates – students not doing any sports (group C), by data of the second period of studies

Thus, among athletes of speed and strength sports the FI indicator is dependably higher compared to the endurance sports and control both in the first ($t = 10.08$; $p<0.001$ – for the athletes of the group B and $t = 10.24$; $p<0.001$ – for the representatives of the group C) and second periods of the studies ($t = 13.08$ and 13.20 with $p<0.001$ in both cases, respectively). So, from the results of the conducted studies we find out that among athletes with special needs similar to the athletes not having functional disorders [20], there are significant differences in the structure of energy exchange caused by different orientation of training process.

That is why, as we see it, the main factor making it impossible to use express method of assessment of somatic health level among athletes with physical disabilities on bioenergy reserves is the phenomenon of «loss» of functional abilities while doing sports.

The latter, as it was noted before, is the result of the specificity of training workloads impact of different orientations both on the structure of energy metabolism [6, 8, 27], and on the organism integrally [17].

As it was noted before [20], we can find out the fact of the specificity of training workloads impact of different orientations on the level of energy potential from the comparative analysis of some somatic health and physical performance indicators of two athletes (the skier B-s M. and the wrestler N-yi V.) – the representatives of the sports different by training process orientation having the same SHLs by the data of H. Apanasenko express method (*fig. 5*).

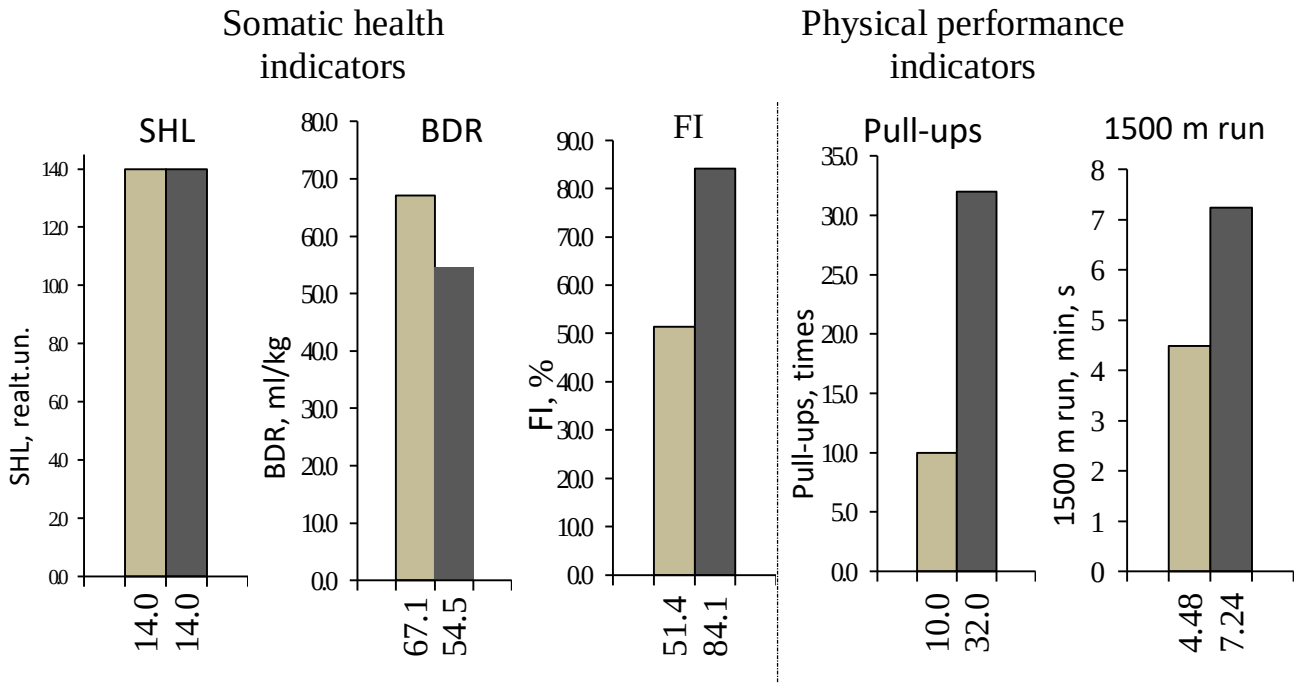

Fig 5. Some individual indicators of somatic health and physical performance of the skier M. B-s and the wrestler V. N-yi with 5 years of training experience having the same level of energy potential of an organism [20]

– skier; – wrestler

Though, as we can see from the picture, the mentioned athletes had different values in BDR and FI indicators, namely: the skier's BDR is dependably higher, whilst the wrestler's average FI values remain higher. Significant differences were recorded also in assessments of specific indicators of physical performance. Thus, the wrestler's force quality (by the data of pull-ups on the beam) was evaluated as «high» (5 points by State-testing scale), whilst his endurance (1500 m run result) was «low» (2 points), the skier's indicators recorded, accordingly, were high in running (time to cover the distance – 4 min. 48 s) and relatively low (more than three times lower than the wrestler's ones) indicators in pull-ups (10 and 32 times, respectively). As we can find out from our previous studies [19], almost single-typed manner of BDR and FI changes among healthy athletes was recorded among two athletes with special needs (training experience of 5 years): V. Z-yi – candidate for Master of Sports in swimming and S. P-ko – candidate for Master of Sports in weightlifting (*fig. 6*).

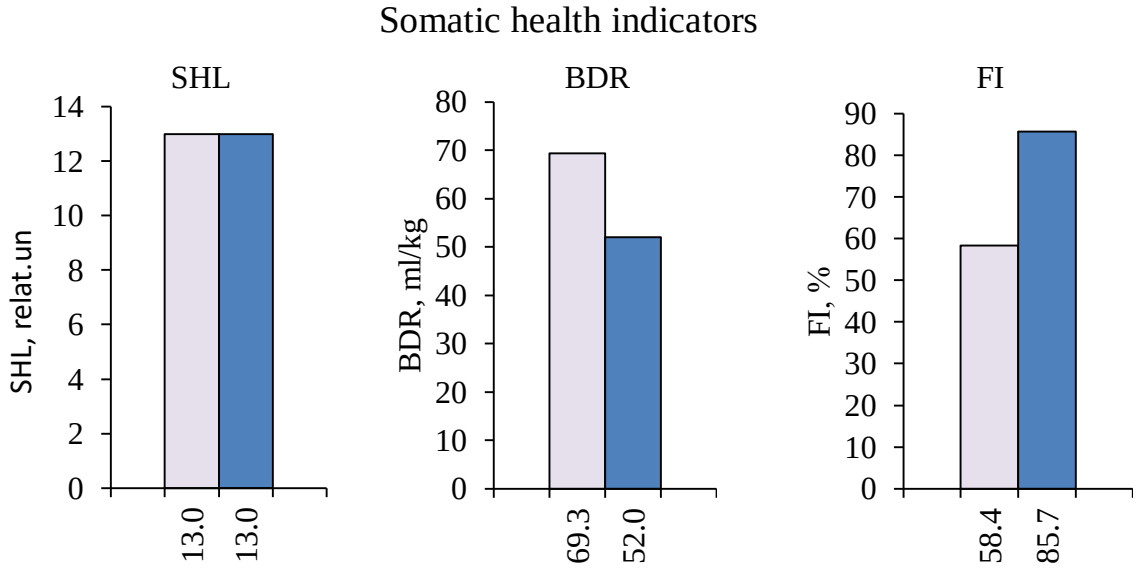

Fig. 6. Some individual indicators of somatic health of the swimmer and the weightlifter with 5 years of training experience having the same level of energy potential of an organism:

In spite of both athletes' SHLs being the same (13 points by the scale of express assessment of somatic health) the average the swimmer's BDR value was evaluated as «high» (69.3 $ml \cdot kg^{-1}$) whilst the weightlifter's one was «lower than average» (52.0 $ml \cdot kg^{-1}$). Accordingly, the weightlifter's FI value remains dependably higher (evaluated as «high»; 85.7 %) compared to the swimmer's one (evaluated as «low»; 58.4 %, respectively). It was very unfortunate that the mentioned athletes' physical performance level studies were not conducted because of physical impossibility to complete running workloads by one of them.

Conclusions. The main factor making it impossible to use express method of assessment of somatic health level among athletes with special needs on bioenergy reserves (as well as among the athletes without locomotor system functional disorders) is the phenomenon of «loss» of functional abilities while doing sports. The latter is the result of specific impact of differently-oriented training workloads both on the structure of energy metabolism and on human organism integrally [17].

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