

EVALUATION OF JUNIOR COURSES STUDENTS' LEVEL OF MOBILIZATION OF FUNCTIONAL BACKLOGS AT THE DOSED PHYSICAL ACTIVITIES AT THE PEDAGOGICAL UNIVERSITY

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Annotation. A study of the functional capacity of the organism lower division students. The study involved 85 students of 1-2 courses, 14 of which were engaged and were part of the team of the University of volleyball. As a student of muscular work performed pedaling on bicycle. The energy level was determined by performing metered loads with changing facilities for closed cycle. The data characterizing the physiological "cost" of adaptation, the level of stress the body of students in different phases of muscular work. Developed and presented model characteristics of the energy level of the body of girls. Reviewed degree of mobilization of functional reserves under load for closed loop five-point scale. Defined physical condition of students during the first year. The recommendations of the evaluation and prediction of the actual state of the physical health of students and improve physical education in high school.

Keywords: student, functional reserves, energy level, exercise.

Introduction

The problem of evaluation of different human organism's and separate systems' functional abilities appeared, actually, in the period of formation of physiology as science. Its sharpness is conditioned by clinical demands with diagnosing of certain disorders or pathologies of normal physiology, with conclusions about human state of health on different stages of ontogeny, with determination of health's dependence on numerous number of influencing factors, among which age, sex, anthropometric indicators, kind of activity, region of residence, social and ecological factors and so on are rather important. The urgency of the mentioned problem has especially been being felt recent decades in connection with general worsening of Ukrainian population's health, unsatisfactory demographic situation in Ukraine, cases of sudden deaths of pupils, sportsmen, military officers [2, 15]. Already taken measure, such as prohibition of test normative at physical culture classes, do not solve the problem but, on the contrary, aggravate it. In many higher educational establishments, physical education has become an optional discipline for senior students with its effectiveness leaving much to be desired and requiring clear determination [7, 11].

Compulsory medical examinations of pupils and students, which are now introduced in practice, require objectification and further improvement, like it is done in the course of medical-biological control of highly qualified sportsmen and sports reserve and which envisages wide spectrum of functional diagnostics' methods [12].

Scientists carry out researches and foundations of functional abilities' reliable prognostication by data of dosed tests [1, 2, 5, 8, 10, 12, 17-19], as far as extreme conditions are accompanied by significant straining of provisioning and regulatory systems [10]. Separate question of functional diagnostics is development or renewal of indicators, criteria of normative limits, characterizing organism's systems both in relaxed state and under influence of different factors, including physical loads.

In our opinion [5, 6], the most adequate, prompt and informative mean of human functional abilities' evaluation as well as evaluation of their mobilization level under urgent adaptation is dosed, cyclic bicycle ergometer load with alternating power as closed cycle [8, 9], which is briefly called "with reverse". This methodic permits to evaluate functional abilities by 30 indicators, combined in 5 groups: 1) indicators of the test itself; 2) criteria of physical workability; 3) heart beat frequency dynamics; 4) indicators of regulation effectiveness (effectiveness of mobilization of reserves); 5) indicators of organism's energetic level (levels of adaptation, tension of functioning) and requires much less time than traditional method of physical workability's evaluation PWC₁₇₀ [10].

D.M. Davidenko et al. [8, 9] introduced a number of non-standard, little known in physiology terms and concepts but they are grounded by different practical and theoretical approaches and by rich apparatus of mathematical processing, by high qualification of specialists of well-known physiological department of physical culture institute, named after P.F. Lesgaft (S. Petersburg). Unfortunately, this methodic have not been implemented in scientific-research activity of specialists though different objective and subjective reasons (one of them is fabricated high cost) that reduces possibilities of its theoretical and practical development and improvement.

Present work has been fulfilled as per topical plans of scientific and research work of biology and principles of health department of South Ukrainian national pedagogic university, named after K.D. Ushynskiy (Odessa) "Systemic adaptation to physical and mental loads on separate stages of human ontogeny" (State registration No. 0109U000206).

Purpose, tasks of the work, material and methods

The purpose of the research was determination of functional reserves' mobilization level of junior students and creation of model characteristics as per the data, obtained in testing with alternating power of load in closed cycle.

We examined 85 1st and 2nd year girl-students of South Ukrainian national pedagogic university, named after K.D. Ushynskiy (Odessa); 14 of them trained volleyball and were the members of university's combined team. By

results of medical examination all girl-students belonged to main health group and took part in all stages of functional abilities' studying, which were carried out at laboratory of age sport physiology of biology and principles of health department.

For determination of mobilization level of functional reserves we used methodic by D.M. Davidenko et al. [8, 9] in its full scope that permitted, by results of testing, to mark out certain groups of reserve abilities' criteria, one of which, i.e. group of organism's energetic level indicators, was taken as the base for solution of our task. As muscular work, girl-students used bicycle ergometer BEД-12 (60 r.p.m) with alternating of load power with constant speed (200 kgm.p.m^{-1} or 33 W p.m^{-1} in closed cycle – first it increased from zero to certain frequency of heart beats [heart beat frequency (HBF), $\text{HBF} = 150 \text{ bpm}^{-1}$], the, with the same speed, it reduced to zero.(see fig.)

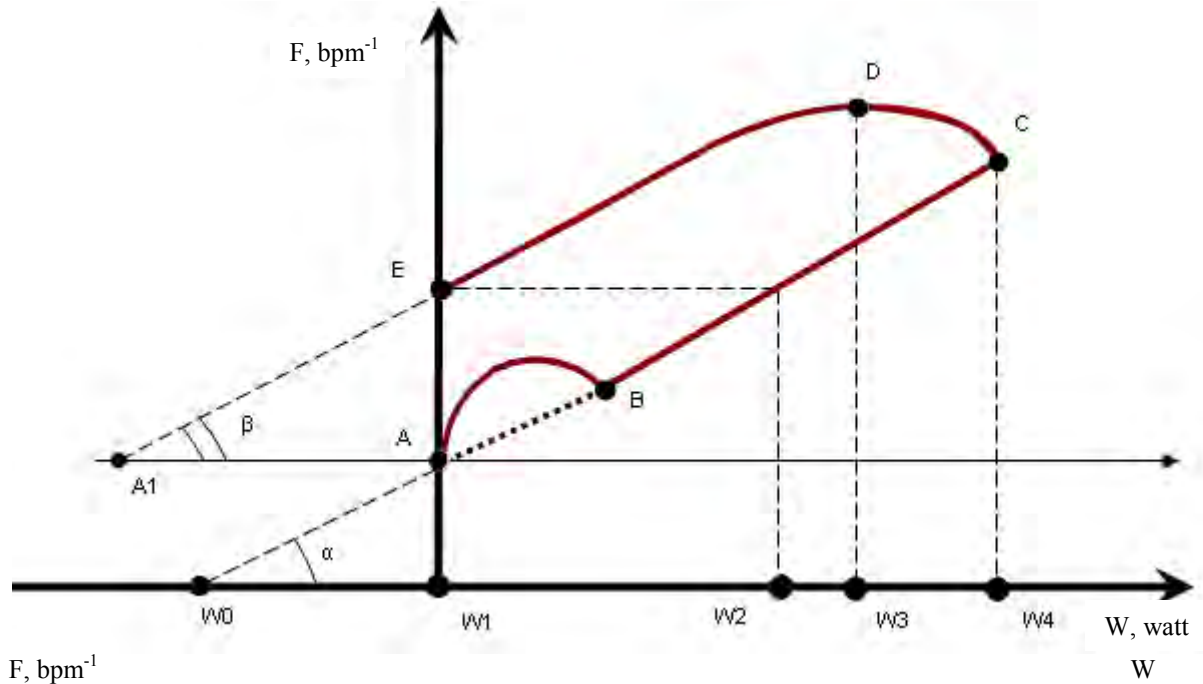


Fig. Diagram of heart beat frequency dynamics with testing in closed cycle (by [9] pre-processed):
W – scale of load power; F – scale of heart beats frequency's changes (HBF) in the course of loading; A – Final HBF; B – Threshold HBF; C – Reverse HBF; D – Maximal HBF; E – HBF at releasing of load.

In the process of testing we registered interconnection of HBF changes and power of physical work in the form of the so-called hysteresis loop, which reflects systemic adaptation organism's response to physical load. We upgraded methodic by D.M. Davidenko et al [8] and programmed it as computer software [5]. This enriched possibilities to operate results of examinations, create data base,; it became possible to obtain test record in printed form directly after 15-20 seconds after its finishing.

Characteristic and methodic of calculations of organism energetic level's indicators in different phases of testing are presented in table 1.

It should be noted that term "energetic level" is used in integrative sense in this methodic, as a concept, characterizing level of activation, functioning, straining of organism in adaptation processes. At the same time, with additional processing of obtained data, the mentioned term can give information about actual level of energetic metabolism in human organism. It is known that interconnection of heart beats frequency, oxygen consumption, energy consumption and power of work permit to determine every of indicators in any phase of test [3, 8, 9, 10]. Besides, D.M. Davidenko et al. [8, 9] established that dynamics of oxygen consumption under physical loads in closed cycle also is described by hysteresis loop. Thus, using of term "energetic level" in the mentioned sense is quite justified.

It should be noted that testing procedure was accompanied by a number of additional methodic, which characterized functional state of cardio-vascular, central nervous and respiratory systems before, in the process of loading and during 30 minutes of recreational period.

Normative points for tests were calculated as per traditional 5 point scale (see table 2).

The obtained data were processed as per traditional methods of mathematical statistics with using of correlation and factor analysis. In this article we have presented results of study of energetic level of girl-students' organisms.

Table 1

Indicators of energetic level of organism

Indicators	Description of indicators	Calculation methodic	Characteristic
W outcome (W)	Organism's activation before load	$W_0 - W_1$	Level of potential functional reserves
W reverse (W)	Organism's straining at moment of reverse	$W_0 - W_4$	Mobilization level of functional reserves under load's reverse
W maximal (W)	Maximal level of organism's straining	$W_0 - W_3$	Maximal level of mobilization of organism's functional reserves
W final (W)	Organism's straining at the end of loading	$W_0 - W_2$	Organism's activation level at the end of loading
A ₁ external (J)	External functioning of heart beats with increasing of load	Cotangent of angle α	External functioning, corresponding to standard value of physiological parameter with increasing of load
A ₂ external (J)	External functioning of heart beats with reducing of load	Cotangent of angle β	External functioning, corresponding to standard value of physiological parameter with reducing of load

Notes: (W) – watt, (J) – joule

Table 2

Standard requirements by 5-point scale of test results' evaluation [14]

Mark		Sigmoid deviations
Qualitative	Quantitative, points	
LOW	1	Lower than $M - 1.5\sigma$
BELOW MIDDLE	2	FROM $M - 0.5\sigma$ TO $M - 1.5\sigma$
MIDDLE	3	From $M - 0.5\sigma$ to $M + 0.5\sigma$
ABOVE MIDDLE	4	From $M + 0.5\sigma$ to $M + 1.5\sigma$
HIGH	5	Higher than $M + 1.5\sigma$

Results of the research

The fulfilled research of pedagogical university junior girl-students' functional reserves and level of their mobilization under physical load in closed cycle permit to make some conclusions concerning test itself. The research proved possibility of using this method for solution of certain tasks and a number of its advantages. E.g., the process of girl-students' testing, depending on reserve abilities, takes in average 8-10 minutes and it is, by timetable, much less than time of all known step-tests [10, 14], it does not require extreme straining of organism and, that is why, is safe. Application of bicycle ergometer in the test ensures precise dosing of physical load power, registration of fulfilled work's volume, permits to involve additional methods (electric cardiography, omega metering and other) directly in the process of testing and, thus, gives possibility to examine current organism's adaptation responses. It should be noted that the obtained data are characterized by higher reliability, as far as extrapolation of diagram of HBF dependence on power of load (hysteresis loop) if carried out not by several but by great number of points and it witnessed by data of pulse cost of work, which at not trained girl –students and sportswomen of the same age reached accordingly 1043.32 ± 27.10 and 1250.50 ± 60.45 beats. The method gives complex characteristics of organism's functional reserves by more than 30 indicators of regulative and executive systems. Introduction of up-to-date technologies' elements enriches the method's possibilities in obtaining, processing and storing of the data. Application of notebook expands sphere of this method's application in "field", out of doors examinations. At the same time some of the offered criteria require further more profound scientific foundation, determination of their informative level and ways for their implementation in practice that conditions, on the one hand, availability of this direction of research and, on the other hand, less quantity of presented in the work (6 from 9) indicators of organism's energetic level.

Analysis of the research's results witnesses that in all groups testing was carried out in rather standard conditions, with one of criteria of this being HBF's on reverse of load, which was determined by conditions of testing and actually was in 1st, 2nd and 3rd groups 151.9 ± 0.58 , 153.59 ± 0.83 and 153.21 ± 1.09 bpm⁻¹, accordingly ($P > 0.05$). Time of work fulfilled by 1st and 2nd year girl-students did not differ and varied in the range from 8.25 ± 0.39 – 8.82 ± 0.52 of not trained girl-students to 9.54 ± 0.40 minutes of sportswomen- students, the data of whom were confidently higher that those of

the 1st year girl-students ($P < 0.05$). Total scope of fulfilled works had similar character of changes. So, physical workability, as an integral indicators of 18-20 years girls' functional abilities positively, but not confidently changed from the first to the second year of studying at pedagogic HEE and reached confident differences in conditions of sport trainings.

Studying of reserve abilities and level of their mobilization of junior pedagogic university girl-students by indicators of energetic level in closed cycle of work showed absence of substantial difference as per most of criteria with trend to its increasing at the second year of study, especially in case of sport's practicing (see table 3). 3).

Table 3

Level of functional reserves' mobilization of junior students by indicators of organism's energetic level under load in closed cycle ($M \pm m$)

Indicators	Groups		
	I 1 st year girl students (n=48)	II 2 nd year girl-students (n=23)	III Sportswomen (n=14)
W initial, (W)	56.50 ±3.30	50.00±4.18	56.78±4.93
W reverse, (W)	184.57±5.27	200.72±9.66	199.33±10.02
W maximal (W)	216.67±5.96	233.44±10.87	231.83±11.12
W final, (W)	133.90 ±4.69	145.50±8.09	137.58±8.51
A ₁ external (J)	1.23±0.04	1.29±0.08	1.40 ±0.07*
A ₂ external (J)	1.34±0.07	1.52±0.11	1.35±0.10

Notes: * $P < 0.05$ by groups III – I. (W) – watt, (J) – joule

So, the level of organism's activation before load W initial, which characterizes level of potential functional reserves, was more optimal at 1st and 2nd groups and depends on output HBF and is connected with time of adaptation to work (coming to point B) and with angle of output loop's part inclination. It makes its contribution to other energetic level's indicators and to mobilization level of functional reserves in all phases of work, substantial increasing of which is registered in period of load's reverse and at maximum of inertial shifts (W reverse and W maximal). As obtained results witness the highest absolute results of these indicators were manifested by older girl-students and by sportswomen and it underlines significance of these factors in ontogeny formation of abilities to using of organism's reserves. It should be noted that sport trainings even at university level, which is rather far from sport of highest achievements, improve mechanism of reserve abilities' mobilization; it is witnessed by the fact that with practically equal HBF of reverse and levels of organism's straining (W reverse and W maximal) volleyball players demonstrated greater time (by 8-16%), scope (by 16-33%) of work and power of load at reverse of test (by 5-12%).

An interesting indicator of effectiveness of functional reserves' mobilization is cotangent of angle α (ctg α), which is connected with external work and corresponds to standard value of physiological parameter with increasing or power of work, in our case, heart beat (A₁ external): the less is inclination angle of output part of hysteresis loop, the greater is ctg α , the higher are reserve abilities and probability of their significant mobilization that is proved by the data of sportswomen-students by criterion A₁ external, which for the latter is confidently higher ($P < 0.05$) comparing with 1st year girl-students. The research's results prove also well-known fact that trained people have more effective recreational processes, with it the chosen method permits to directly characterize them in the process of work, i.e. to evaluate current recreation by shape of loop, by its cross part, by inclination angle of sloping part of hysteresis loop, by external work of heart beat at reducing of load's power (A₂ external), which is characterized by ctg β . Higher values of angle β , like they are at 2nd group girl-students, reflect less effectiveness of recreation (see table 3, fig.). Thus, the carried out research permitted to determine functional abilities and peculiarities of their mobilization by 1st and 2nd year girl-students of higher pedagogical establishment and showed that with dozed loads with reverse there are no confident inre-group differences as per the data of energetic level of organism, that level of organism's straining in these conditions is far from being extreme and physiological responses were adequate. It was noted that sport trainings in volleyball facilitate expansion of reserve abilities of regulation and provision mechanisms, reduce "cost" of adaptation.

Unfortunately, discussing of the obtained results in desirable volume is limited in connection with absence of scientific data in accessible for us literature. As it has been pointed in introduction testing method by loading in closed cycle has not been spread as it deserves, but it is widely and for long period of time (about 25 years) has been being applied in our researches (5, 6 and other) and was represented in some works by D.M. Davidenko et al. (8, 9 and other), in which, mainly, theoretical aspects of this method are rendered.

Comparing of obtained data with previously published [5, 6] showed that in age period from 7 - 8 to 18-19 years practically all presented criteria of organism's energetic level confidently increase (1.27-1,63 times). Dramatic jump of these indicators' increasing is observed at 13-14 and 14-15 years old age with further relative stabilizing at 16-17 years old age that can be conditioned by peculiarities of girl' puberty period [1, 4], finish of which coincides with leaving comprehensive school and entering higher educational establishment. The fulfilled by us research of indicators' dynamics of girl-students' energetic level under dozed physical load with reverse covered ovulation –menstrual cycle and showed more optimal adaptation responses in post-menstrual and post ovulation phases and straining of adaptation

in menstrual and ovulation phases that coincides with data of specialists in sport physiology and sport medicine [15], and will be presented in more detail way in future publications.

It should also be noted that as per researched indicators of human organism's energetic level there is substantial sex distinction. The data of researched by us girl-students differ confidently ($P < 0.05-0.01$) from indicators of boy-students. With it level of internal power of boys' organisms before and after physical work was confidently less, that reflects their more optimal final state and recreation processes. The data of highly qualified sportsmen, obtained in competition period can be taken as model, which would reflect the highest functional reserves and abilities for their mobilization, optimal energetic level of organism in tests with reverse [6].

We created model characteristics as per all indicators of organism's energetic level, which, according to 5-points evaluation scale (see table 4) are parametrical and approach to normal distribution of results.

Table 4

Evaluation of functional reserves of 1st year girl-students as per indicators of organism's energetic level in the process of test in closed cycle

Indicators	Mark, points				
	1	2	3	4	5
	Qualitative mark				
	low	BELOW MIDDLE	middle	Above middle	high
W initial, (W)	<24	24-45	46-67	68-89	>89
W reverse, (W)	<129	129-165	166-202	203-239	>239
W maximal (W)	<154	154-195	196-237	238-279	>279
W final, (W)	<88	88-118	119-149	150-180	>180
A ₁ external (J)	<0.85	0.85-1.1	1.11-1.36	1.37-1.62	>1.62
A ₂ external (J)	<0.66	0.66-1.11	1.12-1.57	1.58-2.03	>2.03

Notes: (W) – watt, (J) – joule

Conclusions:

1. Generalizing the above presented data about functional reserves and level of their mobilization of 1st and 2nd year girl-students of higher pedagogical establishment it should be noted that by the most of indicators of organism's energetic level under load in closed cycle the examined girls of both years of study had practically identical values. We registered trend to their increasing at second year of study and positive dependence on level of physical condition. Sport trainings improve mechanisms of reserve abilities mobilization that is reflected in abilities of sportswomen to demonstrate higher workability in conditions of equal organism's straining at all stages of testing.

2. We created model characteristics of junior pedagogic universities girl-students' functional abilities, which are based on sigmoid deviation from mean value of the obtained data and on 5-points scale's gradation of evaluation levels. The submitted evaluation criteria provide more complete information about adaptation responses that take place in organism under dozed physical loads. On this base it is possible to evaluate and predict actual state of students' health and improve physical education process at appropriate higher educational establishments.

3. Testing method with using of load, alternating in closed cycle and being dozed individually, is safe, informative; it permits to obtain complex characteristic of functional reserves, level and peculiarities of their mobilization, requires minimal time and has other advantages in comparison with know step- and other similar tests; it has passed many years experimental testing and can be recommended for more wide implementation in practice.

The prospects of further researches imply evaluation functional reserves' level of junior pedagogic university girl-students by other parameters in compliance with methodic of dozed cyclic bicycle-ergometer load with alternating of power in closed cycle. Videlicet: by indicators of physical workability, data of heart beats frequency, effectiveness of reserves' mobilization.

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