

PHYSICAL WORKABILITY AS THE BASE OF STUDENTS' FUNCTIONAL POTENTIALS

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Abstract. *Purpose:* to assess the level of students' physical workability and find its connection with physical fitness. *Material:* we tested 150 students (86 girls and 64 boys) of 17-19 years' age. All students were in main health group. The students fulfilled test on stationary bicycle. The complex of tests for physical fitness was used. *Results:* it was found that boys' physical workability results were better than girls'. Analysis of correlation matrix showed that physical workability parameters had close correlations with physical workability. Exception was only some pedagogic tests for explosive power of arms and torso as well as flexibility. *Conclusions:* physical workability indicators were within age and gender standards. Analysis of correlations showed that physical workability parameters substantially influence on results of control tests for physical fitness.

Key words: physical, workability, fitness, functional, testing, students, correlation.

Introduction

It was found that physical workability indicators are the base of functional potentials. Physical workability is an integral indicator, which permits to determine coordinated work of organism's organs and systems, health state, physical condition and functional state of human organism [2, 5]. It is known that physical workability depends on a number of factors, which determine and limit it. Demand in determination of the so-called dynamic health is also paid attention to [1].

In pedagogic researches the main source of information about functional potentials is different test batteries for physical fitness. The same situation exists in physical education process in different educational establishments. In physical education control exercises for physical fitness are used as main criterion of students' functional potentials [11, 12]. When creating factorial structure of girl-students (17-18, 18-19, and 19-20 years' age) functional potentials it is necessary to consider the following indicators: physical condition, physical fitness, physical workability, energy level, cardio-vascular system's condition, effectiveness of cardio functioning regulation and central nervous system [4]. Cardio vascular system's functioning influences on general endurance, speed-power abilities and coordination [15].

In other works it was noted:

- Determination of dynamic of students' somatic health, physical condition, physical and mental workability changes under impact of comprehensive school load [29];
- Substantiation of basketball and volleyball health related influence on functional state of first year students' visual analyzer in period of their adaptation to learning loads. Application of visual trainings at physical education classes permits to improve visual analyzer's indicators [18];
- Control of physical functioning in out-of-class time and at curriculum lessons [24];
- Purposefulness of fitness-yoga for strengthening of psycho-physical and psycho-social state of special health group girl-students at physical culture recreational and training classes [31];
- Raising of schoolchildren's motor fitness through pedagogic control t physical culture lessons [21, 28];
- Weakening of harmful habits' influence on students' workability 25, 26];
- Increase of students' mental workability [20, 27];
- Consideration of perceived tension under game loads [23].

The authors note that:

- Physical workability dynamic depends on period of week and terms of students' studying at educational establishments [30];
- The most important factors in complex fitness of physical rehabilitation group students are power and functional potentials [32];
- Application of modified variant of Harvard step-test permits to completely assess functional potentials of

students with deviations in their health [22];

- Application of oriental gymnastics increase students' physical workability [19].

By completeness of information physical fitness indicators yield the data of physical workability. Especially it concerns the data, received with the help of modern functional tests. However, pedagogic control exercises inform about condition of certain physical qualities.

Physical fitness and physical workability complex study [5] permits to wider assess functioning of children and youth's organisms. In physical culture lessons at educational establishments the received data will permit for teacher and instructor to control educational process at higher quality as well as to have more exact information about pupils/students' physical condition.

For better understanding the structure and correlations of functional potentials' parameters it is necessary to fulfill comparative analysis. When realizing pair correlation it is possible to analyze inter-influence of separate components within certain structure.

The purpose of the work is to assess 17-19 years' age students' physical workability within physical education process and determine its interconnection with physical fitness.

Material and methods

Participants: we tested 150 students (86 girls and 64 boys) of 17-19 years' age. All students were in main health group.

Procedure: for determination of physical workability we used methodic by D.N. Davidenko et al [5]. The students fulfilled test on stationary bicycle (60 rpm^{-1}). Load intensity changed with permanent speed ($200 \text{ kg.m.min}^{-1}$) by closed cycle: first – from zero to heart beats rate (HBR) $153\text{-}155 \text{ bpm}^{-1}$ (the moment of reverse); then at the same speed it reduced to zero (see fig.1). For this methodic modern software was created [2], which permitted to quicker receive the required information.

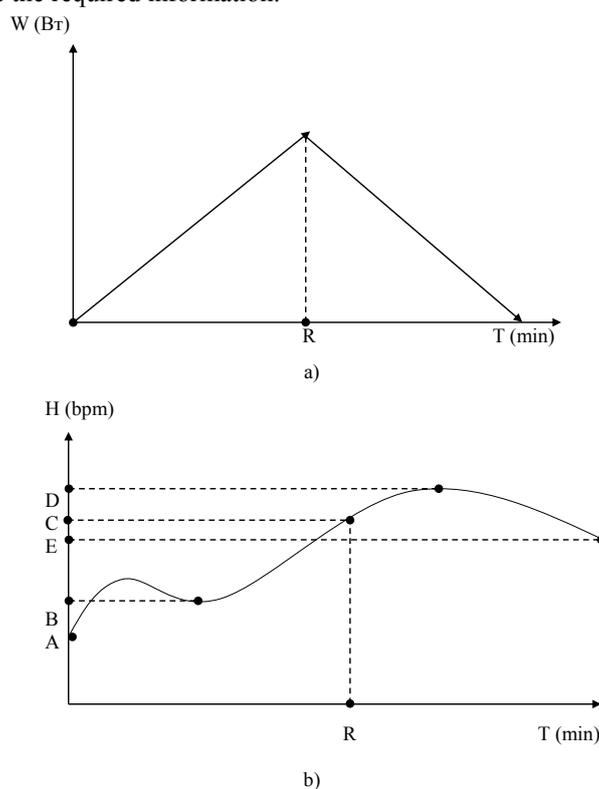


Fig.1. Dynamic of stationary bicycle load (upper part of figure) and heart beats rate changes during test (lower part of figure): W – power of load; R – power of load at reverse; T – time of testing; H – heart beats rate (HBR); A – initial HBR; B – threshold HBR; C – reverse HBR; D – maximal HBR; E – HBR of coming out of load.

The testing was conducted in the following way:

- Sensors of pulse were fixed on student’s body;
- Student took seat on stationary bicycle and adapted to appropriate conditions during several minutes;
- Student started to fulfill test according to methodic;
- After test student was on stationary bicycle 1 minute more for recreation.

In the process of testing correlation of heart beats rate and physical load’s power were registered in the form of hysteretic loop. Hysteretic loop reflects organism’s systemic adaptation to physical load (see fig.2).

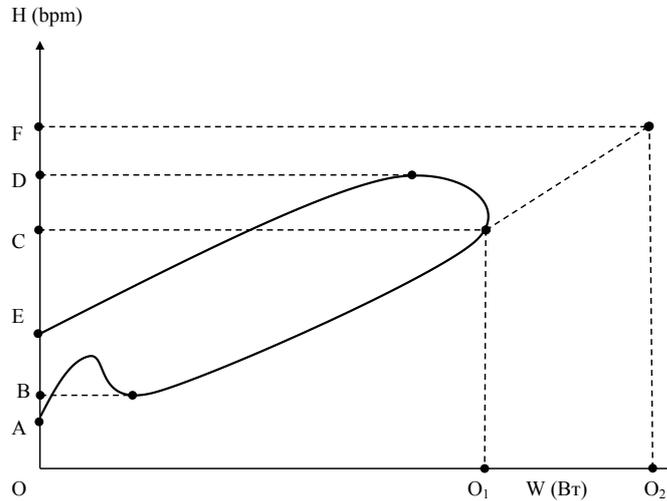


Fig.2. Dynamic of heart beats rate in functional testing: H – heart beats rate (HBR); W – power of load; A – initial HBR; B – threshold HBR; C – reverse HBR; D – maximal HBR; E – HBR of coming out of load. F –HBR=170 bpm⁻¹.

The methodic permits to assess the components of systemic organism’s reaction: functions tension under load test; energy and regulatory components of systemic organism’s reaction; general physical workability (see table 1).

Table 1. Indicators of physical workability

Indicators	Description of indicators
T _{tot} , sec.	Period of work during testing
W _{rev} , Watt	Physical workability at HBR = 153-155 bpm ⁻¹ (the moment of load reverse). To be determined by segment O-O ₁ in fig.2.
A _{tot} , kJ	Scope of work during testing. To be determined by formula: $A_{tot} = W_{rev} \cdot T_{gen}/2$.
PWC ₁₇₀ , Watt	Level of physical workability at HBR = 170 bpm ⁻¹ . To be determined by segment O-O ₁ in fig.2.

Test battery for functional fitness included the following control exercises: 30 meters’ run; 60 meters’ run; 1000 meters’ run; shuttle run (4×9 m); long jump from the spot; high jump from the spot; triple jump from the spot; legs’ raising during 30 sec. lying on back; throw of filled ball from sitting position (ball mass – 1 kg); pressing ups; torso bending from sitting position with feet apart.

Statistical analysis: experimental data were processed with statistical programs SPSS 16. For every studied parameter we determined mean arithmetic (M), error of mean arithmetic (m). In our work we used correlation (by Pearson) analysis. The confidence of the received results was checked by application of standard diagnostic methodic (Student’s t-criterion).

Results of the research

In our research we received the following data (see table 2).

Total time of work fulfillment (T_{tot}) of girl students was 442 ± 13.6 sec., of boy students – 535.05 ± 14.1 sec. Average difference between them was 93.4 sec. Scope of fulfilled work (A_{tot}) in girls' group was within 18.4 ± 0.4 kJ, and boys' – 27.9 ± 0.5 kJ. The distinctions of the received results was confident at $p < 0.001$ and was within 9.5 kJ.

It should be noted that determination of PWC_{170} indicators by the offered methodic is the most accurate. When predicting this indicator, we used great number of points on graph. Other methods are less confident. For example, determination of PWC_{170} with the help of one-moment and two-moment functional tests [9].

Table 2. Indicators of 17-19 years' age students ($M \pm m$)

Indicators	Girls (n=86)	Boys (n=64)
T_{tot} , sec.	442.1 ± 13.6	$535.5 \pm 14.1^{**}$
A_{tot} , kJ	18.4 ± 0.4	$27.9 \pm 0.5^{**}$
PWC_{170} , W	109.2 ± 4.4	$152.1 \pm 4.9^{**}$
PWC_{170}/kg , $BW \cdot kg^{-1}$	1.64 ± 0.08	1.85 ± 0.09
W_{rev} , W	82.4 ± 2.5	$109.1 \pm 3.2^{**}$
MOC, $ml \cdot min^{-1}$	2348.6 ± 67	$3069.7 \pm 81^{**}$
MOC, $ml \cdot min^{-1} \cdot kg^{-1}$	35.2 ± 1.1	$38.6 \pm 1.4^*$

Notes: * – $p < 0.05$; ** – $p < 0.01$; T_{tot} – total time of work fulfillment; A_{tot} – total scope of fulfilled work; W_{rev} – load power at the moment of reverse; MOC – maximal oxygen consumption.

PWC_{170} indicator of girl-students-beginners was 109.2 ± 4.4 W and boy students – by 42.9 W more (152.1 ± 4.9 W). According to the offered in literature physical workability standards [9] the received data in the whole corresponded to average level. After recalculation of PWC_{170} indicator on 1 kg of body mass we can see that in girls it was less (1.64 ± 0.08 $W \cdot kg^{-1}$) comparing with boys (1.85 ± 0.09 $W \cdot kg^{-1}$). However, the difference between them was unconfident. Load power at the moment of reverse (W_{rev}): the data of girls were 82.4 ± 2.5 W and boys – 109.1 ± 3.2 ; difference was within 26.7 W (practically at level of standard deviation in both groups).

The leading indicator of physical workability is maximal oxygen consumption (MOC), which is determined by efficiency of cardio-respiratory system. PWC_{170} value and MOC level determine human physical workability. However, these indicators are directly interconnected. V.L. Karpman et al. [9] determined this connection by formula:

For not-trained:

$$MOC = 1.7 \cdot PWC_{170} + 1240, \text{ if } PWC_{170} < 900 \text{ kg} \cdot \text{m} \cdot \text{min}^{-1};$$

For trained:

$$MOC = 2.2 \cdot PWC_{170} + 1070, \text{ if } PWC_{170} \geq 900 \text{ kg} \cdot \text{m} \cdot \text{min}^{-1}.$$

The calculated MOC values have error up to $\pm 15\%$ from MOC value, received by direct method.

When fulfilling muscular work the girl-students' MOC was 2348.6 ± 67 $ml \cdot min^{-1}$. The boys' MOC was 3069.7 ± 81 $ml \cdot min^{-1}$. Relative MOC indicators and relative PWC_{170} values were at lower border of norm [9].

The data of physical fitness and physical workability correlation analysis are given in table 3.

Correlation analysis permitted to find numerous direct and reverse correlations between appropriate groups of indicators. For example in first years' students we found significant reverse correlations between most

of physical workability parameters, such as: total time of work (T_{tot}), power of load at the moment of reverse (W_{rev}), PWC_{170} , PWC_{170}/kg ; total scope of fulfilled work (A_{tot}) and run tests, which give information about the whole spectrum of motor abilities (speed and speed-power qualities, dexterity, general endurance). We found weak negative correlation, first of all with short distances run ($r = -0.22 \div -0.44$), moderate strength of correlations ($r = -0.5 \div -0.69$) mainly with 1000meters' run and shuttle run (4x9 m), except some cases, where weak correlation prevailed (PWC_{170} – 'shuttle run (4x9m)' ($r = -0.35$), PWC_{170} – "1000 meters' run" ($r = -0.44$), PWC_{170}/kg – "1000 meters' run" ($r = -0.38$)) and strong correlation between control exercise for endurance and total scope of fulfilled work ($r = -0.72$).

Table 3. Correlation between physical workability and physical fitness indicators of 17-19 years' age students (n=150)

Indicators	T_{tot} , c	W_{prev} , W	PWC_{170} , W	PWC_{170}/kg , $W \cdot kg^{-1}$	A_{tot} , kJ
30 meters' run	-03*	-0.26*	-	-0.36*	-0.39*
30 meters' run (from running), sec.	-	-0.24*	-	-0.22*	-
60 meters' run, sec.	-0.41**	-0.33*	-0.32*	-0.39**	-0.44**
Forward torso bending, in sitting position with feet apart, cm.	-	-	-	0.24*	-
Pressing ups in lying position, q-ty of times	0.48**	0.42**	0.39**	0.49**	0.57**
Legs' raising during 30 sec., q-ty of times	0.36**	0.31*	0.28*	-	0.39**
Long jump from the spot, cm	0.54**	0.45**	0.39**	-	0.59**
High jump from the spot, cm	0.44**	0.41**	0.35**	0.38**	0.45**
Triple jump from the spot, cm	0.66**	0.54**	0.48**	0.31*	0.69**
Throw of filled ball, cm	0.22*	-	-	-0.29*	-
Shuttle run (4x9 m), sec.	-0.58**	-0.5**	-0.35**	-	-0.63**
1000 meters' run, min., sec.	-0.69**	-0.52**	-0.44**	-0.38**	-0.72**

Notes: * – $p < 0.05$; ** – $p < 0.01$, confident correlation

Practically all parameters of physical workability had confident positive influence ($r = 0.31 \div 0.69$) on results of jump exercises. Exception was relative level of physical workability and long jump from the spot.

Much worse was influence of physical workability on results of pedagogic tests, which informed about backbone flexibility and about explosive power of arms and torso. It was witnessed by little quantity of weak correlations (1-2).

Discussion

In the sphere of physical culture and sports for monitoring students' physical workability there are widely used one-moment, two-moment and functional tests. Besides, methods of physical workability quantitative assessment were often used. Among them Ruffiet's test, Harvard step-test and test PWC_{170} are the most frequent [1, 4, 9]. However, the received by the mentioned above tests results give little information. The main reasons of it are: inaccuracy in receiving results; inaccuracy of approaches to finding appropriate indicators; they do not consider age changes in organisms of children and youth. Such researches were also accompanied by the absence of single approach and contradiction character of results. It is proved by our research. Some data confidently differ and exceed the compared figures nearly twice. The range of physical workability fluctuations is so wide that their practical usage is possible only with significance caution.

In our opinion method of physical workability testing with the help of physical load by closed cycle [5] complies with the most of known requirements. On the base of the received physical workability results we can assess health state as well as to correct physical education process in higher educational establishments.

This methodic did not get widespread use and was applied only in single studies of elite sportsmen functional reserves [5, 7]. Besides, it was implemented in physical education process of primary schools and some other educational establishments [12]. In available literature there are no complex studies of students' functional potentials, considering physical workability and physical fitness.

The received results of PWC₁₇₀ and MOC are in good agreement with results of other researches [9]. It is worth to pay attention to the fact that fundamental researches of different age people's physical workability (including students) were conducted about 30 years ago. That is why fulfillment of mass studies for receiving up to date PWC model characteristics and other parameters is rather relevant. The presented new parameters of physical workability (T_{tot} , A_{tot} , W_{rev}) provide quite real opportunities to have widespread use in practice alongside with more known indicators of MOC, PWC₁₅₀, PWC₁₇₀. It proves relevance and promising potential of further researches.

Conclusions

Physical workability indicators were within age standards. These indicators were predicted better in boys than in girls. In most cases differences of the mentioned parameters between students by sex were confident.

Analysis of correlations showed that physical workability indicators substantially influence on physical fitness. The most intensively results of control exercises were influenced on (exercises, which assessed endurance, dexterity and legs' explosive power). It is expressed in maximal quantity of significant correlations and their strength. Physical workability moderately correlates with tests for speed power qualities at the account of weak correlation strength. Physical workability practically did not influence on development of flexibility and arms and torso explosive power. In total we registered only 3 significant weak correlations.

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Conflict of interests

The author declares that there is no conflict of interests.

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