



Assessment of the adaptive potential of students of the first course of a technical university

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Abstract

Aim: assessment of the adaptive potential of students of the first course of a technical university.

Material and methods: literature review, methods for assessing adaptive potential and biological age, rapid assessment of the level of physical health; methods of mathematical statistics; stating experiment with the participation of students of the 1 course (n = 56).

Results. A sufficiently high accuracy of recognition of the state of the body provides a method for determining the adaptive potential. In the course of the ascertaining experiment, it was established that 44.64% of students were assigned to the first group - satisfactory adaptation, and 55.36% - the tension of adaptation mechanisms to the second group. Persons with unsatisfactory adaptation or with its failure were not identified. In order to study the changes in the functional state depending on the established adaptive potential, a comparative analysis of the average statistical values of the indices of rapid assessment of physical health and biological age indices, which characterize the biological survival function, as one of the main manifestations of human health, was carried out. Statistically significant differences in some indicators were revealed, namely: adaptive potential (p<0.001); biological age (p<0.1); index "double product" (p<0.001); Ruthier Index (p<0.001); level of physical health (p<0.001).

Conclusions. As a result of these studies, the fact was revealed that an increase in the work of the adaptive mechanisms of the body is accompanied by significant changes, which are reflected in: acceleration of the aging process of the body; the tension of the cardiovascular system at rest and when performing standard physical activity; lowering the level of bioenergy resources of the body.

Key words: prenosological diagnosis; functionality; physical education; health

Анотація

Мета: оцінка адаптаційного потенціалу студентів 1 курсу технічного університету.

Матеріал і методи: літературний огляд, методи оцінки адаптаційного потенціалу та біологічного віку, експрес-оцінки рівня фізичного здоров'я; методи математичної статистики; констатуючий експеримент за участю студенток 1 курсу (n = 56).

Результати. Досить високу точність розпізнавання станів організму забезпечує метод визначення адаптаційного потенціалу. У процесі констатуючого експерименту встановлено, що до першої групи - задовільна адаптація віднесено 44,64% студентів, до другої групи - напруга механізмів адаптації - 55,36%. Осіб з незадовільною адаптацією або ж з її зривом не виявлено. З метою вивчити зміни функціонального стану в залежності від встановленого адаптаційного потенціалу проведено порівняльний аналіз середньостатистичних значень показників індексів експрес-оцінки рівня фізичного здоров'я і біологічного віку, які характеризують біологічну функцію виживання, як одне з основних проявів здоров'я людини. Виявлено статистично достовірні відмінності в деяких показниках, а саме: адаптаційного потенціалу (p<0,001); біологічного віку (p<0,1); індексу «подвійне твір» (p<0,001); індексу Руф'є (p<0,001); рівня фізичного здоров'я (p<0,001).

Висновки. В результаті даних досліджень виявлено факт, що підвищення роботи адаптаційних механізмів організму супроводжується достовірними змінами, які відображаються в: прискоренні процесів старіння організму; напруженості роботи серцево-судинної системи в стані спокою і при виконанні стандартної фізичного навантаження; зниженні рівня біоенергетичних ресурсів організму.

Ключові слова: донозологическая діагностика; функціональне можливості; фізичне виховання; здоров'я

Аннотация

Цель: оценка адаптационного потенциала студентов 1 курса технического университета.

Материал и методы: литературный обзор, методы оценки адаптационного потенциала и биологического возраста, экспресс-оценки уровня физического здоровья; методы математической статистики; констатирующий эксперимент с участием студенток 1 курса (n=56).

Результаты. Достаточно высокую точность распознавания состояний организма обеспечивает метод определения адаптационного потенциала. В процессе констатирующего эксперимента установлено, что к первой группе - удовлетворительная адаптация отнесено 44,64% студентов, к второй группе - напряжение механизмов адаптации - 55,36%. Лиц с неудовлетворительной адаптацией или же с ее срывом не выявлено. С целью изучить изменения функционального состояния в зависимости от установленного адаптационного потенциала проведен сравнительный анализ среднестатистических значений показателей индексов экспресс-оценки уровня физического здоровья и биологического возраста, которые характеризуют биологическую функцию выживания, как одно из основных проявлений здоровья человека. Выведено статистически достоверные отличия в некоторых показателях, а именно: адаптационного потенциала (α<0,001); биологического возраста (p<0,1); индекса «двойное произведение» (p<0,001); индекса Руфье (p<0,001); уровня физического здоровья (p<0,001).

Выводы. В результате данных исследований выявлен факт, что повышение работы адаптационных механизмов организма сопровождается достоверными изменениями, которые отражаются в: ускорении процессов старения организма; напряженности работы сердечно-сосудистой системы в состоянии покоя и при выполнении стандартной физической нагрузки; понижении уровня биоэнергетических ресурсов организма.

Ключевые слова: донозологическая диагностика; функциональные возможности; физическое воспитание; здоровье



Introduction

It is known that the development of the disease is preceded first by donosological and then premorbid conditions. It is these conditions in practically healthy people that are the object of prenosological diagnosis [1, 2], that is, the study of the transition from health to disease. And, according to the author [3], the field of such research is relevant today.

The pre-nosological state is the state of the body when there is a tension of regulatory mechanisms, but disability and the body are not impaired, it is possible to bring the state of physiological norms through preventive and health measures [20]. In addition, the prenosological state is an assessment of the cardiovascular system, since this functional system is an indicator of the adaptive and adaptive activity of the body, reflects the relationship of the body with the environment [4]. And the adaptive capabilities of the body determine the level of human health and the risk of developing diseases, therefore, the study of the adaptive capabilities of the body as an integral criterion of health is most preferable [5].

It is indisputable that maintaining health is especially relevant at the student age, it is during this period that the future professional and the bearer of the intellectual potential of the nation is formed, it follows that the student's health undoubtedly acquires high social significance [6].

The health of students is determined by the features of this life stage. And the authors of [7, 8, 9, 10] noted that students can be attributed to a high risk group, since in addition to difficult age problems, the period of study in modern higher education institutions is associated with the influence of numerous negative factors and the educational process, and lifestyle, which cause a change in the functional state of various body systems and a decrease in adaptive capabilities. The consequence of this is serious medical and socio-psychological problems that arise in one form or another among students [11].

The relevance of this topic, namely, the assessment of the adaptive potential of students, is evidenced by numerous scientific works [12, 13, 14, 15], and the main and unresolved problems to date are the preservation and strengthening of the health of modern youth.

To conduct these studies, they were guided by the facts [16] that "the close relationship between the functional reserves of the body and adaptation is confirmed by numerous studies. In this regard, the adaptive (or adaptive) capabilities of the body can be considered as a measure of health."

The aim – assessment of the adaptive potential of students of 1 course technical university.

Material and methods

Participants

A ascertaining pedagogical experiment was conducted on the basis of the department of physical education and sports of the Dnipro Polytechnic National Technical University (Dnipro) at the beginning of the academic year 2018-2019. The study involved 56 female students of the first year ($x = 17.48$ years old), who, due to their health, are assigned to the main medical group.

Procedure

As a result of the generalization of theoretical knowledge, own practical experience of research [17, 18, 19] and specialists using diagnostic models for assessing the health level of students, simple, affordable methods for assessing the level of health are selected, the use of which does not create any organizational and technical difficulties in the process of mass research.

Methods for assessing adaptive potential as an indicator of the body's functional reserves. The calculation of indicators of adaptive potential (AP, cu) was carried out according to the formula [21]:

$$AP = (0,011 \times HR \text{ (beats per minute)}) + (0,014 \times \text{Systolic blood pressure}) \\ + (0,008 \times \text{Diastolic blood pressure}) + (0,014 \times \text{Age (years)}) \\ + (0,009 \times \text{Body mass (kg)}) - (0,009 \times \text{Body length (sm)}) - 0,273,$$

Where:

AP - adaptive potential (cu);

HR – heart rate (beats per minute)

When distributing the participants of the ascertaining experiment by indicators of adaptive

potential, the following normative values were adhered to [20]:



satisfactory adaptation	1 Group	no more 2,10 cu
stress adaptation mechanisms	2 Group	2,11 – 3,20 cu.;
poor adaptation	3 Group	3,21-4,30 cu;
failure to adapt	4 Group	from 4,30 y.e. and more

Methods for determining biological age as an indicator of age-related destruction [21]. Evaluation of BV (years) was carried out in stages:

First step. The questionnaire method is used to carry out a subjective health assessment (POP). The special questionnaire includes 29 questions that characterize the most important :

aspects of well-being, mood, activity, sleep quality, pain, and a person's life mode. The total value gives a quantitative self-esteem of health equal to 0 for "ideal" and 29 for "very poor" health.

Second phase. Calculation of indicators of actual BV by the formula, for women

$$BV = -1.463 + 0.415 \times PAD - 0.140 \times SB + 0.248 \times MT + 0.694 \times POPs;$$

Where:

PAD - pulse blood pressure (mmHg), calculated by the formula: $PAD = AD_{syst} - AD_{diast}$,
SB - static balance (s), determined when the test subject is standing on his left foot, without shoes with his eyes closed and with his arms down along the torso. The study is conducted without prior training. The best indicator of three attempts is taken into account with an interval of rest of 5 minutes,
MT- body weight (kg),

The third stage. Calculation of the due value of BV (DBV) (years) by the formula:

$$DBV = 0.581 \times KV + 17.3,$$

Where: KV - calendar age (years).

The fourth stage. Based on the obtained data on the difference between BV and DBV, the level of health and the rate of aging of a person is determined (Table 1) [21].

Methods for determining the level of bioenergy reserves of the body according to the method of rapid assessment of the level of physical health. In this system, when examining adults, five simple morphofunctional indices are used [14]:

1. Masso - growth index = body weight (g) / body height (cm).
2. Power index = brush strength (kg) $\times$ 100 / body weight (kg)
3. Double product = heart rate (bpm) $\times$ $AD_{Syst} \div 100$.
4. $PWC_{170} = 37 \times VC (l) + 36 /$ body weight (kg).
5. The Rufier Index = $(4 \times (P1 + P2 + P3) - 200) / 10$.

To calculate indicators and indices in the beginning, according to generally accepted methods, it is necessary to measure standing growth, body weight, heart rate in 1 min (heart rate) and determine systolic blood pressure at rest (AD_{Syst}). Then, with

the help of a hand dynamometer, measure the strength of the muscles of the hand and with the help of a spirometer, the vital capacity of the lungs (VC). Dynamometry and spirometry are performed 2-3 times, taking into account the best result. At the end of the study, the survey participant conducts a Ruthier test. If the subject cannot perform the Ruthier test, 3 points are deducted from the sum. After summing up each received score for a specific indicator in table 2 assesses the level of physical health.

Statistical analysis

Mathematical and statistical processing of the results was carried out on a PC using the Microsoft Office Excel 2007 programs, taking into account existing recommendations [22]. Using standard statistical procedures, the following were calculated: arithmetic mean ($\bar{x}$); standard deviation (σ); when checking the reliability of differences in average values of indicators between samples, Student t-test (t) was used.

When validating, significance levels (α) of 0.05 were taken as the basis; 0.01 and 0.001.



Table 1

Health Assessment

Health level	Deviation from the population standard	Health status, pace of aging, medical advice
1	from -15 to -9 years	The state of health is very good. The pace of aging is sharply slowed down. Dispensary registration and rehabilitation is not subject.
2	from -8.9 to -3 years	The state of health is good. The pace of aging is slow. Dispensary registration and rehabilitation is not subject.
3	from -2.9 to +2.9 years	The state of health is average. The pace of aging does not differ from the population standard. An annual physical examination and prevention is recommended (on-the-job).
4	from +3 to +8.9 years	The state of health is poor. Accelerated pace of aging. Great risk of illness or disability. Mandatory dispensary control and spa treatment are required.
5	from +9 to +15 years	The state of health is very poor. The pace of aging is dramatically accelerated. Very high risk of illness and disability. A thorough medical and instrumental examination and medical rehabilitation are necessary.

Table 2

Level of physical health according to express assessment

Total points	Physical health
<5	low
6-9	below the average
10-14	middle
15-18	above the average
>19	tall

Results

And so, according to the data of our studies, the participants in the stating experiment are distributed as follows: 44.64% (n = 25) students are assigned to the first group - satisfactory adaptation, and 55.36% (n = 31) - the voltage of adaptation mechanisms to the second group. It should be noted that persons with unsatisfactory adaptation or with its failure were not identified.

In order to study changes in the functional state depending on the established adaptive potential, a comparative analysis of the average statistical values of the indices of rapid assessment of physical health and biological age indices, which characterize the biological survival function, as one of the main manifestations of human health [23] (Table 3).

So, in the process of comparative analysis revealed statistically significant differences in some indicators, namely:

- adaptive potential (p≤0.001);
- biological age (p≤0.1);
- index "double product" (p≤0.001);

- Ruthier index (p≤0.001);
- level of physical health (p≤0.001).

Thus, we can conclude that the increase in the work of the adaptive mechanisms of the body of female students of the I course is accompanied by:

- accelerating the aging process of the body;
- tension in the work of the cardiovascular system at rest and when performing standard physical activity;
- lowering the level of bioenergy resources of the body.

Separately, in our opinion, the results of assessing the level of physical health as an indicator of bioenergy resources should be disclosed.

According to the statistical results of our studies, a group of girls with satisfactory adaptation - 44.64% (n = 25), has an average UVD and can be described as a "third state". The "third state" is the boundary of the transition from a state of health to a state of pre-illness [24, 25]. The main sign of pre-disease is the possibility of self-development of the pathological process without changing the strength of the acting factor due to a decrease in health reserves. The boundary of the transition from a state



of health to a state of pre-illness is that level of health that cannot compensate for changes occurring in the body under the influence of negative factors and, as a result, a tendency to self-development of the process is formed [16].

But in the second group - 55.36% (n = 31), it is set below the average level of physical health and already refers to the "dangerous" level of health, which is characterized by the tension of regulatory systems, a decrease in the level of energy mechanisms, which ensures metabolic, structural

changes organism and the limitation of its adaptive capabilities.

Returning to the beginning of our article, that "... the adaptive (or adaptive) capabilities of the body can be considered a measure of health" [22] we can conclude that 55.36% of the main medical group are in a state of self-development of the pathological process without changing strength acting factor due to a decrease in health reserves [1].

Table 3

A comparative analysis of the statistical characteristics of morphofunctional indices of express assessment of the level of physical health and biological age of students depending on the functional state established during the ascertaining experiment (n = 56)

Indicators	Statistical Characteristics		t	p
	satisfactory adaptation, (n=25)	stress adaptation mechanisms, (n=31)		
	$\bar{x} \pm \sigma$	$\bar{x} \pm \sigma$		
AP, cu	1,86±0,17	2,65±0,28	- 12,9 1	≤0,0 01
BV, years	21,41±15,21	28,1±8,64	- 1,96	≤0,1
BV-DBV, years	-6,20±15,44	0,84±8,66	- 2,07	≤0,0 5
	замедленные темпы старения организма	темпы старения не отличается от популяционного стандарта		
MRI, g / cm	330,54±31,16	349,33±55,07	- 1,61	>0,0 5
SI,%	45,99±9,03	47,54±9,58	- 0,61	>0,0 5
DP, cu	79,68±12,32	100,81±16,5	- 5,48	≤0,0 01
PWC170, W / kg	2,47±0,44	2,42±0,43	0,43	>0,0 5
Iruffier, cu	6,90±4,17	12,31±4,67	- 4,58	≤0,0 01
UVZ, points	13,2±3,75	8,84±4,84		
	average UVZ - "Third state"	below average UVZ - "dangerous" level of health.	3,80	≤0,0 01

Note: AP - adaptive potential; BV - biological age, DBV - due biological age, MRI - mass-growth index, SI - power index, DP - index "double product", PWC170 - index of physical performance, IRufier - Roufier index, UVZ - level of physical health.

Discussion

In our work, we present the results of assessing the adaptive potential of students of the course, who complemented and expanded the existing numerous findings of research in this area.

The functional state in the interval between norm and pathology, between full adaptation and maladaptation includes a number of transition states

called donosological and premorbid □20□: physiological norm; prenosological conditions; premorbid conditions; failure (scrapping) of adaptation mechanisms.

The criterion of the pre-nosological state is the assessment of the cardiovascular system, since its indicators are informative provided that relatively simple methodological approaches are used, and it itself largely determines the functional state of the body as a whole [13].



To study the adaptive capabilities of the cardiovascular system using the method of variational pulsometry, which allows you to obtain valuable information about the state of not only functional systems, but also the body as a whole [25].

However, the study of the functional state based on the data of mathematical analysis of the heart rhythm requires special equipment (automated complex), certain experience and knowledge in the field of physiology and clinic. In order to make this technique accessible and possible to use at the pre-medical stage of control, a number of different formulas and tables have been developed that allow us to calculate the adaptive potential of the circulatory system according to a given set of indicators using multiple regression equations [24].

A sufficiently high accuracy of recognition of the state of the body provides a method for determining the adaptive potential [6].

Despite the fact that the assessment of the adaptive potential characterizes health, but to a greater extent this is the result of the interaction of the body with the environment. For example, on the one hand, a person with a high level of health, but fell into an extreme industrial or domestic situation that led to a failure of adaptation, despite significant reserves of functions. On the other hand, in a patient in remission of a chronic somatic disease, the stage of satisfactory adaptation will be determined, although his level of health will be quite low [2].

Despite the fact that the assessment of the adaptive potential characterizes health, but to a greater extent this is the result of the interaction of the body with the environment. For example, on the one hand, a person with a high level of health, but fell into an extreme industrial or domestic situation that led to a failure of adaptation, despite significant reserves of functions. On the other hand, in a patient in remission of a chronic somatic disease, the stage of satisfactory adaptation will be determined, although his level of health will be quite low [2].

In conclusion, we note our solidarity with the opinions of specialists [4, 5] that the solution to the problem is the preservation and strengthening of the health of student youth through the implementation of many measures, and one of them is the introduction of objective and adequate diagnostic methods for assessing the level of health into the educational process. A regular and systematic physical activity is one of the most effective ways to improve human health. In this regard, today there is a need to modernize the work of the departments of physical education and, therefore, the course of the

discipline "Physical Education" from the position of Valeological education of students.

Conclusions

1. It was found that assessing the adaptive potential of students as a process of studying the transition from health to disease is relevant for solving the problem of maintaining and strengthening the health of modern youth. When choosing a method, they were guided by the recommendations] that "the method of adaptive potential of the circulatory system with its high information content is quite accessible in the work of the teacher, trainer and even high school students themselves and can be used to control the effect of physical stress on the student's body in order to optimize them, and also for assessing and predicting the development of physical overtraining, improving the health orientation of physical education lessons and sports training."

2. The results of our work indicate that 44.64% of female students are classified as satisfactory adaptation to the first group, and 55.36% to the second group — the voltage of adaptation mechanisms.

3. In the process of comparative analysis of the average statistical values of the indices of rapid assessment of the level of physical health and biological age of students depending on the established adaptive potential, it was revealed that the increase in the work of the adaptive mechanisms of the body is accompanied by statistically significant changes, which are reflected in: acceleration of the aging process, the tension of the cardiovascular system at rest and when performing standard physical activity, lowering the level of bioenergy resources of the body.

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Conflict of interest

Authors state that there is no conflict of interest.



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