Informative indices of physical and functional state of young men during the process of adaptation to learning

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Authors' Contribution:
A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection.

Abstract

Purpose: to determine indicators of physical development, physical readiness, functional condition of young men in the process of adaptation to learning.

Material: The students of university (n=78, age 18–20 years) were examined. An examination was conducted at the beginning of the first and second years of study. It was studied 8 indexes and 5 indexes for physical development.

Results: it is established that during the first year of study there is an increase in: weight-growth indices; endurance factor; adaptive capacity; diastolic pressure; running record on 1000 m. The vital capacity of the lungs decreased; life index; time of hanging on a bar.

Conclusions: indicators of students' adaptation to learning are suggested to be: body mass index (physical development index); running on 1000 m (the indicator of physical readiness); coefficient of endurance (indicator of functional state).

Keywords: students, adaptation, endurance, weight, strength.

Introduction

According to official statistics, about 30% of university graduates are professionally inapplicable because of poor health [1]. The revealed changes are connected with the way of life of modern students [2]. The risk factors for increasing body mass index (BMI) mention a high intake of sweet soda, enthusiasm for computer games [3], more frequent use of alcohol [3], transition to sedentary lifestyles [4], decrease in active movement and exercise [5], bad habits [6]. In addition to lifestyle, health of young men is influenced upon the following features: living in ecologically disadvantaged areas [7], educational process at the university [8]. It is shown that during the 1-3 courses of study among students is formed chronic emotional stress [9], increased the tension of the mechanisms of regulation of heart rhythm [10].

In the literature, there are data on the increase in the body weight of students [11]. After 1 semester students added about 1 kg of weight [12], during the year – 4,7 kg [5], for a year – 3 kg, together with an increase in the body mass index (BMI) [4].

In other studies, it was found that in the first year the results of hand dynamometry and time of hanging on a bar [13], the results of hand dynamometry and jump in length from the place have changed [14]. It is proposed to use 5- and 15-minute run as indicators of aerobic capacity [9]. It is shown that muscle strength is not associated with academic achievement [15]. As informative indicators of students' health are considered both weight-for-height index and the results of Genchi and Ruffier tests [8].

One approach to assessing physical development is based on the compliance of the main indicators of physical development with age and sex standards. Another approach involves the use of indicator indexes of physical development, physical preparedness, and the functional state of students. Indicators are indexes, most vividly (in the form of statistically significant differences) reflecting the detected changes. Unfortunately, many of them are not unified. This makes it difficult to verify the results of the experiments. Therefore, the question arises of the formation of a set of indicator indexes.

Indicator indexes are important for assessing the functional state of the leading systems of the body and the adequacy of motor regimes [16]. As indicator indexes it is proposed to use: long jump [14], breath retention (Genchi test), heart rate variability [10], maximum oxygen consumption [17], Martinet-Kushelevsky test [16], results of hand dynamometry [11]. The literature data on the informativeness of the mass-growth index are contradictory [18]. In general, the presented data are fragmented, there is no systematic approach to determination of indicator indexes.

Among other ways to solve the problems of increasing the indicators of the physical and functional state of youth can be identified the following: pedagogical control and selection of adequate tests of physical fitness [19, 20]; optimization of physical activities [21, 22]; didactic patterns of the construction of education [23]; formation of positive attitude towards one's health [24, 25]; motivation for successful education [26, 27]; criteria for the effectiveness of the learning process [28, 29].

The authors used different approaches to increase the level of physical and functional state of students and young people. Such approaches can help students adapt to learning.

Adaptation of students to learning is closely related to the internal environment of the university. The conditions of the external environment are also an important factor

doi:10.15561/18189172.2018.0106

in adaptation of students to learning. In studies of the influence of these factors on the students' learning and health indicators it is established: possibilities for increasing the motor activity of students [30, 31]; possibilities of adaptation to physical loads [32, 33]; influence of cardio training methods on power indicators of students [34]; opportunities for improving the functional state of students [35, 36]; directions of the account of individual features of students' development [37, 38]; directions for improving the quality of life of young people [39-41]; possibilities of increasing endurance rates [42]; possibilities for correcting posture [43]; possibilities of social adaptation of students [44, 45].

The authors use various forms of presentation of indicators that are aimed at improving the health of students and youth. This allows students to more successfully adapt to university studies.

Hypothesis: in order to successfully solve the problem it is necessary to identify informative indicator indexes of adaptation to learning.

The purpose of the study is to determine the indicator indexes of physical development, physical preparedness, functional status of young men in the process of adaptation to learning.

Material and methods

Participants. The study was conducted at Vyatka State University (Kirov, Russia) with first and second year students (first and third semesters, September-October). 78 young men of full-time study were examined. The average age of first-year students was 18,51±0,10 years (group 1) and 20,43 ± 0,12 years in the second year of study (group 2). At the time of the study, no one complained of health problems. All students gave voluntary consent to participate in the survey.

Organization of the study. We studied 8 indexes and 5 indexes for physical development, 9 physical fitness indexes, 2 functional tests and 4 indexes and coefficients for the functional state.

We were examined from 52 to 73 students by different indicators from the group of 78 people.

To measure physical development were measured length (cm), body weight (kg), chest circumference (CC, cm) [46] and weight-height indices were calculated [47].

Pignet Index (PI) = S – (W + CC),

S – stature in cm; W – weight in kg; C – chest circumference in cm.

Corpulence Index (CI) also known as Rohrer's Index (RI): (CI) = W/S^3,

W – weight in kg; S – stature in cm ^{3}.

Body Mass Index (BMI) = (W / S^2),

W – weight in kg; S – stature in cm ^{2}.

Erisman Index (EI) or Chest Proportionality Index (CPI) = CC - S^2,

CC – chest circumference in cm; S – stature in cm ^{2}

The flexion muscle force (kg) of the right and left hand was measured using the hand dynamometry method [48]. Then the force index was calculated, i.e. percentage of muscle strength to body weight.

To assess cardiovascular (CV) status in resting conditions were evaluated heart rate (cardiac rate), systolic (SP) and diastolic blood pressure (DP) (mmHg) [49].

To assess the state of the respiratory system, the vital capacity of the lungs (VC, l), respiration rate, Stange's test and Genchi's test were measured. Stange's test (c) was performed as follows: the subject in the standing position breathes in, then exhales deeply and again inhales, 80-90% of the maximum, the time for holding the breath is noted. In Genchi test (c) after a normal exhalation, the subject is holding his breath for as long as possible [47].

VC was measured with a portable spirometer and the vital index (VI) was calculated.

Vital Index (VI)= VC / W,

VC – vital capacity in ml; W – weight in kg [50].

Kerdo Index (KI) = (1 – DP / HR) x 100,

DP – diastolic pressure in mmHg; HR – heart rate in beats per minute [47].

Blood Circulation Efficiency Coefficient (BCEC) = (SP – DP) x HR,

SP – systolic pressure in mmHg; DP – diastolic pressure; HR – heart rate in beats per minute [47].

Endurance Coefficient (EC) = (10 x HR) / PP,

HR – heart rate in beats per minute; PP – pulse pressure e.g. systolic pressure in mmHg – diastolic pressure in mmHg [47].

Adaptive Capacity (AC) = 0,011 x HR + 0,014 x SP + 0,008 x DP + 0,09 x W – 0,009 x S + 0,014 x A – 0,27,

HR – heart rate in beats per minute; SP – systolic pressure; DP – diastolic pressure; W – weight; S – stature in cm; A – age in years [47].

To determine the physical preparedness, the level of development of the basic motor qualities was assessed (Program "Physical Culture") [51]. Young men practiced physical culture 2 times a week for 2 academic hours. The annual load (144 hours) was evenly distributed over semesters. The program included the following sections: athletics (42 hours), volleyball (28 hours), athletic gymnastics (42 hours), swimming (28 hours), offset (4 hours). Classes were conducted according to a typical structure: the introductory part (15-20 min), the main part (35-45 min), the final part (19-15 min). The introductory part consisted of complex of general development exercises, the main part – the exercises of the corresponding sections, the final part – the complex of breathing exercises and exercises developing flexibility.

At the end of each semester, the students passed examinations included testing of the basic physical qualities in the conditions of gym and stadium on the following exercises: running on 30 and 100 m, long jump from the place, inclination from standing on the bench, flexing and extending the arms, hanging on the bar, the slopes from the supine position on the back, running on 1000 m, running on 3000 m.

Statistical analysis. The results of the research were subjected to statistical processing using parametric statistics methods in the licensed software package

Microsoft Excel. Further, the indicators of descriptive statistics were calculated: the arithmetic mean (M), the standard error of the mean (m), which was expressed in the text and tables as M±m. The differences were estimated by the Student's criterion (t) for independent samples and the chi-square test, and considered them reliable at p <0,05 (in the text is indicated as "*").

Results

It was found out statistically significant differences on 11 items on the research of 28 indexes (Table 1). The table shows only statistically significant differences. In the study of physical development, we have not established differences in absolute indexes (mass, body length, etc.). Relative indicators have changed – weight-growth indexes. This indicates a tendency to increase the body weight of young men during the first year of training.

From the indicators of physical preparedness, the time spent on the bar decreased and the run time increased by 1000 m. This indicates a deterioration in the physical preparedness of students during the first year of training. From the indicators of the functional state vital capacity of length and vital index decreased. The endurance factor, adaptive potential, diastolic blood pressure increased. This indicates a worsening of the functional state.

The study established a number of statistically significant differences in physical development, physical fitness, functional status of students in the process of adaptation to learning. Weight-and-growth indices, endurance factor, adaptation potential, diastolic blood pressure and running time on 1000 m increased. There was a decrease in the level of life, the vital index, and the time spent on the bar.

Discussion

Physical development. We have established differences in weight-growth indices, including BMI. Because weight-to-height indexes are recalculating relative indicators, statistically significant differences are more likely to appear in them.

This indicates a tendency to increase the body weight of young men during the first year of training (body weight in this period is normal). This trend was identified by us with the help of recalculation indicators (indexes). Our data on the increase in BMI for the year are consistent with the data on the increase in BMI in young men during the first year of training [4], in the first 1,5 years at the university [52], for the first semester [12]. In our study, the BMI changed by 1,09 kg/m^2, and in another study [52] – by 0,7 kg/m^2. In a study of Pribis P. et al. [17] BMI changes insignificantly. Also according to Zaccagni L. et al. [18] BMI is not an informative indicator.

Although we did not study the component composition of the body, the change in BMI is associated with an increase in fat mass. This is indirectly confirmed by the deterioration in the indicators of physical fitness.

Indexes are traditionally considered indicative indexes, so we suggest using them as screening tests in health monitoring.

Physical fitness. The results of our study are correlated with the data on the physical preparedness of first-year students of Chelyabinsk (Russia) [53], Sterlitamak (Russia) [54]. Our data on the decrease in the time of hanging on the bar and the increase in the running time on 1000 m are confirmed by the literature data [54]. The study [55] shows the ambiguity of high-speed, speed-strength qualities and endurance results. In the literature, it is suggested that the results of carpal dynamometry and long jump from the place [14], for estimating the state of the cardiorespiratory system – running at medium distances [56], the 5- and 15-minute run for estimation of aerobic capacity be considered as the most informative

Table 1. Statistically significant differences in indicators

Parameters	Group 1			Group 2		
	n	M	m	n	M	m
Physical development						
Erisman Index	58	2,71	1,00	59	5,96*	1,00
Rohrer's Index	58	12,44	0,20	59	13,19*	0,26
Pignet Index	58	17,43	1,91	59	11,37*	2,02
Body Mass Index	58	21,89	0,33	60	22,98*	0,39
Physical preparedness						
1000 m, min	50	3,56	0,07	52	3,79*	0,07
Hanging on a bar, sec	59	41,93	3,6	56	33,07*	2,23
Functional state						
Vital capacity of length, ml	60	4091,67	89,92	64	3856,25*	70,43
Vital index, ml/kg	58	60,07	1,1	64	55,66*	0,94
Endurance coefficient	59	14,13	0,51	60	15,84*	0,5
Adaptive capacity	58	2,09	0,02	60	2,19*	0,04
Diastolic blood pressure, mmHg	60	66,12	1,4	64	70,19*	1,16

Note: * - the differences are reliable, p<0,05

for estimating the isokinetic force [57], to evaluate the strength qualities – a long jump from the place [58], to assess the state of the cardiorespiratory system – shuttle run on 20 meters [59].

Functional state and operability. Our data on the reduction of the vital capacity of length, vital index and increase in diastolic blood pressure are confirmed in the literature. Thus, a decrease in vital capacity of length and an increase in diastolic blood pressure is observed in young men who engaged in weightlifting [60]. In the process of adaptation, students have an increase in diastolic blood pressure [61] and a tendency to hypertension [62]. An increase in diastolic blood pressure is a prognostically unfavorable sign and should be taken into account when assessing the response to physical exertion. We compared the endurance factor and the adaptation potential with the norms [47]. The increase in these indicators indexes results in weakening of the cardiovascular system and the tension of adaptation mechanisms. Probably, in this case, the adaptation is non-physiological.

In our opinion, the indicator indexes for the adaptation of young men to learning are those for which statistically significant differences and confirmation in the literature have been obtained.

Conclusions

1. The ambiguous dynamics is shown: the speed-strength qualities did not change, the endurance and the state of the cardio-respiratory system worsened.

2. We suggest to consider the indicator indexes of the process of adaptation of female students for training: BMI (physical development index), running on 1000 m (physical fitness indicator), endurance factor (functional status indicator).

Conflict of interest

The authors state that there is no conflict of interest.

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Cite this article as: Tulyakova OV, Avdeeva MS. Informative indices of physical and functional state of young men during the process of adaptation to learning. *Pedagogics, psychology, medical-biological problems of physical training and sports,* 2018;22(1):44–49. doi:10.15561/18189172.2018.0106

The electronic version of this article is the complete one and can be found online at: http://www.sportpedagogy.org.ua/index.php/PPS/issue/archive

Received: 15.09.2017
Accepted: 08.10.2017; Published: 26.02.2018