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Students' Health and its Interrelation with Physical Fitness Level

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Abstract

The level and dynamics of students' physical health during the 1st and the 2nd years of studying at a Ukrainian higher educational institution are investigated in this article, and the interrelation between the indicators of students' health and physical fitness is defined. Seventy-three students of Zhytomyr National Agroecological University (38 male and 35 female students) took part in the investigation. The level of the students' physical health was evaluated according to the methodology of Professor Apanasenko based on the anthropometry indicators (body weight and lengths, lung capacity, wrist power) and the state of the cardiovascular system (heart rate, blood pressure, heart rate recovery). It has been determined that the physical health level of both male and female students did not improve during the 1st and the 2nd years of studying; more than 80% of the students (both men and women) have below middle and low levels of health; the overall points are measured by 2.31–3.27 points. It indicates the lack of the efficiency of the current system of physical education at Ukrainian higher educational institutions and the necessity of the search for the means of its improvement. The correlation analysis defined an authentic interrelation ($p < 0.05$) between the students' physical fitness level and the indicators of their health. Most of the authentic correlation connections are defined due to the results in the endurance and power exercises.

Key words: health, physical fitness, physical education, students

Introduction

The system of modern higher education in Ukraine is aimed at the preparation of a highly qualified specialists who are capable of performing a reasonable amount of work not decreasing its quality and intensity under free-market conditions and who also should have highly developed psychomotor abilities that reflect the pattern of requirements for the physical and mental health, physical fitness, and working capacity of a student (Bolotin & Bakayev, 2015; Futorny, 2011). However, the analysis of researcher's results (Griban, 2009; Muntyan, 2010; Prysiazhniuk et al., 2018; Mozolev, Halus, Bloschyn-

skyi, & Kovalchuk, 2019) has proven an unsatisfactorily level of physical fitness of the majority of modern students and a continuous increase of the number of students who have reduced general condition of health at the beginning and during the studying at a higher educational institution. About 90% of students have different health problems; more than 50% have an unsatisfactory physical fitness level. Researchers (Maglyovanyi, 2010; O. Zavydivska, N. Zavydivska, & Khanikiants, 2016) consider this situation to be the consequence of the inefficient functioning of the current system of physical education of Ukrainian students.



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Summarizing the data of many research studies (Harso-da & Purohit, 2014; Mohammed, 2018; Warburton, Nicol, & Bredin, 2006), it can be defined that health is the most vital factor of an individual living programme implementation that significantly affects the realization of social tasks. According to the data of the World Health Organization (2015), health is determined to be a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity. In accordance with the definition in the study by Amosov (2002), a person who has harmonious physical and mental development and is well adapted to the surrounding physical and social environment can be considered healthy. As provided by the study by Maglyovanyi (2010), physical health is the state of an organism when integral indicators of the main physiological systems are within the physiological norms and are changed adequately while interacting with the environment. Reasoning from this fact, it can be stated that a healthy person is capable of a complete realization of his/her physical and mental abilities.

The study by Apanasenko (2007) states that there is a safe level of physical health (on the edge of the third and the fourth levels; according to the methodology, it equals 12 points), above which endogenous risk factors of chronic somatic illnesses, the diseases themselves, and deaths caused by them can hardly be found. The scientist mentions that the share of the population of Ukraine that is within the safe zone of health has decreased 1% in the last 20 years.

This work aims to investigate the students' level and dynamics of physical health during their studies and to define the interrelation between the indicators of their health and physical fitness.

Methods

The investigation was conducted in Zhytomyr National Agroecological University in 2015–2017 (during the 1st–4th semesters). Seventy-three students of the faculty of technology (38 male and 35 female students) took part in the research. The level of the students' physical health was investigated according to the methodology of Apanasenko (2007) based on the anthropometry indicators (body weight and lengths, lung capacity, wrist power) and the state of the cardiovascular system (heart rate, blood pressure, heart rate recovery). The methodology defines the amount of points for each of the following five indicators (calculated indices): body mass index, life index, Robinson's index, power index and heart rate recovery after 20 squats in 30 seconds. The body mass index characterizes the peculiarities of the students' constitution, and is defined as the ratio of the bodyweight to body height and is expressed in kg/m². The life index evaluates the reserves of the external respiration functions; it was determined by the ratio of lung capacity to body weight in ml/kg. The power index characterizes the state of the muscle system, and it was designated by the ratio of the wrist power to body weight as a percentage. Robinson's index describes the efficiency of the cardiovascular system functioning. The decrease in this indicator means the improvement of the system functioning. This index was defined in standard units by the product of the heart rate and systolic blood pressure, which was divided by 100. The evaluation of the heart rate recovery was held after 20 squats in 30 seconds. According to the methodology by Apanasenko (2007), a low health level equalled 3 points and less, below the middle 4–6 points, the middle 7–11 points, above the middle 12–15 points, a high 16–18 points (Table 1).

Table 1. The Physical Health Level Evaluation According to the Methodology by Apanasenko (2007)

The indicators investigated		The level of physical health				
		Low	Below the middle	Middle	Above the middle	High
Body mass index (kg/m ²)	men	≤18.9	19.0-20.0	20.1-25.0	25.1-28.0	≥28.1
	women	≤16.9	17.0-18.0	18.1-23.8	23.9-26.0	≥26.1
Numerical score		-2	-1	0		
Life index (ml/kg)	men	≤50	51-55	56-60	61-65	≥66
	women	≤40	41-45	46-50	51-55	≥56
Numerical score		-1	0	1	2	3
Power index (%)	men	≤60	61-65	66-70	71-80	≥81
	women	≤40	41-50	51-55	56-60	≥61
Numerical score		-1	0	1	2	3
Robinson's index (s.u.)	men	≥111	95-110	85-94	70-84	≤69
	women	≥111	95-110	85-94	70-84	≤69
Numerical score		-2	-1	0	3	5
Heart rate recovery (sec)	men	≥180	120-180	90-120	60-90	≤59
	women	≥180	120-180	90-120	60-90	≤59
Numerical score		-2	1	3	5	7
The amount of points		≤3	4-6	7-11	12-15	16-18

The level of physical fitness was estimated due to the following tests: for men – 100 m race, pull-ups, 3000 m race; for women – 100 m race, push-ups, 2000 m race.

During the examinations, the authenticity of the difference between the students' indicators at the beginning and was determined at the end of the experiment based on the student's t-test. To investigate the interrelation between the students' health indicators and physical fitness, the Pearson correlation coefficient

was applied. The significance for all statistical tests was set at $p < 0.05$. All statistical analyses were performed with the SPSS software, version 21, adapted to medical and biological research.

This study complies with the ethical standards of the Act of Ukraine on Higher Education No. 1556-VII dated 01.07.2014 and the Letter from the Ministry of Education and Science of Ukraine on Academic Plagiarism Prevention No. 1/11-8681 dated 15.08.2018.

Results

The analysis of the body mass index of the male students proves that the index did not change authentically during the 1st and the 2nd years of study ($p>0.05$): it was 23.2 kg/m^2 in the 1st semester and 23.4 kg/m^2 in the 4th semester, the difference equalled 0.2 kg/m^2 (Table 2). The body mass index of the female students increased for 0.8 kg/m^2 (from 21.8 to 22.6 kg/m^2) ($p>0.05$). It should be noted that both groups (men, women) have the uptrend of body mass index, which indicates the inefficiency of the current system of physical education and the necessity of its improvement to stabilize the body-weight indicators. According to Table 1, the body mass index of both male and female students corresponds to the physiological norm in all stages of the investigation ($18.50\text{--}24.99 \text{ kg/m}^2$) and equals 0 points; it is the middle level.

The investigation of the dynamics of the life index during studying shows that the indicators of both male and female students have the downtrend, but they are not changed significantly during the research ($p>0.05$) (Table 2). The difference in the indicators in the 1st and the 4th semesters is 0.4 ml/kg for

male students and 0.8 ml/kg for female students. The highest indicators of the life index of the male students are recorded in the 2nd semester (56.6 ml/kg), of the female students in the 1st semester (49.5 ml/kg). The level of functional abilities of the respiratory system according to the life index indicators of the students of both genders equals the middle level in all semesters of study. The conducted analysis of the life index shows the deterioration of the functional ability of the students' respiratory system during studying.

The analysis of the power index indicators shows that they are slightly increased for the students of both groups during studying, but they do not differ authentically at the beginning and at the end of research ($p>0.05$) (Table 2). The highest indicators of the power index of the male students are recorded in the 4th semester (55.5%), of the female students in the 3rd semester (39.1%). Additionally, the power index of both men and women are of a low level at all stages of this investigation; thus, the current system of physical education has the lack of efficient influence on the development and improvement of the students' power characteristics.

Table 2. The Dynamics of the Indicators of the Students' Physical Health during the 1st and the 2nd Years of Studying at an Agricultural Higher Educational Institution (N=73, Mean±SD)

The examined indicators	Semesters of studying				p - significance difference
	1 st	2 nd	3 rd	4 th	
Male students (N=38)					
Body mass index	23.2±0.23	23.1±0.21	23.2±0.20	23.4±0.21	$p>0.05$
Life index	56.5±1.21	56.6±1.16	56.4±1.14	56.1±1.17	$p>0.05$
Power index	54.1±1.17	54.5±1.14	55.3±1.12	55.5±1.09	$p>0.05$
Robinson's index	88.5±1.29	88.7±1.25	88.7±1.21	89.1±1.23	$p>0.05$
Heart rate recovery	131.8±2.93	130.3±2.86	128.5±2.89	129.6±2.91	$p>0.05$
Health level	2.31±0.54	2.48±0.59	2.61±0.60	2.73±0.62	$p>0.05$
Female students (N=35)					
Body mass index	21.8±0.29	22.2±0.26	22.6±0.27	22.6±0.25	$p>0.05$
Life index	49.5±1.44	49.1±1.40	48.8±1.38	48.7±1.35	$p>0.05$
Power index	37.9±1.23	38.7±1.20	39.1±1.18	38.2±1.22	$p>0.05$
Robinson's index	80.9±1.35	81.7±1.32	81.5±1.28	81.8±1.30	$p>0.05$
Heart rate recovery	137.2±4.06	135.6±3.98	138.3±3.88	139.4±3.95	$p>0.05$
Health level	3.08±0.62	3.14±0.60	3.22±0.58	3.27±0.55	$p>0.05$

The research of Robinson's index proves the decrease of the indicators of both male and female students; the lowest indicators are recorded in the 4th semester (Table 2). Robinson's index of the male students was 0.6 s.u. , decreased during studying ($p>0.05$), and it equalled 89.1 s.u. in the 4th semester. The difference of the female students' indicators is 0.9 s.u. , and it is not significant ($p>0.05$); Robinson's index of the female students equalled 81.8 s.u. in the 4th semester. The indicators of the functional abilities of the students' of both genders' cardiovascular system are of the middle level during all semesters of studying.

The investigation of the dynamics of the heart rate recovery after 20 squats in 30 seconds shows that the indicators of the students from both groups were not changed significantly ($p>0.05$) (Table 2). The heart rate recovery of the male students is within the range of 2 mins 10 sec and 2 mins 12 sec, of the female students in the range of 2 mins 15 sec and 2 mins 20 sec. The level of the cardiovascular system functional abilities of both male and female students that was evaluated according to the heart rate recovery after 20 squats is estimated as below the middle.

The analysis of the students' health level shows that the dynamics of the amount of points have a positive character during the 1st and the 2nd years of studying but the indicators of both male and female students in the 1st and the 4th semesters do not differ authentically ($p>0.05$) (Table 2). Therefore, the amount of points equalled 2.31 in the 1st semester and 2.73 points in the 4th semester; the difference is not significant ($p>0.05$). According to Table 1, the health level stays unchanged at all stages of the investigation, and it is evaluated as low. The analysis of the correspondence of the physical health levels shows that the majority of students (men and women) have low and below-the-middle levels of health at all stages of investigation (Table 3). Therefore, 81.6% of male students have a low and below-the-middle health level in the 1st semester (47.4% and 34.2% respectively), and 79% in the 4th semester (39.5% and 39.5%). The number of students who have a middle health level was increased from 13.2% in the 1st semester to 18.4% in the 4th semester. Additionally, the number of male students who have above-the-middle health level was decreased by half (from 5.2% in the 1st semester to 2.6% in the 4th semester).

The dynamics of the health level of the female students have a similar character. In the 1st semester, 54.3% of female students have a low health level, 31.4% below-the-middle health level, 11.4% a middle health level, and just 2.9% have above-the-middle health level. In the 4th semester, the number of female students who have a low health level decreased to 42.9%, and those who have below-the-middle health level increased to 40%. The

number of female students who have a middle health level increased by 5.5% (to 17.1%), and no students were determined to have a high health level in the 4th semester. This emphasizes the lack of the efficient influence of the traditional physical education classes on the physical health level of both male and female students. It also should be mentioned that no male or female students have a high health level during the investigation.

Table 3. Correspondence of the Students with Different Physical Health Levels during the 1st and the 2nd Years of Studying at an Agricultural Higher Educational Institution

Physical health levels	Semesters of studying				The difference in the 1 st and 4 th semesters
	1 st	2 nd	3 rd	4 th	
Male students (N=38)					
Low	47.4%	42.1%	39.5%	39.5%	-7.9%
<i>Below the middle</i>	34.2%	36.9%	42.1%	39.5%	+5.3%
Middle	13.2%	15.8%	15.8%	18.4%	+5.2%
Above the middle	5.2%	5.2%	2.6%	2.6%	-2.6%
High	0%	0%	0%	0%	0%
Female students (N=35)					
Low	54.3%	45.7%	42.9%	42.9%	-11.4%
<i>Below the middle</i>	31.4%	34.3%	34.2%	40.0%	+8.6%
Middle	11.4%	14.3%	17.1%	17.1%	+5.6%
Above the middle	2.9%	5.7%	5.7%	0%	-2.9%
High	0%	0%	0%	0%	0%

Therefore, the conducted investigations showed that the current system of physical education at an agricultural higher educational institution does not have an efficient influence on the students' physical health level. The majority of the students (more than 80%) have a low and below the middle levels of physical health and more than 95% of students are not within the safe zone (12 points). The development of the system of physical education to improve their health and working capacity during the studying activity is required.

The correlation analysis of the students' (both men and women) results in physical exercises (characterizing speed, power and endurance) and their indicators of physical health

was conducted to examine the influence of physical education classes on students' health. The analysis of the correlation coefficients of the examined indicators of the male students and their results in the 100 m race shows the lack of authentic connection of the results in speed development with the indicators of physical health of students ($p > 0.05$); the correlation coefficients are within the range from 0.127 s.u. to 0.215 s.u., and they are lower than an extreme mean ($r = 0.219$ s.u.) (Table 4). This means that the development and improvement of the speed characteristics of students during physical education classes will not promote their physical development, functional state, and physical health.

Table 4. Interrelation of the Physical Fitness Indicators of Male Students of an Agricultural Higher Educational Institution (N=38) and the Indicators of Their Health (Correlation Coefficients, s.u.)

Physical health indicators	Physical fitness indicators		
	100 m race	Pull-ups	3000 m race
Body mass index	0.183	-0.218	0.581
Life index	-0.211	0.223	-0.425
Power index	-0.127	0.625	-0.293
Robinson's index	0.204	-0.271	0.532
Heart rate recovery	0.201	-0.174	0.614
Health level	-0.215	0.314	-0.578

Legend: the critical value of the correlation coefficient is 0.219 s.u. ($p < 0.05$)

The analysis of the interrelation of the students' health indicators and their results in pull-ups showed a strong authentic ($p < 0.05$) connection of the results in power exercise and the indicators of the power index ($r = 0.625$ s.u.) (Table 4). Furthermore, the interrelation of the results in pull-ups of the male students and their life index ($r = 0.223$ s.u.), Robinson's index ($r = -0.271$ s.u.) and health level ($r = 0.314$ s.u.) is determined ($p < 0.05$). A weak correlation connection of the students' power characteristics with the indicators of body mass index ($r = -0.218$ s.u.) and heart rate recovery ($r = -0.174$ s.u.) is de-

termined ($p > 0.05$). Correlation analysis of the male students' results in the 3000 m race defined a strong authentic connection of the results in exercise and the physical health indicators ($p < 0.05$) (Table 4). Thus, the results in the 3000 m race is significantly ($p < 0.05$) interrelated with the body mass index ($r = 0.581$ s.u.), Robinson's index ($r = 0.532$ s.u.), heart rate recovery ($r = 0.614$ s.u.), health level ($r = -0.578$ s.u.). The significant influence of an endurance-developing exercise on the indicators of the life index ($r = -0.425$ s.u.) and power index ($r = -0.293$ s.u.) of the male students ($p < 0.05$) is also determined. The conducted

analysis proved the necessity of the endurance and power characteristics improvement during studying to improve the physical health and functional abilities of the main systems of an organism of students.

The correlation analysis of the results in 100 m race of the female students and their physical health indicators showed a similar trend: the lack of significant connection ($p > 0.05$) of speed characteristics and health indicators of the female students ($r = -0.083$ – -0.223 s.u.) (Table 5). The structure of the

interrelation of the female students' results in push-ups with their health indicators is complicated. Thus, the result in power exercise has as authentic ($p < 0.05$) connection with the indicators of the power index ($r = 0.517$ s.u.), body mass index ($r = -0.274$ s.u.) and health level ($r = 0.281$ s.u.). The interrelation with the indicators of life index ($r = 0.165$ s.u.), Robinson's index ($r = -0.230$ s.u.) and heart rate recovery ($r = -0.233$ s.u.) is determined, but it is not authentic ($p > 0.05$).

Table 5. Interrelation of the Physical Fitness Indicators of Female Students of an Agricultural Higher Educational Institution (N=35) and the Indicators of Their Health (Correlation Coefficients, s.u.)

Physical health indicators	Physical fitness indicators		
	100 m race	Push-ups	2000 m race
Body mass index	0.127	-0.274	0.648
Life index	-0.223	0.165	-0.513
Power index	-0.083	0.517	-0.222
Robinson's index	0.216	-0.230	0.579
Heart rate recovery	0.198	-0.233	0.650
Health level	-0.196	0.281	-0.552

Legend: the critical value of the correlation coefficient is 0.234 s.u. ($p < 0.05$)

The analysis of the interrelation of the female students' results in the 2000 m race with their physical health indicators proved an authentic ($p < 0.05$) connection with the majority of the indicators examined. Thus, the result in the 2000 m race is connected with the body mass index ($r = 0.648$ s.u.), life index ($r = -0.513$ s.u.), Robinson's index ($r = 0.579$ s.u.), heart rate recovery ($r = 0.650$ s.u.), health level ($r = -0.552$ s.u.) significantly. It proves our conclusions on the necessity of the development of endurance to improve the female students' health while studying at an agricultural higher educational institution.

In general, exercise developing endurance allowed determining the most correlation connections in contrast to the other physical exercises, which have a positive influence on the health indicators of students (both men and women). This proves the conclusions of many scientists (Altavilla, D'Elia, & Raiola, 2018; Montesano & Mazzeo, 2019; Wilmore & Costiill, 2004) on the importance of the endurance development and improvement to improve the students' working capacity, health, and efficiency of studying activity.

Discussion

Health protection organizations are commonly considered to be the only ones responsible for health. However, medical science studies the diagnostics of diseases, treatment process and prevention methods. Many other sciences, including physical education, solve the problems of the improvement of health, physical and mental development, and disease prevention, and study the issues aimed at the extension of the morphological and functional abilities of the students' organisms (Altavilla et al., 2018; Amosov, 2002; Bolotin & Bakayev, 2015; Tinazci, Ealrefai, & Musa, 2019).

The works of many researchers (Futorny, 2011; Griban, 2009; Zavydivska et al., 2016) state that the students' of Ukrainian higher educational institutions health is unsatisfactory and characterized by downward trends and the number of students who belong to the physical education group with reduced exercise load and the special medical group is changing from 35% to 50% at Ukrainian higher educational institutions. More than 45% of

students do not meet the requirements of the physical education programme. Additionally, more than 30% do not reach established standards in the endurance and power exercises, and 15% do not do so in the exercises of the other types. Researchers (Muntyan, 2010; Prontenko et al., 2018; Prysiazhniuk et al., 2018) believe that a low health and physical fitness level of students is conditioned by a low level of physical development and health of school graduates, the lack of the students' interest and motives of traditional physical education classes; insufficient health-promoting and training orientation of the means of physical education; studying conditions in the modern higher educational institutions that are characterized by increased studying requirements, and low levels of students' activity and their lifestyle.

The conducted research proves the conclusions of many researchers (Apanasenko, 2007; Bolotin & Bakayev, 2015; Maglyovanyi, 2010) on the insufficient level of the students' physical fitness and health. The majority of the students of both genders (more than 80%) have below-the-middle and low levels of health; more than 95% of students are not within the safe zone. This proves the lack of efficiency of the current system of physical education at a Ukrainian higher educational institution and requires new ways for its improvement. Most of the authentic correlation connections are defined due to the results in the endurance and power exercises. It shows that the main physical characteristics that have a positive influence on the students' health level and the ones that should be focused on during physical education classes are power characteristics and endurance.

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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