

Correlation of Physical Indices with the Subjective Physiological and Neurophysiological Parameters of Health

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Abstract: In our work, we conducted research and analysis of the components of physical health of students of pedagogical specialties. To this end, the vital and strength indices, the Robinson and Rufier indices, and the height-to-weight ratio were determined. The article also confirms the hypothesis that the physical health and the neurophysiological (psychological) state are related and mutually determined, but not in the direct proportion, depending on the type of index and aspect of self-esteem. Specific results were obtained by comparing physical health indices with subjective feelings of psychological or neurophysiological discomfort. Data saturation and their analysis were conducted using the following methods: anthropometry; spirometry; dynamometry; tonometry; functional tests; mathematical and statistical analysis, as well as questionnaires developed by the authors of subjective assessment of their own condition, which were offered remotely. The research was performed on the basis of Khmelnytskyi Humanitarian-Pedagogical Academy at the Department of Physical Culture and Valeology. The experimental part was performed with the participation of students of 1-4 years of three specialties with a total of 118 people, of which 100 were girls and 18 were boys aged 17 to 21 years (region – Ukraine). The average sample values for girls of the Rufier, Robinson, and “strength” indexes were below average; “vital” and “height-to-weight” indices are defined at the average level. Averaged values for the sample for boys were the following: high are “strength” and “height-to-weight” levels; the Robinson index is low, and the Rufier and “vital” indices are below average. The international significance of the article lies in the fact that for the first time the objective and subjective health indices stated by the interviewers have been measured comparatively.

The authors' original contribution is determined by unexpected results obtained by correlating physical indices with subjective physiological and neurophysiological health parameters in young boys and girls.

Keywords: *Physical health; index of health; students; physical activity; correlation of physical health and subjective psycho- and neurophysiological assessment.*

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Introduction

The problem of physical and complex well-being of young people has now become very relevant. Almost 10 years ago the researcher S. Korol confirmed the trend of deteriorating health of students according to the following criteria:

- there is an increase in the number of the first-year students of Sumy State University referred to the special medical group or exempted from physical education classes from 11.7% to 22.5%;
- the level of somatic health of the first-year students is mostly at low and lower than average levels (78.8% of boys and 81.8% of girls). Of the total number of surveyed contingents, 18.9% of students reached the average level, 1.5% higher than average (Korol, 2014).

Recently, the problem has been exacerbated by epidemiological and related factors. The problem of overcoming the COVID-19 pandemic is directly related to the level of collective and individual health (immunity), the basic component of which is physical health. The problem of physical health, especially of students and pupils in Ukraine is traditionally given close attention by scientists: “The problem of preserving and promoting the health of pupils is one of the priority areas of the state’s social policy. The society pays special attention to this problem since the modernization and dissemination of innovative technologies for preserving and promoting the health of children have become strategic areas of activity of various institutions and are being actively implemented nowadays” (Bilyk, 2020, p. 2).

Professor Maksymchuk defines the concept of “human health” as a complex phenomenon, which is considered through the prism of a number of categories: philosophical, social, economic, biological, medical, as an object of consumption, investment; individual and social value; systemic phenomenon, dynamic, constantly interacting with the environment and constantly changing; as a kind of mirror of the socio-economic, environmental, demographic, sanitary and hygienic condition of the country, and is one of the most important social indicators of progress (Maksymchuk 2016, pp. 169-170). These and similar definitions of health are cross-cutting for the various sciences in which problems of human existence and activity, the functioning of the organism are solved: philosophy, law, medicine, psychology, sociology, pedagogy, valeology, physical education, etc. (Berbets et al., 2021; Demchenko, 2021; Karasievych et al., 2021; Kosholap et al., 2021; Prots et al., 2021; Sarancha et al., 2021). However, despite such a wide

range of definitions and multifaceted understanding, we find gaps that need to be revised and improved in Ukrainian valeology and related sciences.

Before directly formulating the relevance and objectives of the study, we will consider in more detail the multidisciplinary understanding of the physical health in the Ukrainian discourse and identify aspects that need to be developed.

For instance, in Kulinichenko's research it is determined that in medicine there are about 80 definitions of human health, which are formulated by the representatives of various scientific schools. This list is impressive both by the variety of interpretations and the variety of features used in defining this concept (Kulinichenko, 2001, p. 6).

Scientists Medynskyi and Karvatska in the study of scientific approaches to the definition of "health" characterize it as a multi-scientific category, the process of formation of which is based on philosophical, medical, social, psychological and pedagogical basis, combines various types of optimal human interaction with the environment:

- in the philosophical interpretation health preserving is the basis of personal well-being and the problem of personality education:

- in the legislative field it is compliance with existing legislation from a humanistic standpoint and human-centrism, as well as the development and implementation of regulations and programs that care for human health;

- from the medical point of view, health depends not only on the absence of nosologies, but it is also determined by environmental factors and society; hygienic conditions; preservation and strengthening of health depends on the level of formation of health-preserving competencies;

- in the psychological sense, health preserving is determined by a combination of spiritual, social and somatic components of life; due to the harmony of the complex of basic human values;

- sociology focuses on the needs of the individual to achieve the highest potential of health and a high degree of social activity;

- from the pedagogical aspect it is a complex characteristic of the personality, which combines motivational, cognitive-intellectual, mental, spiritual, social, activity, physical (motor) components and creates a feeling of inner harmony and life satisfaction;

- in the interpretation of specialists in physical education, it involves the organization of lifestyle by means of physical education, physical activity aimed at health preserving activities; in the valeological aspect it is the focus of the personality on maintaining and strengthening health (Medynskyi & Karvatska, 2019, pp. 168-170).

The physical component of health culture determines the level of functioning of the body as a whole, the degree of exhaustion of its functional systems, consistency (harmony) in work, the state of anthropometric data, adaptive capacity to environmental conditions, various exogenous and endogenous factors (Yazlovetskyi, 2002). In addition, scientists note the existing positive impact of motor activity on the development of cognitive abilities. “The development of motor skills has a significant impact on the development of intelligence, which allows students to succeed in learning, to grow as specialists in their field. The work of hands, in the process of which the plan is implemented and developed, promotes the development of such qualities of reason as critical, flexibility, breadth and activity of thought, the ability to critically examine assumptions and conclusions” (Lynch, 2019, p. 60). However, the triad “physical - neurophysiological – mental” is still underestimated and not fully studied. In our opinion, the correlativity between the physical health and some aspects of human neurophysiological and mental characteristics is a connection that should be deepened, studied and taken into account in the medical and humanitarian sciences of countries with many years of experience of the discrete Soviet science.

Thus, **the relevance** of our article is confirmed by scientific trends that are spreading in Western Europe, but so far virtually ignored in Ukraine. We mean the need for a comprehensive study of physical health complaints, which is associated with negative psychological, psychosocial and neurophysiological consequences, which are manifested in the complex and often cannot be adequately differentiated by the person.

For example, in 2021, Tran, Grotkowski, Miller, et al. conducted a study among students, the design of which was to keep diaries of health by 255 students aged 29 years old on the average. The main result is the autocorrelation of subjective well-being, its neurophysiological and academic manifestations and the emergence of further problems (Tran et al. 2021). It is clear that from such subjective data should be filtered out complaints caused by defects of character, compensation or secondary benefit (for example, a student may complain of ill health to escape physical education), but the general trend is obvious and should be studied in the student environment of all countries.

Thus, our **purpose (objective)** is to study the objective indices of physical health in students of pedagogical specialties, to identify relevant trends, as well as to measure and compare mental / neurophysiological complaints of students with their physical indices. This will be a novelty for Ukrainian valeology and may become the beginning of complex physical and

neurophysiological research. The hypothesis of the study is that students who have extreme indicators of physical health indices tend to subjectively feel and experience psychological and / or neurophysiological destructive feelings (cognitive, subjective, reflexive, etc.).

Methods and design of the research. The research was performed in Khmelnytskyi Humanitarian-Pedagogical Academy at the Department of Physical Culture and Valeology. The experimental part was performed with the participation of students of 1-4 years of Khmelnytskyi Humanitarian-Pedagogical Academy, who study on the specialties “Musical Art”, “Primary Education”, “Ukrainian Philology” with a total of 118 people, of which 100 were girls and 18 were boys aged 17 to 21 years old.

Experimental studies were performed using the following methods: anthropometry; spirometry; dynamometry; tonometry; functional tests; mathematical and statistical analysis.

This technique involves determining: vital and strength indices, Robinson and Ruffer indices, as well as height-to-weight ratio according to the evaluation tables.

Based on the obtained data, the corresponding indices were calculated:

$$\text{Vital index: V.I.} = \frac{\text{Vital capacity of the lungs}}{\text{Body weight}};$$

$$\text{Strength index: S.I.} = \frac{\text{Wrist dynamometry}}{\text{Body weight}} \times 100;$$

$$\text{Ruffer index: R.I.} = \frac{4 \times (\text{HeartRate1} + \text{HeartRate2} + \text{HeartRate3}) - 200}{100};$$

$$\text{Robinson index: Rn.I} = \frac{\text{HeartRate1} \times \text{BloodPressure(Systolik)}}{100};$$

assessment of height-to-weight ratio.

The developed scheme of organization of the research provided the logic and clarity of solving the tasks and the success of which is due to the use of the following methods:

- obtaining retrospective information;
- obtaining personal subjective information;
- collection of current information;
- ascertaining pedagogical experiment;
- mathematical and statistical methods of processing research results;

- methods of organizing work in research groups.

The stage of data collection was a pedagogical experiment of a confirmatory nature.

Methods of mathematical statistics were used to process the primary material using the program SPSS Statistica, taking into account the requirements of statistical methods of medical and biological researches (Lapach et al., 2000).

The authors did the saturation of subjective data by questioning students in the same groups in which physiological measurements were taken.

The international significance of the article lies in the fact that the authors have for the first time compared the objective indicators of students' health with their subjective reflective indicators. Similar studies that have been conducted before have only partially addressed such aspects, or have investigated only one of the approaches. The detailed argumentation of the relevance of the article and its connection with other publications can be seen at the end of the next section.

Literature review

Harmonious development of personality involves mastering not only a wide range of general (natural and humanitarian) and professional competencies, but also the acquisition of the sufficiently high level of physical qualities. "Personality developing approach involves development of students' potential abilities and capabilities, their professionally significant qualities. It directs the process of physical education to the creative adoption of their own activities, as well as the ability to apply them in solving health, educational and educatory tasks" (Kalenskyi et al., 2021. p. 190).

One of the most important tasks of higher education is the formation of the high level of physical culture of the personality in which health preserving competencies are fully formed that allow to exercise own right to health, which ensures physiological existence and belongs to the group of rights that provide natural (biopsychic) integrity of a personality (Hasiuk, 2011).

The concept of physical fitness is closely related to physical health, because the level of development of individual components of motility closely corresponds to the functioning of organs and systems of the body. Accordingly, systemic physical activity, in addition to physical development, brings psychological and moral satisfaction (Kovalenko et al., 2020. p. 94).

Even on such practically everyday examples it is possible to observe the elementary connection “physics - neurophysiology – psyche”.

Unfortunately, in Eastern European countries, in particular in the former Soviet Union, the problem of autonomous study of students' physical health is still widespread, as evidenced by the presence of such publications in leading scientometric databases. On a positive note, such studies are currently linked to COVID-19, acceleration, negative environmental impact, etc. For example, in 2020, such studies showed that restrictions on COVID-19 led to a decline in the life index of Eastern European students (Mozolev et al., 2020). The authors substantiate the expediency of changing approaches to the organization of physical culture, sports and health-maintaining activity, but we do not observe in such studies taking into account and delineating neurophysiological and neuropsychological perspectives in the context of physical development.

When we talk about physical health, we use the term “somatic”, and its correlations with the non-physical plan – “the psycho-somatic health”. We have found many examples and available methods of diagnosing somatic health in scientometric databases. For instance, the methodology of assessing the level of somatic health of a personality by direct indicators, as well as the method of rapid screening was considered by Apanasenko (1992). The problems of reliability to assess the reliability and validity of the Somatic Self-rating Scale (SSS) were considered by Zh. Qi et al. (2010). The reliability, validity and usefulness of the Somatic Symptom Scale-8 (SSS-8) for measuring the burden of somatic symptoms, was investigated by B. Gierk et al. (2014). The multiple regression analysis was used to study examined the relationship of both major life events and daily hassles – the repeated or chronic strains of everyday life – to somatic health by DeLongis et al. (1982).

Thus, in recent years, Western Europe has moved to comprehensive testing and questioning, which synergistically and deterministically represent physical, neurophysiological and mental indices. These, in turn, can be processed and represented to the desired aspect. It has now been proven that psychological, social and physical circumstances (external and internal) even in healthy people cause significant fluctuations in psycho-emotional state and physical tone. In people with chronic diseases, these fluctuations have a much wider amplitude. These regularities are now widely used in the development and application of integrated health measurement scales. Thus, Antonucci, Taurino, Laera and other researchers have tried to identify a model of psychophysical disorders applicable to both relatively healthy people and people with chronic diseases (e.g., cerebral palsy). The task of

such complex measurements is to clarify the biopsychosocial perspective of control, correction, validation, propaedeutics, etc. (Antonucci et al. 2020). The essence of the methodology is in the metric implementation of several scales at the same time: “assessing quality of life, physical and mental health, personal functioning, anxiety, depression, trust in medical treatment and cognitive abilities” (Antonucci et al., 2020, p. 601). As a result, it was found that the most important complex indicators were the level of anxiety, physical functions and vitality. It is the complex consideration of physical, neurophysiological and mental indicators that gives an overall picture of a person’s condition, allows not only to help them medically or psychologically, but also to form their self-reflection and awareness of personal, professional and life prospects.

Today’s specialists in physical education have already assessed the importance of both exercises that affect the physical and mental state, and tools for complex measurements of the parameters of “bio-”, “neuro-”, “psycho-”. This approach is part of the formative, developmental, preventive and therapeutic measures. The studies of Adegaju and Abon, who studied the complex state of students in developing countries (Africa), are interesting. The first thing that has become apparent even without the use of physical and psychometric research is that the majority of students lead a sedentary lifestyle, which is directly related to their vulnerability, depression, extensive functionality and other neurophysiological and psychological indicators (Adegaju, Abon, 2021). For valid recording of such data, the design of the correlation survey performed well, and mathematical data processing was performed “using descriptive statistics of frequency, simple percentage, mean value, standard deviation and bar graph for demographic variables and research questions (Adegaju & Abon, 2021).

Such relatively simple studies of students in developing countries allow us to draw two important physical and at the same time neuropsychological conclusions: a) sedentary youth are prone to destructive self-reflection, depression and anxiety disorders; b) young people who are in optimal physical condition (regularly engaged in physical culture or sports), show stress resistance, high neurophysiological functionality, etc. Therefore, there is a direct relationship between systematic physical activity, physical condition and neuropsychological / neurophysiological indicators.

In recent years, the subjective health of students has not been considered in the context of the real physical state. There is research on subjective health in the context of sociopathic phenomena: victimization (Sentenac et al., 2013); cyber bullying (Läftman et al., 2013); destructive influences of psychosocial school environments (Markkanen et al., 2019).

However, we found a number of articles that indirectly correlate with our study, however, they do not contain a comparison of direct physical indicators with the subjective data of the studied students. Such studies are characterized by narrowly focused neurophysiological studies of certain aspects of health compared with direct subjective reported data or with subjective indirect measures. All these studies, like ours, are done on limited local material and are predominantly randomized. For example, in Scopus publications in recent years, it is common to compare students' subjective measures of their health with neuro- or psychophysiological laboratory-validated measures and find out the pronounced discrepancy: continuation and sleep quality reflected in personal well-being (Pusztai et al., 2019); neurophysiological personality type and its influence on subjective experience of states of personal health (Kim, 2020).

The closest to the topic of our article were studies that comparatively investigate such physical phenomena as adaptation, self-development, and self-regulation of the physical state of students (Ortenburger et al., 2020).

There are a number of studies in which the authors compare, as we do, the real and subjective health of students and/or trainees, but these articles differ in their subject matter from ours because they comparatively analyze health in pathology (physical or psychophysiological). From the above considerations, we conclude that our article is relevant and complements the overall picture of comparative health research in the "real-subjective" mode. We tried to give a "new life" to the already forgotten in the actual science physiometry and showed that its comparison with successful representations of one's state and health are actual problems of physical education of today's youth.

Determination of health indices according to traditional methods

The main work before writing the article was the collection of the objective information about the level of physical health indices of students who participated in the research.

Anthropometric measurements included determination by conventional methods of body length (cm); body weight (kg); vital capacity of the lungs (ml); blood pressure (mm Hg); finger flexor strength (kg). Physiological techniques included measurement of vital capacity of the lungs, blood pressure with the tonometer, heart rate, etc.

The analysis of descriptive statistics of the studied indicators revealed the fact that almost all anthropometric measurements of the studied girls and boys were characterized by large values of variance and,

accordingly, scale and standard deviation. This indicates that the scattering indicators of the sample are not quite homogeneous, and the obtained digital values of the studied indicators have significant deviations from the general arithmetic mean, which in turn is characterized by significant values of the mean error. In our research, checking the normality of the distribution of digital values of the studied indicators was not a fundamental requirement, because we did not use the methods of parametric statistics, but at the same time the initial analysis concluded that the entire study contingent of students is heterogeneous in the whole set of anthropometric measurements and functional tests.

The obtained results of almost all anthropometric measurements of girls and boys are characterized by large values of variance, and, accordingly, the scale and standard deviation. This indicates that the scattering sample is not very homogeneous.

We determined the following basic indices: vital and strength indices, Robinson and Rufier indices, as well as the height-to-weight ratio according to the evaluation tables. For this purpose, the following were measured:

- vital capacity of the lungs - using a dry portable spirometer of two attempts, the interval between attempts was 15 seconds, the best result was recorded;

- blood pressure according to conventional methods using serial sphygmomanometer;

- the strength of the flexors of the hand with the help of medical hand dynamometer of two attempts, the interval between attempts of 30 seconds, the best result was recorded with an accuracy of 0.5 kg;

- heart rate was determined by palpation counting the number of contractions in 15 seconds;

- data for calculating the Rufier index were determined in three stages: heart rate was measured for 15 seconds in the sitting position at rest (heart rate 1). After that, the student performed 30 full squats in 45 seconds with arms outstretched. Immediately after that, the heart rate was measured during the first 15 seconds after exercise (heart rate 2). At the third stage, heart rate was determined at the 45th second of rest of the first minute after exercise (heart rate 3).

Based on the express method of physical health assessment, the content of which is determined and tested by a number of scientific studies, we have assessed the level of physical health of students of pedagogical specialties. The evaluation was performed by comparing the obtained absolute data with the scores using table 1; determination of the final assessment of the quality of health was carried out according to table 2.

Table 1. Correspondence of absolute indicators of indices to points

Indicator	Index – Points				
	Men (women)				
Height-to-weight	18.9 and less (less than 16.9) -2 points	19.0 - 20.0 (17.0-18.0) -1 point	20.1 - 25.0 (18.1-23.8) 0 points	25.1 - 28.0 (23.9-26.0) -1 point	28.1 and more (26.1 and more) -2 points
Vital	50 and less (40 and less) -1 point	51 – 55 (41-45) 0 points	56 – 60 (46-50) 1 point	61 – 65 (51-55) 2 points	66 and more (56 and more) 3 points
Strength	60 and less (40 and less) -1 point	61 – 65 (41-50) 0 points	66 – 70 (51-55) 1 point	71 – 80 (56-60) 2 points	81 and more (61 and more) 3 points
Robinson index	111 and more (111 and more) -2 points	95 – 110 (95-100) -1 point	85 – 94 (85-94) 0 points	70 – 84 (70-84) 3 points	69 and less (69 and less) 5 points
Rufier index	3 and more (3 and more) -2 points	2 – 3 (2-3) 1 point	1.30 - 1.59 (1.30- 1.59) 3 points	1.00 - 1.29 (1.00-1.29) 5 points	0.59 and less (0.59 and less) 7 points

Source: Authors' own conception

Table 2. The ratio of points obtained to health levels

	Quality Levels of Health				
	low	lower than average	average	higher than average	high
Overall health assessment	3 and less points	4 - 6 points	7 - 11 point	12 – 15 points	16 - 18 points

Source: Authors' own conception

The results obtained by us are consistent with the assessment of the state of the low-level somatic health of the first-year students of technical specialties conducted by S. Korol (2014).

A similar situation is described by Boychuk, who claims that in Ukraine there is a tendency of deteriorating health of the population, which has reached a threatening level (Boychuk, 2017).

Correlation of physical indices with the subjective physiological and neurophysiological parameters of health

The intelligence of many contemporary scientists clearly distinguishes between physical health and mental health. In the midst of the COVID-19 epidemic, these issues became particularly acute. Al-Tammemi, Akour, Alfalah believe that in the age of globalization, especially since the spread of COVID-19, more attention should be paid not so much to physical health indicators that cannot be affected quickly, but to mental and neurophysiological sensations, experiences and states, which are subjectively experienced by the individual (Al-Tammemi et al., 2020).

The prevalence of the coronavirus pandemic has forced valeologists and educators to take a new approach to the relationship between physical neurophysiological and mental health, or at least the condition of the younger generation. At the same time, the humanitarians joined the inspection of these conditions en masse in order to increase the coverage of the youth contingent. They were not able to use diagnostic devices, so they turned to less valid, but available and mass test and questioning resources. In developing the subjective data collection questionnaire for the article, we used the experience of the most recent research conducted last year in France and Switzerland through online questionnaires (finding out changes in physical, physiological and mental condition in response to quarantine restrictions during COVID-19) (Cheval et al., 2021). We also used the stress scale and the experience of parents of Australian teenagers who studied the relationship between stress / life satisfaction from the direct and stressful effects of a pandemic (Sciberras et al., 2020). A questionnaire to identify recurring or regular neurophysiological / mental complaints was developed by us and completed by students online to reduce the destructive impact of the interviewer.

Our ultimate task is to determine whether there is a direct dependence of the subjectively assessed psychophysiological state on the objectively recorded indices of physical health of Ukrainian students. At the very beginning of data collection, we realized that the simultaneous diagnosis

of different conditions through personal interviews, semi-structured questionnaires, etc., risks being less reliable than discrete diagnosis. Researchers Hossain, Anjum, Hasan et al. (2020) faced a similar problem. At the very beginning of the presentation of their results, they noted that self-awareness of changes in the physical and psychophysiological state or their self-assessment already provokes anxiety and even autonomic changes.

We tried to find out the subjective neurophysiological states of the students studied above with the help of a detailed questionnaire. Because we realized that we do not have the necessary devices in the field conditions, and the personal data are not completely reliable, we decided to conduct a survey on the most common neurophysiological indicators that can be represented subjectively with a greater or lesser probability: dizziness or predisposition to it, constant pain, mood swings, feelings of exhaustion or fatigue for no apparent reason, or indicate your own condition.

Let's move on to present the most interesting phenomenon - the demonstration of the identified high and medium indices of physical health of young people with subjective qualifications of neurophysiological condition or a disease (less frequently). We did not analyze individuals of low physical performance, as the correlation between negative neurophysiological complaints and low physical health indicators is obvious.

Therefore, the analysis of the numerical values of the indices included in the rapid method of determining physical health showed that in the study totality of girls the best values were characterized by the vital index with an average score of 1, which corresponds to the average values in tabular values (Table 3).

Table 3. *Value and assessment of physical health indices of students of pedagogical university (girls, n = 100)*

Levels	Rufier		Vital		Strength		Robinson		Height-to-weight	
	<i>Number</i>	<i>%</i>	<i>Number</i>	<i>%</i>	<i>Number</i>	<i>%</i>	<i>Number</i>	<i>%</i>	<i>Number</i>	<i>%</i>
High	0	0.0	17	17.0	34	34.0	3	3.0	75	75.0
Higher than average	15	15.0	23	23.0	12	12.0	8	8.0	12	12.0
Average	0	0.0	28	28.0	5	5.0	14	14.0	7	7.0

Lower than average	51	51.0	14	14.0	14	14.0	43	43.0	5	5.0
Low	34	34.0	18	18.0	35	35.0	32	32.0	1	1.0
Total	100	100.0	100	100.0	100	100.0	100	100.0	100	100.0
The average values of the sample										
Grade	2.4		48.6		53.9		107.6		21.1	
Mark	1		1		1		-1		0	
Level	L.A.		A.		L.A.		L.A.		A.	

Source: Authors' own conception

To conduct our analysis, we divide the above levels of physical health into three components: “optimal” which includes levels higher than average and high; “improper” - levels low and lower than average; average level.

Initial analysis of the distribution of the results of the physical health indices of girls of the pedagogical university by levels found out that only in terms of “height-to-weight” ratio 87% of girls were characterized by the optimal level; 85% of girls have inadequate level of the Rufier index; The “vital” index is characterized by 40% of optimal and 32% of inappropriate levels; “power” index - 46% of optimal and 49% of inappropriate levels; Robinson’s index: 11% of optimal and 75% of inappropriate levels. Thus, more than a third of those surveyed had low levels of Robinson’s and strength index, which subjectively caused almost no discomfort. On the other hand, 35 out of 75 girls with a high height-to-weight index complained of psychological discomfort, which can be described as a personal symptom complex with the attitude: *I’m too fat, my feet are too large, I’m depressed*, etc.

At the same time, we state that when calculating the average values of the sample for girls, the indicators of the Rufier, Robinson, and “strength” indices corresponded to the level lower than the average; “vital” and “height-to-weight” indices are defined at the average level. Interestingly, most girls with low endurance and strength indices showed almost no neurophysiological or psychological disturbances, and only low hemodynamic levels were directly correlated with anemic and / or asthenic subjective factors that were not medically tested. Unlike boys, almost 35% of girls admitted to having individual psycho- and neurophysiological conditions that did not show a regular correlation with physical health and were sporadic (recurrent pain, predisposition to depression, dizziness).

Analysis of the values and assessment of the physical health indices of boys revealed that the studied contingent was characterized by high levels of “strength” index of 88.9% and “height-to-weight” of 77.8% of the

sufficient level (Table 4). The values of the Rufier index, which were found in 72.2% of the surveyed, are mostly characterized by the inadequate level; the “vital” index and Robinson index were 66.7% and 88.9%, respectively.

Table 4. *Value and assessment of physical health indices of students of pedagogical university (boys, n = 18)*

Levels	Rufier		Vital		Strength		Robinson		Height-to-weight	
	Number	%	Number	%	Number	%	Number	%	Number	%
High	0	0.0	4	22.2	15	83,3	0	0,0	10	55,6
Higher than average	5	27.8	1	5.6	1	5,6	0	0,0	4	22,2
Average	0	0.0	1	5.6	2	11,1	2	11,1	2	11,1
Lower than average	6	33.3	3	16.7	0	0,0	3	16,7	0	0,0
Low	7	38.9	9	50.0	0	0,0	13	72,2	2	11,1
Total	18	100.0	18	100.0	18	100,0	18	100,0	18	100,0
The average values of the sample										
Grade	2,2		51.9		102.2		124.5		22.6	
Mark	1		0		3		-2		0	
Level	L.A.		L.A.		H.		L.		H.	

Source: Authors' own conception

According to the average values of the sample for boys, the “strength” and “height-to-weight” indices have a high level; the Robinson index is low and the Rufier and “vital” indices are lower than average.

The difference of the results between the percentages of the studied indices and the average values of the sample is explained by the high variance of the input data.

Survey results showed that of the 14 boys with the highest and higherthan average height-to-weight parameters, 6 admitted that they rarely or regularly had symptoms similar to vascular dystonia and mood swings. The strength index (15:13) turned out to be the most equal in its correspondence with neurophysiological self-assessment, i.e., the coincidence of high indicators of both parameters was practically the same. The most expected low correlation was the complex of Robinson, Rufier and “vital” indices, which in the total ratio of physical indicators and

subjective complaints of low endurance was 29:22. However, it should be noted that we did not study the individual picture of each student, but only the statistics of indicators. That is, the same person could have, for example, a low “vital” and a Rufier index. Similarly, with the subjective complaints of regular or sporadic neurophysiological discomfort.

Conclusion

The results of the measurement of physical health indices confirmed the negative trend in Ukraine. The health of children, schoolchildren and students is of particular concern. The analysis of the obtained data confirmed the available statistics that only 5% of school graduates are practically healthy, 40% of schoolchildren are chronically ill, 50% have morpho-functional disorders, up to 80% suffer from various neuropsychiatric disorders. Only 5% of pre-conscription young men have no medical contraindications to military service.

The low level of most physical health indices of students necessitates a more detailed consideration of the development of some components of motility, followed by the definition of its individual components, which are characterized by the greatest impact on the functioning of the body, indicating the level of health.

Thus, the analysis of the structure of physical fitness and the development of some components of student motility will identify those physical qualities that have the greatest positive impact on the level of basic indicators of the components of the above-mentioned indices. To improve the level of physical health of students and, as a consequence, more effective implementation of the principle of health orientation in the process of physical education of young people, it is advisable to act by selecting individual load parameters - individual selection of types of physical activity and exercises. It will significantly increase the level of physical fitness and, as a result, achieve a sufficient and high level, which will lead to harmonious physical development and proper physical health.

The second, hypothetical part of the study revealed the following results. We compared the indices of physically healthy students, students with low physical indices (see previous section) with a subjective assessment of their own physical and neurophysiological condition or its change. The results were surprising especially among the girls. The level of divergence in relation to positive physical indicators and subjectively assessed as negative neurophysiological conditions or diseases was revealed. This can be partly explained by the more asthenic nature of girls, more pronounced

fluctuations in the endocrine profile during the menstrual cycle, the lability of the nervous system, which easily responds to both physical and informational stimuli. Thus, high physical and height-to-weight conditions cause a psychological discomfort, while mediocre endurance and strength indicators have little effect on the subjective psycho-emotional state (except in individual cases of asthenic, anemic or hormonal disorders). As for boys, almost half of those with the highest height-to-weight parameters complain of vegetative-vascular disorders and related psychosomatics. Extremely low indices of pulmonary endurance, strength and hemodynamics are almost entirely correlated with complaints of low endurance, performance and dissatisfaction with physical shape.

Research perspectives. The research is not complete, but rather demonstrative with the conclusions drawn of a limited sampling, therefore our task for the future is more voluminous and specific: we need to create a comparative table and identify the main causes of mismatch of mental and neurophysiological subjective state of students and their physical health, and in fact - with the physical conditions (development, level, indicators). It is clear that there is no direct deterministic connection, but hypothetically there is a psychophysiological dependence of the objective or subjective (characterological) nature.

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References

Adegoju, F. A., & Abon, J. K. (2021). Effect of physical exercise participation on selected indices of mental health between student athletes and non-athletes of Obafemi Awolowo University, Ile-Ife, Nigeria. *European Journal of Physical*

- Education and Sport Science*, 6(10), 55-73.
<http://dx.doi.org/10.46827/ejpe.v6i10.3545>
- Al-Tammemi, A. A. B., Akour, A., & Alfalah, L. (2020). Is it just about physical health?: an online cross-sectional study exploring the psychological distress among university students in Jordan in the midst of COVID-19 pandemic. *Frontiers in Psychology*, 11, 562213.
<https://doi.org/10.3389/fpsyg.2020.562213>
- Antonucci, L. A., Taurino, A., Laera, D., Taurisano, P., Losole, J., Lutricuso, S., Abbatantuono, C., Giglio, M., De Caro, M. F., Varrassi, G. & Puntillo, F. (2020). An Ensemble of Psychological and Physical Health Indices Discriminates Between Individuals with Chronic Pain and Healthy Controls with High Reliability: A Machine Learning Study. *Pain and Therapy*, 9, 601–614. <https://doi.org/10.1007/s40122-020-00191-3>
- Apanasenko, G. L. (1992). *Evolutsiya bioenergetiki i zdorove cheloveka* [Evolution of bioenergy and human health]. MGP Petropolis.
- Berbets, T., Berbets, V., Babii, I., Chyrva, O., Malykhin, A., Sushentseva, L., MEDYNSKII, S., Riaboshapka, O., Matviichuk, T., Solovyov, V., Maksymchuk, I., & Maksymchuk, B. (2021). Developing Independent Creativity in Pupils: Neuroscientific Discourse and Ukraine’s Experience. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, 12(4), 314-328.
<https://doi.org/10.18662/brain/12.4/252>
- Bilyk, V. (2020). Natural science and research training of future psychologists for health-promoting activities. *Revista Romaneasca pentru Educatie Multidimensionala*, 12(2), 01-17. <https://doi.org/10.18662/rrem/12.2/>
- Boychuk, Yu. D. (2017). *Zahalna teoriia zdorovia i zdoroviazberzhennia* [General theory of health and healthcare]. Rozhko Publisher.
- Cheval, B., Sivaramakrishnan, H., Maltagliati, S., Fessler, L., Forestier, C., Sarrazin, P., & Boisgontier, M. P. (2021). Relationships between changes in self-reported physical activity, sedentary behaviour and health during the coronavirus (COVID-19) pandemic in France and Switzerland. *Journal of sports sciences*, 39(6), 699-704.
<https://doi.org/10.1080/02640414.2020.1841396>
- DeLongis, A., Coyne, J., Dakof, G., Folkman, S., & Lazarus, R. S. (1982). Relationship of daily hassles, uplifts, and major life events to health status. *Health Psychology*, 1(2) 119-136. <https://delongis-psych.sites.olt.ubc.ca/files/2018/03/Relationship-of-Daily-Hassles.pdf>
- Demchenko, I., Maksymchuk, B., Bilan, V., Maksymchuk, I., & Kalynovska, I. (2021). Training Future Physical Education Teachers for Professional Activities under the Conditions of Inclusive Education. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, 12(3), 191-213.
<https://doi.org/10.18662/brain/12.3/227>

- Gierk, B., Kohlmann, S., Kroenke, K., Spangenberg, L., Zenger, M., Brähler, E., Löwe, B. (2014). The Somatic Symptom Scale–8 (SSS-8): A Brief Measure of Somatic Symptom Burden. *JAMA Internal Medicine*, 174(3), 399–407. <https://doi.org/10.1001/jamainternmed.2013.12179>
- Hasiuk, I. L. (2011). *Derzhavne upravlinnia fizychnoiu kulturoiu ta sportom: stan ta perspektyvy rozvytku* [State management of physical culture and sports: state and prospects of development]. Baliuk Publishing.
- Hossain, S., Anjum, A., Hasan, M. T., Uddin, M. E., Hossain, M. S., & Sikder, M. T. (2020). Self-perception of physical health conditions and its association with depression and anxiety among Bangladeshi university students. *Journal of affective disorders*, 263, 282-288. <https://doi.org/10.1016/j.jad.2019.11.153>
- Kalenskyi, A., Kulalaieva, N., Dudikova, L., & Miroshnichenko, V. (2021). Risk prevention as a part of professional training of future physical culture teachers. *Revista Romaneasca Pentru Educatie Multidimensionala*, 13(1), 188-207. <https://doi.org/10.18662/rrem/13.1/368/>
- Karasievych, S., Maksymchuk, B., Kuzmenko, V., Slyusarenko, N., Romanyshyna, O., Syvokhop, E., Kolomiitseva, O., Romanishyna, L., Marionda, I., Vykhruhshch, V., Oliinyk, M., Kovalchuk, A., Halaidiuk, M., & Maksymchuk, I. (2021). Training Future Physical Education Teachers for Physical and Sports Activities: Neuropedagogical Approach. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, 12(4), 543-564. <https://doi.org/10.18662/brain/12.4/264>
- Kim, S. R., Nho, J. H., & Kim, H. Y. (2020). Influence of Type D personality on quality of life in university students: The mediating effect of health-promoting behavior and subjective health status. *Psychology in the Schools*, 57(5), 768-782. <https://doi.org/10.1002/pits.22357>
- Korol, S. A. (2014). Otsinka stanu somatychnoho zdorovia ta fizychnoi pidhotovlenosti studentiv I kursu tekhnichnykh spetsialnosti [Assessment of somatic health and physical fitness of students of the first year of technical specialties]. *Pedabobika, psykholohiia ta medyko-biologichni problemy fizychnoho vykhovannia i sportu* [Pedagogy, psychology and medical-biological problems of physical education and sports], 11, 23–29. <https://cyberleninka.ru/article/n/otsenka-sostoyaniya-somaticheskogo-zdorovya-i-fizicheskoy-podgotovlennosti-studentov-i-kursa-tehnicheskikh-spetsialnostey/pdf>
- Kosholap, A., Maksymchuk, B., Branitska, T., Martynets, L., Boichenko, A., Stoliarenko, O., Matsuk, L., Surovov, O., Stoliarenko, O., & Maksymchuk, I. (2021). Neuropsychological Bases of Self-Improvement of Own Physical Health of Future Teachers in the Course of University Education. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, 12(3), 171-190. <https://doi.org/10.18662/brain/12.3/226>

- Kovalenko, A., Grishchuk, E., Rogal, N., Potop, V., Korobeynikov, G., Glazyrin, I., Glazyrina, V., Goraşenco, A., Korobeynikova, L., & Dudnyk, O. (2020). The influence of physical activity on students' psychological well-being. *Revista Romaneasca pentru Educatie Multidimensionala*, 12(2), 86-96. <https://doi.org/10.18662/rrem/12.2/267>
- Kulinichenko, V. L. (2001). *Sovremennaya meditsina: transformatsiya paradigm teorii i praktiki* [Modern medicine: transformation of paradigms of theory and practice]. Center for Practical Philosophy.
- Låftman, S. B., Modin, B., & Östberg, V. (2013). Cyberbullying and subjective health: A large-scale study of students in Stockholm, Sweden. *Children and youth services review*, 35(1), 112-119. <https://doi.org/10.1016/j.childyouth.2012.10.020>
- Lapach, S. I., Chubenko A. V., & Babich, P. N. (2000). Statisticheskie metodyi v mediko-biologicheskikh issledovaniyah s ispolzovaniem EXCEL [Statistical methods in medical-biological researches using EXCEL]. Marion.
- Lynch, T. (2019). The Meaning of “Education” in “Physical Education”. In T. Lynch (Ed.), *Physical Education and Wellbeing* (pp.59-68). Palgrave Macmillan. https://doi.org/10.1007/978-3-030-22266-6_5
- Maksymchuk, B. A. (2016). *Formuvannya valeolobichnoi kompetentnosti maibutnikh uchyteliv u protsesi fizychnoho vykhovannya* [Formation of valeological competence of future teachers in the process of physical education]. Planer.
- Markkanen, I., Välimaa, R., & Kannas, L. (2019). Associations between students' perceptions of the psychosocial school environment and indicators of subjective health in Finnish comprehensive schools. *Children & Society*, 33(5), 488-502. <https://doi.org/10.1111/chso.12334>
- Medynskyi, S. V., & Karvatska, Yu. P. (2019). Heneza naukovykh pidkhodiv do definitisi “zdoroviazberezhennia” [Genesis of scientific approaches to the definition of “healthsaving”]. *Scientific journal of Vasyl Stefanyk Precarpathian National University*, 17(1), 159-171. <https://doi.org/10.15330/esu.17.159-170>
- Mozolev, O., Polishchuk, O., Kravchuk, L., Tatarin, O., Zharovska, O., & Kazymir, V. (2020). Results of monitoring the physical health of female students during the COVID-19 pandemic. *Journal of Physical Education and Sport*, 20(6), 3280 – 3287. <https://doi.org/10.7752/jpes.2020.s6445>
- Ortenburger, D., Waşik, J., Góra, T., Mosler, D., & Borysova, O. (2020). Self-reported evaluation of adaptation to psychophysical strain in the context of subjective health behaviour of physical education students. *Journal of Physical Education and Sport*, 20(1), 477-483. <https://doi.org/10.7752/jpes.2020.s1070>

- Petrovskiy, B. V. (1984). *Entsiklopedicheskiy slovar meditsinskih terminov* [Encyclopedic dictionary of medical terms], Vol. 3. Soviet encyclopedia.
- Prots, R., Yakovliv, V., Medynskiy, S., Kharchenko, R., Hryb, T., Klymenchenko, T., Ihnatenko, S., Buzhyna, I., & Maksymchuk, B. (2021). Psychophysical Training of Young People for Homeland Defence Using means of Physical Culture and Sports. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, 12(3), 149-171. <https://doi.org/10.18662/brain/12.3/225>
- Pusztai, D., Rozmann, N., Horváth, É., Szunomár, S., & Fusz, K. (2019). Health behavior, sleep quality and subjective health status of foreign students in Hungary. *Archives of Psychiatric Nursing*, 33(5), 83-87. [https://www.psychiatricnursing.org/article/S0883-9417\(19\)30066-4/fulltext](https://www.psychiatricnursing.org/article/S0883-9417(19)30066-4/fulltext)
- Qi, Zh., Jialiang, M., & Chunbo, L. (2019). Developing of somatic self-rating scale and its reliability and validity. *BMJ Open*, 9(9), e024290. <https://doi.org/10.1136/bmjopen-2018-024290>
- Sarancha, I., Maksymchuk, B., Gordiichuk, G., Berbets, T., Berbets, V., Chepurna, L., Golub, V., Chernichenko, L., Behas, L., Roienko, S., Bezliudna, N., Rassskazova, O., & Maksymchuk, I. (2021). Neuroscientific Principles in Labour Adaptation of People with Musculoskeletal Disorders. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, 12(4), 206-223. <https://doi.org/10.18662/brain/12.4/245>
- Sciberras, E., Patel, P., Stokes, M. A., Coghill, D., Middeldorp, C. M., Bellgrove, M. A., & Westrupp, E. (2020). Physical health, media use, and mental health in children and adolescents with ADHD during the COVID-19 pandemic in australia. *Journal of attention disorders*, 1087054720978549. <https://doi.org/10.1177/1087054720978549>
- Sentenac, M., Gavin, A., Gabhainn, S. N., Molcho, M., Due, P., Ravens-Sieberer, U., & Godeau, E. (2013). Peer victimization and subjective health among students reporting disability or chronic illness in 11 Western countries. *The European Journal of Public Health*, 23(3), 421-426. <https://doi.org/10.1093/eurpub/cks073>
- Tran, S. T., Grotkowski, K., Miller, S. A., Reed, B. W., Koven, M. L., Buscemi, J., & Greenley, R. N. (2021). Hassles predict physical health complaints in undergraduate students: A dynamic structural equation model analysis of daily diary data. *Psychology & Health*, 36(7), 828-846. <https://doi.org/10.1080/08870446.2020.1800010>
- Yazlovetskyi, V. S. (2002). *Osnovy diabnostyky funktsionalnogo stanu ta zdorovia* [Fundamentals of diagnosis of functional state and health]. Volodymyr Vynnychenko Central Ukrainian State Pedagogical University.