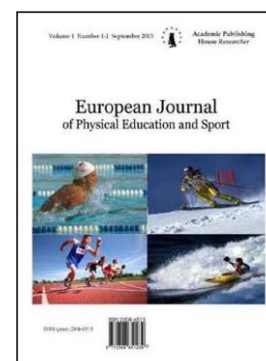


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## Static Strength Tests for Physical Education of Students with Chronic Health Conditions: Metrology Assessment

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### Abstract

The paper deals with the question of metrological conformity of the methods of test control of the level of development of static force endurance of students of with chronic health conditions of universities. The purpose of the work is to perform a metrological analysis of the current methodology of test control of static force endurance of students with chronic health conditions of universities. Research methods: theoretical analysis, systematization, comparison of different views on the problem under study, generalization of scientific and methodological and specialized literature data and methods of obtaining empirical data: pedagogical experiment, pedagogical testing, mathematical methods of processing digital arrays, system-functional analysis. On the basis of the results of the conducted experimental study, the degree of authenticity of the test methods of control of static force endurance of students of with chronic health conditions was established. The possibility of using the results of the study as the initial empirical and theoretical basis of the reorganization of the test control of static strength endurance of students with deviations in the state of health to ensure the realization of the health problems of physical education of students with chronic health conditions is shown.

**Keywords:** student, chronic health conditions, control, testing, static strength endurance, authenticity, validity, reliability.

### 1. Introduction

It is determined that the student's state of health is determined by the level of physical and mental capacity (Ayers, 2004). Accordingly, the overall level of performance is determined by the level of endurance development (Baghurst et al., 2014). Endurance is a basic physical quality that is manifested in professional practice and daily life and ensures the proper development of professionally important physical and psychophysical qualities. One of the important components of physical performance is the level of static endurance (De Corby et al., 2005; Koryahin et al., 2013).

In scientific works (Ayers, 2004; Metzler, 2017; Golovchenko et al., 2001), static force endurance is considered as an important component of performance, which positively influences the vital activity of a muscle cell, its functional state, the metabolic, structural and energy processes in muscle tissue, maintaining the tone muscles and their implementation of the massage-corset function necessary for the normal functioning of the whole body. In addition, static endurance plays a key and equally important role in shaping the posture and maintaining the position of the

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torso: the formation of the correct spine and posture is provided primarily by the ability of the muscles to support static efforts (Overton et al., 2016).

Researchers emphasize (Adyrkhaiev, 2014; Di Tore et al., 2016) that the nature of the manifestation of this type of endurance depends largely on the stability of functional states and general muscular activity, on the combined activity of the cardiovascular and external respiratory system and of the central nervous system activity. In general, the level of development of static endurance depends on the functionality of all organs and systems of the body. This confirms the need for purposeful development of this physical quality in students with chronic health conditions in the process of their physical education: along with the fact that static endurance is important in the development of general physical fitness, it is also one of its most informative indicators (Keating et al., 2009).

## 2. Methods

Purpose: is to perform a metrological analysis of the current methodology of test control of static force endurance of students with chronic health conditions of universities.

The authors highlight the literature review and methods used in the study theoretical: quantitative and qualitative analysis and synthesis, induction and deduction, correlation, comparison and critical reflection, logical method, structural and systemic method, method of systematization and generalization; conduct the analysis of the system and methods of obtaining empirical data: pedagogical experiment, pedagogical testing, mathematical methods of processing digital arrays, system-functional analysis, empirically establish the level of authenticity of tests using correlation analysis (Vincent, 2005).

Participants: students of the Lviv Polytechnic National University of the first year of study were selected for research. 120 boys and 120 girls who entered the first year of study, 40 of them in groups with chronic health conditions with diseases: cardiovascular system, respiratory system, musculoskeletal system, nervous system, digestive organs and metabolism, ophthalmic. The study sample was formed according to students' illnesses. The requirements for the adequacy of its volume at the level  $p < 0.05$  were met.

## 2. Discussion

The analysis of literature in the field of theory and methods of physical education (MacDonald et al., 2019; Koryahin et al., 2013) shows the search for the ways of the most effective differentiated management of the physical condition of students with health disorders. It is widely (Metzler, 2017; Golovchenko et al., 2001) recognized that its basis should be a comprehensive physical training in the wellness and training process and ensuring the functioning of the control system, which includes the diagnosis of the level of development of its components. According to scientific literature development (Baghurst et al., 2014; Dinucci et al., 1990; Di Tore et al., 2016; Plowman et al., 2014), considerable attention should be paid to methods of controlling and improving static endurance. However, there are some inconsistencies in the issue of the specificities of students with chronic health conditions.

Analysis of the latest scientific data on the system of control of static force endurance of students with chronic health conditions (Adyrkhaiev, 2014; Blavt, 2016; De Corby et al., 2005; Macleod et al., 2009) reveals certain, and in some cases, considerable differences in the obtained results. This fact is explained by a number of objectively existing factors: rather heterogeneous contingent of the studied students, differences in the used test methods, the need to take into account the individual physiological features of each student (Adyrkhaiev, 2014; Aiman et al., 2016); the presence of conservative (rhythm of development, linear dimensional features, histological features) and histological features and histological features basic and related diseases in the body) signs that characterize the influence of exercise on the body, etc (Aiman et al., 2016; Blavt, 2016; Overton et al., 2016).

However, the researchers are unanimous in the opinion that the use of test control of students with chronic health conditions plays a proper role in solving the health problems of physical education of universities (Adyrkhaiev, 2014; Blavt, 2016; MacDonald et al., 2019; Koryahin et al., 2013). According to the research, the need to create the necessary basis for the selection and practical use of simple and authentic tests, reflecting the level of development of

static endurance at different stages of physical education of students with health disorders, is quite relevant and significant (Ayers, 2004; Macleod et al., 2009; Blavt, 2016; Overton, et al., 2016).

At the same time, there are many questions today regarding the effectiveness and validity of current test methods for controlling the level of static endurance in students from of students with chronic health conditions and interpreting the results of the tests. The analysis of the scientific literature (Baghurst et al., 2004; Dinucci et al., 1990; Geoffrey et al., 2012; Koryahin et al., 2019) conducted from these positions testifies to the fact that there is insufficient research on the problem and the isolation of the discussion points. The vast majority of existing research on static strength endurance testing has focused mainly on the testing of students with a high level of health, but these issues remain relevant concerning the students with chronic health conditions. With the obvious theoretical and practical significance of the above problem, it is now one of the virtually unexplored.

The significance of our study is determined by the decisive importance for the effective physical education of students with chronic health conditions, the existence of an adequate system of control of static endurance on the one hand and the lack of its metrological justification – on the other. An effective tool for implementing this approach is the detailed analysis of the metrological support of the current methodology of test control of static endurance (Bassett, 2000; Vincent, 2005). The result of this analysis is to substantiate the objective criteria for effective management of students' physical fitness development. Developing a problem of this nature is of practical and scientific interest (Ayers, 2004; Plowman et al., 2014; Silverman et al., 2006; Zhu, 1998). Considering the aforementioned and at the same time insufficiency of elaboration of this problem, we were prompted to consider an important scientific and applied issue that needs to be solved, which actualizes the choice of the research topic.

#### 4. Results

Testing in the form of exercises from static postures to a certain group of muscles is used to assess the status of static endurance of students with chronic health conditions of universities. A common method of assessing static endurance, according to which the test process is monitored, is to perform a series of exercises to hold the appropriate posture in accordance with control standards. The main indicator of static endurance of different muscle groups in tests is time (in seconds) and comparison of the obtained results with the test rating scales (Blavt, 2016; MacDonald et al., 2019).

The choice of test methods for the control of motor performance is based on the fact that the choice of the method by which the study is conducted, largely determines the success of the study. Considering the specificities of the contingent of students with chronic health conditions, the following factors should be taken into account in the selection of test control methods:

- the method should be an adequate test task;
- the method used should not further affect the functional state of the student's body, taking into account the presence of diseases;
- tests must not contain complex motor skills that require long mastering;
- the results obtained by the application of one or the other method must be presented in a readable form (Bassett, 2000; Baghurst et al., 2015; Zhu, 1998).

Based on the above, we use a set of tests of equivalent nature to evaluate the level of development of static endurance of students with chronic health conditions. A good set of tests can be characterized as homogeneous, which is confirmed by the obtained correlation values ( $r = 0,400-0,551$ ) (Vincent, 2005). This made it possible to use the indicators of the selected test exercises for a comprehensive assessment of the student's static endurance of students with chronic health conditions.

Using scientific intelligence (Di Tore et al., 2016; Geoffrey et al., 2012; Koryahin et al., 2019) find also the most important functional function that is used in the process of physical search, diagnosed, and now need to get active information about the state of the study being investigated as a result of the results, and, accordingly, the necessary mathematical information, as well as the correct system of documents – the most important system-forming factor of active management of the process of physical cultivation. As a diagnostic method, testing requires a trusted activity review service (Baghurst et al., 2004). The answer to the provisions of test theories,

the effectiveness of the test search, was used only in the effectiveness of test trials by the basic metrological level of theoretical tests (Zhu, 1998).

Theoretical data that contains a theoretical theory leave a thorough general theoretical theory. We work with them, but this was the most important thing that was shown at an authentic studio. Authentication metrics may be available to see some test that can be changed, or to lose sense of what it is trying to put into practice. The paper confirmed that a number of individuals have been authentically identified as trusts: trust and validity (Blavt, 2016; Vincent, 2005). To determine the reliability of the tests used to monitor the level of development of static endurance, an experimental study of the evaluation of this quality of students with chronic health conditions was conducted. Quantitatively, the degree of authenticity of the test trials is expressed by the coefficients of reliability and validity (Vincent, 2005). The results are shown in Table 1.

**Table 1.** Authenticity of tests of level of development of static endurance

Statistical parameters	Test tasks (s)									
	Holding a corner in a sitting position		Lifting the trunk into the saddle from the supine position		Lifting the legs to the corner 45° from the lying position		Hold the torso parallel to the floor in a supine position		Holding the feet at an angle of 45° with load	
	f	m	f	m	f	m	f	m	f	m
M	18,1	28,8	23,7	39,2	33,3	48,8	5,6	18,6	23,9	33,4
S	3,5	4,7	5,8	6,1	7,6	12,2	1,3	4,2	4,1	5,8
V (%)	30,1	32,4	33,1	38,4	45,2	46,1	43,8	42,5	30,5	30,2
Authenticity of the test										
Reliability	0,676	0,700	0,711	0,702	0,671	0,785	0,654	0,623	0,758	0,756
Validity	0,251	0,267	0,354	0,435	0,300	0,451	0,291	0,298	0,346	0,319

\*m – male students; f – female students

According to the results of the monitoring, the relatively low reliability of each of the test trials (0.75-0.67 – limits acceptable only for the characteristics of a particular group and low) and the validity (0.28-0.35 – limits of low and medium) determines their feasibility complex use: it is proved that the reliability of estimation of controlled indicators increases with the use of more equivalent tests (Plowman et al., 2014).

Test theory emphasizes (Zhu, 1998) that there is no fixed value of authenticity that would allow the test to be considered acceptable. It all depends on the importance of the conclusions drawn from the application of the test. Considering the peculiarities of the contingent of students with chronic health conditions, it is not possible to make general conclusions about this. Empirical characteristics that are determined empirically are significantly influenced by the nature of the sample used to validate the test (Vincent, 2005). To characterize the sample, a variation coefficient was determined in each test trial. The results of this indicator (V) within the range of 28.6-47.4 % (significant variation) indicate that the stability of the results is below the required metrological reliability standards. Such values of the coefficient of variation make it possible to conclude that the statistical population of the studied contingent of students is heterogeneous, and the average value is atypical, so it cannot be used as a generic indicator of this population, and accordingly, to draw certain conclusions on this basis.

This, to a large extent, influences the interpretation of the test results obtained. An objective interpretation is obvious if the position of the test results is uniquely defined on the test scale – it is problem-free (Bassett, 2000). However, if there are no anchor points for the classification of the studied contingent, then the degree of freedom in interpreting the test results becomes too high. According to the theory, test scores are accurate estimates of the subjects (Koryahin et al., 2019). But for the contingent of students with chronic health conditions, they only represent these values with some precision. In our case, test scores of the subjects are given without taking into account the objective limitations due to the presence of a specific disease in the body. Disruption of certain

functional systems of the body of students due to the presence of disease in the body causes some lag in physical development and decrease in the level of physical fitness (Adyrkhaiev, 2014; Blavt, 2016) That is, the presence of physiological features is not considered at all in testing in groups of students who are not formed by nosology.

In practice, there is a situation where students with completely different physiological condition of the body are put in the same conditions, which makes it impossible to ensure standardization and objectification of the testing procedure. Apriori, the degree of authenticity of the techniques used depends on these factors. Given the above, the obtained values can not be generalized: in students of different nosological groups, the criterion for the diagnosis of static endurance can not be average. The use of such criteria leads to the fact that the empirical validity of the test is not ensured, since the assessment criteria do not agree with the nature of the student's illness. All authenticity studies should be performed on representative samples (Vincent, 2005). That is, there is an objective need to overestimate the reliability of test trials in relation to the nosology of students: in this way we try to ensure that the sample is representative (Table 2).

The results show that one and the same test has a "high" degree of authenticity in a certain nosological group of students, while having a "low" one for others. Accordingly, the results of the metrological analysis of current test methods for controlling the level of development of static endurance are not reliable for the whole contingent of students, with chronic health conditions. The least degree of authenticity of the test methods used is observed in groups of students with diseases of the cardiovascular, respiratory and nervous systems. This is due to the fact that the performance of a series of test trials is associated with exertion, accompanied by respiratory retardation and blood redistribution phases. Students with neurological diseases, accordingly, have difficulty adjusting their breathing when coordinating it with movements in such exercises.

**Table 2** Assessment of the authenticity of test tests of the level of development of static student endurance in accordance with nosology

Test tasks	NOSOLOGY (disease)											
	Cardiovascular system		Respiratory system		Neurologica diseases		Musculoskeletal system		Digestive organs and metabolism		Ophthalmic	
	R	V	R	V	R	V	R	V	R	V	R	V
Holding a corner in a sitting position	0,641	0,258	0,666	0,264	0,612	0,207	0,798	0,411	0,788	0,514	0,781	0,378
Lifting the trunk into the saddle from the supine position	0,674	0,288	0,723	0,241	0,623	0,212	0,77	0,475	0,813	0,411	0,748	0,407
Lifting the legs to the corner 45° from the lying position	0,677	0,267	0,756	0,351	0,603	0,215	0,789	0,315	0,878	0,499	0,778	0,350
Hold the torso parallel to the floor in a supine position	0,709	0,385	0,722	0,287	0,634	0,482	0,654	0,201	0,781	0,465	0,765	0,306
Holding the feet at an angle of 45° with load	0,718	0,340	0,789	0,319	0,654	0,448	0,674	0,353	0,815	0,391	0,803	0,386

\*R – reliability f – validity

### 3. Discussion

It should be noted that strength endurance, as well as other qualitative characteristics of muscular activity, is quite specific and is determined by the morpho-functional state of the student

body, which, in turn, is caused by the presence of basic and comorbid diseases in the body (Ayers, 2004; MacDonald et al., 2019). That is, a rather topical issue related to the need for individual testing of students, taking into account all the nosological characteristics of the student body, remains unresolved in the above test requirements. It is impossible to eliminate, due to these factors, the error of metrology testing is impossible, but it is imperative to know them and take them into account in the test control process. As a prerequisite for determining the degree of authenticity by the criterion is that the sample, for which the final conclusions of the test are made, is fully representative (Vincent, 2005; Zhu, 1998). In practice, this requirement is extremely difficult to meet.

The greatest difficulty in interpreting the coefficients of authenticity is that the overriding goal of assessing the level of authenticity of test methods is to determine the practical value of the methodology being developed (Baghurst et al., 2004). The criteria in this case, in our case, act as indicators of direct value to the individual nosology of students. At present, a methodological approach has been developed in the system of controlling the static endurance of students with chronic health conditions developed on the basis of the average criterion (Blavt, 2016; Koryahin et al., 2019). However, the criterion of motor readiness may not be average for students of different nosology.

Considering all the obtained results of the conducted research, it is indisputable that there is a need to improve the test methods of the level of development of static endurance, which is based on the analysis of the data, which testify to the shortcomings of the metrological support of the current system of testing of students with chronic health conditions. Accordingly, this, in turn, causes a decrease in its efficiency. Thus, performing primarily the control function, it practically does not provide it, since the methods used require improvement of the metrological basis. This is largely due to the incompleteness of the development of conceptual ideas and provisions for the content, organization, regulatory support of such activities; lack of comprehensive studies of general trends, features of detection and change of morphofunctional indicators of students with various forms of the disease.

This complicates the development of test technologies aimed at implementing the functions of control of static endurance. Requirements for its evaluation criteria, adapted to the contingent of students with chronic health conditions, have not been formulated to date. There are no common approaches to the assessment of its normative parameters of different nosological groups of students with chronic health conditions. The foregoing demonstrates the objective need for research using complex criteria for dividing students into homogeneous samples, that is, those that are relatively stable over the study period, namely, stay in a university. Modern approaches to the organization of the control process and the principles of the organization of the special testing and its content allow for its modification of students with chronic health conditions and involve the integration of a wide range of factors that determine the effective development of the components of the control system as a whole.

## 5. Conclusion

1. As a result of the conducted research it is established that the current test methods of control of the level of development of static force endurance of students with chronic health conditions do not fully meet the requirements of the theory of tests. The relatively low authenticity of the techniques used ensures the proper level of control and diagnostics of the level of development of the investigated quality, and, therefore, cannot be the basis for the creation of further training programs in physical education of students with chronic health conditions. The existence of scientific-theoretical problems of using the existing test methods of control of static force endurance in the physical education of students with chronic health conditions of universities is clarified. The expediency of further search and development of scientifically substantiated test methods of control of the investigated quality and introduction of the necessary reorganizations in the testing process for realization of scientific and methodological provisions of metrological requirements in the test control of physical education of students with chronic health conditions of universities was proved.

2. Taking into account the shortcomings of the current organization and content of testing of static force endurance in physical education of students with health conditions, the directions of their improvement are determined, on the basis of general and methodological principles of the

control system, and in the formation of its content takes into account the peculiarities of the morphofunctional dynamics development students body. This provides for the consideration and pedagogical conditions for the effective implementation of the content of the test control of static force endurance in the process of physical education of universities, which determines the experimentally substantiated forms, means and methods of its development.

3. The possibility of using the research results as the initial empirical and initial theoretical foundations of the test control reorganization based on the model of knowledge of fundamental provisions of the theory of tests is offered and shown, which will increase the efficiency of diagnostics and allow to obtain a complex assessment of the level of development of static force endurance of students with chronic health conditions.

Further studies provide an analysis of the metrological support of other test trials that are currently used in the control system of students with chronic health conditions of universities.

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