

Ontology of metrological support control to orientation in space of students with chronic diseases at the university

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Abstract

Purpose. The purpose of this study is to carry out a metrological analysis of the current methodology of the test control of the ability to orient in space of students with chronic diseases at a university. *Materials.* To determine the authenticity of the tests used to control the level of development of orientation in space, an experimental study was carried out to assess this quality in students with chronic health conditions at the Lviv Polytechnic National University. Test requirements were made by students with chronic diseases from the I-III years of education. *Conclusions.* The appropriate operating procedures of testing and trial quality basic metrological requirements theory of the test were determined. The control tests used and their assessment system cannot be considered adequate for the specific requirements of the test control of the level of development of the ability to orient in space by students with chronic diseases. The results of measurements of this contingent are reliable and acceptable for evaluating the results of physical education at the university.

Key Words: students, physical education, chronic diseases, test, control, reliability, validity, ability to orient in space

Introduction

Coordination and coordination abilities have been the subject of increased attention of industry professionals for a long time. A general analysis of work on the theory and methodology of physical education of students with chronic diseases (Iedynak, et al., 2017; Koryahin, et al., 2018; Overton, et al., 2016) shows that these abilities are essential in the physical education of students with chronic diseases. Authoritative scholars have suggested to address the problems of physical preparedness of students with chronic diseases by the in-depth development of the concept of development of coordination and coordination capabilities, which allows, as expected, to transform accessible knowledge about the laws of motor activity into innovative approaches to improve physical abilities (Anikieiev, 2015; Ayers, 2004).

A special role in the complex of coordination abilities is given to the ability to orient in space (the ability to accurately determine and simultaneously change the position of the body), whose manifestation is associated with overcoming the coordination difficulties that arise when solving various motor tasks (Godik, 1988). This motion sensation is largely determined by the accuracy of differentiation of force, time, and spatial characteristics of arbitrary movements and is considered to be one of the main indicators in the structure of the quality of coordination abilities and one of the criteria for assessing the level of development (Zatsiorskiy, 2006).

The process of physical education of students with chronic health conditions is recommended to be carried out in accordance with the requirements of controlled processes (Koryahin, et al., 2018). In this case, the decision of the teacher, as the controlling entity, is formed on the basis of comprehensive, objective information about the state of physical characteristics of students under the conditions of the pedagogical process. This information can improve the effectiveness of teaching instructors, including the optimization of the content of programs and plans of physical education to achieve the maximum positive result. In a pedagogical practice, an objective assessment of the physical capabilities of students with chronic diseases is considered to be an important issues (Overton, et al., 2016).

The need for the purposeful development and diagnostics of the ability to optimally control movements and regulate them in space does not call into question the specialists (Zatsiorskiy, 2006; Zhu, 1998). However, the question of the formation and diagnosis of the ability to orient in space as an integral part of coordination

abilities is not yet sufficiently developed and presents considerable difficulties for the teachers of physical education of students with chronic diseases, which also determines the significance of research in this direction.

To date, in the theory and practice of physical education, a solid theoretical and methodological foundation for the study of coordination abilities has been developed, a rich factual material has been obtained, and its meaningful interpretation has been provided (Di Tore, et al., 2016; Godik, 1988; Koryagin & Blavt, 2013). At the same time, a thorough methodological analysis of existing studies has shown that the question of the formation of an optimal structure of the ability to orient in space and its control system in students with chronic diseases has not been optimized because there is a significant limitation in the actual material of the abovementioned question. With regard to the current practice of organizing control and assessing the status of this ability in students, it is monitored and evaluated based on the results of test control (Dinucci, et al., 1990). According to scientific researches (Koryagin & Blavt, 2013; Zatsiorskiy, 2006). The most important and most significant control function during the process of physical education is diagnostic because in the process of control, objective information is obtained about the status of the investigated quality in the form of results that are subjected to further mathematical processing, and the correct assessment system is the most important system-forming factor of active management of the process of physical education. Therefore, according to the data from literary sources (Godik, 1988; Hirtz, 1985), coordination abilities have a diagnostic ability. Thus, by monitoring the dynamics of their development, we can make conclusions about the dynamics of physical health of students. On the basis of the volume of accumulated empirical information and fundamental knowledge about the complex psychophysiological structure of coordination abilities, the connection between the nature of movements that provide orientation in space and the psychophysiological state of the organism (Iedynak, et al., 2017; Hirtz, 1985) is established and confirmed. This is important for students with chronic diseases because the dynamics of their health determines the course of physical education during their education at the university (Anikieiev, 2015; Ayers, 2004).

The effective management of the process of physical education involves the acquisition of objective and reliable information about the dynamics of showing the level of physical fitness of students. The issue of testing physical fitness is an important problem in the theory and method of physical education. Numerous scientific sources (Di Tore, et al., 2016; Koryagin & Blavt, 2013; Mercier, et al., 2013; Overton, et al., 2016) have been devoted to the questions of management of educational and educational processes in the field of physical culture on the basis of the control of physical preparedness. However, this problem is still the subject of debate. Undoubtedly, an improvement in the means and methods of development of physical qualities as well as the ongoing control of this process are the basis for ensuring effectiveness.

In the practice of physical education of students with chronic diseases, who adopted and adapted the non-professional method of diagnostics of orientation abilities, specially selected motor tests are used that must satisfy the requirements of the fundamental provisions of the theory of tests (Godik, 1988; Zatsiorskiy, 2006). However, as clearly shown by the results of longitudinal observation, it is difficult to assess this ability in students with chronic diseases owing to the presence of functional disorders in the health status of students due to the presence of pathology. Therefore, special approaches achieve accuracy, efficiency, and effectiveness in the methodology of assessing the ability to orient students in space and their responses to the metrological requirements of the theory. Currently, the number of students in special educational institutions is low, and researchers do not pay attention to the system of control, which requires additional research. From the practical point of view, the need to establish the extent of test method verification, which is determined by the relevance and study of reliable information about the physical training of students at a certain stage, is important. Given the clear theoretical and practical significance of the abovementioned problem, which has not been previously investigated, the problem was researched.

Materials and methods

The purpose of this study is to carry out a metrological analysis of the current methodology of test control of the ability to orient in space of students with chronic diseases at the university.

Research methods. Statistical analysis. To achieve the objectives, the following methods were used. Specifically, the general scientific methods of theoretical level were the analysis and synthesis, and the methods used to obtaining empirical data were the pedagogical experiment, pedagogical testing mathematical methods for processing digital files, and system-functional analysis.

Presentation of the main research material. The basis for the control of abilities to orient in space includes motor tasks, which require a quick assessment of the situation and reactions to it by rational actions (Hirtz, 1985). On the basis of previous studies (Koryagin & Blavt, 2013; Zatsiorskiy, 2006), the choice of test methods for controlling motor qualities is based on the fact that the choice of the method by which the research is conducted largely determines the success of the study. By taking into account the special features of the contingent of students with chronic diseases, the following factors should be taken into account during this process:

- the method should be adequate to the task of testing;

- the method used should not additionally affect the functional state of the student's body by taking into account the presence of pathologies in it;
- tests should not include difficult motor skills that require long-term mastery;
- results obtained by applying the methods must be presented in a convenient form.

Therefore, to assess the extent of orientation in space, the following tests must be equivalent: throwing a tennis ball in the goal, running to numbered stuffing balls, walking to the goal, testing of linear playback, estimation of the spatial accuracy movements (Hirtz, 1985; Koryagin & Blavt, 2013; Zatsiorskiy, 2006). The feasibility of using such complex tests for the evaluation is possible on the basis of the calculation of the relationship between the test indicators, which confirms the equivalent nature of these tests. The results of calculating the relationship between the selected test trials confirm their equivalence (i.e., the value of correlation is $r = 0.400-0.551$) and characterize the set of tests as homogenous. Therefore, this allowed us to use the indicators of the selected test exercises for the comprehensive assessment of the status of the investigated quality.

Participants. To determine the authenticity of the tests used to control the level of development of orientation in space, an experimental study was carried out to assess this quality in students with chronic diseases at the Lviv Polytechnic National University. The test requirements were made by students with chronic diseases from the I-III years of education.

Results

According to the theory of tests, the effectiveness of test control is ensured only if the tests meet the basic metrological requirements of the theory of tests (Godik, 1988). The methodical tool for the practical implementation of these provisions is to ensure the authenticity of the tests; when the methods of mathematical statistics are used, it can be confirmed that the criteria of reliability and validity are adequately met (Zhu, 1998).

Quantitatively, the degree of authenticity of the tests is expressed using the reliability and validity coefficients, which are calculated using the intra-class correlation coefficient (Zatsiorskiy, 2006). The results are shown in Table 1.

Table 1

Authenticity of the tests of the level of development of ability to orient in space

Statistical parameter s	Test tasks and units of measurement									
	Tennis ball to the goal (number of times)		Running to numbered stuffing balls (s)		Walking to the goal (m)		Linear playback test (m)		Estimation of the spatial accuracy of angular movements (degrees)	
	f	m	f	m	f	m	f	m	f	m
M	16.5	21.8	8.7	9.2	53.3	42.3	0.56	0.48	7.9	13.4
S	3.1	2.7	1.1	0.6	3.6	2.1	0.13	0.22	2.3	3.8
V (%)	31.7	33.8	28.6	29.1	42.6	44.8	47.4	46.1	35.8	34.2
Authenticity of measurements										
Reliability	0.617	0.634	0.719	0.723	0.697	0.688	0.715	0.723	0.911	0.926
Validity	0.215	0.223	0.441	0.423	0.333	0.345	0.394	0.399	0.535	0.541

*m – male students; f – female students

According to the results of monitoring, the relatively low reliability of each of test (0.75-0.67 – the limit is low and is acceptable only for the characterization of a certain group) and validity (0.28-0.35 – the boundary of low and average) leads to the feasibility of their integrated use. In this case, a comprehensive assessment of the tested quality may be more reliable. The reliability of the assessment of controlled indicators increases with the use of more equivalent tests. The greatest degree of authenticity is provided by the test that estimates spatial accuracy movements; the smallest degree of authenticity is provided by the "Tennis ball to the goal" test, which confirms the previous data on the low authenticity of tests of hitting the target (Zhu, 1998).

According to the theory of tests (Godik, 1988; Zatsiorskiy, 2006), there is no fixed value of reliability that would allow to consider the test acceptable. It all depends on the importance of the conclusions drawn on the basis of the application of the test. The corresponding quantitative information obtained during the control process allows individuals to individualize the process of physical education in accordance with its requirements and tasks. The use of a non-informative test is, first of all, a deterioration in the quality of the educational process (Koryagin & Blavt, 2013). However, by taking into account the specifics of the contingent of students with chronic diseases, it is not possible to make general conclusions about this. According to the theory of tests, the reliability characteristics determined by the empirical method considerably affect the character of the sample used to test the test on reliability indicators. To characterize the sample in each test, the coefficient of variation was determined. The obtained results of this indicator within V 28.6-47.4% (significant variation) indicate that

the stability of the results is below the required metrological standards of reliability. Such values of the coefficient of variation allow us to conclude that the statistical aggregate is non-uniform, and the average value is non-typical, and therefore it cannot be used as a general indicator of this aggregate. In our case, this is also explained by the fact that obtaining stable characteristics in repeated testing of students with health deviations is difficult with the same test, because the traits that are being tested are labile. The characteristics largely depend on many internal and external factors, including the physical condition of students owing to the presence of disease in the body. Uncontrolled changes in the physical condition of students owing to the presence of pathological abnormalities in the state of health, mental stress, fatigue, over-stress, and period of disease remission results in a variation in the test results (Koryahin, et al., 2018), which is not taken into account at all when working with students with chronic diseases.

The validation of test also involves taking into account the composition of the sample on which it is conducted (Godik, 1988; Zatsiorskiy, 2006). If there are no reference points for the classification of the investigated contingent, then the degree of freedom in the interpretation of the test results becomes too high. In our case, the test assessments of the test subjects are exposed without objective restrictions owing to the presence of certain diseases in the body. Therefore, the manifestation of the ability to orient in space is due to the functioning of the complex interaction of the motor, visual, auditory, tactile, vestibular analysers, sensorimotor mechanism, and the state of central and peripheral parts of the nervous system (psychophysiological mechanisms of management and regulation). In this case, the violation of these functional systems causes secondary deviations: violation of the musculoskeletal system, weakness of respiratory muscles, violation of spatial patterns of self-control and self-regulation, coordination of movements, cardiovascular disease, neurosis, rapid fatigue, backwardness in physical development, decrease in the level of physical preparedness (Hirtz, 1985). Because students have certain disabilities in their health, this process can be accompanied by the complexity of driving a motor vehicle in the course of coordinated movements. It can be assumed that the corresponding differences in the functional state of students in each test case led to varying degrees of authenticity. Therefore, we assume that the obtained values cannot be generalized. All reliability and validity studies should be performed on representative samples. According to the test theory (Godik, 1988; Zatsiorskiy, 2006), the authenticity of the tests will be different in various test groups. Thus, there is an objective need to overestimate the reliability of the test in relation to students' diseases, which ensures the representativeness of the sample (Table 2).

Table 2

Assessment of the authenticity of tests on the level of development of the ability to orient in space by students depending on a disease

*R – Reliability; V – Validity

Test tasks	Disease											
	Cardiovascular		Respiratory		Nervous system		Support-motor apparatus		Metabolism and digestive organs		Organs of sight	
	R	V	R	V	R	V	R	V	R	V	R	V
Tennis ball to the goal	0.615	0.551	0.603	0.316	0.607	0.227	0.635	0.331	0.774	0.534	0.615	0.218
Running to numbered stuffing balls	0.814	0.254	0.755	0.284	0.632	0.252	0.643	0.375	0.923	0.454	0.884	0.423
Walking to the goal	0.631	0.316	0.732	0.395	0.618	0.203	0.652	0.225	0.753	0.483	0.703	0.235
Linear playback test	0.713	0.518	0.754	0.224	0.634	0.482	0.654	0.201	0.734	0.441	0.732	0.315
Estimation of the spatial accuracy of angular movements	0.815	0.574	0.774	0.337	0.654	0.448	0.674	0.353	0.885	0.384	0.851	0.326

The obtained results allow to conclude that the same test has a "high" degree of authenticity for a certain group of student diseases, while it has a "low" degree of authenticity for others.

Discussion

The generalization of the obtained data confirms the hypothesis that during the physical education of students with chronic diseases, the authenticity of tests is not substantiated with regard to the specificity of the contingent in connection with the functional characteristics of their health. The obtained information apriori may be acceptable as reliable without the objective metric estimates of test measurements. These measurements are consistent with those available in the literature (Di Tore, et al., 2016; Godik, 1988; Koryagin & Blavt, 2013; Koryahin, et al., 2016; Zatsiorskiy, 2006; Zhu, 1998). Clearly, the complex nature of the physiological mechanism of organizing arbitrary movements and the complexity of their quantitative evaluation have led to the

fact that during the physical education of students with chronic diseases, the system of assessment of coordination abilities remains inadequately scientifically sound and standardized.

The results of the experimental study provide an understanding that the evaluation of the results of tests should be considered from system positions by taking into account the interconnections of all coordination abilities, depending on the individual characteristics of students, which are conditioned, first of all, by the presence of the chronic disease in the body and the initial level of physical fitness (Iedynak, et al., 2017; Koryahin, et al., 2018; Overton, et al., 2016).

In general, the materials presented in this article on the metrological analysis of the current methodology of the test control of the ability to orient in space by students with chronic diseases at the university can be used to substantiate the general methodology of research in the field to further improve the level of development of this ability in students with chronic diseases as an integral component of coordination.

Conclusions.

Thus, for the specific conditions in the study, the control tests used and their assessment system cannot be considered adequate for the specific requirements of the test control of the level of development of the ability to orient in space of students with chronic diseases. The results of measurements of this contingent are reliable and acceptable for the evaluation of results of the course of physical education at the university.

The consideration of the basic aspects of metrological maintenance of the current system of test control of the level of development of orientation in space of students with chronic diseases at the university determines the need for the improvement, development, and introduction of new approaches and technologies in this direction. The need for the reorganization of student test control with health disorders does not relieve the importance of practical work and does not deny the right to exist for the already created tests. At the same time, the presented facts convincingly point to the need for additional research, development, and formation of scientifically grounded methods of testing the level of development of the ability to orient during the physical education of students with chronic diseases by taking into account all objective factors of the investigated contingent.

Conflict of interest

The authors state no conflict of interest.

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