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ORIGINAL SCIENTIFIC ARTICLE

APPLICATION OF ELECTRONIC MEANS IN ENDURANCE COORDINATION TESTING OF STUDENTS WITH DISABILITIES WHO ARE WAR VETERANS

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Abstract

The purpose of the study was to determine the effectiveness of the use of electronic means created based on information and communication technologies in coordination testing of the endurance of students with disabilities who are war veterans in practical physical education classes.

Materials and methods. To solve research problems, scientific intelligence applied the implementation of research at the theoretical and empirical levels. Analysis, synthesis, generalization, induction, systematization, pedagogical experiment, methods of mathematical statistics and technical modeling were used. The study involved 46 students who are war veterans (males aged 29-35).

Results. An electronic mean for determining coordination endurance based on information and communication technologies and software has been developed. The design of the mean involves the use of mobile and stationary measuring units and a personal computer. The measuring unit contains analog and digital sensors. Information about the student's performance on the test is displayed on the personal computer screen. Approbation of the developed mean involved establishing the degree of its authenticity by comparing the results of testing the coordination endurance of students with disabilities who are war veterans implemented using traditional methods of measurement and the results of testing using the developed mean. The calculation of the reliability and validity of the tests showed that the recording of control results by electronic means allows ensuring a high level of authenticity of the tests.

Conclusions. The use of the electronic control means of coordination endurance presented in the work allows the achievement of a high level of reliability of control results in real time. Based on the summaries of the conducted empirical research, it was established that the introduction of electronic means of control in the process of physical education of students with disabilities who are war veterans helps to ensure the effectiveness of this process.

Keywords: student with disabilities, war veterans, physical education, testing, control, means, information and communication technologies, inclusive.

Introduction

Ukrainian society has been in a state of war for several years in a row. As a result, the number of war veterans in the country is constantly increasing. Ensuring the opportunity for war veterans to obtain quality education in accordance with the characteristics, needs and opportunities is one of the key priorities of modern Ukrainian social and educational policy.

The main component of social interaction and integration of war veterans, among whom there are many people with disabilities, in higher education is inclusion (Ghosh, Santana, & Opelt, 2020). Among the main educational areas of inclusion implementation are the formation and improvement of motor functions that are impaired as a result of a pathological process, compensation of the main defect, and correction of secondary violations that arose in connection with participation in combat operations (Barmak, Barmaksezian, & Der-Martirosian, 2021).

There is no doubt that in order to work with students with disabilities, it is necessary to introduce special methods,

pedagogical technologies, and adaptive technical means into the educational process (Page, Anderson, & Charteris, 2021).

Obtaining new scientific data on physical education as a component of the inclusion of students with disabilities (Grenier, 2007), whose number in higher education institutions of Ukraine is currently constantly increasing at the expense of war veterans, is a social need of Ukrainian society, which has especially gained importance recently, in connection with a full-scale invasion of russia on the territory of Ukraine and prolonged hostilities.

In scientific sources, the potential of physical education in the inclusion of students with disabilities is analyzed (Barboza, Ramos, Abreu, & Castro, 2019; Bertills, Granlund, Dahlström, & Augustine, 2018b; Lieberman, & Houston-Wilson, 2017). It was determined that for such students, physical activity is fundamental to health and individual well-being (Klavina, Jerlinder, Hammar, & Soulie, 2014). The role and place of physical education in the process of formation of vital skills, full physical and psychological rehabilitation of war veterans are proven (Jenner, 2017). In contrast to knowledge, abilities, and skills, in the process of physical education, the acquisition of experience of independent activity in the direction of physical improvement based on universal knowledge by war veteran students is expected (Hunter-Johnson, 2018).

The work of researchers who analyzed the experience of the development of inclusive physical education in universities is of great importance for our research (Sokurianska, Bataeva, & Bakirov, 2019; Molina, 2015). Based on the study of several international documents, it was established that students with disabilities should not be limited in the process of physical education, but a differentiated approach should be applied to them (Blavt, 2022; Malekpour, Isfahani, Amiri, Faramarzi, Heidari, & Shahidi, 2012).

Certain works are focused on new facts, ideas, and approaches to the development and implementation of the process of eliminating health defects in the context of the progress of information and communication technologies (ICT) (Gogoi, 2019; Koryahin, Iedynak, Blavt, Galamandjuk, Prozar, Zaikin, Veselovska, Golub, Kucher, & Gurtova, 2019). The expediency of introducing modern ICT into the process of physical education of students is substantiated (Blavt, Iedynak, Pityn, Hluhov, Guska, Stadnyk, Zaikin, & Karatnyk, 2022; Bhat, Nazir, & Khan, 2018). A number of works are focused on the application of the potential of ICT as a control tool in physical education (Koryahin, Mykytyuk, Turchyn, Blavt, Prystynskyi, & Stadnyk, 2021; Mykytyuk, Blavt, Hnatchuk, Stechkevych, & Helzhynska, 2022; O'Brien, Bourne, Heerey, Timmins, & Pizzari, 2019).

Therefore, the current state of development of the content of physical education of students with disabilities – war veterans at the current stage is different from what is needed, and the research is characterized by individual character and fragmentation. This makes it necessary to carry out further research in the indicated direction, in particular through the development (modernization) of innovative practices of pedagogical content, physical education, and ICT.

The purpose of this study is to determine the effectiveness of the use of electronic means created based on information and communication technologies in coordination testing of the endurance of disabled students of war veterans in practical physical education classes.

Materials and methods

Research methods

Scientific intelligence involved the implementation of research at the theoretical and empirical levels. At the same time, when solving tasks at the theoretical level, general scientific research methods were used: analysis, synthesis, generalization, induction, and systematization.

At the empirical level of the research, a pedagogical experiment, methods of mathematical statistics and technical modeling were applied in the process of creating electronic means.

For the assessment of coordination endurance, the ability to perform complex coordination exercises is monitored for a certain time without disturbing the rhythm of their execution, balance, and coordination of movements during the performance of the test task, specialized test exercises were used: "Walk to the goal", "Kopylov's test" (Bös, 2001; Columbet, 2014). In the selection of test exercises, it is taken into account that walking is an important component of the functional state of the body, taking into account the presence of disorders in students with disabilities. Taking into account the above, the test exercise "Walking to the goal" was used in the study to determine the level of development of the ability to navigate in space. Carrying out the test. The test participant is given the opportunity to estimate the distance to the center of the circle from the starting line during an arbitrary time. Then they blindfold the student with a tight bandage and make him walk to the center of the circle at any pace. At the end of the distance, the test participant stops on his own and signals the end of the test by raising his hand. The center of gravity of the body is marked with chalk between the feet. Result. The distance (measured in centimeters) from the projection of the body's center of gravity, marked on the floor, to the center of the circle.

Kopylov's test. With the help of the test, the development of the ability to coordinate hand movements is being tested. Carrying out the test. The test participant takes the starting position with the body bent forward, holding the ball in one hand. At the command "Start!" performs an imaginary figure eight between the legs at knee level with the ball as quickly as possible. The ball must be passed from hand to hand. With an arbitrary amplitude of the hands, the test participant should not tear off the feet from the floor. To get familiar with the test, students do 4-5 full "eights" beforehand. One scoring attempt is allowed. If the ball is released from the hands, the attempt is repeated. Result. Time to perform ten "eights", recorded with an accuracy of 0.1 seconds.

The tests selected by us provide sufficiently reliable information about the level of development of coordination endurance. In addition, these are quite simple exercises that do not require additional complex equipment. In the selection of test exercises, it is taken into account that walking is an important component of the functional state of the body, taking into account the presence of disorders in students with disabilities.

Study participants

The first-year students from Lviv Polytechnic National University, Kamianets-Podilskyi Ivan Ohiienko National

University, Educational and Rehabilitation Institution of Higher Education "Kamianets-Podilskyi State Institute" took part in a pedagogical experiment. The study involved 46 students – war veterans (males 29-35 years).

Those who were unable to participate in full training because of an injury, sickness, or any physical complaint were excluded. All students provided written, informed consent for their involvement in this study.

The organization of the study took into account the provisions of the Declaration of Helsinki of the World Medical Association (WMA-2013) on the ethical principles of medical research with human participation; the research protocol was approved by the ethics committee of the Lviv Polytechnic National University.

Study organization

It provided for the organization of pedagogical testing using selected test exercises at the beginning of the school year and at the end of the physical education course. For this, traditional methods of recording test results were used and a device for controlling coordination endurance was developed during the research.

Statistical analysis

The following methods of mathematical statistics were used for the statistical analysis of the research results: dispersion and correlation analysis to determine reliability and validity coefficients. The level of reliability of the tests was established by calculating the correlation coefficient. Descriptive statistics methods were used to analyze the test results of the studied sample of students. The work uses SPSS Version 21.

Results

To carry out scientific research in a certain direction, we note that people with disabilities have the greatest requirements in physical development precisely for coordination endurance, since they are prone to failure when fatigued due to various "breaks" in the body (Qi, & Ha, 2012). Coordination is characterized by the ability of people to control their movements (Hirtz, 1985). It should be noted that the level of coordination endurance, as a type of special endurance, is determined not only by the degree of development of vegetative functions that provide movement but also by its stability, which acts as a factor of resistance against fatigue of the neuromotor functions of movement control (Schielke, 1989).

It has been proven that this quality is already embedded in every person from birth, but it must be developed by performing a set of various exercises. In addition, the effectiveness of all motor abilities limits the development of coordination abilities, which at the same time are an important component of physical fitness. Compared to other motor abilities, coordination endurance is the most multi-component in terms of structure and measurement, and it is difficult to control its development (Golle, & Rymarcewicz, 2021).

On the other hand, the control of the development of coordination endurance using the test exercises defined in the study depends on the human factor.

The perception of the person performing the control, in the standardization of compliance with all methodological requirements that are visually established during the control, the performance of exercises complex in terms of the coordination structure during a certain time, when the main parameters of different dimensions are measured: maintaining the rhythm of the performance, stability of posture, coordination of movements, as required by the test task, can be subjective. The possibility of errors also occurs when recording results with a stopwatch, ruler, etc.

The developed electronic means for testing coordination endurance (Fig. 1) uses a mobile measuring unit, which is placed on the body of a student performing a test task, a stationary unit, and a personal computer. The measuring unit contains analog and digital sensors (Hotra, Mykytyuk, Diskovskyi, Barylo, & Vezyr, 2018), whose function is to register signals that occur during exercise, a microcontroller, and a transceiver module (Wojcik, Vistak, Mykytyuk, Politanskyi, Diskovskyi, Sushynskyi, Kremer, Prystay, Jaxylykova, & Shedreyeva, 2020).

Results are displayed using the LCD of a personal computer or mobile telecommunication system, which has a high-speed interface subsystem in which the received signal

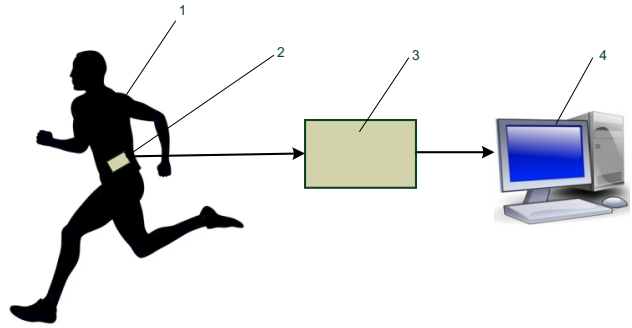

Fig. 1. Scheme electronic means in endurance coordination testing and where: 1 – student, 2 – mobile measuring unit, 3 – stationary measuring unit, 4 – personal computer

is processed on a real-time scale. In the internal memory of a personal computer with the use of developed software, it is provided for the analysis of the received test signals and their storage.

The microcontroller used to implement the electronic means contains a classic set of computing elements, uses a real-time timer, and has a program memory with the possibility of self-programming. In addition, the microcontroller provides registration and programmatic analysis of input information for recording test results and regulates the components of the developed structure.

To implement the electronic means, the ESP8266 Wi-Fi wireless communication USB 17 interface was used. The interface additionally provides the ability to control the preservation of the execution rhythm, balance, and coordination of movements.

The study involved determining the degree of reliability (Vanhelst, Beghin, Fardy, Ulmer, & Czaplicki, 2016) in three values: within-subject variation, change in mean value, and test-retest correlation (Tab. 1). Thus, we meant the repeatability or reproducibility of a measure or variable (Zanevskyy, & Labartkava, 2020). It is recognized that an

Table 1. The results and authenticity of control test trials of coordination endurance (n = 46)

Statistical parameters	Test tasks and measurement results							
	Walking to the goal (cm)		Walking to the goal (cm)		Kopylov's test (s)		Kopylov's test(s)	
Period of the experiment	at the beginning		at the end		at the beginning		at the end	
Method of measurement	T	A	T	A	T	A	T	A
M	53.3	51.6	47.4	42.3	1.10	1.04	1.00	0.56
S	3.6	2.1	3.6	2.1	0.09	0.06	0.07	0.05
V (%)	42.6	29.1	43.1	24.8	47.4	22.1	45.8	21.5
Reliability(rtt)	0.719	0.911	0.697	0.944	0.715	0.911	0.726	0.926
Validity (rtt)	0.119	0.239	0.169	0.258	0.155	0.223	0.171	0.226

*Note: T – using the test exercises, A – using the electronic means

important use of reliability is the estimation of sample size for experimental studies. Since we were interested in the issue of reproducibility of individual values obtained using different equipment, but by the same observer. In order to estimate the standard error under such conditions, it was considered appropriate to use many students and several trials rather than one and many trials.

The obtained results of the V(%) indicator when measured by the traditional method within the limits (significant variation) indicate that the stability of the test results is lower than the required metrological standards of reliability. Intraclass correlation coefficients reliability from moderate to excellent was observed for all students in the process of testing by using the test exercises (0.72-0.80) and using the electronic means (0.85-0.95); coefficients validity in the process of testing by using the test exercises (0.10-0.20) and using the electronic means (0.20-0.25). Thus, the device was sensitive to detect small changes during the test exercise.

Discussion

Considering that Ukraine has been in a state of martial law for a year and has been in a state of war for eight years, the educational community faces new challenges: ensuring a full-fledged opportunity to receive higher education for participants in hostilities, and above all for war veterans, among whom there are many persons with disabilities. Therefore, there are many problems with the participation of persons with disabilities in the educational process in universities, in particular, when an inclusive perspective is added to the high-quality teaching of physical education. We agree with our research (Ghosh, Santana, & Opelt, 2020; Lieberman, & Houston-Wilson, 2017), that physical education at the university is one of the main ways of correcting violations of physical development, motor readiness, and psychomotor skills of students with disabilities – war veterans.

It has been proven that for students with disabilities to fully receive quality physical education, opportunities for evaluating the effects of this process must be created. The quality of physical education is determined by the quality of receiving operational reliable information about its progress (Ivashchenko, Yermakova, Cieślicka, & Śukowska, 2015; Koryahin, Mykytyuk, Blavt, Dolnikova, & Stadnyk, 2020; O'Brien, Philpott, Lester, Belton, Duncan, Donovan, Chambers, & Utesch, 2021). We support ideas (Koryahin, Blavt, Vanivska, & Stadnyk, 2020) about the need to use ICT means in the physical education of students with disabilities, in particular war veterans, which ensure the urgency and objectivity of the received control information.

In our study, we considered the possibility of the application of electronic means, developed using ICT, in the process control of physical education of students with disabilities and war veterans as an opportunity to increase the effectiveness of control and physical education in general. This expands the available information (Gogoi, 2019; Mykytyuk, Blavt, Hnatchuk, Stechkevych, & Helzhynska, 2022) regarding the necessity and feasibility of using ICT in physical education.

We align the research findings with the existing idea that in addition to providing students with disabilities with choices about what is assessed, it is possible to provide options related to how students are assessed (Ivashchenko, 2020). In this sense, it is the parameters of coordination endurance, which were investigated in the implemented research, that are the most optimal option for evaluating the results of physical education of students with disabilities of war veterans.

Compared to other forms of physical education, there is a limited amount of research that supports the practice of inclusion for war veterans in higher education, and although interest has grown significantly over the past decade, no experimental research has been conducted in this area to date.

The works established (Blavt, 2022; Malekpour, Isfahani, Amiri, Faramarzi, Heidari, & Shahidi, 2012; Stodden, Langendorfer, & Roberton, 2009), that the construction of the physical education process based on the results of permanent control allows to intensify the process of physical training and increase the efficiency of managing this process. In connection with the above, the question of the necessity for each student with a disability an individual trajectory for his physical education, which is implemented in different but defined forms, and contributes to the achievement of a positive result based on the results of objective control, is actualized.

Conclusions

It was found that since the first use of ICT until today, this industry is characterized by significant progress and innovation. As for the educational sector, the use of ICT

made it possible to reformat the organizational forms of this process, in particular, physical education. Considering the intensive development of ICT, the use of their potential in the educational process of physical education is a determining factor in ensuring the effectiveness of this process.

Control in physical education is positioned as a mandatory and necessary method of monitoring this process. The expediency of careful control of coordination endurance, which in terms of structure and measurement is the most multicomponent and difficult to control its development, in the physical education of students with disabilities – war veterans is determined by the objective necessity of carrying out the inclusive process in the conditions of an educational institution.

The research paper presents a electronic means of control of coordination endurance developed based on ICT in students with disabilities – war veterans. Experimental practical testing of the electronic means of control, reliability and validity were determined, the coefficients of which exceed the obtained control values using test exercises. Based on the summaries of the conducted empirical research, it was established that the introduction of electronic means of control in the process of physical education of students with disabilities – war veterans helps to ensure the effectiveness of this process. Improving test results as evidence of the performance of physical education.

The issue of optimization of physical education involves such a construction of this process, in which the choice of means, methods, methods, forms, and pace of learning takes into account the peculiarities of the motor and functional readiness of students, the level of their physical development and state of health, reliable information on this can be obtained from the results of objective urgent control.

Conflicts of interest

No conflicts of interest exist.

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ЗАСТОСУВАННЯ ЕЛЕКТРОННИХ ЗАСОБІВ У ТЕСТУВАННІ КООРДИНАЦІЙНОЇ ВИТРИВАЛОСТІ СТУДЕНТІВ З ІНВАЛІДНІСТЮ – ВЕТЕРАНІВ ВІЙНИ

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 2 табл., 4 рис., 16 джерел.

Мета дослідження – полягає у визначенні ефективності використання електронних засобів, створених на основі інформаційно-комунікаційних технологій, у тестуванні координаційної витривалості студентів з інвалідністю ветеранів війни у їхньому фізичному вихованні.

Матеріали та методи. Для вирішення дослідницьких завдань наукової розвідки, дослідження реалізовано на теоретичному та емпіричному рівнях. Використано аналіз, синтез, узагальнення, індукція, систематизація, педагогічний експеримент, методи математичної статистики та технічного моделювання. У дослідженні взяли участь 46 студентів – ветеранів війни (чоловіки 29-35 років).

Результати. Розроблено електронний засіб для визначення координаційної витривалості на основі інформаційно-комунікаційних технологій та програмного забезпечення. Конструкція засобу передбачає використання мобільного та стаціонарного вимірювальних блоків та персонального комп'ютера. Вимірювальний блок містить аналогові та цифрові сенсори. Інформація про виконання тесту студентом подається на екран персонального комп'ютера. Апробація розробленого пристрою передбачала установлення ступеня його автентичності, шляхом порівняння результатів тестування координаційної витривалості виховання студентів з інвалідністю – ветеранів війни реалізованого з використанням педагогічних тестів та тестування з використанням розробленого засобу контролю. Обчислення надійності та валідності тестів показало, що фіксація результатів контролю електронним засобом дозволяє забезпечити високий рівень автентичності тестів.

Висновки. Використання представленого у роботі електронного засобу контролю координаційної витривалості дозволяє досягти високого рівня достовірності результатів контролю в режимі реального часу. На підставі підсумків проведеного емпіричного дослідження встановлено, що впровадження електронних засобів контролю в процес фізичного виховання студентів з інвалідністю – ветеранів війни сприяє забезпеченню ефективності цього процесу.

Ключові слова: студент з інвалідністю, ветеран війни, фізичне виховання, тестування, контроль, засіб, інформаційно-комунікаційні технології, інклюзія.

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