Journal of Learning Theory and Methodology
Журнал теорії та методології навчання

ISSN 2708-7581 (Online)
ISSN-L 2708-7573

Original Scientific Article

Physical Education in the Restoration of Damaged Functions in Students After Blast Tbi Complicated By Acuborotrauma

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

DOI: 10.17309/jltm.2024.5.2.02

Abstract

Background. In the conditions of a long armed conflict, and, therefore, a permanent increase in the number of students affected by the war, there is a need to reorganize the content of physical education in higher schools, in accordance with modern requests and needs.

Objectives. The purpose of the article is to reveal the effectiveness of the implementation of a differentiated PE program in restoring gait and balance functions in students after blast TBI, complicated by acuborotrauma.

Materials and methods. The "10 Meter Walk Test" was used for the implementation of the experiment, the results of which were processed using the methods of mathematical statistics. The studied sample consisted of 20 students after blast TBI, complicated by acuborotrauma, in the first year of study at a higher education institution.

Results. In conclusion, according to the results of the final test cut, there is every reason to consider the implemented differential program effective in achieving the effectiveness of the correction of vestibular dysfunctions. This was reflected in the improvement of the results of the "10 Meter Walk Test" both in integral results and in intermediate sections, as well as in the results of tests used to control the level of balance development. The recorded positive dynamics within 9-19% of all students of the studied sample is evidence in favor of the implemented program.

Conclusions. Research-experimental verification of the effectiveness of the implementation of the developed differentiated physical education course program for students after blast TBI, complicated by acuborotrauma, proved the effectiveness of the proposed innovations. The established dynamics of the studied indicators and their analysis made it possible to answer questions about the effectiveness of the implemented differentiated program aimed at eliminating functional disorders in the body of students as a result of blast TBI, complicated by acuborotrauma. The effectiveness of the implementation of the program is proven on the basis of the established improvement of the test results of the students of the studied sample.

Keywords: physical education, student of higher education, blast TBI, acuborotrauma, program, effectiveness.

Introduction

Since the escalation of the war in Ukraine on February 24, 2022, the number of people affected by active hostilities has been increasing every day. As a result of constant shelling, serious injuries are suffered not only by the military but also by the civilian population.

The russian-Ukrainian war is characterized by the use of the entire range of modern weapons (Misyura, 2023). It was studied (Sirko, Pilipenko, Romanukha, & Skrypnik, 2020) that this led to an increase in the number of victims with a brain injury from the action of a mine blast wave – blast traumatic brain injury (TBI). In recent military conflicts, blast TBI has been recognized as the most common injury of military personnel (VA Research on Traumatic Brain Injury, 2019) – about 60% of BI cases, and 80% of them are mild.

Blast TBI, which is a separate traumatic effect on the brain, can include damage to the hearing organs and the vestibular apparatus – acubarotrauma (acoustic trauma and pressure trauma) (Plurad, 2011). Only according to 2017 data (Shvets, Kikh, & Lukianchuk, 2019), as a result of military operations in eastern Ukraine, blast TBI accounted for 30.8% of all mechanical combat injuries and injuries. At the same time, ear damage due to acubarotrauma among blast TBI was 22.8% (Galushka, Podolyan, Shvets, & Gorshkov, 2019).

According to extreme data (Blavt, Galamanzhuk, Huska, Iedynak, Pityn, Kachurak, Faidevych, & Turka, 2024), the full-scale invasion significantly increased the frequency of this

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type of injury and made blast TBI a real challenge for the higher education system of Ukraine: every year, students after blast TBI in there are more and more institutions of higher education. So, like the rest of the spheres of the country's life, higher education has faced a certain range of problems and challenges (Blavt, Bodnar, Mykhalskyi, Gurtova, & Tsovkh, 2023), seeking to organize such an educational process that is focused on strengthening the effective response to the primary and prospective needs of students, who suffered from the war.

In institutions of higher education, the function of health care is assigned to the discipline of "Physical education" (Kuntjoro, Soegiyanto, Setijono, & Suhiharto, 2022; Chernenko, Muszkieta, Dolynniy, Oliynyk, & Honcharenko, 2022). In the conditions of a long armed conflict, and, therefore, a permanent increase in the number of students affected by the war, and the expectation of maintaining this trend in the future, there is a need to reorganize this process by modern requirements.

As researched (Bannikova, Kalinkin, & Magnushevskyi, 2018), the high specific weight of brain injury in terms of war injuries, a significant percentage of disability acquisition due to blast TBI (Teasell, Bayona, Marshall, & et al., 2007) disappointing forecasts of recovery of working capacity (Langlois, Rutland-Brown, & Wald, 2006) attribute this problem in Ukraine to several priorities. An analysis of the scientific output of research on this issue (Shvets, Kikh, Parkhomenko, & Lukianchuk, 2020; Ng, & Lee, 2019; Misyura, Ruban, & Mishin 2022; Perkins, Gracey, Kelly, & Jim, 2022) confirms that currently blast TBI, including complicated by acuborotrauma, is an actual interdisciplinary problem.

Along with that, the importance of the timely application of restorative physical therapy after injuries has been emphasized in numerous scientific investigations (Blavt, & Gurtova, 2023; Shvet, Kikh, & Parkhomenko, & Lukianchuk, 2020; Blavt, & Herasymenko, 2024). It has been studied (Denby, Murphy, Busuttil, Sakel, & Wilkinson, 2020; Shvets, Podolian, & Holinko, 2020; Sushchenko, Demchenko, & Bobrovnyk, 2024), the consequences of any BI, including blast TBI and complicated by acuborotrauma, can develop and manifest over the years.

The need for exercise after a stroke has been studied (Galeno, Pullano, Mourad, Galeoto, & Frontani, 2022; Bland, Zampieri, & Damiano, 2011; Vander Vegt, Hill-Pearson, Hershaw, Loftin, Bobula, & Souvignier, 2022). It has been proven (Carrick, Mclellan, Brock, Randall, & Oggero, 2015; Bannikova, Kalinkin, & Magnushevskyi, 2018; Lorenz, Charrette, O'Neil-Pirozzi, Doucett, & Fong, 2018) that physical activity contributes to the elimination of symptoms of connected with brain injury.

It is believed (Pellerin, Wilson, & Haegele, 2022; Canto, Chesire, Buckley, Andrews, & Roehrig, 2014; Blavt, 2023) that higher education has all the opportunities and potential for student health. Scientists (Grenier, Patey, & Grenier-Burtis, 2022; Blavt, Galamanzhuk, Huska, Iedynak, Pityn, Kachurak, Faidevych, & Turka, 2024; Jantz, P.B., Davies, & Bigler, 2014) point to the need to introduce innovations corresponding today's needs in the educational process of physical education of higher schools, which can ensure the effectiveness of this process.

Taking into account the situation of daily risks of terrorist tactics of waging war by russia, studying the capabilities of physical education to restore the working capacity of students to prevent late complications of akubotrauma after blast TBI is an urgent issue today.

The purpose of the article is to reveal the effectiveness of the implementation of a differentiated PE program in restoring gait and balance functions in students after blast TBI, complicated by acubarotrauma.

Material and Methods

Study Participants

20 students after blast TBI, complicated by acubarotrauma, in the 1st year of study aged from 18 to 23 years from Lviv Polytechnic National University and Stepan Gzhytskyi National University of Veterinary Medicine and Biotechnologies of Lviv during the one-year course of PE were involved in the experimental study. Students for the study sample were selected based on a medical examination in the presence of mild blast TBI, but complicated by acuborotrauma. The absence of pronounced acute symptoms and the doctor's permission to participate in the testing were significant in the selection of students to participate in the study.

The selection of the contingent for the experimental study was guided by the data (Kim, Yun, Lee, Lee, Sung, Lee, Kim, Park, Choi, Song, Choi, Koo, & Kim, 2024) that age, gender, duration of the disease, species are not aggravations of vestibular disorders do not affect the result.

Students were invited to participate in the study based on anonymity and informed consent.The study was planned and carried out following the principles of bioethics set forth by the World Medical Association (WMA–2013) in the Helsinki Declaration «Ethical Principles of Medical Research Involving Humans» and UNESCO in the «General Declaration on Bioethics and Human Rights».

Methods

The experimental research was implemented at the theoretical and empirical levels. In the list of theoretical methods, there are analysis, synthesis, and generalization. A pedagogical experiment implemented by pedagogical testing was empirically applied, and mathematical statistics methods were used to process the results.

The choice of the testing method was guided by the recommendations (Unver, Baris, Yuksel, Cekmece, Kalkan, & Karatosun, 2017), which consider gait control to be an important indicator of the process of restoring damaged functions after injuries.

Considering the ease of use and evaluation of the results (de Baptista, Vicente, Souza, Cardoso, Ramalho, & Mattiello-Sverzut, 2020), the «10 Meter Walk Test» (10MWT) (Physiopedia), which is non-invasive and safe, was used to implement the experiment to monitor recovery after blast TBI (Hirsch, Williams, Norton, & Hammond, 2014)

Test procedure. Equipment Required: a clear pathway with a set distance (6, 8, or 10 meters in length depending on distance tested). The student must walk 10 meters unaided, with the intervening 6 meters timed to account for acceleration and deceleration (Fig. 1). The time is recorded (to the nearest second) and the walking speed is calculated.

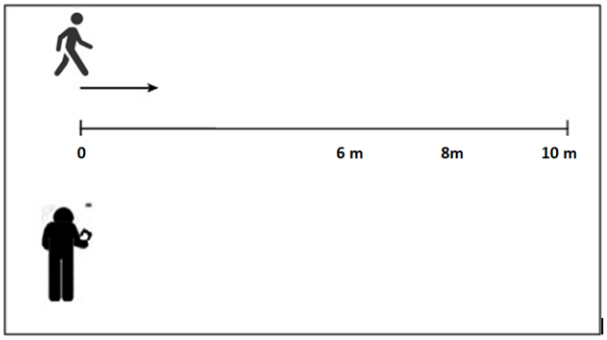

Fig. 1. Scheme of the 10MWT (Blavt, Galamanzhuk, Huska, Iedynak, Pityn, Kachurak, Faidevych, & Turka, 2024)

The student walks without assistance for 10 meters, with the time measured for the intermediate 6 meters to allow for acceleration and deceleration Perform three trials and calculate the average of three trials. Scoring: The time (to the nearest second) is fixed. Walking speed (meters/second) can be calculated by dividing 10 meters by total time in seconds. 10MWT оцінили швидкість ходьби в метрах за секунду за короткий проміжок часу.

The basic Romberg test (Fruth, & Fawcett, 2019) was used to investigate and assess vertical stability (Fig. 2.). It proven (Kim, Kim, Kim, Kim, & Han, 2012), thet be a sensitive and accurate means of measuring the degree of disequilibrium caused by head trauma.

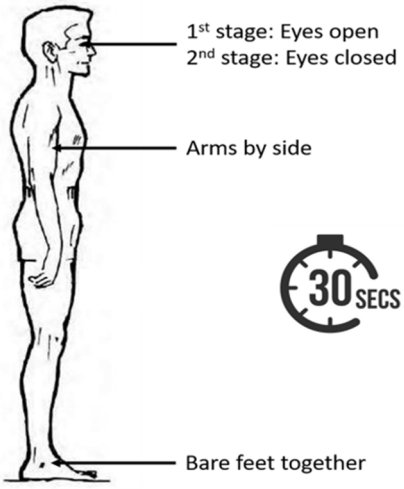

Fig. 2. Scheme of the Romberg test (Epomedicine)

Romberg's test is performed standing, arms extended forward, fingers slightly apart. The student first performs the test task with his eyes open, and then his stability is assessed in the absence of visual control (Fruth, & Fawcett, 2020).

Research Organization

A week after the beginning of the educational process, the students of the studied sample passed the initial test, the next one was scheduled three months later. Each student performed three attempts, and the average value of the three attempts was used for analysis.

Before the start of the testing, a clear instruction was given regarding the procedure for the implementation of the test exercise and the evaluation of the results. If the student felt certain symptoms while performing the test, such as severe shortness of breath, chest pain, dizziness, pain in the legs, etc., the test was stopped.

The comparative experiment involved recording the test results before the start of the study and at the end of the academic semester during which the program was implemented. The result of the experiment was considered to be the dynamics of the studied parameters.

Statistical Analysis

All statistical analyses were performed using SPSS Version 24.0 (IBM Corporation). Рівень статистичної значущості встановлено на рівні 5%. Виміряні дані представлені як середнє трьох спроб± стандартне відхилення.

Results

Our scientific search is based on the fact that concussion combined with acubarotrauma contributes to the prevalence of sensory (hearing, vision loss) and cognitive impairments (Shvets, Podolyan, & Golinko, 2020), accompanied by balance problems (Hillier, & McDonnell, 2015). This leads to a deterioration of functional independence against the background of vestibular disorders, in particular, chronic dizziness and loss of translational control (Rosen, Delpy, Pape, Kodosky, & Kruger, 2021).

It has been studied (Shvets, Kikh, Parkhomenko, & Lukianchuk, 2020; Shvets, Podolian, & Holinko, 2020) that one of the key aspects of acubarotrauma is that, along with damage to the hearing organs, damage to other parts of the central nervous system is observed. This is almost always accompanied by movement disorders (Overview of Traumatic Brain Injury) such as problems in maintaining body stability, which requires monitoring of such disorders during the recovery process (Galeno, Pullano, Mourad, Galeoto, & Frontani, 2022; Misyura, 2023).

Based on the information (Overview of Traumatic Brain Injury; Bland, Zampieri, & Damiano, 2011) that no two BIs are the same and based on the new generalization of accumulated experience, a differentiated physical education program was developed for students after blast TBI. The program was guided by evidence (Carrick, Mclellan, Brock, Randall, & Oggero, 2015) that vestibular complaints are the most common consequence of blast TBI, and vestibular function recovery is identified as the most important physical therapy method (Vander Vegt, Hill-Pearson, Hershaw, Loftin, Bobula, & Souvignier, 2022).

The implementation of a differentiated approach was to provide students with post-blast TBI complicated by trauma with physical education opportunities that are adapted to their abilities. The special tasks of the program were directed to the improvement of specific motor skills with a focus on the elimination of functional disorders of the gait function using a targeted influence on the state of the vestibular apparatus.

Table 1. Test control results

Statistical parameters		Test tasks and measurement results										effect,%
		at the beginning of the experiment					after of the experiment					
		X	S	As	Me	V	X	S	As	Me	V	
10MWT	2 м (с)	1.12	0.28	0.006	11.09	32.1	1.02	0.19	0.004	1.04	21.1	9.6
	6 м (с)	4.38	0.89	0.04	4.20	27.4	4.07	0.71	0.23	3.98	23.2	9.1
	8 м (с)	7.53	0.52	0.39	7.42	31.2	6.91	0.58	0.31	6.77	26.1	8.78
	10 м (с)	9.06	0.65	0.57	8.67	28.7	8.03	0.48	0.42	7.99	21.9	12.1
	V (m/s)	0.91	0.54	0.051	0.88	28.5	0.81	0.32	0.39	0.75	22.7	12.05
Romberg's test (points)	eyes open	12.77	1.93	0.06	12.01	33.2	16.02	2.12	0.87	15.99	24.1	18.17
	eyes closed	7.88	1.75	0.04	7.01	29.2	11.01	1.22	0.63	10.81	21.5	19.04

*The differences in the results at the beginning and after of the experiment are significant (p<0.05–0.001)

Using recommendations (Yushkovska, 2016; Pérez-Rodríguez, García-Gómez, Coterón, García-Hernández, & Pérez-Tejero, 2021), the basis of the program is the use of various aerobic and gymnastic exercises that involve the afferent visual and proprioceptive systems and the vestibular apparatus.

Evaluation of program outcomes was conducted using information (Wellons, Duhe, MacDowell, Hodge, Oxborough, & Levitzky, 2022) that included outcome measures to quantify gait and balance development, as impairments are a common symptom following blast TBI complicated by acuborotrauma (Shvets, Kikh, Parkhomenko, & Lukianchuk, 2020). This was guided by the data (Morgan, Murphy, Opheim, & McGinley, 2016; van der Veen, Perera, Fino, Franke, Agyemang, Skop, Wilde, Sponheim, Stamenkovic, Thomas, & Walker, 2023) that information about equilibrium in the presence of various diseases is valuable for determining the level of functions, changes in functions and consequences for health.

So, in conclusion, according to the results of the final test section (Table 1), there is every reason to consider the implemented differential program effective in achieving the effectiveness of the correction of vestibular dysfunctions. This was reflected in the improvement of the 10MWT results both in the integral results and in the intermediate sections, as well as in the results of the tests used to control the level of balance development. The recorded increase in the speed of overcoming the 10MWT distance attracts attention.

Based on the results of calculating walking speed, which according to data (Graham, Ostir, Kuo, Fisher, & Ottenbacher, 2008), is a correlator of numerous indicators of physical condition and general health, we observe positive dynamics in the studied parameters. After comparing the distance covered in the first and last minutes by the students of the studied sample, conclusions were drawn about the development of fatigue and its effect on walking speed: after the end of the experiment, there was a decrease in the manifestations of fatigue in the performance of the exercise.

Discussion

The relevance of research into various aspects of the recovery process after blast TBI is proven by numerous scientific searches (Shvets, Kikh, & Lukianchuk, 2019; Plurad, 2011; Misyura, Ruban, & Mishin, 2022). The dominant factor in the effectiveness of this process is recognized (Blavt, Galamanzhuk, Huska, Iedynak, Pityn, Kachurak, Faidevych, & Turka, 2024) as the introduction of innovations and the formation of special educational programs (Pérez-Rodríguez, García-Gómez, Coterón, García-Hernández, & Pérez-Tejero, 2021; Chernenko, Muszkieta, Dolynniy, & Honcharenko, 2022; Blavt, & Herasymenko, 2024) in the process of physical education of students to meet today's challenges.

The scientific and applied problem of justifying the reorganization of the content of physical education in higher education is caused by the realities of martial law in Ukraine. The need for further investigation is supported by data (Galeno, Pullano, Mourad, Galeoto, & Frontani, 2022; Ng, & Lee, 2019) regarding blast TBI symptoms that typically resolve within 7-10 days, but remain with dizziness and balance dysfunction that affect on quality of life (Shvets, Kikh, & Lukianchuk, 2019; Ogihara, Kamo, Tanaka, Azami, Kato, Endo, Tsunoda, & Fushiki, 2022; Wellons, Duhe, MacDowell, Oxborough, & Madhav, 2024).

Our results are consistent with the results of the study (Kim, Yun, Lee, Lee, Sung, Lee, Kim, Park, Choi, Song, Choi, Koo, & Kim, 2024; Ogihara, Kamo, Tanaka, Azami, Kato, Endo, Tsunoda, & Fushiki, 2022; Lorenz, Charrette, O'Neil-Pirozzi, Doucett, & Fong, 2018), which proved that the implementation of a differentiated approach in the correction of vestibular disorders after blast TBI contributes to the reduction of motor imbalances.

The conducted research is consistent with information (Wellons, Duhe, MacDowell, Hodge, Oxborough, Levitzky, 2022; Wellons, Duhe, MacDowell, Oxborough, & Madhav, 2024) regarding the feasibility of using gait assessment to monitor the recovery of vestibular disorders, in particular after blast TBI (Jain, 2016; Misyura, 2023). It has been argued (Thorman, Loyd, Clendaniel, Dibble, & Schubert, 2022; Hao, Pu, He, Remis, Yao, & Li, 2024) that gait speed is an indicator of both general functional health and the condition of the vestibular apparatus.

We agree with the authors on the effectiveness of aerobic activities (Yushkovska, 2016; Pérez-Rodríguez, García-Gómez, Coterón, García-Hernández, & Pérez-Tejero, 2021) in the recovery process after blast TBI. We support scientific ideas (Wise, Hoffman, Powell, Bombardier, & Bell, 2012; Mala, & Rasmussen, 2017; Marklund, Bellander, Godbolt, Levin, & McCrory, 2019) regarding the need for physical activity in TBI recovery.

The research results complement the works (Shvets, Kikh, Parkhomenko, & Lukianchuk, 2020; Denby, Mur-

phy, Busuttil, Sakel, & Wilkinson, 2020; Shvets, Podolian, & Holinko, 2020) that an important indicator of the rehabilitation of persons after blast TBI is the control of spatial stability Instead, the relevance of the conducted research is confirmed by the data (Blavt, & Gurtova, 2023), according to which the violation of postural control is considered one of the main problems in the physical education of students who were injured as a result of the war.

Guided by the information (Brushko, Bannikova, & Kovelska, 2021) that the correct and justified choice of instrumental evaluation methods is a mandatory condition for the adequacy of the applied means, the gait parameters control test was chosen. Such tests are widely used to determine walking speed, health and functional status: in neurological diseases (Brushko, Bannikova, & Kovelska, 2021; Tyson, & Connell, 2009), orthopedic injuries (Master, Coleman, Dobson, Bennell, Hinman, Jakiela, & White, 2021), for children with cerebral palsy (Kolonyuk, 2023), after traumatic brain injury (Bland, Zampieri, & Damiano, 2011), in diseases of the cardiovascular, respiratory systems, and musculoskeletal system (Yushkovska, 2016), in Duchenne muscular dystrophy (Pizzato, Baptista, Martinez, Sobreira, & Mattiello, 2016).

For the first time, we used a test to evaluate gait parameters as an indicator of vestibular disorders in students after blast TBI, complicated by acuborotrauma, in the process of physical education. Given the data (Lam, T., Noonan, V., et al., 2007), that a change of 0.13 m/s in the results of the 10MWT is evidence of significant changes in the functioning of the vestibular apparatus, the experiment can be considered a success.

Conclusions

In the conditions of countering the challenges of martial law, domestic institutions of higher education continue to work and make every effort to maintain this trend in the future. The full-scale invasion significantly increased the number of students who suffered war injuries, including blast TBI, which posed a real challenge to the educational process, considering that in the current situation, it affects both military and civilians alike, given the threat of missile strikes.

Given the consequences of blast TBI, complicated by acuborotrauma, which are characterized by a long-term effect on work capacity and general well-being, it requires innovative ideas and provisions in the formation and implementation of the content of physical education as a factor in preserving the health of students after blast TBI, complicated by acuborotrauma. A proven differentiated program of physical education for students after blast TBI complicated by acuborotrauma is aimed at providing a targeted collective impact on the vestibular apparatus.

Research and experimental verification of the effectiveness of the implementation of the developed program proved the effectiveness of the proposed innovations in eliminating functional disorders in the body of students due to blast TBI, complicated by acupressure. The effectiveness of the implementation of the program has been proven based on the established improvement of the test results of the students of the studied sample within 9-19%.

In general, experimental data proved that the developed and implemented physical education course program for students after blast TBI, complicated by acupressure, is effective and contributes to the elimination of vestibular disorders as a consequence of acupressure.

Conflicts of interest

No conflicts of interest exist.

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Фізичне виховання у відновленні ушкоджених функцій у здобувачів вищої освіти після вибухової черепно-мозкової травми, ускладненої акуборотравмою

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

Реферат. Стаття: 8 с., 1 табл., 2 рис., 63 джерела.

Історія питання. В умовах тривалого збройного конфлікту, а, відтак перманентним збільшенням здобувачів вищої освіти , постраждалих від війни, виникає потреба у реорганізації змісту фізичного виховання вищої школи, відповідно до сучасних запитів та потреб.

Мета статті – виявити ефективність впровадження диференційованої програми ФВ у відновленні функцій ходи та рівноваги у здобувачів вищої освіти після вибухової черепно-мозкової травми, ускладненої акуборотравмою.

Матеріали та методи. Для реалізації експерименту використано «10 Metre Walk Test», результати якого опрацьовані методами математичної статистики. Досліджувану вибірку склали 20 здобувачів вищої освіти (чоловіки) після вибухової черепно-мозкової травми, ускладненої акуборотравмою, першого року навчання у закладі вищої освіти.

Результати. У підсумку, за результатами підсумкового тестового зрізу, є усі підстави вважати упроваджену диференційну програму ефективною у досягненні ефективності корекції вестибулярних дисфункцій. Зазначене знайшло своє відображення у покращенні результатів «10 Metre Walk Test» як у цілісних результатах, так і на проміжних ділянках, а також результатів тестів, використаних для контролю рівня розвитку рівноваги. Зафіксована позитивна динаміка у межах 9-19% в усіх здобувачів вищої освіти досліджуваної вибірки є свідченням на користь упровадженої програми.

Висновки. Дослідно-експериментальна перевірка ефективності впровадження розробленої диференційованої програми курсу фізичного виховання для здобувачів вищої освіти після вибухової черепно-мозкової травми, ускладненої акуборотравмою, засвідчила дієвість запропонованих новацій. Установлена динаміка досліджуваних показників та їхній аналіз дозволив дати відповідь на питання щодо ефективності упровадженої диференційованої програми, скерованої на усунення функціональних порушень в організмі здобувачів вищої освіти внаслідок вибухової черепно-мозкової травми, ускладнених акуборотравмою. Доведена результативність реалізації програми на основі установленого покращення результатів тестування здобувачів вищої освіти досліджуваної вибірки.

Ключові слова: фізичне виховання, здобувач вищої освіти, вибухова черепно-мозкова травма, акуборотравма, програма, ефективність.

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Cite this article as: Blavt, O., & Gurtova, T. (2024). Physical Education in the Restoration of Damaged Functions in Students After Blast Tbi Complicated By Acuborotrauma. *Journal of Learning Theory and Methodology, 5*(2), 56-63. https://doi.org/10.17309/jltm.2024.5.2.02

Received: 20.07.2024. Accepted: 24.08.2024. Published: 30.08.2024