



Inclusive Physical Education of Students with Disabilities Due to War Injuries: Restoration of the Functions of the Lower Extremities

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Abstract

Background. The relevance of the study is because the institutions of higher education are now tasked with creating all the conditions for the recovery of body functions lost as a result of injuries of students with disabilities, which additionally actualizes the stated problem in connection with the long-term hostilities on the territory of Ukraine.

Objectives. The purpose of the article is to reveal the effectiveness of the developed program of inclusive PE on the recovery of lost functions due to injuries of the lower limbs in students with disabilities.

Materials and methods. To solve the tasks, a complex of scientific intelligence methods was used at the empirical and theoretical level: literature analysis, observation, testing, experiment, and methods of mathematical statistics. The test program consisted of the star excursion balance, weight-bearing lunge test, and the single leg stance test. 24 male students with disabilities in the first year of study at a higher education institution took part in the experiment.

Results. According to the qualitative assessment of the obtained results, it can be stated that after the end of the experiment, there is a general tendency to increase the results of the test tasks. A significant improvement of the indicators was found in all the investigated parameters without exception: as a positive trend in the range of 15% is observed. The results of the static and dynamic tests performed with support on the injured leg were significantly lower than with support on the uninjured leg ($p < 0.05$).

Conclusions. The results of the final testing allow us to ascertain the effectiveness of the implemented program. Statistically reliable positive dynamics of the set of investigated indicators proved that the implementation of the developed inclusive PE program for students with disabilities due to injuries of the lower extremities ensures the effectiveness of recovery due to functional injuries.

Keywords: inclusion, physical education, student with disabilities, war trauma, program, effectiveness.

Introduction

Since the armed aggression of Russia on the territory of Ukraine in 2014, society and the state have faced a challenge, when a large number of people from among the participants in hostilities and the civilian population acquired the status of disability due to injuries. After the start of the full-scale invasion, the number of injuries, including multiple blast injuries, increased significantly (Shvets, Horishna, Deputat, Rychka, Zhaldak, & Kih, 2022).

As a result, in the conditions of a long war, the number of students with disabilities due to injuries in institutions of higher education is permanently increasing. Institutions of

higher education are tasked with creating all the conditions for restoring functions lost as a result of injuries and improving the health of students with disabilities (Page, Anderson, & Charteris, 2021), which additionally actualizes the stated problem in connection with the long-term hostilities in the territory of Ukraine.

The relevance of the identified issues is determined by the fact that everyone can face in Ukraine today – injuries as a result of military operations. Statistics show that 70% of war injuries are extremity injuries (Shvets, Horishna, Deputat, Rychka, Zhaldak, & Kih, 2022). Of all persons requiring rehabilitation, the most common types of injuries during military conflicts are injuries of the lower extremities (64.3%) (McKinley, D'Alleyrand, Valerio, Schoebel, Tetsworth, & Elster, 2018), especially among military personnel, sprained an-

kles are very by widespread trauma (Waterman BR, Belmont, Cameron, Deberardino, Owens, 2010). It is also important that 50–70% of cases of diseases of various etiologies develop after an injury if timely rehabilitation measures are taken to restore the lost functions of the limbs (Doherty, Delahunt, Caulfield, Hertel, Ryan, & Bleakley, 2014; Al-Mohrej, & Al-Kenani, 2016).

The identified question becomes especially relevant given the fact that the timely restoration of affected functions in students with disabilities is a factor in preventing physical maladaptation of such students and ensuring their further ability to effectively perform their professional activities (Goodwin, & Watkinson, 2020; Blavt, 2022). Landmarks for solving this problem are considered from the standpoint of inclusive education (Grenier, Patey, & Grenier-Burtis, 2022) using forms, means, and methods of physical education (PE) (Kuntjoro, Soegiyanto, Setijono, & Suhianto, 2022; Pocock, & Miyahara, 2018).

Despite the obvious interest of scientists in the issues of restoration of the affected functions as a result of war injuries of students with disabilities in the modern scientific discourse, we note the low degree of its systematic comprehensive study about higher education.

The purpose of the article is to reveal the effectiveness of the developed program of inclusive PE on the restoration of lost functions due to lower limb injuries in students with disabilities.

Material and Methods

Study Participants

24 male with disabilities in the 1st year of study from Lviv Polytechnic National University and Drohobych Ivan Franko State Pedagogical University were involved in the experimental study (Tab. 1).

The results of the screening of health risks related to participation in the experiment and the absence of pronounced symptoms of trauma exacerbation were the guiding principles in the selection process of the participants. The studied sample consisted of students who acquired a disability due to the presence of anamnesis of injured, ankle, complex fractures, or knee injuries of only one limb and were recovered within half a year.

Table 1. Anthropometric data study participants

Number of participants	24
Age (years)	20.20±2.33
Heigh (cm)	178.15±6.04
Leg length	96.70±5.12
Weight (Kg)	72.70±7.18

A medical worker's permission to participate in the experiment was obtained for each participant of the studied sample. Students who voluntarily agreed to participate in the experiment provided informed written 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 research was carried out using methods of the theoretical (analysis, synthesis, generalization) and empirical (pedagogical experiment, pedagogical testing, methods of mathematical statistics) levels.

The choice of pedagogical testing methods is justified by the need to use several indicators that measure different parameters. This position is supported by evidence (Ivashchenko, 2020) that suggests that using multiple measures of outcome and assessment provides a more comprehensive understanding of all aspects of the recovery process (De la Motte, Lisman, Gribbin, Murphy, & Deuster, 2019).

Using research findings (Kim, & Kim, 2018; Wang, Yu, Zhang, Wang, & Chen, 2023; Picot, Terrier, Forestier, Fourchet, & Mc Keon, 2021), on balance factors that are recommended to be considered in the recovery process, we prepared a set of tests. The execution of the selected tests does not require complex equipment, is easy to reproduce, and at the same time allows the assessment of various aspects of the process of restoring the functions of the injured lower limbs.

The Star Excursion Balance Test (SEBT) is a dynamic test that requires strength, flexibility, and proprioception (Kaminski, & Gribble, 2003). SEBT was designed to be used as a rehabilitative tool for lower extremity pathologic conditions, the test can be used to to screen deficits in dynamic postural control due to musculoskeletal injuries (e.g. chronic ankle instability) (Gribbl, Hertel, & Plisky, 2012). Test procedure. The person performing the test must maintain a their balance on one leg, while using the other leg to reach as far as possible in 8 different directions (Fig. 1) (Star Excursion Balance Test).

The Single Leg Stance (SLS) рекомендуют (Sibley, Straus, Inness, Salbach, Jaglal, 2013) is used to assess static postural and balance control (Single_Leg_Stance_Test).

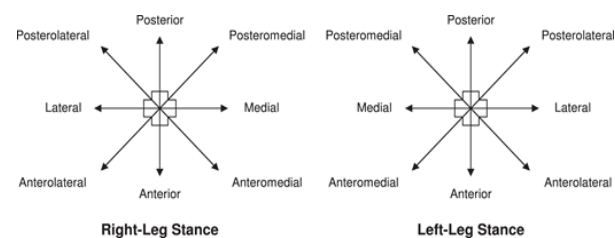


Fig. 1. Scheme of the SEBT (Gribbl, Hertel, & Plisky, 2012)

Performed with eyes open and hands on the hips. Student stands on one leg unassisted; time begins when opposite foot leaves the ground; time stops immediately when opposite foot touches the ground and/or when hands leave the hips (Single Leg Stance Test).

Weight-bearing lunge test (WBLT) was used to control the mobility of the ankle joint (Fig. 2). WBLT implemented the evaluation of the range of motion of dorsiflexion in the ankle joint by the inclinometer method (Cosby, & Hertel, 2011), according to which they control the appropriate amplitude in the ankle, the presence of limited mobility and the range of motion as a risk factor for injuries to the lower extremities during physical activity or any which movement and which are recommended for use in the assessment of ankle and foot injury (Hall, & Docherty, 2017).

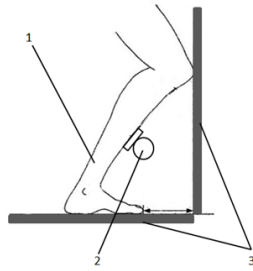


Fig. 2. Scheme of the WBLT: 1 – student, 2 – inclinometer, 3 – vertical and horizontal line

Test Procedure

This test needs to be done against a wall. A standard tape measure (cm) is necessary. Students are asked to place their feet in such a way that an imaginary line drawn through the heel and big toe is aligned on the tape measure on the floor. Furthermore, a vertical line is drawn on the wall in line with the tape measure. Students are instructed to lunge forward until their knee touches the wall (vertical line). The heel is required to remain in contact with the floor at all times. The foot is moved away from the wall to the point where the knee can only make slight contact with the wall, while the heel remains in contact with the floor. This puts the ankle joint in maximal dorsiflexion. The leg not being tested can rest on the floor and students are allowed to hold onto the wall for support. The maximum distance from the wall to the tip of the big toe is recorded (Weight-bearing lunge test).

Research Organization

To implement the experiment and achieve homogeneity of the studied sample, forms were prepared with the basic information of the participants of the studied sample, such as age, height, body weight, gender, and nature of injury. Before testing, all students were provided with clear instructions regarding the tests, the procedure for performing them and evaluating the results. After an appropriate warm-up, an opportunity was given to try to perform the test exercise three times, the average of three attempts was used in the analysis. Testing was implemented during two academic semesters at the beginning and at the end of the PE course.

Statistical Analysis

All statistical analyses were performed using SPSS Version 22.0 (IBM Corporation). The studied data were presented using the methods of descriptive statistics, the main one-dimensional variables were used: the value of the arithmetic mean (X), standard deviation (S), median (Me), and coefficient of variation (V). Statistical significance was established using the Student's test, setting the level of significance at $p \leq 0.05$ (Myers, Well, & Lorch Jr, 2010).

Results

It should be noted that according to the data (Ursone, 2010), traumatic injuries of the limbs as a result of military actions differ in the mechanism of influence and consequences

on the body. At the same time, according to ideas (Bluman, & Ficke, 2010), the results of recovery after injury depend not only on treatment but also on complex physical rehabilitation with the formation of individual programs. Accordingly, as stated (Pellerin, Wilson, & Haegele, 2022), the current concept of inclusive PE involves a model that is primarily focused on the needs of each student with disabilities (Qi, & Ha, 2012).

Therefore, taking into account the above, and guided by information from literary sources, a PE program for students with disabilities due to injuries of the lower extremities was developed and tested. Here it was taken into account that, there are certain patterns according to which the lost functions are restored after injury to the lower extremities (Kisner, Colby, & Borstad, 2017).

The basis of the developed program was a differentiated approach to the definition of PE tactics, a comprehensive assessment of the achieved results, and the phasing of the implementation of modern approaches to optimize this process.

The priority of an individual flexible approach as an element of control over the recovery process became significant in the creation of the program (Rekaa, Hanisch, & Ytterhus, 2019). Special attention is focused on the prevention of the development of contractures in the joints of the limbs for the formation and assimilation of new motor skills (Bezell, Grindstaff, Sauer, Magrum, MIngersoll, & Hertel, 2012).

The program provides for timely correction based on indicators of control, which were used to systematically determine functional limitations in the lower extremities of students and monitor the effectiveness of the program (Snyder, Parsons, Valovich McLeod, Curtis Bay, Michener, & Sauers, 2008).

The effectiveness of the implementation of the program during the inclusive PE of students with disabilities due to injuries of the lower extremities is proven by the results of comparative control (Tab. 2). Qualitative assessment and mathematical-statistical processing of the results obtained after the end of the pedagogical experiment in the studied sample of students with disabilities provide the basis for a conclusion about the dynamics of shifts in the studied indicators, which are chosen as correlates of the recovery process after injuries of the lower extremities.

A significant improvement of indicators was found in all studied indicators without exception: according to the qualitative assessment of all studied parameters, it can be stated that after the end of the experiment, there is a general tendency to increase the results of the performance of test tasks.

The ability to maintain balance without support is a complex motor task, which has been observed to be significantly impaired when performing SLST with support on the injured limb. Despite the presence of positive dynamics in the test results, the results of the static and dynamic tests performed with support on the injured leg were significantly lower than with support on the uninjured leg ($p < 0.05$).

As a result, the average values of the results of the SLST based on the healthy limb moved into the range of values that are close to the normative averages. If at the beginning of the study, the performance of SLST with support on the injured limb was accompanied by significant difficulties, then at the end, along with the dynamics in the results, its performance did not cause significant stress to the participants of the studied sample.

Table 2. Results of test control

Statistical parameters	Test tasks and measurement results											
	at the beginning of the experiment					after of the experiment					effect,%	
	X	S	As	Me	V	X	S	As	Me	V		
SEBT (sm) healthy limb	anterior	71.54	3.15	0.04	69.3	37.8	77.48	3.19	0.25	75.3	24.5	8.33
	anteromedial	73.33	5.8	0.04	73.3	22.3	81.2	3.55	0.47	80.6	25.9	10.71
	medial	77.18	5.3	0.68	77.01	32.7	85.6	5.9	0.63	84.3	34.1	10.96
	posteromedial	90.3	6.9	0.12	89.2	23.9	98.1	5.4	0.20	97.5	34.0	8.63
	posterior	88.7	3.51	0.51	88.1	33.4	99.9	5.9	0.01	99.1	27.9	12.62
	posterolateral	83.1	4.76	0.37	82.4	24.6	88.4	6.19	0.20	87.9	25.6	6.37
	lateral	69.41	4.23	0.38	1270	33.5	75.42	4.11	0.23	6.00	36.8	8.65
	anterolatera	72.76	4.11	0.42	70.02	35.7	80.1	3.8	0.65	79.3	23.4	12.13
SEBT (sm) injured limb	anterior	53.6	6.1	0.44	52.34	23.5	59.5	5.8	0.34	59.2	26.7	11.07
	anteromedial	55.90	4.04	0.25	54.12	29.0	62.93	5.3	0.14	62.23	33.6	12.57
	medial	60.34	5.15	0.15	60.01	27.9	71.55	5.9	0.52	70.49	33.0	18.05
	posteromedial	81.2	4.55	0.47	80.6	45.9	88.7	4.51	0.51	88.1	23.4	9.23
	posterior	76.61	3.97	0.36	6.11	43.4	84.3	4.5	0.62	85.0	28.4	10.03
	posterolateral	70.23	5.11	0.47	69.3	35.1	74.15	4.09	0.60	73.2	29.7	5.58
	lateral	59.15	4.1	0.06	58.67	40.4	68.28	3.08	0.35	38.32	33.5	15.43
	anterolateral	63.46	4.5	0.38	62.56	26.7	71.33	3.01	0.53	70.08	25.2	7.87
SLST (s)	injured limb	2.38	0.61	0.83	2.22	27.4	4.99	0.65	0.22	4.78	22.5	10.9
	healthy limb	9.01	1.02	0.53	8.99	27.2	23.0	3.11	4.62	21.3	26.7	15.27
WBLT	distance (sm)	8.6	2.33	3.17	21.1	25.1	12.1	3.16	0.48	9.95	23.5	4.69
	angle0	28.68	3.6	0.69	29.4	23.9	36.16	4.3	0.35	38.32	25.6	2.06

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

The results of SEBT improved in all directions, the lowest indicators were recorded in the anterior direction, which is obviously determined by the increased risk of injury (Smith, Chimera, & Warren, 2015). The results of the SEBT of the injured limb are lower than the results of the healthy limb, which is natural since injuries of the lower extremities reduce the results of the SEBT (Picot, Terrier, Forestier, Fourchet, & Mc Keon, 2021).

The greatest increase in SEBT results was recorded in lateral distances (15.43 %), in the direction, the smallest in injured limb in posterolateral distances (5.58 %).

The results of WBLT showed an increase in the range of extension in the ankle joint, which, accordingly, affected an increase in the distance of posterior displacement of the ankle. If before the beginning of the study, the amount of ankle flexion was sufficient for normal walking, but indicated the risk of possible injuries (Matthew, Hoch, & McKeon, 2011), then at the end of the study, the index reached values that allow moving to more complex exercises. However, achieving average values requires further measures.

Discussion

The «degree» of the importance of restoring lost functions as a result of the injuries of students who received disabilities due to combat injuries significantly increased after the start of a full-scale war in Ukraine. Accordingly, the higher school, as a social institution, faces the task of creating the most possible favorable conditions for the implementation of the process of restoration of damaged functions in students with disabilities.

We agree with the opinion (Page, Anderson, & Charteris, 2021) that a prominent feature of inclusive PE, as a tool for ensuring the restoration of lost functions (Keles, ten Braak, & Munthe, 2022), is its dynamism (Kuntjoro, Soegiyanto, Setijono, & Suhiharto, 2022; Wolbring, & Lillywhite, 2021), because there is a constant modification of this process by the challenges of today (Blavt, Chaplinskyi, Prozar, Pityn, Helzhynska, Dmytruk, Hrebik, & Kovalchuk, 2023).

Our research is consistent with the information (Pocock, & Miyahara, 2018) that modern inclusive PE, as a means of restoring lost functions, requires the formation of modern content based on innovative pedagogical technologies. We support scientific approaches (Blavt, Iedynak, Pereverzieva, Holub, & Melnyk, 2023) that obtaining new scientific data on the recovery after war trauma of students with disabilities is a social need of Ukrainian society, which has especially gained importance recently, in connection with the full-scale invasion of Russia on the territory of Ukraine and prolonged hostilities.

Research is consistent with data (Lieberman, & Houston-Wilson, 2017; Goodwin, & Watkinson, 2020) that implementing a differentiated approach in PE is a powerful challenge, but this approach facilitates the process of inclusion (Pocock, & Miyahara, 2018; Kuntjoro, Soegiyanto, Setijono, & Suhiharto, 2022). The obtained research results correspond to experimental data (Blavt, & Gurtova, 2023), which prove the effectiveness of a differentiated approach in inclusive PE.

Our study extends the results of previous research that evidence of balance deficits, empirically quantified using foot and ankle capacity measurements, can be used as predictors

of the possibility of developing chronic ankle instability (Al-Mohrej, & Al-Kenani, 2016).

The need for urgent restoration of the functions of the lower limbs, which are affected after injuries, is due to the evidence (Bezell, Grindstaff, Sauer, Magrum, Mingersoll, & Hertel, 2012) that 20% of people develop the development of chronic ankle instability. This condition may be the result of a deficit in lower limb muscle strength and balance, or a possible impairment of postural control (Wang, Yu, Zhang, Wang, & Chen, 2023). Walking, jumping, occupational involvement, and physical activities can be affected (Snyder, Parsons, Valovich McLeod, Curtis Bay, Michener, & Sauers, 2008).

Our study is consistent with other empirical evidence that balance development declines with fitness level (Zhang, Talaber, Truong, & Vargas, 2019), and that increased ankle flexibility leads to an increase in dynamic balance control outcomes, namely distance to posterior reach distances (Seever, Mason, & Zech, 2022; Chaiwanichsiri, Lorrprayoon, & Noomanoch, 2005). The results are consistent with the evidence regarding the strong correlation between flexor strength and posterior directions of the injured limb (Domingues, Serenza, Muniz, de Oliveira, Salim, Fogagnolo, Kfuri, & Ferreira, 2018); that dynamic balance deficits are observed in both injured and uninjured limbs when tested in selected directions of the SEBT (Doherty, Bleakley, Hertel, Caulfield, Ryan, & Delahunt, 2015); that a program aimed at the development of balancing on one leg helps to improve dynamic balance (Rasool, & George, 2007).

The conducted research is consistent with the evidence regarding the need for balance development as a condition for the success of the recovery process after acquired injuries, as lower extremity injuries reduce the effectiveness of SEBT (Picot, Terrier, Forestier, Fourchet, & Mc Keon, 2021). Accordingly (de la Motte, Lisman, Gribbin, Murphy, & Deuster, 2019), an insufficient level of balance indicates the presence of an injury of the lower extremities, and the dynamics of the development of balance, accordingly, provides information about the recovery process (Gribble, Hertel, & Plisky, 2012; Cimbiz & Bayazit, 2004).

The results of the conducted experiment confirm (Qi & Ha, 2012; Lieberman, & Houston-Wilson, 2017) that timely permanent control of the PE process is a factor in ensuring its effectiveness, which counteracts the development of complications due to injuries, or at least makes it possible to minimize the effects of negative the script

Conclusions

Currently, Ukraine has become the epicenter of extreme situations, when citizens suffer from Russian terrorist attacks for a long time. In the conditions of global challenges of the course of hostilities, both military personnel and representatives of the civilian population are equally at risk of receiving military injuries. Therefore, in institutions of higher education, there is a situation of a high percentage of students with disabilities due to war injuries.

The solution to the issue of restoration of functions of students with disabilities lost as a result of injuries to the lower limbs in the process of education can be seen in the development and implementation in practice of approaches

appropriate to the challenges of the time, which strengthen the practical potential for the organization and implementation of inclusive PE. An experimental study was conducted, the main purpose of which was to study the impact of the proposed innovations, which were implemented in the developed PE program, the main task of which was to restore the functions of the lower limbs of students with disabilities lost as a result of war injuries.

The obtained results of the final testing make it possible to state the effectiveness of the implemented program, as positive dynamics within 10-15% are observed for all the studied parameters. Statistically reliable positive dynamics of the set of investigated indicators proved that the implementation of the developed inclusive PE program for students with disabilities due to injuries of the lower extremities ensures the effectiveness of recovery due to functional injuries.

Conflicts of interest

No conflicts of interest exist.

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Інклюзивне фізичне виховання студентів з інвалідністю внаслідок травм війни: відновлення функцій нижніх кінцівок

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 8 с., 2 табл., 2 рис., 49 джерел.

Історія питання. Актуальність дослідження обумовлена тим, що на заклади вищої освіти нині покладено завдання створити всі умови для відновлення втрачених внаслідок травмувань функцій організму та покращання стану здоров'я студентів з інвалідністю, що додатково актуалізує означену проблему в зв'язку з тривалими бойовими діями на території України.

Мега статті – виявити ефективність впливу розробленої програми інклюзивного фізичного виховання на відновлення втрачених функцій внаслідок травмувань нижніх кінцівок у студентів з інвалідністю.

Матеріали та методи. Для вирішення поставлених завдань використовували комплекс методів наукової розвідки на емпіричному та теоретичному рівні: аналіз літератури, спостереження, тестування, експеримент, методи математичної статистики. Тестову програму склали тести: балансу зіркової екскурсії, стійки на одній нозі та тест на випад із навантаженням. В експерименті взяли участь 24 здобувачі вищої освіти з інвалідністю чоловічої статі першого року навчання у закладі вищої освіти.

Результати. Згідно якісної оцінки отриманих результатів можна стверджувати, що після закінчення експерименту спостерігається загальна тенденція до зростання результатів виконання тестових завдань. Достовірне покращення показників виявлено у всіх без винятку досліджуваних параметрах: так як спостерігається позитивна динаміка в межах до 15 %. Попри наявність позитивної динаміки у підсумках, результати статичного і динамічного тесту з виконанням з опорою на травмованій нозі були значно нижчими, а ніж з опорою на неушкодженій нозі ($p < 0.05$).

Висновки. Отримані результати підсумкового тестування дають констатувати ефективність упровадженної програми. Статистично достовірною позитивною динамікою комплексу досліджуваних показників засвідчила, що реалізація розробленої програми інклюзивного фізичного виховання для студентів з інвалідністю внаслідок травм нижніх кінцівок, забезпечує ефективність відновлення ушкоджених функцій.

Ключові слова: інклюзія, фізичне виховання, здобувач вищої освіти з інвалідністю, травма війни.

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