



Postural Control Development of Students with Disabilities in the Process of Inclusive Physical Education

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Abstract

Background. An important aspect of ensuring the effectiveness of inclusive physical education of students with disabilities in higher education is taking into account the increase in certain violations in the state of health of students caused by the long war of the Russian Federation against Ukraine. As a result, a powerful factor of disability, a violation of postural control, is considered one of the main problems in inclusive PE of students with disabilities.

The study purpose was to reveal the effectiveness of inclusive PE classes on the development of postural control of students with disabilities in the process of implementing the developed program.

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. 30 first-year students with disabilities took part in the experiment. The organization of the study provided for the determination of the state of the studied parameters as a consequence of the action of the developed program aimed at correcting the postural control of students with disabilities.

Results. According to the results of the test control of maintaining balance and orientation in space, the development of postural control of students with disabilities after the end of the experimental study was established. The results of the study established an improvement in the quality of the balance function, as a correlator of translational control, in students of the studied sample after the end of the experimental study within 20%.

Conclusions. Considering the fact that postural control is ensured by the functional activity of the somatosensory, vestibular, visual and neuromuscular systems, scientifically based use of the tools of the developed inclusive PE program became a factor in improving the studied parameters of postural control of students with disabilities.

The established statistically reliable positive dynamics of the set of postural control indicators proved that the implementation of the developed innovations in the PE of students with disabilities provides a targeted impact on the normalization of balance functions. The obtained results of the conducted pedagogical experiment prove the effectiveness of the author's development of pedagogical actions regarding the correlation of postural control of students with disabilities in the process of inclusive physical education.

Keywords: inclusive, physical education, students with disabilities, postural control, program, effectiveness.

Introduction

The military aggression of the Russian Federation against Ukraine became a powerful factor in increasing the number of students with disabilities in higher education institutions. The undeniable role of the higher school as a social institution that forms not only a competent specialist, but also ensures the health of students with disabilities (Goodwin & Watkinson, 2020).

Currently, in Ukrainian society, special attention is paid to the process of gradually changing the attitude towards

persons with disabilities. Overcoming obstacles to the integration of the above-mentioned social group is due to the European integration initiatives of Ukraine as a strong, independent and democratic country, which provides opportunities for them to acquire quality educational knowledge. This becomes especially important in connection with the long-term hostilities on the territory of our country.

In higher education, as a system of pedagogical activities aimed at strengthening health, harmonious development of forms, functions and physical capabilities, formation of vital motor skills and abilities, high-quality inclusive PE acquires special relevance (Simões, Lorenzini, Gavioli, Caminha, De Souza Júnior, & De Melo, 2018).

Today, much attention is paid to current trends in the development of inclusive PE in Ukraine, as they are in an active state of activity development. The scientific pursuit of quality assurance in inclusive PE is the subject of numerous studies (Page, Anderson, & Charteris, 2021; Barber, 2018; Haegele, Giese Wilson, & Oldörp, 2020).

As indicated (Nanayakkara, 2022; Ruscitti, Thomas, & Bentley, 2017), a prominent feature of inclusive PE is its dynamism, as there is a constant adaptation of this process to the individual characteristics of students with disabilities (Lidor, & Hutzler, 2019).

An important aspect of ensuring the effectiveness of physical education for students with disabilities in higher education is taking into account the increase in certain disorders in their health (Keles, ten Braak, & Munthe, 2022; Goodwin, & Watkinson, 2000). Amputations of limbs and craniocerebral injuries caused by the long war of the Russian Federation against Ukraine occupy a special place among them. As a result of the indicated factors of disability, the violation of postural control is considered (Matiychuk, Nikitenko, & Maslova, 2023; Matiychuk, & Vlasyuk, 2023) to be one of the main problems in the PE process of students with disabilities.

The relevance of the chosen direction of research is due to the fact that psychological disorders, a state of tension or accumulated traumatization due to the impact of long-term terrorist attacks in Russia, according to certain theories, "is expressed in the curves of the spine" (Gurgel, Dourado, Moreira, Serafini, Menegotto, Reppold, & Soldera, 2012). At the same time, according to information (Bansal, Katzman, & Giangregorio, 2014), postural control, as the ability to hold the body in space, achieving both stability and orientation, ensures the achievement of balance in any situation. The significance of the study is determined by the fact that the coordination of the vertical position of the body while standing is an indicator of the functional state of the human body, and the level of its health (Hicheur, Vieilledent, & Berthoz, 2005).

We emphasize the importance of the development of postural control, given that it is a key component of the safe performance of vital functions in everyday activities, a factor in minimizing secondary complications for the preservation of motor function, and an external indicator of the state of health and quality of life (Voronova, Lazareva, Kovelska, & Kobinskyi, 2021). It is important to note that the normalization of postural antigravity mechanisms ensures motor development and prevention of contractures and deformations due to injuries (Halmágyi, & Curthoys, 2021).

The purpose of the article is to reveal the effectiveness of inclusive PE classes on the development of postural control of students with disabilities in the process of implementing the developed program.

Material and methods

Study participants

The research was conducted in the Department of PE of the National University «Lviv Polytechnic» and Department of physical education, sports and health 2Stepan Gzhytskyi National University of Veterinary Medicine and Biotechnologies of Lviv during the one-year course of PE. 30 first-year

students with disabilities (an equal number of girls and boys) took part in the experiment. The study was conducted following the Helsinki Declaration of the World Medical Association (WMA-2013) WMA, Ethical Principles of Medical Research Involving Human Subjects.

Methods

A complex of adequate methods of scientific intelligence was used to solve the tasks. Research at the theoretical level provided for the formation of an inclusive PE program for students with disabilities based on information from literary sources. For this, general scientific methods were used, including analysis, systematization, and generalization.

During the research at the empirical level, a complex of pedagogical methods was used: observation, testing, experiment, which included ascertaining and formative stages. At the final stage, the methods of mathematical statistics were applied to process and analyze the results of the experimental research and determine their reliability.

Because body balance control is considered part of postural control, the basic Romberg test (Blak, Wall, Rockette, & Kitch, 1983) was used to investigate and assess vertical stability. The testing consisted of two equal time (30 s) periods of recording parameters of the test performance with eyes open and eyes closed.

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.

The tests "Walking to the goal" and "Walking in a straight line with closed eyes" (Magill & Anderson, 2017) were used to determine the level of development of the ability to navigate in space.

The procedure of the "Walking to the goal" test assumes that the student from the starting line during an arbitrary time estimates the distance to the center of the circle, which he must walk to the center of the circle at an arbitrary pace. At the end of the test, mark the projection of the body's center of gravity between the feet. Measure the distance from the marked projection of the center of gravity of the body to the center of the circle.

The test "Walking in a straight line with closed eyes" involves the following: a student from the starting line at an arbitrary pace blindfolded must reach a distance of 15 meters to the center of the circle. At the end of the test, mark the projection of the body's center of gravity between the feet. The result is the distance Deviation to the right or left from the marked projection of the center of gravity of the body – to the center of the circle.

"Stabilan 01-2" stability analyzer was used to register and analyze the statodynamic stability of the body of the participants of the research sample. This is how to evaluate the individual resistance of the body to the movement of the general center of mass in the sagittal and frontal planes and, in general, determine the effectiveness of maintaining balance.

Study organization

Consent was obtained from each participant of the studied sample, in accordance with established international re-

quirements. Permission was obtained from a medical worker to conduct the study, as well as data on the physical condition based on the medical history and medical examination of students with disabilities who were planned to be involved in the experiment. The ability to move independently, to perform self-care in everyday activities, which was confirmed by a primary care physician based on medical history and medical examination, was significant in the selection of participants of the experiment. Students with disabilities who had cognitive impairments were not included in the study.

The organization of the study provided for the determination of the state of the studied parameters at the beginning of the experiment and the detection of changes due to the action of the experimental factor. The introduction of a developed program aimed at correcting the postural control of students with disabilities in the process of inclusive PE was considered an experimental factor.

Statistical analysis

Statistics were used to prevent errors and biases in the evaluation of research results, in this case, the results of a pedagogical experiment. The choice of statistical methods was guided by the fact that the proper use of statistical methods is the basis for ensuring reliable conclusions of empirical research and the correct application of research results.

At the initial stage, methods of descriptive statistics were used. Finally, to determine the reliability of the obtained empirical results, the methods of inductive statistics (Bhandari, 2023) were used, which made it possible to draw general conclusions under the given assumptions. All statistical analyses were performed using SPSS Version 21.

Results

The premise of our research is that successful postural control depends on the operation of a complex postural control system that works together to achieve body balance (King, Horak, Mancini, Chesnutt, Sullivan, & Chapman, 2013). This system is formed by the somatosensory, vestibular, visual and neuromuscular systems. Any deviations in the activity of the listed systems cause the loss of postural control (Gandolfi, Valè, Filippetti, Dimitrova, Geroïn, Picelli, & Smania, 2018).

The essential role of postural control in ensuring the performance of vital functions in various static and dynamic activities such as sitting, standing, crawling, walking and running, the ability to contract the relevant muscles necessary to maintain posture, and the ability to make small adjustments in response for changes in position. Maintaining postural stability in both dynamic and static conditions involves establishing a balance between destabilizing and stabilizing forces and requires sensory information received from these systems (Voronova, Lazareva, Kovel'ska, & Kobinskyi, 2021).

All of the above was the basis of the developed inclusive PE program. It was also taken into account that the pathological physiology of a postural control system disorder is multifaceted and consists of the synthesis of certain components (biomechanical, motor, sensory), orientation in space, control of dynamic movements, and cognitive processing.

Therefore, while studying different approaches using PE tools, we tried to combine them into a comprehensive pro-

gram that would maximally take into account all the affected areas individually for each of the students with disabilities in the studied sample. A significant feature of the program is that it provides for the correction of the physical development of a student with a disability in the educational process through the introduction of the necessary PE equipment, based on individual needs and certain individual functional differences.

Because there is no single approach to solving the problem of regulating postural control in the process of inclusive PE, the basis of the formation of the content of classes is the complexity in the choice of means of influencing the formation of physiological stereotypes. Special attention was paid to the correction of body position regulation mechanisms, focusing on the exceptional importance of the muscle stretching factor in relation to the effect on the central nervous system.

When forming the content of classes in a certain sequence, the goal and task were specified, the forms of classes were defined for the implementation of differentiated content, and the current diagnosis of each state of the studied indicators of each student with disabilities, ensuring systematicity in the implementation of content correction following the results obtained, allowing for flexibility and changes during its implementation.

Considering the above, the normalization of postural control is a rather difficult task. Therefore, they tried to focus on certain individual aspects, which are considered to be an integral part of postural control.

According to scientific data, postural control has two main goals: postural balance, which is based on sensorimotor coordination, and postural orientation, which ensures the maintenance of an appropriate relationship between body parts or with the environment during the performance of a certain task (Gurgel, Dourado, Moreira, Serafini, Menegotto, Reppold, & Soldera, 2012). Based on the above, the scientific intelligence provided for the formation of conclusions about the quality of the introduced innovations based on the results of motion tests and stabiography, which provided information about the specified parameters (Tabl. 1, 2).

The Romberg test was used as a «background» test in which the proprioceptive, visual, and vestibular analyzers operate in a natural mode (Blak, Wall, Rockette, & Kitch, 1983). Body balance, considered as the ability to maintain the body's center of gravity above the plane of support, which is ensured by the interaction of complex systems (Vovkanych, & Bergtraum, 2013), according to the results of testing, is characterized by the absence of a fundamental gender difference. Therefore, this aspect was not investigated in the control results.

It was established that the role of visual control has a significant place in maintaining balance in students with disabilities: the duration of maintaining balance without visual control is almost half as long, and the range of oscillations is more pronounced than when eyes are open. Therefore, at the end of the study, the place of visual control is somewhat leveled as a compensatory mechanism for maintaining body balance.

According to the results of Romberg's test, changes in the quality of coordination of the vertical position of the body while standing in a complex position were evaluated; the

Table 1. Test control results of students of the studied sample

Statistical parameters	Test tasks and measurement results							
	Romberg's test with eyes open (points)		Romberg's test with eyes closed (points)		Walking to the goal (sm)		Walking in a straight line with closed eyes (sm)	
	at the beginning	after	at the beginning	after	at the beginning	after	at the beginning	after
M	14.13	18.21	7.17	10.3	44.23	35.12	131.6	106.5
S	3.5	3.09	2.31	2.06	3.15	2.88	14.03	11.08

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

Table 2. Stabiliography results of students of the studied sample

Period of the experiment	Statistical parameters (M±S)				
	The center of the body amplitude in the frontal plane (mm)	The center of the body amplitude in the sagittal plane (mm)	Area of an ellipse, mm ²	The quality of the equilibrium function, %	
with open eyes	at the beginning	3.31±0.53	2.95±0.52	93.2±3.1	53.1±3.5
	after	3.02±0.88	2.61±0.82	89.1±2.9	65.3±4.8
with closed eyes	at the beginning	3.93±0.21	3.99±0.92	173.6±4.5	40.1±2.2
	after	3.57±0.93	3.21±0.54	160.2±3.4	47.4±3.3

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

level of formation of skills of the motor-sensory system for managing body stability and changes in the quality of neuromuscular activity in students of the studied sample. The presence of statistically significant positive changes (up to 30%) after the approval of the developed program was established (at the $p < 0.05$ level), which, in our opinion, is associated with a favorable effect due to its implementation.

Regarding the correction of the ability to navigate in space, the changes in the studied indicators (up to 20%) also confirm the success of the program, however, the proposed tasks were quite difficult to reproduce, especially in the absence of visual control.

According to the results of stabiography at the beginning of the study, a significant spread in the frontal plane compared to the sagittal plane was observed in the students of the studied sample. Obviously, this is a consequence of the fact that in the presence of disability, in the presence of pathological curves in the spine, it is much more difficult to maintain balance in the sagittal plane. In the end, it was possible to reduce the spread to some extent.

The results of improvement in the quality of balance at the end of the experimental study (within 20%) are a consequence of the improvement in particular of muscle balance in the process of engaging in inclusive PE. The latter is also a factor in the displacement of the body's center of gravity, as a balance stabilizer. However, the effect of the optimal ratio between body weight and height as a functional factor stabilizing the balance function is not excluded.

Discussion

The leading idea of inclusive education is the need to ensure comprehensive personality development and health care of students with disabilities, which contributes to their successful adaptation in the environment of higher educa-

tion and is the basis for further integration into social life (Mieghem, Verschueren, Petry, & Struyf, 2020). The potential of PE to provide the above has been researched and confirmed (Rouse, 2009; Ruscitti, Thomas, & Bentley, 2017). Therefore, we coordinate our research and emphasize the need to adapt the content, forms, methods and technologies of inclusive PE, as the main factor of health preservation, to the needs of modern times (Mihajlovic, & Meier, 2022).

Our research is based on the information that the rapid increase in the number of students with disabilities since the full-scale invasion of Russia on the territory of Ukraine and the long hostilities, the solution to the scientific and practical problem of overcoming health disorders in the process of obtaining higher education needs improvement, primarily by developing (modernization) of innovative pedagogical and practices (Pocock, & Miyahara, 2018; Grenier, Collins, Wright, & Kearns, 2014).

To date, there is no consensus on the optimal approach to implementing inclusive PE in higher education. In the conditions of active search for effective solutions to such a situation, it seems appropriate to study the possibilities of PE, which are answers to the challenges of the time, based on experimental activity. The science, experience and practice of advanced countries of the EU and the world confirm the need, with the development of new and improved technologies, to constantly create new programs of inclusive PE to improve the physical development of students with disabilities. Our study extends the findings of the research (Ruscitti, Thomas, & Bentley, 2017; Block, & Obrusnikova, 2007; Blavt, 2022) regarding the improvement of inclusive PE programs.

Among the wide spectrum of disorders of students with disabilities, limb amputations and brain injuries, which are accompanied by postural control disorders, are now the most common (Voronova, Lazareva, Kovelska, & Kobinskyi, 2021). The consequence of this is disorders of motor and muscle

functions, impaired coordination of movements, pathologies of muscle tone, which are manifested by weakness of a certain group of muscles, deformation of the spine and joints, formation of contractures, etc. (Hallett, DelRosso, Elble, Ferri, Horak, Lehericy, Mancini, Matsushashi, Matsumoto, Muthuraman, Raethjen, & Shibasaki, 2021). Our study expands the circle of scientific research on the elimination of these violations in the process of inclusive PE (Goodwin, & Watkinson, 2020; Ruscitti, Thomas, & Bentley, 2017). The system of knowledge regarding directions for postural control correction in the process of inclusive PE was supplemented (Matiychuk, Nikitenko, & Maslova, 2023; Matiychuk, & Vlasjuk, 2023).

The conclusions of scientists have confirmed, that the study of postural control is a rather difficult task, since possible disturbances in many sensory systems and other physiological mechanisms of regulation of this parameter, in particular the center of body mass, should be taken into account (Gurgel, Dourado, Moreira, Serafini, Menegotto, Reppold, & Soldara, 2012; Vovkanych, & Bergtraum, 2013).

The results of the conducted study confirm the results of previous studies regarding the need for targeted influence in the process of inclusive PE, taking into account the specific violations of students with disabilities (Lidor, & Hutzler, 2019; Koryahin, Blavt, Bakhmat, Guska, Ludovyk, Prozar, Bodnar, Kravets, & Bezgrebnaya, 2019). Our research is consistent with the findings of a previous study (Ivashchenko, 2020) that a targeted effect on a certain functional characteristic leads not only to its improvement but also to some others that were not affected due to the «crossover effect».

The results obtained during the pedagogical experiment confirm the conclusions of scientists (Mihajlovic, & Meier, 2022; Justin, & Zhu, 2017; Grenier, Patey, & Grenier-Burtis, 2022) regarding the need to organize inclusive PE based on the effective selection of organizational forms, methods, and technologies and teaching aids, which is based on a differentiated approach taking into account the factor of students' disability, based on individual needs and individual functional differences.

We support scientific approaches (Matiychuk, Nikitenko, & Maslova, 2023; Matiychuk, & Vlasjuk, 2023) that adding stabilometric criteria to postural control in the process of inclusive PE contributes to improving the diagnosis of existing disorders and makes it possible to objectively monitor the state of the investigated balance indicators and spatial orientation of the bodies of students with disabilities, and is a factor in the effectiveness of the applied innovations.

Research that has been conducted (Goodwin, & Watkinson, 2020; Page, Anderson, & Charteris, 2021; Ruscitti, Thomas, & Bentley, 2017) suggests that a professional approach to harnessing the potential of inclusive PE, which is based on changes in understanding and practices of this process to ensure the improvement of the physical condition of students with disabilities, will have a positive impact on the inclusive policy in the field of education.

The practical significance of the research results lies in the possibility of adapting the proposed innovations in the inclusive PE of students with disabilities.

Conclusions

Inclusion in higher education is an urgent need of the hour since the military aggression of the Russian Federation

on the territory of Ukraine became a factor in the significant increase in the number of students with disabilities. Society's demands for high-quality graduates of a higher school provide for its highest possible development, to a large extent due to the need to ensure high effectiveness in the education or work of students with disabilities.

The higher school, which ensures the fulfillment of the social order - the preparation of a comprehensively developed harmonious personality, provides for the formation of physically healthy specialists. The latter is intended to be implemented by the modern theory and practice of inclusive PE, which is based on the need to eliminate the segregation of students with disabilities in the environment of higher education, aimed at preventing existing negative trends in their physical development, health to ensure a full, productive life and activities in the process of obtaining a higher education education

The systematization and generalization of the final results at the end of the experiment testify to the benefit of using the developed translational control correction program in the process of inclusive PE. According to the obtained results, the statistically reliable positive dynamics of the complex of studied indicators of EG students proved that the implementation of the intended content of the developed inclusive PE program for students with disabilities ensures effectiveness in the development of postural control: the analysis of the state of the studied parameters before and after the action of the experimental factor by the method of test control and stabilography proved improvement in their values according to the results of the final cut of the results of the indicators of the balance function and orientation in space.

Taking into account the fact that translational control is provided by the functional activity of the somatosensory, vestibular, visual and neuromuscular systems, scientifically based use of the means of use of the developed inclusive PE program became a factor in improving the studied parameters of translational control of students with disabilities. In general, the results of the conducted pedagogical experiment prove the effectiveness of inclusive PE classes on the development of postural control of students with disabilities in the process of implementing the developed program.

Conflicts of interest

No conflicts of interest exist.

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Розвиток постурального контролю студентів з інвалідністю у процесі інклюзивного фізичного виховання

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

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Важливим напрямом забезпечення ефективності інклюзивного фізичного виховання здобувачів вищої освіти з інвалідністю у вищій школі є урахування збільшення певних порушень у стані здоров'я здобувачів вищої освіти, зумовлені тривалою війною РФ проти України. Як наслідок, потужного чинника інвалідизації, порушення постурального контролю, вважається одним з головних проблем у інклюзивному фізичному вихованні здобувачів вищої освіти з інвалідністю.

Мета статті – виявити ефективність впливу занять інклюзивного фізичного виховання на розвиток постурального контролю здобувачів вищої освіти з інвалідністю у процесі реалізації розробленої програми.

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. В експерименті взяли участь 30 здобувачів вищої освіти з інвалідністю першого року навчання у закладі вищої освіти. Організація дослідження передбачала визначення стану досліджуваних параметрів як наслідку дії розробленої програми, скерованої на корекцію постурального контролю здобувачів вищої освіти з інвалідністю.

Результати. За результатами тестового контролю утримання рівноваги та орієнтування у просторі встановлено розвиток постурального контролю здобувачів вищої освіти з інвалідністю по закінченні експериментального дослідження. Підсумками дослідження встановлено покращання якості функції рівноваги, як корелятора поступального контролю, у здобувачів вищої освіти досліджуваної вибірки у межах 20%.

Висновки. Зважаючи, на те, що постуральний контроль забезпечується функціональною діяльністю соматосенсорної, вестибулярної, зорової та нервово-м'язової систем, науково-обґрунтоване використання засобів розробленої програми інклюзивного фізичного виховання стало чинником покращання досліджуваних параметрів постурального контролю здобувачів вищої освіти з інвалідністю.

Установлена статистично достовірна позитивна динаміка комплексу показників постурального контролю засвідчила, що реалізація розроблених новацій у фізичному вихованні здобувачів вищої освіти з інвалідністю забезпечує цілеспрямований вплив на нормалізацію функцій рівноваги. Отримані результати проведеного педагогічного експерименту доводять ефективність авторської розробки педагогічних дій щодо кореляції постурального контролю здобувачів вищої освіти з інвалідністю в процесі інклюзивного фізичного виховання.

Ключові слова: інклюзія, фізичне виховання, здобувач вищої освіти з інвалідністю, постуральний контроль, програма, ефективність.

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