

# Physical culture and sports rehabilitation of amateur athletes after brain contusion with post-traumatic stress disorder in the training motor mode

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## Abstract

**Purpose.** The purpose of the study was to determine the effectiveness of a correctional rehabilitation program aimed at restoring balance, correcting walking, and the quality of life of amateur athletes with the consequences of brain contusion in a training motor mode.

**Material & Methods.** Under observation were 38 men aged 25-42 years with long-term consequences of a closed craniocerebral injury in the late long-term period. The duration of the post-traumatic period is six months. In all patients, complications of brain contusion were impaired coordination and balance. All patients were involved in amateur sports before the injury. Patients were randomly divided into two groups: Gr1 (n=20) and Gr2 (n=18). The study was carried out in 2 stages. Stage 1 (28 days) was held on the basis of the Ukrainian Research Institute of Prosthetics, Prosthesis Construction and Recovery in Kharkiv. After the 1st stage, the same positive dynamics were observed in the athletes of both groups. Stage 2 (42 days) self-study according to the recommendations provided in the training motor mode. At the same time, the studied Gr1 were engaged under the supervision of a specialist in physical culture and sports rehabilitation using modern messenger applications (Viber, Telegram, WhatsApp). Post-traumatic stress disorder was diagnosed according to the recommendations of the Ministry of Health of Ukraine. For a rapid assessment of well-being, activity, and mood, online testing was carried out according to the SAN methodology. Studies of human statics were carried out using a hardware-software basometric complex developed at the Ukrainian Research Institute of Prosthetics.

**Results.** The correctional rehabilitation program was composed of two stages. Stage 2 – training (42 days). This stage corresponds to the recovery phase when residual effects are eliminated and permanent compensations are fixed and improved. The long-term goal of the ICF concept is returning to amateur sports. The program of persons Gr1 included vestibular gymnastics and Nordic walking. Amateur athletes Gr2 were engaged in kinesiotherapy and training walking. During the day, men of both groups took sessions of segmental reflex massage, worked out in the gym, had individual and group conversations, and auto-training. After the 1st stage of rehabilitation, the coefficient of resistance to walking statics in amateur athletes of both groups tended to increase, because in Gr1 individuals the result was better. After the 2nd stage of rehabilitation in men Gr1, the coefficient of resistance approached the standard value ( $p < 0,05$ ). In patients, Gr2 remained at the same level ( $p > 0,05$ ). During the primary study, a pronounced asymmetry of the posture was noted, which is confirmed by the rotation of the pressure centers of the extremities in Gr1 by 1,140 and in Gr2 by 1,110 ( $p < 0,05$ ). After stage 1, there were significant changes in the index in the patients of both groups. ( $p < 0,05$ ). After stage 2 in Gr1 patients, the index of rotation of the center of pressure of the extremities approached the standard value ( $p < 0,05$ ). In patients, Gr2 remained at the same level ( $p > 0,05$ ). That is, the amateur athletes of Gr2 have a state of posture asymmetry. After stage 2, the fluctuations in the CCM in the frontal plane acquired significant differences compared to the standard value ( $p < 0,05$ ). After the course of rehabilitation measures, both groups showed positive dynamics of all static parameters characterizing the postural posture, however, there were no significant changes in Gr2 patients ( $p > 0,05$ ). The index of fluctuations in the CCP in the sagittal plane of amateur athletes Gr2 remained 1,42 mm

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higher than the standard value.

**Conclusions.** Thus, there is a need to develop correctional and rehabilitation programs and popularize remote rehabilitation for participants in military events with the consequences of brain contusion and PTSD. The results of our work have confirmed the effectiveness of self-study according to the recommendations provided under the supervision of a specialist in physical culture and sports rehabilitation using modern messenger applications (Viber, Telegram, WhatsApp).

**Keywords:** postural stability, resistance, post-traumatic stress disorder, vestibular gymnastics, auto-training, telerehabilitation.

## Introduction

Military events, unfortunately, affect health, physical abilities, emotional and mental health. Even after the actual combat event is over, the impact of the traumatic events of the war can lead to years of reduced quality of life for the population. Society is already facing the consequences of a long war. An open question is how to restore and maintain the physical and psychological health of the population, especially those of working age.

Of course, the participants in the hostilities receive the greatest trauma. About 73% of combat injuries are accompanied by brain contusion. In 50–90% of cases, after a brain injury, neurological symptoms persist or new neurological syndromes form, leading to disability. According to scientific research, local disorders are detected after a few weeks due to damage to the central and peripheral vestibular apparatus, in the form of disorders in the functions of eight cranial nerves (Misyura et al., 2022). The consequence of such violations is changes in the stereotype of walking. Restoring balance and adjusting gait is an important aspect of improving quality of life and returning to sports activities (Misyura, 2023; Saleeva et al., 2022; Kouris et al., 2018).

The second challenge of war is post-traumatic syndrome (PTSD), which occurs against the background of a traumatic event. According to thirty-nine empirical studies, the prevalence of the phenomenon of post-traumatic growth ranges from 30% to 70% of victims of various types of injuries (Linley & Joseph, 2004; Tedeschi & Calhoun, 2004). PTSD is a reaction to an emergency that can cause stress for anyone. Clinicians believe that PTSD is a painful condition or a state of low-stress tolerance and a person's desire to rethink traumatic memories (Diagnostics of PTSD in the conditions of war: advice of psychologists 2023). People of young and middle age are more susceptible to PTSD. They become more emotional disorders, and alcohol or drug addiction may occur, requiring immediate psychological support, and assistance in socialization. One of the post-traumatic reactions is sleep disturbance. Training, especially in the fresh air, improves the functioning of the cardiovascular system and affects the normalization of sleep (Diagnostics of PTSD in the

conditions of war: advice of psychologists 2023, Olkhovyi et al., 2016). In this aspect, the return to amateur sports is one of the ways for men of working age to return to normal life. However, in modern scientific and methodological literature, almost no attention is paid to the problem of physical culture and sports rehabilitation, as well as the restoration of amateur athletes who were participants in hostilities.

*Purpose* – to determine the effectiveness of the correctional rehabilitation program aimed at restoring balance, correcting walking, and the quality of life of amateur athletes with the consequences of brain contusion in the training motor mode.

## Material and methods of research

### *Participants*

Under observation were 38 men aged 25-42 years with long-term consequences of a closed craniocerebral injury in the late long-term period. The duration of the post-traumatic period is six months. In all patients, complications of brain contusion were impaired coordination and balance. All patients were involved in amateur sports before the injury. Patients were randomly divided into two groups: Gr1 (n=20) and Gr2 (n=18).

### *Procedure*

The study was carried out in 2 stages. Stage 1 (28 days) was held on the basis of the Ukrainian Research Institute of Prosthetics, prosthetic construction and rehabilitation in Kharkiv. After the 1st stage, the same positive dynamics were observed in the athletes of both groups. Stage 2 (42 days) self-study according to the recommendations provided in the training motor mode. At the same time, Gr1 patients were trained under the supervision of a specialist in physical culture and sports rehabilitation using modern messenger applications (Viber, Telegram, WhatsApp). The study was conducted by the principles of bioethics outlined in the Declaration of Helsinki "Ethical Principles for Medical Research Involving Humans" and the "Common Declaration on Bioethics and Human Rights (UNESCO)". When organizing and conducting the study, the principles of voluntari-

ness, anonymity, and trust were used. All men participating in the study provided written consent to participate.

*Post-traumatic stress disorder* was diagnosed according to the recommendations of the Ministry of Health of Ukraine (Diagnostics of PTSD in the conditions of war: advice of psychologists 2023). To be diagnosed with PTSD, you must have all of these symptoms for at least one month:

- ✓ at least one symptom of re-experiencing;
- ✓ at least one symptom of avoidance;
- ✓ at least two symptoms of excitement and reactivity;
- ✓ at least two symptoms of cognition and mood.

For a quick assessment of well-being, activity, and mood, online testing was carried out according to the *SAN methodology*. The test scale consists of indices (3 2 1 0 1 2 3) and is located between thirty pairs of words of opposite meanings, reflecting mobility, speed, and rate of functions (activity), strength, health, fatigue (well-being), as well as characteristics of the emotional state (mood). The patient must select and mark the number that most accurately reflects his condition at the time of the examination. Scores greater than 4 points indicate a favorable condition of the subject, scores below 4 indicate the opposite. Normal state scores are in the range of 5,0-5,5 points (Well-being-activity-mood 2023).

Studies of human statics were carried out using a hardware-software basometric complex developed at the Ukrainian Research Institute of Prosthetics, the work of which is based on the methods of basometry and stabilometry (Saleeva et al., 2022).

*Stabilometry* is a method for determining stability, i.e. measurement of the coordinates of the migration of the projection of the common center of pressure (CCP) or the resulting vector of the reaction of the support on the horizontal plane, characterizing the ability to maintain a stable state in a standing position. During the study, a graphical linear registration of oscillations of the common center of pressure occurs separately in the frontal (right-to-left) and sagittal (forward-backward) planes and the calculation of the average amplitude of the oscillations is performed. After conducting stabilometric studies, we studied the fluctuations of the CCP in the frontal and sagittal planes, which characterize the stability when the patient is standing.

#### *Statistical analysis*

Statistical data processing was carried out using the statistical package STATISTICA 13.0 (StatSoft). The arithmetic mean value was calculated –  $M$ ; standard deviation –  $\delta$ ; dispersion –  $D$ ; the error of the arithmetic mean is  $\pm m$ . To determine significant differences, the Student's para-

metric test ( $t$ ) was used; differences were considered statistically significant at  $p < 0,05$ .

## Results

The correctional rehabilitation program was composed of two stages. Stage 2 – training (42 days). This stage corresponds to the recovery phase, when residual effects are eliminated, and permanent compensations are fixed and improved. The objectives of this period were the maximum possible resumption of physical activity; increased tolerance to physical activity; formation of high-quality permanent compensations; the formation of a stable desire and a conscious attitude to the implementation of physical exercises (Andreyuk, 2017; Bezeha, 2022; Honcharov et al., 2020, Kletsenko et al., 2022; Kouris et al., 2018). The special tasks of the training stage are the creation of prerequisites for in-depth sports training in the future, and the provision of comprehensive physical fitness (Briskin, 2005).

The long-term goal of the ICF concept is a return to amateur sports.

Athletes Gr1 were engaged in the variable part of the author's methodology. Amateur athletes Gr2 according to the recommendations were provided by the specialists of the Ukrainian Research Institute of Prosthetics (Figure 1).

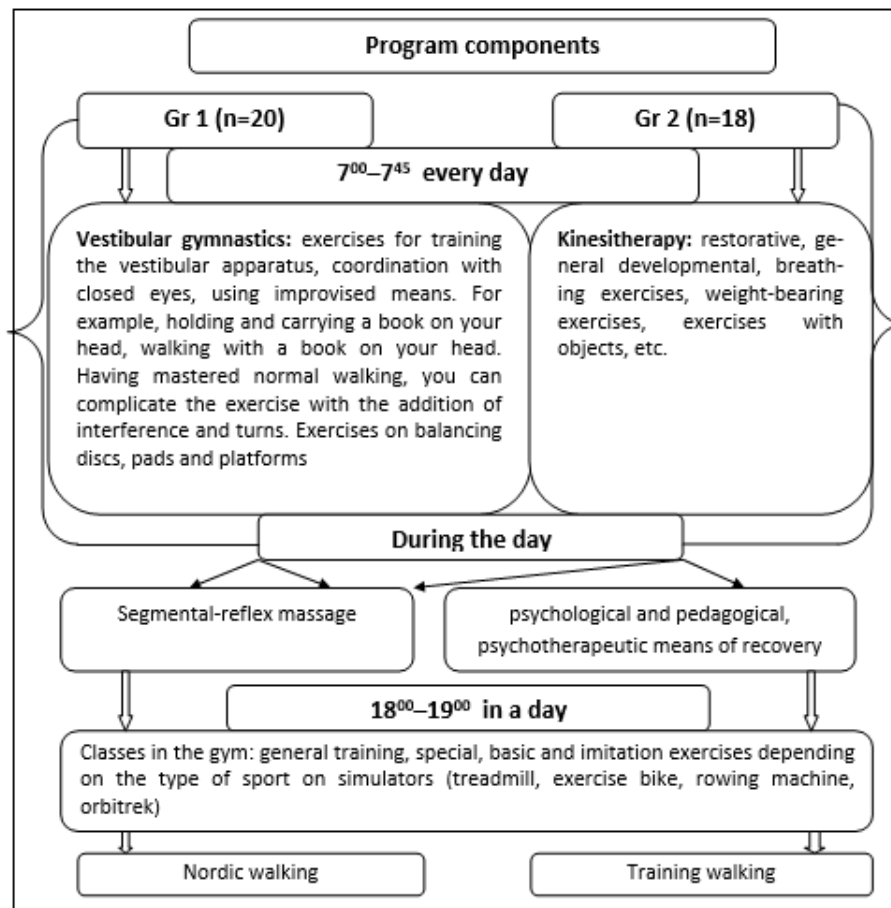
The load distribution in both groups was the same.

*Massage*. First, a segmental-reflex massage was performed, that is, the paravertebral zones of all spinal segments of the spine were massaged in the direction of afferent nerve impulses from S3 to C1. The ultimate goal was to apply mechanical stimulation to the root of the spinal nerves at the points of their exit from the spine. This contributed to the reflex activation of the motor centers of the central nervous system, and metabolic processes in the muscles and other tissues of the musculoskeletal system. At the same time, the activity of the internal organs and systems of the body, including the vestibular apparatus, is stimulated reflexively. After a reflex effect on the body, to consolidate the resulting feedback, a classic massage of the whole body, including the neck and the back of the head, was performed according to the method of P.B. Efimenko.

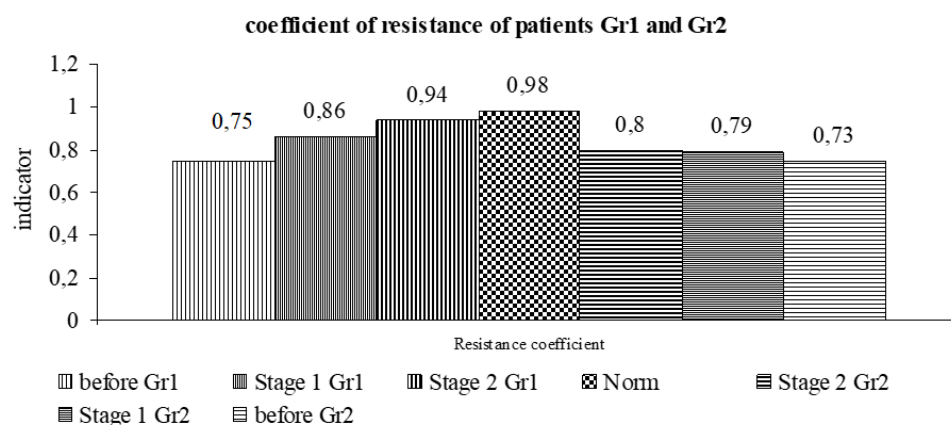
Psychological and pedagogical methods were used to help with PTSD: individual and group conversations, instilling self-confidence, and auto-training.

The dynamics of all characteristics were monitored after each stage. To assess the emotional state of patients, a test of differentiated mental state self-assessment according to the SAN scale was used. We assessed well-being, activity, and mood (Table 1).

After the 2nd stage, in both groups, the indi-



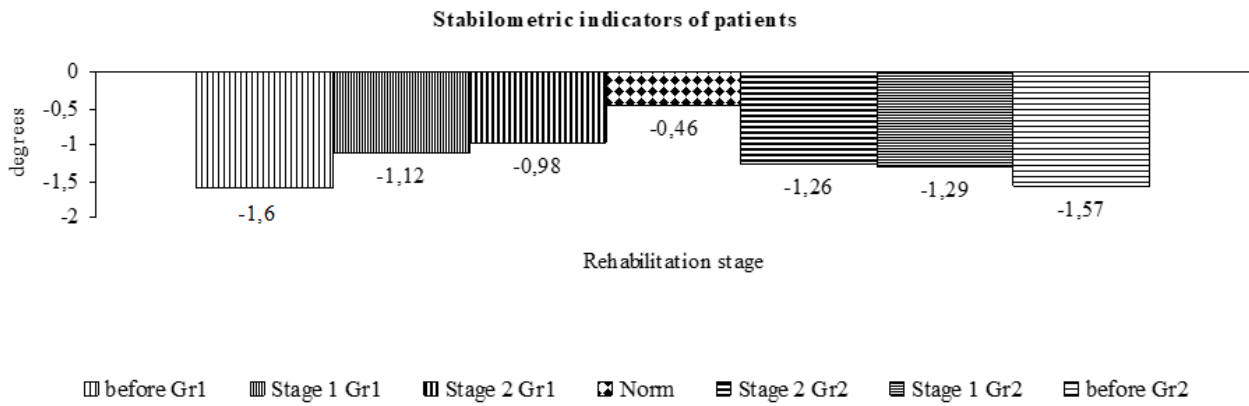
**Figure 1.** Scheme of the correction and rehabilitation program for amateur athletes Gr1 and Gr2 in the training motor mode.



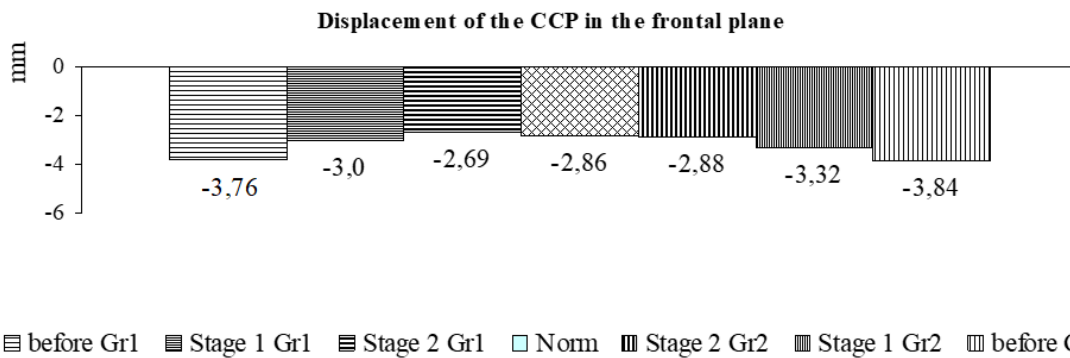
**Figure 2.** Dynamics of static walking resistance coefficient indicator of amateur athletes Gr1 (n=20) and Gr2 (n=18).

**Table 1.** Comparative characteristics of the indicators of the emotional state of amateur athletes Gr1 and Gr2 on the SAN scale, points

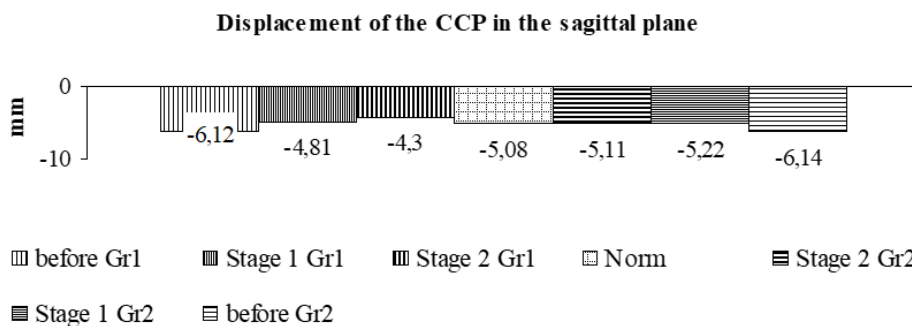
		Well-being	Activity	Mood
Gr1 (n=20)	before the program	3,25±0,41	3,35±0,27	3,8±0,64
	1 stage	4,15±0,58	4,3±0,36	4,25±0,72
	2 stage	5,2±0,34	5,5±0,48	5,3±0,38
Gr2 (n=18)	before the program	3,21±0,53	3,45±0,56	3,75±0,46
	1 stage	4,45±0,67	4,15±0,72	4,25±0,56
	2 stage	5,3±0,48	5,2±0,43	5,3±0,73



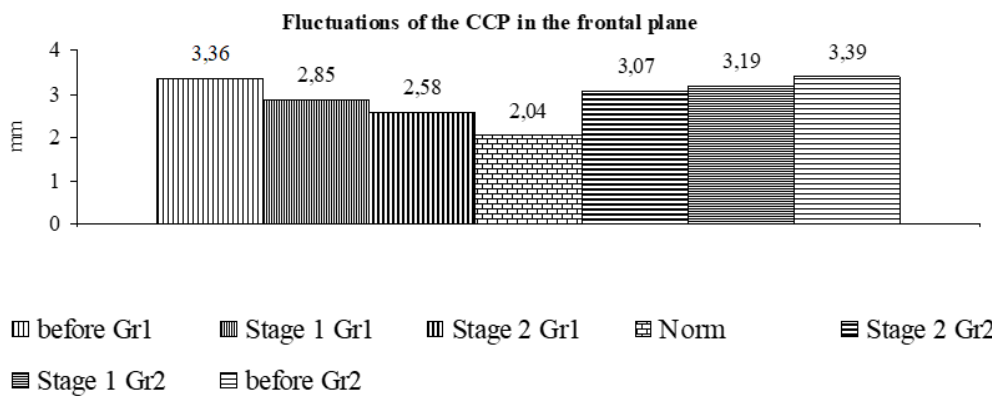
**Figure 3.** Dynamics of the index of rotation of the center of pressure of the limbs of amateur athletes Gr1 (n=20) and Gr2 (n=18).



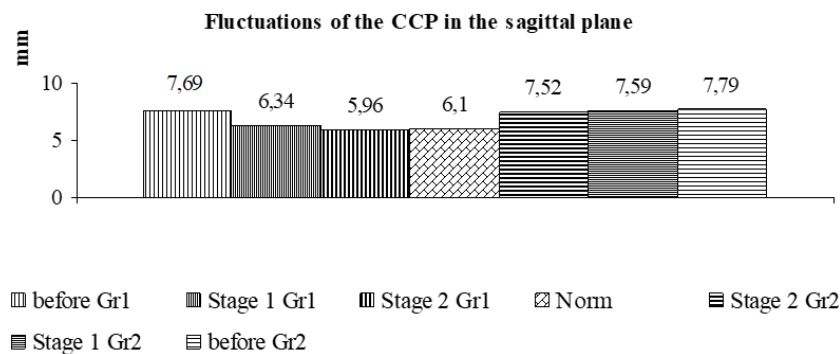
**Figure 4.** Dynamics of the indicator of fluctuations of the general center of pressure in the frontal plane of amateur athletes Gr1 (n=20) and Gr2 (n=18).



**Figure 5.** Dynamics of fluctuations of the general center of pressure in the sagittal plane of amateur athletes Gr1 (n=20) and Gr2 (n=18).



**Figure 6.** Dynamics of the indicator of fluctuations of the general center of pressure in the frontal plane of amateur athletes Gr1 (n=20) and Gr2 (n=18).



**Figure 7.** Dynamics of fluctuations of the general center of pressure in the sagittal plane of amateur athletes Gr1 (n=20) and Gr2 (n=18).

caters of the emotional state according to the SAN scale received a normal assessment ( $p < 0,05$ ).

Biomechanical studies of gait statics during the primary study indicated a decrease in all parameters of support ability and stability when standing in patients of both groups compared with the standard value ( $p < 0,05$ ). After the 1st stage of rehabilitation, the coefficient of resistance to walking statics in amateur athletes of both groups tended to increase, because in Gr1 individuals the result was better. After the 2nd stage of rehabilitation in Gr1 men, the coefficient of resistance approached the normative value ( $p < 0,05$ ). In men, Gr2 remained at the same level ( $p > 0,05$ ).

At the same time, during the primary study, a pronounced asymmetry of the posture was noted, which is confirmed by the rotation of the pressure centers of the limbs in Gr1 by  $1,14^\circ$  and in Gr2 by  $1,11^\circ$  ( $p < 0,05$ ). After stage 1, there were significant changes in the index in the subjects of both groups ( $p < 0,05$ ). After the 2nd stage, in persons Gr1, the index of rotation of the center of pressure of the extremities approached the normative value ( $p < 0,05$ ). In patients, Gr2 remained at the same level ( $p > 0,05$ ). That is, amateur athletes Gr2 have a state of asymmetry of posture, which may occur because of standing, the projection of the center of pressure of one of the limbs is shifted to the forefoot (Figure 3).

In patients of both groups, there is an increase in the displacement of the common center of pressure in both the frontal and sagittal planes. After stage 2, the fluctuations in the CCP in the frontal plane acquired significant differences compared to the standard value ( $p < 0,05$ ) (Fig. 4).

The index of CCP fluctuation in the sagittal plane also acquired significant differences after stage 2 compared to the standard value ( $p < 0,05$ ) (Figure 5).

It was also noted that by the course of rehabilitation, athletes of both groups had reduced postural stability, which is reflected in an increase in the amplitude of fluctuations in the general center of pressure ( $p < 0,05$ ) both in the sagittal and frontal planes (Figure 6; Figure 7).

After the course of rehabilitation measures, patients of both groups showed positive dynamics of all static parameters characterizing the postural posture, however, there were no significant changes in Gr2 patients ( $p > 0,05$ ). The index of CCP fluctuation in the sagittal plane of amateur athletes Gr2 was still 1,42 mm higher than the standard value (Figure 7).

After all, all the above positive changes in the parameters of statics indicate the restoration of postural stability and resistance in amateur athletes after rehabilitation measures.

Thus, significant changes in the emotional state and restoration of all walking static parameters confirmed the advantages of the author's correction and rehabilitation program.

## Discussion

Andreyuk, N.L. (2017) believes that sports require high coordination and balance from athletes. Sport training increases the stability of the vestibular analyzer, forms complex motor skills, improves vestibular function, and increases statokinetic stability. The results of our work confirmed the results of the author (Andreyuk, 2017).

Agree with Kouris, I. et. al. (2018) that vestibular gymnastics may be more effective than conventional kinesiotherapy for improving balance. The use of balance exercises improves both static and dynamic balance, even in the elderly. We agree with the authors that the use of balancing balls is a relatively inexpensive, safe, and simple means to improve balance (Kouris, 2018).

The result of this work confirms the previous work of Misyura et al. (2022) regarding individualization in the development of a correctional and rehabilitation program. It is the multidisciplinary approach that brings the return of amateur athletes with the consequences of brain contusion to sports activities closer (Olkhovyi et al., 2020). In the literature, we have come across isolated works that highlight the problem of certain reserve possibilities for restoring the walking pattern of people with the consequences of brain contusion not

only in the early stages but also in the long term. We have confirmed that with properly selected means of physical education and sports rehabilitation, the quality of life of victims is significantly improved (Misyura et al., 2022).

Remote rehabilitation is carried out remotely using special equipment and involves the use of modern telecommunication technologies to provide services regardless of external barriers. In 2013, the effectiveness of a remote rehabilitation program on depression, fatigue, and overall quality of life in patients with multiple sclerosis was studied in the United States. In the group that underwent remote rehabilitation, significant improvements in the psychological state were noted. We confirm the benefits of this type of rehabilitation (Telerehabilitation: New Technologies in Physical Therapy 2023).

During training, telecommunication supervision by a physical rehabilitation specialist (telerehabilitation) together with the use of psychological and pedagogical methods such as self-confidence building and self-training has a positive effect on the results of the process, which was confirmed in our study.

## Conclusions

Special tasks of the 2nd stage of the correctional rehabilitation program at the training stage for amateur athletes are the creation of prerequisites for in-depth sports training, ensuring comprehensive physical fitness, and returning to amateur sports. After stage 2, the emotional state of the subjects of both groups with post-traumatic stress disorder received a normal assessment according to the SAN scale.

From a biomechanical point of view, maintaining balance is effective when the center of gravity remains in line with the center of pressure. In the primary study, the biomechanical parameters of walking statics in amateur athletes with brain contusion indicated a decrease in all indicators of support ability and standing stability. At the end of stage 2, all studied characteristics had a positive trend. However, due to vestibular gymnastics (Tsakanikas, 2020), and Nordic walking (Misyura et al., 2022; Misyura, 2023) and telerehabilitation (Telerehabilitation: new technologies in physical therapy 2023) involved in the author's program, the parameters of walking statics approached the normative value in amateur athletes Gr1. The results of the study indicate the restoration of postural stability and resistance in amateur athletes Gr1.

Thus, there is a need to develop correctional and rehabilitation programs and popularize remote rehabilitation for participants in military events with the consequences of brain contusion and PTSD. The results of our work have confirmed

the effectiveness of self-study according to the recommendations provided under the supervision of a specialist in physical culture and sports rehabilitation using modern messenger applications (Viber, Telegram, WhatsApp).

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Conceptualization, L.R.; methodology, L.R.; software, V.M.; check, L.R. and V.M.; formal analysis, M.M.; investigation, O.G.; resources, O.A.; data curation, M.M.; writing - rough preparation, O.A.; writing - review and editing, L.R.; visualization, O.G.; supervision, L.R.; project administration, L.R. All authors have read and agreed with the published version of the manuscript.

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### Conflict of interest

The authors declare that there is no conflict of interest.