Optimization of Rehabilitation Effects of Futsal as Part of Comprehensive Correctional and Developmental Program on the Motor, Regulatory and Adaptation Potential of Boy at the Age Of 10-12 With ICP

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ABSTRACT

Introduction. The article presents the results of a survey of children with ICP at the age of 10-12 years old when playing futsal with them. The heart rate variability (HRV) method was used to determine the dynamics of the functional state (FS) of the students. A program of physical rehabilitation has been developed, based on an assessment of the regulatory systems state of children with ICP aimed at optimizing the FS and motor capabilities of young football players with neuromotor deficiency of the locomotor.

Academic Research Work management. The study was conducted on the basis of the state budgetary educational institution “Boarding School No. 5” of Samara Region, Tolyatti and it was attended by 14 children with a form of ICP spastic diplegia.

Research Results. Individual selection has been carried out based on the HRV indicators of adequate physical activity when playing futsal as rehabilitation effects. Experimental data has been obtained on the optimization of FS and the increase in the motor capabilities of children of 10-12 years old with ICP in the experimental group (EG).

Discussion and Conclusion. An assessment of the regulatory systems of the body of children with ICP is given both at the beginning of the training process and at the end of the research period, which lasted 7 months. It has been established that individual tolerance and physical activity dosing when practicing futsal in combination with other means of rehabilitation are the main reason for optimizing HRV indicators and developing motor abilities of children of 10-12 years old with ICP.

Introduction

According to the Ministry of Labor and Social Protection of the Russian Federation, the number of children with cerebral palsy (ICP) has increased over the last 10 years by more than 30% [1]. The causes of this disease are diverse, and the symptoms are polymorphic [13, 14]. The following basic structural and functional disorders are observed in children with ICP: damage to proprioceptors, delayed formation of motor unconditioned reflexes and skills associated with low (atony) alternatively, excessively high (hypertonus, spasm) muscle tone, contracture of joints, hyperkinesis, etc.
Practically all children have comorbid diseases, somatic diseases (respiratory system, excretory system, GIT) and secondary neuropsychiatric abnormalities in the form of psychomotor, speech and mental problems, reduction of the level of physical qualities, various degrees of social maladjustment [14,15].

Despite the large number of methods for the rehabilitation of children with ICP, adaptive sport is becoming an increasingly popular means of restoring impaired functions. It also opens up broad opportunities in the socialization and integration of young athletes with ICP in modern society [12,14].

Any sports training places special demands on the functional state of the student, causing a response of the organism and its functional systems to the load [2,4,5]. The cardiovascular system is the first to adapt to changing conditions: the heart rate increases, and the contractile force of the myocardium, MBV, tone, and blood velocity [15].

The training process can be carried out in different environmental conditions (level of atmospheric pressure, air, water temperature, gravity). The nature of muscular activity differs depending on the type of sports involved in. All this causes changes in the circulatory system, which is the main limiting factor in the performance of an athlete [1,6].

One of the most popular types of adaptive sports is futsal. This type of adaptive sport is of interest in adolescent boys and, it can be assumed that it is effective in the rehabilitation of children with ICP.

However, children and adolescents with ICP have pathological features of the development of the musculoskeletal system, which negatively affects the functional state of the cardiovascular system [18,19,20].

**Aim of study** is to optimize the functional state of 10-12-year-old children with ICP in terms of norm-typical index in the process of futsal.

*Tasks:*
1) To assess motor abilities at the beginning and end of the research;
2) To determine the level of the functional class of children with ICP with spastic diplegia;
3) To develop recommendations for children with ICP while futsal taking into account monitoring observations.

**Literature review**

Currently, the number of schoolchildren with health problems and disabilities in Russia is constantly increasing. The modern education system is focused on those who meet certain requirements, on children who are able to study according to a program common to all. As a result, children with disabilities and special educational needs are in a state of deficit in motor activity (hypokinesia), receiving short-term motor rehabilitation 1-2 times a year, which is not enough for an actively growing and developing organism [1, 4, 14].

It is obvious that the system of training and rehabilitation of children with ICP has certain difficulties caused by the ineffective organization of the rehabilitation process in specialized educational institutions for children with disabilities. This incomplete and imperfect rehabilitation, which does not use modern technologies, can lead to the progression of the disease. The deterioration of health further prevents children with ICP from interaction with healthy children and adapt to the modern world [22].

Certain changes occur in the body in the process of a child ontogenesis with ICP. To correct their associated diseases and secondary abnormalities, certain teaching methods are used, new technologies are also used to develop speech, higher mental functions, and motor skills depending on the form of ICP.

At present, futsal is included in the curriculum in secondary schools, special boarding schools, and higher educational institutions [7]. When practicing futsal in special (correctional) educational institutions, a combination of physical exercises and excitement from uncompromising sports wrestling occurs, and the game develops a sense of collectivism and the ability to fight for victory [1,4].

Football in Latin America in the XX century gave birth to the futsal [5]. It was played by schoolchildren, students but only in reduced compositions. In this sport, training and competitions were held both in open areas and indoors (gym). Certain rules of the game for futsal were developed, according to which many tournaments were held,
but only amateur teams participated in these tournaments. Futsal gained its popularity in Brazil, Uruguay, and Argentina because of the availability including cost-effectiveness.

Futsal lessons are also attractive for young sportsmen with disabilities, including those with ICP. Playing futsal young athletes reveal their talents, begin to better communicate with their peers, develop physical qualities [8, 16]. In world practice, young football players with ICP are actively engaged in it in the Netherlands, England, and Spain where futsal is popular.

The game of futsal allows achieving a high degree of physical fitness without great material costs, to develop such important physical qualities as strength, speed, endurance, agility, quickness of thinking and many other motor and mental abilities.

One of the main tasks in Russia, which not only faces health care but also requires the participation of society and the state, is a concern for the future generation. For the time being, the state does not have enough strength to create conditions for people with central nervous system damage (CNS) that meet the European standards so that they return to normal life [12]. Currently, there are not developed enough new rehabilitation methods to help coaches who teach futsal for children with ICP, and few textbooks have been published.

At the same time, it is not enough written about the correction of children with ICP with the help of exercises that should be performed daily in scientific and methodological sources, both in educational and rehabilitation medical institutions, and at home.

Each child with ICP has an individual set of reasons for the beginning of the disease and the nozological features of its manifestation at the stages of ontogenesis. But the common manifestation of the pathology of ICP is motor disorders [23,24,25].

These disorders may be due to the predominance of the somatic motor system damage, when different hyperkinesis spastic paralysis is formed, or the lesion of the extrapyramidal formations, when various hyperkinesia and changes in the muscle tone of the extrapyramidal type are observed [18]. There may be cerebellar forms of infantile cerebral palsy, in which the leading symptom is a violation of the accuracy of movements, in the form of ataxia of the body, limbs, dysmetria, combined with atony and a peculiar chanted speech [19].

Infantile cerebral paralysis can occur antenatal - due to blood circulation failure in the uterini-placenta-fetus system, due to intoxication, nutritional disorders, various infections of the mother and her injuries. They can be the result of damage to the skull of a child during childbirth with cerebrovascular disease, especially hypoxia and asphyxia in the prenatal and natal periods [10,19,20,22].

The earlier a brain damage has occurred, the more serious the problems can be in the future. For example, when a child’s brain is damaged during its natural development, it creates an entirely different, more severe clinical picture than with the corresponding diseases and injuries in an adult.

Certain changes occur in a child with ICP during growth, which necessitates the appropriate motor devices that the patient forms in accordance with their capabilities making up a complex set of functional layers. All these factors can change the clinical picture of disorders at different stages of the child’s development.

**Materials and Methods**

The study involved 14 children with ICP, they were divided into 2 groups of experimental (EG) and control (CG). Physiological parameters and motor qualities have been examined in children with ICP at the beginning and end of the study under the same conditions, both in the control and experimental groups. The study has been conducted in a boarding school №5, urban district Togliatti In the CG, children with ICP have been engaged twice a week in a regular program with two physical education lessons, and in the EG they also did futsal twice a week, and trained in the dry pool and did therapeutic swimming twice a week. They had massage once a week and performed a set of exercises for stretching at the end of each training session.
The study of children with ICP was carried out using the “Varicard 2.51” hardware and software [9].

The presented equipment solves the problem of assessing the adaptive capacity of the organism based on the analysis of heart rate variability, ECG and its full decoding with measuring amplitude-time parameters and issuing a medical and physiological certificate [3,21]. After the study, the so-called “State Rate” is shown in the certificate, which indicates the general state of the regulatory systems of children with ICP using NTI indicators (norm-typical index), showing the results by age and sex group.

Measuring has been made at the beginning and at the end of the training session. In this case, the test has been selected with breath hold on while inhaling and exhaling. This test consists of five stages: 1. This stage passes the at rest (5 minutes). 2. The second stage is carried out with a breath hold while inhaling (hold the breath for as long as possible). 3. The third stage is quiet breathing (5 minutes). 4. The fourth stage is holding the breath but now while exhaling (hold the breath for as long as possible). 5. The fifth stage is again quiet breathing (5 minutes). The maximum amount of time taken for measuring is 25 minutes.

7 tests have been applied either to assess the level of motor abilities with this pathology in children involved in futsal.

Motor performance testing

Test 1. Zigzag ball control keeping feet hard (time trial). Counters are placed at a distance of one step between them, the total number of 10 pieces.

Test 2. Shuttle run with ball control keeping feet hard 3x10 m (time trial). Starting position before the start of the exercise is the following: the leading leg is located in front of the other leg, and the ball is in front of the leading leg.

Test 3. Tennis ball control in a straight line 5 m (time trial). Control is carried out with a tennis ball with a little finger of a strong leg for each step. Follow the exercise technique.

Test 4. Kicking off the goal ball (the number of points scored). It is performed on a fixed ball with the inner lifting side of a strong leg, a distance of 10 meters.

Test 5. Juggling a football (number of times). This technical exercise is performed with the left and right foot without letting the ball fall to the floor.

Test 6. The frequency of movements through 10 counters (time trial). During the exercise you need to slightly bend the knees, arms bent with the angle of 90 degrees.

Test 7. Sports and technical course (time trial). The player being tested must cross the course including: speed run from a jump-start (10 m), ball control (10 m), 3 counters groundmoves at a 12-meter segment followed by stopping the ball in a circle 1 m in diameter, acceleration (10 m) followed by goal attempt from a distance of 6 meters.

Research results

At the beginning of the study, both groups had the same results in terms of functional class, meaning the donozological and premorbid states between normal and pathological. Thus, in the EG, the state of regulatory systems indicates fatigue at the beginning of the study (Figure 1.1), while in the CG overexertion of regulatory systems is observed (Figure 1.2).
We observe the premorbid state and physiological norm respectively (Figure 2.1) at the beginning of the study in the EG according to the indicators of the functional class during the breath holding on inhalation and exhalation. In turn, in the CG we see the physiological norm and the donozological state during the breath hold on inhalation and exhalation at the beginning of the study (Figure 2.2).
At the beginning of this study we also paid attention to the low level of motor abilities of children of 10-12 years old with ICP when practicing futsal. Children with this pathology initially had trouble in performing exercises during the training process. Therefore, we used motor tests to help us to determine the level of motor skills in children with ICP at the age of 10 - 12 years old involved in futsal in the EG and CG.

Table 1

<table>
<thead>
<tr>
<th>№</th>
<th>Name of the test/ experiment</th>
<th>At the beginning of the study (M±m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Zigzag ball control keeping feet hard (time trial)</td>
<td>17,6 ± 0,1</td>
</tr>
<tr>
<td>2</td>
<td>Shuttle run with ball control keeping feet hard 3x10 m (time trial)</td>
<td>17,92±0,11</td>
</tr>
<tr>
<td>3</td>
<td>Tennis ball control in a straight line 5 m</td>
<td>5,53±0,11</td>
</tr>
<tr>
<td>4</td>
<td>Kicking off the goal ball (the number of points scored)</td>
<td>4,5±0,5</td>
</tr>
<tr>
<td>5</td>
<td>Juggling a football (number of times)</td>
<td>3,75±0,24</td>
</tr>
<tr>
<td>6</td>
<td>The frequency of movements through 10 counters (time trial)</td>
<td>8,56±0,1</td>
</tr>
<tr>
<td>7</td>
<td>Sports and technical course (time trial)</td>
<td>38,3±40,26</td>
</tr>
</tbody>
</table>

Note: **-p<0,05; *-p<0,01.
Table 2

The results of testing motor skills at the beginning of the study of the control group (CG)

<table>
<thead>
<tr>
<th>№</th>
<th>Name of the test/ experiment</th>
<th>At the beginning of the study (M+m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Zigzag ball control keeping feet hard (time trial)</td>
<td>17,26±0,04</td>
</tr>
<tr>
<td>2</td>
<td>Shuttle run with ball control keeping feet hard 3x10 m (time trial)</td>
<td>16,68±0,18</td>
</tr>
<tr>
<td>3</td>
<td>Tennis ball control in a straight line 5 m</td>
<td>5,43±0,13</td>
</tr>
<tr>
<td>4</td>
<td>Kicking off the goal ball (the number of points scored)</td>
<td>5,25±0,24</td>
</tr>
<tr>
<td>5</td>
<td>Juggling a football (number of times)</td>
<td>4±0,18</td>
</tr>
<tr>
<td>6</td>
<td>The frequency of movements through 10 counters (time trial)</td>
<td>8,45±0,1</td>
</tr>
<tr>
<td>7</td>
<td>Sports and technical course (time trial)</td>
<td>37,97±2,1</td>
</tr>
</tbody>
</table>

Note: **-p<0,05; *-p<0,01.

We have compiled a comprehensive physical rehabilitation program for children with ICP according to which they have been trained on Monday, Tuesday, Wednesday and Thursday to improve the functional state of children with ICP and develop motor skills. It consisted of exercises in a dry pool and therapeutic swimming, a special set of futsal exercises, exercise therapy, massage and stretching.

The program has a *correctional and developmental* focus. In boys with ICP in the age of 10-12 years growth processes are accelerated, there comes a “half-height jump” but with a certain delay compared to healthy boys. Therefore, exercises are aimed at enhancing growth, reducing spasm and hypertonicity of muscles. In this sensitive period, the rehabilitation effect of the motor effects of futsal can be more strongly displayed leading to compensatory changes of the loco-motor and neuromuscular system of children with ICP.

Table 3 shows the program of physical rehabilitation for boys of 10-12 years old with ICP.

Table 3

Implementation program of physical rehabilitation for children with ICP

<table>
<thead>
<tr>
<th>№</th>
<th>Kind of rehabilitation</th>
<th>Methodological recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kinesitherapy in a dry pool</td>
<td>2 times a week for 10-15 minutes in a pool filled with balls</td>
</tr>
<tr>
<td>2</td>
<td>Therapeutic swimming</td>
<td>2 times a week for 25-30 minutes in a specialized pool</td>
</tr>
<tr>
<td>3</td>
<td>Futsal</td>
<td>2 times a week for 45 minutes in a large gym</td>
</tr>
<tr>
<td>4</td>
<td>Massage</td>
<td>Once a week</td>
</tr>
<tr>
<td>5</td>
<td>Stretching</td>
<td>2 times a week</td>
</tr>
</tbody>
</table>

It is effective to use classes in a dry pool and therapeutic swimming in water during classes with children with cerebral pathology. Classes in a dry pool contribute to the movement development, movements coordination, balance, proprioceptive (muscular) sensitivity, all sensory systems. Performing a set of exercises in a dry pool cardiovascular and respiratory systems are activated, spasticity and hyperkinesis are noticeably reduced, paretic (weakened) muscle function is stimulated, and spinal motility and joints of the upper and lower extremities are increased, creating a positive psycho-emotional mood in children with ICP.
Kinesitherapy in a dry pool for children with ICP.

**«Corners»**. The goal is to develop dynamic and static coordination. Four children with ICP take their places in the corners of the pool; the fifth child will be leading and goes to the middle of a dry pool. Children with cerebral pathology should run from one corner to another as quickly as possible, and the leader tries to take someone else’s place at that time. The one whose corner is occupied becomes the leader.

**«Fast legs»**. The goal is to massage and strengthen the muscles of the legs. Children with ICP sit down on the board of the pool. At the signal of the trainer, they lower their legs into the dry pool and begin to swing them quickly.

**«Bicycle»**. The goal is to massage the soles, as well as the calf muscles. Sit with your back to the board of the pool, straight arms to the sides on the board, legs together stretched forward. It is necessary to perform the movement of the legs, as on a bicycle, while trying to disperse as much as possible the balls to the side.

**«Knockout game»**. The goal is to develop the fine motor skills of hands, 3 items (counters) are hidden at the bottom of a dry pool, 4 players try to find them, the one who stays without a counter is eliminated, then 2 items (counters) are hidden and then 1 item. The one who find items (counters) wins.

**«Craters»**. The goal is massage and coordination of hand movements. Children with this pathology place their right and left hands into the pool alternately and make rotational movements. Then the same is done with both hands.

**Therapeutic swimming**. The pool in which the child with ICP is taking classes should be well lit, ventilated, and warm, the air temperature in the room should not be below 23 °C and not above 25 °C, and the water temperature should be from 32 °C to 35 °C. These classes are being held in a specialized pool and take 25-30 minutes. In addition, warm water has an analgesic effect, helps to relax tense muscles and normalizes vegetative functions during therapeutic swimming, which in turn helps to regulate the processes of exaltation and inhibition in the central nervous system.

**The content of exercises in therapeutic swimming for children with ICP**
1. Exercises to stretch the muscles, relieve tension in the muscles, expand the range of movements;
2. Exercises to strengthen the leading and antagonistic muscle groups;
3. Endurance exercise to maintain the efficiency of the functional state of the organs;
4. Relaxation exercises (to eliminate muscle cramps, eliminate cramps);
5. Training to walk;
6. Exercises to develop the muscle strength.

**Exercises from futsal.** They are powerful means of influencing the body, expanding the range of possibilities in the first place of the motor sphere, disturbed by a persistent defect. Many examples from practice can be cited when a positive effect on the psychomotor function of a child occurs with the help of special exercises. In addition, children with ICP develop complex technical elements, begin to confidently navigate in space.

We used the following set of exercises (Monday, Wednesday) for better ball possession:
1. Right foot on the ball. Ball is rolled by the sole to the left and right sides. Ball is rolled by soles back and forth (toe-heel). All these stages are repeated with the left foot.
2. Right foot on the ball. The ball is rolled by a sole towards oneself, then we toe the ball forward. All these stages are repeated with the left foot.
3. Right foot on the ball. The ball is rolled by a sole towards oneself, then with the inside of the foot roll the ball forward. All these stages are repeated with the left foot.
4. Right foot on the ball. Roll the ball with the right foot, then we perform this motion with the sole (toe-heel). All these stages are repeated with the left foot.
5. Exercise on the coordination stairs - “in-out”. Start the exercise by stand with your feet shoulder-width astride before beginning of the stairs. Step (do not jump, namely step) into the first section of the stairs, first with your left foot and then with your right foot. After the right foot is in the first section, immediately put the left foot to the left of the next section of the stairs, then the right foot to the right of the stairs. Again, step with your left foot inside the stairs, and
then step with the right foot as well (as if to return to the previous position). Repeat this pattern of movement until the stairs ends.

6. Exercise on the coordination stairs - “in-out” (jump). Jump with two feet, then place your feet astride in the next section, then feet close in the next one. Afterwards try to do this: both feet are outside the stairs and right foot inside, then both feet outside and left one inside. Then try to alternate: both feet outside the stairs, right foot inside, both feet outside, left one inside.

7. Move forward alternating: 2 feet inside (alternately), 1 running sidestep outside. Feel the rhythm: “inside-inside-outside”, “inside-inside-outside”, and so cross the stairs by zigzag. The steps with the right foot from the stairs should be only to the right side, the left - only to the left.

8. Slalom. On an area about (22.5 x 9 meters) in size, racks or cones indicate the location of the slalom. Players break up into small groups lined up before slalom; each player has a ball at his foot. At the command of the coach, one starts dribbling, driving the ball between the racks, and ending his route by running straight back. A player who missed a rack or cone, or went off the area, must return to the last rack before resuming his run.

9. Dribbling in step. Players are divided in 2 groups. Each player has a ball at his foot. The dribs are lined into a corridor 3 meters wide, and in this space, dribbling in step in one foot is carried out. The ball is touched alternately with the inner-outsider part of the leg lift.

10. Exercise “Shuttle”. Players stand in two rows facing each other; the ball is at the foot of the first player of one team. He makes a pass to the first player of the opposing team, and he runs in the same direction and stands at the end of the row, waiting for his turn. The player to whom the pass is addressed processes the ball and returns it to the next player from the opposing team; he also runs after the ball and stands at the end of the row and so on. Players must not run exactly along the line of movement of the ball so as not to interfere with the next pass; they should move away from the trajectory of the ball. Ball passes are performed in three touches.

11. Pass - "Way out." Players are divided into pairs (one ball for two). Player A opens, then Player B makes a pass to Player A on the way out, Player B tries to take the ball with one touch and hit the ball with the second touch on the ball for accuracy in small gates. Players perform the exercise both by right and left foot.

12. Playing football at the small gate 5x5.

After the training session on futsal, an additional tool (1 per week) in the form of massage was used as well.

Massage. It has a beneficial effect on the skin, subcutaneous fat layer, muscles, joints, ligaments and tendons, as well as the circulatory, lymphatic, nervous and respiratory systems of children with ICP. Mobility and painless muscle contraction are the main factors determining the quality of life of children with ICP. Pain and certain discomfort can prevent them from performing motor actions in life. Therefore, we have included stretching exercises in this program, which have been performed 2 times a week at the end of a futsal training session with children with ICP. Stretching can increase mobility, improve muscle mechanics and expand the capabilities of children with ICP.

Set of exercises for stretching for children with ICP

Exercise 1 - Stretching the middle part of the chest. Stand at arm's length from the gymnastic wall. Extend your arm and press it against the gymnastic wall, so that the arm is parallel to the floor. The palm is pressed against the support, the arm in the elbow joint is straightened, and the fingers are looking back. Stay in this position for 30 seconds. Breathe evenly. Then repeat the movement with the other hand in the opposite direction.

Exercise 2 - Lifting the knee to the opposite shoulder. You need to take a comfortable position near the gymnastic wall. Slowly pull up your left knee towards the right shoulder, help yourself with your hand. After that, you need to stay in this position for 30 seconds. Then repeat the movement for the other leg.
Exercise 3 - Stretching one leg. You need to stand next to the gymnastic wall, the back is straight. Grip the left foot with the left hand in order to feel how the quadriceps muscle of the thigh stretches. We stay in this position for 30 seconds, after which we repeat the same with the other leg.

Exercise 4 - Stretching the calf muscles. For balance you need to rest your palms on the gymnastic wall. Step one leg forward, knee is bent, leg is straight. Both feet are not detached from the floor, the back is straight. The straightened back leg is gradually moved back until we feel the calf muscle stretching. Hold in this position for 30-60 seconds. Do the same with the other leg.

Exercise 5 - Touching the toes in a sitting position. Sit on the floor, bring the legs together and pull them in front of you. Slowly lean forward until a pulling sensation occurs in the lower back. Lean as far as possible and stay in this position for 30 seconds. No need to make excessive efforts if you cannot get to the toes.

At the end of a futsal training session, a set of exercises was performed for the muscles of the lower leg, the back surface of the thigh, the buttocks, the lateral surface of the thigh, the front surface of the thigh, etc. Also, the dry pool and therapeutic swimming in the pool were mandatory (Tuesday, Thursday), and once a week a biomedical remedy in the form of massage under the guidance of a specialist was performed. After executing the program of activities for physical rehabilitation of children with IPC, it was possible to observe a decrease in the reflex excitability of muscles, prevention of the contractures development, synkinesis reduction, muscle function stimulation, lymph and blood circulation improvement, and trophic disorders decrease.

The control stage of the pedagogical experiment.

Assessing the indicators of the regulation systems of children with ICP at the end of the research (control stage), it is important to note that there are significant differences in EG and CG. The obtained indicators of children with ICP in EG after the training process show a good physical condition when the regulation of the cardiovascular system is normal, as well as psycho-emotional and energy supply of the body as a whole (Figure 3.1.). Indicators of children with ICP in CG have changed for the worse, overwork of regulatory systems is observed (Figure 3.2.). Stable physiological norm.

### State estimation of regulatory systems

<table>
<thead>
<tr>
<th>Performance level</th>
<th>Value</th>
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<tbody>
<tr>
<td>Normocardic</td>
<td>0</td>
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<tr>
<td>Regulation stability</td>
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</tr>
<tr>
<td>Normal rhythm stability</td>
<td>0</td>
</tr>
<tr>
<td>Vegetal homeostasis</td>
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<tr>
<td>Normal vegetal balance</td>
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</tr>
<tr>
<td>Activity of the sympathetic vascular center</td>
<td>0</td>
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<tr>
<td>Normal activity of the vascular center</td>
<td>0</td>
</tr>
<tr>
<td>Degree of management centralization activity</td>
<td>-1</td>
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</tbody>
</table>

Figure 3.1 Pie chart of the values of HRV indices and assessment of regulatory systems at the beginning of the study in the EG.
Figure 3.2 Pie chart of the values of HRV indices and assessment of regulatory systems at the beginning of the study in the CG.

"State Rate" has also changed in children with ICP in both group by the end of the study. In the EG, there is a noticeable improvement in the functional class in all five stages (Figure 4.1.). Moreover, in the CG, the functional class is in the zone of the premorbid state and the breakdown of adaptation (Figure 4.2.), in terms of breath-holding rates at the stages the time during breath-holding in the EG has increased markedly which cannot be said about CG. This indicator shows the improvement of hypoxic endurance of the EG.

![State estimation of regulatory systems](image)

### Performance level

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute tachycardia</td>
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<tr>
<td>Regulation stability</td>
<td>1</td>
</tr>
<tr>
<td>Moderate arrhythmia</td>
<td>1</td>
</tr>
<tr>
<td>Vegetal homeostasis</td>
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<tr>
<td>Distinct predominance of sympathetic nervous system</td>
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</tr>
<tr>
<td>Activity of the sympathetic vascular center</td>
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<tr>
<td>Moderately increased activity of the vascular center</td>
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<td>Degree of management centralization</td>
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<tr>
<td>Moderate decrease in activity of central regulation levels</td>
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</tbody>
</table>

Figure 4.1 Assessment of the functional state of regulatory systems (breath-holding test) in the EG at the end of the study.

Figure 4.2 Assessment of the functional state of regulatory systems (breath-holding test) in the CG at the beginning of the study.
Table 4, 5 shows the results of motor testing in the EG and CG at the recital stage of PE.

**Table 4**

<table>
<thead>
<tr>
<th>№</th>
<th>Name of the test/ experiment</th>
<th>At the end of the study (M±m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Zigzag ball control keeping feet hard (time trial)</td>
<td>13,53±0,08**</td>
</tr>
<tr>
<td>2</td>
<td>Shuttle run with ball control keeping feet hard 3x10 m (time trial)</td>
<td>11,7±0,06 **</td>
</tr>
<tr>
<td>3</td>
<td>Tennis ball control in a straight line 5 m</td>
<td>3,57±0,1</td>
</tr>
<tr>
<td>4</td>
<td>Kicking off the goal ball (the number of points scored)</td>
<td>10±0,26</td>
</tr>
<tr>
<td>5</td>
<td>Juggling a football (number of times)</td>
<td>6,62±0,18</td>
</tr>
<tr>
<td>6</td>
<td>The frequency of movements through 10 counters (time trial)</td>
<td>5,7±0,007**</td>
</tr>
<tr>
<td>7</td>
<td>Sports and technical course (time trial)</td>
<td>32,53±0,17</td>
</tr>
</tbody>
</table>

**Note:** **-p<0,05; *-p<0,01.

**Table 5**

<table>
<thead>
<tr>
<th>№</th>
<th>Name of the test/ experiment</th>
<th>At the end of the study (M±m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Zigzag ball control keeping feet hard (time trial)</td>
<td>15,94±0,007</td>
</tr>
<tr>
<td>2</td>
<td>Shuttle run with ball control keeping feet hard 3x10 m (time trial)</td>
<td>15,69±0,1</td>
</tr>
<tr>
<td>3</td>
<td>Tennis ball control in a straight line 5 m</td>
<td>4,73±0,11*</td>
</tr>
<tr>
<td>4</td>
<td>Kicking off the goal ball (the number of points scored)</td>
<td>6,77±0,23*</td>
</tr>
<tr>
<td>5</td>
<td>Juggling a football (number of times)</td>
<td>6,22±0,15</td>
</tr>
<tr>
<td>6</td>
<td>The frequency of movements through 10 counters (time trial)</td>
<td>7,6±0,1</td>
</tr>
<tr>
<td>7</td>
<td>Sports and technical course (time trial)</td>
<td>36,9±0,21*</td>
</tr>
</tbody>
</table>

**Note:** **-p<0,05; *-p<0,01.

Children with ICP very often experience problems in targeted movements that are developed in the process of learning (praxis), while walking, working. Specially selected set of football exercises helps to correct these defects a bit in the EG. In most cases, football is a coordinating sport, therefore, positive results are observed in the EG during the movement of the body in space.

For all motor tests, a reduction in time and an increase in the frequency of movements when performing them have been obtained on average by 15–20%.

This testifies to the effectiveness of the rehabilitation training program and the effectiveness of using such a coordinating sport as futsal for the physical rehabilitation of sick children and adolescents with ICP.

**Discussion and Conclusion**

Due to the deterioration of the health state of children with ICP in the CG, physical education teachers in correctional educational institutions, in consultation with their parents, need to create an optimal day regimen and organize a full rest of students, select the optimal physical activity, monitor their sleep and nutrition and try to avoid
stressful situations in the family. At the end of the study there is an improvement in the functional state due to the correct distribution of work and rest, the selection of adequate physical exertion in the EG. Moreover, the confidence of young players in their abilities has increased, and health has improved.

Thus, playing futsal in combination with other physical rehabilitation facilities for children with ICP with spastic diplegia has contributed to a positive effect and a significant improvement in the functions of the locomotor (supporting-motor apparatus), cardiorespiratory, and central nervous systems, and psycho-emotional condition of boys with ICP.

References