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# Study on cardio-respiratory adaptive mechanisms for performance athletes with physical disabilities

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**Abstract**

**Introduction**.Recently, the emphasis has been on the problems faced by performance athletes with physical deficiencies of the spine. **The aim** of the paper is to train coaches in awareness of physical problems, especially of the spine in swimming athletes aged 10-12 years and the development of kinetic programs on land in order to correct them.
**Material and method**. Research on the effectiveness of kinetic programs as means of correction are very numerous and, in this regard, we aim to select the most effective exercises to correct deficiencies acquired by swimmers and change the functional parameters of the cardio-respiratory system during their training. In order to highlight the need for kinetic correction programs, the coach must work in collaboration with the sports doctor and the physiotherapist in order to prevent possible deviations from normal somatic-functional values.
**Results and discussions**. Regarding the estimation of the adaptive possibilities of the cardio-respiratory capacity, hence the need to apply a complex of tests to assess the effort capacity of athletes.
**Conclusions.** In this sense, we will submit to the study the performance group from the University Sports Club from Suceava, and the recovery programs will take place within the Swimming and Kinesiology Complex, Suceava.

**Keywords:** *adaptive mechanisms, performance swimmers, functional physical deficiencies, kinetic means,*

## INTRODUCTION

This paper aims to address the issue of mechanisms for adapting cardio-respiratory functions to performance athletes who may have vicious postures or even functional physical deficiencies. For swimmers in the prepubertal period from a somatic-functional point of view, compared to the effectiveness of training programs that depend on the knowledge of the coach, requires a correlation between children's abilities and proposed objectives.
In this sense, when designing a training program must be based on an assessment of the somatic-functional abilities that the athlete has.
The problem is to detect in time the possible deviations from the morph-functional status, and then through an estimate based on the results obtained at the initial evaluation we will be able to coordinate the training program in order to obtain the desired performance.
In the literature, body posture is a function of the human body based on the synergistic and coordinated action of the elements of the musculoskeletal system and the central and peripheral nervous system to maintain, body stability, balance and constant relationships between body segments, between body and environment [1].
It is known that about 99% of total calcium is found in the skeleton and 1% in extravascular fluid and plasma. Low calcium intake can be the cause of rickets in children, which will later cause changes in the physical development of adolescents and adults. That is why it is considered important to know the normal reference intervals for calcium, depending on age, sex, physical activity [2].
In addition to calcium, magnesium is also important in muscle contraction, insulin metabolism, heart excitability and in influencing vasomotor tone.
Magnesium is an important nutrient for the body, as it is the fourth mineral with a role in preventing and treating some pathologies. Approximately 30-40% of the total quantity of magnesium in the human body is found in muscles and soft tissues, 1% in the skeleton, a small quantity in the plasma and approximately 60% in the bones. Along with calcium, sodium and potassium ions, magnesium ions regulate the mechanism of blood clotting and neuromuscular excitability. On the other hand, magnesium is involved in energy metabolism, in the synthesis of protein, of the deoxyribonucleic acid and of the ribonucleic acid, in the glucose homeostasis and in the mineral metabolism.
The decrease in the amount of magnesium in the blood can cause the disruption of the activities of some enzymes and the development of certain metabolisms. The consequences are irritability, nervousness, lack of concentration, changes in the heart rate and and in the

normal activity of the heart, and also the possibility of high blood pressure. The poor nutrition and the lack of an adequate intake of calcium and magnesium influenced the capacity for muscle contraction, strength and the ability for muscle coordination [3].

One of the essential trace elements is iron that is found in the human body in a quantity of 3-4 g. Most of this amount is found in hemoglobin whose role is to transport oxygen and carbon dioxide between the lungs and tissues, but also to regulate blood pH.

For biological systems that use iron in metabolic processes, the balance between the two oxidation states is very important. (Fe2+ and Fe3+) [4]. In the onset of postural deficits, there occur, in addition to heredity, the environmental factors, the endocrine activity and the hormone secretion, the biomechanical factors or the metabolic ones [5].

Regarding the performance swimmer, at the prepubertal age there are various causes (overload of the osteo-myo-arthro-kinetic apparatus through various mechanisms) that can determine in time, the installation of postural deficiencies of the spine, with implications on cardio-respiratory function.

At the same time, the causes that can be incriminated can be of an endocrine-metabolic nature, by the fact that the organism can have a vulnerable genetic baggage prone to the installation of these deficits.

If the aquatic environment normally influences the human body by the following aspects:

- The horizontal position of the body, which ensures the relaxation of the muscles and frees the spine from body weight;
- Water pressure on the chest determines the development of cardio-respiratory function muscles, morph-functional adaptive processes, thermoregulation of lung capacities, joint mobility, psycho-motor adaptive processes, improvement of motor and psycho-motor schemes stored in memory, especially during raising and developing children [6].

It is known from the literature that the frequency of breathing is related to the swimming technique and can have values between 30-40 resp. / min.

In this sense, we can specify that swimming influences the increase of the thoracic perimeter, of the vital capacity, of the respiratory flow and of the maximum oxygen consumption, but most of the times the means used improperly during the trainings can lead to the installation. Certain physical deficiencies of the spine [7].

For sports people, physical effort is supported by nutrient intake. Carbohydrates are considered a fuel for exercises that take place with intensity ranging from medium to high. Reducing the amount of carbohydrates below 40% can lead to decreased glycogen stores and the occurrence of fatigue or exhaustion. We must not forget fats, considered a source of energy and the consumption of which depends on the type of exercise and its intensity.

It is important to consider protein intake that is useful for strength and endurance, especially if the glycogen reserve has decreased. The need for proteins depends on the type of physical activity, its intensity and the body mass index.

Water is another important nutrient in physical activity. If 1% of the body weight is lost, the consequence may be a decrease in the effort capacity [8].

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Water is another important nutrient in physical activity. If 1% of the body weight is lost, the consequence may be a decrease in the effort capacity. In the case of performance sports, especially in children in the prepubertal period, we can specify that at present there is no periodic monitoring or evaluation of body posture and especially the spine. The vast majority of coaches do not pay attention to this aspect, and possible deviations from the physiological postural status are discovered too late.

In this sense, we aimed to follow athletes who tend to have postural deficits and their influence on the performance of cardio-respiratory capacity during sports training.

2 The hypothesis of this study: it is assumed that by applying a work program developed based on evaluations of effort capacity, its effectiveness can be managed in order to achieve sports performance.

3 The aim of our study is to conduct on-ground exercise programs on the status of female athletes, members of the research group, focusing on meeting the objectives of the programs, especially aimed at improving cardio-respiratory capacity by correcting physical deficiencies at the time of evaluation.

**Material and method**

The research was carried out on a number of 15 swimming athletes aged between 10 and 12 years (3 athletes diagnosed with thoracic-lumbar C scoliosis, 3 athletes with kyphosis, 2 athletes with kyphotic attitude and 7 athletes with a normal spine) for a period of six months. The research took place at the Swimming and Kinesiology Complex in Suceava between: January 1, 2021 - June 30, 2021 (Table 1):

- Stage I consisted in identifying the subjects to be studied and performing the initial evaluation of the functional parameters;
- The second stage consisted in the application of the actual program elaborated based on the performed evaluations;
- Stage III consisted of the final evaluation, analysis and interpretation of the data obtained in order to draw conclusions regarding the study.

**Results and discussion**

**Table 2 Heart rate**

| Statistical indicators | Normal Heart Rate | | | Effort Heart Rate | | | Heart Rate after 5 minutes | | |
|---|---|---|---|---|---|---|---|---|---|
| | IT | TF | D | IT | TF | D | IT | TF | D |
| X | 69.40 | 68.07 | 1.33 | 135.60 | 128.93 | 6.67 | 73.13 | 68.60 | 4.53 |
| σ | 3.30 | 2.93 | 1.25 | 6.41 | 2.64 | 4.08 | 3.70 | 3.03 | 2.28 |
| CV% | 4.76 | 4.31 | 93.54 | 4.72 | 2.05 | 61.16 | 5.06 | 4.42 | 50.22 |

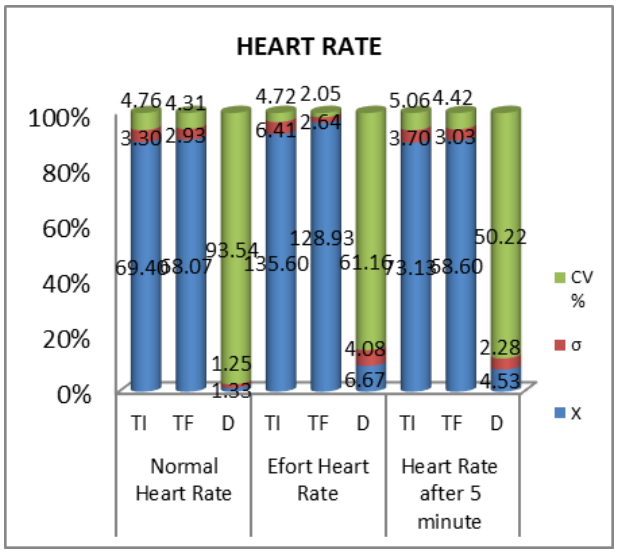


**Figure 1 Heart Rate**

**Table 1** Presentation of the work program

| Work program-model | | | |
|---|---|---|---|
| General objectives | Educating the complex neuromuscular and psychic reflex of correct postural attitude of athletes. | | |
| | Toning the specific muscles to maintain the correct postural attitude of the athletes. | | |
| | Ensuring the formation of self-control in static and dynamic activities. | | |
| | Awareness of a correct postural attitude at all times in all static and dynamic activities of athletes. | | |
| Normal postural attitude | Objective | Specific development of the back muscles, thoracic muscles, diaphragm muscles, abdominal and sacro-lumbar muscles, arm, thigh and leg muscles. | |
| | Content - prevention | Static and dynamic exercises to maintain / increase proprioceptive abilities and correct body posture. | |
| Kyphotic atitude - | Objective | Development of the back muscles by toning in shortening conditions.<br>Development of trunk muscles by toning in shortening conditions.<br>Development of the muscles of the anterior part of the thorax by toning in conditions of elongation. | |
| | Content | Exercises for training and educating the correct postural attitude of the body in orthostatic position, lying down, with objects (sticks, elastic bands, balls, weights) | |
| Total kyphosis | Objective | Toning the back muscles in conditions of shortening through exercises performed concentrically and inside the contraction segment.<br>Toning of the anterior muscles of the thorax and abdomen through exercises performed eccentrically and outside the contraction segment.<br>Correction of secondary deficiencies. | |
| | Content | Static exercises in supine position, orthostatism and hanging | |
| | | Dynamic exercises with objects and devices | |
| Thoracic - lumbar "C" scolios is (left) | Objective | Differentiated toning of the posterior muscles<br>Toning in conditions of shortening the muscle groups from the convexity by concentric movements and inside the contraction segment.<br>Toning in conditions of elongation of muscle groups from the concavity of the curve and outside the contraction segment.<br>Straightening the pelvis and balancing the scapular girdle<br>Creating a reflex of correct postural attitude. | |
| | Content | Static exercises | From fundamental positions and their derivatives with asymmetric structure<br>Exercises by asymmetrical arrangement of the limbs, torso and lower limbs |
| | | Dynamic exercises | Upper limb exercises<br>Trunk exercises<br>Lower limb exercises<br>Breathing exercises<br>Applied exercises<br>Postural reeducation exercises. |

A difference of 1.33 b / min can be seen from table no. 1 in the normal heart rate test.(Table 2) In the heart rate effort test a difference of 6.67 b / min was obtained and in the heart rate test after 5 min the average difference between the initial and final testing is 4.53 b / min.(Figure 1)
The change in the heart rate is a component of the cardiovascular system's ability to adjust cardiac output according to the demands of the physical effort.
An increased heart rate will determine the increase in the amount of oxygen in the myocardium [9].

**Table no. 3** Respiratory rate

| Statistical indicators | Respiratory rate at rest | | | Respiratory rate in effort | | | Respiratory rate after 5 min post effort | | |
|---|---|---|---|---|---|---|---|---|---|
| | IT | TF | D | IT | TF | D | IT | TF | D |
| X | 21.07 | 20.47 | 0.60 | 33.27 | 29.27 | 4.00 | 22.33 | 20.87 | 1.47 |
| σ | 1.34 | 1.20 | 0.61 | 4.33 | 3.04 | 1.71 | 1.30 | 1.15 | 1.09 |
| CV% | 6.36 | 5.88 | 101.84 | 13.01 | 10.40 | 42.82 | 5.82 | 5.50 | 74.13 |

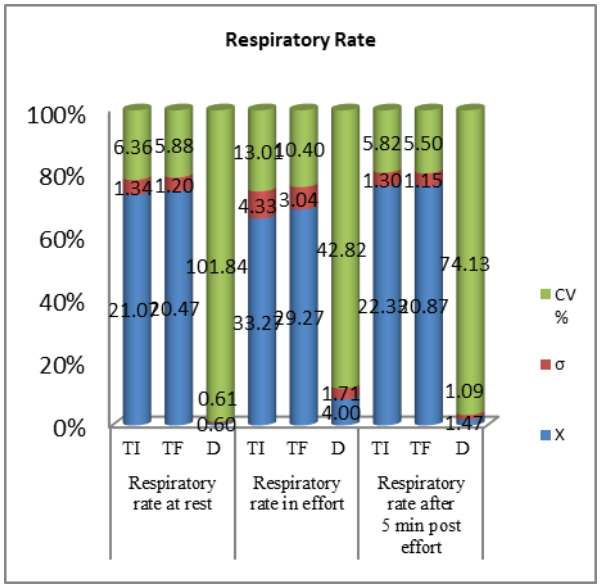


**Figure 2 Respiratory Rate**

In the table (Table 3) above we can specify that in the respiratory rate of rest test the difference of the average central tendency is 0.60 resp. / min.
In the respiratory rate of effort test the average difference is 4 resp. / min, and in the respiratory rate test after 5 min post effort the average difference between the initial and final testing is 1.47 resp. / min. (Figure 2).
The reference intervals for the respiratory and heart rate are in accordance with the existing derived diagrams that depend on the age [10].
The increase in the heart rate variability is considered a marker of parasympathetic activity and relaxation [11].

**Table no.4** Swimming-specific tests

| Statistical indicators | Pron e floating | | | Mushroom float | | | Front sliding with crawl legs | | |
|---|---|---|---|---|---|---|---|---|---|
| | IT | TF | D | IT | TF | D | IT | TF | D |
| X | 18.27 | 23.53 | 5.27 | 18.67 | 21.20 | 2.53 | 11.53 | 15.40 | 3.87 |
| σ | 2.26 | 2.94 | 1.44 | 4.22 | 4.12 | 1.15 | 0.88 | 1.36 | 1.26 |
| CV% | 12.40 | 12.50 | 27.27 | 22.62 | 19.43 | 45.28 | 7.67 | 8.81 | 32.53 |

Regarding the specific swimming tests, an average difference of 5.27 sec is observed in the prone floating test, in the mushroom float test the average difference is 2.53 sec. (Table 3) And in the front sliding with crawl legs test, a difference of 3.87 m is observed. (Figure 3)
Not all statistical indicators have been calculated in this study, due to the small group of subjects. In the performance group under study, we found different cases of postural attitudes and deficits of the spine. The study will be extended over a longer period of time and we will continue the research in order to obtain conclusive results.

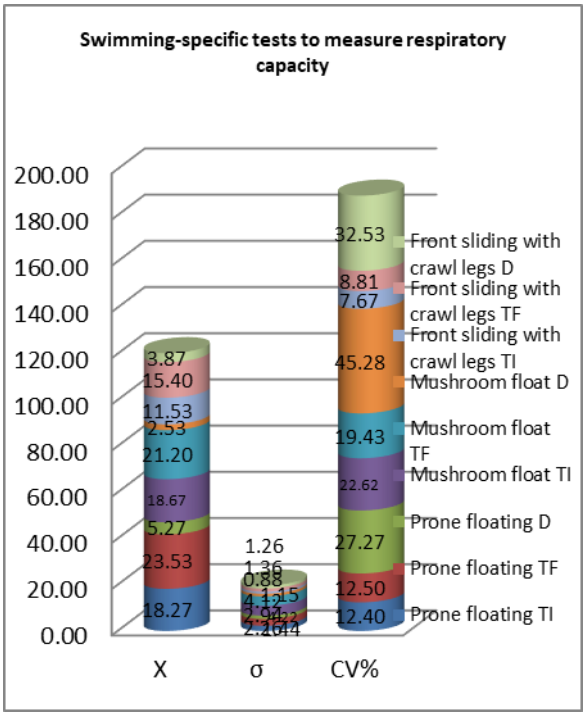


**Figure 3 Swimming-specific tests**

**Conclusions**

- Recent studies show that the prepubertal period is a stage of growth and development that requires special attention from parents and coaches;
- The study showed that even in performance sports vicious postural attitudes and even the installation of physical deficiencies of the spine can be acquired;
- The difference in group mean results is significant in all tests proposed in the study;
- Swimming athletes obtained positive results in terms of performance, due to the ability to adapt to cardio-respiratory processes achieved due to the program;
- In the specific test of swimming "front sliding with crawl legs" the group average shows a difference of 3.87 m, which confirms that, the kinetic means on land help to increase sports performance.

**Author contribution**

All the authors had the same contribution

**Accordance to ethics standards**

The study complies with the rules of ethics and deontology according to the legislation in force

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