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## VARIATION OF PULSE AND OXYGEN SATURATION DURING BUILDING AND FITNESS TRAINING SPECIFIC TO THE PERIOD OF MUSCLE DEFINITION

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### Abstract

*Aim.* Through different training methods specific to bodybuilding and fitness, the values of the cardio-respiratory indicators change depending on the training variables and the adaptation to the athlete's specific effort. In this sense, we initiated a case study in order to know the variation of pulse and oxygen saturation during bodybuilding and fitness training specific to the period of muscle definition in a bodybuilding and fitness athlete with 25 years of experience, with periods of interruption of cumulative sports activity of approximately 5 years.

*Methods.* The 46-year-old athlete performs at least three workouts per week, 3 muscle groups per workout, analytically working the whole body through basic or isolation exercises, through the bodybuilding and fitness-specific method of repetitions to failure combined with other period-specific methods of muscle definition. For two weeks, in the time interval between 01.07.2023-31.07.2023, pulse and oxygen saturation values were monitored after each set during training.

*Results.* The lowest pulse values were measured during exercises for the trigeminal muscles, and the highest at the level of the quadriceps muscles, the lowest average at the level of the abdominal muscles, the highest at the level of the biceps muscles, respectively the lowest level of saturation of oxygen was measured during exercise for the trigeminal muscles, the highest in the biceps muscles.

*Conclusions.* In conclusion, oxygen saturation increases in direct proportion to the respiratory rate.

*Keywords:* Effort, heart rate, oxygen saturation, bodybuilding and fitness.

### Introduction

In physical and sports education, the activity is not exclusively physical or motor, only the form of expression of the finality is given by manifestation characteristics at the motor behavior level. Adaptation through motor behavior is possible only to the extent that motor acts represent appropriate responses to situations, and the appropriateness of the action to the situation is a complex, gradually constituted process. Man has numerous mechanisms of self-regulation, starting with those that ensure homeostasis, continuing with the mechanisms that, subject to probabilistic legitimacy, allow the increase of performance by choosing the criterion of efficiency, up to those that ensure the development resulting from the learning process (Horghidan, 2000).

In accordance with Juvenal's dictum "MENS SANA IN CORPORE SANO" if the human body functions in optimal parameters all functions are at the same level, therefore the concern for maintaining an optimal state of health expressed through the physical appearance is a condition of modern fitness. If fitness outlines the physique, bodybuilding brings it out and the psyche through motivation, perseverance, self-improvement, attitude enhances it.

Any change, physical modeling-psychic dimension is achieved with a physical and mental effort, that is why body building requires an interdisciplinary approach, to investigate the influence of personality on physical performance and vice versa, and in our case the personality factors determining the effectiveness of training bodybuilding and fitness. The essential characteristic of man is to present himself as an individuality, a unique result of the convergence of a multitude of biological, psychological, social and cultural factors that give him uniqueness both in the mental and in the behavioral sphere.

Bodybuilding or physical culture is a discipline that, through training with weights, overloads (resistance training) and a specific diet (Ionescu & Anton, 2004) has as its final objective the change of body composition with the increase of muscle mass and the reduction of body fat, where the goals they are aesthetic but also competitive. In bodybuilding competitions, the participants evoke their muscular development through their own forms of presentation and specific body display positions during the competition. They are judged based on musculature, physical condition and symmetry. To look better during competitions, bodybuilders prepare through a combination of fat loss, dehydration, tanning and the use of special creams. During periods of physical development, bodybuilders follow heavy training, specific nutrition programs and follow a schedule of at least 6-8 hours of rest for faster recovery of trained muscle groups.

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Muscle hypertrophy or increasing the size of the muscles is the main objective of bodybuilding by making large changes in the chemistry of the muscle, (Bompa & Haff, 2014) thus, the muscle mass develops more as a result of the contraction of the elements of the muscle fibers (myosin filaments), than of an increased flow of fluid and plasma, as usually happens. This explains why the strength of bodybuilders is not always proportional to their body size. In bodybuilding, typically sub-maximal loads are used, athletes contracting the muscles to the point of refusal and the contraction of muscle fibers varies as follows: when some get tired others come into operation (Bompa & Haff, 2014). It is very important to perform the maximum number of repetitions in a series, usually between 6-12, if the weight is too light the load is increased and vice versa so that the stimulation of the muscle creates sufficient tension during the executions. Maximizing skeletal muscle hypertrophy requires appropriate training strategies, the authors believe (Alves et al., 2020), concluding that there is a training model that separates training into four distinct periods known as the off-season, pre-competition, peak week before competition and post-competition, each period containing a specific dosage spectrum, regarding intensity, volume, type of basal (multiple joints) or segmental (single joint) exercise, athletes performing training with higher intensity loads, lower number of repetitions and longer rest periods in the off-season than before competition. Bodybuilding and fitness is a long-lived sport, with great performances being achieved by athletes in the master categories. Men over 40 are doing more gym workouts to improve their body image as a way to boost their personal self-esteem and sex appeal (De La Poza, 2015).

*The aim* of the study: Knowing the variation of some somato-functional indices during bodybuilding and fitness training by means specific to the definition period preceding participation in the competition. Determining the body composition and some somato-functional/biomotor indices of the athlete selected for the case study, who practices bodybuilding and fitness, before and at the end of the experiment, as well as at the end of each series of each exercise within the bodybuilding training program and fitness.

### Objectives

Monitoring the values of the measured percentages of body composition and biomotor indicators at the beginning, during and at the end of the bodybuilding and fitness training specific to the pre-competitive preparation period.

In order to know the variation of the measured percentages of body composition and biomotor indicators during bodybuilding and fitness training, at the beginning and end of the training we set the following tasks:

-Determining the body composition and some somato-functional/biomotor indices of the athlete participating in the study, who practices bodybuilding and fitness, at the beginning, during and at the end of training:

-Measuring the level of muscle strength in the arms and some indicators that reflect body harmony and general health - initial and final;

-Establishing the resulting differences between the pulse and oxygen saturation values measured after each series of each exercise specific to the muscle group trained by methods specific to bodybuilding and fitness in the period preceding the participation in the competition, respectively the period of muscle definition;

### Assumption

Pulse and oxygen saturation during analytical work on muscle groups performed using the method of repetitions to failure combined with other methods specific to the training period register a sinusoidal path depending on the trained muscle group.

### Methods

The method of observation, experiment, measurement, statistics.

Classifications of training principles, methods and techniques specific to bodybuilding and fitness.

Weider principles of training. Training methods for developing strength and muscle mass.

Joe Weider (29.11.1919-23.03.2013) was one of the most important promoters of bodybuilding, laying the foundations of the IFBB (International Federation of Bodybuilding) professional division. During his career as a trainer and promoter of bodybuilding he managed to develop and promote his own training system "The Weider System" which contains a series of training methods with general applicability, which was implemented by the great world bodybuilding champions with high efficiency.

Known as "Weider" training methods in bodybuilding and fitness, the following combined and advanced training methods have applicability in the training of experienced athletes requiring high and very high physical and mental efforts.

Weider developed working principles, methods and techniques depending on the combination of the type of exercises with the training mode on days, depending on the nature of the training and the execution of the exercises, being divided in turn into three groups:

#### A. Methods that contribute to the efficiency of training in cycles:

1. Training cycling. To keep the body receptive to adaptation, the year will be divided into training periods for muscle mass, strength and definition for the dual purpose of variety and competitive preparation;

2. Division by days. The work week is divided into upper and lower body workouts for more intense workouts, with blood flow being directed to the upper or lower body;

3. Double separation of training. Carrying out the training in two shorter parts per day, one group in the morning and one muscle group in the evening, so the intensity and muscle stimulation will be greater;

4. Muscle confusion. This principle is based on the researcher Pavlov's theory regarding the repeated stimulus that loses its importance, so the muscle gets used to the same stress over a long period of time and the phenomenon of tolerance intervenes, and to avoid stagnation the exercises, the intensity, the number of repetitions and sets must be varied;

5. Permanent heating, active rest. Before starting training, a short warm-up session should be performed with free exercises of the body segments and the whole body in all axes and planes of movement;

6. Variation method. As many training techniques as possible are used (with high or low number of repetitions, high or low speed of execution, varied exercises) to stimulate as large a number of muscle fibers as possible);

7. Eclectic training. Training programs must include both basic exercises (several muscle groups are included in the execution of the movement) and isolation exercises (one muscle group);

8. Instinctive training. Experimenting with different training techniques, diets, different intensity, repetitions and sets depending on the body's response);

*B. Methods that contribute to the good organization of training. These methods are included in the training of advanced athletes.*

1. The method of multiple sets. A single set is not enough for effective muscle fiber stimulation, it is recommended to perform at least 2-3 sets up to 5-6 sets per muscle group (small muscle group 2-4 sets, large muscle group 4-6 sets);

2. The supersets. Performing two exercises for antagonistic muscle groups, without a break (biceps-triceps, chest-back);

3. Composite sets. Performing two exercises for the same muscle group without a break in between for maximum pumping.

4. The tricks. The execution of three different exercises of the same muscle group, a mini-circuit, which increase muscle resistance and contribute to a faster pumping of the muscles;

5. The giant sets. The set is composed of 4-5 exercises for the same muscle group, performed without a break between them. A minimum of 2-3 sets are performed for a muscle group with medium weights, sub-medium weights to allow the execution of 25-30 repetitions within the giant series;

6. Break-rest method. Performing a higher number of repetitions than usual, but with the same weight, with small breaks of a few seconds. Choose a heavy weight to be able to perform 2-3 repetitions, after a few seconds of rest try to perform another 2-3 repetitions, thus reaching a greater number of repetitions performed with a heavy weight;

7. The principle of prioritization. Deficient groups are trained at the beginning of training so that maximum output is directed to them when muscles are less fatigued and energy is higher than at the middle or end of training;

8. Pre-exhaustion. Analytical work for the muscle group begins with an isolation exercise (overfatiguing the muscle), followed by a core exercise (quadriceps extensions, followed by squats or pulley flutters, followed by chest press);

9. The pyramid principle. The continuous increase of the load, from light to heavy, starting with a number of 12-15 reps, as the weight increases decreases and the proposed number of repetitions (can be the maximum repetitions of a set), the weight is quickly decreased and the exercise is continued until exhaustion, the weight is gradually reduced until no more repetitions can be performed, in this way the intensity and pumping increase with each set;

*C. Principles that can explain the execution of each exercise. Sense of execution. Especially for advanced.*

1. Method of isolation. Through this technique in execution only certain muscles are contracted without the involvement of other muscle groups (the arm fixed to the Scott bench for the biceps, the flexion of the forearm on the arm is performed only by the biceps muscle);

2. Cheating executions. When no more repetitions can be performed with proper form, a small swing or hyperextension, etc. can be used. to complete or initiate the movement and pass the dead spot, cheating the correct execution by a small thrust that allows the pass over the weak point;

3. The principle of quality. It refers to decreasing the rest time between sets while maintaining the same no. of reps, used in the build-up period to increase training intensity and gain definition and vascularity.

4. Continuous tension. Permanent movement control throughout the execution, maintaining constant tension both in the positive phase and in the negative phase (without reaching the maximum amplitude of movement);

5. Forced repetitions. Performing a few repetitions at the end of the set with the help of a partner, for total exhaustion of the worked muscle group;

6. Pumping. Performing a large number of repetitions at a sustained pace with small breaks between sets, so the muscle will open more capillaries.

7. Burning. Performing 3-4 forced repetitions after performing the proposed maximum number of repetitions, as long as the weight can still be moved even a few centimeters of movement of the weight produces the sensation of burning in the muscle.

8. Negative repetitions (retro-gravity). A heavier weight is used so that for the execution a partner is needed on the positive side of the movement, the execution on the negative side in yield mode, the weight is lowered as slowly as possible, without help;



9. Partial repetitions. Only a part of the movement amplitude of a repetition is performed, at the base, in the middle, at the top, until exhaustion, the weight used can be variable on different segments of the movement. Partial repetitions can improve weak points.;

10. Principle of peak contraction. When the end of the movement is reached, the muscle is kept tense for a few seconds, isometric at the top. You can rotate the weight so that the muscle is under tension even at its maximum point, where it is generally more relaxed.

11. The principle of speed. The positive part of the movement is performed explosively, with controlled return, to reach the phasic fibers and increase the strength and muscle mass;

12. Principle of isotension. Muscle contractions in different positions, for certain muscle groups, held for 7-11 seconds, as during muscle stretching, in breaks between sets or at the end of training and in posing sessions.

The main methods of developing strength and muscle mass (Bompa & Haff, 2014) that have proven their usefulness and efficiency throughout practice in the field are:

1. The method of "pyramidal growth" of the load.
2. The method of "pyramidal increase and decrease" of the load.
3. The "double step" increase method of the load.
4. The method of isometric contractions. The "circuit" method.

5. The method of efforts until refusal. It is the basic method in bodybuilding to stimulate growth and lactic acid production.

6. The explosive "Power Training" method.

7. The mental attitude method.

Other less used methods but which involve a special control of the movement are:

- Method 21 or Magic 21 suitable for pushing exercises for the muscles of the chest, shoulders, biceps, triceps;
- Movement doubling method;
- The dropset method for extreme pumping (the weight is constantly lowered until no more repetitions can be performed).

Total training method.

It is practically a summation of the listed methods, methods corresponding to the athlete's level of training. We believe that a total training goes beyond the limits of the training room, extending even to the social and personal life of the athlete. By saying this, we mean the time of recovery and scientific nutrition, the moments of rest whether active or passive, the overcompensation phenomena, the socio-professional activities of the athlete. To the extent that an athlete manages to thoroughly approach all these aspects of training, we can say that he has valuable chances to access great performance in sports.

All these methods are part of the practice of athletes, each one customizing their training according to the response of their own body. We could constitute a separate research in the attempt to classify them from the most effective to the weakest, from the most used to the least used by bodybuilders. In general, training is similar to athletes within a group, club, gym, nationality, depending on the training method and specialist knowledge of the coach/instructor, etc.

From the aforementioned principles and methods found in the practice of athletes and coaches, we selected, applied and monitored during training, the techniques and methods suitable for the muscle definition phase, which are included in training for at least 2-3 months combined with mandatory cardio training in the last month, prior to the competition, and from the multitude of specific exercises we have selected the most frequently used ones, which have proven their effectiveness and can be performed in any gym with the latest generation or older equipment, listed briefly, as follows:

Training cycling, day splitting, muscle confusion, warm-up, active rest, variation method, eclectic training, instinctive training, multiple set method, compound sets, trisets, giant sets, rest-rest method, prioritization principle, pre-exhaustion, principle pyramidal, isolation method, cheat runs, principle of quality, continuous tension, pumping, burning, partial repetitions, principle of peak contraction, principle of isotension. Muscle contractions in different positions, for certain muscle groups, held for 7-11 seconds, as in muscle stretching, in breaks between sets or at the end of training and in posing sessions.

#### *Organization and conduct of the case study*

The study was carried out between 01.07.2023-31.07.2023 during the weekly training program at the gym aimed at participating in the National Bodybuilding and Fitness Championship organized between 29.08.2023-04.09.2023 in Sibiu, time interval in which they were carried out 2 workouts for each muscle group, including the most effective exercises used in the practice of athletes and coaches. It should be noted that the athlete was at the beginning of the period of food restrictions, with an emphasis on balanced nutrition and a specific diet by increasing the intake of proteins and reducing the intake of fatty acids and carbohydrates to a minimum, respectively the consumption of processed foods, fats, sweets, bakery products, pastry. During this period, he used as nutritional supplements two protein bars on training day and one on cardio day to provide the necessary energy in the absence of carbohydrates from the usual/normal diet.



In the process of setting up the case study, I observed in the periods preceding this study aspects related to the equipment of the bodybuilding and fitness rooms, the training routine of the athletes, their personality and behavior in the gym, and last but not least, I visually evaluated their physical appearance. At the same time, I took the pulse of bodybuilding and fitness competitions literally by attending the competition as an athlete, for the last 3 consecutive years.

In order to capture as many aspects as possible of the effects of bodybuilding training, namely the harmony of body development, health status and segmental strength, we performed anthropometric measurements (height, weight, indirect BMI), biological measurements (pulse, oxygen saturation 2), of expressed body composition in percentage (body and visceral fat) and arm strength measured with hand dynamometer, expressed in kg.

The biomotor measurements were performed using the apparatus described briefly below, the measurement standards being presented in the instructions for use or the user manual of each apparatus.

The measurements were carried out strictly following the instructions for use of the equipment used to be sure of the accuracy of the results.

Heart rate and oxygen saturation were measured 2 minutes after maximal arm strength effort with a hand dynamometer by pulling the handle with the fingers of the right and left hand toward the palm, a single trial.

The pulse and oxygen saturation were measured immediately after the completion of each set of the exercise or circuit related to the training of a muscle group, and the value displayed by the measuring device was accumulated for each muscle group and then compared with the total value of the other muscle groups, in order to establish a ranking of the variation of these parameters of effort specific to bodybuilding and fitness training.

Brief presentation of the apparatus and devices used to perform bio-motor measurements:

-Ultrasonic height meter used to measure body height, model U-grow UHM-001, by ultrasonic technology with LCD display, unit of measurement Anglo-Saxon (ft) / Metric (cm);

-The body composition measuring monitor Monitor BF-508 from OMRON used for determining body composition and BMI which is a clinically validated device for determining body composition, which provides an analysis of the whole body, a complete picture of body composition, including of the percentage of adipose tissue, visceral adipose tissue and body mass index (BMI). It provides high accuracy so that daily progress can be monitored. It can be used for people aged between 10-80 years, maximum weight capacity (kg): 150.00

- The Puloximeter measuring device for measuring pulse values and oxygen saturation. The digital pulse oximeter features high accuracy and repeatability and is easy to use. Basically, a finger is inserted into the photoelectric sensor to establish the diagnosis, and the oxygen saturation is shown on the screen.

Technical specifications: SP02 measurement 35%-100% and pulse measurement: 30bpm – 250 bpm

-To measure the muscle strength at the level of the arm/hand (handgrip strength) I used the electronic hand dynamometer EH101, which is a high-precision medical device, which ensures the digital reading of the grip strength, the display of the maximum self-capturing value of the grip strength gripping, storing and retrieving results for different users, adjustable handle, valid for all users of different ages, equipped with high-precision grip force sensor, which allows the evaluation of results by age and gender groups. kg/lb, maximum capacity: 90 kg/ 198 lb.

#### *The period, place and subjects of the research*

The study was conducted on a 46-year-old sportswoman, of normal weight, who trains regularly 3/4 times a week in order to participate in bodybuilding and fitness competitions in the female master category.

The choice of the study participant was made according to the following general criteria:

Inclusion criteria: preparing to compete in the national championship or other domestic and international competitions;

Exclusion criteria: discontinuity in training in the last 6 months, due to illness, injury or personal reasons, non-qualification or non-participation in competitions in the last year prior to inclusion in the case study.

He freely expressed his agreement to participate in the experiment.

Participation in the test was voluntary based on the informed consent of each participant, and the study follows the principles of the Declaration of Helsinki, the study was approved de Ethics Board of National University of Physical Education and Sport, Bucharest, Romania, no 2089/01.10.2020.

The location of the research was the bodybuilding and fitness room set up at home (in the area of the subcarpathians of curvature, mountain area with clean air), with semi-professional equipment, which has sufficient equipment, offering optimal training conditions.

The training devices were made especially for practice and meet all the requirements of quality, technicality and functionality.

These provided the athlete with an optimal premise for training and exercise, and the possibilities of adjustment and integration in all devices facilitate the adaptation of the devices to the demands of the anthropometry of any individual subject.

Total work time per workout 1:45, break between muscle groups 3-5 minutes, between exercises of the same muscle group 2-3 minutes, between the first series and the second series 1-2 minutes of the same exercise.

Generally the main (large) group is trained at the beginning of the workout for 45-60 minutes, followed by the second muscle group, usually medium, for 30-45 minutes and the smaller group for 15-30 minutes.

Training duration varies depending on the size of the muscle group, the number of muscle groups worked per training, the preparation period (shorter in the strength period with fewer exercises per muscle group, longer in the definition period with more exercises and more many series per training, ambient temperature, physical and mental tone, as well as other factors. Oxygen saturation and resting heart rate after warm-up (5-10 minutes) usually averaged 98-99/75-85. The resumption of the next series was performed when the pulse returned to 80-90 pulsations per minute, and the thoracic stroke in inhalation and exhalation to recover the oxygen deficit decreased to 0, breathing was performed without the intervention of the intercostal muscles.

## Results

Body composition values indicate a low level of body fat (40-59 years under 21=low level), visceral fat has a normal value (limits 1-9), and BMI value indicates a normal level (limits 18.5-25) . We observe a tendency to decrease the values of the body fat percentage at a slower rate than the BMI, from which we can conclude that the muscle mass is maintained and the adipose layer reduced, aspects that correlated with the strength value related to the athlete's age, indicate a strong level of it and the expected yield of bodybuilding and fitness training.

Table 1. Determination of body composition at the beginning and end of training

Nr. crt.	Muscle groups training/	Sex	Age	Height	Weight	FAT Body fat	Vfat Visceral fat	BMI	Dynamometer right	Dynamometer Left
1.	back, shoulders and abdomen	F	46	1,63	56/55,5	19,4/19,1	4	21,1/ 20,9	37 kg/ ,7kg	37,1/ 36
2.	chest, shoulders, biceps				55,8/55,4	18,7/18,4	4	21/ 20,9	38,9kg/ 38,5kg	39,6/ 39,1
3.	Thighs, calves, abdomen				55,4/55,1	17,9/17,5	4	20,9/ 20,7	36,7kg/ 36,3kg	38,9/ 37,3

Table 2. The highest, lowest and average oxygen saturation and pulse monitored at the end of the series of exercises specific to analytical work on muscle groups

No. crt.	Muscle groups	The highest value Sat. O2 /exercise	Highest heart rate/exercise value	The lowest value Sat. O2 /exercise	Lowest heart rate/exercise value
1	Calves	<b>98</b>	<b>107</b>	<b>96,5</b>	<b>102,5</b>
2	Abdominal	<b>98,75</b>	<b>107,75</b>	<b>96</b>	<b>101</b>
3	Chest	<b>99</b>	<b>109,5</b>	<b>97</b>	<b>99,5</b>
4	Shoulders	<b>98,75</b>	<b>115</b>	<b>96,75</b>	<b>106</b>
5	Back	<b>98,71</b>	<b>117,14</b>	<b>96,28</b>	<b>101,57</b>
6	Triceps	<b>98,6</b>	<b>117,6</b>	<b>96,2</b>	<b>103</b>
7	Quadriceps	<b>98,6</b>	<b>120,2</b>	<b>97,1</b>	<b>105,4</b>
8.	Femurs	<b>99</b>	<b>121,5</b>	<b>97</b>	<b>105</b>
9.	Biceps	<b>99</b>	<b>126,25</b>	<b>98</b>	<b>114,25</b>

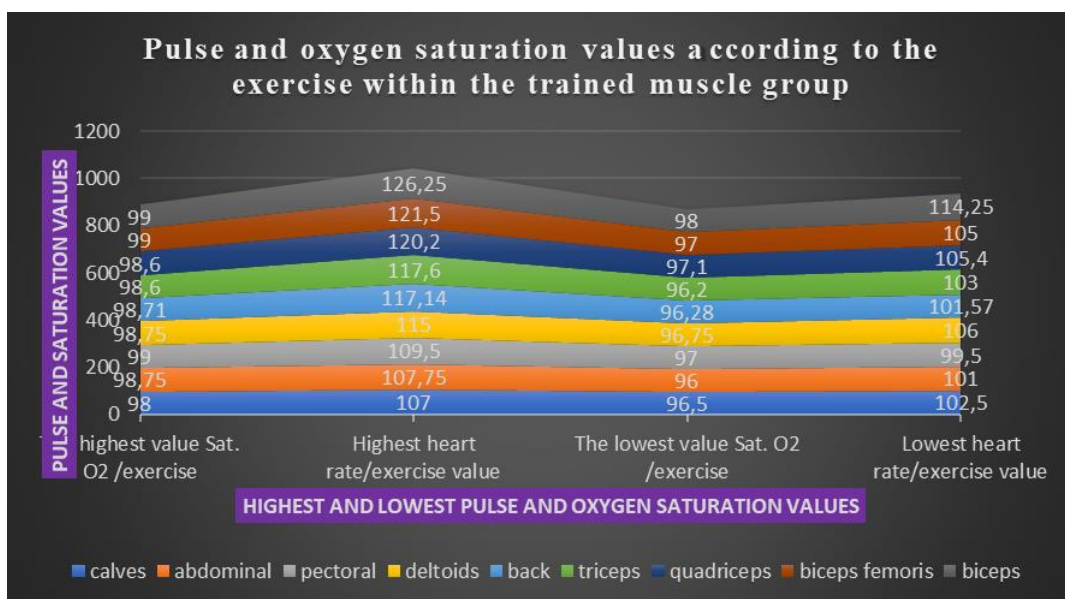


Figure 1. Pulse and O2 saturation values measured at the end of the set of an exercise specific to the trained muscle group

As can be seen, the highest cumulative value of pulse averages and oxygen saturation measured at the end of each set of exercises performed for the trained muscle groups resulted in the biceps muscle, followed in descending order for pulse variation by the biceps femoris muscle, quadriceps, triceps, back, shoulders, chest and calves.

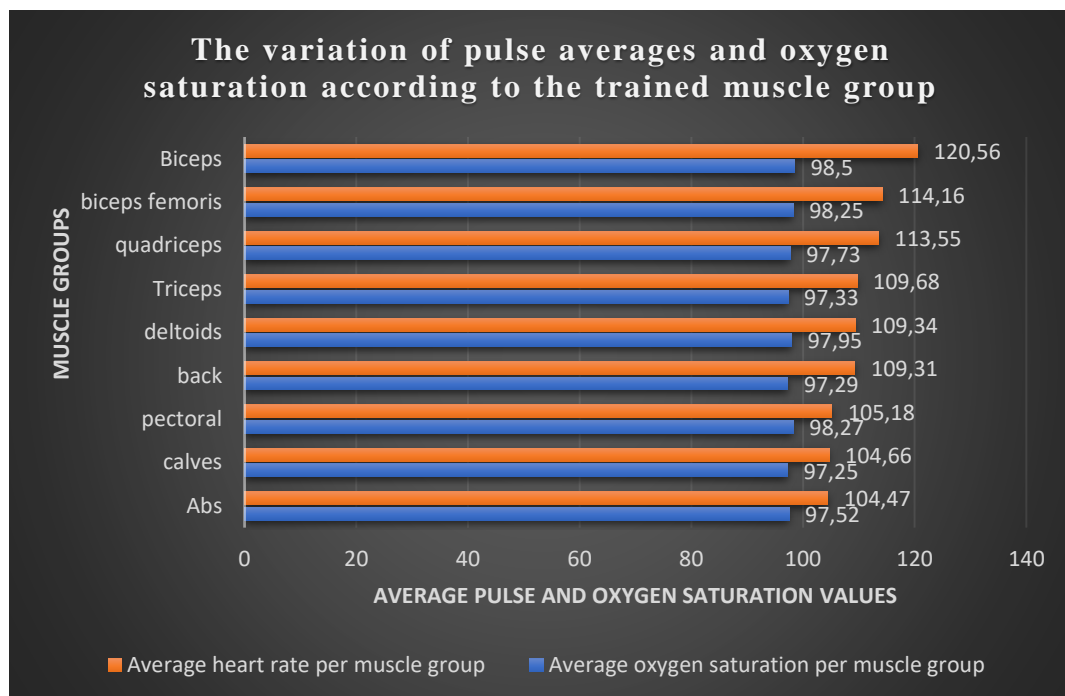


Figure 2. Mean values of heart rate and O2 saturation measured at the end of the set of an exercise specific to the trained muscle group

Training for biceps requires the most intense cardio-vascular apparatus, an aspect expressed by the highest values of the pulse but with an oxygen saturation close to the state of rest, which, compared to the other values measured at the end of the series of each exercise of the trained muscle group, presents the higher percentage. Appearance due to full and prolonged exhalation on return and deep inspiration on flexion, as well as chest expansion more in the sagittal plane as the arm and elbows press the chest to the side to isolate the movement.

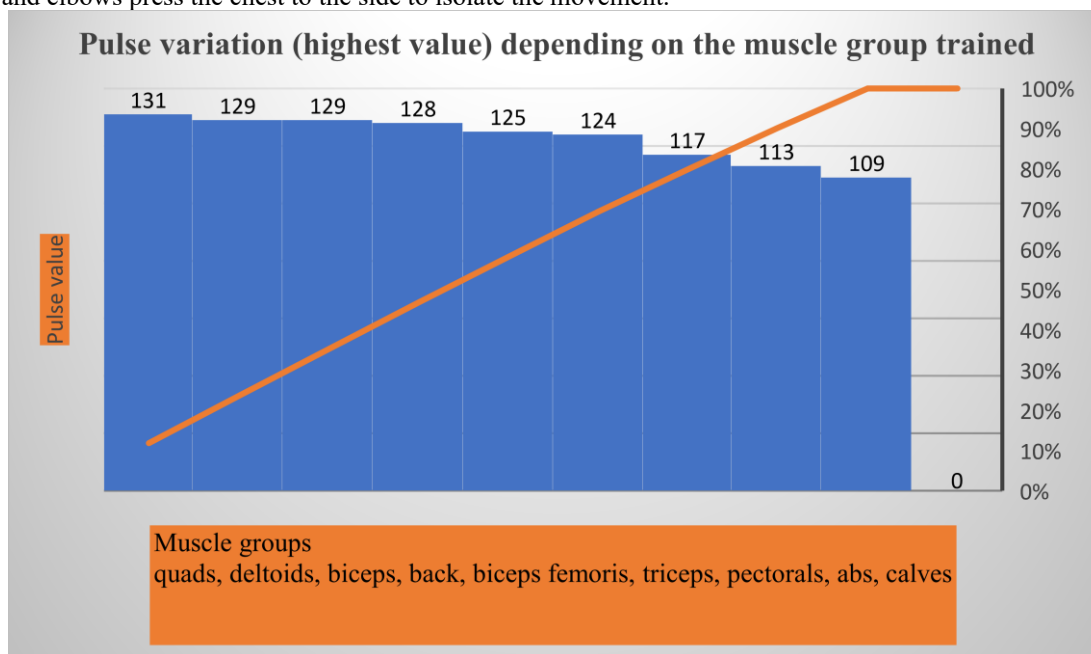


Figure 3. Pulse variation according to the trained muscle group

As can be seen in the figure above, the highest pulse was measured at the level of the quadriceps muscles during the exercise performed in the superset, i.e. lunges with front support, dumbbell in hand followed by side lunges with arching, without pause.

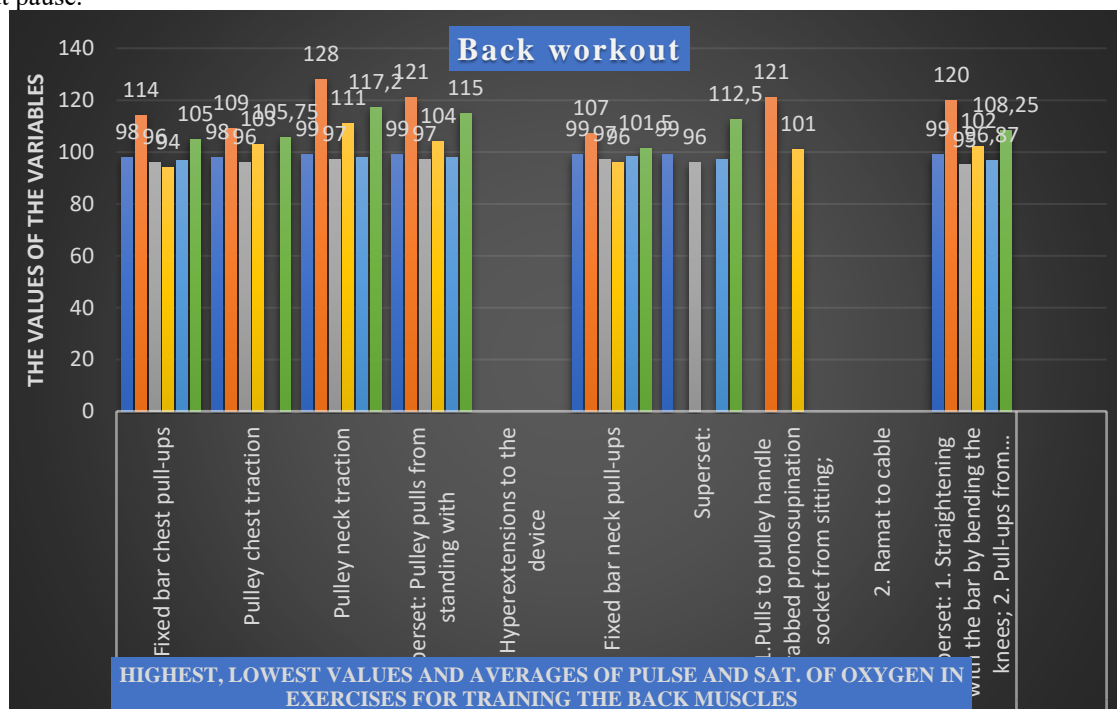


Figure 4. Variation of heart rate and O2 saturation measured at the end of the series for the exercises specific to the analytical work for the back muscles



Because the back is open with the shoulder blades adducted (tip to the side), the chest in maximum amplitude on the chest pull, in particular, the measured values are not the highest compared to the other similarly trained groups, but the version of the pulls performed on the back of the neck shows lower values of the pulse and oxygen saturation, and the thickening/density/isolation exercises require more intensively the cardio-vascular apparatus due to co-contractions and the reduction of synergies in the execution of the movement.

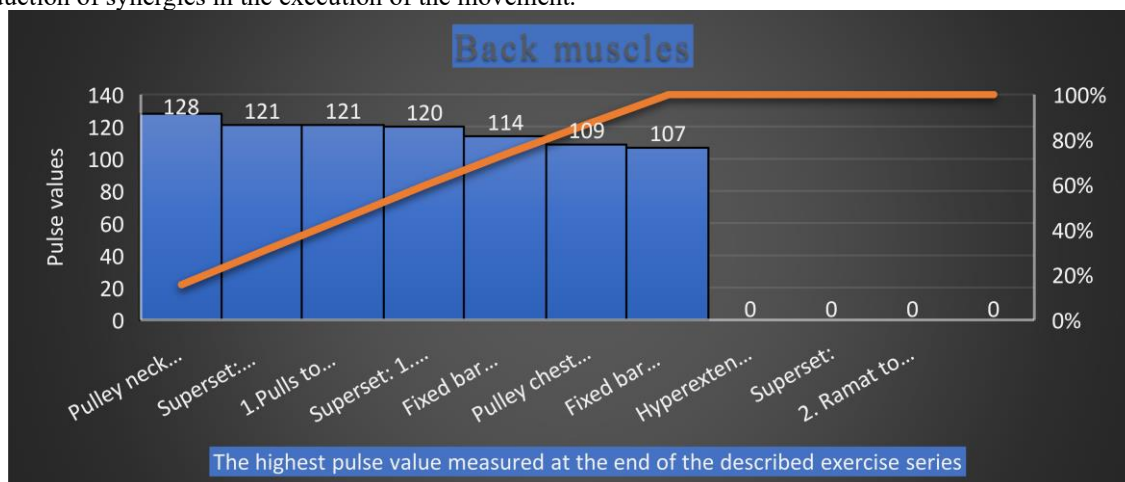


Figure 5. Pulse variation measured at the end of the series for the exercises specific to the analytical work for the back muscles

An uneven variation of the measured values can be observed, however, the heart rate increased the most during the execution of wide pulley pulls (higher than shoulder level), at the back of the neck, during the execution of the other exercises the head remains in trunk extension and oxygenation in runtime is easier.

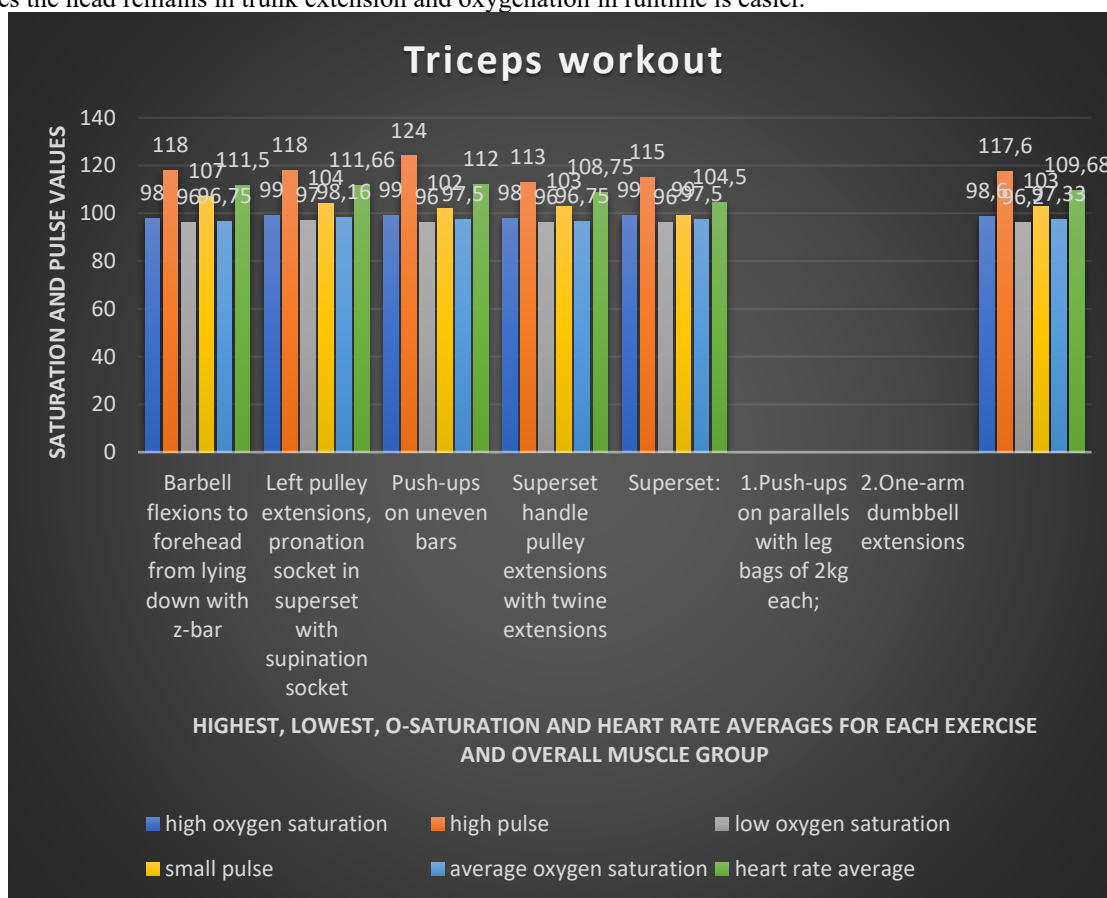


Figure 6. Variation of heart rate and O2 saturation measured at the end of the series for the exercises specific to the analytical work for the triceps muscle

Parallel push-ups, the core exercise, are the most demanding of the cardio-respiratory system, followed by prone front z-bar push-ups and standing pull-ups with handle/string grip in pronation, supination, or pronosupination, which are exercises of isolation.

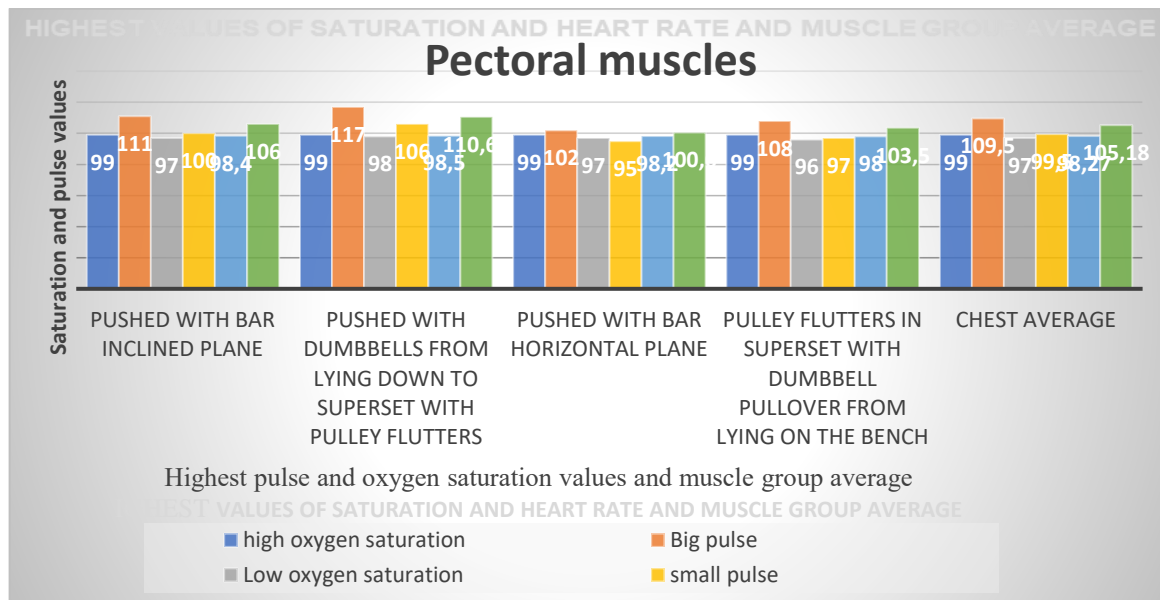


Figure 7. Variation of heart rate and O<sub>2</sub> saturation measured at the end of the series for the exercises specific to the analytical work for the pectoral muscles

Oxygen saturation during the training of the pectoral muscles reaches almost the highest values in every aspect exercise due to the wide opening of the chest during execution and the facilitation of breathing.

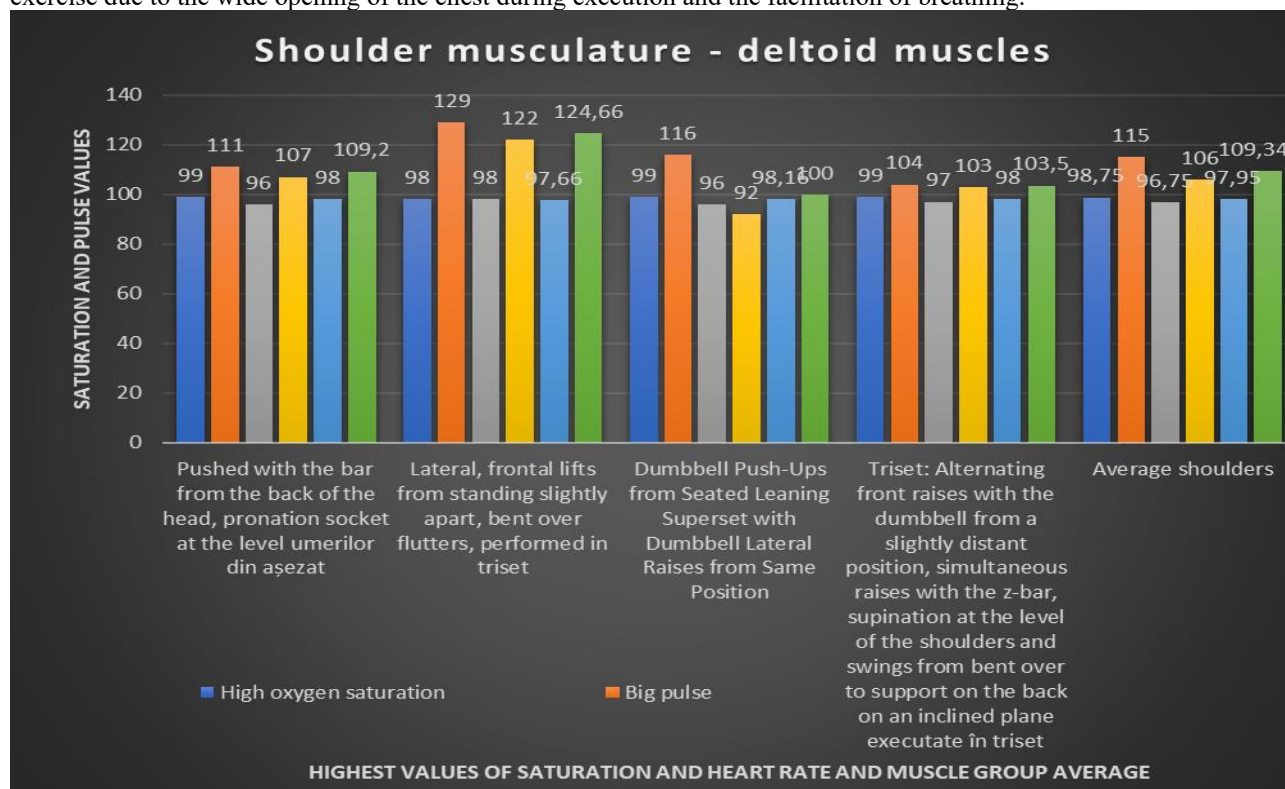


Figure 8. Variation of heart rate and O<sub>2</sub> saturation measured at the end of the series for the exercises specific to the analytical work for the deltoid muscles

The deltoids clothe the shoulders from the front and from the sides and from the back, therefore they act synergistically with the upper back muscles and the upper pectoral muscles during the execution of the basic exercises, and during the isolation exercises it puts pressure on the chest both inhaling and exhaling, aspect which is reflected in higher pulse values with a medium to low oxygen saturation.

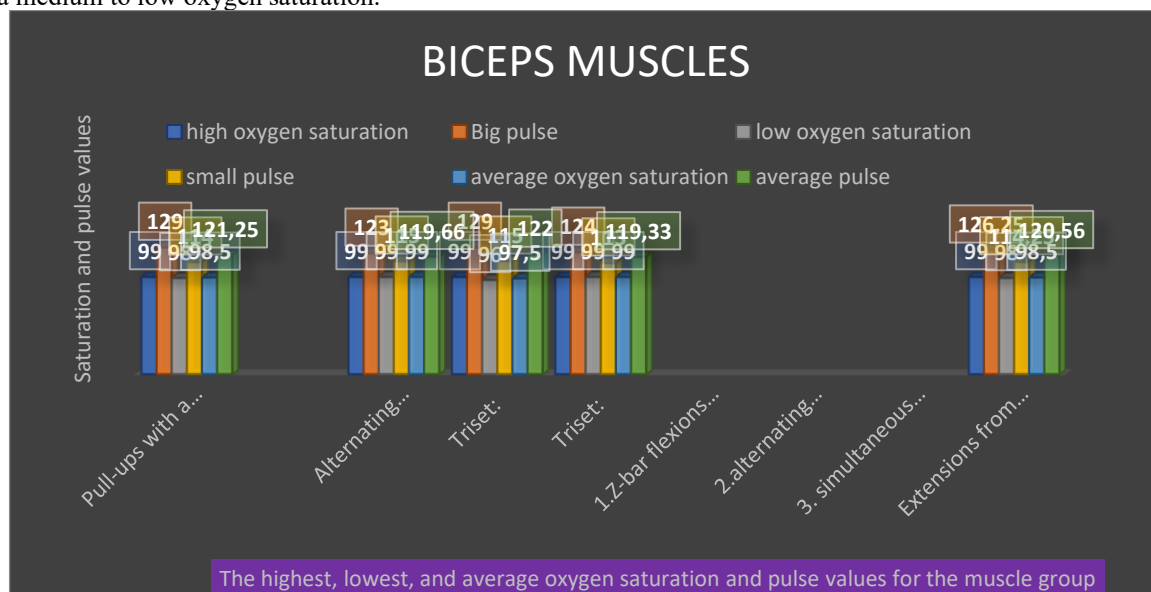


Figure 9. Variation of heart rate and O2 saturation measured at the end of the series for the exercises specific to the analytical work for the biceps muscles

Pull-ups on the fixed bar, performed with supination at the shoulder level, place intense strain on the cardio-respiratory system, the chest being slightly stuck in hanging on the return and during the pull-up phase it is not open like an accordion during the execution of pull-ups for the back, an aspect that is reflected in high pulse values but with a level of oxygen saturation close to the resting state.

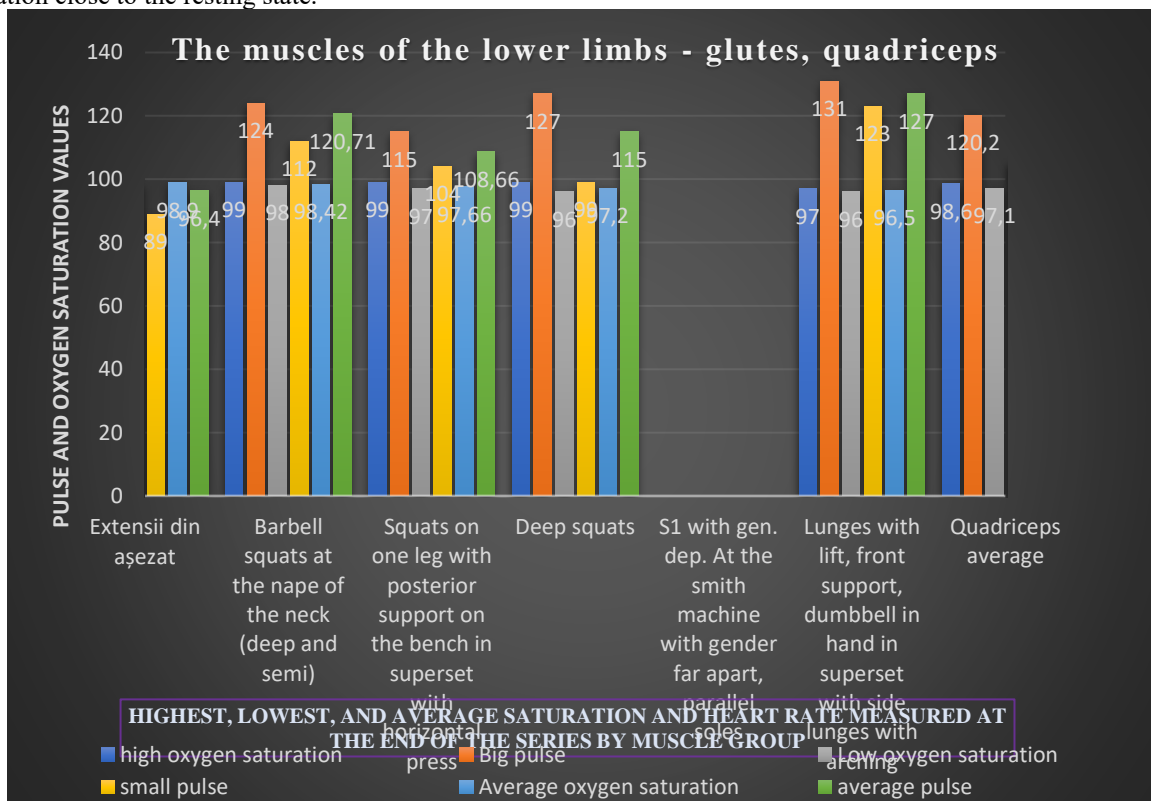


Figure 10. Variation of heart rate and O2 saturation measured at the end of the series for the exercises specific to the analytical work for the quadriceps muscles

Lunges make intense demands on the cardio-respiratory apparatus, especially if they are performed with a load (bar on the back of the neck or dumbbells), from moving or from jumping, being a basic exercise that addresses the muscles of the lower limbs and the buttocks in particular, but it takes part of the effort and calves, abdomen and lower back.

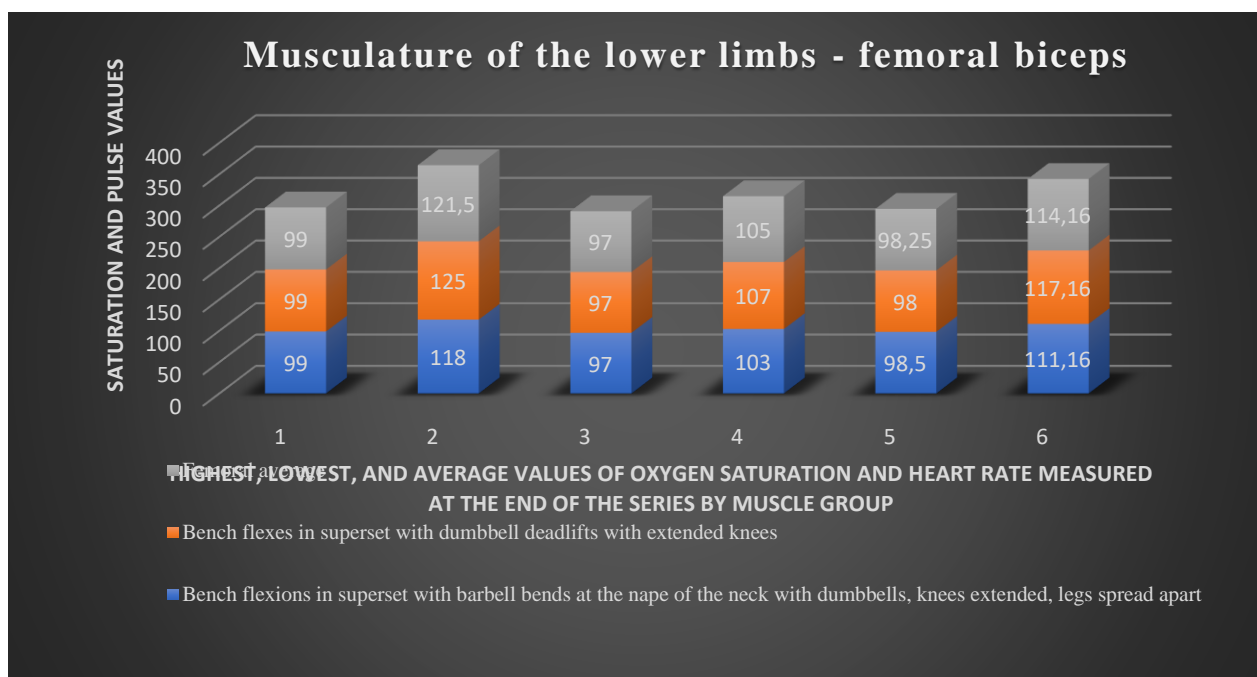


Figure 11. Variation of heart rate and O<sub>2</sub> saturation measured at the end of the series for the exercises specific to the analytical work for the biceps femoris musculature

Performed in a combined set, the exercises for the femoral biceps require the cardio-respiratory system in terms of pulse at a medium to high level compared to the pectorals, abdomen or calves but with a good oxygen saturation.

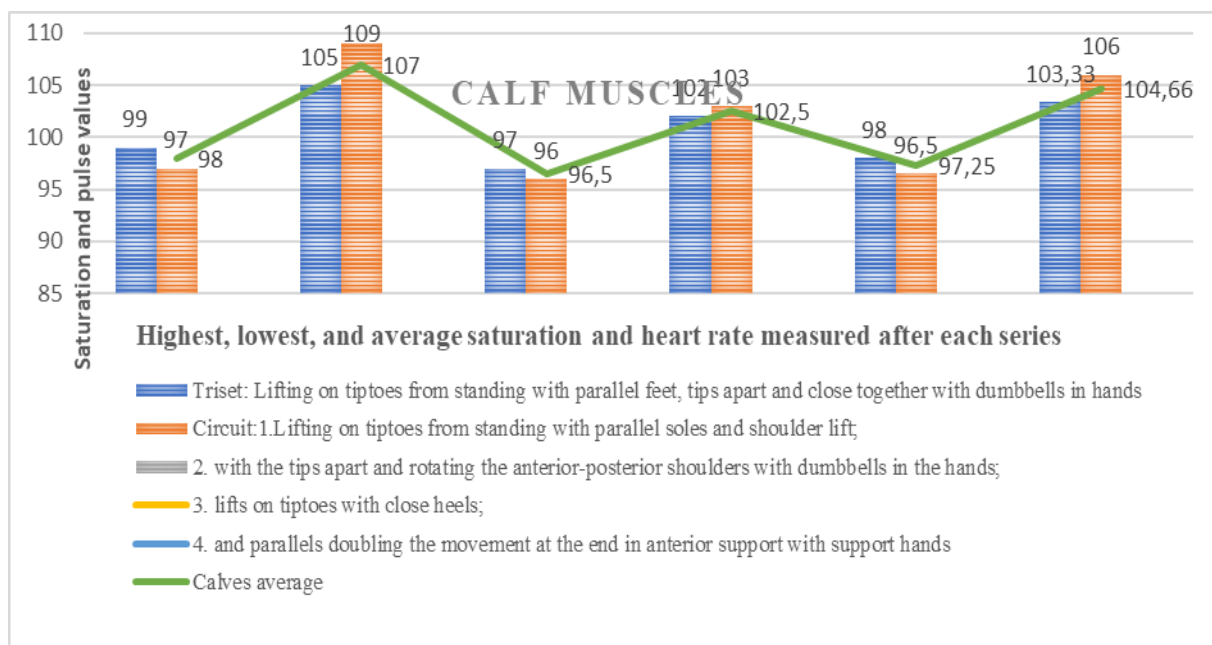


Figure 12. Variation of heart rate and O<sub>2</sub> saturation measured at the end of the series for the exercises specific to the analytical work for the calves muscles

The calf muscles, being located at the lower level, do not put intense strain on the cardio-respiratory system, the pulse values being relatively low during effort compared to other smaller muscle groups, biceps, triceps, but they require a greater number of repetitions (20-40 with load or body weight in a combined set) to feel the burn specific to the work to the brim. As can be seen in the figure below, analytical abdominal work exercises performed in the circuit have a greater total execution time with inhalation and exhalation per execution and return so that the heart rate and oxygen saturation are maintained at an optimal level even if the effort is considerable with a high number of repetitions. (over 100 cumulative per series).

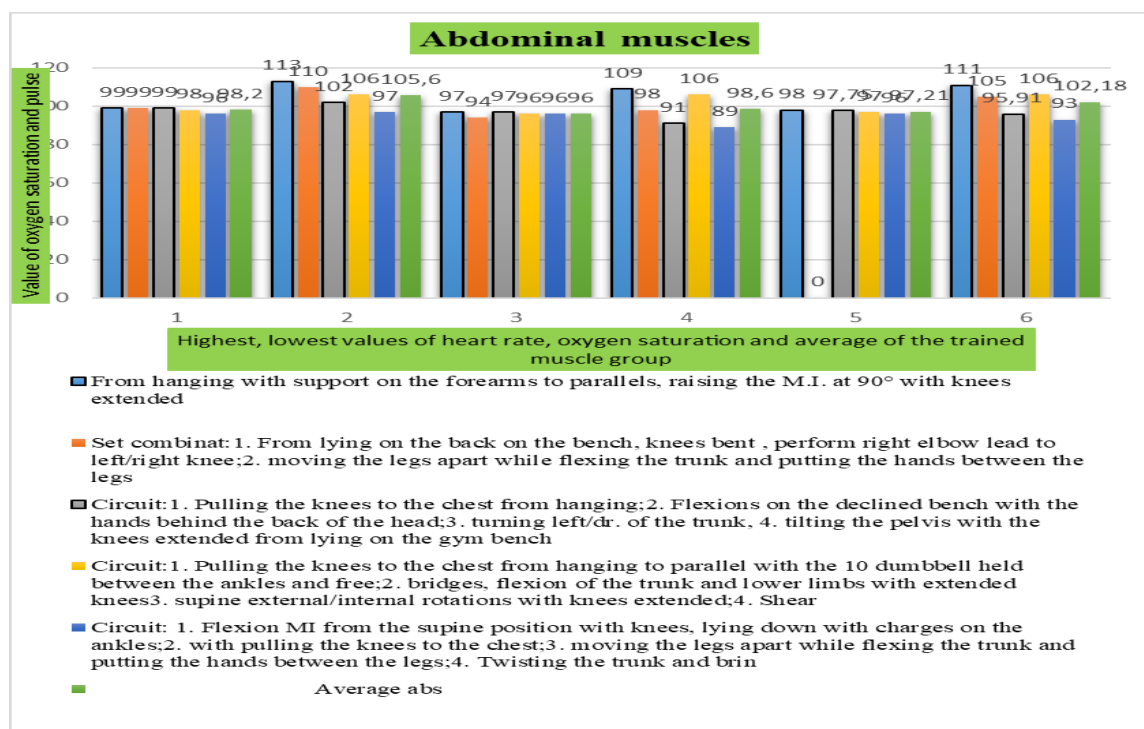


Figure 13. Variation of heart rate and O2 saturation measured at the end of the series for the exercises specific to the analytical work for the abs muscles

### Discussions

We believe that the results of our study will have relevance in the field of sports in general, bodybuilding and fitness in particular, in order to minimize the negative effects of overtraining and maximize the contribution/success to sports performance through the appropriate dosage of effort. We recommend the need to expand and promote the knowledge of the variation of pulse values and oxygen saturation during the effort specific to the preparation periods in order to optimize the training and obtain the competitive sports form.

The sports activity undertaken shapes the personality, and each sports discipline is characterized by common psychological requirements but also specific to the sport practiced. The level of intensity of the effort translated in our case by the pulse and oxygen saturation values depends on many direct or indirect variables among which the most important is the adaptation to the specific effort, the physical and mental tone at the time of training to channel all the energy in order to obtain a maximum yield.

During the Covid 19 pandemic, many athletes have experimented with home exercises, limiting themselves to stretchers, flexballs, dumbbells, barbells, simple multi-functional benches to continue training and maintain their muscle mass and strength developed over years of hard training and exercises at the gym with complex and diverse equipment (Salvador et al., 2022).

Competitive bodybuilders must adhere to an individualized training program for optimal results and athletic fitness, as well as a well-structured diet based on their metabolism and category, often aided by muscle-building or fat-burning drugs and culminating in with a posing competition on stage.

It is absolutely normal to have differences between an athlete and a non-athlete on all levels, some authors have studied in this sense, certain aspects regarding "Self-efficacy and endurance: differences between fitness/bodybuilding athletes and non-athletes" (Romero, Guzman & Vazquez, 2022), considering that the descriptive and transversal study of self-



efficacy and resistance is a challenge for sports psychology, favoring the development of mental strength, control and performance improvement in athletes. Diet and physical activity occupy a considerable place in people's lives. These two branches together are believed to lead the individual to a healthier life. In this context, knowing that diet combined with regular physical activity has transcendence in everyday life, the authors (Grifante & Werner, 2022) set out to assess the nutritional status and analyze the eating habits of bodybuilders at a gym. In this sense, food consumption and anthropometric evaluation were evaluated by bioimpedance performed on 45 participants, obtaining parameters of: weight, body mass index (BMI), fat percentage (CG%) and lean mass (MM%), metabolic age and visceral fat. The reasons that led exercisers to seek out weight training were for health, aesthetics and enjoyment. It was concluded that a multidisciplinary team, especially a nutritionist, is needed in terms of food issues, in order to better guide practitioners in terms of nutrition and physical activity.

Bodybuilder-type training can affect heart rate variability (HRV), which has considerable potential to assess the role of the autonomic nervous system (ANS), believe the authors (Mert, Ilguy, Dural, Mert & Ozakin, 2017) who conducted an approach scientifically designed for bodybuilders to achieve better results while protecting their health by investigating HRV parameters in bodybuilders compared to healthy control subjects and the effects of creatine supplementation. Manipulation of resistance training variables is crucial to correctly plan the induced stimuli. When reporting exercise variables in resistance training protocols, sports scientists and practitioners often refer to the load lifted and the total number of repetitions (Coratella, 2022). Manipulation of one or more variables allows increasing, equalizing or decreasing the stimuli related to each exercise. All variables explored should be mentioned by sport scientists and practitioners for each exercise when reporting resistance training protocols. Choosing the best working method and technique for increasing strength and muscle hypertrophy is a constant concern in performance sports, especially bodybuilding and fitness. According to (Herzog, 2018), muscles that are lengthened while activated (ie, eccentric muscle action) are stronger and require less energy (per unit force) than muscles that shorten (ie, concentric contraction) or that remain at a constant length (eg, isometric contraction), is well known. Muscle excitation of the posterior chain in different deadlift variations was measured during execution in ten competitive bodybuilders (training age 10.6 +/- 1.8 years) performed Romanian curls, (RD), leg curls on a step (step-RD) and deadlift with rigid legs (SD) with a 1-RM of 80%, (Coratella, Tornatore, Longo, Esposito & Ce, 2022). Excitation of the gluteus maximus, gluteus medius, biceps femoris, semitendinosus, erector spinae longissimus, and iliocostalis was assessed in both the ascending and descending phases. The descending phase had fewer differences between exercises.

Low-intensity resistance exercise with blood flow restriction (BFR) has been shown to induce a prominent increase in muscle activation in response to muscle fatigue (Yasuda, Loenneke, Ogasawara & Abe, 2013), and muscle strength and hypertrophy following training resistance can be achieved to varying degrees depending on the approach taken (Nunes, et al., 2020).

Low-load exercise training performed under blood flow restriction can increase muscle hypertrophy and maximal strength to a similar extent as classical high-load strength training. However, the blood flow restriction method causes only minor neural adaptations. In an attempt to maximize training gains, the study authors (Duchateau, Stragier, Baudry, & Carpentier, 2021) propose the use of other protocols that combine high voluntary activation, mechanical tension, and metabolic stress. Starting from the importance of the principles and means of bodybuilding aimed at the somatic-functional and psychological development of practitioners, a sociological study (Dobrescu, 2018), of survey type, was carried out on first and second year students of the Faculty of Movement, Sport and Sciences of Health in Bacău, within Sport and the Top Motor Performance program. The results of the survey led to the respondents' conviction that the practice of fitness-improving sports and in this case bodybuilding (even as a professional sport) have extensive beneficial effects for their general physical and mental development such as: improvement of health status, beneficial influence on behavior, improving motor skills, ensures a good level of fitness, mental-emotional balance, develops communication skills (especially non-verbal communication) and also develops aesthetic sense. With the rapid development of society and economy, people's living standards are improving day by day, and more and more attention is paid to physical health, which has triggered an increase in fitness. The impact of bodybuilding exercises on physical fitness based on deep learning algorithm was analyzed in a paper (Sun & Wang, 2022) as a reference for fitness enthusiasts to choose scientific and directed exercise methods, which provides a theoretical basis for promoting bodybuilding and fitness. The results of the data showed that under the scientific and reasonable conditions, bodybuilding and fitness exercises have a corresponding positive effect on the subjects' body shape and posture. It is more practical to choose a combination of aerobic and anaerobic exercises.

Inactivity leads to morbidity and mortality, while new and engaging approaches to fitness improve health outcomes, the authors (Quindry, Williamson-Reisdorph, & French, 2020) quantified improvements in aerobic fitness, body composition, resting metabolic rate, resting blood pressure and triacylglycerol after an 8-week HIIT regimen. Implications of heart rate (HR) monitoring in franchised group exercise with wearable technology serve as an unexplored scientific approach to understanding novel exercise prescriptions on health-fitness outcomes.

The hand grip strength test (HGS) is commonly used as an indicator of general muscle strength in medical and sports practices. (Gasiór, Pawłowski, Williams, Dabrowski, & Rameckers, 2018)

Given its predictive validity and simplicity, dynamometrically measured grip strength should be considered a useful vital sign for screening middle-aged and older adults (Bohannon, 2008).

To measure body weight and body composition, respectively body and visceral fat, the authors (Diana, Nurdin, Anwar, Riyadi, & Khomsan, 2018) used the Bioelectrical Impedance Analysis (BIA) monitor (OMRON (R) Karada Scan Body Composition) in their research Monitor HBF-358-BW), body analyzer also used in our study to determine body fat and BMI. Based on the results, the authors concluded that adults, especially women, need to pay attention to their body fat to reduce the risk of high blood pressure.

### Conclusions

The values of the anthropometric, physiological and motor measurements fall within the accepted or internationally recognized limits, registering a visible downward curve of body fat during the monitored period.

The lowest pulse values were measured during the exercises for the trigeminal muscles, and the highest at the level of the quadriceps muscles, Average the lowest at the level of the abdominal muscles, the highest at the level of the biceps muscles, respectively the lowest level of saturation of oxygen was measured during exercise for the trigeminal muscles, the highest in the biceps muscles. In conclusion, oxygen saturation increases in direct proportion to the respiratory rate.

The highest pulse values were detected during the execution of analytical exercises in compound set (131 quadriceps) or triset (129 shoulders), the body segments performing the movement alternately with the right/left upper limb, respectively the right/left lower limb, thus the cardio work -pulmonary and muscular almost doubled as working time. During the performance of the basic exercises, for example, pull-ups for the back or biceps, squats for the thighs, the heart rate (128, 129) recorded an increased value close to the compound or triset exercises, but during the performance of the circuits for the abdominal and calf muscles the heart rate averaged while saturation decreased. A plausible explanation could be given by the high frequency of inhalation and exhalation in each movement of the execution of the movement and on the return, respiratory acts that accompany the movement executed at a more alert pace having little load or only the body weight, while in the other exercises the load is greater or work against gravity with one's own weight.

Pros: The use of machines and devices accessible to athletes in order to monitor some parameters of the effectiveness of bodybuilding and fitness training, in order to obtain the sports form but also the effects of the training on the state of health. Knowing the variation of some essential effort parameters in sports can contribute decisively to the improvement of athletes' performances as well as to the prevention of overloads in the specific effort. The research results can constitute a premise for other comparative studies between athletes of different genders, from the same sports age category, and last but not least, they will be able to be extrapolated and applied for the knowledge and dosage of effort in any sports branch, individual or team sports.

Minuses: The case study does not allow comparison with other athletes of the same or different gender, nor does it allow an analysis of the variation of the investigated values by sports age categories.

### References

- Alves, R. C., Prestes, J., Enes, A., of Moraes, W. M., Trindade, T. B., de Salles, B. F. & Aragon, A. A. (2020). Training programs designed for muscle hypertrophy in bodybuilders: a narrative review. *Sports*, Volume: 8(149). doi:10.3390/sports8110149.
- Bompa, T. O. & Haff, G. G. (2014). *Periodizarea. Teoria și metodologia antrenamentului* (Periodization. Training theory and methodology). Bucharest: Ad Point Promo.
- Coratella, G. (2022). Appropriate Reporting of Exercise Variables in Resistance Training Protocols: Much more than Load and Number of Repetitions. *Sports Medicine-Open*, 8(1/99). doi:10.1186/s40798-022-00492-1.
- Coratella, G., Tornatore, G., Longo, S., Esposito, F. & Ce, E. (2022). An Electromyographic Analysis of Romanian, Step-Romanian, and Stiff-Leg Deadlift: Implication for Resistance Training. *International Journal Of Enviromental Research And Public Health*, 19(3). doi:10.3390/ijerph19031903.
- De La Poza, E., Jodar, L. & Alkasadi, M. (2015). Modelling the propagation of adult male muscle dysmorphia in Spain: economic, emotional and social drivers. *Applied Economics*, 47(12), 1159-1169. doi:10.1080/00036846.2013.870657.
- Diana, R., Nurdin, N., Anwar, F., Riyadi, H. & Khomsan, A. (2018). Risk Factors of Hypertension among Adult in Rural Indonesia. *Jurnal Gizi Dan Pangan*, 13(3), 111-116. doi:10.25182/jgp.2018.13.3.111-116.
- Dobrescu, T. (2018). The students' perception of practicing bodybuilding considering the definition of fitness for the future sports trainers. *10th World Conference On Educational Sciences (WCES-2018)*, 5(1), 49-56. doi:10.18844/prosoc.v5i1.3382.
- Duchateau, J., Stragier, S., Baudry, S. & Carpentier, A. (2021). Strength Training: In Search of Optimal Strategies to Maximize Neuromuscular Performance. *Exercise And Sport Sciences Reviews*, 49(1), 2-14. doi:10.1249/JES.0000000000000234.
- Gasior, J., Pawlowski, M., Williams, C., Dabrowski, M. & Rameckers, E. (2018). Assessment of maximal isometric hand grip strength in school-aged children. *Open Medicine*, 13(1), 22-28. doi:10.1515/med-2018-0004.



- Grifante, V. & Werner, M. (2022). Classification of nutritional status and food habit in bodybuilding practitioners in an academy. *Rbne-Revista Brasileira De Nutricao Esportiva*, 16(100), 372-382.
- Herzog, W. (2018). Why are muscles strong, and why do they require little energy in eccentric action? *Journal Of Sport And Health Science*, 7(3), 255-264. doi:10.1016/j.shs.2018.05.005.
- Horghidan, V. (2000). *Problematica psihomotricității*. București: Globus.
- Ionescu, A. & Anton, B. (2004). *Dirijarea medicală a efortului*. București: Proxima.
- Quindry, J., Williamson-Reisdorph, C. & French, J. (2020). Health and fitness benefits using a heart rate intensity-based group fitness exercise regimen. *Journal Of Human Sport And Exercise*, 15(3), 692-705. doi:10.14198/jhse.2020.153.18.
- Mert, K., Ilguy, S., Dural, M., Mert, G. & Ozakin, E. (2017). Effects of creatine supplementation on cardiac autonomic functions in bodybuilders. *Pace-Pacing And Clinical Electrophysiology*, 40(6), 721-727. doi:10.1111/pace.13096.
- Romero, M., Guzman, M., & Vazquez, C. (2022). Self-efficacy and resilience: differences between fitness/bodybuilding athletes and non-athletes. *Retos-nuevas tendencias en educacion fisica deporte y recreacion* (44), 232-241. doi:WOS:000835409600001.
- Salvador, R., Frontini, R., C, R., Lopes, P., Oliveira, J., Maia, J. & Monteiro, D. (2022). Exercise Dependence and Anxiety in Cross-Trainers, Bodybuilders and Gym Exercisers During COVID19. *Perceptual and motor skills*, 129(4), 1210-1225. doi:10.1177/00315125221098326.
- Sun, M. & Wang, L. (2022). Effect of Bodybuilding and Fitness Exercise on Physical Fitness Based on Deep Learning. *Emergency Medicine International*, 2022(3891109). doi:10.1155/2022/3891109.
- Yasuda, T., Loenneke, J., Ogasawara, R. & Abe, T. (2013). Influence of continuous or intermittent blood flow restriction on muscle activation during low-intensity multiple sets of resistance exercise. *Acta Physiologica Hungarica*, 100(4), 419-426. doi:10.1556/APhysiol.100.2013.4.6.
- [https://krispsychology.files.wordpress.com/2012/05/autonomie-personala\\_instrument.pdf](https://krispsychology.files.wordpress.com/2012/05/autonomie-personala_instrument.pdf)
- <http://discobolulunefs.ro/en/reviste/>
- [https://www.google.ro/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwiOs6Kpq4HxAhUohv0HHb0aD3EQFjAAegQIAxAD&url=https%3A%2F%2Fwww.weider.ro%2Fnutritie-sportiva%2Fantrenamente%2Fghid-de-antrenament-weider&usg=AOvVaw01-4SpMbkX70UOvf0qj\\_N-](https://www.google.ro/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwiOs6Kpq4HxAhUohv0HHb0aD3EQFjAAegQIAxAD&url=https%3A%2F%2Fwww.weider.ro%2Fnutritie-sportiva%2Fantrenamente%2Fghid-de-antrenament-weider&usg=AOvVaw01-4SpMbkX70UOvf0qj_N-)