NATIONAL UNIVERSITY OF PHYSICAL EDUCATION AND SPORTS OF BUCHREST

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Abstract of the doctoral thesis:

DIAGNOSIS OF EXERCISE CAPACITY IN WATER POLO PLAYERS – JUNIOR III

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Keywords: water polo, effort zones, exercise capacity, lactic acid, heart rate, psychomotricity.

Introduction:

The game of water polo is one of those sports where acyclic movements are predominant. During a water polo match, the swimming technique, the covered distances and the exercise intensity differ, which shows that a water polo player must train with all three types of effort (aerobic, anaerobic lactacid and anaerobic alactacid).

Part I: *Theoretical background of the research*, which includes 5 chapters. **Chapter I**: *Motivation for the choice of theme, research directions and stages*; **Chapter II**: *Theoretical and conceptual framework for achieving the research directions*; **Chapter III**: *Anatomic-functional and mental particularities of pubertal age*; **Chapter IV**: *Water polo game and performance capacity*; **Chapter V**: *Conclusions and elements of novelty drawn from the theoretical part*.

Motivation for the choice of theme is supported by the poor approach of the research conducted so far for this age group and especially this sports discipline; the second reason is related to coaches, who select and train young talents using old-fashioned criteria.

Research directions: This approach highlights the enrichment of information under the intellectual, physical, technical-tactical and mental aspects.

From the *intellectual-cognitive* point of view, our research brings to the forefront how to address specific effort in water polo game, in relation to the metabolic effort zones and the power and capacity of pathways to synthesize and resynthesize the ATP. Recent studies of specialists in the field emphasize the importance of metabolic preparation to water polo players. Our research brings up-

to-date information about the athletes' body reaction to different types of training and compares these reactions to those of the adults.

From the *physical* standpoint, our research shows that, in preparing the modern game of water polo, a particular role is played by the mixed training for VO_2max at the central level, the anaerobic alactic (AA) pathway recruiting, at the peripheral level, the type II (fast) muscle fibers and the velocity effort. At the same time, specialized foreign literature that makes reference to the characteristics of effort in the game of water polo recommends to train the metabolic effort zones just as in swimmers. A water polo player uses in preparation swimming volumes between 4,000 and 6,000 m per day.

From the *technical-tactical* point of view, our research presents the metabolic demands during a match and during training, as well as the athletes' body reaction to these demands, which enables the coach to choose the correct tactical play, introducing into the team the best and most fit athletes.

From the *mental* standpoint, our research approaches both theoretical and practical aspects related to the players' motor and mental spheres, suggesting how to optimize them and the correlation between them during the specific effort.

The various demands of water polo game, in terms of effort, require the coaches in the field to know the energy pathways and apply them during training in different proportions, depending on the periodization of preparation, of metabolic means on effort zones.

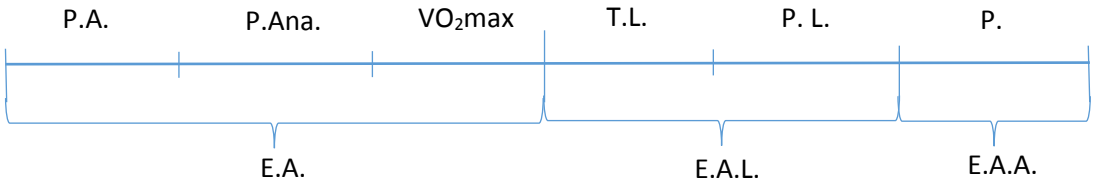

Figure 1. Distribution of metabolic effort zones according to the influence of O_2 on ATP resynthesis and exercise intensity. Legend: **P.A.** (Aerobic Threshold); **P.Ana.** (Anaerobic Threshold); **VO_2max** (Maximum Oxygen Consumption); **T.L.** (Tolerance to lactic acid accumulation); **P.L.** (Production of lactic acid); **P.** (Power); **E.A.** (Aerobic effort); **E.A.L.** (Anaerobic Lactacid Effort); **E.A.A.** (Anaerobic Alactacid Effort).

Conclusions drawn from the theoretical part: In this first part of the thesis, we wanted to bring updated and globally used specific information in order to support the water polo coaches in our country.

- It should be noted that, for reaching the steady state of maximum oxygen consumption (VO_2max), this one passes through many steady states which can be found in the concept of **VO_2 DRIFT**;
- The concept of VO_2 DRIFT represents the slow component of VO_2, therefore coaches must know this concept to avoid workouts in this effort zone;
- During training, there is something more important than knowing the VO_2max, namely knowing the maximum aerobic velocity (**VAM**), on the basis of which aerobic capacity can be developed. Athletes with a high VAM value reach sooner the maximum oxygen consumption, which is very important in training the upper endurance zone.
- Alactacid DO_2 does not overexert the body during exercise. The coach must necessarily know the following aspect: in DO_2 produced during power exercises, shorter breaks are allowed because there is no lactic acid accumulation, and the exercise-break ratio of 1:20 becomes 1:10 or 1:8, which makes possible to increase the work volume with maximal intensity;
- In pubertal children or adolescents, qualitative aerobic training is recommended to be associated with velocity training for exerting the I, IIa and IIb fibers and ensuring a good cardiovascular and psychomotor development (anaerobic threshold, VO_2, alactacid training, lactacid training);
- The game of water polo is characterized by an effort preponderantly situated in the VO_2 zone and with anaerobic penetrations;
- It seems that weight training is beneficial for children, who can participate in. The risk of injury, in the case of children and adolescents, is as low as in the case of adults, obviously if they practice a correct and carefully supervised training;
- It is recommended to use weight apparatus instead of individual weights, because it is thus removed the possibility to drop them to the floor. Weight training in children and adolescents will be performed according to the principles used for adults.

Part II: *Preliminary research on testing psychomotricity and exercise capacity through nonspecific means (on dry land) in water polo players – junior III,* which includes 3 chapters. **Chapter VI**: *Preliminary research methodology*; **Chapter VII**: *Recommended preparation programmes*; **Chapter VIII**: *Conclusions and elements of novelty drawn from the preliminary research*.

Purpose of preliminary research: Presenting the connection between effort dynamics/zoning and sports performance prediction, after applying some nonspecific tests to the players of two water polo clubs; Knowing the psychomotor capacity of water polo players – junior III and the possibility to achieve a positive

transfer of results towards the specific aquatic preparation for improving performances.

The **research methods** used were: test method, graphical method, statistical and mathematical methods (arithmetic mean, standard deviation, coefficient of variability, Pearson's correlation coefficient, coefficient of determination, Mann-Whitney U test, Kolmogorov-Smirnov test).

In the second part of the thesis, the **tests used** were the following: 5-minute endurance test; VAM-EVAL endurance test (maximum aerobic velocity); Bruininks-Oseretsky test battery, Second edition (BOT-2).

Conclusions of the preliminary research (the two research hypotheses have been validated):

- Using the Polar S625X Running Computer in testing/evaluations provides the coaches information about the following: metabolic cost, effort zoning, effort dynamics directing, covered distances, etc., which leads to an objective assessment of exercise capacity level;
- Results achieved in exercise capacity testing through nonspecific means show that the athletes from Steaua Sports Club have higher aerobic exercise capacity compared to those from Racovita Sports Club. The higher exercise capacity on dry land is correlated to a very good performance in the water environment, too.
- The lower the heartbeat and the longer the high-intensity effort, the higher the exercise capacity due to the economy of effort, functional harmony, etc.;
- The utilization of tests (VAM-EVAL and the 5-minute endurance test) reveals their role, value and limitations in assessing the athletes' effort. Coaches can make a clear distinction between the tests appropriate to assess the functional state and those accessible to them, which allows the measurement of exercise capacity;
- General and specific physical preparation on dry land is particularly important in the case of children to increase the water-specific motor acquisitions;
- The psychomotricity gained through the nonspecific preparation on dry land achieves a positive transfer towards the specific aquatic preparation, due to the improvement of motor skills and abilities;
- The results obtained in the championship by the athletes from Steaua Sports Club compared to those from Racovita Sports Club corroborate with the results obtained after applying the Bruininks-Oseretsky test battery, Second edition (BOT-2).

Part III: *Final research on the metabolic response to specific effort correlated with the effort zones in water polo players – junior III*, includes 4 chapters. **Chapter IX**: *Final research methodology*; **Chapter X**: *Presentation, analysis and interpretation of results*; **Chapter XI**: *Conclusions and elements of originality drawn from the final research*; **Chapter XII**: *Result dissemination and research limitations*.

Purpose of final research: Presenting the advantages of using, in the preparation of water polo players – junior III, the T-2000 test and knowing the exercise capacity level by means of biochemical tests.

Devices used: ABL835 Automatic blood gas analyzer; Dry chemistry analyzer - SPOTCHEM EZ Model SP-4430, designed by the Japanese Company ARKRAY Inc.; LACTATE PRO Lactate analyzer; HOSAND GT. AQUA Telemetry system.

Conclusions of the final research (the four research hypotheses have been validated):

- The effort in junior athletes follows the same training principles as in the case of adults. Among the external exercise parameters, the work-break ratio changes in favor of children;
- Biochemical measurements of specific effort performed at different intensity levels allow comparisons between athletes or positions in the team;
- Children may work with weights, however not for the muscle growth, but for improving the coordination capacity;
- Endurance training under high intensity and volume conditions is efficient and effective to increase endurance in pubertal children;
- A particularly important aspect refers to educating the sense of tempo and rhythm, without which the athletes cannot achieve the variations in intensity required by the effort zones;
- The lack of swimming preparation specific to the metabolic effort zones makes the water polo players unable to sustain efficiently the game-specific effort, and the technical-tactical performances have very large fluctuations in their forms of manifestation;
- After analyzing the metabolic cost during the 6 trials (3 specific to swimming and 3 specific to water polo game), we can conclude that, although the training intensity is low, the metabolic cost is high, which shows that the athletes are not trained (adapted) in these effort zones. The post-effort value of PCO_2 suggests that the respiratory system is not well trained and cannot sustain the exercise performed, which indicates that the metabolic response on effort zones in the game of water polo provides the coaches information about the specific preparation level of the players;

- The reliability and accuracy of the field data entitle us to assert that, regardless of the nature of effort specific to a sports discipline, in children and juniors, the effort must rely on improving the higher aerobic capacity, which will also induce unavoidably the development of anaerobic capacities;
- Extrapolating the correlation between LA and pH at R=1.18 (respiratory quotient), it can be noted that as the exercise intensity increases in our experimental athletes, the energy for effort sustaining is given by the anaerobic glycolysis, not by the lipid system, as it would be normal for the economy of effort (Crossover phenomenon). The assessment of these parameters shows that, for acyclic sports (sports games, combat disciplines, etc.), one should use mixed training means similar to those in the game, VO_2max for the central level and AA/AL (capacity: 5 to 15 sec.) for the peripheral level (recruiting type II muscle fibers and velocity work);
- It is possible to express intensity in percentages of the theoretical maximum frequency, as a condition to reach maximum oxygen consumption;
- One cannot make a correct prediction about/ connection between the maximum heart rate value reached and the performance level;
- Apparently paradoxically, the utilization of lactic acid production in our research is correlated with the higher aerobic processes, and the test results validate the correct choice of means proposed/ selected for the experiment, in close relationship with the effort specificity, the research title and the hypothesis appropriateness.

Elements of originality: Any type of research has elements of originality and is even more important if it brings a few or several elements of novelty. As regards the preliminary research, we think that its elements of originality are the following:

- Using the Polar S625X Running Computer to determine the effort dynamics and the metabolic cost during some nonspecific tests (on dry land) in water polo players – junior III;
- Establishing the psychomotricity level of water polo players – junior III by means of the Bruininks-Oseretsky test battery, Second edition (BOT-2);
- Establishing the VAM on dry land in water polo players – junior III;
- Correlating the preparation on dry land and the aquatic preparation of water polo players – junior III;
- Applying the T-2000 test to determine temporal limits and swimming velocities specific to the preparation on effort zones in water polo players – junior III;
- Establishing the lactic acid values in effort trials specific to the game of water polo – junior III;

- Establishing the relationship between respiratory system and exercise capacity level in water polo players – junior III;
- Correlating the exercise capacity level and the metabolic training on effort zones in water polo players;
- For the first time in Romania, the "interrupted trial" method is applied to this age category and this discipline, just as the use of the HOSAND GT. AQUA Telemetry system in the training of water polo players at this level is an original idea.

Research limitations:

- As these biochemical analyses underlie our research, they represent an efficient method to diagnose the exercise parameters, but unfortunately the high costs involved will hinder the constant use of this method;
- As to getting results, the collection process is difficult, because it involves, besides specialists in physical education and sports field, experts in biochemistry, and this requires the existence of an interdisciplinary team;
- Measurement and control devices have high costs, their purchase and maintenance being too expensive;
- Another limitation of the research would be the fact that water polo teams are not equipped with such high-tech devices, consequently the training schedule is not scientifically designed;
- It must be emphasized that the accuracy of biochemical diagnosis depends on the number of analyses per athlete;
- The nonexistence of comparative data in the past restricts a lot the diagnosis;
- Through the rhythmic investigation of biochemical reactivity during the year, the adaptation level and the effects of various stimuli can be controlled more rigorously. On these bases, the preparation plan can be corrected at the right moments, before appearing some possible signs of maladaptation;
- The lack of VAM-EVAL testing in the water environment, because of the inexistence in Romania of the specific device and software, as well of the specialists in measurement and interpretation of the collected data.

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