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"BABEŞ-BOLYAI" UNIVERSITY OF CLUJ-NAPOCA
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CONTRIBUTIONS REGARDING ATHLETIC TRAINING OPTIMIZATION – MOUNTAIN RUNNING RACES - THROUGH THE INFLUENCE OF TRAINING ALTITUDE TRAINING

SUMMARY OF DOCTORAL THESIS

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Keywords*:* altitude, mountain race, aerobic capacity, erythropoietin, hypoxia, haemoglobin, maximum aerobic velocity, maximum volume of oxygen.

The doctoral thesis, entitled ***Contributions regarding athletic training optimization –mountain running races– through the influence of altitude training,*** analyses the altitude training of the athletes specialised in mountain race athletic branch, through individualised training approach and directed according to the values of the maximum aerobic velocity.

The theme chosen to be researched is intended as gap filler of the literature and practice of this athletic branch. I wish that the solutions which have been adopted as a result of interpretation of data to improve the theoretical models, but also the practical ones in this area.

The doctoral thesis structure

The doctoral thesis is structured on the following parts: ***Introduction, Part I –*** *Scientific substantiation of the thesis****, Part II*** *– Preliminary research on altitude training of runners specialised in mountain race athletic branch****, Part III*** *Personal research on altitude training of runners specialised in mountain race – athletic branch,* ***Conclusions, Bibliography and Appendices.***

In the **introduction** part there is presented the importance of the theme chosen for research, the purpose of research and the reason for choosing the theme.

The interest in altitude training is part of the current questions which we must answer in connection with the competitive sport, at the intersection of the adaptation to altitude training and the acclimatization to hypoxia.

The scientific knowledge related to sports training are quite vast but still very far from the complexity of responses received from the human body and their transfer from practitioners (coaches, athletes) are often faced with two disadvantages:

➔ the first one is to convey the pieces of information simplified and thus they can be wrongly understood;

➔ the second one is to convey them non-contextually and so the interested parties may misinterpret them.

The aim of the research is to optimize the performance capacity of the mountain cross country race runners by addressing, in the sports training of some preparatory stages at altitude, in which an individualized training program is applied, according to ***the maximum aerobic velocity*** values on a representative sample.

The reasons which have led me to opt for this theme are: finding some methods and effective means that can optimize the training in the mountain race athletic branch. Concretely: using the individualized training method depending on the VAM values and its application at an average altitude of 2000m as an important indicator of the increase in effort capacity.

Part I **-** *Scientific substantiation of the thesis* contains five chapters structured as follows:

Chapter 1 *Scientific substantiation of sports training* with the subchapter entitled *The concept of sports training* focuses on several definitions of the sports training. In the subchapter entitled *Contents of sports training* there are presented the fundamental factors of training, namely: physical, technical, tactical, physiological, theoretical and psychological, essential factors of any training program, regardless of the athlete's age, individual potential, level of training or preparation phase.

Chapter I also includes the subchapter entitled *Effort in sports training* where there are presented:- Dimensioning and possibilities for effort evaluation, Specificity, Effort volume, Effort intensity, Effort duration, Effort density, Amplitude and frequency of stimuli in sports training, Effort complexity, Types of effort and their sources of energy and the adaptation to effort, Characteristics of adaptation to effort, Forms of adaptation to effort, Effort capacity, Evaluation of effort capacity, Effort training zones and blood lactate concentration.

Effort and rest are two components of sports training which, for the acquisition of an effective adaptation of the organism, they must be found in an optimum ratio, separated on different periods of training and according to the objectives pursued, age, sex etc.

The expression of an effort is done according to its support capacity by an athlete in a particular moment of his training.

The effort *volume* is synonymous with the concept of total "labour" from physics and it is represented by the total amount of mechanical work carried out during the course of a training unit.

In the sports training, the notion of *intensity* is synonymous with that of physical power or with mechanical work per unit of time thus, for the development of resistance or speed the intensity is measured in m/s, and for the force development exercises it is expressed as a percentage of F_{max}.

The effort duration is represented by the time the effort acts as excitant on the organism (*M. Georgescu*) or, more concretely, the time in which there are carried out certain exercises and series of envisaged volume and intensity exercises.

The effort density, or the stimulus density, represents the ratio between the time of stimulation and the time of rest from a unit training or in other words, the ratio between the duration of effort and the duration of breaks between efforts.

The complexity is another parameter of effort and it is represented by the number of driving operations carried out simultaneously during an activity.

The conditions of competition or of training require either a single way for the release of chemical energy, or both, which gave rise to 3 types of effort: ***anaerobic, aerobic and mixed*** (*M. Georgescu*).

The effort capacity is the maximum amount of mechanical work done per unit of time.

The aerobic effort capacity or the aerobic channel is the main way of progress in mountain running test.

The evaluation of effort capacity is done through field samples or laboratory samples, while assessing both the anaerobic capacity (alactic and lactic), and the aerobic one, using direct methods (which measure directly and accurately the researched parameter) and indirect (the researched parameter is estimated based on the relationship with other measurable parameters).

Chapter 2 – Mountain running, characteristics and techniques, has the following subchapters: *Appearance of mountain race, Historical landmarks, Appearance of National Mountain Running Organizations, Running technique in mountain race.*

An important aspect that should be noted is the fact that: the mountain running is a athletic branch.

In Romania the first official mountain running competition organized by the Romanian Athletics Federation took place in 2008, Sinaia.

The mountain running technique is approached by acquiring the middle-distance and long-distance running technique. The running step is identical with the long-distance race, but the obstacles arising along the way as well as the land relief leads the runner to tempo variations and to different settlements of the foot on the ground.

Considering the fact that the runway presents a different configuration of the ground, through its nature and profile, the race shall be adapted to the land conditions while taking into consideration:

- ⇨ the maintenance of general body balance;
- ⇨ the minimum modification of the pace set in moderate tempo;
- ⇨ the overcoming of obstacles with minimal effort.

In mountain running races we have: - running on flat ground, running uphill, walking uphill, descending slightly flat ground and descending rough ground.

Chapter 3 – The physiological and psychological characteristics of the athletes specialized in mountain running athletic branch with the subchapters: *Physiological characteristics, The body's adaptation to aerobic training, Psychological characteristics.*

Through training, the body's operational efficiency increases, as a result, its work capacity also increases gradually. Any increase in performance is based on a long period of adjustment and training, the body having morphological, physiological and psychological types of reaction.

Chapter 4 - Altitude- environmental factor contributing to the growth of sports performance has the following subchapters: *Hypoxia-physiologic adaptation to hypoxia, Cardiovascular adaptation to hypoxia, Respiratory adaptation to hypoxia, Haematological adaptations, Altitude effect on driving qualities, Performance capacity in hypoxia.*

Hypoxia is a pathological condition which involves an insufficient intake of oxygen in the body.

The physiological functions of the body under hypoxic stress will change in short-term (immediately), medium-term (a few days) and long-term (a few weeks). Two successive phases are characteristic: a period of acute stimulation followed by a period of chronic hypoxia acclimatization to hypoxia.

The transition from sea level to altitude is usually done in a few hours. In the first 48 hours, the driving qualities represent a constant of the level depending on the preparation from the plain. Starting with the 3rd day, under the previously shown bioclimatic factors, along with the functional status, the yield also worsens, by decreasing the main indexes of driving qualities.

Historically speaking the performances achieved in the aptitude tests from the Olympic Games in Mexico 1968 have clearly shown the altitude effect which decreased the performance capacity in sports involving aerobic efforts.

The last chapter of the first part is **Chapter 5 – Sports performance training at altitude,** with the subchapters: *Training methods in hypoxia, Altitude selection, Duration and effects of altitude training, Nutrition and training in hypoxia, Studies on the effects of various stages of altitude training on aerobic performance factors, Conclusions.*

There are several methods of training in hypoxia, namely:

➔ the traditional method: *lives and trains at altitude* (live high-train high LHTH);

➔ other more recent methods: *lives at altitude and trains at base* (live high-train low; LHTL), *lives at base and trains at altitude* (live low-train high; LLTH)

The choice of training at altitude should take into consideration the following factors:

- Existing climatic factors;
- Training objectives;
- The purpose of the various stages of preparation:
- after competition;
- in the preparatory period (most commonly used);
- during competition;
- The health of the athlete;
- The athlete's mental state;

- The financial aspect that involves the altitude training.

Part II includes *Preliminary research aiming at the altitude training of the athletes specialized in mountain running – athletic branch*. The first chapter of the second part is chapter 6 with the subchapters: *Research premises; Purpose of research; Objectives and tasks of the research; Preliminary research hypothesis; Stages of research; Research organization; Subjects of research; Equipment and materials used in the research; Research methods used and their application; Training plan established for 21 days of training stage at an altitude of 2000m and 600m.*

The mountain race is a relatively new test introduced in the Romanian Athletic Federation calendar, the training methods are taken from other related athletic branches: long-distance, cross country race.

The increase of performance in sport represents a permanent concern of coaches and of sports technicians.

The individualisation of training is a reality of the sport performance.

In the first stage of the preliminary research we observed the records of the maximum aerobic velocity (VAM) and of the maximum volume of oxygen (VO_2max) at athletes practicing mountain running - athletic branch before and after carrying out a preparatory stage of 21 days at an altitude of 2000m, athletes of French origin who carry out a training stage at C.N.E.A Font Romeu, France and who follow ***an individualized training*** program, *in terms of effort intensity, depending on the VAM and VO2max, values determined before the training stage*. The second stage in the preliminary research has been the training plan adaptation of French athletes to a group of Romanian athletes, practicing mountain running athletic branch, who carry out a training stage of 21 days at an altitude of 600m, in Blaj locality, Alba county, with the aim of highlighting *the effectiveness and accuracy of the proposed training methods, the necessity of individualization of training*, more precisely reconsidering the preparation of athletes specialised in this athletic branch, as well as the existence of a starting point in the training of the maximum aerobic velocity and of the increase of the maximum volume of oxygen by introducing in the training plan a preparatory stage of 21 days at higher altitude, which is the subject of the experimental research from the fifth part of the present paper.

In the preliminary research part we have used: *The directed pedagogical observation method; The method of measurement and evaluation; The comparative method; The statistical and mathematical method; The graphical method.*

The character of this preliminary research is an ascertaining one, through which I aim, on the one hand to point out the level which can be reached through the implementation of the training plan taken from the French athletes, and on the other hand to assure marks on which the subsequent experimental research can rely.

The monitoring of the group of athletes from France, who had undergone a training stage of 21 days, at an altitude of 2000m, and who had a training program planned and executed, in accordance with the VAM individual values, has proved an increase of 2,01% of the VAM and of 2,00% of the VO_2 max, which shows the effectiveness of the altitude training.

The monitoring of the group of athletes from Romania, who had undergone a training stage of 21 days, at an altitude of 600m and who had trained according to the individualized training program, has proved an increase of 1% of the VAM and of the VO_2max, which shows the efficiency of the training method carried out in accordance with the individual VAM and VO_2 max values.

This preliminary research, helped me to answer to hypothesis 1 of the present paper and has created the premises of the experimental research of the third part of the paper, namely: the inclusion of the training program of the year 2014 under the same conditions as in 2013 (before the National Mountain Running Championship) for the athletes from Group 2 (Blaj), of a training stage of 21 days at an altitude of 2000m (‘Piatra Arsă’) which applies the training method programmed in accordance with the individual VAM values, which leads to the triggering in the runners’ body of the physiological and biochemical effects favourable to support effort capacity regarding:

- ➔ respiratory physiology;
- ➔ physiology of cardiac activity;
- ➔ biochemical composition of blood (haemoglobin, hematocrit, erythropoietin);
- ➔ energy component of the muscular system (lactic acid, ATP, glucose).

Part III - *Personal research on altitude training of runners specialised in mountain race – athletic branch*, includes the following chapters:

Chapter 9 - Determination of research framework; with the subchapters: *The purpose of the research; Objectives of research; Working hypotheses; Stages of research; Organization of research; Battery of tests applied; Equipment and materials used in the research; Organization of research; Subjects of research;*

Chapter 10 - Research methods, with the subchapters: *Literature study method; Investigation method; Research experiment; The method of measurement and evaluation; The statistical and mathematical method; Verification of statistical hypotheses;*

Chapter 11 – Operational methods used in the altitude training stage – mountain running branch with the subchapters: *Training plan for athletes in the experimental group; Training plan for athletes in the control group;*

Chapter 12- Research results

Chapter 13- Conclusions

In the personal research part –**the purpose of the research** is to optimize the performance capacity of the mountain cross country race runners by addressing, in the sports training of some preparatory stages at altitude, some individualized training methods as well, depending on the MAV values, on a representative sample.

Working hypotheses

a. The introduction of a three-week training stage at an altitude of 600m in which the classical methods of training are used, that improves the sports performance of the athletes practicing mountain running sport test.

b. The inclusion of a preparatory training stage of 21 days at an altitude of 2000m in which an individualized training method is used with tempos set according to the MAV and PMA values, which leads to the triggering in the runners' body of the physiological and biochemical effects favourable to support effort capacity regarding:

- ➔ respiratory physiology;
- ➔ physiology of cardiac activity;
- ➔ biochemical composition of blood (haemoglobin, hematocrit, erythropoietin);
- ➔ energy component of the muscular system (lactic acid, ATP, glucose).

Organisation of research

This process consisted in the application of a battery of tests that have investigated the anthropometric, physiological, biochemical and metric indicators on 2 groups of 10 athletes specialized in mountain running sport test.

Battery of tests applied

1) The anthropometric indicators evaluate the degree of growth and the degree of physical development:

- dimensions of somatic mass: body weight – expressed in kg.

2) The biochemical indicators which determine the biological reactivity of the athletes:

- complete blood count (CBC);
- erythropoietin (EPO);

3) The physiological indicators that determine the level of effort capacity:

- maximum aerobic velocity (MAV);
- maximum oxygen consumption (VO_2 max);
- heart rate;
- oxygen saturation.

The approach of biological investigation has been conducted with the support of the Medical Praxis Laboratory of Blaj, under the strict supervision of Mrs. Talhos Mariana primary medical doctor clinical laboratory and microbiology at the Municipal Hospital Blaj.

In order to determine the maximum aerobic velocity (MAV) the TMI (le Train Maximal Impose) test has been used and for determining the maximum oxygen consumption (VO_2 max) it was used the *Mercier formula* $\boldsymbol{VO_2max = VMA \times 3,5}$.

Subjects of research

The selection of subjects was done with the written consent of those concerned.

The subjects who participated in the research were 10 in number for the group experiment aged between 18 and 29 years, and 10 athletes aged between 18 and 38 years for the control group.

As a result of the data analysis the research hypothesis has been confirmed.

The inclusion of a preparatory training stage of 21 days at an altitude of 2000m in which an individualized training method is used with tempos set according to VAM and VO_2max values, which leads to the triggering in the runners' body of the physiological and biochemical effects favourable to support effort capacity regarding:

- ***respiratory physiology;***
- ***physiology of cardiac activity;***
- ***biochemical composition of blood (haemoglobin, hematocrit, erythropoietin);***

Confirmed by the difference of higher performance obtained from the subjects in the final testing.

Concerning the VAM values: from an average of 19,29 km/h obtained in initial testing there has been recorded an increase of 4,86% reaching a value of 20,23km/h. The VO_2max has increased with 5,1% from an average of 67,37% to 70,80%.

Regarding the respiratory physiology, as a result of the measurements made with the help of a pulse oximeter a major decrease in oxygen concentration is found from 100% to values of 93,76% that grow slightly towards the end of the training stage due to the phenomenon of acclimatization.

Changes in the physiology of cardiac activity are highlighted as a result of monitoring heart activity, by measuring the pulse in the morning and in the evening the following is discovered. In the first 5 days the average cardiac frequency is of 65,02 beats/min, dropping at the end of training to an average of 52,22 beats/min due to the phenomenon of acclimatization.

As far as the biochemical composition of the blood is concerned, there have been recorded the biggest changes: the EPO has increased in altitude with 26,5% from an average of 5,18% to an average of 6,55%, the haemoglobin increased by 4,4% from an average of 14,51 before and at 15,15 after the preparatory stage.

Finally there can be determined a significant increase of performance capacity, due to favourable changes in physiological and biochemical products, as a result of exposure to hypoxia and of effective method of individualized training with fixed values of the VAM.

As a result of theoretical and experimental conclusions, drawn from preliminary research, of the second part of the work and of the experimental research in part 3, allow

me to make some recommendations regarding the planning and conducting of the individualized training according to the MAV values at altitude.

The use of VAM values in athletics training mountain running test:

- ➔ As an indicator of the effort intensity;
- ➔ As a means of training in order to increase aerobic effort capacity;

The use of training stage at altitude

- ➔ As a means to improve the aerobic performance capacity.

Combining the individualized training depending on the VAM values, with the altitude training and their use as a means to improve the sports form of the athletes specialized in mountain running sport test.

In order to increase aerobic performance of the athletes practicing mountain running athletic branch, I recommend performing two stages of training at altitude. The first stage should be in spring before the European and Balkan championships and the second one in August before the national and world championships of the same kind.

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