

MINISTRY OF EDUCATION, RESEARCH, YOUTH AND SPORT  
NATIONAL UNIVERSITY OF PHYSICAL EDUCATION AND SPORT

**BLOOD LACTATE RESPONSE, AN IMPORTANT TOOL IN PREDICTING  
AND OPTIMIZING ENDURANCE IN FOOTBALL**

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**Key words: blood lactate, optimization, prediction, endurance, football**

Over time, professional sports, in general, and football in particular, have undergone multiple transformations, becoming a social phenomenon which encompasses an important segment of the Earth's population. Researchers from different areas of activity have put themselves to the service of professional sports, eventually contributing to the formation of an interdisciplinary field, where every element has a well-defined place. For decades, research and scientific information have prevailed generating unimaginable results in the sports field.

Nowadays, biochemical diagnosis represents a basic means of planning sports training, by establishing with precision the status of the professional sportsman. Having clear information about the response of the sportsman's body to the effort to which he or she has been submitted, one can assure with a large dose of objectivity the continuity of the training and the evolution prognosis in terms of efficiency and performance for those involved in the sports activity.

This paper, even through its title "Blood lactate response – an important tool in predicting and optimizing endurance in football" is connected to the current elements of professional sports. This thesis focuses on the information obtained from the professional sportsman through invasive methods, the tested element being the blood lactate concentration, which is known to be an accurate indicator of effort intensity. Our doctoral thesis is structured in three parts: a theoretical part, a preliminary research and an experimental research.

The first part represents the theoretical foundation of the paper and it consists of the following chapters:

- Introduction
- Present knowledge stage of the specialized literature

- The muscle – active movement component
- Aspects concerning endurance in football
- Blood lactate, biochemical diagnosis component in physical effort

In this first part, the author motivated the choice of this topic, respectively the necessity of approaching training from a scientific perspective, as well as the latest advancements in the field, as reflected in the specialized literature, more precisely the relationship between effort intensity and blood lactate concentration. We highlight here the existence of a wide international literature, as compared to the domestic literature, in which we have only sporadically encountered this topic, especially in the medical field and less in practical applications.

Due to the nature of this topic, which is based on the physiological response of the human body to specific physical effort, it seemed necessary that the theoretical foundation of the paper should include elements referring to the morphology and the physiology of the striated muscle, the enumeration of the human body energy sources, the means of producing mechanical energy, as well as the physical characteristics of specific effort in football. We dedicated the end of the first part to the notion of blood lactate, more specifically to the course of production and elimination, its effects on the body, its direct relationship with physical exercise and the subchapter ends with a few theoretical conclusions concerning these aspects, presented in a concise but clear manner.

The second part of the thesis focuses on a preliminary research, through which the author sought, on the one hand, to answer the question of training personalization, based on the blood lactate concentration as an answer to specific effort and on the other hand to insure the basis for the experimental research presented in the third part of this paper. Basically, the preliminary research consisted of registering the blood lactate level at the end of and during a football competition. Thirty-seven subjects coming from 3 different teams have been monitored. We tested a senior players team with ages between 19 and 38 and two junior players teams, one with players between the ages of 17 and 18 and the other one between the ages of 14 and 15.

The results marked a large segment of blood lactate concentration values, as a response of the human body to physical effort, respectively between 8.2 mmol/l and 15.1 mmol/l for the subjects who played full game and over 6 mmol/l for those with part-time performance. After close scrutiny, we were able to determine that the results were conditioned by a large number of factors: the dynamics of offense and defense proceedings, the players' profiles according to positions, individual profiles in the same position, age and football

experience, individual value of each player, metabolic memory of the body, the match conditions etc. The only values which do not respect this pattern are the ones registered by the goalkeeper, which are close to blood lactate values when at rest. The rather small concentrations of blood lactate registered with the goalkeeper position, as compared to those of the rest of the players, entitle us to assert that the physical training of the goalkeeper must be reconsidered in contrast with the other positions, where even if we encounter different values within the same position, lactacidemia levels are sufficiently large as to disturb effort capacity. This single fact entitles us to assert that blood lactate is an indicator for training personalization in football and this personalization, in reference to the goalkeeper's position and the rest of the football players will focus on effort intensity during training, more precisely: low lactate concentration exercises for goalkeepers i.e. alactic anaerobic and aerobic exercises, low and high lactate concentration exercises for the rest of the players i.e. anaerobic-alactacid exercises, lactic-anaerobic and aerobic exercises.

Our preliminary research enables us to confirm our hypothesis: *“Blood lactate response can become an indicator in endurance optimization in the relationship goalkeeper - field-player”* and creates the premises of experimental research from the third part of the paper, more specifically high lactate concentrations in football players require lactate threshold training. A question mark is raised in terms of training methods, more precisely the issue of solving a controversy between domain specialists, that of choosing between training the lactate tolerant energy system or accumulating the systems through specific training.

The third part of our paper has an experimental character and during this endeavor we seek to elucidate the two hypotheses:

*Hypothesis 1: Training the lactate anaerobic system as a single unit during a practice, as a result of the high level of blood lactate in football, can contribute to the optimization of endurance capacity in football.*

*Hypothesis 2: Following repeated maximal efforts, blood lactate values can be an indicator for the prediction of acidosis tolerance.*

The verification of the research hypotheses involved the use of two groups of subjects: the experiment group (11 subjects) and the control group (11 subjects), who were submitted to a 60 seconds maximal endurance test, divided into 3 segments of 20 seconds, with an active break of 40 seconds between the segments, the effort consisting of circuit training. Both at the end and during the exercises certain indicators were measured: blood lactate levels, overall performance, performance on effort segments, cardiac sequence at the beginning and at the

end of each effort segment, cardiac sequence after the effort (minute 2.30 - 3). Before the test the maximum aerobic speed will be measured.

The training programs for the experiment and control teams lasted 8 weeks. The first and the last week (1 and 8) were saved for evaluations (initial and final tests) and the weeks in-between (2 to 7) were intended for the subjects' training. The subjects from the two groups trained together, following identical training programs, except for Tuesday (the second day of the weekly training) towards the final period of the fundamental part, when the training means were different for the subjects of the two groups, as follows:

- the subjects of the experiment group were applied a 30-40 minute lactic-anaerobic training program (maximal efforts of 30-60 second, with a 3-4 minute break in-between);
- the subjects of the control group had their lactic-anaerobic training program replaced by a 30 minute aerobic effort program.

The statistical analysis and interpretation of the results led to the following conclusions:

*Hypothesis 1: The training of the lactic-anaerobic system as a single unit during a practice, as a result of the high level of blood lactate concentration in football, can contribute to the optimization of effort capacity in football.*

This hypothesis was confirmed by the results of the research experiment, over the course of which the subjects of the experiment group have significantly improved their performances on the maximal effort test. From an average of 271.8 meters obtained at the initial testing, after applying a lactic-anaerobic exercise program (one training per week, over the course of 6 weeks), an average of 282.2 meters was obtained, as compared to the subjects of the control group whose performances obtained at the physical effort test do not differ significantly from the initial testing, where they obtained an average performance of 269.5 meters meanwhile at the final testing an average of 271.3 was obtained. These performances were registered on a high blood lactate concentration i.e. 13.9 mmol/l (initial test) and 15.5 mmol/l (final test) – average values obtained by the subjects of the experiment group, respectively 13.8 mmol/l and 13.5 mmol/l – the results obtained by the subjects of the control team. The statistical methods confirmed that there were significant differences between the performances obtained by the subjects of the experiment group and the subjects of the control group at the maximal effort test, at the final testing, in favor of the experiment group. Nevertheless, no significant differences were registered regarding the average level of blood lactate concentration both at the initial and the final testing. We can thus conclude that the

subjects of the experimental group have tolerated much better the high levels of blood lactate concentration at the final testing, obtaining superior performances, as compared to the subjects of the control group, who, approximately on the same background of lactacidemia, have registered inferior results.

*Hypothesis 2: After repeated maximal efforts, blood lactate values can be an indicator for the prediction of acidosis tolerance.*

Confirmed by the larger performance difference obtained by the subjects from the 8-12 mmol/l lactate level, between the initial and the final tests, respectively 15 meters, as compared to the performance difference between the two tests in the case of the subjects with a lactate level of >12 mmol/l, respectively an average of 9.4 meters, provided that the results are related to the average of the overall performance of 282.2 meters, obtained by the subjects of the experiment group i.e. the result of the maximal effort test has to be equal to or higher than this.

Following the theoretical and experimental conclusions drawn from preliminary research from the second part of the paper and from the experimental research from the third part we are able to make a few recommendations concerning the possible approaches to football training, on the basis of registering blood lactate concentration level.

1. The use of blood lactate in football training:
  - as indicator of effort intensity;
  - as indicator of the way players engage in effort over the course of a sports competition;
  - as indicator of acidosis tolerance in the case of a maximal effort, related to the obtained performance.
2. Avoiding high lactate concentrations in goalkeeper training.
3. Training the lactic-anaerobic system as a single unit during the football training.

Hoping that the information contained in this paper will be useful to football practitioners, the author expresses his gratitude to the professors in the U.N.E.F.S.<sup>1</sup>, who contributed to his formation as a coach and physical education teacher and to those who brought their contribution to the completion of this doctoral thesis.

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<sup>1</sup> National University of Physical Education and Sport from Bucharest.