

## THEORY OF HYPOXIC IMPACT ON CYCLING

*Professional paper*

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### **Abstract**

*In cycling was noted that the tolerance and adaptation to hypoxic stress have strictly individual character. It was found that the adaptation processes in high-altitude conditions have phase pattern. Admittedly, from the set of all activities that provide high efficiency of training process for cyclists as primary role are the special effects of hypoxia training. Increased workability of cyclists after the returning from altitude training camp is reserved for a longer period (around 30-40 days) depending on the discipline, training methods during this period, and cyclists altitude training experience.*

**Keywords:** *hypoxia adaptation altitude, training, development, cyclists*

### **INTRODUCTION**

Hypoxia is a condition that sets in when levels of oxygen in air contains less oxygen molecules compared to the air at the sea level, which troubles human activities. The main reason for this is the significant change in the barometric pressure, which is normally a function of significant altitude changes. Barometric pressure is related to atmosphere density which is proportionally reduced by it. Following it the partial pressure of inhaled oxygen is reduced (Zhelyazkov, & Dacheva (Желязков, & Дашева), 2011).

The condition of hypoxia is known for thousands of years, and as more than 30 million people all over the world live at 2500 or more meters above sea level. Its scientific explanation was formed during 19<sup>th</sup> century. In the modern era of sport physiology and sports theory we can point the names of Krastev, Iliev, Staykov and Dasheva and many others who worked on the problems regarding hypoxia in sports.

The barometric pressure is directly related to atmosphere density and it reduces proportionally. This means that as the barometric pressure lowers the inhaled air has lower partial oxygen levels (pO<sub>2</sub>). This means that one unit of inhaled air contains less oxygen molecules compared to the sea level, in other words hypoxia hinders the normal human body activities. From these positions we turn our attention to the hypoxic training of road cyclists where we find priority link between training and competition activities.

The aim of the following theoretical study is to reveal the characteristic of the theory of hypoxic effects of road cycling.

### **METHODS**

The study was conducted using the following methods: survey of information sources, document materials, theoretical analysis and synthesis.

### **RESULTS**

Sport training in unconventional altitude conditions is seen as a powerful factor that increases adaptation abilities of athletes and puts it to a qualitatively new level that ensures maximum realization during competition (Zhelyazkov, & Dacheva (Желязков & Дашева), 2011).

Hypoxia adaptation is realized in three main directions:

- Expanding the capacity human body of oxygen reception and transport;
- Improving the mechanism of oxygen uptake by body tissues;

- Economization of body power consumption through changes at cellular and subcellular level. Adaptation changes develop gradually and most important of them are:
- Increased hematopoiesis, thanks to which the number of red blood cells, and the concentration and total amount of hemoglobin in blood substantially increases. The regression model shows that relationship between geographical height and hemoglobin concentration has a complex character of a third order polynomial.
- ATP re-synthesis is increased
- The respiratory enzymes in tissues activity and increases the activity of enzymes which are directly or indirectly involved in the oxidation processes are increased;
- Dissociation of oxyhemoglobin curve in such matter that oxygen passes into the tissue at a lower gradient (pO<sub>2</sub>), on both sides of the biological membranes, changes;
- Permeability of capillaries improves the and the size and number of mitochondria and cellular structures specialized for oxygen acceptance and use increases.

In cycling was noted that the tolerance and adaptation to hypoxic stress have strictly individual character. It was found that the adaptation processes in high-altitude conditions have phase pattern. Based on a summary of a number of authors researches, we can outline the following main phases:

*Phase of primary reaction* (phase of false adaptation stability) – from seven hours to 2-3 days. It is characterized by and overall positive emotional arousal and increased functional activity.

*Phase of acute adaptation* (acclimatization) has individual duration between 3 and 6 days. During this period, we find a significant decrease of VO<sub>2</sub> max which is partially restored at the end of the third week. Heart rate is also increased, even in the recovery period, which is normal human body reaction during adaptation process. Due to the fact that human organism fights hypoxia the recovery time after training is longer. Also a highlighted fatigue appears. Training loads should be with medium volume and low intensity.

*Phase of transient adaptation* has duration between 5-10 days. It is characterized by a relatively stable structural and functional changes. Partial effects of this transition are expressed in development of erythrocytosis, which is accompanied by a remarkable increase of surface breathing, increased adre-

nergic regulation of heart and increase concentration of hemoglobin. During this phase cyclists' performance gradually increases. Negative phenomena influence is gradually decreased and human body normalizes its functions. This phase is most strongly influenced by the individual tolerability of the cyclists to hypoxic stress, as well as his experiences with altitude training.

*Stable phase (sustainable) adaptation* (after the 10<sup>th</sup> to 20<sup>th</sup> day). It is characterized with the improvement of all indexes of human body functional state: heart rate at rest is lowered to a stable pace, also breathing rhythm is stabilized, blood pressure is normalized, aerobic capacity is increased and a sustainable wellbeing appears. The volume and intensity of training loads progressively increases in order to reach a level close to normal altitude conditions – at the end of the second week.

A natural sequel of adaptation process in altitude conditions is the phase of re-acclimatization. The different recovery speed of neuromuscular apparatus and cardiorespiratory system during this phase generally creates an opportunity for excellent sport results during this period. Here we must keep in mind that this period also has phase character. He runs as a curved function of time at an exponential law, but with significant variations around the main trend, which over time gradually subside. Possible are both excellent and poor performances when participating in competitions during the re-acclimatization phase.

The wavering pace of sport performance curve in the re-acclimatization phase is explained by varying speed of re-adaptations of various functional systems and subsystems to normal conditions. Re-adaptation time depends on many factors, but two of them are the most important:

- Duration of stay in altitude conditions;
- Main character of training work during the acclimatization period.

A prolonged altitude training in cycling causes a larger adaptation changes and leaves a long lasting marks on performance. It also has a long lasting effect on functional capacity of human body if during re-acclimatization it is used in adequate way.

Adaptation speed of various body functions and system differs. Breathing and blood circulation normalize faster than the changes of blood and muscle structures. The return to normal conditions of partial oxygen pressure immediately removes the lack of O<sub>2</sub> in blood and the need for increase air ventilation and blood minute volume circulation. Normalization of ventilation immediately removes hypercapnia, but also alkaline-acid balance and normal buffer capacity of blood is gradually restored over a few days. Approximately the same time duration is necessary to restore human body water balance.

Restore of usual levels of individual subsystems functioning (as respiration, blood circulation, internal environment) and the whole system (human body) requires several days for optimal coordination and synchronization. Perhaps the lack of harmony between these changes during re-acclimatization period is the reason for instability of sport results in the initial phase. This is described by many authors and we find different views on the optimal time for participation in competitions after altitude training camp.

In the later stages of acclimatization – at the end of the second week after a more dynamic changes have been completed and fine-tuning system regulations is close to optimum can be achieved excellent sport results in the endurance disciplines with long lasting intense physical activities. Increased workability of cyclists after the returning from altitude training camp is reserved for a longer period (around 30-40 days) depending on the discipline, training methods during this period, and cyclists altitude training experience. Altitude training positive effect remains for a longer period when training sessions demand high levels of aerobic capacity, and they must be close to the upper limit of the aerobic metabolism close to anaerobic threshold. After this period are experienced the first symptoms of maladaptation. First related is the blood circulation, respiration, blood composition, and the oxygen utilization by tissues.

Studies show that more than 85-90% of the best performances after altitude training are registered between 3<sup>rd</sup>-4<sup>th</sup> and 18<sup>th</sup>-24<sup>th</sup> day. Clearly, sport training process in the phase of acclimatization to medium altitude conditions and during re-acclimatization – after the return to normal conditions should be pursuant to the specific changes of human body functional capacity. This requires appropriate changes in training methodology, without which it will not be possible to make optimum use of functional potential gained during altitude training and realize the increase operational capacity in cycling competitions under normal conditions.

## CONCLUSIONS

Admittedly, from the set of all activities that provide high efficiency of training process for cyclists as primary role are the special effects of hypoxia training.

Their structure, content and time duration will not only optimize, but adequately change training process management. It is therefore appropriate to have an analysis of activities associated with the type of training. We believe that this will allow our specialists to professionally analyze and better forecast future coaching activities for the successful development of cycling in Bulgaria.

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