Case analysis of exercise and nutritional balance, biological monitoring, and training load during altitude training

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Abstract

In this paper, under the same conditions of load intensity, comparative study of altitude training environment marathoners changes biochemical markers, in order to identify marathon load intensity effective evaluation methods and means in plain. Altitude training conditions and provide scientific in accordance with training theory. Through the plains and altitude training, the collected physiological and biochemical indexes analysis to identify elite athletes physiological and biochemical characteristics of indicators. Creatine kinase, blood urea, hemoglobin four indicators to focus lesson units for analysis. In this paper, physiological and biochemical indices of the Chinese elite male marathoners training process monitor and concrete empirical example. Indexes and analysis through case studies and group combining research training during various training methods. Then establishment of physiological and biochemical evaluation system.

Keywords: Marathon, Nutritional balance, Tracking and monitoring, Biochemical indicators, Comparative analysis.

1. INTRODUCTION

With the gradual rise of the marathon movement, altitude training has been carried out to improve the means necessary marathon athletes of physical functions. It has been widely adopted trainer, marathon today altitude training project which achieved some experience and achievements (Lewis, 2015; Girard, 2013; Buchheit, 2014). Due to special circumstances, altitude training plateau level of stimulation to the body than the plain training large extent on the body to stimulate the athletes to withstand the intensity of exercise load and load also must also face hypoxia, dry climate, altitude and so cold Environmental issues (Tong, 2015; Michalczyk, 2016). We can say that altitude training can enhance athletes under hypoxic state high-intensity training to improve the athlete's bodily functions, the potential power players to play their own kind of training means physical limits (Paoli, 2016).

Altitude training is hypoxia, under special environmental conditions and strong ultraviolet radiation (Schmitt, 2013; Stellingwerff, 2014). An intensive training, athletes can achieve in plain training can not be reached with the training load training results, so that more players can approach their physical limits, and more depth play the body's own potential, better training and the completion of every game (Alexandre, 2012). The effectiveness of post-altitude training athletes with better training effect is completed altitude training return plains, the body's physiological and biochemical function will produce superior recovery state, the athlete's body function level will be significantly improved (Walsh, 2016; Düking, 2016; Neal, 2013). Altitude training is an important way to improve the player results, the difference Altitude Training and Plain Training Institute exists mainly reflected in: (1) at the same absolute exercise load, physiological athlete's stimulus altitude training were more than plain; (2) different environments for training individual anaerobic threshold intensity of the environment, in heart function and breathing machines and other stimuli, there are different characteristics.

Elite marathon referred to herein is for the national excellent athletes. Scientific training with a scientific approach to athletic training athletes. Results from the study of its connotation contains two meanings: First, the ability to limit the boundaries of individual research projects, as far as possible to explore human potential is close to that goal; the second is to maximize the efficiency of training, up to a certain train shortest training time level (Debevec, 2014; Mazze, 2016). In short, the goal is to maximize the training to achieve absolute and relative target. To this end, coaches just by some local experience and knowledge of the law is not enough, they must be shared with all relevant research disciplines researchers, using a variety of indicators showing the ability to monitor the movement of the training process in order to achieve the most good training effect. Thus,
it is determined and related research methods to test a variety of indicators of scientific training has become the extension of the main content (Haakonsen, 2016).

Elite marathon runners in this article are the maximum energy of 80% of body functions during the experiment exercise, there will be micro-muscle injury. Immediately after serum creatine kinase plateau set of motion changes significantly (p<0.05), with significant differences. 12 hours after exercise, the two groups have reached a peak creatine kinase, and then gradually recover, which is substantially the same as the views of other researchers. Special plateau environment immediate cause serum creatine kinase after plateau set of motion on the show a substantial rise over the previous quiet parameter appears significant, continued to rise in the 12 hours after exercise, peak, peak relatively high plains group. The rate of change of serum creatine kinase values immediately after the emergence of a significant movement of the two groups, indicating that the same training program, training in high altitude level of stimulation on skeletal muscle is more intense, deeper, heavier damage on skeletal muscle.

2. MATERIALS AND METHODS

2.1 The study objects

Subjects were excellent marathon athletes 8 female, healthy, non-native plateau who can adapt and plains, plateaus two training mode. Before experimental operation, the physical indicators are normal subjects, no abnormal state, each function and biochemical indices of the experiment involved are normal. 8 Mingmalasong athletes were randomly divided into groups plains and plateaus group, every four pairs, set the plain plateau group training times are five weeks. The basic situation of two players as shown in Table 1.

<table>
<thead>
<tr>
<th>group</th>
<th>age</th>
<th>height</th>
<th>weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain group</td>
<td>27.5±3.24</td>
<td>163.9±2.48</td>
<td>48.9±2.14</td>
</tr>
<tr>
<td>Plateau group</td>
<td>25.4±2.11</td>
<td>164.8±3.96</td>
<td>49.2±3.29</td>
</tr>
</tbody>
</table>

2.2 Research methods

Using aerobic capacity and anaerobic capacity polar heart rate, heart and lung function portable telemetry systems and Lactate-scout lactate analyzer, calculation and analysis of athletes. Blood lactate test using a curing enzyme electrode, heart rate, blood lactate test, the test venue for sports training base.

Use Monitoring Blood Lactic Acid, Japan Kyoto, blood lactate analyzer Lactate ProTMLT-1710. Earlobe blood collected using a quantitative instrument automatically draw 5 microliters of whole blood, blood samples automatic detection, measurement is completed in 60 seconds, the repeatability (C.V) precision of 3% of the test results. General training sessions focused on training content immediately after the end of the 3 minutes measured.

Creatine kinase measurement instruments Blood Urea is produced in Shenzhen RaytoLeidu RT-1904C semi-automatic biochemical analyzer; reagent BIOSINO Biotechnology Co., Ltd. production of a kit. 50 microliters of blood collected fingertips, into 0.5 ml conical tubes were centrifuged through a centrifuge to obtain serum waiting to be tested. Determination of a morning was focus on general training sessions per week for 24 hours.

Indexes measuring instrument serum testosterone production Shenzhen MAGIMUZYME-III (intelligent) type of quantitative ELISA analyzer, the instrument has detected faster (1-2 hours), the instrument can calculate the results of their own data, they can always quiz, specificity, reproducible, stable color results and so on. Reagents times by Beijing Icahn Biotechnology Limited production of testosterone quantitative detection kit.100 microliters of blood collection means, into 0.5 ml conical tubes were centrifuged with 3000rpm*10min centrifuge measured in serum.
Hemoglobin index were detected using blood cell count. Weekly initial training, in a quiet state athletes conduct a test, Ear 20 microliters of blood, understand and master athletes whether anemia, as well as environmental external factors on the physical function of stimulus level.

3. RESULTS AND DISCUSSION

3.1 Exercise heart rate applied in marathon training tracking and monitoring

Sports athletes heart rate is a reflection of the current load on the body is an important indicator of the degree of stimulation. Since the heart rate 120bpm? Within the anaerobic threshold heart rate range is highly correlated with the intensity of training, so the target heart rate (mean athletes physiological load intensity target value) has been widely used in modern training. While the sports center rate monitor exercise intensity is an important means to understand the physiological load caused by the athlete. It is noteworthy that, when the heart rate during exercise marathon runner reaches the anaerobic threshold heart rate gradually from the original linear relationship, so after use exceeds the anaerobic threshold heart rate training load evaluation, only the point corresponding to, and not simply speculation physiological load at this time. Meanwhile, under the same load, with the improvement of exercise capacity, the average heart rate will decline, mainly due to the increased coordination of action (energy saving technology) and strengthen myocardial contractility (ability to improve ejection) caused. High-level athletes in heart rate or decrease in heart rate at the same running speed under the same load under the improved technology could improve athlete movements, muscle relaxation ability to improve performance. Figure 1 is a marathon runner to run training courses relaxation heart rate monitor instance.

![Figure 1](image1.png)

**Figure 1.** A marathon runner to run training courses relaxation heart rate monitor instance

Athletes during training heart rate monitoring method is in the process of training for athletes to wear the wrist, after training the heart rate table information into a computer, and changes in heart rate is determined by the players physical condition, for example, from long-distance training heart rate trends can be seen in front of the main requirements to run relaxed, slower, so the heart rate is low, after the process requires athletes to accelerate the heart rate significantly higher than the previous. With a heart rate monitor to control the intensity of training athletes know to facilitate their training situation, but also facilitate the completion of the training coaches to be checked. Figure 2 is a long-distance athlete training courses in heart rate cases.

![Figure 2](image2.png)

**Figure 2.** Players first 38 kilometers the first training session heart rate change
From the change of heart rate interval training sessions 5000m viewed (Figure 3), the average heart rate of 171 athletes, the maximum heart rate, intermittent time of 6 minutes, the athlete's heart rate during intermittent recovery faster, proceeding to the next set of training when the heart rate can be restored to 100 times less, indicating that athletes can fully recover, coaches may be appropriate to shorten the time interval, increase the difficulty of training. Changes from 1000m intermittent training session heart rate view (Figure 4), the average heart rate of 156 athletes, the heart rate of 178 innings, intermittent time of 2 minutes, during the next set of training, athlete's heart rate can be restored to 130, indicating that athletes are able to train the next group. Players from each training heart rate recovery speed, the better the functional state of athletes, no fatigue. It should be noted that, when the single-use heart rate monitor training intensity indicator, does not reflect the accumulated strength, because when athletes under poor functional state, or longer training time, the fatigue began to accumulate as the heart rate will exceed the real exercise intensity. If used to evaluate the training intensity will be some deviation.

**Figure 3.** Athletes 5000m intermittent running workout heart rate change

**Figure 4.** Athletes 1000m intermittent running workout heart rate change

Preparatory activities before the training session, training session high intensity interval time can also be used to monitor heart rate. Athletes Warning effects and physical condition of the athletes may also be mobilized through the training session before the heart rate after the preparatory activities to reflect that the coaches to see if the athlete's body has already done for special training sessions to prepare. Athletes in the special training class, by measuring heart rate immediately after its entry training and heart rate changes intermittently restored, can determine the athlete Special Training Course Training intermittent schedule is reasonable. In general, high-intensity intermittent training and special long moderate-intensity endurance training interspersed, it can make special training to withstand heavy load training muscle groups in the training process to obtain appropriate adjustments and recovery.

Coach specific training in arranging several sets of intensive and specialized training and moderate intensity, we must also pay attention to reasonable arrangements for rest time athlete. If, at the increased training load of athletes, interval training time between short and high intensity exercise special action is too dense, the body has not been appropriate recovery, it began to train the next group, the local muscle fatigue sports injury induced, resulting in athletes decreased exercise capacity. Instead athlete intermittent time is too long, resulting in the body and also to have a re-mobilization process, re-habilitation load influence the effectiveness of training.
Therefore, when the continuity of the high-intensity special training class, the time interval between each control heart rate 120b/min or so and then the next set of exercises to ensure the training effect.

3.2 Plain, plateau training biochemical indexes

3.2.1 Changes of serum creatine kinase

As can be seen from Table 2 and Figure 5, immediately after the plain set of motion serum creatine kinase changes are not obvious, but 12 hours after exercise reached its peak, and then continued to decline. Immediately after the plateau group on the plateau, with respect to the values of serum creatine kinase appears quiet rising state, immediately after exercise changes significantly (p <0.05), with significant differences; 12 hours after exercise peaked and then began to decline in serum creatine kinase, 48 hours significantly decreased rate, returned to the quiet state.

**Table 2 Changes of serum creatine kinase (n=8) (unit: mmol/L)**

<table>
<thead>
<tr>
<th></th>
<th>Rest state Before exercise</th>
<th>Immediately After exercise</th>
<th>12h after exercise</th>
<th>24h after exercise</th>
<th>48h after exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plain group</strong></td>
<td>189.8±83.90</td>
<td>219.4±48.1</td>
<td>342.8±87.9</td>
<td>314.1±68.7</td>
<td>273.8±57.4</td>
</tr>
<tr>
<td><strong>Plateau group</strong></td>
<td>215.9±42.4</td>
<td>372.5±57.9</td>
<td>380.2±51.3</td>
<td>257.0±71.3</td>
<td>194.4±36.2</td>
</tr>
</tbody>
</table>

**Figure 5. Changes of serum creatine kinase**

Blood urea as amino acid and protein metabolism in the final product, not only can monitor the sports training load, but also can reflect the body's metabolism and muscle fatigue recovery. Blood Urea is subject urea synthesis in liver, kidney function and excretion of. In normal training state, urea values in a relatively balanced state. Usually before and after exercise and the next morning to take trace (20 microliters) finger blood was measured. After the training session, morning value 8.0 mmol/L or more is normal, but also need to athlete's own body, the feel, the size of the intensity of training as well as other indicators of physical function were athletes comprehensive analysis.

Under normal physiological state of the body, urea production and excretion in a relatively balanced, relatively stable state. High Intensity Training consumes a lot of muscle glycogen, the body's equilibrium destroyed; when catabolism enhanced physical function, there will be an increase in the amount of urea phenomenon, prompting blood urea levels in the blood rises. Many studies have shown that high-intensity exercise training after making substantial increases in blood urea, blood urea value immediately appears significantly improved after training, 12 hours after exercise, will reach a peak; after recovery after training and adjustment after exercise 48 hours, blood urea nitrogen returned to the quiet state.

**3.2.2 Changes in blood urea**

As can be seen from Table 3 and Figure 6, the plain set of athletic training 12 hours Blood Urea peak, then gradually began to decline, 48 hours after exercise returned to normal. After the beginning of the plateau plateau
group, at rest before exercise appear to rise more than the quiet state, immediately after exercise and 12 hours (p <0.01) after exercise, with extremely significant difference. 48 hours after exercise, blood urea recovered quiet state.

**Table 3 Changes of blood urea (n=8) (unit: mmol/L)**

<table>
<thead>
<tr>
<th></th>
<th>Rest value</th>
<th>Rest state before exercise</th>
<th>Immediately after exercise</th>
<th>12h after exercise</th>
<th>24h after exercise</th>
<th>48h after exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain group</td>
<td>3.54±1.94</td>
<td>3.54±1.03</td>
<td>4.57±1.32</td>
<td>8.83±2.42</td>
<td>4.13±0.82</td>
<td>3.72±0.96</td>
</tr>
<tr>
<td>Plateau group</td>
<td>3.85±1.83</td>
<td>5.83±1.21</td>
<td>7.24±1.42</td>
<td>11.45±2.94</td>
<td>5.23±1.84</td>
<td>3.72±0.85</td>
</tr>
</tbody>
</table>

**Figure 6. Changes in blood urea**

Testosterone is to strengthen the body's own anabolic raised an androgen, in sports training, to improve the health of athletes load level, load and withstand motion and time have good results. The research shows that testosterone in the blood during exercise training appears to rise, then a state of decline. However, the fall time of serum testosterone, is affected by exercise training in a variety of factors. If you insist on long-term continuous heavy load training, especially in the body can cause potential endurance training athletes in a quiet state serum testosterone decline, and in the early training, athletes will be elevated serum testosterone phenomenon, with the training volume and intensity of training increase, enhance blood testosterone value will go down state, but after adjustment training serum testosterone will gradually recover.

### 3.2.3 Hemoglobin phase change

As can be seen from Table 4 and Figure 7, changes in the plains group, plateau Group, in a quiet state of the plain obvious. Through the 3,4,5 weeks of training (p <0.05), result were significant differences. After the plateau, hemoglobin plateau group increased, compared with the plain group difference was not significant (p>0.05), but the plateau group 2 to 3 weeks, will continue an upward trend (p <0.01) after the altitude training, with extreme significant difference in hemoglobin values are likely to continue to rise.

**Table 4 Changes of hemoglobin (n=8) (unit: Hb/g*L⁻¹)**

<table>
<thead>
<tr>
<th></th>
<th>Rest value</th>
<th>Exercise training for 1 weeks</th>
<th>Exercise training for 2 weeks</th>
<th>Exercise training for 3 weeks</th>
<th>Exercise training for 4 weeks</th>
<th>Exercise training for 5 weeks</th>
<th>Plain group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain group</td>
<td>137.4</td>
<td>137.9</td>
<td>137.5</td>
<td>132.8</td>
<td>131.2</td>
<td>131.5</td>
<td>132.8</td>
</tr>
<tr>
<td>Plateau group</td>
<td>±3.24</td>
<td>±4.61</td>
<td>±5.87</td>
<td>±3.98</td>
<td>±3.41</td>
<td>±4.27</td>
<td>±3.82</td>
</tr>
<tr>
<td></td>
<td>±4.24</td>
<td>±5.13</td>
<td>±5.71</td>
<td>129.5±2.46</td>
<td>±4.21</td>
<td>±6.24</td>
<td>±2.79</td>
</tr>
</tbody>
</table>

Hemoglobin is the main transport oxygen and carbon dioxide, and the cushioning effect from acidic substances involved in regulating the body's acid-base balance of the important indicators. Hemoglobin is more susceptible to a blood index, which reflects the change in body function athletes, athletes whether anemia and other conditions. Generally the normal range of hemoglobin values is male 120 ~ 160g / L, women 110 ~ 150 g / L. Middle and Long Distance hemoglobin, marathon and other endurance athletes can reach the maximum level of
aerobic capacity, the current general male athletes at 160g / L, women athletes in the 140 g / L or so, the athlete will be able to play the greatest demand for oxygen ability.

![Figure 7. Hemoglobin phase change](image)

### 3.3 Comparative analysis of the characteristics of biochemical indices

Creatine kinase, also known as creatine kinase, is one of the key enzymes in muscle energy metabolism, its role is reversible transfer of high-energy phosphate bond between the catalytic adenosine triphosphate and creatine phosphate. Serum creatine kinase is a muscle in training athletes to withstand the intensity of the stimulation, the training load to bear, as well as fatigue athletes after exercise, recovery. An understanding and mastery of the damage means. After training a large amount of high-intensity training, there will be a clear sense of pain, serum creatine kinase which has a positive relationship. Therefore, the degree of change in serum creatine kinase can be used as the athletes in the training process is subjected to bodily functions stimulation intensity and the degree of injury and recovery situation.

In function of the body in good condition, the membrane structure of skeletal muscle cells intact and functioning properly, intracellular creatine kinase rarely penetrate the cell membrane of human serum creatine kinase maintained within the normal range of values. Data research study results indicate that any movement can make the membrane structure of skeletal muscle cells shift that enhance cell membrane permeability, resulting in serum creatine kinase levels change. The human body in everyday situations, serum creatine kinase activity is low, but in pathological conditions and after strenuous exercise, serum creatine kinase activity appeared significantly higher.

Can be found through research, group and quiet plain plateau value set in a quiet state measured are within the normal range of serum creatine kinase, and no significant difference. Plateau group before exercise is still slightly higher than the value of quiet quiet plain value, because of altitude plateau in the early group, the body of the plateau special circumstances, such as lack of oxygen, strong ultraviolet radiation, cold and dry etc. in stress, resulting in the body athletes serum creatine kinase values rise. Lack of oxygen and harsh plateau climate, may cause cell damage athletes.

### 4. CONCLUSION

Through the plains, altitude training, the collected physiological and biochemical indexes analysis to identify elite athletes physiological and biochemical characteristics of indicators. By creatine kinase, blood urea, hemoglobin four indicators in order to focus lesson units for analysis. In this paper, physiological and biochemical indices of the Chinese elite male marathoners training process monitor and concrete empirical example, Indexes and analysis through case studies and group combining research training during various training methods, the establishment of physiological and biochemical evaluation system. To monitor as the starting point to explore the structural load of excellent marathon athletes during altitude training, rhythm characteristics, identify the basis for the development of effective training load, the realization of sports training process of tracking and monitoring.
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REFERENCES


HaakonssenE.C., RossM.L., KnightE.J. (2015). The Effects of a Calcium-Rich Pre-Exercise Meal on Biomarkers of Calcium Homeostasis in Competitive Female Cyclists: A Randomised Crossover Trial, Plos one, 10(5), e0123302.


MazzeoF., SantamariaS., MondaV. (2016). Dietary Supplements Use in Competitive and Non-Competitive Boxer: An Exploratory Study, Biology and Medicine, 8, 294.


SchmittL., RegnardJ., DesmarestsM. (2013). Fatigue shifts and scatters heart rate variability in elite endurance athletes, Plos one, 2013, 8(8), e71588.


WalshN.P., OliverSJ. (2016). Exercise, immune function and respiratory infection: An update on the influence of training and environmental stress, Immunology and cell biology, 94(2), 132-139.