ARTICLE

The Observation of Blood Biochemistry and HSP72 Expression Changing Rules in Peripheral Blood of Flying-saucer-athletes under High Temperature Training

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Objective: To study the effect of training under high temperature on blood and heat shock protein 72 (HSP72) expression of flying saucer athletes. Methods: The numbers of training group and control group are 30. Twenty-four flying saucer athletes in Zhejiang province were selected and randomly divided into training group and control group, 15 in each group. Peripheral venous blood of each group was taken before and after the experiment. The HSP72 content of lymphocyte, blood routine and biochemical indexes were measured respectively. Results: There was significant difference in white blood cell count before and after the experiment (P< 0.05). The expression of HSP72 and the white blood cell in training group was higher than that control group (P< 0.05). Conclusions: Organism could be affected and turned to stress state due to training under high temperature. It is necessary to provide the safeguard for the flying saucer athletes under high temperature in order to prevent the damage.

1. Introduction

In recent years, the adaptability and tolerance of athletes under high temperature environment has become one of the hot spots in sports medicine research, which has aroused wide concern in sports medicine. Summer training is an important part of athletes’ training cycle throughout the year. It is a key period to improve their competitive level. Effective use of high temperature and high humidity environment in summer training institute to carry out heat adaptation training can significantly improve the aerobic exercise capacity of human body from the perspective of environmental change [1].

When the Zhejiang flying-saucer athletes are in summer training in the external environment with high temperature, strong sunshine radiation, high air humidity, the body can produce more heat. In high temperature and humidity environment, human body may suffer from inattention, decrease neuromuscular excitability, weak muscle activity ability, slow motor response and reduced accuracy and co-
ordination of movement [3]. Therefore, the impact of high temperature and high humidity on athletes must be fully considered during summer training of the flying-saucer team in Zhejiang province.

During summer training, in order to adapt to the external environment, the body produces more heat and sweats so that biochemical indexes and blood routine in the blood will change accordingly. Heat shock protein is necessary for survival of the body under normal or high temperature environment, which is most closely related to cell protection. It is not only a group of protective proteins with high self-defence [3] but also the most sensitive heat stress protein to heat and exercise stimulation. It is easily induced by heat stress and reflects the degree of heat stress of the body to a certain extent [4]. Among them, heat shock protein 72 (HSP72) has the closest relationship with heat stress. In this study, by observing changes of blood routine and blood biochemical indexes of flying-saucer athletes and expression characteristics of HSP72 in peripheral blood under high temperature training and comparing with control group, the changes of blood indexes and HSP72 expression in peripheral blood under high temperature training can be evaluated and discussed. It provides reference for body function monitoring in the training under high temperature and high humidity, so as to improve the quality of summer training and reach a higher competitive level.

2. Materials and Methods

2.1 Research Objects and Main Reagents

30 flying-saucer athletes were selected from Zhejiang PRC Shoot Archer & Bicycle Management Centre. They are in good health without hobbies, such as smoking and drinking and family history of genetic disease. They are 15 ~ 24 years old with an average age of 18.34±3.16 years old with training time of 3 ~ 11 years. Thirty participants were randomly divided into two groups: the high temperature training group (hereinafter referred to as the training group) and the control group with 15 participants in each group. According to homogeneity of variance test, counting data such as age and training years of two group members showed no significant difference (P>0.05), which was comparable. The lymphocyte separation solution was provided by Shanghai Qiantu Biotechnology Co., LTD. and the human heat shock protein 72 (HSP-72) enzyme-linked immunosorbent assay (ELISA) kit was provided by Shanghai Jianglai Biotechnology Co., LTD.

2.2 Experimental Methods

Flying-saucer athletes in high temperature training group need to train in high temperature environment (30 ~ 36 °C) for 1 day with training simulation of official competition. Five groups of 30 bullets were fired in a row with an interval of 20min for each group. Fifteen flying-saucer athletes in the control group were trained with empty guns in room. Blood should be collected immediately before and after training.

2.3 Laboratory Inspection

Blood tests are arranged for the two groups of athletes before and after the experiment. Blood tests are arranged for the two groups of athletes before and after the experiment. The blood is drawn and placed in two anticoagulant tubes containing EDTA sodium. One of the tubes was sent to the laboratory of Zhejiang Institute of Sports Science for blood routine and biochemical test. Another tube of blood naturally coagulated at room temperature for 10 ~ 20 minutes. After centrifugation for about 20 minutes (2000 ~ 3000 RPM), the supernatant was carefully collected and sent to the laboratory of Shanghai Jianglai Biotechnology Co., LTD. Blood indicators include regular indexes, like red blood cells, hemoglobin, white blood cell, platelet count and blood biochemical indexes reflecting body’s metabolism, such as CK (myocardial kinase), Bun (blood urea nitrogen) as well as indexes reflecting body’s electrolyte of Na+ (sodium), K+ (potassium), Ca2+ (calcium ion), Cl- (chloride ion). Examination of HSP72 expression level in peripheral blood: Double antibody sandwich method was used for the determination. Operation steps: adding sample, adding enzyme, tempering, liquid preparation, washing, color development, termination and determination.

2.4 Statistic Analysis

SPSS 22.0 statistical software is used for statistical analysis. Measurement data are showed as mean±standard deviation (±s). One-way analysis of variance of LSD method is used to compare the data between two groups.

3. Results

3.1 Blood Routine Comparison between Two Groups before and after Experiment

Table 1. Comparison of blood routine before and after experiment (mean±s, n=15)

| Groups       | Red blood cell (10^9/L) | Hemoglobin (g/L) | White blood cell (10^9/L) | Blood platelet (10^9/L) |
|--------------|-------------------------|------------------|---------------------------|------------------------|
| Training group | Before experiment      | 4.97±0.40        | 144.05±10.01              | 5.52±1.32              | 214.28±45.24           |
|              | After experiment        | 4.88±0.36        | 143.69±9.56               | 7.81±1.61              | 214.16±44.72           |
| Control group | Before experiment      |                  |                           |                        |                        |
|              | After experiment        |                  |                           |                        |                        |
3.2 Comparison of Blood Biochemical Indexes between Two Groups before and after the Experiment

Before and after the experiment, there was no significant difference in the count of red blood cells, hemoglobin, white blood cells and platelets between two groups before and after the high temperature training (P > 0.05). There were significant differences in the count of white blood cells between training group and control group before and after the training (P < 0.05), as shown in Table 1.

3.3 Comparison of HSP72 Expression in Peripheral Blood between Two Groups before and after the Experiment

Before and after the experiment, there was no difference in the count of white blood cells and platelets between two groups (P > 0.05), as shown in Table 2.

4. Discussion

Flying saucer is an outdoor sport with complex technology and high precision, which requires athletes to have strong psychological quality and anti-interference ability, as well as a high level of stability, consistency, flexible coordination ability and continuity. They are also required to be less susceptible to outside training environment. The location of zhejiang flying-saucer team is located in Changxing county, Huzhou city, Zhejiang province. Changxing county is located in the transition region from the low hills in northern Zhejiang province to the plain on the west coast of Taihu Lake. The terrain is high in the west and low in the east with a subtropical monsoon climate [5]. Every year in July and August, the weather is very hot with strong sunshine radiation. The high temperature weather lasts for a long time. The highest temperature is over 39 °C and surface temperature in the afternoon is even over 50 °C. There is plenty of rain and high air humidity. There is a close relationship between human movement ability and temperature change. High temperature and humidity will seriously hinder body heat dissipation, affecting body temperature regulation and body fluid regulation [6]. It was found that before experiment, there were no significant differences in blood routine, biochemical indexes and HSP72 expression in vivo between two groups (P > 0.05). After the experiment, CK, Bun, Ca²⁺, Na⁺, CT, K⁺ showed no difference between two groups (P > 0.05). The white blood cell count increased in the training group, which was significantly different from that before the training group and the control group (P < 0.05), which may be related to high temperature stress [6].

This study also shows that the expression of HSP72 in the flying saucer athletes of the training group is higher than that before the experiment (P < 0.05) and higher than that of the control group (P < 0.05), suggesting that the expression of HSP72 in the flying saucer athletes of the training group would increase in stress after high temperature training, indicating that the high temperature is the main factor leading to the increase of HSP72 level of the flying saucer athletes of training group. HSP is produced by biological cells under the action of a series of stress factors. High thermal stimulation can cause HSP72 aggregation and improve heat tolerance [7-8]. In high temperature and humidity environment, exercise aggravates the rise of body temperature, while exercise heat stress promotes the rise of HSP72 in the body. Studies [8] have confirmed that if the HSP72 gene of mice is knocked out, thermal adaptation level of mice will sig-

### Table 2. Comparison of blood biochemistry before and after the experiment (±s, n=15)

| Groups | CK (U/L) | Bun (mmol/L) | Na⁺ (mmol/L) | K⁺ (mmol/L) | Ca²⁺ (mmol/L) | Cl⁻ (mmol/L) |
|--------|----------|--------------|--------------|-------------|---------------|--------------|
| Before experiment | 5.03±0.31 | 144.36±9.36 | 5.82±1.35 | 213.95±46.03 |
| After experiment | 5.02±0.29 | 144.24±9.28 | 5.79±1.42 | 214.06±45.67 |

*Note: Compared with control group after training, P < 0.05; Compared with the training group before training, P > 0.05.*

### Table 3. Comparison of HSP72 expression before and after two groups of experiments (±s, n=15)

| Groups | Before experiment (pg/ml) | After experiment (pg/ml) |
|--------|--------------------------|-------------------------|
| Training group | 878.12±127.16 | 1132.18±223.28²*² |
| Control group | 887.25±137.24 | 864.73±125.42²³ |

*Note: Compared with before training, P < 0.05; Compared with the control group after training, P < 0.05.*

Before the experiment, there was no significant difference in HSP72 expression between two groups (P > 0.05). After the experiment, the expression of HSP72 in the training group was significantly higher than that before the experiment (P < 0.05) and higher than that in the control group (P < 0.05), as shown in Table 3.
significantly decrease. On the contrary, thermal adaptation of transgenic mice to heat is significantly enhanced due to the over-expression of HSP72. Based on this, the expression of HSP72 can be monitored during the summer training of flying saucer athletes and new problems that may appear in summer training can be found in time, so as to effectively prevent heat diseases and slow down the occurrence of sports fatigue. However, the current academic research on HSP is not deep enough. At what level does HSP expression rise to indicate that the body is already on the edge of stress\(^{[10]}\), and the risks of heat diseases such as heat spasm and heat syncope are significantly increased, which needs further discussion.

References

[1] Jiexiu Zhao, Lili Lai. Heat adaptation training to improve athletic ability[J]. Journal of Sports Science, 2011, 31(5): 90.

[2] Jiexiu Zhao. High temperature and humidity environment and exercise fatigue[J]. Chinese Journal of Sports Medicine, 2008, 27(2): 238-242.

[3] Yanmei Lu. Expression of heat shock protein 70 under heat stress and exercise conditions[J]. Science and Technology Information, 2010(14): 197-198.

[4] Shuqiang Cui, Lili Lai, Jiexiu Zhao, et al. Changes of plasma free HSP72 concentration before and after acute high-intensity exercise stress under different humidity and high temperature[J]. Chinese Journal of Sports Medicine, 2013, 32(1): 20-23+49.

[5] Yufen Zhu, Chunhua Sun, Xiaojin Zhao, et al. Analysis and research on the variation and difference of air quality in urban area of changxing county[J]. Environmental Science Guide, 2015, 34(6): 51-54.

[6] Jianhong Yang, Xiaojuan Chen, Zhongzhi Tang. Effects of sunstroke decoction on HSP72 expression and blood biochemistry in peripheral blood of soldiers before and after high temperature training[J]. Journal of Local Surgery, 2011, 20(1): 36-38.

[7] Yamada P, Amorim F, Moseley P, et al. Heat shock protein 72 response to exercise in humans. Sports Med, 2008, 38(9): 715-733.

[8] Noble EG, Milhe KJ, Melling CW. Heat shock proteins and exercise: a primer. Appl Physiol Nutr Metab, 2008, 33(5): 1050-1065.

[9] Argaud L, Ferry T, Le QH, et al. Short-and long-term outcomes of heat stroke following the 2003 heat wave in Lyon, France[J]. Arch Intern Med, 2007, 167(20): 2177-2183.

[10] Zhongzhi Tang, Shaofan Weng, Sen Peng. Effect of high temperature training on HSP72 expression in soldiers’ blood and lymphocytes[J]. Chinese Journal of Emergency Medicine, 2008, 28(8): 698-701.

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