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Reducing fatigue of athletes following oral administration of Huangqi Jianzhong Tang

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KEY WORDS Chinese herb drugs; fatigue; lactate

ABSTRACT

AIM: To study the effect of Huangqi Jianzhong Tang in reducing fatigue improvement in athletes. **METHODS:** Twelve athletes were randomly separated into a control group, whose members were administered with placebos, and the experimental group, whose members were administered with Huangqi Jianzhong Tang. During the eight weeks of the experiment, test subjects continued exercise as usual. Preliminary and final exhaustion times, anaerobic thresholds, and kinetic energies were determined. **RESULTS:** Huangqi Jianzhong Tang might increase exhaustion time, positively influence anaerobic threshold, and also enhance recovery from fatigue. **CONCLUSION:** Huangqi Jianzhong Tang reduced fatigue by increasing the oxygen uptake and the systemic utility of oxygen.

INTRODUCTION

Huangqi Jianzhong Tang, a famous traditional Chinese medicine, was made from Radix Paeoniae, Rhizoma Zingiberis, *Saccharum granorum*, Fructus Zizyphi, Radix Glycyrrhixae, Cortex Cinnamomi, and Radix Astragali. The medicine was used to treat peptic ulcers, and as an anticonvulsant in the ancient orient.

Glycolysis is the principal route by which glucose, fructose, and galactose is metabolized[1]. Glycolysis provides ATP which allows skeletal muscles to perform efficiently and to stimulate lactate production under the anaerobic conditions that caused fatigue[2]. Some Chinese medicines can stimulate blood circulation, improving the transport of ability to transport highly nutritional minerals and assisting excretion and the elimination of the by-products of metabolism, accelerating recovery from fatigue[3,4]. This work effectively establishes a clinical model to evaluate the reduction of fatigue. Huangqi Jianzhong Tang was found to promote the reduction of fatigue and the mechanism was examined in athletes.

MATERIALS AND METHODS

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Subjects The subjects were twelve senior male high school basketball players.

Huangqi Jianzhong Tang The Huangqi Jianzhong Tang used herein was a powdered, scientifically prepared. Chinese herb extract obtained from Sun Ten Pharmaceutical Co, Ltd, Taiwan. The product was verified by the Brion Research Institute of Taiwan. The placebos were fried starch.

Equipments The Q65, Q-Plex and wireless cardiopulmonary monitor were purchased from Quinton Co, Ltd, USA.

Kinetic energy and cardiopulmonary function experiments The mean age of the 12 test subjects was (20.1±1.1) a, their mean height was (179±7) cm, and their mean weight was (71±8) kg. The subjects were randomly divided into two equal groups, both of which experienced the same experimental conditions, except in that the experimental group was administered "Huangqi Jianzhong Tang", while the control group was administered the placebos. The double-blind method was used in this study. During the experimental period of eight weeks, test subjects continued to exercise as usual. The kinetic energy of both groups was determined before and after the experiment. Prior to testing, subjects wore masks to collect their exhaled breath and wore heartbeat monitors to monitor the intensity of the exercise. The Bruce treadmill system was calibrated, and Tab 1 specifies lists the test protocol. In this system, speed and angle steadily gradually increased with time. Test subjects ran until exhaustion. Blood pressure and $V_{O_2,\,max}$ were obtained directly from the monitor. The post-experimental test results were then compared to the pre-experimental tests.

Biostatistical analysis All data were analyzed using SPSS software for Windows, which applied the mixed 2-way ANOVA to determine variances. This statistical analysis used α=0.05.

Tab 1. The bruce protocol.

Speed	Slope	Running time
1.7 m/h	10 %	3 min
2.5 m/h	12 %	3 min
3.4 m/h	14 %	3 min
4.2 m/h	16 %	3 min
5.0 m/h	18 %	3 min
5.5 m/h	20 %	3 min
6.0 m/h	20 %	3 min

RESULTS

Huangqi Jianzhong Tang enhanced fatigue elimination The efficiency of Huangqi Jianzhong Tang in eliminating fatigue was mirrored in the kinetic energy determined by two indicators exhaustion and anaerobic threshold. A higher efficiency corresponded to a higher kinetic energy[5]. Therefore, the difference between the preliminary and the final kinetic energy of subjects with or without Huangqi Jianzhong Tang was determined. Two by two (pre-experiment and post-experiment) combinations were subjected to two-way ANOVA to obtain principal analytical results and elucidate the interactions between the two groups.

From Tab 2, subjects' bodily effects on the exhaustion time of the experimental and control groups obtained in pre- and post-tests revealed that no interaction occurred between the groups and the tests was significant within the groups. Restated the post-experimental exhaustion time of the experimental group (820 s±31 s) significantly exceeded that of the control group (780 s±28 s) (Tab 3). The general linear model was applied to intra-subject factors of experimental and control groups and no difference between the pre- and post-test results for both groups (Tab 4.1 & 4.2). These results suggests that Huangqi Jianzhong Tang may increase exhaustion time.

The variance of the differences between the anaero-

Tab 2. Tests of within-subject effects (exhaustion time).

Source	Sum of squares	df	Mean square	*F*	*P*
Within-subject	20416.7	1	20416.67	11.00	0.008
Within-subject×group	416.7	1	416.67	0.22	0.646
Error	18566.7	10	1856.67		

Tab 3. Tests of between-group effects (exhaustion time).

Source	Sum of squares	df	Mean square	*F*	*P*
Between-group	14016.7	1	14016.67	10.18	0.01
Within-group	13766.7	10	1376.67		

Tab 4.1. Tests of within-subject effects in experimental group (exhaustion time).

Source (sphericity assumed)	Sum of squares	df	Mean square	*F*	*P*
Within-subject	7500.0	1	7500.00	5.60	0.064
Error	6700.0	5	1340.00		

Tab 4.2. Tests of within-subject effects in control group (exhaustion time).

Source (sphericity assumed)	Sum of squares	df	Mean square	*F*	*P*
Within-subjects	13333.3	1	13333.33	5.62	0.064
Error	11866.7	5	2373.33		

Tab 5. ANOVA in anaerobic threshold between groups.

Source		Sum of squares	df	Mean square	*F*	*P*
Pre-test	Between-group	257.6	1	257.62	0.32	0.586
	Within-group	8137.1	10	813.71		
	Total	8394.7	11			
Post-test	Between-group	1015.7	1	1015.68	2.35	0.157
	Within-group	4328.5	10	432.5		
	Total	5344.2	11			

bic thresholds of the groups were insignificant (Tab 5). Hence, intra-group analysis also found that the variance was insignificant (Tab 6). However the interaction between the two groups was significant (P<0.05).

Tab 6. Tests of within-subject effects (anaerobic threshold).

Source (Sphericity assumed)	Sum of squares	df	Mean square	*F*	*P*
Within-subject	136.3	1	136.33	1.57	0.239
Within-subject×group	1148.2	1	1148.17	13.19	0.005
Error	870.7	10	87.08		

In fact, the anaerobic threshold can be considerably increased by stamina training[6,7]. However, this work found that the anaerobic threshold of the control group (pre-test: 142±30; post-test: 133±19) did not increase through training (Tab 7). However, it did increase in the experimental group (pre-test: 132±27; post-test: 151±22) (Tab 8). This finding implies that Huangqi Jianzhong Tang increases the anaerobic threshold. The analysis revealed that two factors that governed of the kinetic energy were enhanced, demonstrating that Huangqi Jianzhong Tang can increase the ability to recover from fatigue.

Tab 7. Tests of within-subject in control group (anaerobic threshold).

Source (linear)	Sum of squares	df	Mean square	*F*	*P*
Within-subject	246.6	1	246.61	2.66	0.164
Error	462.9	5	92.57		

Tab 8. Tests of within-subject effects in experimental group (anaerobic threshold).

Source (linear)	Sum of squares	df	Mean square	*F*	*P*
Within-subject	1037.9	1	1037.88	12.72	0.016
Error	407.9	5	81.58		

DISCUSSION

Huangqi Jianzhong Tang very effectively eliminates fatigue, showing that the kinetic energy of athlete was closely related to body stamina recovery [5]. Furthermore, a study of the effects of a Taiwanese folk medicine (ligusticum, deer's blood, tortoise shell gelatin) on the stamina of white mice revealed that a mixture of deer's blood and tortoise shell gelatin markedly increased the stamina of the white mice[8]. The soft-shelled turtle has been shown to recover quickly from fatigue. Meanwhile, in this study, the post-experimental test values (820 s±31 s) of the group to which the "Huangqi Jianzhong Tang" clearly exceeded preliminary test values (770 s±37 s). Accordingly, Huangqi Jianzhong Tang was observed to reduce fatigue by increasing the time exhaustion.

Anaerobic thresholds have been shown to be physiologically very important in physical exercise. Researchers have found that of the aspects related to stamina building exercise, anaerobic threshold was more important than $V_{O_2,\,max}$ [9,10]. Studies of the relationship between performance over 5000 m and breathing thresholds have revealed that the two were correlated, at r=0.84, implying that the anaerobic threshold represented 71 % of the 5000 m race variables. Facts that relate to the height of anaerobic threshold with respect to vis-a-vis $V_{O_2,\,max}$ and kinetic energy revealed that anaerobic threshold aided training was very practical because the delivery and utility of the increased oxygen improved fatigue[11]. This work found that the anaerobic threshold, $V_{O_2,\,max}$ and heart pressure was improved, suggesting that the mechanism of fatigue elimination by Huangqi Jianzhong Tang is systemic.

Muscle accounts for the most of the consumption of oxygen and glucose during movement. The common definition of muscular fatigue is that a muscle does not maintain the required or expected force or power output[12]. Muscular fatigue results from specific impairments within the muscle under conditions of oxygen deficiency, called ischemia. Under such conditions, the anaerobic pathway of the muscle cells is followed and lactate that causes fatigue is rapidly accumulated[13]. This work focuses on muscles to elucidate the effects of Huangqi Jianzhong Tang. The iso-kinetic strength of muscles was tested to evaluate muscular fatigue, using a Kin-Com dynamometer. The variance of anaerobic threshold was analyzed, demonstrating that the concentric knee extensor and flexor strength increased at all of the angular velocities tested. Notably, the only statistically significant increases occurred in concentric knee extensor strength at an angular velocity of 1/3 and π rad/s, and in flexor strength at angular velocity of 2/3 and 4/3 π rad/s. The analysis also confirmed that Huangqi Jianzhong Tang effectively increased muscle strength, by reducing muscular fatigue.

The reduction of fatigue due to Huangqi Jianzhong Tang may be follow from the herb composites but not to a single component. Results were similar to those obtained in the study of valerian's sedative effect[14-16].

Furthermore, the lactate peak was much lower in the experimental group than in the control group (data not shown). This finding suggested that the pathway for fatigue improvement by Huangqi Jianzhong Tang was as follows. Namely, the medicine increased the oxygen uptake from the system and delivered it to a local tissue to accelerate lactate metabolism, thereby reducing fatigue. Human fatigue can be categorized as acute or chronic fatigue. Increasing kinetic energy and cardiopulmonary functions can reduce both types. Most traditional Chinese herbs were found to reduce fatigue in clinical trials. Huangqi Jianzhong Tang was selected for the study of the mechanism by which such herbs are effective, as well as the examination of their clinical applications. The study of Huangqi Jianzhong Tang has established the benefits of such herbs in reducing fatigue, both systemically and locally. The molecular mechanism will be clarified in the future.

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