Medbiotech Journal

MBTJ, 1(4): 149-154, 2017

Research Paper

Effect of Vitamin C Intake Following Exhaustive Aerobic Exercise on Serum Immunoglobulins A and G in Wushu Athletes

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Received: 06 October 2017 Accepted: 09 November 2017 Published: 01 December 2017

Abstract

The present study aims to investigate the effect of vitamin C intake following exhaustive aerobic training on Immunoglobulins A (IgA) and G (IgG) in a number of 24 wushu athletes. The study adopts an experimental design and a field study approach. The population of the study consisted of 62 wushu athletes in Oshnavieh County. From among the population, a number of 24 athletes were randomly selected as the participants and assigned into an experimental group taking vitamin C (N=12) or a control group without vitamin C (N=12). The experimental subjects took 500 mg vitamin C per day for five subsequent days while the control subjects received no vitamin supplement during the same period. Blood samples were taken from each group in three stages. The first blood samples were taken before the training was started (at rest). The second blood sampling was conducted on the experimental subjects following vitamin C intake and on the control subjects following the training protocol (after the Day 5). Then the subjects in either group took Bruce test to measure their peak aerobic power, which immediately followed by the third blood sampling. In every sampling stage, serum IgA, IgG and cortisol were measured in either group. The data was collected through a few instruments including Health Status and Profile Questionnaire, a height meter device, a weight scale, a treadmill, a pulse meter as well as ELISA kit to measure cortisol concentration, serum IgA and IgG. Results showed that vitamin C intake significantly affected serum IgA, IgG and cortisol in the experimental subjects ($P \leq 0.05$). Findings showed that vitamin C induced increases in IgA and IgG concentrations, which may in turn contribute to improved immune performance and decreased risk of infectious diseases. However, cortisol levels decreased in the experimental subjects considerably ($P \leq 0.05$). The results also revealed that vitamin C intake following exhaustive training helped improve some of the indices in the immune system (3). It is, therefore, recommended that elite athletes use dietary supplementation and antioxidant vitamins to reduce the risk of heavy training so that they may minimize the potential disorders in their immune performance and avoid infections.

Keywords: Vitamin C; Immunoglobulin; Bruce Test; Cortisol

How to cite the article:
F. Hasanloei[1], H. Asadpour, V. Karvani, Effect of Vitamin C Intake Following Exhaustive Aerobic Exercise on Serum Immunoglobulins A and G in Wushu Athletes, Medbiotech J. 2017; 1(4): 149-154, DOI: 10.22034/mbt.2017.87028

1. Introduction

From among the functional systems, the immune system holds a particular niche so that it not only sets the stage for growth and development but also increases the resistance to disorders and prevents diseases. Consistent performance of this system would guarantee the individual's health while its malfunction endangers life [1]. Human body is

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always vulnerable to the infectious environments. Microorganisms have a potential for uncontrollable propagation, pathological damage and perishing of the host. Still, most infections are short-term and leave slight permanent damages. This owes much to the performance of the immune system in fighting the infections. Thus, when the fragile balance between offensive microorganisms and the immune system is disturbed, there is a potential chance of infection. Such balance may be disturbed by the swarm of infectious microorganisms or the repression of the immune system. Normally, numerous factors may contribute to the reinforcement or suppression of the immune system. Understanding the factors affecting the immune system would help increase adaption to various situations [1]. Many people believe that the more they do physical exercise, the more they will be resistant to diseases, hence the improvement of their health. This belief comes primarily out of the wholesome effects of sports on some body systems including the cardio-vascular and respiratory systems. However, research has shown that long-term, heavy training exerts adverse effects on the immune system causing infections in upper respiratory tract and destroying the immune factors. It is not clear why the athletes are vulnerable to infections, particularly respiratory tract infections; however, the loss of immunoglobulin (Ig) has yet been suggested as a potential reason [2].

Several studies have been conducted on the effect of training intensity on the immune system. The results suggest that people who take regular, low-intensity exercise are less vulnerable to respiratory infections comparing with inactive people. However, athletes who perform heavy training are more vulnerable to infections [3]. The generation and propagation of immune cells (Ig) decreases in heavy training. Increases in blood cortisol may account for this reduction in Ig concentration. On the other hand, vitamin C contributes to the reduction of cortisol levels and increases in Ig [4]. Ebrahim et al., (2003) compared the effect of a single session exhaustive training on salivary IgA variations between professional and leisure adolescent athletes [5].

Their study adopted a quasi-experimental design with at least three training sessions per week. They exposed the salivary IgA concentration, which plays the main role in mucosal immunity and prevention of upper respiratory tract infections, to a single session exhaustive training. They reported that IgA concentration significantly decreased in the professional athletes following the training.

Ig or antibodies are glycoprotein molecules produced by B cells and plasma cells. IgG is the most common serum Ig and IgA is predominant in salivary secretions (monomer in blood and dimer in secretions) [6]. Research has shown that moderate, regular exercise affects the immune system through hormone secretion and parameter increases; however, heavy and long-term training have been reported to disturb the immune function. Nevertheless, athletes who perform regular, aerobic exercises are less vulnerable to respiratory infections comparing with inactive people [7]. Nowadays, people tend to heed the quality of their life, improved health and prevention of diseases. As one of the vital systems, the function of the immune system may guarantee health while its malfunction poses serious risk to life [8]. Considering the effect of training on the cortisol level and its reciprocal effect on Ig concentration and based on a review of the literature, we may suggest that the training time and intensity, type of activity, sex and age are the determining factors contributing to variations in IgA and IgG. In this regard, different trainings at the same level of intensity cause dissimilar variations in hormone and immune factors, particularly cortisol concentration.

The contradictory findings and lack of studies on heavy training diets call for further studies on the issue [9]. Thus, the present study aims to investigate the effect of progressive aerobic training to exhaustion (Bruce test) on IgA and IgG concentration, cortisol variations and the effect of vitamin C intake on these variations.

2. Methodology

The study adopts an experimental design whereby a control and an experimental group participated in a pre- and a post-test. The population of the study consisted of 62 wushu athletes in Oshnavieh County. Following the completion of Volunteer forms, a personal data sheet and medical records sheet, a number of 24 wushu athletes, who had no history of acute diseases or daily drug intake, were selected and randomly assigned into two twelve-member groups including a control (no vitamin) and an experimental (vitamin C) group. In this regard, the participants went over to the laboratory at 4:30 in the afternoon of the day before the training program. There the blood samples were taken at rest to examine the cortisol level as well as IgG and IgA concentrations as the first sampling stage. Then the experimental subjects took 500 mg vitamin C per day for 6 days while the control subjects received no vitamin and continued their routine activities. Following the Day 6, the second blood sampling was conducted in either group.

Afterwards, the subjects in either group participated in the test according to a premeditated timetable at 4:30 p.m. in different days. Before the test was conducted, the participants were weighed. At the due test date, the participants did warm-up exercises first, including a 5-minute large-muscle stretching (biceps, femoral quadriceps, hamstring, hip and chest muscles) and a 3-minute joint warm-up. Then they went over the treadmill and performed the Bruce test that included a standardized test comprising seven 3-minute stages. The test began at a low speed and incline on the treadmill and mounted gradually until the individual reached the exhaustion level where he could no longer continue the training. The duration that every individual did the test was considered as his record. Bruce formula was run to calculate VO_{2max} in every individual. Immediately upon the competition of the test, the third blood sampling was conducted. The data was collected through a few instruments including Health Status and Profile Questionnaire, a height meter device, a weight scale, a treadmill, a pulse meter as well as ELISA kit to measure cortisol concentration and serum IgA and IgG. Descriptive statistics including mean, mean deviation and standard deviation were used to describe the raw data. Inferential statistics including dependant t test was run to analyze the data (α=0.05). Statistical analysis was conducted using SPSS 14 and Excel 2003.

3. Results

As shown in Table 1, the mean and standard deviation of the experimental subjects' age are 22.50 and 1.7, respectively, while those of the control subjects are 22.41 and 1.6, respectively. The mean and standard deviation of the experimental subjects' height are 158.50 and 3.8, respectively, while those of the control subjects are 157.83 and 3.9, respectively. The mean and standard deviation of the experimental subjects' weight are 60.91 and 5.1, respectively, while those of the control subjects are 59.62 and 3.9, respectively.

As shown in Table 2, comparing with the first blood sampling, both IgA and IgG concentrations have increased in the second sampling at every level of significance in the experimental subjects following the vitamin C intake (α=0.000). We may conclude that vitamin C supplementation has contributed to increases in IgA and IgG following the five-day period of vitamin intake (P≤0.05). However, the cortisol concentration has decreased in the experimental subjects during the same period (α=0.005). Thus, this suggests that vitamin C intake increases IgA and IgG but reduces cortisol in blood.

Table 1. Descriptive statistics of data analyses in either group.

Descriptive statistics		Experimental group		Control group	
Variable	**Number**	**Mean**	**SD**	**Mean**	**SD**
Age	12	22.50	1.78	22.41	1.67
Height	12	158.50	3.84	157.83	3.94
Weight	12	60.91	5.12	59.62	3.96

Table 2. Dependent t test results of the comparison of mean IgG, IgA and cortisol concentrations in either group in the first (pre-test) and second blood sampling.

Variable	Stage	Groups	Statistical indices					
			Mean differences	**Increase or decrease**	**SD**	**df**	**t**	**P**
IgG	Comparison of the first and second sampling	Experimental	+4.4758	Increased IgG	2.5182	11	+6.157	0.000
		Control	-0.4075	Decreased IgG	0.9302	11	-1.517	0.157
IgA	Comparison of the first and second sampling	Experimental	+0.4425	Increased IgA	0.2469	11	+6.207	0.000
		Control	-0.2516	Decreased IgA	0.4680	11	-1.86	0.089
Cortisol	Comparison of the first and second sampling	Experimental	-32.4166	Decreased cortisol	31.715	11	-3.514	0.005
		Control	+7.75	Increased cortisol	22.73	11	+1.181	0.263

Table 3. Dependent t test results of the comparison of mean IgG, IgA and cortisol concentrations in either group in the second (following the five-day vitamin C intake) and third blood sampling.

Variable	Stage	Groups	Statistical indices					
			Mean differences	Increase or decrease	SD	df	t	P
IgG	Comparison of the third and second sampling	Experimental	-1.2825	Decreased IgG	0.3708	11	-11.979	0.000
		Control	-1.028	Decreased IgG	0.3103	11	-11.477	0.000
IgA	Comparison of the third and second sampling	Experimental	-0.1283	Decreased IgA	0.2391	11	-1.554	0.038
		Control	-0.2666	Decreased IgA	12.89	11	-3.86	0.003
Cortisol	Comparison of the third and second sampling	Experimental	+11.58	Increased cortisol	19.21	11	+3.112	0.010
		Control	+27.91	Increased cortisol	22.73	11	+5.03	0.000

As shown in Table 3, IgA and IgG concentrations have significantly decreased in the third blood sampling (the effect of training) in either group comparing with the second blood sampling (the effect of Vitamin C intake). Thus, we may conclude that the decrease was induced by training ($P \leq 0.05$) while the cortisol levels significantly increased in either group following the training (experimental group: $\alpha=0.010$; control group: $\alpha=0.000$).

As illustrated in Figure 1, there is no significant difference in IgA concentration in either group in the first sampling (at rest); however, following 5 days of vitamin C intake, IgA significantly increased in the experimental subjects. Following the training session, IgA concentration significantly decreased in either group. This reduction is illustrated in Table 3 and Figure 1.

As illustrated in Figure 2, there is no significant difference in IgG concentration between the control and experimental subjects in the first blood sampling at rest. However, following five days of vitamin C intake, the IgG concentration significantly increased in the experimental subjects. Nevertheless, Following the training session, IgG concentration significantly decreased in either group though the decrease in the control subjects was more dramatic. The variable reduction of IgG in either group is illustrated in Table 3 and Figure 2.

As shown in Figure 3, cortisol levels significantly decreased in the experimental subjects following five days of vitamin C intake. However, the hormone significantly increased in either group following the training though the increase was more dramatic in the control group. The variable increase of cortisol in either group is illustrated in Table 3 and Figure 3.

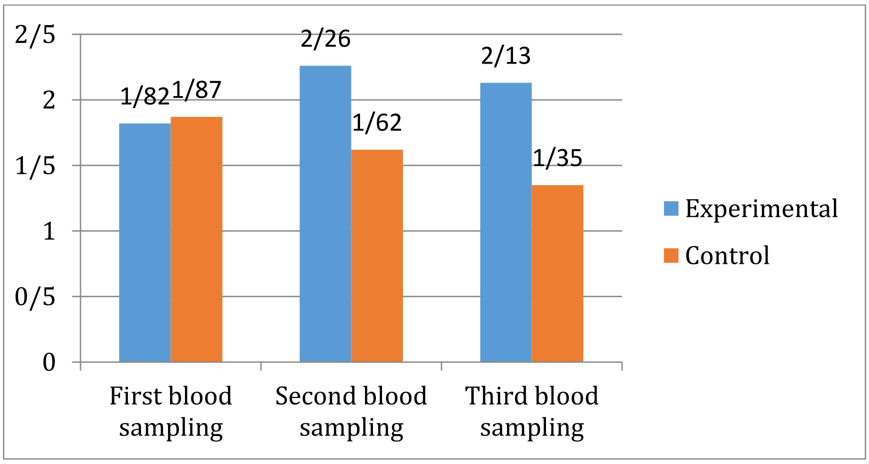

Figure 1. IgA concentrations in the three stages of blood sampling.

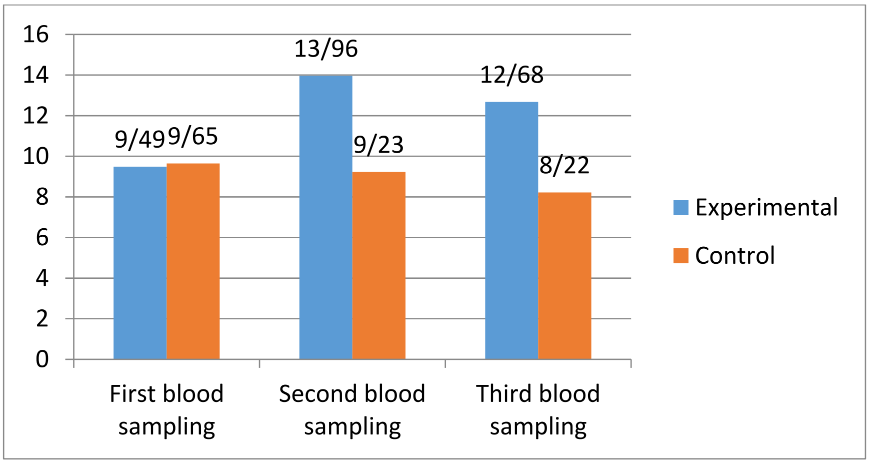

Figure 2. IgG concentrations in the three stages of blood sampling.

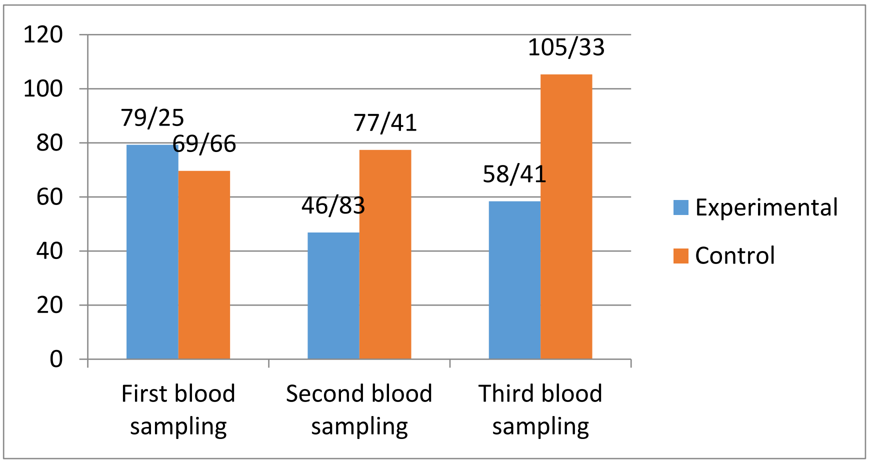

Figure 3. Cortisol concentrations in the three stages of blood sampling.

4. Discussion and Conclusion

The results showed that IgG and IgA concentrations increased significantly in the experimental subjects following vitamin C intake. This is consistent with the findings of Peters et al. (1996) [10]. The increases in IgA and IgG concentrations may protect athletes against infections following training; however, heavy training may discharge vitamin C supply in the body and increase the vulnerability of infections. Vitamin C is stored in large supplies in leucocytes and serves anti-septic purposes such as increased generation of lymphocyte T, avoided corticosteroid suppression of neutrophil activity and inhibited viral propagation. Besides, vitamin C is an important water-soluble antioxidant found in adrenal glands in large amounts, which contributes to the generation of adrenalin, noradrenaline and cortisol that are secreted in response to the stress. As one of the reactive oxygen species (ROS) that is important in both the intra- and extra-cellular fluids, it functions as an antioxidant both directly and indirectly through reconstruction of restored vitamin E [2,10].

The secretion level of IgA and IgG depends on the intensity, duration and type of activity. Various mechanisms have been proposed to account for variations in Ig concentration including increased secretion of the hormones suppressing the immune system such as cortisol, epinephrine and enkephalin as well as the activity of sympathetic nervous system and psychophysical pressures. Increased epinephrine and cortisol secretions depend on the training intensity. A certain training intensity threshold about 60 percent VO_{2max} is required to help release epinephrine. Individual differences are more effective in glucocorticoid response to training in the athletes who do heavy training since cortisol is only secreted in response to heavy training. As a steroid hormone, cortisol is the most important catabolic hormone. Slight increases in plasma cortisol may increase immune responses while high concentration of this hormone exerts inhibitory effects [8].

At high concentration, cortisol causes calcium-induced activation of endonuclease and the consequent incomplete death of thymocytes. However, low levels of cortisol increase the proliferative responses and lymphocytes. Moreover, cortisol exerts both acute and chronic effects in inflammatory responses [11]. Cortisol secretion is not a consistent process so that the concentration of plasma cortisol begins increasing slightly after midnight and maximizes at about 6-8:00 A.M (about 15 microgram per deciliter). The peak Ig secretion time is exactly the reverse of cortisol. As one of its side effects, cortisol weakens the immune system. Cortisol concentration increases during and after exercise training. Increased cortisol levels influence lymphocytes that in turn reduce Ig generation [12]. The present findings showed that vitamin C intake reduced cortisol levels in the wushu athletes, which is consistent with the findings of Noorshahi (2008) [8], Pool (2001) [4] and Nieman et al., (2000) [13]. Vitamin C intake following an exhaustive exercise could improve some indices of the immune system [10]. Thus, it is recommended that athletes with high performance use dietary supplements and antioxidant vitamins to reduce the risks of heavy exercises so that they may prevent the disorders in their immune system and the infections.

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