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Original Article

The Effect of an Intense Anaerobic Exercise Session on Serum Levels of IgG, IgM and IgA in Handball, Volleyball and Climbing Sports

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A B S T R A C T

Background and Aims: The immune system protects the body against many invasive foreign materials. The aim of this study was to investigate the effect of an intense anaerobic exercise session on serum IgG, IgM and IgA levels in handballists, volleybalists and climbers.

Materials and Methods: In this study, 45 professional athletes with the average age of 20-30 years who had participated in the major leagues and the first batch of Zahedan city were enrolled. To assess anaerobic power the 30 second Wingate test was used. Blood samples before, immediately after, and 2h after exercises were collected, and serum levels of immunoglobulins IgG, IgM and IgA were measured by nephelometry method.

Results: The results of this study indicated that the level of serum immunoglobulins IgG, IgM ، IgA concentration in all three study groups before and after and two hours past exercise did not show significant change (P>0.05).

Conclusion: Our findings showed that short anaerobic exercise does not have any effect on the level of immunoglobulins in athletes.

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Introduction

Regular and moderate exercise affects immune functions of the body, and has various roles in prevention and treatment of many diseases, including cardiovascular disease, obesity, diabetes, hypertension and osteoporosis [1, 2]. A wide range of sporting activities, including short-term exercises, severe long-endurance activities and regular light exercise affect the immune function. Studying the long-term effects of regular exercise on performance of the immune system has wide application in promotion of public health and prevention of diseases among the nations that are facing an increasing active elderly population [2, 3]. Most studies have focused on adaptive response of serum and salivary immunoglobulin [4, 5]. The most abundant immunoglobulin in serum and saliva are IgG and IgA, respectively [6]. Immunoglobulins have a direct role against infectious diseases and are vital for the body defense. The IgA present in the mucous membranes lies in the first line of defense against viral infections.

Exercise has some effect on immune function regarding susceptibility to diseases. Evidence has shown that exercise induces changes in salivary IgA concentration, and its amount is dependent on the duration and frequency of exercise [7, 8, 9]. There are conflicting results about the effect of intense exercise on immunoglobulin levels. Several studies have demonstrated increased concentrations of immunoglobulins such as the one reported by Hans and colleagues. They indicated that the serum levels of IgA, IgG, and IgM in the first hours after a marathon race rose and returned to normal during recovery [10]. Imanipour et al. (2009) conducted a research on active men and showed that fourteen weeks of running exercise induces significant difference in the level of IgA and IgM [11]. Andrew et al. (2009) conducted a study on fifteen active men who had exercise for 60 minutes with 75% of VO_2-max. Their results showed that the amounts of IgA, IgG, IgG2 and IgG3 were significantly increased [12]. However, some other studies have pointed out a reduction in the concentration of immunoglobulin. David et al. (2007), for example, reported that the levels of serum IgG and IgM of ten elite male runners who had intensive training for three weeks had a significant decrease (average 38%) [13]. Demytro et al. (2002), Daly and his colleague (1998), Gleason et al. (1999) and Gleason and Mcdonald (1995) all reported decreased secretion of IgA [14, 15, 16, 17]. On the other hand, many studies have reported no change in immunoglobulin concentrations. For example, Crdova et al. (2010) reported that a volleyball tournament season has no effect on serum immunoglobulin IgA [18]. Mashiko and colleagues (2004) showed that after 20 days of intense training of rugby, significant changes were observed in serum levels of IgG and IgM in male athletes, while several other studies have reported no change in IgA concentration [19]. Several studies have also indicated changes in the amount of immunoglobulin secretion in marathon runners [20, 21, 22], ultramarathon [23] and swimming [24].

Exhaustive exercise training is defined as an intensive exercise being at the highest possible level after which the athletes do not work because of exhaustion [25].

Due to the conflicting results regarding the effect of exercise on serum immunoglobulins and uncertainty regarding its impact, and also due to a lack of investigation on the effects of short-term exhaustive training in various sports, we performed this study to determine the effects of an exhaustive exercise on serum levels of immunoglobulins (IgG, IgM, IgA) in sport athletes.

Materials and Methods

This semi-experimental study was performed on 45 male athletes in Zahedan, Iran, affiliated with the Shahrdary Volleyball league and first batch of handball and climbing (each team comprised 15 athletes) who had been invited to the Zahedan city league. Informed consent form was completed by all of the athletes based on ethics committee of sports leagues. The Ethics Committee of Zahedan University of Medical Science, Zahedan, Iran approved this Study.

Training program

In this study, an anaerobic exercise training program (Wingate) using a bicycle ergometer in three sessions was used. Each practice session lasted two hours, and included a warm-up team at the beginning followed by exercises and cool-down team at the end. Wingate test is a maximum effort (30 seconds) on a bicycle that calculates anaerobic function of the lower extremities.

Each person has to warm up for 5 minutes on the exercise bike before the test. They were allowed to recover for 1 to 2 minutes after testing to prevent cramps. Blood samples before and immediately after the end of the practice session and two hours after the exercise session were collected by expert lab staff, and transferred to the laboratory for testing. Measurement of immunoglobulin levels was performed by nephelometry assay using a commercial kit manufactured by Binding Company made in England.

Statistical Analysis

The results obtained from blood samples were analyzed using SPSS version 18. Descriptive statistics was used for the classification and regulation of index data (mean and standard deviation of the distribution). The Kolmogorov-Smirnov (KS) test was used to determine the normal distribution of data. The repeated measures test was applied for comparison of the pre-test and post-test intra-group sets, and one way ANOVA test was used for the comparison between the study groups.

Results

General and anthropometric characteristics of the subjects are presented in Table 1. Results of repeated measures test showed that immunoglobulin levels in handbalists, volleybalists and climbers before, after and 2 hours after exercise did not differ significantly ($P > 0.05$) (Table 2).

Table 1. Anthropometric characteristics of male athletes of major league and first batch of volleybalists, handbalists and climbers in Zahedan city.

Groups	Age (year)	Weight (kg)	Height (cm)	Body mass index (kg/m^2)
Climber	26±4	71±5	176±5	23±2
Volleybalist	25±7	79±6	183±8	26±9
Handbalist	22±3	76±2	180±3	23±1

Table 2. Results of repeated measures of IgG, IgA and IgM levels in athletes Hndbalyst, Volleybalist and Climbist before, after and 2 hours after exercise.

	Before exercise	After exercise	2 hrs after exercise	P value
		IgG (g/L)		
Climbist	14.57±4.64	15.3±3.72	15.12±1.82	**0.8**
Volleybalist	13.51±4.28	12.85±2.52	13.87±3.57	**0.6**
Handbalist	15.07±2.45	14.75±2.87	14.64±3.4	**0.9**
		TgM (g/L)		
Climbist	1.13±0.53	1.26±0.72	1.02±0.38	**0.5**
Volleybalist	1.06±0.46	1.14±0.36	1.07±0.38	**0.6**
Handbalist	1.09±0.34	1.26±0.28	1.11±0.39	**0.3**
		IgA(g/L)		
Climbist	2.27±0.61	2.52±0.31	2.1±0.29	**0.4**
Volleybalist	1.59±0.64	1.64±0.53	1.59±0.59	**0.8**
Handbalist	1.72±0.71	2.04±0.65	1.92±0.65	**0.4**

Data are presented as Mean±SD

Results of one-way ANOVA showed no significant difference in immunoglobulin levels among the three study groups (P> 0.05). Serum levels of IgG in mountaineering athletes after exercise increased and then after two hours decreased. In volleybalists it decreased immediately after exercise but not before, white it showed decreased IgG in the mountaineers group. Although IgM level in all three groups increased after training and then decreased, these changes were not significant. Also, serum IgA level in climber and handbalist athletes after exercise increased and then decreased, but no changes in levels of IgA in volleybalist athletes were observed before and after exercise. On the other hand, the mean serum levels of IgG in all groups indicates increase after exercise followed by a decrease, while no changes in serum levels of IgM and IgA could be seen (Fig. 1).

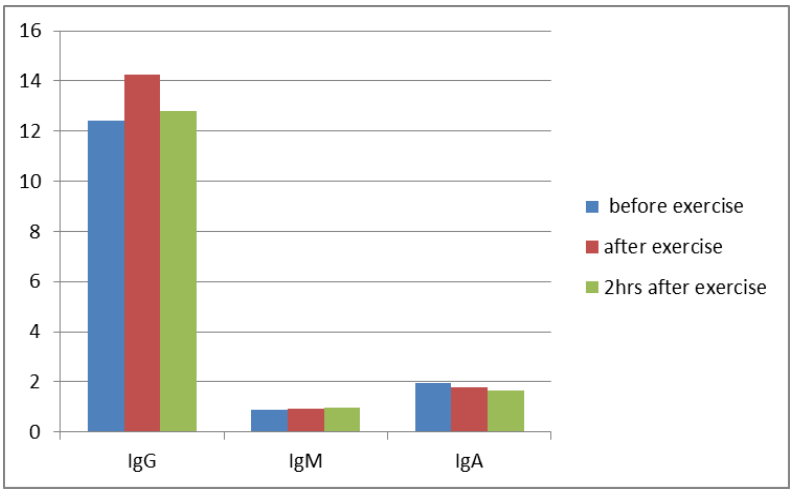

Fig. 1. The comparison of serum IgG, IgM and IgA (g/L) before, immediately after, and two hours after training in volleybalists, handbalists and climbers of Zahedan city.

Discussion

Overall, we reported the change in concentration of some immunoglobulins in athletes. The mechanisms underlying serum immunoglobulin changes in response to exercise in athletes have not been adequately addressed [2] and any changes in the amount of these factors must be considered. A slight increase (less than 20%) in the concentration of serum that can be observed after severe acute exercises is attributed to changes in serum volume. Increase in serum immunoglobulin concentrations less than 10% is attributed to the daily changes and to the reserve immunoglobulin exchange of extravascular circulation and lymphatic vessels or circulation [26, 27, 28]. Various cells and soluble factors are involved in the regulation of Ig production by B cells. These factors include the number and proportion of circulating lymphoid cells and lymphoid tissues, release of immune regulatory factors such as cytokines, the number and sensitivity of lymphocyte receptors for these molecules, neuro-hormonal changes such as circulating hormone levels, the subject sensitivity and the effect of psychological stress. These factors may act parallel to each other. In addition, the acute effects of exercise program may persist and have overlapping or interfering chronic impacts [2]. As Hans and colleagues (2002) have reported, plasma levels of Ig A, IgG and IgM increase at the first hours after Marathon race, but return to normal afterward [10]. Since monocytes increase during exercise and prostaglandins are produced by these cells, it is suggested that soluble factors such as prostaglandins released during exercise have indirect effects on the production of immunoglobulins [29].

The major salivary secretory immunoglobulin is IgA that prevents antigens to enter the upper respiratory tract. Excretion of this molecule depends on intensity, duration and type of physical activity. Different mechanisms have been proposed by researchers to explain any

change of this molecule: reduction of salivary flow, physical and psychological pressures, sympathetic nervous system and secretion of immune system suppressive factors such as cortisol, epinephrine and encephalin [30]. Perhaps one of the reasons that IgA did not change significantly in our study was due to severity and duration of the activity of athletes. Some researchers reported a decrease in serum immunoglobulin level after stressful activities [17]. Portman reported the reason for this reduction to be its increase in blood cells [31]. Some believe that the improper position of the arm during blood sampling may affect the serum immunoglobulin level [17]. Also, several studies have noted that serum immunoglobulin levels will return to the initial level 24 hours after intense physical activity [32,33,34].The results of these researches are consistent with Michel et al. (1996), Mashyko et al. (2004), Cordova et al. (2010) and inconsistent with the results of Allegro and colleagues (2008), Dolly et al. (1998), Gleason et al. (1995), and Demytro et al. (2002) [35,19,18,15, 14,12]. The results of Platinum and colleagues (1999) showed that exercise intensity has no significant influence on the salivary IgA concentration [36], while Klentro and his colleagues (2002) indicated reduction of immunoglobulins after intense physical activity and its increase after prolonged moderate activity [37].

Conclusion

According to the research results, the duration and intensity of the exercise are determining factors in the immune response to exercise [16, 37, 38, 39]. It can be concluded from this study that short intense exercises has no significant effect on serum IgG, IgA and IgM concentration. Some limitations of this study such as short duration of investigation could be addressed in further studies. As the evaluation of immune system components in connection with each other is difficult, and since relations of this system with other organ systems are complex, the results of this study should be reviewed in future researches. The role of short-term intense exercise or prolonged anaerobic exercise on serum immunoglobulins and other immune system functions as well as the role of these factors on the creation of response in skeletal muscle after exhaustive exercise should be precisely investigated.

Conflict of Interest

There is no conflict of interest to declare.

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References

[1]. Hejazi K and Attarzadeh Hosseini R. Influence of Selected Exercise on Serum Immunoglobulin, Testosterone and Cortisol in Semi-Endurance Elite Runners. Asian Journal of Sports Medicine 2012; 3(3):185-192.

[2]. Hoff P, Belavý D.L, Huscher D, Lang A, Hahne M, Kuhlmey A.K, et al. Effects of 60-day bed rest with and without exercise on cellular and humoral immunological parameters. Cell Mol Immunol 2014 Nov 10.

[3]. Jeng KC1, Yang CS, Siu WY, Tsai YS, Liao WJ, Kuo JS. Supplementation with vitamins c and e enhances cytokine production by peripheral blood mononucler cells in healthy adults. Am.jclin. Nutr 1996; 64:960-5

[4]. Laing S.J, Gwynne D, Blackwell J, Williams M, Walters R, Walsh N.P. Salivary IgAresponse to prolonged exercise in a hot environment in trained cyclists, Eur. J. Appl. Physiol 2005; 93: 665- 671.

[5]. Alexander J Koch. Immune Response to Resistance Exercise, American Journal of Lifestyle medicine 2010;4: 244-252.

[6]. Koch A.J. Immune Response to Exercise, Brazilian Journal of Biomotricity 2010; 2: 92-103.

[7]. Moreira A, Delgado L, Moreira P, Haahtela T. Does exercise increase the risk of upper respiratory tract infections? British Medical Bulletin 2009; 90: 111-131.

[8]. Mackinnon L.T, Hooper S. Mucosal (secretory) immune system responses to exercise of varying intensity and during overtraining, Int. J. Sports. Med 1994; 3:179-183.

[9]. Fahlman M.M, Engels H.J. Mucosal IgA and URTI in American college football players: a year longitudinal study, Med. Sci. Sports Exerc 2005; 37: 374-380.

[10]. Hanns C.G, Andreas M, Wolfgang S, Markus M, Karl K, Eberhard K, Lothar R. IgG, IgA, IgM, and Plasma Volume Changes During Long-distance Running 2002; 13:15-20.

[11]. Vahid I, Valiollah S, Mehdi A. The Effects of Physical Activity OnHomoral Immune System (IgA, IgG, IgM), Procedia Social And Behavioral Sciences 2009; 1: 2718–2721.

[12]. Mckune A.J, Semple S.J, Smith L.L, Wadee A.A. Complement, immunoglobulin and creatine kinase response in black and white males after muscle-damaging exercise. 2009; SAJSM 2: 47-52.

[13]. David C, Nieman. Marathon Training and Immune Function, Sports Med 2007; 37: 412-415.

[14]. Dimitriou L, Sharp N.C, Doherty M. Circadian effects on the acute responses of salivary cortisol and IgA in well trained swimmers. Br J Sports Med 2002; 36(4): 260-64.

[15]. Daly R.M, Rich P.A, Klein R. Hormonal responses to physical training in high-level peripubertal male gymnasts. Eur J ApplPhysiolOccupPhysiol 1998; 79(1): 74-81.

[16]. Gleeson M, Hall S.T, McDonald W.A, Flanagan A.J, Clancy R.L. Salivary IgA subclasses and infection risk in elite swimmers. Immunol Cell Biol 1999; 77(4): 351-55.

[17]. Gleeson M, McDonald W.A. The effect on immunity of long term intensive training in elite swimmers". Clinical and Experimental Immunology 1995; 102: 210-216.

[18]. A Crdova A, Sureda A, TurJ.A, Pons A. Immune Response To Exercise In Elite Sportsmen During The Competitive Season, J. Physiol. Biochem. 2010; 66: 1-6.

[19]. Mashiko T, Umed T, Nakaji S, Sugawara K. Effect of exercise on the physical condition of college rugby players during summer training camp. Sports Med 2004; 38:186-190.

[20]. Shoelson, Jongsoon Lee and Allison B, Goldfine. “Inflammation and insulin resistance”. J Clin Invest 2006; 116:1793-801.

[21]. Thomas N.E, Leyshon A, Hughes M.G, Davies B, Graham M, Baker J.S, The efect of anaerobic exercise on salivary cortisol, testosterone and immunoglobulin (A) in boys aged 15–16 years, Eur J ApplPhysiol 2009; 107: 455–461.

[22]. David C. Marathon Training and Immune Function. Sports Med 2007; 37: 412-415.

[23]. McKune A.J, Smith L, Semple S.J, Wadee A. Influence of ultra-endurance exerciseon immunoglobulin isotypes and subclasses, Br. J. Sports Med 2005; 39: 665-670

[24]. Walsh N.P, Blannin A.K, Clark A.M, Cook L, Robson P.J, Glesson M. The Effect of High intensity Intermittent Exercise on Saliva IgA, Total Protein and a- Amilase. J Sports Sei 1999; 17: 129-1374.

[25]. Leonard joseph H, Roslizaeati N, Safrusahar M.Y, Efri N.M, Das S, et al. Effect of pubertal developmental stages and lower limb kinetics during vertical

jump task in sepak takraw sport. Clin ter 2009;160(5):403-407.

[26]. Verde T.J, Thomas S.G, Moore R.W, Shek P, Shephard R.J. Immune responses and increased training of the elite athlete, Immune function in sport and exercise J. Appl. Physiol 2007; 103: 693-699.

[27]. Byum A, Wiik B.P, Gustavsson E, Veiby O.P, Reseland J, Haugen A.H, Opstad P.K. The Effect Of Strenuous Exercise, Calorie Deficiency And Sleep Deprivation On White Blood Cells, Plasma Immunoglobulin And Cytokines. Scandinavian Journal Of Immunology 1996; 43(2): 228-235

[28]. Fry A.C, Kraemer W.J, Ramsey L.T. Pituitary-adrenalgonadal responses to high-intensity resistance exercise overtraining. J ApplPhysiol 1998; 85: 2352-9.

[29]. Mackinnon L.T. Immunity in athletes. Int J SportMed 1997; 98: 562–568.

[30]. Armstrong R. "Initial events in exercise-induced muscular injury". Med Sci Sports Exert 1990; 22.(4): 429-35.

[31]. Poortmans J.R. Serum protein determination during short exhaustive physical activity". Journal of AplliedPhysiology 1971; 30: 190-92.

[32]. Sawka M. young R.C. Human intravascular immunoglobulin response to exercise – heat and hypohydraition".Auiation, Space, and Enuironmental Medicine 1989; 60: 634-638.

[33]. Peter EM. Exercise, immunology and upper respiratory tract infections. Int. Sport Med.1997; 18: S69 – S77.

[34]. Shabkhiz F, Taghikhani M, AminianRazavi T, Zahirhasan M, et al. The effect of 6 weeks ofcontinuous and interval aerobic trainings on the Humoral immune system in old female wistar rats, Harkat 2004; 26: 107-125 (Persian).

[35]. Allgrove J.E, Gleeson M, Gomes E, Hough J. Effects of exerciseintensity on salivary antimicrobial proteins and markers of stress in active men,Journal of Sports Sciences 2008; 26(6): 653 – 661.

[36]. Bernstein E.D, Kaye E, Abrutyn P, Gross M.D, Murasko D.M. "Immune response to influenza vaccination in a large healthy elderly population".Vaccine 1999; 17: 82-94.

[37]. Klentrou P, Cievalak T, Macneil M, Vintinner A, Plyey M. Effect of Moderate Exercise on Salivary Immunoglobulin A, and Infection Risk in Humans 2002; 87(2):153-158.

[38]. Zelante T, De Luca A, Bonifazi P, Montagnoli C, Bozza S, Moretti S, et al. IL-23 and the Th17 pathway promote inflammation and impair antifungal immune resistance. Eur J Immunol 2007;37:2695–706.

[39]. Rangachari M, Mauermann N, Marty RR,Dirnhofer S, Kurrer MO, Komnenovic V, et al. T- bet negatively regulates autoimmune myocarditis by suppressing local production of interleukin 17. J Exp Med 2006; 203(8): 2009-201.