

## Effect of a session training on serum concentration of immunoglobulin A, cortisol and lipoprotein in the morning and the afternoon in elite male Taekwondo

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### Abstract

*Introduction:* Studies show that our body follows a daily cycle so-called circadian rhythm which affects a large number of physiological and psychological actions such as body temperature, metabolism, blood pressure, hormone secretion and athletic performance. The purpose of this study was to investigate the effect of a training session on serum concentrations of immunoglobulin A, cortisol and lipoprotein at different hours of the day in elite male Taekwondo athletes.

*Material & Methods:* Twenty eight elite male sport of Taekwondo athletes with  $23.7 \pm 2.7$  years old and  $10.2 \pm 5.4$

years experience in sports were divided into two groups as experimental group ( $n = 14$ ) and control group ( $n = 14$ ) randomly. The experimental group did a steady training program for 60 min corresponded with 70-90 percentage of their heart rate reserve at 08:00 A.M and 08:00 P.M in two different days. The control group rested at the same time and place. Blood samples were collected before and after training.

*Results:* Serum cortisol concentrations before and after training was higher in the morning significantly ( $P < 0.05$ ) and there was no significant difference between serum immunoglobulin A concentrations before training in the morning and at the afternoon. Serum cholesterol concentrations after the training in the afternoon were lower than after exercise in the morning significantly ( $P < 0.05$ ), serum HDL concentrations in the morning were higher than in the afternoon ( $P < 0.05$ ), serum vLDL and TG concentrations were higher in the afternoon than the morning ( $P < 0.05$ ).

*Conclusions:* Results show that a training session is effective on concentrations of serum lipids and lipoproteins and is associated with circadian changes in some of factors, so that a training session in the morning was leading to increased in serum cortisol concentrations of the elite Taekwondo athletes.

**Key Words:** Taekwondo, Cortisol, Immunoglobulin A, Serum lipoproteins

## 1. Introduction

Paying attention to the important intrinsic factor so-called biological clock and its effect on physiological position and so on physical performance especially during different times of the day is essential. Recent findings of chronobiology (effect of time on physiological variables) show that human's body experiences a lot of changes during the 24 hours of a day and has specific potential at different hours (1). Circadian changes involved in physiological processes of athletic

performance have been studied a lot in the past 20 years. In recent studies changes in circadian rhythm at resting position have been shown in metabolic variables (oxygen consumption and carbon dioxide production), ventilator and cardio-respiratory responses (minute ventilation, heart rate, cardiac output, blood pressure) temperature regulation variables (skin and body core temperature, blood flow) and hormones secretion (cortisol, catecholamines) (1-4). Also, earliest findings of chronobiology science indicate that human's body experience of many changes during the 24 hours of a day and have specific potential at different hours. In between, circadian hormonal changes (such as cortisol) seem to have a strong influence upon these changes (2,5). Cortisol is the most important catabolic hormone in the body. Cortisol is a steroid hormone which is secreted from cortex of adrenal glands and mainly has catabolic effects. Cortisol's response to stress has always been considered as a marker of work pressure. A lot of findings have been obtained regarding the relation between cortisol and work pressure. This stress can be due to stressful mental stimuli such as daily work or physical activity (6,7) which leads to decline performance during work or competition (4). The secretion of the corticotrophin releasing factor (CRH) and cortisol is high in the early morning and becomes low at the sunset or in the late afternoon. This is because of the circadian changes in the commands issued from hypothalamus which cause changes in cortisol secretion (8). Since one the effect of cortisol effects is a suppressing impact on immune system and serum, plasma and salivary levels of this hormone increases during and after physical activity, as a result the decrease in immunoglobulin A is attributed to the increase in cortisol level; as the increase in cortisol affects B lymphocytes and prevents antibodies generation and immunoglobulin production declines (9,10). Immunoglobulin A is one of the most important immunoglobulin's in different body secretions (4). Physical performance considering its type (short-term or long-term), can be affected by the time of performance in different ways (11). Despite these findings, researchers believe that there is evidence which show that athletic potential are at their best level on the afternoon or on the early evening; when body core temperature and metabolism are at the highest level (12) (11). Fayaz izadi (2010) stated in her study that most people experience the lowest body temperature in

one to 3 hours before waking up on the morning and the highest on the late afternoon. She showed that strength is around 5% greater at noon (13). Hill (1999) demonstrated that aerobic capacity increases by 4 percent and anaerobic performance is improved by 5 percent on the afternoon (6). This might not makes much difference for an amateur athlete, but it is so important for a professional athlete. Reilly et al. (2000) showed that reaction time, anaerobic power, flexibility and muscular strength have significant differences in the afternoon (compared with on the morning) which is probably as a result of the higher temperature of the body and hormonal secretion in the afternoon (14). Few studies have investigated the impact of time of day on cortisol response to sport activities. Several studies reported that the cortisol response to physical activity and sport activity is the same on the morning and in the afternoon (15,16). On the other hand, Dimitriou et al. (2002) believed that exercise training could make infection in athlete on the morning. These researchers with studying 14 professional swimmers found that cortisol has the highest level on the morning whereas IgA has the lowest. Cortisol is weakened immune system while IgA helps get rid of infection of the body. Therefore, they concluded that if athletes do exercise intense on the morning they are more exposure to infection (8). Other researchers do not accept this idea though. For example Fayaz izadi (2010) believe that professional athletes start exercising when they feel their body is ready. Professional athletes know their body very well and realize that when their physical and mental circadian rhythms are at the highest level. She also believed that most of the professional athletes can choose the time of their training but they try to choose it when they are at their best (13). Also, Kanaley et al. (2001) showed in their study that cortisol concentrations at rest and after exercising at 07:00 A.M are higher than 07:00 P.M and 12:00 A.M (15). Since sport competitions have been became compacted recently, taekwondo athletes, exactly like other athletes, have to exercise for long hours of the day or have to add to the number of training sessions of a day to improve their performance and achieve succeed in continental, world and Olympic competitions. The increase of training hours of day and decrease in recovery time may prevent to restore the physiological variables to their original levels before training. Therefore, athletes are

likely to face immune response disability and increase in physical and mental stress. To investigate previous studies shows that most studies on circadian rhythm, conducted on various criteria such as muscular performance, physiological performance at rest and in response to moderate and intensive training so far, and blood factors, especially lipids and blood lipoproteins, which are vital cardio-vascular risk factors, have been less considered. It is cited that endurance training can impact the blood lipid profiles via altering intravascular enzymes activities. The results of sports studies on blood lipid are not the same; approximately half of reports have been stated the positive effect of doing exercise on lipids and the other reports have been seated the opposite or no effect (5). Response of blood lipids to a one-session sport activity has been reported in numerous studies which included decline in TC, LDL and TG and increase in HDL, but these changes have not been verified completely. Therefore, considering aforementioned contrasting reports regarding the subject, the present study has been designed to examine the effects of time of doing exercise on IgA, cortisol concentrations and blood lipids.

## **2. Materials & Methods**

### *Subjects*

28 male elite Taekwondo athletes volunteered for the study. Subjects were randomly divided into an experience group ( $n=14$ ) and a control group ( $n = 14$ ). Personal characteristics of the subjects are illustrated in Table 1. None of the subjects had history of hormone disorder and were under medical treatment during the study. Subjects were asked not to participate in any sport activity at least 48 hours before conducting the research and to keep their normal diet and sleep schedules.

### *Training Program*

The experimental group took part in a similar Taekwondo training routine in 2 different days (3 days apart from each other) and 2 different hours (08:00 A.M and 08:00 P.M) at the range of 70 to 90 percent of heart rate reserve. The routine training protocol included a 10-minute warm-up, 10 minutes of kicks, 10 minutes of punches, a 10-minute combined training, a 5-minute training competition and a 5-minute

warm-down. Between every stage athletes had a 2-minute active resting. Intensity training was controlled with Pular stethoscope. Control group rested at the time and place of the study. Training protocol was the same in both days and done by and under supervision of an international Taekwondo coach.

### *Method of Data Collecting*

On the first testing day, subjects were weighed with the at least clothing and using Siemens scale with 0.1 kilogram precision and then their height were measured without any footwear while they were normally holding their breath. Measurement of the subcutaneous fat was done with Yagami calipers, made in Japan, in 7 subscapular, triceps, midaxillary, pectoral, suprailiac, abdominal and thigh regions. Fat percentages of the subjects were calculated by Jackson & Pollock formula. Blood samples were taken immediately before and after both training session by a lab technician in the study place. 5 milliliter of blood was taken from each subject's right hand immediately before and after exercise and centrifuged in the same place to prevent blood clots. It was maintained the temperature minus 20°C after transporting to the lab. In order to find the amount of immunoglobulin A, kits were used made by Binding Company (England). Serum cortisol concentrations were measured with ELISA method by Radim kits made in Italy. Also, measurements of serum lipoproteins of subjects were done with enzymatic method using Pars Azmoon kits (Germany).

### *Statistical Analysis*

Results were expressed as the mean  $\pm$ SD and distributions of all variables were assessed for normality. In order to compare studied variables in physical activity on the morning and in the afternoon and also to investigate the changes of the variables from before up until after any training session were used dependent student's t-Test. In addition, the relationship between cortisol and immunoglobulin A were examined using Pearson correlation test. All the statistical computations were performed by SPSS-16 and the significance level for the whole study was  $P < 0.05$ .

### 3. Results

Personal characteristics of the subjects were shown in Table 1. No significant differences were observed in anthropometric and body composition characteristics of the subjects between two groups.

**Table 1.** Personal characteristics of the participants (mean  $\pm$  SD)

Variables	Experience Group (n=14)	Control Group (n=14)
Age (year)	22.9 $\pm$ 1.9	24.5 $\pm$ 0.7
Height (cm)	179.8 $\pm$ 4.9	178.8 $\pm$ 5.1
Weight (kg)	73.2 $\pm$ 5.7	68.1 $\pm$ 4.2
Body Mass Index (kg/m <sup>2</sup> )	22.85 $\pm$ 2.1	21.49 $\pm$ 2.4
Body fat (%)	12.8 $\pm$ 5.3	11.9 $\pm$ 4.5
Sport Experience (year)	10.6 $\pm$ 4.4	9.8 $\pm$ 6.4

The cortisol, immunoglobulin A, cholesterol, LDL, HDL, vLDL and triglyceride concentrations before and after both training sessions in the morning and in the afternoon are presented in Table 2. As shown in Table 2, there was no significant difference between serum concentration of cholesterol before the training, on the morning and in the afternoon. But, serum concentrations of cholesterol after the training in the afternoon was lower than after the training on the morning significantly ( $t=2.995$ ,  $P=0.01$ ). Results indicate that serum concentration of cholesterol after the training on the morning and in the afternoon did not differ significantly. On the other hand, there was no significant difference between serum concentrations of LDL in physical activity on the morning and in the afternoon and also that didn't change after the 2 training sessions significantly.

Serum concentrations of HDL on the morning was significantly higher than in the afternoon ( $t=2.51$ ,  $P=0.026$ ) and before and after the training ( $t=2.399$ ,  $P=0.032$ ). However, serum concentrations of HDL after the both training sessions did not change significantly.

Serum concentrations of vLDL in the afternoon was higher than on the morning significantly ( $t=3.56$ ,  $P=0.004$ ) and before and after the training ( $t=3.165$ ,  $P=0.007$ ). Both sessions of physical activity caused to reduce serum concentrations vLDL after the training ( $P=0.03$  and  $P=0.005$  for

training on the morning and in the afternoon respectively). Serum concentrations of TG in the afternoon was higher than on the morning significantly ( $t=2.319$ ,  $P=0.007$ ) and before and after the training ( $t=2.512$ ,  $P=0.026$ ). Although training on the morning didn't change TG level significantly, but the training in the afternoon caused to decrease serum concentrations of TG after the training ( $P=0.002$ ).

**Table 2.** Descriptive results of cortisol, immunoglobulin A, cholesterol, LDL, HDL, vLDL and triglyceride concentrations (mean  $\pm$  SD)

Variables	Morning		Afternoon	
	Before Exercise	After Exercise	Before Exercise	After Exercise
Cortisol(nmol/ml)	167.5 $\pm$ 26.2a	119.3 $\pm$ 2.2b,c	106.1 $\pm$ 55.9	81.4 $\pm$ 41.7
IgA (mg/dl)	2.3 $\pm$ 0.6	2.2 $\pm$ 2.4b	2.3 $\pm$ 0.7	2.4 $\pm$ 0.8
Cholestrol(mg/dl)	152.4 $\pm$ 17.1	154.6 $\pm$ 18.1	147.9 $\pm$ 20.4	145.1 $\pm$ 16.2b
LDL (mg/dl)	97.2 $\pm$ 12.8	96.9 $\pm$ 13.6	88.1 $\pm$ 17.5	88.3 $\pm$ 11.4
HDL (mg/dl)	36.8 $\pm$ 5.4a	39.9 $\pm$ 8.8b,c	31 $\pm$ 9.4	32.9 $\pm$ 10.5
vLDL (mg/dl)	19.6 $\pm$ 9.9	17.8 $\pm$ 8.1	29 $\pm$ 12.7a	23.9 $\pm$ 10.2b,c
TG (mg/dl)	96.3 $\pm$ 48.8	88.4 $\pm$ 40.1	170.2 $\pm$ 126.1a	140.4 $\pm$ 110.1b,c

a: significant difference between before the training on the morning and in the afternoon ( $P<0.05$ )

b: significant difference between after the training on the morning and in the afternoon ( $P<0.05$ )

c: significant difference before and after the training ( $P<0.05$ )

Table 3 illustrates the Pearson correlation test results for cortisol and serum Immunoglobulin A in before and after the training on the morning and in the afternoon. Results give the indication that the correlation between cortisol and serum Immunoglobulin A in four sampling times before and after the training on the morning and in the afternoon was negative and there was only a significant correlation in the afternoon training.



**Table 3.** The relationship between cortisol and IgA on the morning and in the afternoon

Sampling Time	r	P values
Before morning training	-0.364	0.2
After morning training	-0.349	0.222
Before afternoon training	-0.541	0.049*
After afternoon training	-0.33	0.25

\* Significant relationship ( $P < 0.05$ )

#### 4. Discussion

The purpose of the present study was to investigate the effect of one session Taekwondo training in different times of day on serum concentrations of IgA, cortisol, lipid and serum lipoproteins of male elite Taekwondo. The results of experimental group show that the training on the morning leads to significant elevation of cortisol concentrations and it has more positive effects on blood lipids in the afternoon. Most of the previous studies on circadian rhythm agree with our results and state that sport activities enhance the performance better in the afternoon rather than on the morning. Some of these studies hold the body temperature responsible for which is higher in the afternoon and at night and probably facilitate metabolic processes (12,13,15,17). The results of some researchers showed that one training session on 2 times (morning and afternoon), had no significant impact on IgA concentration. Previous scientific evidences suggest different mechanisms for IgA concentration changes. These mechanisms consist of: the amount of secretion of suppressing hormones such as cortisol, beta endorphin, enkephalin, physical stress, mental stress, reduction of salivary flow and insufficiency of training intensity. These results are agree with researches of Boostani et al. (2011) (18) and Fayaz izadi (2010) (13) and disagree with Reid et al. (2001) (9) and Pyne (2000) (16). One of the probable reasons for these disagreements might be dissimilar training intensities in the researches.

Also, the present study indicates that the training on the morning, cause to increase cortisol concentration significantly which agree with previous studies (13,18,19). It could be duo to increase in cortisol secretion from adrenal glands and decrease in its clearance during physical activity on

the morning. During physical activity hypothalamus-pituitary-adrenal (HPA) axis activates and increases the secretion of adrenocorticotrophin (ACTH) hormone which leads in the increase in cortisol secretion (20). It should also be noted that varied mechanisms have been suggested for the cortisol concentration changes after physical activity including: stimulation of HPA axis, ACTH secretion, body core temperature, PH changes, sympathetic nervous system, hypoxia, lactate accumulation and mental stress. Results of present study agree with Boostani et al. (2011) and Fayaz izadi (2010) that could be on account of the same training intensity (13,18). Daly et al. (1998) in their research on gymnastic athletes reported that low intensity of routine gymnastic training does not alter adrenalin function (5). Corral et al. (1994) also in their study on prepubescent boys did not observe any significant changes in cortisol concentration after a 30-minutes aerobic exercise (20). These results disagree with of the present study. Of course intensity, duration, type, and the environment of the training and age of the subjects might be responsible for the disagreement. They also disagree with Dimitriou et al. (2002); since they showed that the cortisol response to the physical activity in the afternoon is greater than on the morning (8). The reason could be attributed to the difference in the subjects (Taekwondo athletes vs. swimmers) and the type of exercise (Taekwondo exercises vs. swimming).

Other findings of the present study are the negative relationship between cortisol and Immunoglobulin A in four different sampling times before and after training on the morning and in the afternoon and that correlation was only significant before training in the afternoon, which might be duo to the difference between IgA and cortisol response to physical activity. This finding agrees with the results of Boostani et al. (2011) and Fayaz izadi (2010) and Tharp et al. (1990) (13,18,4, 21). As the mechanisms which reduce IgA are not completely clear yet, the present study demonstrates that cortisol has no significant effect on IgA concentration.

## **5. Conclusion**

In summary, it must be admitted that the circadian rhythm and its impact on athletic performance is a multidimensional factor which should

be looked at different possible angles and there should be more wide-ranging researches to find the right time to training which has the maximum efficiency for athletes.

**Conflict of interests:** No conflict of interests amongst authors.

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