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Original Article

The effects of continuous aerobic training versus weight training with high-intensity intermittent exercise on physical performance, hormonal responses, and psychological fitness in Thai military

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Abstract

This study aimed to compare the effects of continuous aerobic training (CAT) versus weight training with high-intensity intermittent exercise (WT/HIIE) on physical performance, hormonal responses, and psychological fitness in air force men. Forty-one participants were randomly allocated to the control group (CON), CAT, and WT/HIIE. The CAT and WT/HIIE were designed to yield the same energy expenditure/session. Both groups performed 3 times/week for 12 weeks. Results showed that the CON showed no significant change in all parameters. Both CAT and WT/HIIE increased ($p<0.05$) muscular strength (leg), muscular power, speed, testosterone, testosterone/cortisol ratio, mental state and mental health. Only WT/HIIE decreased ($p<0.05$) cortisol, stress level and increased ($p<0.05$) muscular strength (chest), muscular endurance, aerobic capacity, insulin-like growth factor 1, and mental quality. We concluded that both CAT and WT/HIIE were effective in improving physical performance, hormonal responses, and psychological fitness in air force men, but the WT/HIIE appeared to confer greater overall improvements than the continuous aerobic training program.

Keywords: weight training with high-intensity intermittent exercise, physical performance, hormonal responses, psychological fitness

1. Introduction

The military physical performance levels directly impact on soldiers combat readiness. Military physical training programs had beneficial effects on physical performance, and underscoring in physical performance test was the increased risk of death in the battlefield. To improve physical fitness in the military, research showed that muscle strength and aerobic capacity were the keys to readiness (Vickers, 2009). Weight training and cardiovascular training which were appropriately designed could promote effective military physical performance (Jameson & Vickers, 2010). Improvement in physical performance required the analysis of many factors. Speed, strength, power, flexibility, endurance, and cooperation with military duties could affect military fighting effectiveness and survivability in the battlefield (Harman *et al.*, 2008). Weight training programs which address maximal strength and maximal power were increasingly

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being recognized as potentially important components of military fitness in the United States of America (U.S. Army Training and Doctrine Command, 2010). Strength training and endurance training were frequently used in military and civilian populations for improving physical performance. For example, Hickson reported that the idea of interference when attempting to develop strength and cardiovascular endurance concurrently (Hickson, 1980).

Elevations in hormones with weight training take place in unique physiological surroundings. The primary insulin-like growth factor which were studied in many types of exercise was insulin-like growth factor 1 (IGF-1). Elevated levels of IGF-1 response to various types of physical activities and exercise protocols seemed to be closely related to regulatory factors of IGF-1 transport and release (Blum *et al*., 1989). Kraemer *et al*. (1990, 1991) reported that IGF-1 response to weight training was lower at the starting concentrations in both men and women. Another hormone was testosterone. Resting testosterone concentrations during weight training increased in both pre-pubertal and pubertal boys (Tsolakis *et al*., 2000). Alen and co-worker reported that the resting testosterone concentration was significantly elevated in men (Alen et al., 1988). Increasing testosterone concentrations had been reported in some studies, but there were several studies reported that no significant difference. Häkkinen and co-worker reported that in a 1-year training period, there were no significant differences in elite Olympic weightlifters (Häkkinen, Pakarinen, Alen, Kauhanen, & Kompi, 1987). In addition, psychological fitness, as a part of the total force fitness in the U.S. Air Force, had been improved by aerobic exercise, including walking, jogging, swimming, and cycling (Guszkowska, 2004). Resources about psychological fitness had been focused on the theories of stress, prevention, psychological health and well-being. Psychological fitness had been shown to be influenced by both psychological and physiological stimuli (Caldwell *et al*., 1994). Rodrigues and co-worker revealed that aerobic physical fitness tended to present reduced patterns in anatomic response to psychological fitness in Brazilian Army Personnel, as shown by the behavior of the level of conductibility on the skin (Rodrigues, Martinez, Duarte, & Ribeiro, 2007).

The purpose of the present study was to investigate the effects of weight training with high-intensity intermittent exercise on physical performance, hormonal responses, and psychological fitness in Thai military. In order to derive the information regarding the relative efficacy, the results of the weight training with high-intensity intermittent exercise were compared with those of continuous aerobic training that was designed to yield the same energy expenditure/exercise session. We hypothesized that weight training with high-intensity intermittent exercise would yield more favorable adaptations than continuous aerobic training in improving physical performance, hormonal responses, and psychological fitness.

2. Materials and Methods

2.1 Participants

A total of 45 Royal Thai Air Force men aged 20-25 years were recruited from the Royal Thai air force security forces command, Bangkok, Thailand. All participants had VO_2max at least 40 ml/kg/min, performed 1RM bench press 1.0 times their body weight, and had experienced at least 6 months of weight training and aerobic training. All participants were in good health, free from diabetes mellitus, hypertension, and cardiovascular disease, non-smoker, free from hormone replacement therapy, and without any supplement. An informed consent was obtained from all participants. The present study was approved by the Ethics Committee of the Mae Fah Luang University and conducted according to the Helsinki Declaration.

The eligible participants were randomly allocated into three groups: control group (CON), continuous aerobic training group (CAT), and weight training with high-intensity intermittent exercise group (WT/HIIE). Participants were excluded if they dropped out or completed less than 80% of the training schedule. Four subjects dropped out by the end of the study, the reasons for withdrawal included physical discomfort and exercise less than 80% of total time, thus the remaining were 41 subjects; 14 subjects in CON, 13 subjects in CAT, and 14 subjects in WT/HIIE.

2.2 Exercise training interventions

The CON was conducted with standardized military physical training which were jumping jacks, squat, lateral flexion, burpee, windmill, push-up, back extension, sit-up, 50 meters sprint, 2,000 meter run (3-5 Borg scale) including warm-up, cool-down, and stretching. Total time for CON was 30 minutes a day. The CAT was conducted with standardized military physical training combined with 15 minutes running at moderate intensity (40-60% heart rate reserve), including warm-up, cool-down, and stretching. Total time for CAT was 45 minutes a day. The WT/HIIE was conducted with standardized military physical training combined with continuous 15 minutes weight training with high-intensity intermittent exercise which was continuous high knees running in place (>85% heart rate reserve) 20 seconds, standing rest 40 seconds, bench press (60-80% 1RM) 20 seconds, and standing rest 40 seconds, including warm-up, cool-down, and stretching. Bench press exercise was performed 3 seconds per repetition with metronome and adjusted the intensity every 4 weeks. For high knees running in place a heart rate monitor was used for measuring heart rate. Total time for WT/HIIE was 45 minutes a day. Both CAT and WT/HIIE training programs were designed to achieve equal amounts of caloric expenditure during the respective exercise session (Keytel *et al*., 2005; Robergs, Gordon, Reynolds, & Walker, 2007). All three groups performed 3 days/week for 12 weeks, training on Monday, Wednesday, and Friday at 05.00-07.00 PM. In order to ensure compliance that the subjects were monitored on a weekly basis and total energy expenditure on the monthly basis. Exercise intensity was increased accordingly as the subjects got fit. All the exercise sessions were supervised and the compliance and adherence were monitored by the investigators.

2.3 Measurements

On the first day, blood samples were collected at 07.00-08.00 AM. Insulin-like growth factor 1, testosterone, and cortisol level were measured with standard procedures in the certified clinical laboratory. Two hours after lunch, the participants were asked to perform biological data and psychological fitness data assessments. Physical performance data assessments were performed on the second day under the same experimental conditions described below. All the post-measurements were performed 48 hours after the last bout of exercise in order to avoid the acute effects of exercise.

2.4 Biological data measures

Body weight was measured with the weight scale (Tanita, Japan). Waist-to-hip ratio was measured with plastic tape (Butterfly, China). Percent body fat was measured with caliper (Body Caliper, Italy). Resting heart rate and blood pressure were measured with digital blood pressure desire (Omron, Japan).

2.5 Physical performance data measures

Muscular strength (chest) measurement was performed with flat bench press equipment (Powertec, USA & Ivanko, USA) and muscular strength (leg) measurement was performed with leg strength dynamometer digital (Takei, Japan) (Earle, 2006). Muscular endurance measurement was performed with 2-minute push up (Department of the army, 1998) and muscular power measurement was performed with vertical jump testing equipment (Vertec, USA) (Arthur, Arthur, & Bailey, 1998). Body flexibility measurement was performed with standing trunk flexion meter (Takei, japan) (Kurt & Pekünlü, 2015). Speed measurement was performed in 40-yard sprint (Baechle & Earle, 2008) and aerobic capacity (VO_2max) measurement was performed in 1.5 mile run (Fahey, Insel, & Roth, 2007).

2.6 Biochemistry data measures

Blood samples were collected by registered nurses (Bumrungrad hospital) at 07.00-08.00 AM. Insulin-like growth factor 1 (IGF-1), testosterone, and cortisol level were measured with standard procedures in the certified clinical laboratory (N-Health Lab, Bangkok, Thailand).

2.7 Psychological fitness measures

TMHI-15 and ST-5 questionnaires could be administered individually or in a group setting. Respondents were asked to read each statement carefully and then to check the box that best reflects their level of agreement with the statement (Department of Mental Health, 2009; Mongkol, Tangseree, Udomratn, Huttapanom, & Chuta, 2007).

2.8 Statistical analyses

The data, including biological data, physiological data, biochemical data, and psychological data were demonstrated by mean and standard deviation. Statistical comparisons between baseline and after 12 weeks were conducted using the paired student's t-test with significant level at $P<0.05$. Statistical comparisons among three groups (CON, CAT, and WT/HIIE) were conducted using the repeated measures ANOVA with significant level at $P<0.05$.

2.9 Ethical consideration

All protocols and procedures that used in this study were reviewed and approved by the Faculty of Anti-aging and Regenerative Medicine, Mae Fah Luang University, Thailand (REH-59124). All participants were informed about all details regarding the study, and asked to sign an informed consent form. The participants were able to stop the experiment at any time without consequences. All the data produced in this study were anonymous and were kept strictly confidential.

3. Results and Discussion

3.1 Results

3.1.1 Biological data, the comparisons between baseline and after 12 weeks

No changes in biological data were observed in CON. Body weight, body mass index, waist-to-hip ratio, and resting heart rate decreased ($P<0.05$) in both CAT and WT/HIIE. Percent body fat and systolic blood pressure decreased ($P<0.05$) only in WT/HIIE. No significant differences were observed among the three groups for any parameter at baseline. After 12 weeks, resting heart rate per minute in WT/HIIE was significantly lower than in CON and CAT ($P<0.05$) (Table 1).

3.1.2 Physical performance data, the comparisons between baseline and after 12 weeks

No changes in physical performance data were observed in CON. Muscular strength (leg), muscular power, and speed increased ($P<0.05$) in both CAT and WT/HIIE. Muscular strength (chest), muscular endurance, and aerobic capacity increased ($P<0.05$) only in WT/HIIE. No significant differences were observed among three groups for all parameters at baseline. After 12 weeks, muscular strength (chest), muscular endurance, and aerobic capacity in WT/HIIE were significantly higher than inCON and CAT ($P<0.05$) (Table 2).

3.1.3 Biochemical data, the comparisons between baseline and after 12 weeks

No changes in biochemistry data were observed in CON. Testosterone and testosterone/cortisol ratio increased ($P<0.05$) in both CAT and WT/HIIE. Only WT/HIIE had significant increases ($P<0.05$) in insulin-like growth factor 1 and decreases ($P<0.05$) in cortisol. No significant differences were observed among the three groups for any parameter at baseline. After 12 weeks, insulin-like growth factor 1 in WT/HIIE was significantly higher than in CON and CAT ($P<0.05$) (Table 3).

Table 1. Comparisons of biological data between baseline and after 12 weeks and among three groups of subjects: control group (CON), continuous aerobic training group (CAT), and weight training with high-intensity intermittent exercise group (WT/HIIE)

	CON (n=14)		CAT (n=13)		WT/HIIE (n=14)	
	Baseline	After 12 weeks	Baseline	After 12 weeks	Baseline	After 12 weeks
Age (y)	21.07±0.26		21.31±0.85		21.21±0.80	
Height (cm)	170.57±3.91		172.11±3.50		169.75±4.09	
Body weight (kg)	68.05±4.83	68.40±4.72	70.38±3.84	68.50±3.53*	69.87±4.12	67.66±3.58*
Body mass index (kg/m^2)	23.39±1.63	23.51±1.61	23.74±1.19	23.12±1.16*	24.24±1.14	23.48±1.07*
Waist-to-hip ratio	0.80±0.04	0.80±0.04	0.81±0.02	0.80±0.02*	0.80±0.04	0.79±0.04*
Percent body fat	18.70±4.05	18.95±3.96	19.30±2.83	19.11±2.80	20.98±2.68	20.25±2.22*
Resting heart rate per minute	70.57±7.89	69.71±7.18	73.15±7.36	71.69±6.31*	70.21±9.17	64.43±6.68*†#
Systolic blood pressure (mmHg)	118.14±7.36	119.07±5.42	120.46±8.60	119.77±6.13	123.35±10.83	120.50±7.86*
Diastolic blood pressure (mmHg)	72.29±9.44	71.86±8.17	75.15±5.68	74.08±4.51	77.35±6.34	76.42±4.76

Data are mean±SEM
CON (control subjects), CAT (continuous aerobic training subjects), WT/HIIE (weight training with high-intensity intermittent exercise subjects)
* P<0.05 of baseline vs. after 12 weeks, † P<0.05 vs. control subjects, # P<0.05 vs. continuous aerobic training subjects

Table 2. Comparisons of physical performance data between baseline and after 12 weeks and among three groups of subjects: control group (CON), continuous aerobic training group (CAT), and weight training with high-intensity intermittent exercise group (WT/HIIE)

	CON (n=14)		CAT (n=13)		WT/HIIE (n=14)	
	Baseline	After 12 weeks	Baseline	After 12 weeks	Baseline	After 12 weeks
Muscular strength, chest (kg)	71.42±4.35	71.96±3.55	73.26±4.25	73.07±3.83	73.03±4.40	77.32±5.67*†#
Muscular strength, leg (kg)	109.10±13.13	110.28±12.75	111.53±13.11	116.38±11.85*	110.50±9.19	117.46±10.15*
Muscular endurance (2-minute push up)	55.50±7.92	56.21±6.41	53.54±6.45	53.69±4.30	55.71±6.87	61.78±5.93*†#
Muscular power, vertical jump (inch)	16.57±2.46	16.78±2.82	17.34±2.51	17.96±2.29*	17.21±2.19	18.07±1.82*
Body flexibility (cm)	14.85±3.41	14.61±3.42	13.56±3.32	13.81±3.53	13.42±2.50	13.70±2.41
Speed, 40-yard sprint (second)	6.12±0.50	6.07±0.48	6.47±0.49	6.13±0.49*	6.51±0.50	6.11±0.33*
Aerobic capacity, VO_2max (ml/kg/min)	40.66±0.77	40.88±0.80	40.47±0.79	40.65±0.60	40.35±0.65	42.29±0.64*†#

Data are mean±SEM
CON (control subjects), CAT (continuous aerobic training subjects), WT/HIIE (weight training with high-intensity intermittent exercise subjects)
* P<0.05 of baseline vs. after 12 weeks, † P<0.05 vs. control subjects, # P<0.05 vs. continuous aerobic training subjects

Table 3. Comparisons of biochemistry data between baseline and after 12 weeks and among three groups of subjects: control group (CON), continuous aerobic training group (CAT), and weight training with high-intensity intermittent exercise group (WT/HIIE)

	CON (n=14)		CAT (n=13)		WT/HIIE (n=14)	
	Baseline	After 12 weeks	Baseline	After 12 weeks	Baseline	After 12 weeks
Insulin-like growth factor 1 (ng/ml)	209.96±37.47	211.22±33.46	205.56±41.04	212.70±45.27	212.10±35.16	247.37±39.03*†#
Testosterone (ng/ml)	3.82±0.55	3.77±0.58	4.00±0.59	4.11±0.58*	4.06±0.77	4.20±0.68*
Cortisol (μg/dl)	12.17±2.45	11.99±1.94	13.22±1.80	12.67±2.06	12.99±1.74	11.88±1.65*
Testosterone/cortisol ratio	0.32±0.07	0.31±0.05	0.30±0.05	0.33±0.07*	0.31±0.07	0.35±0.07*

Data are mean±SEM
CON (control subjects), CAT (continuous aerobic training subjects), WT/HIIE (weight training with high-intensity intermittent exercise subjects)
* P<0.05 of baseline vs. after 12 weeks, † P<0.05 vs. control subjects, # P<0.05 vs. continuous aerobic training subjects

3.1.4 Psychological data, the comparisons between baseline and after 12 weeks

No changes in psychological data were observed in CON. Mental state and mental health increased (P<0.05) in both CAT and WT/HIIE. Only WT/HIIE had significant increases (P<0.05) in mental quality and decreases (P<0.05) in stress level. No significant differences were observed among three groups for all parameters at baseline. After 12 weeks, mental quality in WT/HIIE was significantly higher than in CON and CAT (P<0.05), mental state in CAT and WT/HIIE were significantly higher than in CON (P<0.05), stress level in WT/HIIE was significantly lower than in CON (P<0.05) (Table 4).

3.2 Discussion

The major findings of the present study were that both continuous aerobic training and weight training with high-intensity intermittent exercise were effective in improving physical performance, hormonal responses, and psychological fitness in air force men and that weight training with high-intensity intermittent exercise conferred greater overall improvements than the continuous aerobic training matched for energy expenditure/exercise session. These results suggested that the weight training with high-intensity intermittent exercise could be prescribed safely, efficient, and effective strategy for improving physiological, biochemical, and psychological functions in Thai military.

We found that both CAT and WT/HIIE significantly improved biological parameters including body weight, body mass index, waist-to-hip ratio, and resting heart rate, which was similar to the study by Jameson and Vicker who found that resistance training and cardiovascular training could promote effective military biological and physical performance parameters (Jameson & Vickers, 2010), and also agreed with Sato *et al*. (2007) who reported that moderate exercise training had been proposed due to health benefit, including an increase of physical fitness and decreased risk of obesity, cardiovascular disease and metabolic syndrome. Performing weight training 3 days/week significantly improved biological parameters and showed similar result with the U.S. Army Training and Doctrine Command, which found that weight training programs significantly improved body composition and physical fitness in the United States of America military (U.S. Army Training and Doctrine Command, 2010). There was no change in diastolic blood pressure in the three groups of this study. Witid and co-worker also reported similar result that continuous and interval training showed no significant change in diastolic blood pressure in their subjects (Mitranun, Deerochanawong, Tanaka, & Suksom, 2014). In this study, WT/HIIE had significantly decreased systolic blood pressure after 12 weeks, which was similar to the study by Hambrecht *et al*. (2000) who found that systolic blood pressure was reduced by exercise training owing to aerobic exercise being responsible for reduction of total peripheral resistance. It was reduced by attenuation of sympathetic activity and increased vagal tone. The reduction of total peripheral resistance after exercise was significantly correlated with changes in stroke volume. The other finding of the present study was that WT/HIIE was more effective as compared to CAT for improving percent body fat. Such result was also reported in the study by Knapik and co-workers who reported that the military who added high-intensity interval training in their daily physical activity could improve biological and physical fitness parameters when compared with other groups (Knapik *et al*., 1990).

In the present study, both CAT and WT/HIIE had significantly improved physical performance parameters, which included muscular strength (leg), muscular power, and speed. Marcinik, Hodgdon, O'Brien, and Mittleman (1985) also reported that the addition of circuit strength training in basic physical training could improve and gain physical fitness and muscular strength in Navy recruits. Vickers showed that physical training was known to benefit healthy individuals in many aspects such as muscle strength and aerobic capacity (Vickers, 2009). Anaerobic exercise alone and aerobic exercise combined with resistance exercise showed improvement in the physical fitness in elderly (Larose *et al*., 2010). Performing weight training 3 days/week yielded significantly improved muscular strength (chest) and muscular endurance (chest) after 12 weeks. William and Tunde also found that weight training was a successful way to develop military strength and power, and concluded that weight training program, tools, equipment, and facilities were needed to fulfill properly designed programs (William & Tunde, 2012). High-intensity intermittent exercise in this study was performed on high knee running in place at high intensity of

Table 4. Comparisons of psychological fitness data between baseline and after 12 weeks and among three groups of subjects: control group (CON), continuous aerobic training group (CAT), and weight training with high-intensity intermittent exercise group (WT/HIIE)

	CON (n=14)		CAT (n=13)		WT/HIIE (n=14)	
	Baseline	After 12 weeks	Baseline	After 12 weeks	Baseline	After 12 weeks
Mental state	8.64±1.39	8.86±1.16	8.77±1.16	9.85±0.89*†	8.93±1.38	10.00±1.03*†
Mental capacity	12.29±1.38	12.43±1.28	12.77±1.30	12.69±1.70	12.57±1.94	12.86±1.70
Mental quality	12.00±1.24	12.14±1.46	11.85±1.40	12.08±1.38	12.14±1.61	13.50±1.45*†#
Supporting factors	13.29±1.93	13.07±1.63	13.92±2.06	14.15±1.72	13.85±2.65	14.14±2.31
Mental health (TMHI-15)	46.21±4.31	46.50±4.18	47.31±4.15	48.23±3.81*	47.50±6.04	49.64±5.19*
Stress level (ST-5)	5.43±2.27	5.36±1.98	5.23±1.48	5.08±1.25	5.50±1.69	3.86±1.56*†

Data are mean±SEM
CON (control subjects), CAT (continuous aerobic training subjects), WT/HIIE (weight training with high-intensity intermittent exercise subjects)
* P<0.05 of baseline vs. after 12 weeks, † P<0.05 vs. control subjects, # P<0.05 vs. continuous aerobic training subjects

oxygen consumption (>85% heart rate reserve) alternating with standing rest, and the work-to-rest ratio was 1:2, while CAT was performed on running at moderate intensity (40-60% heart rate reserve). The results showed that only WT/HIIE significantly increased aerobic capacity (VO_2max) which was similar to the result reported by Helgerud *et al*. (2007) that aerobic high intensity interval training significantly augmented VO_2max and time to exhaustion more than a traditional training program with moderately-trained males. Similarly, Laursen, Shing, Peake, Coombes, and Jenkins (2005) found an increase in VO_2max and ventilator threshold in 3 groups of well-trained cyclists following 3 different high-intensity interval training protocols of varying intensities and work-to-rest ratios. The greater improvement in VO_2max observed in this study might have been due to an increased stroke volume including a training-induced enlargement of left ventricular chamber size, and cardiac muscle hypertrophy with enhanced contractility during systole. Increased VO_2max was a result of increased stroke volume, which improved cardiac output; the latter was determined by the increases in oxidative enzymes and mitochondrial content (Saltin *et al*., 1968). Weight training with high-intensity intermittent exercise was shown to be more effective when compared to continuous aerobic training for improving muscular strength (chest), muscular endurance, and aerobic capacity, which was similar to the study by Knapik *et al*. (2004) who determined that the new program which combined progressive calisthenics exercise, interval training, and endurance runs had significantly decreased injury rate and increased cardiovascular endurance and muscular strength when compared to standard training.

Both CAT and WT/HIIE increased testosterone and testosterone/cortisol ratio in blood test which was similar to the study by Kraemer et al., who showed that androgen receptors which were the receptors for testosterone could increase by 1-2 high intensity weight training sessions that led to muscle hypertrophy (Kraemer *et al*., 2006). Galbo also showed that resistance training, high-intensity interval training could change hormone production that contributed to body's adaptation (Galbo, 1983). In this study, WT/HIIE had significantly increased testosterone/cortisol ratio, which is used as an indication of anabolic/catabolic status of skeletal muscle during the training program, thus this increase meant that WT/HIIE increased muscle protein synthesis more than muscle breakdown (Häkkinen, 1989). Weight training with high-intensity intermittent exercise performed by flat bench press at 60-80% 1RM combined with high knees running in place at high intensity of oxygen consumption (>85% heart rate reserve) alternated with standing rest, performed 15 minute/day, 3 days/week, was efficient intensity to increase insulin-like growth factor 1, similar to the result reported by Kahn et al., who examined that resistance training enhanced muscle hypertrophy and resting insulin-like growth factor 1 concentrations in an experimental group than untrained men (Kahn *et al*., 2002). The increase of insulin-like growth factor 1 was stimulated by resistance training which induced the liver cell DNA to secrete insulin-like growth factors 1, a process that took about 8-29 hours (Yeoh & Baxter, 1988). The autocrine release mechanism of insulin-like growth factor 1 might be paramount in the insulin-like growth factor 1 influence on muscle. It was shown that insulin-like growth factor 1 was responsive to weight training in men (Kraemer *et al*., 1990). Only WT/HIIE decreased morning cortisol level, which was similar to the study by Florini, who reported that resistance training could reduce chronic exercise response of cortisol that might play a primary role in tissue homeostasis entailing muscle breakdown (Florini, 1987), as well as the study by Lim and Hong, who found that the exercise combined with meditation had improved positive psychological effects, and decreased depression, and was related to decreased cortisol concentration (Lim & Hong, 2010).

Questionnaires from Department of Mental Health, which were TMHI-15, and ST-5 were used to measure psychological fitness in Thai military (Department of Mental Health, 2009; Mongkol *et al*., 2007). Both CAT and WT/HIIE increased mental state and mental health. Jowkar and Akbari reported that the exercise improved mental health in athletes in all dimensions compared with non-athletes (Jowkar & Akbari, 2009) and Lim and Hong also reported that regular exercise could decrease the negative effect of depression and improve mental health (Lim & Hong, 2010). No change in mental capacity or supporting factors were found in the three groups: CON, CAT, and WT/HIIE. Kohut *et al*. (2006) showed that aerobic exercise did not appear to be involved with psychosocial factors in adults. Only WT/HIIE decreased stress levels as also found by McGannon and Poon, who reported that one of the ways that the psychologist had identified to produce a reduction in stress and treatment in psychological fitness was exercise (McGannon & Poon, 2005). Only WT/HIIE increased the number of subjects in good mental health and low stress level after 12 weeks. Moreover, WT/HIIE decreased stress level and morning cortisol concentration. These results were notable to the fact that weight training was based on focusing on movement, and mind-muscle connection improved in psychological fitness. Chan *et al*. (2012) also reported that exercise improved depressive symptoms in elderly. Therefore, weight training with a concentration on movement reduced the activation of sympathoadrenal system, hypothalamic pituitary adrenal axis, effecting reduction of stress level and cortisol concentration in the blood stream (Anderson & Taylor, 2011).

4. Conclusions

Both continuous aerobic training and weight training with high-intensity intermittent exercise exerted beneficial effects on biological data, physical performance, hormonal responses, and psychological fitness in air force men. However, weight training with high-intensity intermittent exercise was more effective than continuous aerobic training in many of those parameters and some improvements were observed only in the weight training with high-intensity intermittent exercise group. Therefore, weight training with high-intensity intermittent exercise might be a safe, efficient, and effective strategy for improving physical, biochemical, and psychological functions in Thai military.

5. Limitation of This Study

Last 2 weeks of this study, we could not control daily life behaviors of our subjects because of their missions in the base camp and this might affect the results of biological and biochemical data.

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