SALIVARY HORMONE RESPONSE TO 12-WEEK BLOCK-PERIODIZED TRAINING IN NAVAL SPECIAL WARFARE OPERATORS

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ABSTRACT

Oliver, JM, Abt, JP, Sell, TC, Beals, K, Wood, DE, and Lephart, SM. Salivary hormone response to 12-week block-periodized training in naval special warfare operators. *J Strength Cond Res* 29(1): 66–73, 2015—Naval Special Warfare (NSW) Operators are expected to maintain a high degree of physical readiness requiring continual operational training. The physiological and psychological demands associated with operational training can result in physiological consequences evidenced by hormonal alterations justifying the need for periodized training to maintain or improve physical readiness. This study examined the pattern and time course of hormone changes during 12-week block-periodized training program (BP) in NSW Operators undergoing routine training. Eighteen NSW Operators (31 ± 6 years, 86.6 ± 9.0 kg, 176.2 ± 5.9 cm, 17.5 ± 6.5% fat) participated in a 12-week BP during routine operational training. Salivary free testosterone (FT), dehydroepiandrosterone sulfate (DHEA-S), and cortisol (C) were obtained at 4 time points coincident with changes in intensity and volume. In the second block of training in which intensity and volume were increased, FT and C increased by 20.3 ± 7.4 and 20.8 ± 9.9%, respectively. Free testosterone and C returned to baseline values concomitant with the decrease in intensity and volume at the conclusion of the third block of training. No significant differences were observed in FT-to-C ratio over the course of training. DHEA-S increased 23.1 ± 11.0% following block 1, with a further increase observed following block 2 (57.0 ± 17.4%). Our data indicate training following BP produces a pattern and time course of hormone changes congruent with changes in intensity and volume suggesting BP as a potential training model for NSW Operators and other Special Forces Operators involved in operational training.

KEY WORDS hormones, military, resistance training, performance, block periodization

INTRODUCTION

Despite advances in military technology, missions and operational training continue to be physically and psychologically demanding (13,25,31,40). According to a report published by the Naval Health Research Center, of the 15 missions rated highest in composite based on importance of determining the physical demands of Navy SEAL mission operations, the highest ranking mission had been performed by 85% of Naval Special Warfare (NSW) Operators with 50% of Operators performing 8 of the 15 identified (35). To effectively train for these missions, the Operators must perform strength and endurance training simultaneously, known as concurrent training. In studies investigating the effect of concurrent training using traditional periodization (TP) models, concurrent training has been shown to attenuate strength (22), hypertrophy (22,28), and power (14,22), having no effect on endurance capacity (1) when compared with strength training alone. Given the need for variation in intensity and volume for continued optimization of performance characteristics (3), there exists a need for identifying a periodization model to optimize performance in NSW Operators and other Special Operations Forces (SOF) Operators in which concurrent training is necessary.

One factor in identifying a potential periodization model to enhance performance in SOF Operators is the simultaneous participation in operational training. In an effort to mimic military operations, operational training often exposes military personnel to extreme physiological stressors including reduced caloric intake (caloric deficit) during periods of high caloric expenditure, sleep deprivation, and exposure to extreme temperatures (13,31), known to influence hormonal patterns, specifically testosterone (T) and cortisol (C) because of their anabolic and catabolic properties,

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Journal of Strength and Conditioning Research

respectively (13,25,31,38,40). Operational training is associated with a decrease in total testosterone (TT) (13,25,31), free testosterone (FT) (25), with concomitant increases in C (25,31,38,40). Free testosterone may be more indicative of the anabolic status as the binding of T with serum sex hormone-binding globulin (SHBG) reduces the anabolic activity of this hormone (27). Tanskanen et al. (38) reported similar concentrations of TT before and during strenuous military training, with an increase in SHBG.

A secondary underlying issue regarding the implementation of a training program concurrent with operational training is the psychological stress induced by military operational training. Dehydroepiandrosterone and its sulfate ester dehydroepiandrosterone sulfate (DHEA-S) are best known for their role as precursors to the sex steroids testosterone and estrogen (34); however, recent evidence suggests a link between DHEA and DHEA-S to operational stress, resilience, and performance during stressful military operations (39). Taylor et al. (40) showed that overall performance during a low-intensity captivity-related challenge was positively related to DHEA-S. Furthermore, overall performance during a high-intensity captivity-related challenge was inversely related to the DHEA-S-to-C ratio (40). In evaluating the DHEA, DHEA-S, C, and psychological symptoms of dissociation, and military performance, DHEA and DHEA-S have been shown to be a positive predictor of superior performance in an underwater navigation examination as well as negatively related to stress-induced symptoms of dissociation during performance of the examination (30).

Block periodization (BP) training has been suggested to serve the need of varying intensity and volume while managing multiple operational training schedules (24). Although BP has been purported to be linear in nature (6), the benefits of BP are in the medium or short-sized cycles (mesocycles), which allow concentration of training on specific trainable characteristics, and flexibility in program design compared with TP (16,24). García-Pallarés et al. (11) reported greater gains in measures of performance in kayakers performing BP compared with TP despite the longer duration of TP. In well-trained cyclists, subjects performing BP achieved a larger relative improvement in $\dot{V}O_2max$ and a tendency toward larger increases in power output at 2 mmol lactate when similar volumes were performed (37). Furthermore, Painter et al. (32) reported a slight improvement for all force measurements and greater effect size in BP compared with TP in a group of track and field athletes engaged in additional sport-specific training. However, no data are available on the hormonal response to BP.

Based on previous studies (2,15), it has been postulated that basal hormone concentrations reflect the current anabolic or catabolic state of muscle. That is, changes in the volume and intensity of training may elicit transient changes in basal hormonal levels (23). As evidence, concurrent training using TP produces a significantly different pattern than strength training alone (4,5,22), despite performance of similar strength training activities. Given the varying intensities and volume associated with each block of training, basal hormonal concentrations in BP should be reflective of the volume and intensity of the current block. Taking into account the link between hormones and the physiological state of the body as evidenced in those previous studies highlighted, we theorized that measurements of the hormonal response to BP would provide a useful and reliable means of studying the effect of BP in SOF Operators undergoing operational training. Therefore, the purpose of this investigation was to determine the effect of changes in intensity and volume associated with BP on the pattern and time course of salivary hormones (FT, C, and DHEA-S) in SOF Operators actively performing operational training. Saliva sampling provides a noninvasive easily implemented alternative to blood sampling that can be easily implemented in this population. Furthermore, steroid hormones have been shown to be reliably assayed in saliva (12).

METHODS

Experimental Approach to Problem

To investigate the effect of a BP program coincident with operational training on the pattern of salivary hormone concentrations congruent with changes in volume and intensity, a longitudinal research design was employed. The total duration of the present study was 13 weeks, with the training program lasting 12 weeks. Basal salivary hormones were sampled 1 week before initiation of training (week 0), then again at 4-week intervals (i.e., weeks 3, 7, and 11) coincident with changes in intensity and volume before a week of reduced intensity and volume, or unloading. The 12-week BP program was separated into 4-week blocks differing in volume and intensity in which the fourth week of each block was designated as an unloading week before initiation of the next training block during which intensity and volume were adjusted according to the goal of training.

Subjects

Eighteen NSW Operators participated (age, 31 ± 6 years; body mass, 86.6 ± 9.0 kg; height, 176.2 ± 5.9 cm; body fat, 17.5 ± 6.5% fat). Selection criteria included (a) active duty Operators between the ages of 18 and 55, (b) reporting not having been diagnosed with any musculoskeletal injuries within the previous 3-month period, and (c) agreeing to not consume any nutritional or ergogenic supplements excluding protein supplementation and/or a daily vitamin for the duration of the training period. Subjects meeting all criteria were informed of the experimental procedures. This study was approved by the Institutional Review Board of the University. All subjects signed an informed consent in accordance with the Institutional Review Board of the University.

Body Composition

Height and body mass were recorded to the nearest 0.01 cm and 0.02 kg, respectively, using a stadiometer (Seca, Hanover, MD, USA) and digital scale (BOD POD; Cosmed, Chicago, IL, USA) calibrated according to manufacturer guidelines. Body composition was then determined using air displacement plethysmography (BOD POD; Cosmed) calibrated according to manufacturer guidelines with subjects in appropriate attire (spandex and swim cap) to reduce air displacement and performed by a trained researcher. Previous studies indicate air displacement plethysmography to be an accurate and reliable means to assess changes in body composition (29).

Training

All subjects were well trained and familiar with all exercises performed throughout the 12-week training. Exercise sessions were monitored by a Certified Strength and Conditioning Specialist and subjects were provided detailed forms outlining the training for the week. These forms were filled out and evaluated weekly for compliance. A post-workout recovery beverage (20 g protein, 45 g carbohydrates, 3.5 g fat) was provided on training days (Muscle Milk Collegiate; Cytosport, Benicia, CA, USA) to all subjects and was consumed immediately after workout.

In accordance with BP principles, 3 blocks each lasting 4 weeks were performed (16). All workouts commenced with a dynamic warm-up and movement prep. Resistance training was performed 4 $\text{d}\cdot\text{wk}^{-1}$ immediately followed by conditioning. The resistance exercises and their corresponding set and repetition scheme are presented in Table 1. Each block targeted specific performance characteristics with an unload week scheduled for the fourth week of each block to allow for recovery before initiating the next block of training.

Block 1 (Weeks 1–4). The first block was devoted to the development of basic abilities including cardiorespiratory endurance, muscular strength, and basic coordination. On Monday and Thursday of block 1, subjects performed pull exercises of the upper-body and lower-body musculature. Pushing exercises of the upper and lower musculature were performed on Tuesday and Friday. All exercises were performed at an intensity of 8–12 repetition maximum (RM) (weeks 1 and 2) or 5RM (week 3) with rest between sets of 2–3 minutes. Cardiorespiratory conditioning consisted of intervals (1:1 work:rest ratio) performed on Monday and Thursday and tempo endurance training on Wednesday and Friday lasting ≤25 minutes. A longer (30–60 minutes) slower endurance exercise session was performed on Wednesday and Saturday.

Block 2 (Weeks 5–8). The second block focused on the development of power and strength endurance. Olympic lifts were performed at an intensity of 4–6 1RM with 2–3 minutes of rest between sets on Monday and Thursday. On Tuesday and Friday, subjects performed a metabolic circuit, in which resistance exercises were performed at an intensity of 10–15RM every 60 seconds. Conditioning during block 2 was only performed on Monday (1:1 ratio) and Thursday (repeated 10 seconds sprints, 1 minute recovery) and consisted of high-intensity intervals lasting ≤15 minutes following performance of resistance training. A longer (30–60 minutes) slower endurance exercise session was performed on Saturday.

Block 3 (Weeks 9–12). The third and final block focused on power, strength, and tactical drills performed at a high intensity with short rest. Subjects performed Olympic lifts and multi-joint strength exercises at an intensity of 3–5RM explosively with rest of 2–3 minutes on Monday and Wednesday. On Tuesday, subjects performed maximal effort lifts with 3–5RM with 2–3 minutes of rest. High-intensity interval strength training performed on Friday lasted ≤25 minutes. Agility drills were performed following power training on Monday and Wednesday, with interval training preceded by strength training on Tuesday. A longer (30–60 minutes) slower endurance exercise session was performed on Saturday.

Resting Hormone Sampling

Salivary samples were collected before the initiation of training, at the conclusion of weeks 3, 7, and 11 coincident with the final week in each training block before unloading. Samples were always collected on Sunday, after 24–48 hours of no training. Subjects were provided salivary testing materials and instructed not to eat, drink (except water), or brush teeth at least 2 hours before collection. Instruction for collection included the collection of salivary samples in the morning within 30 minutes of waking, before lunch, just before dinner, and before bedtime in sterile tubes provided by ZRT Laboratory (Beaverton, OR, USA). Subjects subsequently labeled (time and date) and stored salivary samples at −20° C until returning to the laboratory where procedures, date, and time were verified. Samples were then immediately stored at −20° C until further analysis. All analyses were entrusted to ZRT Laboratory.

Free Testosterone and Dehydroepiandrosterone Sulfate. The morning sample was analyzed for FT and DHEA-S. Free testosterone levels were determined by enzyme immunoassay (EIA) (IBL America, Minneapolis, MN, USA). Interassay coefficient of variation for FT was 15% at 24 $\text{pg}\cdot\text{ml}^{-1}$, 15% at 84 $\text{pg}\cdot\text{ml}^{-1}$, and 15% at 377 $\text{pg}\cdot\text{ml}^{-1}$. The detectable limit was 5–3333 $\text{pg}\cdot\text{ml}^{-1}$ and samples giving results >3333 $\text{pg}\cdot\text{ml}^{-1}$ were diluted and reassayed for accurate reporting. Salivary DHEA-S was determined by an EIA (DRG International, Springfield, NJ, USA). Interassay coefficient of variation for DHEA-S was 11% at 2.6 $\text{ng}\cdot\text{ml}^{-1}$, 9% at 3.6 $\text{ng}\cdot\text{ml}^{-1}$ and 8% at 10.2 $\text{ng}\cdot\text{ml}^{-1}$. The detectable limit was 0.5–125 $\text{ng}\cdot\text{ml}^{-1}$ and samples giving results >125 $\text{ng}\cdot\text{ml}^{-1}$ were diluted and reassayed for accurate reporting.

Cortisol. All salivary samples were analyzed for C. The morning C was determined by EIA (Pantex, Santa Monica, CA, USA) with an interassay coefficient of variation of 14% at 1.3 $\text{ng}\cdot\text{ml}^{-1}$, 20% at 3.0 $\text{ng}\cdot\text{ml}^{-1}$, and 7% at 11.8 $\text{ng}\cdot\text{ml}^{-1}$.

TABLE 1. Resistance exercises, sets, and repetitions over the course of the 12-week block-periodized training period.

Monday		Tuesday		Thursday		Friday	
Exercise	Sets × reps	Exercise	Sets × reps	Exercise	Sets × reps	Exercise	Sets × reps
Block 1 (weeks 1–3)							
Lower-body pull	3 × 10	Lower-body push	3 × 10	Lower-body pull	3 × 10	Lower-body push	3 × 10
Lower-body pull	3 × 10	Lower-body push	3 × 10	Lower-body pull	3 × 10	Lower-body push	3 × 10
Upper-body pull	3 × 10	Upper-body push	3 × 10	Upper-body pull	3 × 10	Upper-body push	3 × 10
Upper-body pull	3 × 15	Upper-body push	3 × 20	Upper-body pull	3 × 10	Upper-body push	3 × 10
Block 2 (weeks 4–7)							
Olympic lift	3 × 8	Lower-body push	3 × 10	Olympic lift	3 × 8	Lower-body push	3 × 10
Olympic lift	4 × 5	Lower-body pull	3 × 10	Olympic lift	4 × 5	Lower-body pull	3 × 10
Olympic lift	4 × 5	Lower-body pull	3 × 10	Olympic lift	4 × 5	Lower-body pull	3 × 10
Olympic lift	3 × 5	Upper-body push	3 × 10	Olympic lift	4 × 5	Upper-body push	3 × 10
		Upper-body push	3 × 10			Upper-body push	3 × 10
		Upper-body pull	3 × 10			Upper-body pull	3 × 10
		Upper-body pull	3 × 10			Upper-body pull	3 × 10
		Isolation push	3 × 10			Isolation push	3 × 10
		Isolation pull	3 × 10			Isolation pull	3 × 10
Block 3 (week 9–12)							
Olympic lift	4 × 3	Lower-body push	4 × 4	Olympic lift	5 × 1	High-intensity interval cross training	
Olympic Lift	3 × 3	Lower-body pull	4 × 5	Olympic lift	5 × 2		
Upper-body push	4 × 5	Upper-body pull	3 × 6	Lower-body pull	4 × 5		
Upper-body push	8 × 2	Upper-body pull	3 × 6	Upper-body push	4 × 5		
Upper-body push	4 × 6			Upper-body pull	2 × 10		

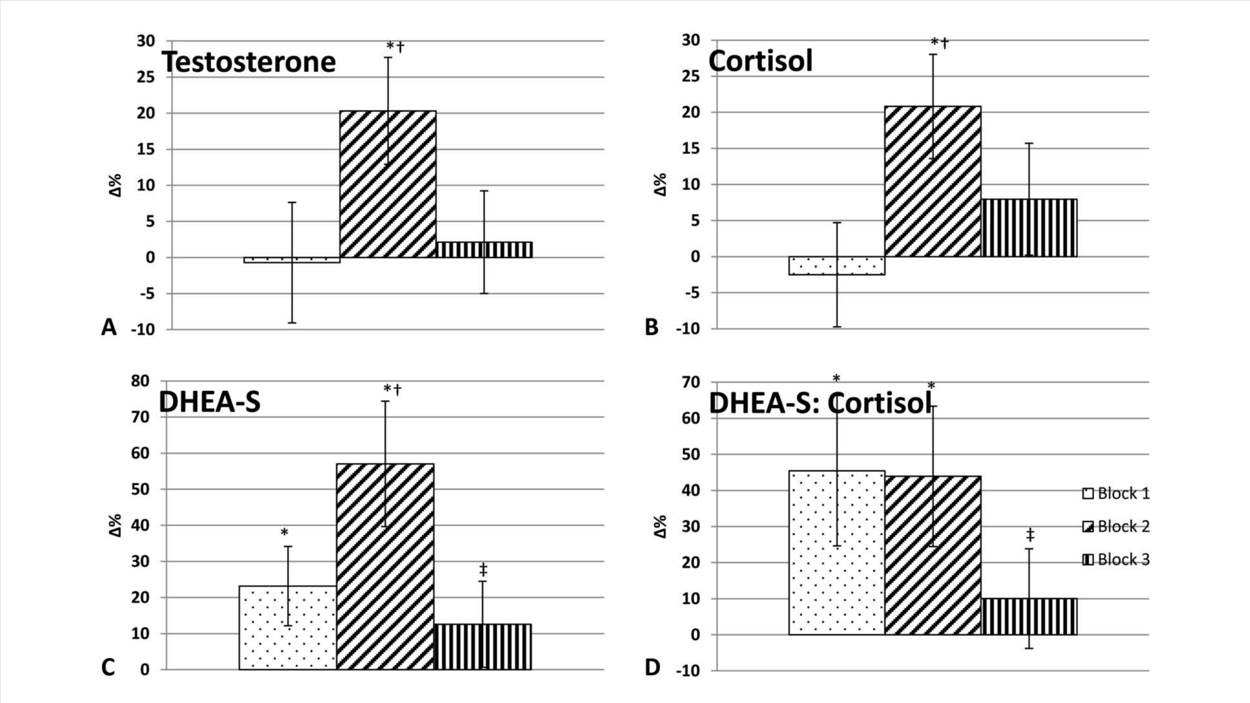

Figure 1. Percent change from baseline in salivary (A) free testosterone, (B) cortisol, (C) DHEA-S, and (D) DHEA:C ratio. *Significantly different from baseline; †significantly different from block 1; ‡significantly different from block 2; $p \leq 0.05$.

The detectable limit is 0.1–30 $\text{ng}\cdot\text{ml}^{-1}$ and samples giving results >30 $\text{ng}\cdot\text{ml}^{-1}$ are diluted and reassayed for accurate reporting. The remaining salivary samples were also analyzed by EIA (Pantex) with an interassay coefficient of variation of 14% at 0.6 $\text{ng}\cdot\text{ml}^{-1}$, 12% at 1.0 $\text{ng}\cdot\text{ml}^{-1}$, and 10% at 5.1 $\text{ng}\cdot\text{ml}^{-1}$. The detectable limit is 0.3–24.8 $\text{ng}\cdot\text{ml}^{-1}$ and samples giving results >24.8 $\text{ng}\cdot\text{ml}^{-1}$ were diluted and reassayed for accurate reporting. The average daily C was used for statistical analyses.

Statistical Analyses

Data were analyzed using SPSS Version 20.0 (SPSS, Inc., Chicago, IL, USA). Descriptive statistics were calculated for all measurements. A repeated-measures analysis of variance (ANOVA) was used to evaluate percentage change from baseline in FT, C, DHEA-S, as well as the ratio of DHEA-S-to-C. Data were normally distributed and ANOVA assumptions were met. When a significant main effect was observed, post hoc analysis was performed using least squares difference. Statistical significance was defined as $p \leq 0.05$. All values are presented as mean ± *SEE.*

RESULTS

Training compliance was ≥90% for the duration of the study. Figures 1A–D depict the percent change from baseline over the course of the training in FT, C, DHEA-S, and DHEA-S-to-C ratio. No changes were observed following the first 4 weeks of training corresponding to block 1. Both FT (Figure 1A) and C (Figure 1B) demonstrated a significant increase at the conclusion of the second block of training (20.3 ± 7.4 and 20.8 ± 9.9%, respectively) coincident with an increase in intensity and volume. Following block 3, in which intensity was increased and volume reduced, both FT and C decreased back to levels similar to that of baseline. DHEA-S (Figure 1C) increased following block 1 (23.1 ± 11.0%), with a further increase observed at the conclusion of block 2 (57.0 ± 17.4%). DHEA-S returned to baseline values at the conclusion of training (block 3), similar to that of FT and C. Similar in pattern, the DHEA-S:C ratio increased following block 1 (69.2 ± 28.2%) and remained elevated at the conclusion of block 2, returning to baseline levels following block 3.

DISCUSSION

In the current study, we investigated the pattern and time course of salivary hormone changes in response to BP in NSW Operators simultaneously undergoing operational training. The main finding of the current study was that the pattern and time course of changes in hormones, specifically FT and C, were congruent with changes in volume and intensity of the training during the preceding block, despite concurrent performance of operational training. Although we were unable to assess the physiological and psychological demands of the multiple operational training missions performed by the current subjects, a number of investigators have reported on the hormonal response to stressful military operations (13,25,31,38,40), albeit not in NSW operations. Significant reductions in T during the course of an 8-week intensive training military course in U.S. Army Rangers, a Special Forces unit within the U.S. military, have been reported reaching levels commonly observed in men with hypogonadism (31). The authors also observed a significant increase in C (32%) after the 8-week military training. The Soldiers in that study (31) were exposed to various stages of caloric deficit and temperature extremes similar to those experienced during operational training in Operators (35) in preparation for missions.

It has been suggested that changes in T and C reflect changes in intensity, duration, and mode of exercise and that these changes are indicative of the current state of muscle. As evidence, studies investigating the effect of resistance training, endurance training, or the combination of both training types have demonstrated a correlation between the hormonal response of T and C to the changes in muscle and performance (4,5,22). Although the mechanism by which concurrent training attenuates increases in strength, hypertrophy, and power, while concomitantly having little to no effect on endurance capacity are likely multifactorial (10), an apparent normal hormonal response, as evidenced by changes congruent with mode, intensity, and duration of exercise at least, provides a strong case for further study of the possible performance and physiological changes resulting from BP in SOF Operators undergoing operational training.

No changes were observed in basal levels of salivary FT of C after the first block of training. In the week preceding salivary sampling (week 3; Table 1), Operators were performing a loading scheme most closely related to the development of basic strength. A novel aspect of the current study was the measure of salivary FT. Given that 78% of salivary T is made up of FT (17), warranting comparison to those studies in which only salivary T was measured. Crewther et al. (9) reported no differences in salivary T or C following strength training when evaluating the acute effect of various loading schemes on salivary T and C in a group of recreational strength trainees. However, the acute hormonal environment following resistance exercise is not always reflected in basal levels (23). Furthermore, dramatic differences have been observed between strength training and concurrent training in serum TT and C. Passelergue and Lac (33) investigated the salivary T and C response in junior wrestlers performing concurrent training. In their study, no changes were observed in salivary T or C during the first 7 weeks, which most closely resembled the training performed in the first block of this study. In that study (33), it must be noted that salivary samples were taken at 1730 hours. Salivary T (20) and C follow a circadian rhythm with the highest values of salivary T observed upon waking. In the current study, only morning samples were used in the analyses for salivary FT, whereas the average salivary C was used for analyses (41).

The focus of block 2 was on the development of power and strength endurance. Whereas the development of power is characterized by high intensity and low volume (19), suggesting a reduction in basal FT levels (36), the strength endurance component of block 2 incorporated training with high volume at moderate intensities with short rest periods. Using relatively short rest intervals between sets has been shown to augment the acute T response to both hypertrophic and strength training (42), whereas shorter rest intervals have been shown to increase C (18,21), and have no effect on C (42). Similar to the increases observed in salivary FT and C observed in the current study, Crewther et al. (9) reported significantly higher concentrations of T and C in saliva sampled immediately after and up to 60 minutes after a hypertrophic loading scheme. Again, it must be noted that acute hormonal responses do not always result in similar changes to resting levels (23). One of the issues surrounding identifying a potential mechanism for the role concurrent training plays in the apparent attenuation of strength and lean mass gains is highlighted by the fact differences exist in the exercise mode, training frequency, intensity, and training status of the population used (10,26). The second block of training, because of the high volume of resistance training (Tuesday and Thursday; Table 1) and aerobic training, most closely resembles the training performed in the study by Kraemer et al. (22). In that study, the authors reported increases in serum T, preceded by an increase in C. This led the authors to conclude the increased total work associated with concurrent training may have led to a type of overtraining response, which was further highlighted by the smaller increase in strength observed in the concurrent group compared with the resistance training–only group. The authors further concluded that a reduction in training volume would be needed to create an environment where an anabolic response occurred to elicit greater muscle size, strength, and/or power and minimize the occurrence of overtraining. In that study, subjects were not performing additional operational training.

Interestingly, and in agreement with that which was suggested by Kraemer et al. (22), the third and final block of training was characterized by a reduction in training volume, with a concomitant increase in intensity, identified as the realization phase in BP (16). Furthermore, longer slow endurance exercise was reduced to 1 day a week. This resulted in a return of FT and C to baseline levels. We recognize one of the limitations of the current study was the lack of performance data. Because of the differing schedules and attempting to first identify the pattern and time course of hormones in Operators currently performing operational training, this was not possible. Previous studies have supported the use of BP in athletes compared with TP (11,32,37). Furthermore, Passelergue and Lac (33) reported significant correlations between salivary C and the ratio of T-to-C to performance measures.

The fact that no elevations in salivary C were observed in the absence of a concomitant elevation in salivary FT, supports further study of the potential for BP to enhance performance in SOF Operators participating in operational training.

Another significant finding of the current study was the effect of BP on DHEA-S. Recent studies have demonstrated that higher levels DHEA-S are associated with reduced stress and maintenance of performance during stressful military operations (30,40). Although the determination of stress related to and performance during operational training was not assessed in the current study, subjects in the current study were concurrently involved in operational training. Because of the need for continued mission preparedness, Operators must undergo operational training that mimics the physiological and psychological stress of missions. We observed an increase in DHEA-S during blocks 1 and 2 of the BP training. Furthermore, the DHEA-S-to-C ratio following blocks 1 and 2 suggest an anabolic response (40). The discrepancy between our results and those of previous investigators (30,40) is possibly attributable to the performance of exercise. In those previous studies (30,40), subjects were only performing operational training. Unfortunately, determining the direct effect of training on DHEA-S is difficult. This is because of the contradictory results observed in those studies that have investigated the effect of chronic exercise on DHEA and DHEA-S, with the results being more mixed for DHEA-S (8). Despite this fact, the addition of exercise in a periodized model may increase the production of DHEA-S and reduce the stress response resulting from military operational training allowing for greater performance during the said training as some have demonstrated an increase in DHEA-S postresistance exercise (7) as measured in both serum and saliva. Further research should seek to determine if the addition of exercise during stressful military operations attenuates the stress response. A second possible explanation to the differing results is the time of sample collection. Previous studies evaluated the acute response to stressful military operations, whereas we sought to examine the basal hormonal response to a combined physical and operational training.

In summary, the pattern and time course of salivary hormones in the current study were indicative of the previous training stimuli induced by the BP. Although these data only examined the hormonal response, given the apparent normal hormonal pattern despite operational training and the previous studies in which hormones, specifically salivary T and C, have been shown to be correlated with performance measures, a strong case can be made for further study of the possible physiological and performance changes associated with BP in SOF Operators performing operational training.

Practical Applications

The physical demands required of Operators to successfully complete a mission involve muscular endurance, strength, power, and/or endurance. These skills have been identified by a comprehensive report from the Naval Health Research Center as "lifting/dragging/carrying," "walking/hiking/skiing," "swimming/diving," and "jumping/bumping" (35). Hence, development of training programs to elicit improvement in performance characteristics associated with these tasks is of importance to Special Forces. Although it is difficult to make the case for BP given the lack of a comparative group and performance data in the current study, previous authors have reported on the performance and hormonal adaptations following training using other models of periodization (4,5,22) when performing concurrent training. These studies have reported performance of concurrent training results in attenuation of performance improvements and physiological adaptations (4,5,22), and an altered hormonal pattern and response indicative of overtraining (22). Our data demonstrate a pattern and time course of FT and C congruent with changes in intensity and volume. Furthermore, the DHEA-S response suggests a possible role of exercise in the attenuation of stress associated with stressful military operations. Block-periodized training may promote greater improvements in performance and physiological adaptations while performing concurrent training than TP.

Acknowledgments

This work was supported by the Office of Naval Research N00014-11-1-0929. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Department of Defense, Office of Naval Research, or Naval Special Warfare Command. We thank those Operators who participated in this study. We would also like to thank the graduate students from the Neuromuscular Research Laboratory at the University of Pittsburgh for their assistance in data collection. No conflicts of interest exist for the investigators.

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