Original Research

Decreases in Maximal Oxygen Uptake Among Army Reserve Officers' Training Corps Cadets Following Three Months Without Mandatory Physical Training

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ABSTRACT

International Journal of Exercise Science 5(4) : 354-359, 2012. During the academic year, Army ROTC cadets are required to participate in mandatory physical training; however, during summer months training is not required. The purpose of this study was to determine if there is a change in cadet VO_{2max} after the summer when training is not mandatory. Participants completed a graded exercise treadmill test to determine their VO_{2max} in late spring of 2010 and again in early fall of 2010. Results indicated that over a three-month break from mandatory physical training, a significant decrease in VO_{2max} was seen for both genders in ROTC cadets.

KEY WORDS: VO_2, ROTC, detraining

INTRODUCTION

Physical training is important for the preparation of military cadets, including those enrolled in the Reserve Officers' Training Corps (ROTC) programs. The ROTC program provides leadership and military training at schools and universities across the country (16). Participation in regular training and testing of physical fitness is required in order to ensure service members are optimally prepared to meet the physical demands of their missions (6). In the military, particularly ROTC programs, cardiovascular endurance and muscle endurance are most commonly measured, thus, regular physical training is often centered on these variables (16). For the purpose of this study, we were interested in the cardiovascular endurance of the participants. Cardiovascular endurance reflects the ability of the lungs, blood, heart, muscles, and other organs and organ systems to transport and utilize oxygen (9). Measuring cardiovascular endurance helps not only to characterize an individual's ability to perform a certain task, but it can also be used to quantify the effect of a change in training regimen on performance (6). Maximal oxygen uptake (VO_{2max}) is a commonly used measure for assessing cardiovascular endurance.

Changes can occur in VO_{2max} with both physical training and detraining (14). Participating in different levels of exercise

training can lead to increases in VO_{2max}, yet it is generally agreed upon that training completed with intensities between 40-80% of VO_{2max}, 3 days/week, for 30 minutes/day will elicit increases in an individuals' VO_{2max} (17,14,10,11,20). The amount of increase observed depends on the initial fitness level of the individual, but increases of approximately 10% are observed (20). Cadets in the Army ROTC program are required to participate in mandatory physical training 3 days/week at training intensities of at least 40-80% of VO_{2max},, which should result in increases in VO_{2max}. However, it is has not been empirically shown that such training among Army ROTC cadets actually elicits increases in laboratory measured VO_{2max}, as a field-based 2 mile run is used to evaluate cardiovascular fitness among army ROTC cadets (5).

Detraining, the partial or complete loss of training-induced adaptations, can have a negative impact on VO_{2max} (16,15). The magnitude of the performance decline following a period of detraining appears to be related to initial fitness level, total time under reduced or absence of training stimuli, and if training stimuli is reduced or completely removed (15). A study by Coyle et al. (3) stated that highly trained athletes have been shown to decrease their VO_{2max} by 6 to 14% during a training cessation of three to six weeks. However, Madsen, Pederson, Djurhuus, and Klitgaard (12) reported that endurance capacity can vary considerably during detraining without changes in VO_{2max}.

Limited research has been conducted on the fitness levels of ROTC cadets (19). Moreover, to the authors' knowledge, no published studies have examined how changes in Army ROTC cadets' physical training (training or detraining) may influence cadets' cardiovascular fitness. Therefore the primary purpose of this study is to determine if VO_{2max} changes from early May to early August (13 weeks) in cadets when training is not mandatory.

METHODS

Participants

Participants were recruited from a three-school consortium of Army ROTC cadets. Of 51 enrolled cadets, 32 were returning cadets who completed testing at both time points. Cadets ranged from first year through fourth year students in the ROTC program. Descriptive characteristics of study participants are presented in table 1. The average age of the returning cadets, was 21.2 ± 2.9 years.

Table 1. Baseline Participant Characteristics

Variable	Males n = 24	Females n = 8
Age (years)	21.1 ± 2.0	21.4 ± 4.8
Weight (kg)	83.4 ± 11.1	59.2 ± 6.2
Height (cm)	178.8 ± 6.9	162.6 ± 5.2
BMI (kg/m^2)	26.1 ± 2.7	22.3 ± 1.6
Waist (cm)	87.2 ± 8.5	73.9 ± 6.9
Max HR (bpm)	196 ± 8	192 ± 13
VO_{2MAX} (L/min)	4.5 ± 0.5	2.93 ± 0.4
VO_{2MAX} (ml/kg/min)	53.3 ± 5.7	48.6 ± 3.3

Note. All values are presented as *M* ± *SD*. BMI = body mass index; Max HR = maximum heart-rate; VO_{2MAX} = maximal oxygen uptake.

Protocol

Cardiovascular fitness testing was completed during the spring and fall semesters of 2010. Prior to cardiovascular

fitness testing, each participant's body mass was measured to the nearest 0.1 kg with a digital scale (Tanita TBF-300A, Tanita Corporation, Tokyo, Japan), and height was measured to the nearest 0.5 cm using a portable stadiometer (Seca Road Rod 214 portable stadiometer, Seca GmbH & Co. KG, Hamburg, Germany). Waist circumference was measured to the nearest 0.5 cm on bare skin at the level of the umbilicus using a non-stretchable fiberglass measuring tape.

Participants were asked to complete a graded exercise treadmill test in order to determine their VO_{2max}. A modified Taylor protocol was used when administering the treadmill test (18). Participants first completed a 2 minute warm-up on an even grade at 7 miles per hour (mph). Following the warm-up, the treadmill test was completed at a constant speed of 7 mph as the grade increased one percent every minute. Once the participant reached volitional exhaustion, the administrator would then decrease the speed and incline so the cool-down could begin, which consisted of 3-5 minutes at a comfortable walking pace.

Each participant's VO_{2max} was assessed during the treadmill test using a Medgraphics Ultima metabolic cart (CPX model, Medical Graphics Corporation, St. Paul, Minnesota) operating BreezeSuite software (version 6.2, Medical Graphics Corporation, St. Paul, Minnesota). Breath-by-breath gas exchange data was collected and averaged over 30-second time intervals during the treadmill test. The VO_{2max} for each treadmill test was calculated as the highest 30-second time interval. Each participant's heart rate, in beats per minute (bpm), was also measured during the treadmill test using a chest-positioned Polar monitor (model T31, Polar Electro Oy, Kempele, Finland). Summary data was recorded for each participant and included maximum heart-rate (bpm), relative VO_{2max} (ml/kg/min), and VO_{2max} (L/min).

Statistical Analysis

Data were analyzed using the statistical package for the Social Sciences (SPSS) for Windows, version 18.0. Descriptive statistics were used to compute various demographic variables. In order to determine if VO_{2max} changed over the summer in cadets when training was not mandatory, a 2(time) X 2 (gender) within-between ANOVA was used. Partial eta-squared (η_p^2) effect sizes were calculated for ANOVA *F*-tests to provide a context for the magnitude of differences for all comparisons. Effect sizes were interpreted as small (.01 to .05), medium (.06 to .13), or large (≥ .14) (2). Alpha was set ≤ .05 for all analyses.

RESULTS

The primary objective of this study was to determine if Army ROTC cadets' VO_{2max} changed over a 13-week period (early May to Early August) when training was not mandatory. Mean measurements of VO_{2max} during the spring testing session and fall testing session for all returning cadets are presented in a gender stratified format within figure 1.

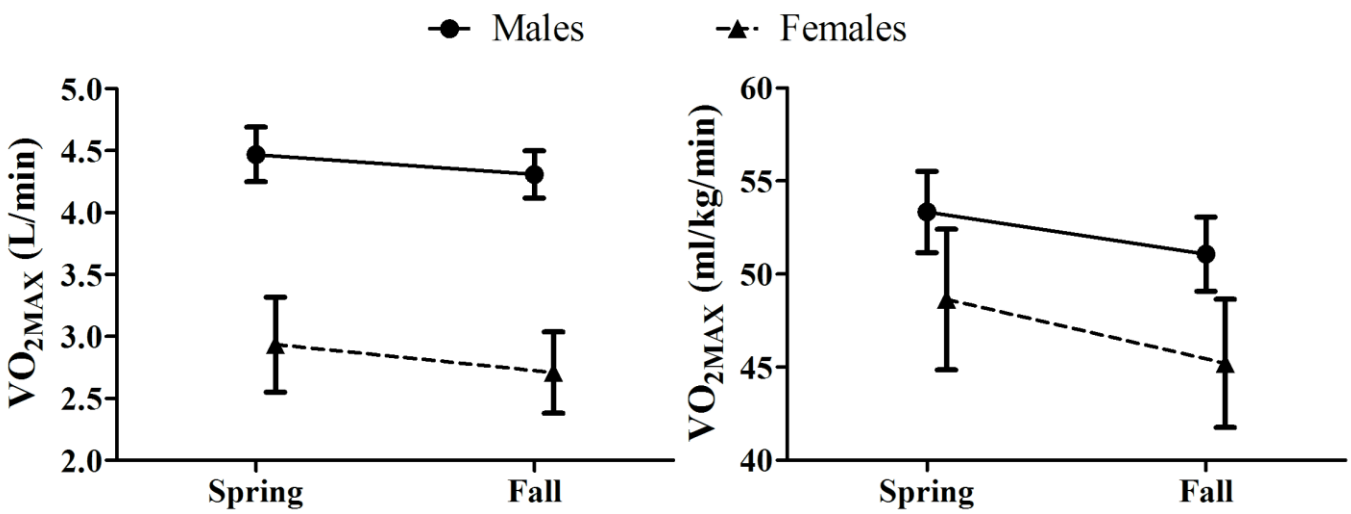

Figure 1. Gender-stratified mean changes in absolute VO_{2MAX} (L/min) and relative VO_{2MAX} (ml/kg/min) from spring semester to fall semester (13 weeks). Error bars represent 95% confidence intervals.

Significant decreases in absolute (males: 4.47 l/m to 4.31 l/m; females: 2.93 l/m to 2.71 l/m, respectively) (F[1, 30] = 7.81, p = .009, η_p = .21) and relative VO_{2max} (males: 53.34 to 51.07 ml/kg/mn; females 48.64 to 45.20 ml/kg/mn, respectively)(53.34)(F[1, 30] = 13.82, p = .001, η_p = .32) were observed after 13 weeks when training was not mandatory. For both absolute (F [1, 30] = 68.76, p < .001, η_p = .70) and relative (F [1, 30] = 7.79, p = .009, η_p = .21) analyses, males had significantly higher VO_{2max} than females. Generally, the VO_{2max} of females was approximately 15% to 25% below that of males, which is consistent with previously published literature (6,13). No significant time by gender interactions were found for either the absolute or relative VO_{2max} analyses.

DISCUSSION

The main objective of this study was to determine if non-mandatory training periods lead to changes in VO_{2max} for ROTC cadets. Cadets engage in frequent and intense physical training during the academic year, only to be left unsupervised during three months of summer. While previous studies have established that physical training leads to increases in VO_{2max} (17,14,10,11,20), it has also been established that detraining will have the opposite effect (3,4,15).

The findings of this study showed that there was a significant decrease (males: 4.3%; females: 7.1%), in the cadets' VO_{2max} over the three months from spring semester to fall semester suggesting the possibility of a detraining effect (15). Effect sizes associated with observed declines in absolute and relative VO_{2max} (η_p^2 = .21 and η_p^2 = .32, respectively) were large and suggestive of a biologically meaningful reduction in VO_{2max} among cadets from spring semester to fall semester. Similar to our results, Kovacs, et al. (8), found that as little as five weeks of unsupervised training reduced speed, power, and aerobic endurance in nationally competitive tennis players.

Limitations to this study exist, and should be considered when interpreting the results. The sample size, especially for the female cadets, was small, and it was also not known if the cadets did any physical training during the summer months. However, given the intense nature of the school year physical training required of the cadets, it is presumed that training is less intense, and possibly less frequent, during the summer, or non-supervised period. Additionally, these results can only apply to groups involved in mandatory physical training, which is generally limited to ROTC cadets and other military personnel.

In summary, this study found that over a three-month break from mandatory physical training, a significant decrease in VO_{2max} was seen for male and female ROTC cadets. While the cadets did not necessarily cease training, it has been previously established that if training is discontinued, gains in fitness regress by approximately 50% within 4-12 weeks (15), which is similar to the length of the cadets non-mandatory summer breaks. In this study, the cadets did lose fitness over time, measured by VO_{2max}, which may have been mitigated with a reduced training approach (7). In fact, training loads of as little as 1-2 days a week, at your previous intensity, for as little as 15-20 minutes, can be sufficient to maintain cardiovascular fitness and muscular strength for up to three months (1) or the same length as the cadets non-mandatory summer break. Given the need for ROTC cadets, and other military personnel, to maintain year-round fitness, even a reduced load training program would be prudent during non-mandatory periods. Therefore, cadet training should be designed to minimize any unnecessary reductions in fitness levels, particularly during the non-mandatory training summer months. Implementing a reduced-load training program can help cadets maintain their hard-earned fitness levels, which over time should decrease the burden of re-training that occurs each academic year in many ROTC cadets.

More research on the effect of detraining in ROTC cadets is needed. Future studies should include larger sample sizes and more equal representation of females and males.

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