AN EXAMINATION OF CHANGES IN UPPER AND LOWER BODY POWER IN ROTC CADETS OVER THE COURSE OF A YEAR

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The purpose of this study was to examine upper and lower body power in Army Reserve Officers Training Corps (ROTC) cadets over the course of a year. Twenty-three ROTC cadets completed two upper body and two lower body power assessments at three different time periods. The three time periods were April 2010, September 2010, and April 2011. The four assessments were a seated medicine ball throw, a force plate push-up, and a countermovement vertical jump on a force plate while simultaneously touching the highest vane they could reach on a Vertec™ placed next to the force plate. No significant changes were found for the medicine ball throw ($F = .27$, $p = .77$) or the push-up ($F = .38$, $p = .69$). However, significant changes were found for the force plate power output ($F = 7.5$, $p = .004$) and Vertec ($F = 5.39$, $p = .013$).

KEY WORDS: force plate, medicine ball throw, push-up, Vertec™, vertical jump.

INTRODUCTION: There is growing interest in assessing and increasing the muscular power of army soldiers. Increasing muscular power may better prepare the soldiers for combat conditions. The vertical jump, seated medicine ball throw, and various force plate exercises can be used to assess power. The Vertec™ has been used for many years as a method to assess lower body power in a wide range of subjects (Faigenbaum, McFarland, Schwerdtman, Ratamess, Kang, & Hoffman, 2006). Using a force plate and a medicine ball throw to measure upper and lower body power are becoming more common (Wilson, Murphy, & Giorgi, 1996; Hrysomallis & Kidgell, 2001; Faigenbaum, McFarland, Keiper, Trvlin, Ratamess, Kang, & Hoffman, 2007; Davis, Kang, Boswell, DuBose, Altman, & Binkley, 2008). Army ROTC cadets have required physical training during the school year but not during the summer. If the cadets are less active during the summer due to the lack of required physical training they could see a loss of the training gains they acquired during the school year. The purpose of this study was to examine upper and lower body power in Army Reserve Officer Training Corps (ROTC) cadets over the course of a year.

METHOD: Twenty-three ROTC cadets (17 males, 6 females) from North Dakota State University volunteered for this study (age 21.0±2.26 years, height 174.3±9.86 cm, body mass 76.07±15.48 kg). Each participant completed two upper body and two lower body power assessments during April 2010, September 2010, and April 2011. On one day the participants completed three medicine ball throws with a 4 kg medicine ball, followed by three separate individual push-ups on a force plate (Advanced Mechanical Technology Incorporated, Accupower) with approximately one minute rest between each push-up. For the medicine ball throw the subjects sat with their back against a wall and used a chest pass style of throw; the distance of the throw was measured from the wall to near side of the medicine ball after it landed. For the push-ups the subjects started in the normal push-up position with back straight and their hands approximately shoulder width apart. The participants were instructed to drop down into the bottom of the push-up and explode up immediately, their hands leaving the force plate if possible. On a different day the participants completed three countermovement vertical jumps while standing on a force plate. A Vertec™ was placed immediately next to the forceplate on the side of the participant's dominant reaching hand. The vertical jump displacement was the difference between the highest vane touched on the Vertec™ and a zero standing reach height. All the force plate data was gathered at 1200 Hz.

Means were calculated for all four dependent variables for each testing time. Separate repeated measures ANOVAs were computed for each dependent variable across the three testing times. If the ANOVA result was found to be significant, Bonferroni-adjusted pairwise comparisons were used to determine the location of significant differences between the three testing times. Statistical signifiance was set at $p<0.05$.

RESULTS: The means for each dependent variable for each testing time are presented in Table 1. No significant differences were found between the three testing times for the medicine ball throw ($F=0.27$, $p=0.77$) and the push-up ($F=0.38$, $p=0.69$). However, there were significant differences between the three testing times for vertical jump force plate power ($F=7.51$, $p=0.04$) and Vertec™ displacements ($F=5.39$, $p=0.013$). Follow-up pairwise comparisons revealed a significant decrease from testing time one to testing time two in vertical jump force plate power ($p=0.002$) and a significant improvement from testing time two to testing time three for vertical jump Vertec™ displacement ($p=0.04$).

Table 1
Means and Standard Deviations for all Dependent Variables.

	April 2010	**September** 2010	**April** 2011
Medicine ball throw	4.41 ±0.90 m	4.37 ±0.90 m	4.36 ±0.82 m
Push-up on force plate power	20.24 ±5.74 W/kg	20.93 ±6.94 W/kg	20.87 ±4.86 W/kg
VJ force plate power	49.22 ±8.24 W/kg	46.02 ±8.66 W/kg	47.34 ±6.55 W/kg
VJ Vertec™ displacement	47.95 ±9.45 cm	45.91 ±8.95 cm	49.11 ±10.57 cm

DISCUSSION: Since physical training is not required during the summer we had speculated that there would be a significant drop in cadets' power output from April 2010 to September 2010, followed by a significant increase from September 2010 to April 2011 due to nine months of physical training. Cadets in this sample had been doing ancillary physical training involving plyometrics during the 9 months preceding the first assessment period of this study (April 2010). The extra physical training involved box jumps to a single box and in a series, as well as plyometric push-ups. This plyometric training was discontinued after May 2010, which we thought would lead to an even greater decrease in power between the April 2010 and September 2010 testing times. However, there were not significant changes in the cadet's upper body power output between any of the testing times, suggesting that they maintained their upper body power through the year. There were some significant changes in the cadets' lower body power during the year. It is interesting that the Vertec™ displacement means between April 2010 and September 2010 were not significantly different (although they approached significance) while the concurrently measured vertical jump force plate power means significantly decreased. Similarly, the Vertec™ displacement means from September 2010 to April 2011 significantly increased, while the force plate power means were found to have non-significant increases. In fact, the force plate power output means for April 2011 were lower than April 2010. Although the cadet's had no required physical training over the summer; they had nine months of physical training to improve. It appears that the combination of no summer physical training required and the discontinuation of the plyometric program may have led to significant decreases that could not be regained, even with long term physical training. Although the Vertec™ results do not agree with the force plate results across the three testing times, we hypothesize that this may be due to a learning effect, which we have found in previous research when using a Vertec™ (Christensen et al., 2011). There was found to be a range of 3.1cm between three vertical jumps using the Vertec™, whereas the same three jumps were found to only have a range of .55cm using the estimated force plate vertical jumps. The means of the three vertical jumps were 10cm higher with the Vertec™ than the estimated vertical jump mean with the force plate (Christensen, et al., 2011). The lack of significant changes in upper body power was somewhat of a surprise. The cadets' normal physical training involves large amounts of push-up repetitions and long distance running. It could be argued that push-ups are a power activity (lower exercise volume that can be completed) and long distance running is an aerobic activity. This could be a possible explanation as to why upper body power was

maintained whereas lower body power significantly decreased and did not rebound to previous levels.

CONCLUSION: No significant changes were found in upper body power of Army ROTC cadets over the span of a year. However, some significant changes were found in lower body power. The discontinuation of extra physical training involving plyometrics and no required physical training over the summer appears to have led to a significant drop in lower body power as measured by the force plate. The decreases were not regained, even after nine months of normal physical training. Although it is nearly impossible to know how much a difference the changes we found in power would make in the cadet's real life settings, any changes that could improve the outcome of life threatening situations is desirable. It is suggested that the cadets should be encouraged to complete some power oriented lower body activities during the summer to maintain their lower body power. It also appears that normal physical training is not enough to significantly improve muscular power. If increases in muscular power are desired for Army ROTC cadets, some power related training, such as plyometrics may be necessary.

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