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Original Research

Evaluation of the Effectiveness of ROTC Army Cadet Exercise Training for the Army Combat Fitness Test

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ABSTRACT

International Journal of Exercise Science 17(4): 172-182, 2024. The Army Combat Fitness Test (ACFT) is used to evaluate the fitness level of potential Cadets for military readiness. The purpose of this study was to evaluate the effectiveness of the exercise training program implemented by an Army Reserve Officers' Training Corps (ROTC) program to gauge the performance metrics of the ACFT. METHODS: Twenty-six student Cadets of the ROTC at the University of Alabama at Birmingham (UAB) program participated in the study. Over an 8-month period, the ROTC Cadets trained on campus three days per week. Training was performed in a circuit training format and each participant cycled through each of the four training stations (Strength, Conditioning, Core, and Endurance) for 15 minutes each session (for a total training time of 60 minutes). Each Cadet had body mass and body composition assessed as well as each component of the ACFT [maximum dead lift (MDL), standing power throw (SPT), hand release push-up (HRP), sprint-drag-carry (SDC), leg tuck/plank (LTK/PLK), and 2-mile run (2MR)]. Each variable was evaluated at three time points (pre-, mid-, and post-training program). RESULTS: There was a significant difference in the 2MR score between time points [$F(2,50) = 4.530$, $p = .016$, $\eta^2 = 0.153$] with a significant difference between time point at pre- and post-training ($p = .02$). No other variables displayed a significant change: body mass ($p = .741$), body fat percentage ($p = .238$), MDL ($p = .061$), SPT ($p = .308$), HRP ($p = .126$), SDC ($p = 0.132$), LTK/PLK ($p = 0.583$). CONCLUSION: The results of this study suggest that the short-term training program used improves 2MR, but not other components of the ACFT over the course of an academic year.

KEY WORDS: Tactical performance, military, physical fitness, human performance, exercise training, warfighter

INTRODUCTION

The Army Reserve Officers' Training Corps (ROTC) Program challenges students mentally and physically to develop skills related to critical thinking and leadership. As a part of this program, students will become United States Army Officers upon college graduation.

According to the Department of Defense, physical fitness is essential to combat readiness and is an important part of the general health and well-being of Service Members. Soldiers must maintain cardiovascular endurance, muscular strength and endurance, flexibility, balance, agility, and explosive power. Physical fitness is a crucial part of success in the military — especially in the beginning of a military career. Individuals with low levels of physical fitness are more susceptible to injury (5). Along with maintaining physical fitness requirements, military personnel are prone to injury. Age and prior injury are independent variables of injury risk (6). Though injury risk is not completely preventable, precautionary measures are still in place to lessen the possibility of injury during Physical Training (PT). Regular testing and performance monitoring may be the most effective way to inform training state. This process is also used to improve training programs (10).

The Army Combat Fitness Test (ACFT) is designed to assess overall readiness by providing an objective means to hold soldiers accountable and transform the fitness culture of the Army, reduce preventable injuries, and increase mental toughness and endurance (15). The ACFT is an evolution of its precursor, the Army Physical Fitness Test (APFT), which was designed to reflect the types of physical fitness that accurately predicts military performance. The APFT was designed to test cardiovascular fitness, muscular strength, and muscular endurance by having Cadets complete two minutes of push-ups, two minutes of sit-ups, and a two-mile run (2MR) (14). The ACFT aims to evaluate combat readiness by providing an objective tool to measure their readiness and maintain a high level of physical fitness (4). The ACFT consists of six events: 3-repetition maximum deadlift (MDL), standing power throw (SPT), hand release push-up (HRP), the sprint-drag-carry (SDC), leg tuck (LTK) or plank (PLK), and the 2MR. Recently, the LTK has been fully replaced by the PLK as the test of record (1).

The APFT scores were dependent upon gender and age – the highest score obtainable being a 300, whereas a score of 180 (60 points per event) was required to pass. For the ACFT, the highest overall score that can be achieved is a 600 (100 points per event) with the passing requirement being a score of 360. Scoring ranges from 0-100 points, with 60 points being the minimum score (per event) required to pass the event. The MDL is a test of muscular strength. It is a strong predictor of a soldier's ability to carry a fallen soldier, and to lift and move personnel and equipment (16). The SPT measures upper and lower body explosive power, flexibility, and dynamic balance (16). The HRP measures upper body muscular endurance and represents repetitive and continuous pushing used in combat tasks (16). A soldier's ability to push an opponent away during man-to-man contact, take cover, or low crawl depends on these HRP-related strengths. The SDC is a measure of muscular power and strength, and anaerobic capacity (16). All of these attributes are needed to succeed at high-intensity combat tasks. The LTK tests

muscular strength and endurance assets that are beneficial to soldiers in all activities involving climbing. Lastly, the 2MR assesses the cardiovascular endurance capacity of the soldier (16).

With changes to the Army's standard physical test, the U.S. Army anticipates that the ACFT will better predict and assess preparedness of soldiers for combat (15, 16). ROTC PT is required by the U.S. Army to be performed and standardized to meet the human performance needs of the U.S. Army (14). Likewise, PT performed by the Cadets is designed in such a way to prepare the Cadets to successfully complete the six events of the ACFT (14, 15, 16). The purpose of this study was to evaluate the effectiveness of the current exercise training program implemented by an ROTC program to gauge the performance metrics of the ACFT.

METHODS

Participants

The participants (n = 26) (16 males and 10 females) involved in this study were all Cadets in the University of Alabama at Birmingham's (UAB) Army ROTC program. A Cadet is considered a trainee for the U.S. Army ROTC, but is not yet classified as a solider in the U.S. Army. Twenty-six college-aged Cadets between the ages of 18 – 30 years completed both pre- and post-intervention testing. The cadet representation included cadets from each classification (1st, 2nd, 3rd, or 4th Year). Inclusion criteria include: approved for physical training by both the Department of Defense Medical Exam Review Board (DoDMERB) and the UAB ROTC program, as well as absence of any suspected/diagnosed pulmonary or cardiovascular related disease(s). Recruitment occurred between the Summer and Fall semester of 2020 and in the Spring of 2021. "Zero Day" is a day primarily set aside for recruitment and is typically during the first week of class each semester. During this event, students learn about the Army ROTC program and its events throughout the semester as well as opportunities available as a part of the program. It is during this initial meeting when participant recruitment for the study was performed. The study was approved by the UAB Institutional Review Board. Participants were informed about the study and provided written informed consent. Study followed all ethical standards per the International Journal of Exercise Science (8).

Protocol

Height, weight, and body composition were measured before and after the twelve-week training program. Body composition was measured using a bioelectrical impedance analysis (BIA) device (Omron Model HBF-514C; Omron Healthcare, Inc., Lake Forest, IL, USA). Height and weight were measured using standard scales. Each participant completed the ACFT as prescribed by the ACFT Field Testing Manual (15). All testing was done early in the day, between the hours of 5:30 – 7:00 am. The ACFT is conducted with a continuous 70-min clock and rest periods are not timed (16). The cadet takes rest periods between events as they feel necessary but the U.S. Army recommends not timing or requiring specific rest periods, but challenges each cadet to take the minimum rest periods they may require in order to complete it within the 70-minute window (16). Participants were not required to be fasted but were encouraged to properly hydrate in the days leading up to testing.

The ACFT protocol began with the MDL. Participants stepped inside a hexagon shaped bar with feet shoulder width apart and placed their hands on the midpoint of the bar for weight distribution. The participant slightly bent their knees and hips to grasp the bar while their arms were fully extended with the back flat and head straight. With heels remaining on the ground, and bar in hands, the participant lifted while keeping the back straight until standing in the upright position. The MDL was scored as the maximal weight lifted with proper technique three times.

For the SPT, participants were positioned on the opposite side of the start line and raised a 10-pound medicine ball with both hands, grasping it on both sides. The participant threw the medicine ball backward and overhead for distance. Each participant had two attempts with no practice attempt. Following the SPT, Cadets performed the HRP event. Cadets began in the prone position with their hands flat on the ground. Feet were together or boot width apart with flexed ankles. The head was not required to be on the ground. The Cadet pushed up from the ground maintaining body alignment with elbows fully extended at the top. Cadets then bent at the elbows until they were at the starting position. Once back on the ground, Cadets immediately moved both arms out laterally, putting the elbows into a T-position then, bent them to move the hands back under the shoulders. Cadets had two minutes to complete as many HRP as possible.

Cadets began in a prone position once again for the SDC. This was a timed event where time started once the Cadet began. When ready, the Cadet would sprint 25 meters, touch the line with both hands and feet, and then sprint back to the start where they completed the drag. The Cadet would then grab the handles of the sled and pull it backwards for 25 m and then turn around and repeat the same process until the start line was reached again. At this time, the Cadet performed a lateral slide for 25 m touching with both hands and feet, then completed the same movement (facing the same way) back to the start. Next, the Cadets picked up two 40-pound kettlebells (one in each hand) and carried them for 25 m and turned to repeat the same movement to the start line. The Cadet then placed each kettlebell down and walked 25 m for the final time, touching with both hands and feet again. Time was stopped after the Cadet crossed the line during the final sprint.

For the LTK, participants gripped the bar with their hands and hung with their feet off the ground and arms fully extended. When hanging from the bar, hands were placed alternately. Participants lifted their knees by flexing the hips until knees or thighs touched the elbows. To begin the next repetition, the participant returned to the hanging start position. The goal was to maintain a relative vertical posture while moving their hips and knees up and down without excessive swinging of the lower extremities. Since the completion of this study, and updates to the ACFT have been made, the LTK is no longer applicable. The plank (PLK) is now the standard event (1, 16). For the PLK, the cadet to lay prone, keeping upper body elevated and supported by the elbows. The hips and legs are raised off the floor, supporting the body on forearms and toes with the elbows positioned directly under the shoulders. Once cadet lifted the knees off the floor to get into position, they must maintain straight body alignment from shoulders through

hips, knees, and ankles. Any deviations from the standard posture would warrant 2 verbal reminders to maintain posture. After the 2nd verbal reminder, the test was ended if the participant was unable to maintain proper form or once a maximum time of 2 minutes is reached.

During the academic year in which this study was conducted, this transition was being made by the ROTC program and cadets were permitted to select whether they performed the LTK or PLK. Standard scoring was provided by the U.S. Army to standardize the differences in the two tests (1, 16). Finally, participants completed the 2MR and subsequently ran two miles on a quarter mile (0.25) long track and were timed.

Training Intervention: Cadets completed a training program three days per week for 20 weeks total (8 weeks in the Fall 2020 semester and 12 weeks in the Spring 2021 semester) that consisted of exercises performed within the ACFT as well as those similar. With the exception of Spring and Winter breaks and inclement weather, training was performed in a circuit training format and each participant cycled through each of the training stations for 15 minutes each session (for a total training time of 60 minutes). Standard sessions included:

- Endurance: 2-mile run (capped at 21 minutes during ACFT) and sprints (for distance or time).
- Conditioning: Four different movements were selected each session and had to be different each session from what had already been performed that week in order to target more muscle groups as well as to allow for diversity of workouts. Exercises included: SDC (25-meter sprint, 25-meter sled drag, 18kg kettlebell carry), 4.5kg underhanded power throw, power jumps, burpees, plate pushes, medicine ball slams, bodyweight squats, jump ropes, box jumps, power clean, T-test, lateral lunge, staggered jump squat, tuck jump, mountain climbers, single leg hops. Each event lasted one minute with alternating ratios of exercise: rest in seconds (e.g., 30:30, 40:20, 20:40). Cadets alternated between exercises.
- Resistance training: The program was designed for ROTC Cadets to focus on two ACFT events each session (6 total ACFT events) to ensure that each event was trained each week. The Strengthening (Resistance) session consisted of compound (Deadlifts, Forward Lunge, Shoulder Press, Push Ups) as well as accessory movements (Pull ups, Bicep Curls, Leg Tuck).
- Core: consisted of abdominal exercises using body weight or free weights following a work to rest ratio such as Planks, Crunches, Russian Twists, Flutter Kicks, Scissors, Six Inches, etc.) At least four different exercises were completed during this session consecutively for thirty seconds to one minute each, and Cadets alternated between exercises.

The study participants would start at a different station each session and would rotate every 15 minutes until the 60 minutes were completed to ensure they did each station. Intensity was prescribed using a combination of a modified 10-pt rating of perceived exertion (RPE) scale (11)

as well as a repetitions in reserve (RIR) scale (3, 17) (displayed in Tables 1 & 2). The day before each session, senior leaders were provided with the training session for the following day. Each morning of training, the senior class leaders of the UAB Army ROTC program went over proper exercise form, repetition aims, and sets prior to breaking off with their physical training groups and beginning the session for the day. The Cadets were provided an exercise library to educate them on the movements that were being asked of them in the training protocol. At the end of the week, the same leaders provided a summary and feedback to the research team. Feedback included whether the time allotted was sufficient to complete the exercises, if they were enjoyed by participants, or if they felt too difficult or put undue time constraints on cadets.

Table 1. Set & repetition prescription (reps) & Repetitions in Reserve (RIR) scale.

Day 1	Day 2	Day 3
3 x 6-10 reps	3 x 12-15 reps	3 x 4-6 reps
RIR 8.5	RIR 8	RIR 9

Table 2. Repetitions in Reserve (RIR) scale and repetitions (reps).

Rating	Description of RIR
10	Maximum effort
9	Could perform 1 more rep
8	Could perform 2 more reps
7	Could perform 3 more reps
5 – 6	Could perform 4 – 6 more reps
3 – 4	Light effort to complete
1 – 2	Little-to-no effort to complete

To develop leadership skills and better organize training sessions, UAB ROTC required the Cadets to be split into cohorts and assigned cohort leaders. The cadet leaders were trained by ROTC faculty on proper form and disseminated this information to their cohorts. Further, cadets were monitored by cohort leaders each training session. Due to campus-instituted constraints due to COVID-19 mitigation protocols, investigators in the Fall 2020 semester met remotely with the physical fitness leader of each cohort on a weekly basis to provide a summary of training and to answer any questions that arose. The cohort leader then disseminated the training program to their fellow Cadets for each week. However, other than this minor meeting adjustment, there was no other part of the training that was considered virtual or online in nature. In the Spring 2021 semester, Cadets were led in-person by senior-level Cadets under the supervision of graduate-level Cadets and ROTC faculty. Each session was of either a low, moderate, or high intensity to ensure that Cadets had proper recovery between sessions. Baseline measures were collected in September 2020. The Fall semester training program lasted from September 2020 – December 2020. Mid-point measures were collected in January 2021 at the start of the Spring 2021 semester and post-training measures were collected in May 2021 at the end of the Spring 2021 semester. There were no exercise requirements between semesters (about 6 weeks). Students were encouraged to exercise during those breaks in the academic calendar, but the ROTC does not mandate physical training between semesters.

Statistical Analysis

A repeated-measures ANOVA was used to compare all dependent variables for each Cadet over time. If significant differences were found, a post-hoc analysis with Bonferroni correction was used to determine differences between groups. If the homogeneity of variances assumption was violated, a Greenhouse-Geisser correction was utilized. All analyses were conducted using SPSS software (Version 25, SPSS, Inc., Chicago, IL). Statistical significance was defined as a *p*-level less than 0.05 and partial eta squared values were calculated to determine effect size.

RESULTS

The cadets displayed a high rate of achieving passing scores at each stage of testing. In particular, the cadets showed a high pass rate at baseline for each test: (MDL = 92%, SPT = 94%, HRP = 96%, SDC = 92%, LTP = 98%, 2MR = 80%, Total score = 78%).

Table 3 displays the results of exercise training data (mean and standard deviation) for Army ROTC Cadets for the ACFT. There was a significant difference in the 2MR score between time points [$F(2,50) = 4.530$, $p = 0.016$, $\eta^2 = 0.153$]. Upon using a Bonferroni correction to determine differences between groups, there was a significant difference between time point 1 and 3 ($p = 0.02$). However, no significant differences existed between time point 1 and 2 ($p = 0.773$) and time point 2 and 3 ($p = 0.266$). No other variables displayed a significant change across the three time points: body mass ($p = 0.741$), body fat percentage ($p = 0.238$), MDL ($p = 0.061$), SPT ($p = 0.308$), HRP ($p = 0.126$), SDC ($p = 0.132$), LTK/PLK ($p = 0.583$).

Table 3. Mean ± SD of outcome variables.

	Baseline	Midpoint	Post
Body Mass (kg)	70.4 ± 14.8	70.2 ± 14.7	70.8 ± 15.3
Body Fat (%)	24.5 ± 4.1	25.1 ± 5.7	23.5 ± 7.7
ACFT Measures			
3 Rep Max Deadlift (MDL)	70.8 ± 19.4	77.9 ± 14.0	74.0 ± 19.9
Standing Power Throw (SPT)	71.3 ± 13.3	68.9 ± 14.8	71.7 ± 12.3
Hand Release Push-up (HRP)	77.5 ± 14.7	78.2 ± 10.7	74.2 ± 12.3
Sprint-Drag-Carry (SDC)	79.6 ± 22.4	83.6 ± 14.4	85 ± 12.6
Leg Tuck/Plank (LTP)	68.7 ± 23.9	72.2 ± 19.7	67.9 ± 23.3
2 Mile Run	67.0 ± 27.1[a]	71.6 ± 28.0[ab]	80.0 ± 12.1[b]
Total Score	434.4 ± 94.8	453.1 ± 76.4	452.1 ± 68.8

-Different letters represent significant difference between timepoints.

-Baseline = pre-Fall 2020 semester, Midpoint = pre-Spring 2021 semester, Post = post-Spring 2021 semester

DISCUSSION

Our findings indicate that a 3-day per week exercise program improves aerobic endurance, measured by 2MR score, over the course of an academic year in an ROTC population. Additionally, the training program successfully maintained levels of muscular endurance and

muscular strength, measured by HRP and MDL, which are critical components of the ACFT, even though there were long periods of unstructured or unsupervised training.

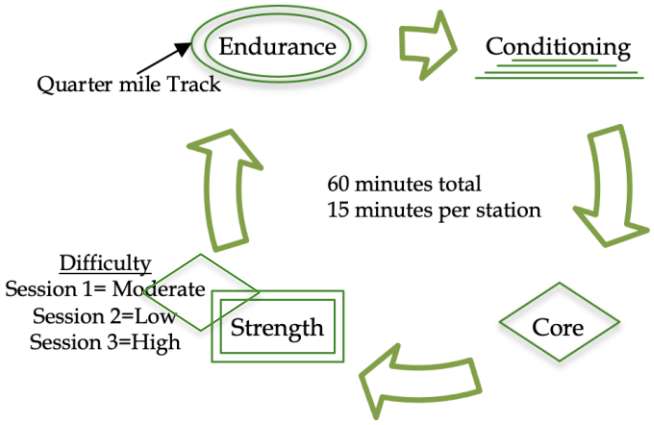

Figure 1. Visual illustration of the four Cadets rotation through each training protocol.

In order to meet the current physical activity guidelines, individuals must aim for at least 150 minutes of moderate aerobic or 75 minutes of vigorous aerobic activity per week as well as two or more days of full-body muscle-strengthening activities per week, which the current study included (14). Previous findings in an Air Force ROTC study indicated that two days of physical training per week were insufficient to improve fitness scores (8). Their conclusion was that the level of PT was likely enough to maintain physical fitness, but not enough to improve physical fitness in a sample that was already sufficiently physically fit (8). Our findings suggest that three days per week is also insufficient for improvement of most aspects of military physical fitness but appears to be sufficient to increase aerobic endurance. This is in agreement with the prior work by Macky and DeFreitas (8) but further expands it to suggest that three days is still not likely enough to lead to substantial physical fitness improvements. The 2MR scores were the lowest baseline score and was the only one that showed significant improvement. This is perhaps not a coincidence in that the other tests already showed a very high success rate so the level of pass improvement was already going to be somewhat limited. Additionally, while this is a similar sample with similar PT styles, it adds to the literature in that the current study assessed U.S. Army cadets while the study by Mackey and DeFreitas studied U.S. Air Force cadets (8). While these are likely very similar individuals with similar physical fitness profiles, both branches of the military can benefit from seeing this information confirmed in multiple studies.

In the current study, the training program was tailored specifically to the ACFT by using similar movements, such as the deadlift and SDC elements. However, it did not improve total or all sub-component scores, which may be due to several factors. First, given our population's high baseline ACFT scores and relatively high level of fitness at the beginning of the program, the amount of training may not have been enough to elicit substantial physical improvements. The current ROTC population only held regular PT three days per week, which limited our ability

to implement a training program that was fully able to take advantage of the principles of progress overload in a highly fit, military population (11). Furthermore, only 15 minutes per session were focused on factors such as muscular endurance and strength, which was likely an inadequate amount of time to accumulate enough volume to elicit adaptations for these variables. The weight used for exercise was determined by the individual's choice of resistance. To ensure better progress in the future, it is recommended that Cadets record their training and aim to increase volume or intensity each week while more closely incorporating RIR metrics (6, 17).

As the ACFT is a newly developed measure employed by the U.S. Army, physical training programs should be re-evaluated across the Army. At the time of this study, the plank was the alternative to the LTK. Since the completion of this study, and updates to the ACFT have been made, the LTK is no longer applicable. The plank is now the standard event (16). Previous research indicates that this is likely due to the differences in difficulty of the LTK for females (13). Overall, our study underscores the importance of tailoring training programs to specific aspects of physical fitness and highlights the positive impact of an Army ROTC exercise program on aspects of physical fitness.

Our study has strengths and limitations. A notable strength is that in a population like this which is composed entirely of a university-based ROTC program with student cadets, 3 days/week of PT is sufficient to at minimum maintain physical readiness for military physical fitness. While improvement is certainly desirable and often the goal, there are cases where a student cadet, with all of the demands on their time between ROTC as well as academic or other part-time occupational pursuits may have limited time for PT. Three days/week of PT is not an overbearing or time-consuming requirement, so this is certainly a potentially positive development that the 3/day week PT design is sufficient to at least maintain fitness when those cadets may have very tight schedules with limited time for PT.

Another consideration is the high degree of fitness, using military standards, that the current sample of cadets displayed at baseline. A large percentage of the cadets were already highly fit and passing each of the tests, as well as the overall score. Therefore, it is possible that while they performed the PT each week enough to at least maintain the level of fitness that they currently possessed, there may not have been a high degree of motivation to improve beyond the scores that they were already able to achieve. This is similar to the findings by Mackey and DeFreitas (8) and should be a consideration for future studies in order to be able to provide a more thorough and detailed analysis of the current training programs that ROTC programs are employing.

A limitation is that we did not record how much (or if any) exercise or physical training was performed outside of the three training days per week. Differences in physical training frequency may explain why some Cadets improved while others did not. Due to the time period that the data was collected, the ACFT did not have any punitive nature with failure of the test, which may have influenced Cadet effort. Furthermore, the ACFT was treated as a pass-fail, so

this likely plays a role in the limitation of all-out efforts of those highly fit Cadets. An additional limitation is that part of the study was completed via remote training with research personnel rather than in-person, which reduced accountability more than in-person training. However, each Cadet had a group leader that led them in the training so perhaps this issue was somewhat alleviated. In addition, the mid-point testing was done following a winter break between semesters that lasted about a month. This could have possibly influenced the data at that time point. Additionally, in regard to BIA testing, cadets were not required to arrive in a fasted (or not fasted) state, potentially influencing the body composition data.

In conclusion, our findings indicate that a 3-day per week exercise program consisting of 15 minutes of self-paced running per session (45 minutes total per week) improves aerobic endurance yet was insufficient to increase MDL, HRP, PLK, or SDC time. Future research should determine the optimal frequency, intensity, and duration of training to improve ACFT performance, which is an essential test for Soldiers in the U.S. Army. As currently constructed, the standardized training performed by ROTC programs is sufficient to maintain fitness in already highly fit individuals, but it is undetermined if it is sufficient to improve fitness levels to fully ensure military preparedness. Future research should aim to expand on the current work by looking more specifically at individuals who may initially fail the ACFT and what is the necessary amount of training required to lead to significant improvement to pass the ACFT.

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