

Physical Performance Among Air Force ROTC Cadets Following Non-Mandatory Training

Cameron S. Mackey; Quincy Johnson; J. Jay Dawes; Jason M. DeFreitas

- INTRODUCTION:** Due to the standard collegiate academic calendar (two semesters), U.S. Air Force Reserve Officers' Training Corps (ROTC) cadets have an approximate 3-mo break over the summer in which physical training (PT) is neither regulated nor required. The purpose of this investigation was to determine if significant changes in cadet physical fitness assessment (PFA) scores occur after a ~3-mo summer break when training is not mandatory.
- METHODS:** Male ($N = 28$) and female ($N = 10$) cadets performed the PFA in April and August. Cadets were split into two groups depending on if they participated in field training over the summer [FT; $N = 12$ (men = 6, women = 6)] or did not [NFT; $N = 26$ (men = 22, women = 4)] to determine if engaging in field training had any effect on performance.
- RESULTS:** Cadets performed significantly better on run time (7%), pushups (7.6%), sit-ups (5.8%), and overall composite score (3.6%) before summer break compared to after. Significant time \times group interactions were observed for abdominal circumference and run time. Abdominal circumference paired samples t -tests indicated that while the FT group did not differ between the spring and fall time points, the NFT did. There was a main effect for time in which cadets had a significantly larger abdominal circumference in the spring compared to the fall semester.
- CONCLUSION:** Nonmandatory physical training over summer break may significantly decrease a cadets' performance on the PFA. Additionally, it appears that even the inclusion of field training for some cadets was not enough to prevent the detraining that took place over summer break.
- KEYWORDS:** air force, ROTC, physical fitness test, physical training, physical performance.

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The Reserve Officers' Training Corps (ROTC) is one of three primary commissioning sources for officers in the U.S. military. Currently, the Air Force ROTC program is the largest and oldest source of commissioned officers for the U.S. Air Force. Specifically, the Air Force ROTC's program is located on 145 college and university campuses along with more than 1100 additional institutions across the United States. A key element of Air Force ROTC programs is to physically prepare cadets for the rigors of military service. Thus, physical training (PT) serves as an important component of the ROTC experience, which seeks to improve overall physical fitness, and develop discipline and comradery.¹¹ Being physically fit allows cadets and airmen to properly support the Air Force mission, and PT is incorporated as a part of the Air Force culture to establish an environment for members to maintain physical fitness and health to meet expeditionary mission requirements.²

The U.S. Air Force uses the directives provided in Air Force Instruction (AFI) 36-2905 to conduct its physical fitness

assessment (PFA), consisting of 1-min push-ups, 1-min sit-ups, abdominal circumference measurement (inches), and a 1.5-mi run component.² The PFA is structured to assess the muscular endurance of specific muscle groups, body composition, and the functional capacity of the cardiovascular system.² Additionally, the PFA is meant to provide commanders with a tool to assist in the determination of overall fitness of their military personnel and is the primary instrument for evaluating cadet fitness.² For cadets in ROTC programs, the PFA is taken each semester and contracted cadets (i.e., those on scholarship) must

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pass in order to avoid disciplinary action or dismissal from the program.¹ Currently, Air Force ROTC cadets are required to take part in PT at least twice per week during the semester and at least 80% attendance is mandatory in order to pass their leadership laboratory course.¹ However, this mandatory PT only takes place during the fall and spring semesters. This means that cadets are without a structured/mandatory PT program over the summer period (~3 mo) and could be susceptible to detraining.

Detraining, the partial or complete loss of training-induced adaptations, may have a significant negative impact on aerobic and anaerobic performance.^{5–7} 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 the training stimuli is reduced or completely removed.^{6,7} Studies by Mujika and Padilla^{6,7} reported that maximal oxygen uptake can be reduced between 4–14% in less than 4 wk and up to 20% during long-term (greater than 4 wk) training cessation. In addition, these authors found that endurance performance declines rapidly (less than 4 wk) as a consequence of an insufficient training stimulus and that significant or complete reversal of training-induced performance improvements occurs during long-term inactivity.^{6,7} While limited research has been conducted on the fitness levels of ROTC cadets,^{5,11} to the authors' knowledge, no published studies have examined changes in PFA performance in Air Force ROTC cadets following summer break when PT is not mandatory. Consequently, it is unknown to what extent ROTC cadets' PFA scores are affected by summer break. Therefore, the purpose of this investigation was to determine if significant changes in cadet physical performance occur after summer break when training is not mandatory. We hypothesized that PFA performance measures would decrease as a function of detraining over summer break.

METHODS

Subjects

Male ($N = 28$) and female ($N = 10$) Air Force ROTC cadets (mean \pm SD; age 20 ± 1 ; height 176 ± 8 cm; body mass 75 ± 11 kg; body mass index 24 ± 3) performed the PFA (body composition, 1-min pushups, 1-min sit-ups, and 1.5-mi run) in both the spring (April) and fall (August) semesters of 2018. Additionally, cadets were split into two groups depending on participation in field training over the summer [field training (FT); $N = 12$ (men = 6, women = 6)] or did not [no field training (NFT); $N = 26$ (men = 22, women = 4)] to determine if engagement in field training had any effect on cadet performance in the fall. During the spring semester, cadets had participated in mandatory PT sessions twice per week (1 h per session) from January through April, which generally consisted of a group-organized warm-up, pushups, pull-ups, sit-ups, and running. The University Institutional Review Board for human subjects research approved this study (ED-18-94) and an informed consent was signed by participants prior to data gathering and analysis.

Field training is a necessary part of the cadets' professional growth and development and marks a transition from follower to leader on their path to becoming commissioned second lieutenants in the Air Force. Cadets transitioning into their junior year must complete field training, which is designed to train, evaluate, and rank cadets on physical fitness, leadership, professionalism, communication, decision-making, and warrior ethos.³ Cadets spend 2 wk at field training during the summer, which takes place at Maxwell Air Force Base, AL. During those weeks at field training, the cadets participated in group-organized physical training daily, which generally consisted of stretching and calisthenics (warm-up), upper- and lower-body strengthening exercises, and a distance run.

Procedure

Officers and noncommissioned officers who were certified as physical training leaders conducted the field-based tests according to AFI 36-2905 as part of the usual program assessment practices.² Anthropometrics was the first component assessed followed by the timed pushups, sit-ups, and the 1.5-mi (2.4-k) run. A standardized rest period of 3 min was used between components. Cadets receive up to 60 points for the run, 20 points for the abdominal circumference measurement, and 10 points each for the sit-up and pushup components. The composite score is the sum of each component score out of a possible 100 points. Cadets perform the PFA at least once per semester, must earn a composite score of 75 or greater, and meet the component minimums in order to pass the PFA. A composite score of 74.9 or lower and/or one or more component minimums not met results in an unsatisfactory PFA.

Anthropometric measurements included height, body mass (on a calibrated scale), and abdominal circumference measurements (inches). However, only the abdominal circumference measurement was used for the body composition component score.² For abdominal circumference, the cadets stood stationary while the tester conducted the measurement using a standard tape measure (Gulick II Tape Measure Model 67,020, FitnessMart division of Country Technology, Inc., Gays Mills, WI) starting at the superior border of the iliac crest and moving around them to place the tape in a horizontal plane around the abdomen. The tester took three measurements to the nearest half inch and the average was recorded for the abdominal circumference score.

Cadets performed push-ups starting in the "up" position, in which hands were slightly wider than shoulder width apart, palms or fists on the floor with arms fully extended while maintaining a rigid hip and spinal posture. On command, the cadet would flex his/her elbows and lower his/her entire body as a single unit until the upper arms were at least parallel with the ground (elbows bent at 90°). The cadet returned to the starting position while raising his/her entire body until the elbows were fully extended. Any deviation to this form resulted in the attempt not being counted toward their component value. Cadets performed continuous push-ups for 1 min or volitional fatigue and the results were recorded.

Cadets performed sit-ups by starting on their back with the knees bent at a 90° angle and their feet or heels in contact with the floor. A partner held the feet with hands, applying adequate pressure across the dorsum of the foot to keep the heels anchored to the floor. The heels were required to remain in contact with the ground throughout the test. With the cadet's arms crossed over their chest and hands/fingers on the shoulders or resting on the upper chest, the cadet performed a complete repetition when they rose from the down position until the elbows touched the knees or thighs, and then returned to the down position so that the shoulder blades touched the floor/mat. Any deviation to this form resulted in the attempt not being counted. Cadets performed continuous sit-ups for 1 min and the results were recorded.

The run was performed on an approved distance track. Cadets gathered at a 400-m track and were briefed about the purpose and organization of the test. An officer or noncommissioned officer delivered a standardized set of instructions according to AFI 36-2905,² and then used a stopwatch to record total time as each cadet completed the 1.5-mi (2.4-k) run.

Statistical Analyses

All data were analyzed using PASW software version 24.0 (SPSS Inc., Chicago, IL, USA). Separate two-way mixed factorial ANOVAs [Group (FT vs. NFT) \times Time (spring vs. fall)] were run for each dependent variable (1-min pushups, 1-min sit-ups, abdominal circumference, run time, and composite score). When appropriate, follow-up analyses included *t*-tests with Bonferroni corrections. Partial eta squared (η_p^2) values were reported to estimate ANOVA effect sizes. An alpha level of $P \leq 0.05$ was considered significant for all comparisons.

RESULTS

No time \times group interaction was observed for composite score ($F_{1,36} = 3.33$; $P = 0.08$, $\eta_p^2 = 0.09$). However, there was a main effect for time ($F_{1,36} = 19.43$; $P \leq 0.001$, $\eta_p^2 = 0.35$) in which cadets performed significantly better in the spring (mean \pm SD; 94.02 ± 5.66) compared to the fall (90.67 ± 5.66) semester (Fig. 1A).

No time \times group interaction was observed for pushups ($F_{1,36} = 2.58$; $P = 0.12$, $\eta_p^2 = 0.07$). However, there was a main effect for time ($F_{1,36} = 5.70$; $P = 0.022$, $\eta_p^2 = 0.14$), in which cadets performed significantly more pushups in the spring (54.26 ± 13.18 repetitions) compared to the fall (50.45 ± 14.77 repetitions) semester (Fig. 1B).

No time \times group interaction was observed for sit-ups ($F_{1,36} = 1.23$; $P = 0.33$, $\eta_p^2 = 0.03$). However, there was a main effect for time ($F_{1,36} = 5.66$; $P = 0.016$, $\eta_p^2 = 0.14$), in which cadets performed significantly more sit-ups in the spring (56.34 ± 6.45 repetitions) compared to the fall (53.24 ± 9.58 repetitions) semester (Fig. 1C).

A significant time \times group interaction was observed for run time ($F_{1,36} = 5.46$; $P = 0.025$, $\eta_p^2 = 0.13$). Pairwise comparisons revealed no significant difference between the FT and

NFT groups ($P = 0.91$) for fall and spring. In addition, paired samples *t*-tests indicated that both the FT and NFT groups ran the 1.5-mi run significantly faster in the spring compared to the fall semester ($P \leq 0.001$). There was a main effect for time ($F_{1,36} = 56.93$; $P \leq 0.001$, $\eta_p^2 = 0.61$), in which cadets ran the 1.5-mi run significantly faster in the spring (666.45 ± 76.10 s) compared to the fall (713.11 ± 78.53 s) semester (Fig. 1D).

A significant time \times group interaction was observed for abdominal circumference ($F_{1,36} = 5.62$; $P = 0.023$, $\eta_p^2 = 0.14$). Pairwise comparisons revealed no significant differences between the FT and NFT groups ($P = 0.09$) for fall and spring. However, paired samples *t*-tests indicated that while the FT group did not differ between time points ($P = 0.24$), the NFT did (mean difference = 1.08 , $P \leq 0.001$). In addition, there was a main effect for time ($F_{1,36} = 4.12$; $P = 0.05$, $\eta_p^2 = 0.10$), in which cadets had a significantly larger abdominal circumference in the spring (32.04 ± 2.67 "") compared to the fall (31.33 ± 2.37 "") semester (Fig. 1E).

DISCUSSION

The purpose of this investigation was to determine if significant changes occur in cadet physical performance after summer break when training is not mandatory. The primary findings of the present investigation were that significant reductions in performance on the PFA occurred following summer break (i.e., 3 mo of unsupervised/nonmandatory physical training). In addition, it appears that even those cadets who participated in field training during the summer break were unable to maintain their scores from the spring semester PFA. Furthermore, our findings revealed that although there were no differences in abdominal circumference between FT and NFT groups, a larger abdominal circumference was recorded in the spring compared to the fall. The results of this study are significant and contribute to the field by providing additional evidence that a break in mandatory physical training negatively impacts muscular endurance and cardiorespiratory fitness (CRF) in this population. These findings can be used by physical fitness leaders (PFL) to develop self-directed and/or group-organized strength and conditioning programs to maintain physical fitness and reduce the likelihood of detraining between periods of mandatory training.

Several investigations have shown that participation in a structured physical training program, such as those offered by ROTC, has a positive impact on health, fitness, and physical performance within ROTC populations.^{5,6,9,11} In fact, previous research by Thomas *et al.*¹¹ exemplified the importance of participation in a standard ROTC physical training program for Army cadets. After completing 3 d/wk of physical training that included regular resistance and aerobic training over the course of 28 wk during the academic year for 1 h/d, cadets scored above the 83rd percentile on all Army Physical Fitness Test items. Although our study had a separate methodological design, significant decreases in pushup and sit-up ability were observed over the course of the summer break for a group of

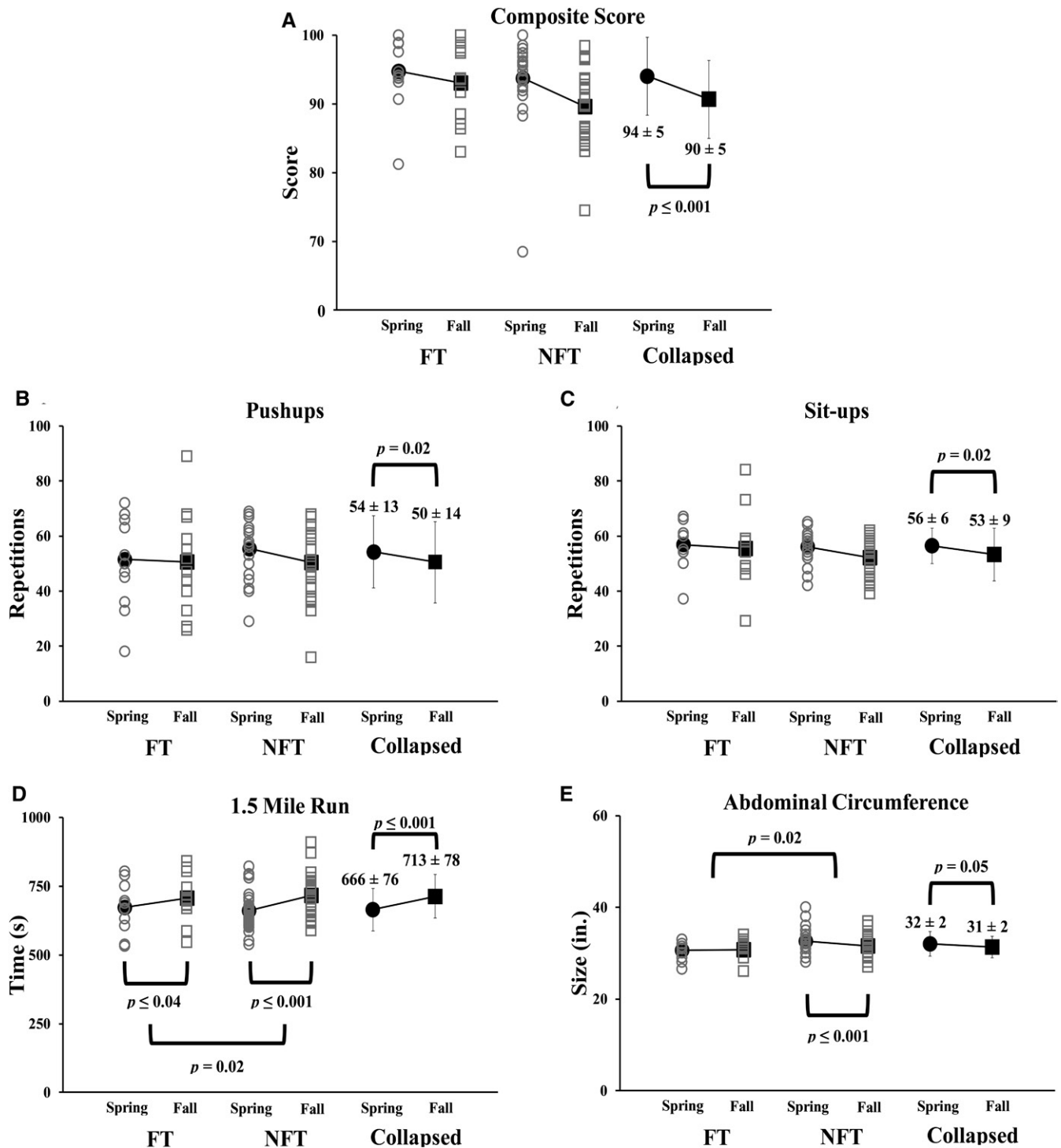


Fig. 1. A) Composite, B) pushup, C) sit-up, D) 1.5-mi run, and E) abdominal circumference physical fitness assessment scores for each cadet who either participated in field training (FT) or did not participate in field training (NFT), including collapsed scores, during the spring (circles) and fall (squares) semesters.

cadets who had a similar training background as those in the study by Thomas et al.¹¹ While there is a paucity of literature examining the effects of a break in mandatory physical training for a military and/or tactical population,⁵ our findings aid in elucidating the effects a summer break has on physical fitness performance in an ROTC population.

Recently, there has been an increase in investigations studying the relationships between abdominal circumference and physical fitness in tactical populations,^{3,4,8,10} but limited information is available regarding changes in abdominal circumference over the course of a break and its effects on physical performance. For example, Nogueira et al.⁸ analyzed the

relationship between CRF and abdominal circumference in over 4000 male firefighters and observed that as the firefighter's abdominal circumference decreased their CRF increased. Similarly, Steed *et al.*¹⁰ demonstrated that as percent body fat increased so did the 2-mi run time in Army ROTC cadets. While the findings by Nogueira *et al.*⁸ and Steed *et al.*¹⁰ were able to show the relationship between abdominal circumference and/or body composition with physical fitness, our study may be the first to have explored the effects of detraining on abdominal circumference in ROTC populations. Our investigation revealed a reduction in abdominal circumference in the fall compared to the spring semester (Fig. 1E). This smaller abdominal circumference measurement was unexpected and may have been due to changes in diet, physical activity level, or hydration status (*i.e.*, water weight). However, due to the decrement in sit-up performance post-break, it is possible that the result was due to a reduction in the amount of time spent training the abdominal muscles over the break.

Timed pushups and sit-ups, or assessments of local muscular endurance, are often used to assess physical fitness levels and active-duty readiness in the ROTC population.^{1,11} In our study, cadets performed significantly more pushups and sit-ups in the spring compared to the fall. Specifically, timed pushup performance dropped by ~7% (Fig. 1B) and timed sit-up performance dropped ~5% (Fig. 1C) over the course of the summer break. While a decrease in physical activity level over summer break most likely explains the decrements in performance seen in these measures, a limitation of this study is that actual physical activity was not accounted for over the summer break. The researchers believe that accounting for physical activity, perhaps by surveying cadets, would help bridge the gap on descriptively understanding the difference between in-semester vs. summer break physical activity levels. Overall, if the goal is reducing the effects of detraining, the authors encourage PFLs to provide a progressive exercise program focused on improving, or at the least maintaining, local muscular endurance during a nonmandatory physical training period in order to prevent cadets from losing progress toward becoming or staying physically fit for service.

The 1.5-mi run is used in the Air Force PFA as their field test measure of CRF and general health status.² The present study observed significant increases in 1.5-mi run times for cadets in the fall compared to the spring, which may be due to diminished fitness or detraining. While the results of this investigation agree with previous research, which indicates that significant decreases in CRF can occur in less than 4 wk of training cessation,^{5–7} this investigation revealed this occurrence over the course of a 3-mo break from mandatory physical training. Although cadets may exercise over the course of the summer break, improvements in fitness cannot be maintained or enhanced without a sufficient training stimulus (*i.e.*, appropriate training volume and intensity). As observed in the present study, even cadets who participated in field training over the summer experienced significant reductions in CRF in the fall. Therefore, it is suggested that cadets be given a physical fitness

regimen incorporating a sufficient amount of training over the break to maintain CRF.

There are a few potential limitations to this study that should be addressed. Firstly, the cadets who were put into the FT group were those cadets who were mandated to exercise during the summer going into their junior year in order to continue with the program (*i.e.*, this was not randomized). In addition, unsupervised PT was not reported or documented for this investigation. The inclusion of outside PT the cadets may or may not have done would have aided in bolstering the results observed in this study and in future investigations. Although PFA scores were observed at two time points, the spring and the fall, it may be more beneficial to include additional time points (*i.e.*, summer and/or winter PFA). The inclusion of these additional PFAs may aid in bridging the gap between current findings and the postulations in our field of study about changes in PFA performance over the course of a break from mandatory physical fitness programs. Second, after identifying specific changes in PFA performance over the course of a break, investigators could then use their findings to compare and quantify the extent of these temporal changes throughout the academic year. By identifying these changes, ROTC programs could identify potential problem time periods and better tailor or implement physical training regimens for their cadets. Additionally, collecting physical activity/training and diet information throughout an academic year may aid in providing supplementary information which could be used to identify outside factors impacting cadets' physical performance. Lastly, assessing changes in PFA performance based on class rank (*i.e.*, freshman, sophomore, junior, senior) would allow for ROTC commanders and cadre to see if more time in the program leads to better physical performance.

In conclusion, this study was designed to determine if significant changes in cadet physical performance occur after summer break when training is not mandatory. The evidence of the present study indicated that nonmandatory physical training over summer break may significantly decrease a cadets' performance on the PFA. In addition, it appears that even the inclusion of field training for some cadets was not enough to prevent the detraining that took place over summer break. Therefore, PFLs should consider implementing additional physical training education, potential fitness monitoring devices to encourage physical training, and/or a physical training program during nonmandatory training periods in order to help cadets minimize any unnecessary reductions in fitness levels. This may aid in decreasing the amount of retraining that occurs each academic year for ROTC detachments.

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