International Journal of EXERCISE SCIENCE

Original Research

Implementation of High Intensity Interval Training and Autoregulatory Progressive Resistance Exercise in a Law Enforcement Training Academy

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ABSTRACT

International Journal of Exercise Science 15(4): 1246-1261, 2022. The purpose of this investigation was to assess the feasibility and efficacy of implementing autoregulatory progressive resistance exercise (APRE) and high intensity interval training (HIIT) methodologies to improve physical fitness and occupational physical ability in police cadets. Two law enforcement academy classes were stratified into a standard care academy training cohort (SC; n=32, m=27, f=5) and a high performance cohort (HP; n=31; m=27, f=4) that utilized APRE and HIIT methodologies during a 17-week academy training program. Demographic, internal loading parameters, anthropometric, fitness outcomes (i.e., 1.5-mile run, 1-repetition maximum bench press, sit-up repetitions, push-up repetitions, & 300m run) and timed completion of a occupation physical ability test (OPAT) were collected at three academy time points (entrance, mid-point and exit). Mixed factor (time vs. group) repeated measures ANOVA were used to evaluate the effects of the training intervention on performance outcomes. Significance was set at $p<0.05$. Both groups demonstrated significant improvements in all fitness outcomes except the OPAT from entrance to exit tests ($p<0.05$). The HP experienced greater improvements in push-up performance compared to the SC ($p<0.001$). OPAT time decreased in both groups from entrance to midpoint, but significantly increased from baseline to exit ($p<.05$). Despite similar inter-group fitness improvements, the HP reported lower session RPE values ($p<0.01$), indicating fitness adaptations occurred at a lower internal load. This study demonstrated the feasibility of successfully implementing APRE and HIIT methodologies within a cadet population. Furthermore, these methodologies produced similar improvements in cadet fitness and occupational performance at a lower internal load.

KEY WORDS: 30-15 IFT, police cadets, fitness, individualization, APRE

INTRODUCTION

There are approximately 681 state and local law enforcement academies (10) preparing cadets for the diverse physical and occupational demands of law enforcement which may include foot

pursuit, suspect apprehension, forcible entry, stair climbing, close quarters combat, and maneuvering through obstacles (3,28,37). To perform these tasks, officers must possess healthy levels of cardiorespiratory fitness (3,27–29,37), body composition (27,28,36), muscular strength (28,36), power (27–29), and endurance (27,28). There appears to be substantial variability in the training programs and outcome assessments utilized by academies which may be due, in part, to the fact that there are no federal physical fitness or occupational physical ability standards for law enforcement officers (24). Furthermore, this variability makes it difficult to ascertain the efficacy of academy training programs to enhance occupational readiness and to develop an evidence-based approach to cadet preparation on a more global level. Regardless, limited research has demonstrated that academy training programs are generally effective at improving various physical fitness parameters in law enforcement cadets (13,15,21,26,41). Additionally, there is evidence of diminishing physiological returns during the later phases of academy training programs (15,21). Thus, it is critical to evaluate alternative, individualized, and periodized training strategies to optimize occupational readiness and fitness in a law enforcement academy.

Several high performance training methodologies, more commonly applied in elite athletic populations, may be incorporated in an academy training program to optimize occupational readiness. For instance, individualized high intensity interval training (HIIT) utilizing protocols based on the 30-15 Intermittent Fitness Test (IFT) outcomes, have been found to enhance tactically relevant performance outcomes (5), including aerobic endurance (26) and reduced risk of injury in tactical populations (25). However, the efficacy of this scaled metabolic conditioning program is largely unknown in law enforcement populations. In addition, Autoregulatory Progressive Resistance Exercise (APRE) is a resistance training strategy that modifies the training stimulus on a set-by-set basis to account for differences in physiological readiness to perform and adapt to stress (39). An autoregulatory training approach may be useful in a law enforcement academy where additional physical (i.e., defensive tactics training) and psychological stressors (i.e., classroom preparation) are present. Although APRE has been found to improve upper body strength in American football players (20), its effectiveness in a law enforcement population is unknown.

Given the importance of optimizing the occupational readiness of approximately 59,000 U.S. law enforcement cadets each year (10), it is critical to create evidence-based practices to guide practitioners in the development of safe and effective training programs. Therefore, the purpose of this study was to evaluate the feasibility and efficacy of implementing APRE and HIIT training methodologies in a law enforcement academy physical training program to improve physical fitness and occupational physical ability. We hypothesized that a periodized APRE program would increase upper body strength more than a standard care academy resistance training program. Similarly, it was hypothesized that a periodized, scaled HIIT program would improve aerobic and anaerobic capacity in cadets compared to a standard academy training program. Lastly, it was hypothesized that a combined APRE and HIIT training program would

produce a greater improvement in occupational physical ability compared to a standard academy training program.

METHODS

Participants

A convenience sample of 63 (54 male, 9 female) cadets representing two academy classes from a state law enforcement training academy participated in this study. Table 1 displays the demographic and anthropometric outcomes of the cadets stratified by cohort (control vs. high performance) and sex. This investigation was approved by the participating University's Institutional Review Board (IRB #50942). Given the observatory nature of this study, informed consent was not required. Data were collected by the training academy staff, de-identified, and provided to the investigators for analysis. This research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science (22).

Table 1. Subjects' demographic and physical characteristics stratified by cohort and sex.

	n	*% of cohort*	*Age (yr)*	*Body mass (kg)*	*Height (cm)*
Control					
Male	27	84.4%	27.4 ± 5.4	97.4 ± 17.1	181.3 ± 7.5
Female	5	15.6%	26.2 ± 3.1	69.1 ± 10.8	166.6 ± 7.7
Total	32	100%	27.2 ± 5.1	93.0 ± 19.2	179.0 ± 9.2
High Performance					
Male	27	87.1%	28.9 ± 8.1	92.7 ± 17.1	181.0 ± 6.4
Female	4	12.9%	24.5 ± 1.3	60.4 ± 8.2	163.2 ± 5.2
Total	31	100%	28.4 ± 7.7	88.5 ± 20.3	178.7 ± 8.7

Protocol

All data were collected and maintained on spreadsheets (Microsoft Excel, Redmond, WA) by training academy staff. The principal investigator received de-identified data of 63 police cadets who successfully completed the entrance and exit academy requirements. Specifically, the data included the cadets' class number, the law enforcement agency the cadet represented, anthropometric data (body mass, standing height), demographic data (age, sex), and results of the physical fitness tests (i.e., 1.5 mile run time, number of sit-ups completed in one minute, one-repetition maximum bench press, maximum push-up test and 300 m run time, OPAT) at each of three standardized time points (Entrance: Week 1; Midpoint: Week 9; Exit: Week 17).

Physical Fitness Tests and Anthropometrics: The training academy utilized five validated fitness standards, administered at three time points, to identify minimal physiological readiness to successfully complete the academy and perform occupational tasks. The standards were created by an independent contractor and developed through a criterion referenced validation process. Prior to the start of the fitness assessments, each cadet's body mass was measured on a digital scale (Healthometer 499KL, Sunbeam, Boca Raton, FL) and height was self-reported to the training instructor. Detailed descriptions of each of the assessments were described elsewhere (21). Briefly, the assessments were administered in the following order: Maximum bench press,

one-minute sit-up test, 300 m run, two-minute push-up test and 1.5-mile run test. For the maximum bench press, the academy required a minimum standard of resistance load-to-body mass (RL/BM) ratio of 0.64 and 0.73 during the entrance and exit exams, respectively. Previous research has reported high test-retest reliability (ICC: 0.95-0.99) for this test (30,35). For the one-minute sit-up test, the academy required a minimum standard of 18 completed repetitions for both entrance and exit exams. Previous research has reported that this protocol yields acceptable levels of test-retest reliability (ICC = 0.93) (2). The 300 m run had a required completion time of ≤65 s during the entrance and exit exams. Previous research has found high test-retest reliability (ICC = 0.98) in similar protocols of anaerobic power (40). The two-minute push-up test had required minimum academy standards of 20 and 25 repetitions during the entrance and exit tests, respectively. Similar push-up protocols have reported acceptable levels of reliability (ICC = 0.93-0.98) (2,23). Lastly, the 1.5-mile run had a required minimum completion time of 17:12 and 16:15 minutes for the entrance and exit exams, respectively. High test-retest reliability (ICC = 0.95) has been reported in timed distance runs in different populations (11).

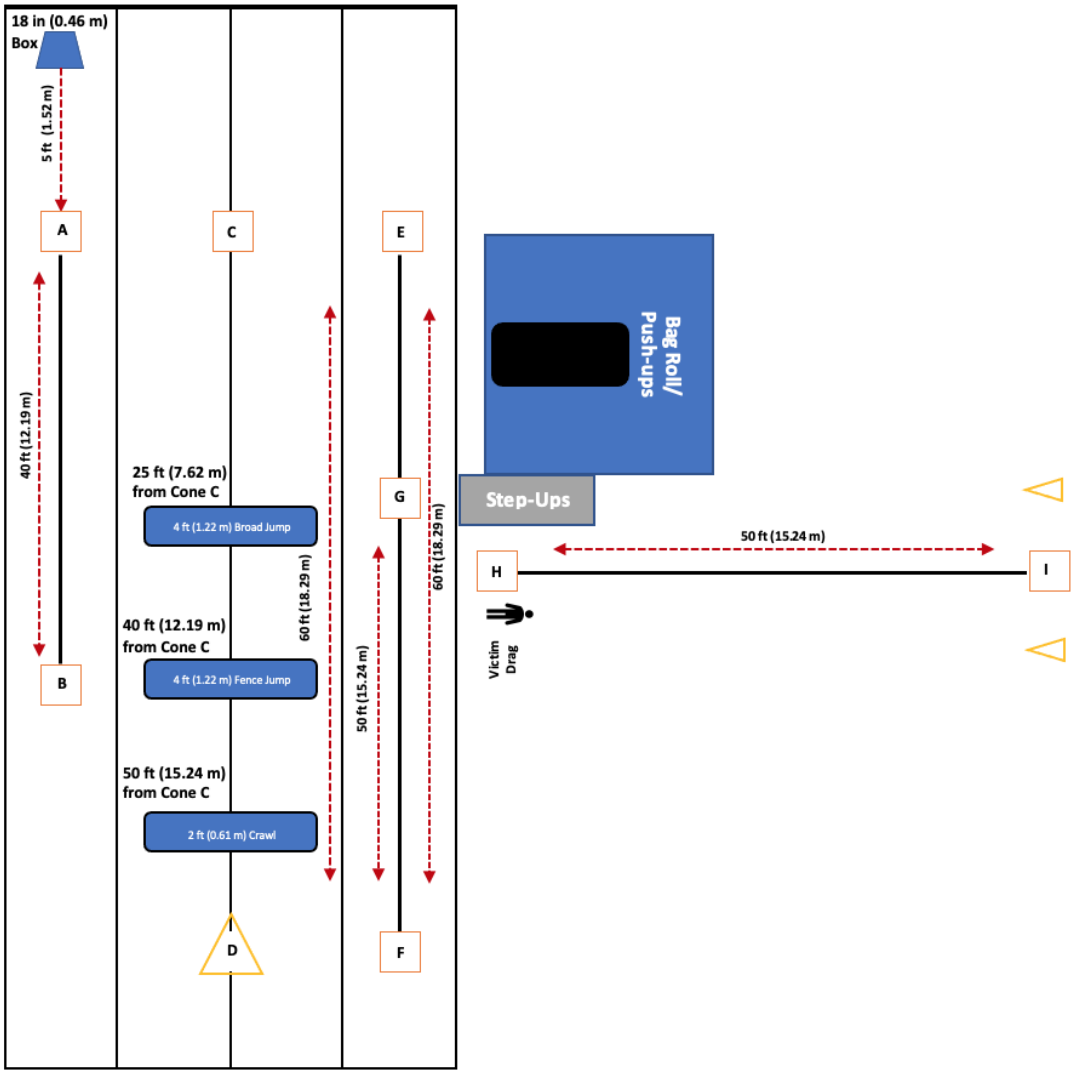

Figure 1. Schematic of the occupational physical ability test dimensions.

Occupational Physical Ability Test (OPAT): OPATs are designed to reflect scenarios commonly experienced by incumbent officers (29) and can be utilized to evaluate cadets' occupational readiness (28). A schematic of the OPAT used in this study is presented in Figure 1. The cadet began seated on a 0.46 m box (Power-Plyo Box, Power Systems, Knoxville TN,), located 1.52 m from cone A. The cadet ran around cone B and returned to cone A and repeated for a total distance of 48.8 m. When the cadet approached cone A, they ran around the left side of cone A towards cone C. At cone C, the cadet ran towards the obstacle course. Next, the cadet performed a 1.22 m long jump and scaled and descended a custom-built 1.22 m barrier. Then, the cadet performed a 0.61 m crawl under a custom built barrier. Next, the cadet ran around cone D towards cone E. The cadet ran towards the left side of cone E, straddled a 31.8 kg bag (MMA heavy bag, Everlast, Moberly, MO) and performed 3 complete lateral rolls simulating a ground apprehension. The cadet performed 10 push-ups and again performed 3 bag straddle rolls. The cadet stood up and ran behind cone E towards cone C. The cadet repeated the obstacle course, running towards cone D. The cadet ran around cone D towards cone E. The cadet then made a left turn around cone E and ran towards the step box (brand). The cadet performed 12 step-ups on a 0.31 m box (Power-Plyo Box, Power Systems, Knoxville, TN) representing an ascent of a flight of stairs. For each step-up, both feet had to touch the step. Upon completion of the step-ups, the cadet ran 15.24 m from point G towards cone F. The cadet then ran around cone F towards point G. When the cadet reached point G, they completed 12 step-ups and proceeded to the victim rescue task. When the cadet touched the mannequin, a split time representing the chase and apprehension portion of the test was recorded. The cadet then positioned themselves behind the 41 kg mannequin (Legged Grappling Dummy, Combat Sports, Lenexa, KS) fixed with a 11 kg weighted vest (All Pro Weight Vest, Hillsborough, NJ) (total mass: 52 kg), grabbed the mannequin by the wrist and dragged it 15.24 m (from cones H to I). Final completion time was recorded using a stopwatch (Sportline, Hazelton, PA) when the mannequin's feet passed cone I. The victim drag time was calculated as completion time minus chase and apprehension time. All times were converted to fractional minutes for analysis.

Standard Academy Training Program: All academy classes performed exercise training three times per week for approximately 1 hour. However, different instructors were responsible for training a given class and had autonomy to modify the exercise session parameters and modes. While the general goal of the physical training program was to prepare the cadets to successfully meet the exit fitness test standards, each instructor utilized a variety of training methodologies to achieve this goal. Each training session began with a dynamic warm-up consisting of a variety of calisthenic exercises. The academy physical training program was divided into two phases (Phase 1: Weeks 1-8; Phase 2: Weeks 10-16) in which resistance and endurance training volume and/or intensity were increased. Resistance training was performed on Mondays, high intensity cross training (e.g., 0.5-mile run, 50 sit-ups, 75 push-ups, 100 body weight squats, 0.5-mile run (11)) was performed on Wednesdays and a choice of resistance training or high intensity cross training was performed on Fridays. Resistance training followed a pyramid scheme which involved completion of a warm-up set of 8-15 repetitions followed by three to four working sets composed of a decreasing number of repetitions per set and increasing load.

High Performance Training Program: The high performance training program included an autoregulated bench press and periodized shuttle run programs. These training modalities were performed on the same day, once per week. The remaining training days followed the standard academy training program.

30-15 Intermittent Fitness Test and High Intensity Interval Program: A modified 30-15IFT protocol utilizing a 28m course (8,19) was used for this study. The 30-15 IFT protocol consisted of a 30 s shuttle run followed by 15 s of active recovery (7). The 30-15 IFT has high test-retest reliability (ICC = 0.84) (4) and is a valid measure of aerobic (5,6,9) and anaerobic fitness (5). Using a prerecorded audio file consisting of auditory tones, the cadets were required to run back and forth between two sets of lines 28 m apart (8). The velocity of the first 30 s stage was set at 8 km·hr^{-1} with the speed increasing 0.5 km·hr^{-1} for each subsequent stage. During the 15 s recovery period, the cadets were instructed to walk forward to the nearest line to begin the next stage. Cadets were instructed to complete as many stages as possible. Termination of the protocol occurred when the cadet was no longer able to maintain the required running velocity or unable to reach the 2 m safe zone upon the audio signal, three consecutive times. The velocity from the last successfully completed stage determined the cadet's maximal aerobic velocity from the Intermittent Fitness Test (V_{IFT}) and utilized to calculate each cadet's training velocities in the shuttle run program. Similar interval-based shuttle run program have been shown to produce improvements in fitness outcomes (34,38).

***Table 2**. Parameters of the shuttle run program completed by the high performance group.*

Training Week	Test	Work (s)	Rest (s)	Intensity (% V_{IFT})	# of intervals	Sets	Inter-set Recovery duration (min)	Total work duration (min)	Total exercise duration (min)
2	30-15								
3		20	20	90	3	4	2	4	14-16
4		20	20	92	3	4	2	4	14-16
5		15	15	95	4	4	2	4	14-16
6		15	15	98	4	4	2	4	14-16
7		10	10	101	6	3	2	3	12-14
8		10	10	104	6	3	2	3	12-14
9	30-15								
10		20	20	92	3	4	2	4	12-14
11		20	20	95	3	4	2	4	12-14
12		15	15	98	4	4	2	4	12-14
13		15	15	101	4	4	2	4	12-14
14		10	10	104	6	3	2	3	10-12
15		10	10	107	6	3	2	3	10-12
16	30-15								

Table 2 outlines the 12-week shuttle run program completed once per week during the training academy. The results of the entrance and midpoint 30-15 IFT were used to program Phase 1 (training weeks 3-8) and Phase 2 (training weeks 10-15). A spreadsheet was created with each cadet's V_{IFT} results to calculate individualized shuttle run distances, and thus velocities, for each

shuttle intensity, and rounded to the nearest fifth meter. Thus, the shuttle run velocities were individually set based on the fitness level of each cadet, such that the relative intensity was similar for each cadet, but the absolute running velocity varied. Each set of workout intervals was two minutes in duration. Upon completion of the two minute interval, the cadet was provided with two minutes of recovery while another cadet started their interval. Two 40 m course layouts with cones at 5 m intervals were applied to the academy's running track for the shuttle runs.

Autoregulatory Progressive Resistance Training Program: The APRE protocol was selected based on its success in athletic populations (20). The APRE protocol utilized the entrance and midpoint 1-RM bench press assessment results for subsequent programming. The APRE portion of the program only utilized the bench press exercise to demonstrate a proof-of-concept. Specifically, the 10-RM (repetition maximum), 6-RM and 3-RM APRE protocols outlined by Siff (39) were utilized for exercise programming and each of the protocols followed the same progressive parameter scheme. The first two sets of the bench press within a training session were performed at submaximal intensities. The third set consisted of performing repetitions to fatigue with the specified RM load. The cadet utilized data tables to adjust their load for the last set based on the number of repetitions performed in set 3. Set 4 was then completed for maximum repetitions using the new load. Similar to set 3, the cadet utilized the data table to determine the starting RM load for the next resistance training session. The cadets had a two minute recovery period between each working set. Table 3 outlines the 14-week linear periodized APRE program for the high performance group. When the protocol changed within the program, the final RM workload of the last workout was used to estimate the cadets' 1-RM, which was converted to the new protocol's estimated RM. A conversion table was utilized for RM conversions (17).

Table 3. *14-week periodized autoregulatory progressive resistance exercise (APRE) bench press program used by the high performance group.*

Training Week	**Protocol**	**Training Focus**
1		Entrance Fitness Assessment
2-4	10RM	Hypertrophy
5-6	6RM	Strength / Hypertrophy
7-8	3RM	Strength/Power
9		Midpoint Fitness Assessment
10-11	10RM	Hypertrophy
12-14	6RM	Strength / Hypertrophy
15-16	3RM	Strength/Power
17		Exit Fitness Assessment

Statistical Analysis

Data were reported as mean ± standard deviation. Normality of data was assessed using Shapiro-Wilks tests. The relative change in fitness outcomes across the time points was calculated relative to the baseline value: (% Difference = posttest value – entrance value) / entrance value) x 100). 2 x 3 (group vs. time) mixed factor repeated measures ANOVA were used to evaluate the effects of the training interventions over time on performance outcomes. If

the assumption of sphericity was violated, the Greenhouse-Geisser adjusted values were reported. Independent t-tests were used for post-hoc analysis to identify differences between groups at the three time points and a Bonferroni adjustment (i.e., $p \leq 0.017$) was applied to control for inflation of Type I error. Cohen's f effect sizes were defined as 0.1, 0.25, and 0.40 (small, medium, large, respectively)(14). Furthermore, partial eta squared (ηp^2) effect sizes are defined as 0.01, 0.06 and 0.14 (small, medium, large, respectively) (31). An a priori power analysis was performed utilizing a statistical software program (G*Power V 3.1) and used the following parameters to determine adequate sample size: test: F-test (ANOVA: repeated measures, within-between interaction), effect size f=0.25, 1-β=0.8, and α=0.05. Thus, a total of 28 subjects were required to identify a significant interaction effect on fitness and OPAT outcomes. Significance was set to $p < 0.05$ for all analysis unless otherwise specified. Microsoft Excel and SPSS Software Program (version 26.0; SPSS, Inc., Armonk, NY) were used to organize and analyze the data.

RESULTS

Figure 2 presents a comparison of physical fitness and OPAT outcomes between control and high performance groups at three time points (entrance, mid-point, and exit) during a law enforcement academy training program. There was a significant main effect of group on push-up performance and 1.5-mile performance ($p < 0.05$). Specifically, the high performance group completed more push-ups ($p = 0.006$; Figure 2D) and completed the 1.5-mile run in a shorter duration than the control group ($p = 0.027$; Figure 2E). Thus, after controlling for the difference in pretest values between groups, there was a significant group by time interaction effect for push-ups ($F(1,58)=7.950$, $p=0.007$, $\eta_p^2=0.12$, power = 0.79; Figure 2D) indicating that the high performance group improved significantly more from mid to exit exams compared to the control group. After controlling for pretest values in the 1.5-mile run there also was a significant group by time interaction effect ($F(1,58)=9.422$, $p=0.003$, $\eta_p^2=0.14$, power=0.86; Figure 2E) indicating that the high performance group decreased the 1.5-mile time from mid to exit exams compared to the control group. There were no significant group by time interaction effects for bench press ($p = 0.634$), sit-ups ($p = 0.858$), 300 m run ($p = 0.489$), and OPAT ($p = 0.592$). Among all cadets and fitness assessments there were main effects for time such that all physical assessments significantly improved in both groups throughout the training program. Specifically, there were improvements for 1-RM bench press ($F(1.74,106.2)=47.6$ $p<0.001$, $\eta_p^2=0.45$, observed power =1.0; Figure 2A), sit-ups completed ($F(2,122)=62.6$ $p<0.001$, $\eta_p^2=0.51$, observed power =1.0; Figure 2B), 300 m run time ($F(2,118)=47.4$ $p<0.001$, $\eta_p^2=0.45$, observed power =1.0; Figure 2C) and 1.5-mile run time ($F(1.5, 86.9)=115.1$ $p<0.001$, $\eta_p^2=0.66$, observed power=1; Figure 2E). In contrast, there was a significant increase in OPAT completion time ($F(1.4, 80.6)=32.1$ $p<0.001$, $\eta_p^2=0.36$, observed power =1.0; Figure 2F) between the entrance and exit assessments.

Figure 3 presents the average relative change in performance over time for all assessments between the control and high performance groups. Overall, push-ups had the greatest average relative improvement, whereas the smallest relative improvement occurred in the OPAT. Sit-up, 300 m run, push-up, 1.5-mile run and OPAT assessments had greater relative improvement

in the first half of the training program (entrance vs. mid-point) compared to the last half (mid-point vs. exit). The OPAT completion times in both groups experienced similar relative improvement to 300 m in the first half of the training program, however, the second half of the training program led to a decrease of OPAT performance. The control group experienced higher relative improvements during the first half of the training program in all assessments compared to the high performance group ($p<0.05$). Similarly, the control group had greater improvements in the second half of the training program in all tests except push-ups and 1.5-mile run compared to the high performance group. Figure 4 describes the average mean inter-phase (phase 1: entrance – mid-point; phase 2: Mid-point -Exit) sRPE for both control and high performance groups. In all phases and modalities, the high performance group reported significantly lower training loads compared to the control group.

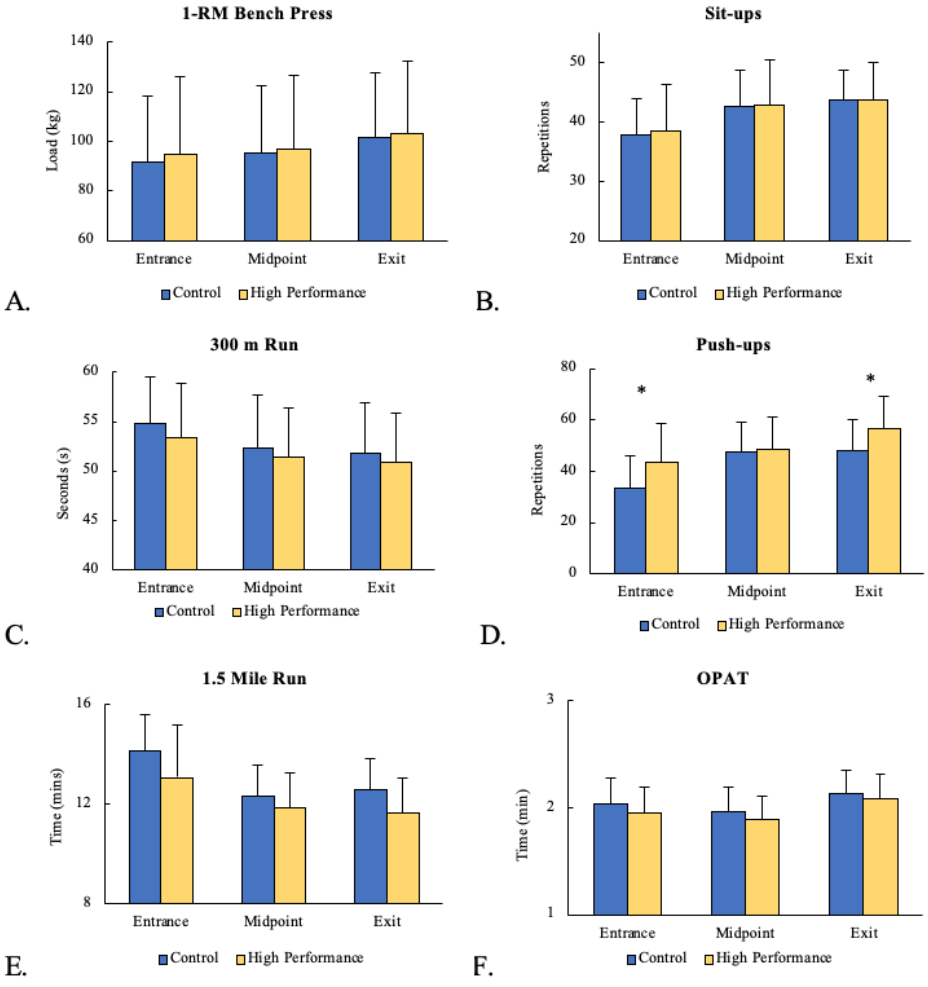

Figure 2A-F. Comparison of physical fitness and occupational physical ability test (OPAT) outcomes between control and high performance groups at three time points (entrance, mid-point, and exit) during a police academy training program. Values represent mean ± SD. *Significant difference between groups ($p \leq 0.01$).

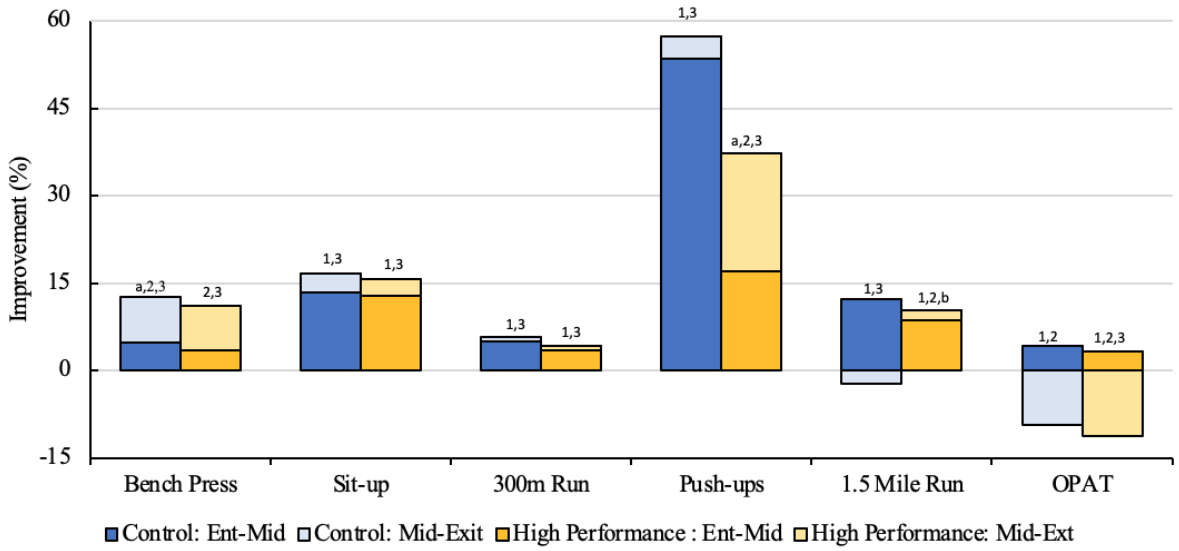

Figure 3. Average relative improvement in physical fitness outcomes between control and high performance groups. Entrance (ent), Mid-point (mid), Exit (ext). [1] Significant difference ($p<0.01$) from ent-mid. [2] Significant difference ($p<0.01$) from mid-ext. [3] Significant difference ($p<0.01$) from ent-ext. [a] Significant difference ($p<0.05$) from ent-mid. [b] Significant difference ($p<0.01$) from ent-ext. Statistical outcomes reflect analysis conducted on raw data.

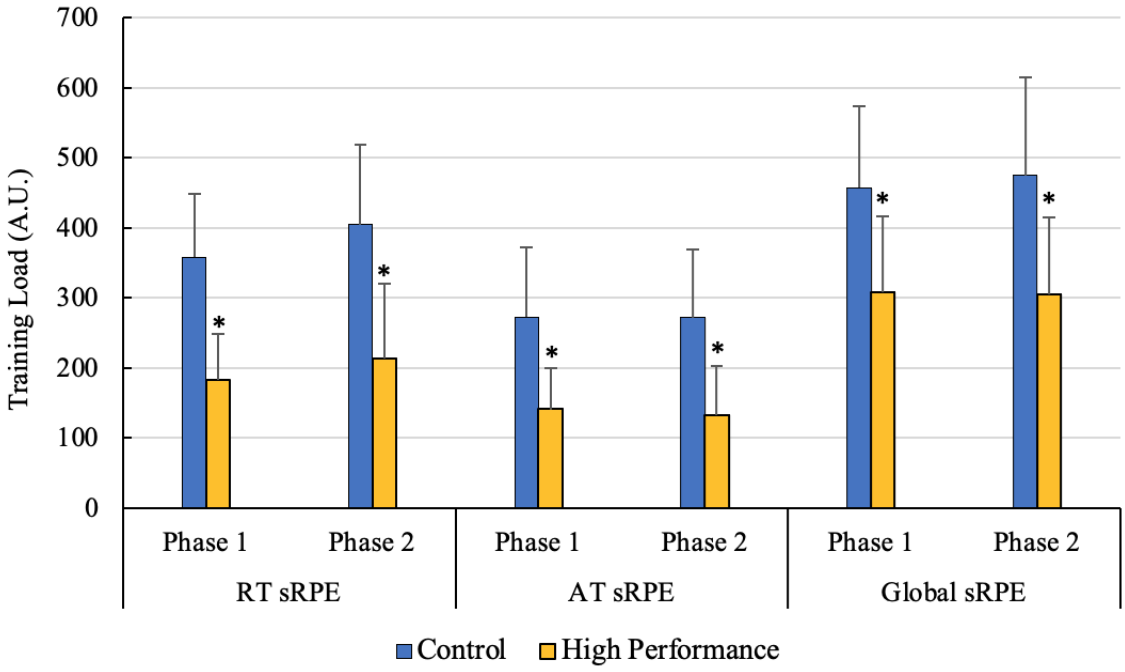

Figure 4. Comparison of average phase 1 (Entrance-Midpoint) and 2 (Midpoint-Exit) training loads (session RPE; sRPE) for resistance training (RT), aerobic training (AT), and overall exercise session (Global) between control and high performance groups. Values represent mean ± SD. Significant difference between groups within an academy phase: *$p < 0.001$, **$p < 0.01$.

DISCUSSION

The purpose of this study was to evaluate the feasibility and effectiveness of integrating APRE and HIIT to improve physical fitness and occupational physical ability test (OPAT) outcomes. First, it was hypothesized that a periodized APRE program would produce greater 1-RM bench press strength in cadets compared to the standard academy training program. Although there were no significant differences in 1-RM bench press strength between the groups, the high performance group experienced similar fitness improvements with lower perceived effort (Figure 4). This reflects greater efficiency of an autoregulated training program compared to the standard academy training program. No attempt was made to match volume and intensity between the control and high performance group training program because the volume and intensity of the APRE program was set each training day based on individual performance (20). Ultimately, this information could potentially explain the non-significant differences between the groups.

Although the improvements in 1 RM bench press strength observed in this study are similar to the results of Mann et al. (20), who compared the use of APRE versus linear periodized programs for increasing bench press performance in collegiate American Football players, Mann and colleagues (20) noted these results in substantially less time (6 weeks vs. 17 weeks). A potential explanation for this result may be the difference in training frequency focused on improving bench press performance between the current investigation and Mann et al. (20) (1 vs. 3 days). This is supported by research from Schoenfeld and colleagues (33) who observed greater training frequencies led to greater increases in bench press strength. Despite the differences between the Mann et al. (20) investigation, the short term increases in bench press exhibited in this study suggest that autoregulatory progressive resistance exercise protocols could be utilized in law enforcement academy training programs to improve bench press performance in cadets.

For the second aim of this investigation, we hypothesized that a periodized metabolic conditioning program utilizing the 30-15 IFT and subsequent HIIT program would produce improved 300 m and 1.5 mile run performances when compared to the standard academy training program. There were no significant differences between the control and high performance group for the 300 m run (Figure 2C) and 1.5-mile run (Figure 2E), despite the high performance group exhibiting greater mean scores for both tests. Both groups exhibited significant increases in the 300 m run in the first half of the training program as well as overall, but not during the second half of the training program. This result mirrored a previous investigation utilizing an academy exercise program (21). Furthermore, with regard to the 1.5 mile run, both groups experienced similar overall improvement at the end of the training academy. Unfortunately, objective training volume and intensity parameters were not available from the control group, which limits the ability to make comparisons between groups. Despite these results, average training loads in the high performance group were significantly lower than the control group (Figure 4), suggesting that the improvement in all fitness parameters were achieved at a lower physiological cost (1,12,18).

The current results suggest that utilizing the 30-15 IFT and subsequent individualized HIIT program could be a viable alternative to improving anaerobic power and aerobic endurance in law enforcement cadets. In a previous investigation by Orr et al. (25), the authors found that a V_{IFT} score ≤16 on the 30-15 IFT was associated with greater levels of injury in law enforcement cadets. In the present study, 42% of the high performance group exceeded this V_{IFT} threshold at the entrance exam and 47% at the exit exam. Despite these results, only 9% of the total experimental population experienced injuries compared to the 25% of the cohort in the Orr et al. (25) investigation, suggesting that further research is needed to strengthen the predictive power of the V_{IFT} to predict injury risk in law enforcement cadets.

The observed improvements in 1.5 mile performance were further supported by Orr and colleagues (26) who evaluated the impact of a 10-week, 30-15 IFT-derived ability-based program to improve aerobic endurance in law enforcement cadets. They found that while there was no significant difference in aerobic endurance between groups, there was a decreased risk of injury observed in the intervention group (26). These results suggest that higher intensity, lower training load (Figure 4), metabolic conditioning programs may reduce risk of injury compared to traditional long, slow distance running. Interestingly, in the current investigation, the high performance group experienced fewer injuries compared to the control group (n=3 vs n=5, respectively) throughout the academy training program, suggesting that an increased training volume may increase risk of injury. Although the exact running volumes performed by each group are unknown, sRPE was recorded throughout the training academy to subjectively account for training load and indicated that the high performance group completed the HIIT at a lesser internal training load.

Lastly, the effectiveness of the standard academy training program versus the high performance program to improve OPAT performance was evaluated. There were no significant differences between groups in OPAT performance, however, each group experienced similar improvements in OPAT completion time (Figure 2F) between entrance and mid-point evaluation. Similar results regarding the effectiveness of academy physical training program to improve OPAT performance were noted in a study by Rossomanno et al. (32) in which they observed a significant reduction ($p < 0.01$) in physical ability test completion times following a 6-month fitness program in police officers. Although the current study maintained consistent supervised training sessions through the training academy, a reduction in OPAT performance was observed in the second half of training. Since the OPAT was not required for completion of the academy training program, the cadets were instructed to complete the course with submaximal effort to prevent injury, and thus reflected the increased OPAT completion times. Regardless, the results of the current study promote the importance of maintaining physical fitness to facilitate occupational readiness as an incumbent law enforcement officer.

During the training academy, the high performance group reported a significantly lower training load compared to the control group in all modes of training. When combined with the results of the fitness evaluations, it can be inferred that the high performance group experienced similar fitness gains compared to the control group at a lower internal load. Furthermore, the

lower training load may, in part, explain the reduced number of injuries sustained by the high performance group (16). The inclusion of the APRE and 30-15 IFT may have influenced these results as they scaled daily training loads based on the fitness level of each cadet and thus may assist in preventing overtraining. In addition, these scaled training methodologies reduce the risk of overtraining a cadet with a lower fitness level and undertraining a cadet with a higher fitness level. Despite the results, evaluating specific effects of the high performance training program, each group experienced significant relative improvements in all fitness evaluations during the academy training (Figure 2). Improvements in overall fitness of law enforcement cadets as a result of a training academy physical training program has been previously reported (13,15,21,41).

There were several limitations in this investigation that may have influenced the observed results. First, the training protocols utilized in both groups were not matched for volume or intensity. While physical training days were standard for all academy classes (occurring three times per week for approximately 1 hour), different instructors were responsible for training a given class and had autonomy to modify the exercise session parameters and modes. While the general goal of the physical training program for the cadets is to prepare them to successfully pass the exit evaluations, each instructor may utilize a variety of methodologies to achieve this goal. Second, the intervention programs for the high performance group occurred on the same day with the two remaining training days dedicated to standard training practices as dictated by the instructor. As a result, it is impossible to determine if observed improvements in fitness are solely a result of the experimental methodologies. Third, the five fitness tests were evaluated on a proprietary scale developed by the academy, in which cadets earned points based on the performance of each test. There are benchmark scores that must be met at the entrance and exit exams to allow the cadets to start and complete the training academy, respectively. Specifically, the 1-RM bench press, sit-up, and push-up tests have cutoff points that do not necessitate the cadet to perform maximally to obtain maximum points. Additionally, instructors may encourage cadets to not perform at maximal levels of exertion to reduce the risk of injury during the evaluations. Ultimately, this may mean that some of the test values may underestimate the true maximal performance for each fitness outcome. Lastly, we observed significant differences in push-up performance between both groups at the entrance and exit exam but not the midpoint assessments. A potential reason for this may be due to the mid-point assessments having no specific benchmarks to reach (unlike the entrance and exit exams) and are simply utilized to track cadet progress. As a result, the cadets may have displayed suboptimal effort when completing these assessments.

In conclusion, the purpose of this study was to evaluate the effectiveness of APRE and HIIT to improve 1-RM bench press, 300 m run, 1.5 mi run, and OPAT outcomes compared to a law enforcement academy's standard physical training program. Although there were no differences in 1 RM bench press, 300 m run and 1.5 mile run performances between the control and high performance groups, the high performance group achieved similar fitness improvements with lower perceived effort. This suggests that training methodologies such as APRE and 30-15 IFT/HIIT, could be utilized to individualize training protocols, improve

physical and occupational fitness and potentially reduce risk of injury sustained in law enforcement cadets. Similarly, there were no differences in OPAT performance between groups, although each group experienced significant improvements in OPAT completion time during the academy. This reflects the importance of physical fitness in maintaining occupational readiness in law enforcement officers.

ACKNOWLEDGMENTS

The authors would like to thank the Kentucky Department of Criminal Justice Training Center for their assistance in this project. There was no conflict of interest to report.

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