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Amy Crawley
University of West Florida

Ross Sherman
Grand Valley State University, sherमारo@gvsu.edu

William Crawley
University of West Florida

Ludmila M. Cosio-Lima
University of West Florida

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PHYSICAL FITNESS OF POLICE ACADEMY CADETS: BASELINE CHARACTERISTICS AND CHANGES DURING A 16-WEEK ACADEMY

AMY A. CRAWLEY,¹ ROSS A. SHERMAN,² WILLIAM R. CRAWLEY,³ AND LUDMILA M. COSIO-LIMA¹

¹Department of Exercise Science and Community Health, University of West Florida, Pensacola, Florida; ²Department of Movement Science, Grand Valley State University, Allendale, Michigan; and ³Criminology and Criminal Justice, University of West Florida, Pensacola, Florida

ABSTRACT

Crawley, AA, Sherman, RA, Crawley, WR, and Cosio-Lima, LM. Physical fitness of police academy cadets: baseline characteristics and changes during a 16-week academy. *J Strength Cond Res* 30(5): 1416–1424, 2016—Police academies traditionally emphasize the importance of being physically fit. The purpose of this research was to determine cadet baseline physical fitness characteristics and assess effectiveness of a 16-week training program. Sixty-eight cadets (61 men, 7 women) volunteered to have baseline physical fitness characteristics assessed, and 55 cadets (49 men, 6 women) completed further testing at weeks 8 and 16. The testing comprised hand grip (strength), arm crank (upper-body power), 30 seconds Wingate (lower body power), sum of skinfolds and percentage body fat (body composition), 40-yard dash (sprint speed), 1 repetition maximum bench press (strength), T-test (agility), and sit-and-reach (flexibility). In addition, cadets completed standardized state testing (push-ups, sit-ups, vertical jump, and half-mile shuttle run). The training program consisted of 1 hour sessions, 3 d·wk⁻¹, including aerobic, plyometrics, body weight, and resistance exercise. Significant changes were found in agility ($p < 0.01$), upper-body and lower-body peak power ($p \leq 0.05$), sit-ups ($p < 0.01$), push-ups ($p \leq 0.05$) across the first 8 weeks, and in agility ($p \leq 0.05$), lower-body peak power ($p \leq 0.05$), sit-ups ($p < 0.01$), push-ups ($p \leq 0.05$), half-mile shuttle run ($p < 0.01$) across the full 16 weeks. However, none of the variables showed significant change across the second half of the program (weeks 8–16). A number of individual parameters of

physical fitness showed evidence of improvement in the first 8 weeks, whereas none of the variables showed significant improvement in the second 8 weeks. This suggests modifications could be made to increase overall effectiveness of cadet physical training specifically after the 8-week mark.

KEY WORDS tactical athlete, law enforcement, fitness assessments

INTRODUCTION

Tactical athletes, such as military, firefighters, and police officers require speed, strength, agility, and endurance training for the physical preparation of their job (35,36). Law enforcement officers are often required to make quick adaptation from sedentary, passive functions to hostile environments where maximal body exertion is needed (32). Although, research has demonstrated that a police officer's job is surprisingly often sedentary (2,4,6), it is recognized that physical fitness is an essential component of being prepared to do infrequent but often critical tasks, including pursuing fleeing subjects, controlling those resisting arrest, grappling, and handcuffing, as well as crowd control (6). The ability to perform these various physical responsibilities can determine the occupational effectiveness of a police officer.

Accordingly, the importance of evaluating the physical fitness of police officers (like any tactical athlete) cannot be underestimated (28). It is essential to obtain an accurate baseline of existing performance levels (36) to both develop and assess an effective physical training program. Ideal exercise programming should train law enforcement personnel specifically for the movements and explosiveness they will require in their daily tasks. This would include targeting aerobic capacity, anaerobic power, muscular strength and endurance, flexibility, and appropriate body composition (33). To be effective, the principles of overload (the concept that a physiological system must be progressively and systematically stressed beyond the level to which it is currently accustomed to) and specificity (that the training effect is particular to the muscles

Address correspondence to Amy A. Crawley, acrawley@uwf.edu.

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involved, fiber types recruited, energy systems used, and velocity and type of contractions) must be addressed (5).

There appears to be a gap in the tactical athlete literature, specifically focusing on police cadet physical preparedness and the outcomes of training within the academy setting. This is not the case for other tactical populations as evidenced by several research studies on firefighter recruits (24,28,31) and military (9,11,18,20,29,37) personnel.

Therefore, the purpose of this research was to: (a) establish baseline preacademy physical fitness data for this specific population; and (b) investigate the impact of a supervised 16-week physical fitness training program on police academy cadets.

METHODS

Experimental Approach to the Problem

This study used an observational design, in that physical fitness was assessed at predetermined time points (week 1, 8, and 16) whereas cadets followed a standardized physical fitness training program developed by the Michigan Commission on Law Enforcement Standards (MCOLES). This research was designed to determine baseline physical fitness levels of police cadets to evaluate whether a supervised 16-week training program administered to them resulted in an increase in their physical fitness. This was identified by statistically significant improvements in the selected aerobic, anaerobic, agility, power, strength, flexibility, and body composition measurements.

Subjects

Sixty-eight healthy adults (61 men and 7 women; mean [$\pm SD$] age 23 [± 3] years; height 178 [± 8] cm; and body mass 83.1 [± 12.2] kg), who were enrolled in a university-housed police academy within the school of criminal justice, volunteered for the study and completed baseline physical fitness testing. Owing to injury, illness, and or scheduling conflicts, 55 cadets (49 men and 6 women; mean [$\pm SD$] age 23 [± 3] years; height 178 [± 8] cm; and body mass 83.5 [± 12.6] kg) completed the full 16-week academy held during the months of May–August.

Before enrolling in the academy, all cadets had to successfully pass a standardized physical fitness test (MCOLES) and received physician approval to participate in the academy. This study was approved by the Grand Valley State University Human Research Review Committee, and all participants were informed of the benefits and risks of the investigation before signing an institutionally approved informed consent document to participate in the study. Before each testing session, participants were encouraged to refrain from high intensity physical activity and consuming caffeine or alcohol during the preceding 24 hours. Participants were also encouraged to maintain adequate hydration status before and during each testing session. The study conforms to the Code of Ethics of the World Medical Association (approved by the ethics advisory board of Swansea University) and required players to provide informed consent before participation.

Procedures

Physical Fitness Testing. Fitness testing was performed at weeks 1 (baseline), 8, and 16 of the police cadet academy. The cadets were tested at the same time of day (10 AM–2 PM) and were dressed in standard academy t-shirt and shorts, and their own athletic shoes. The order of tests went from nonfatiguing (sum of skinfolds, hand grip, and vertical jump) to agility (T-test) to maximum speed (40-yard dash, 1 repetition maximum [1RM] bench press) to flexibility (sit and reach) and ended with anaerobic capacity tests (upper-body arm crank, 30 seconds Wingate).

Sum of Skinfold: Skinfold measurements were taken with subjects wearing shorts (men), or shorts and a sports top (women). A 7-site method was used and all measurements were taken on the right side of the body (1). To ensure reliability of the measurement, the same experienced technicians performed all skinfold measurements on the same cadets. The gauge was read to the closest 0.2 mm using a Harpenden (Baty International, Burgess Hill, United Kingdom) caliper. The measurements were taken at each skinfold site in 2 rotations. If any of the measurements differed by more than 1 mm, a third measurement was taken and the mean value was used to determine sum of skinfold. Percentage body fat was calculated using 7-site Jackson-Pollack and Siri equations (1).

Hand grip strength test: A hand dynamometer (Jamar; Sammons Preston Royalan, Bolingbrook, IL, USA) was used to measure maximal grip strength. Before testing, the grip size was adjusted so that the middle finger, second phalanx, was at a right angle around the grip. A standardized protocol was followed for all testing (1).

Vertical jump test: Participants were instructed to stand with feet flat and the dominant hand reaching upward until the tips of the fingers touched the bottom vane of the vertical jumping device (Vertec; Sports Imports, Columbus, OH, USA). Subjects, keeping feet in a square stance and using a countermovement, jumped as high as possible to hit the vanes. This number was then recorded and each participant was given 3 trials to complete their highest jump (23).

Agility T-test: The T-test was used to measure agility. Four cones were arranged in a “T” formation; the bottom of the “T” was 10 yards from the top and sides were 5 yards apart from the center. The subjects performed a 20-yard dynamic warm-up for 5 minutes, including forward and backward jog, side shuffles, high knees, and butt kickers. The test began with subjects standing at the bottom of the “T” and then sprinting forward to touch the base of the center cone. Subjects then shuffled (without crossing over) the feet to the right touching the base of the right cone and then shuffled to the left touching the base of the left cone. Subjects then shuffled back to the center cone (touched the base) and finally back peddled their way out past the starting point. Time to complete the test was measured using infrared light gates (TC-System; Brower Timing Systems, Draper, UT, USA). The best time of 2 trials was recorded (23).

Sprint speed: The 40-yard dash was used to determine maximum running speed (sprint power) of the participants. Subjects warmed up using the same dynamic drills as before the agility test and 1 practice trial at 50–80% maximal effort. Participants began in a 3-point stance at the start line. The timing, as measured by the infrared light gates (TC-System; Brower Timing Systems), began with their first movement and ended as they crossed the finish line. Each participant was given 2 trials (best time recorded) with a 5-minute rest in between (23).

1RM bench press: The subject was instructed to lay supine on the bench (with shoulder blades and glutes touching) and both feet flat on the floor. A standardized protocol was followed for all testing (23). Typically, the 1RM was found within 5 trials and was recorded in kilograms.

Sit and reach Flexibility: Subjects were already warmed up, having just performed the speed and agility tests. The sit and reach box (Acuflex I; Novel Products, Inc., Rockton, IL, USA) was braced against a wall and subjects sat with their legs fully extended (medial sides of their feet 20 cm apart, no shoes) and bottoms of the feet against the box. While exhaling, subjects slowly bent forward toward the top of the box with 1 hand over the other. The technician ensured that the knees stayed in full extension and that movement was conducted slowly and smoothly. Subjects performed 4 trials, each held for 1–2 seconds, and the farthest reach was recorded in centimeters (1).

Upper-body power test: The arm crank test is an upper-body measure of anaerobic power. The subjects were seated in a chair behind the arm ergometer (Ergomedic 891E; Monark Exercise AB, Vansbro, Sweden) with feet flat on the floor. Participants were instructed to warm-up for 2 minutes with no resistance at 40–50 W. The subject was then instructed to crank the wheel as hard and fast as possible, up to maximal cadence. The resistive load, 2% (women) and 5% (men) of the subject's body weight in kilograms (34), was then added and the subject cranked for 30 seconds. During the test, the participants remained seated and were given strong verbal encouragement. Participants then performed a cool-down for 2–3 minutes with no resistance (34). Measurement of pedal cadence was taken every 5 seconds and peak power was determined from the highest 5 second block recorded and adjusted relative to body weight.

Lower-body power test: The 30 seconds Wingate Anaerobic Test was performed on a resistance-braked cycle ergometer (Ergomedic 894E; Monark Exercise AB) linked to a computer. The seat height was adjusted to allow for a slight bend of the knee in the lower pedal position and the subject's feet were secured using toe clips. The fly wheel resistance was 7.5% of the participant's body weight (1). The warm-up consisted of 5 minutes of low to moderate intensity pedaling (50–60 rpm) with 5 sprints at the end of each minute lasting 4–6 seconds. After a 2 minute recovery period, the subjects were instructed to pedal between 80 and 100 rpm and then the 7.5% load was added to the resistive force for 30 seconds. During the test, the partici-

part remained seated and was given strong verbal encouragement. Following, the subject performed a 2–5 minute cool-down on a cycle ergometer (1). Peak power was determined from the highest 5-second block recorded and adjusted relative to body weight.

Michigan Commission on Law Enforcement Standards Law Enforcement Fitness Testing: Participants also completed push-up, sit-up, and vertical jump tests, and a 1/2 mile shuttle run, at weeks 1, 8, and 16 of the academy as required by MCOLES. All MCOLES tests were administered by the academy physical training (PT) instructor except vertical jump, which was performed within the research study. These tests were conducted within a 2–4 days time span of the laboratory and field-based testing.

Upper-body endurance test: To assess upper-body endurance, the subject was required to do as many push-ups as possible in 60 seconds. The push-ups were performed on a gym floor. The subjects' hands were positioned shoulder width apart with the feet no more than 6 inches apart. The center of the participant's breast bone was positioned over a 3-inch indicator. On a signal, the participant, who started in the up position with the elbows locked, descended downward keeping the body in a "flat" plane until the breast bone touched the indicator. The participant then returned to the up position (counted as 1 push-up). The participant was allowed to rest in the up position with arms fully locked but only full repetitions were recorded (22).

Core endurance: The sit-up test required the subject to do as many repetitions as possible in 60 seconds. To begin, the participant laid on a mat with the knees bent at 90°, feet flat on the floor, with the hands overlapped behind the head. The feet were held tightly to the floor by another participant during the test. On a signal, the subject raised their shoulders from the mat keeping the hands overlapped behind the head and touched the elbows to the knees. Then, the participant descended until the shoulder blades touched the mat. The subject was allowed to rest in the down position but only full repetitions were recorded (22).

Aerobic endurance test: The half-mile shuttle run is a timed test where the participant completed 15 round trips between 2 cones placed 88 feet apart. The subject was required to run from the starting cone, around the far cone, and then return to the starting cone. This equaled 1 round trip. The subject was informed when the fifth, 10th, and 13th round trips had been completed. The time to complete the run was recorded in minutes and seconds (22).

Physical Fitness Training Program. As part of the academy curriculum, the cadets were required to participate in a physical training program for $1 \text{ h} \cdot \text{d}^{-1}$, $3 \text{ d} \cdot \text{wk}^{-1}$, for 16 weeks. These training sessions were performed at different times of the day depending on the schedule for that day. The targeted components of the program included

cardiovascular endurance, absolute strength, dynamic strength, flexibility, and team building. Three days of the week were focused on the fitness-related components with one of those days reserved for team building. Much of the program revolved around the 4 MCOLES tests (push-ups, sit-ups, running, and jumping) to ensure that cadets were prepared to pass the final PT tests at the end of the academy. Before the start of each session, a dynamic warm-up of calisthenics type exercises were performed for 5–10 minutes. At the end of the training sessions, the cadets performed a cool-down using static stretching. A representative week of the PT program is shown in Table 1. This program was outlined by the state MCOLES physical training manual and supervised by a law enforcement officer on the academy staff who had attended a training program through the Cooper Institute (Law Enforcement Fitness Specialist course).

Cardiovascular endurance was the main component targeted for this training program and was incorporated into every training session. The participants used a variety of modes of exercise training, including running, walking, jogging, circuits, relays, sprint intervals, hills, and stadium

stairs. Time progressed from 20 minutes segments to 60 minutes over the 16 weeks. As an example, the cadets began with 2-mile runs and progressed to 5 miles by the end of the academy.

Absolute strength and dynamic strength were trained, 1–2 days per week, as either their own session, or as a smaller portion of time on days dedicated to cardiovascular activity. Methods of training included resistance training, plyometrics, boxing circuits, Insanity, and an obstacle course. The most often used method was body weight plyometrics such as jump squats, burpees, lunges, push-ups, single or double leg hops, half squats, long jumps, planks, and medicine ball tosses. During resistance training, the cadets performed 3 sets of 8–12 reps for 10 exercises, including the leg press, leg extension, leg curl, lat pulldown, seated row, bench press, shoulder press, triceps press, arm curls, and calf raises.

Flexibility was trained using both dynamic and static stretches typically as a part of the warm-up or cool-down phase of each training session. The dynamic warm-up included jumping jacks, arm swings, trunk twisting, side bending, side stretching, high marching, twisting knee lifts,

TABLE 1. Sample training week at the police academy.

Monday	Tuesday	Wednesday	Thursday	Friday
Outside group run	Off	Plyometric exercises	Off	Obstacle course
Calisthenics routine		Box jumps		Push-ups
Half squat		Split squat jumps		Dummy drag
Push-ups		Double leg vertical power jump		95-pound bag carry
Pull-ups		Single, double, and alt leg hops		Half-mile shuttle run
Chin-ups		Clap push-up		Track sprints
Sit-ups/crunches		Weight training		220 m
Back extensions		Leg press		Guidelines:
Heel raises		Leg extension		Obstacle course: push-ups × 60 s,
Guidelines:		Lying leg curl		dummy drag, 95-pound bag carry,
Run 2 miles		Lat pulldown		and half-mile shuttle run for time.
continuously.		Seated row		Track sprints: perform 8 repetitions in
Calisthenics:		Bench press		42 s or less. Rest 2 min between
perform each		Shoulder press		each rep.
exercise for 60 s,		Triceps press and bicep curls		
1–3 sets.		Calf raises		
		Abdominal curls and back		
		extension		
		Guidelines:		
		Plyometrics: perform 1 set of		
		10 reps with 3 min of slow		
		walking between each exercise		
		Weight training: perform 2–3		
		sets of 8–12 reps with 1 min		
		rest periods.		

TABLE 2. Baseline anthropometric characteristics of police academy cadets (mean \pm SD).

Variable	Male ($n = 61$)	Female ($n = 7$)	Both ($n = 68$)
Age (y)	23.4 \pm 2.9	22.7 \pm 2.1	23 \pm 3
Height (cm)	180 \pm 7	167 \pm 7	178 \pm 8
Weight (kg)	84.9 \pm 11.5	67.5 \pm 5.7	83.1 \pm 12.2
Sum of skinfolds (mm)	85.9 \pm 33.2	106.9 \pm 32.7	88.1 \pm 33.5
Body fat (%)	12.8 \pm 6.1	20.8 \pm 5.3	13.6 \pm 6.5
Body mass index ($\text{kg} \cdot \text{m}^{-2}$)	26.3 \pm 2.7	24.4 \pm 3.7	26.1 \pm 2.9

stride jumping, high knees, butt kickers, skipping, karaoke, leg swings, backward sprinting, and lateral shuffles. As part of the cool-down, static stretches performed, included traditional movements such as Achilles' tendon/calf stretch, skier's stretch, quadriceps stretch, hurdler's stretch, straddle stretch, groin stretch, back stretch, and archer.

The team building component of the training program occurred on 1 day of the week and included activities such as basketball, volleyball, and ultimate football. Although the cadets were encouraged to remain active during these sessions, progressive improvements in fitness were not monitored because of the greater emphasis on the development of camaraderie, cooperation, and teamwork.

Statistical Analyses

A one-way analysis of variance (ANOVA) was used to test for differences in markers of physical fitness across the 16-week training program. If a significant difference was found, a Bonferroni post-hoc test was used to determine between which measurement points (Weeks 1, 8 and 16) those

TABLE 3. Baseline fitness characteristics of police academy cadets (mean \pm SD).*

Test	Male ($n = 61$)	Female ($n = 7$)	Both ($n = 68$)
Sprint (s)	5.51 \pm 0.42	6.46 \pm 0.31	5.61 \pm 0.50
T-test (s)	11.4 \pm 1.2	12.98 \pm 1.12	11.52 \pm 1.52
1RM bench (kg)	89 \pm 27	38 \pm 8	85 \pm 28
Hand grip-RH (kg)	55 \pm 10	34 \pm 5	53 \pm 11
Hand grip-LH (kg)	52 \pm 10	31 \pm 8	50 \pm 12
Sit and reach (cm)	28.0 \pm 8.5	32.1 \pm 6.2	28.4 \pm 8.3
Vertical jump (cm)	59.1 \pm 11.1	39.9 \pm 4.5	57.1 \pm 12.1
Push-ups (reps)	47 \pm 13	18 \pm 10	44 \pm 15
Sit-ups (reps)	44 \pm 8	36 \pm 8	43 \pm 8
Shuttle run (min:s)	3:49 \pm 0:13	4:31 \pm 0:14	3:53 \pm 0:19
Arm crank PPO ($\text{W} \cdot \text{kg}^{-1}$)	2.4 \pm 0.6	1.2 \pm 0.4	2.2 \pm 0.7
Wingate PPO ($\text{W} \cdot \text{kg}^{-1}$)	10.4 \pm 1.8	8.6 \pm 1.2	10.2 \pm 1.9

*1RM = 1 repetition maximum; RH = right hand; LH = left hand; PPO = peak power output.

differences existed within the 16-week training program. Statistical significance was defined as $p < 0.05$ for all the tests. Statistical analyses were performed using a statistical software package (SPSS, version 18, SPSS Inc, Chicago). All values are presented as mean and SD.

RESULTS

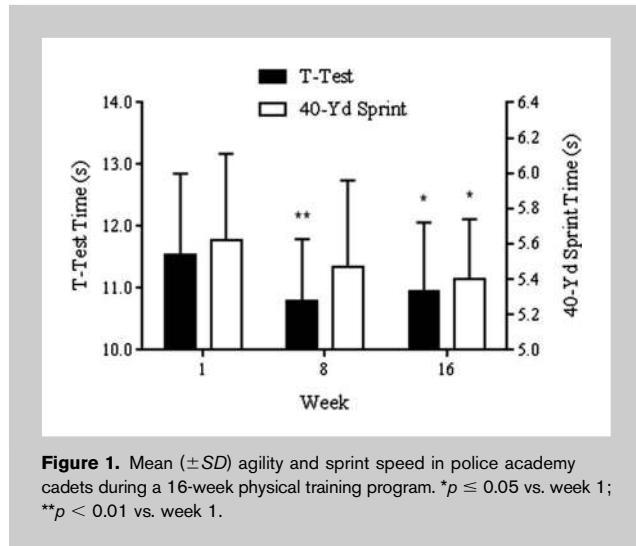
Baseline Physical Fitness Characteristics

Anthropometry. On entry to the academy, police cadets had a body mass of 83.1 \pm 12.2 kg, which classified their body mass index (BMI) as 26.1 \pm 2.9 $\text{kg} \cdot \text{m}^{-2}$. Their 7-site skinfolds sum was 88.1 \pm 33.5 mm, which was equivalent to a body fat percentage of 13.6 \pm 6.5% (Table 2 for male and female data).

Physical Fitness. Cadet aerobic capacity was assessed using a half-mile shuttle run, which was completed in 3:53 \pm 0:19 minutes, and their sit-and-reach flexibility was 28.4 \pm 8.3 cm. Maximum isometric grip strength for the right and left hand was found to be 53 \pm 11 kg and 50 \pm 12 kg, respectively, and 1RM bench press was 85 \pm 28 kg. Cadets were also able to perform 44 \pm 15 push-ups and 43 \pm 8 sit ups in a 60-second timed assessment of muscular endurance. Laboratory-based testing of upper (20 seconds arm crank) and lower (30 seconds Wingate) body peak power output (PPO) showed cadets were able to produce 2.2 \pm 0.7 $\text{W} \cdot \text{kg}^{-1}$ and 10.2 \pm 1.9 $\text{W} \cdot \text{kg}^{-1}$, respectively, and had a vertical jump height of 57.1 \pm 12.1 cm. In field-based testing of power, 40-yard sprint time was 5.61 \pm 0.50 seconds and T-test agility time was 11.52 \pm 1.52 seconds (Table 3 for male and female data).

16-Week Physical Fitness Testing Program. A number of variables were found to have significant changes from weeks 1–8 (agility, upper-body and lower-body peak power, sit ups, push-ups) or across the whole of the 16-week program (agility, lower-body peak power, sit up, push-ups, half-mile shuttle run). However, none of the variables showed significant change across the second half of the program (weeks 8–16).

Agility was found to significantly improve ($p < 0.01$) by



6.5% across the first 8-week block but not across the second 8-week block (week 1: 11.5 ± 1.3 seconds; week 8: 10.8 ± 1.0 seconds; week 16: 11.0 ± 1.1 seconds). Furthermore, a significant ($p \leq 0.05$) 5.0% improvement was observed across the duration of the 16-week program. Sprint speed improved significantly ($p \leq 0.05$) by 3.8% across the full 16-week program (week 1: 5.6 ± 0.5 seconds; week 16: 5.4 ± 0.3 seconds; $p \leq 0.05$), however no significant changes were seen in sprint speed across either of the 2 separate 8-week blocks (Figure 1).

Upper-body PPO showed a significant ($p \leq 0.05$) improvement of 12.5% across the first 8-week block but not across the second 8-week block and showed a trend, although not significant ($p = 0.05$), toward a decrease in upper-body power across the full 16 weeks (week 1: 2.2 ± 0.7 W·kg⁻¹; week 8: 2.5 ± 0.5 W·kg⁻¹; week 16: 2.4 ± 0.5 W·kg⁻¹). Lower-body PPO improved significantly ($p \leq 0.05$) by 9.4% across the first 8-week block and by 6.7%

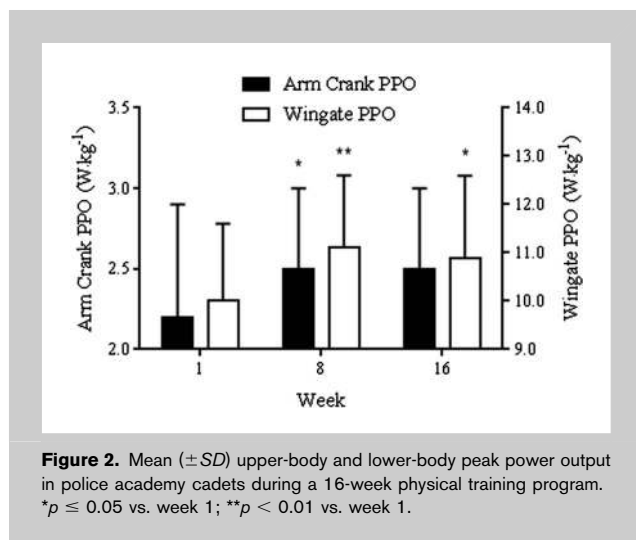


Figure 2. Mean (±SD) upper-body and lower-body peak power output in police academy cadets during a 16-week physical training program. * $p \leq 0.05$ vs. week 1; ** $p < 0.01$ vs. week 1.

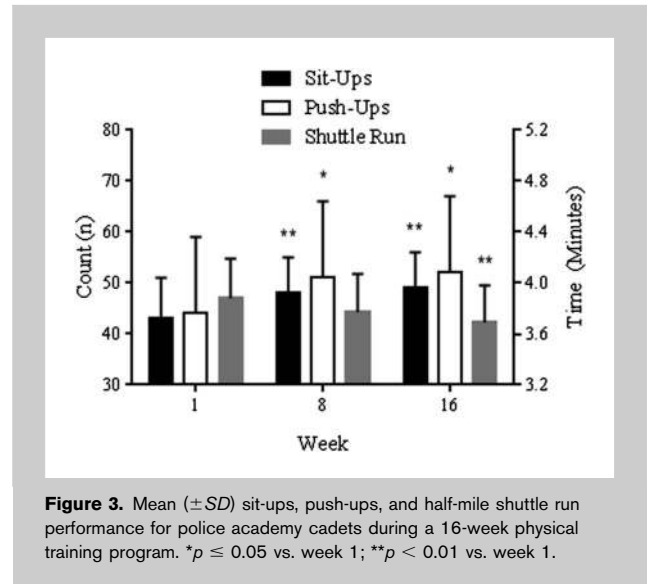


Figure 3. Mean (±SD) sit-ups, push-ups, and half-mile shuttle run performance for police academy cadets during a 16-week physical training program. * $p \leq 0.05$ vs. week 1; ** $p < 0.01$ vs. week 1.

across the whole PFT program (week 1: 10.1 ± 1.7 W·kg⁻¹; week 8: 11.0 ± 1.4 W·kg⁻¹; week 16: 10.8 ± 1.6 W·kg⁻¹; $n = 53$), but again, as with all previous variables, not across the second 8-week block (Figure 2).

Jump height showed no significant improvement as a result of the training program, however, there was a demonstrated trend ($p = 0.06$) toward improvement across the full 16 weeks of the program (week 1: 56.5 ± 10.5 cm; week 16: 61.2 ± 10.2 cm).

State Standardized (MCOLES) Testing. There were significant improvements in all the MCOLES physical fitness measures, i.e., number of completed sit-ups and push-ups, and the half-mile shuttle run time, as a result of the 16-week training program (see Figure 3). Core endurance improved significantly (12.9%; $p < 0.01$) across the first 8-week block, but again not across the second 8-week block, and there was a significant improvement (16.5%; $p < 0.01$) across the full 16-week training program (week 1: 42 ± 8; week 8: 48 ± 7; week 16: 49 ± 7). Upper-body endurance increased significantly (14.6%; $p \leq 0.05$) during the first 8-week block, and as with all previous variables not across the second 8-week block. However, there was a significant improvement (17.3%; $p \leq 0.05$) in the number of push-ups completed across the full 16 weeks of the training program (week 1: 44 ± 14; week 8: 50 ± 14; week 16: 51 ± 15). Aerobic endurance significantly improved (4.6%; $p < 0.01$) but only across the full 16-week training program (week 1: 3:53 ± 0:19 minutes:seconds; week 16: 3:41 ± 0:17 minutes:seconds).

DISCUSSION

This research determined a baseline fitness profile for police academy cadets and provided meaningful insight into cadet fitness levels before engaging in a physical training program.

The observed 16-week program resulted in a number of individual parameters of physical fitness evidencing improvement in the first 8 weeks, whereas none of the variables showed significant improvement in the second 8 weeks. This suggests modifications could be made to increase overall effectiveness of the training program.

Cadet BMI on entry into the academy classified them as clinically overweight, although their body fat percentage was better than the average when compared with the general population (1,3) (see Table 2). This is often the case with BMI in active populations, as it does not have the ability to differentiate between muscle weight and fat weight and tends to overestimate fatness in active populations (5,3). This trend is also found in baseline characteristics of military, Special Weapons and Tactics (SWAT), and firefighter recruits (26,28,37). In addition, body fat percentage among subjects in our study was similar to those reported by Boyce et al. (7). They examined body composition changes on police officers over a 12-year period and observed a significant increase in body composition in all subjects, regardless of race or sex. Moreover, percent body fat in all officers over a 12-year span increased significantly; up to a 64% increase was observed in initially obese male officers. As previously noted by Boyce et al., (7) the results of the current study reiterate that body composition needs to be addressed early to maintain within healthy limits throughout a police officer career. It is well known that body composition has an impact on health and performance in police officers. Therefore, it is important for the police force and academies to implement or educate recruits on adequate nutrition and physical training throughout their career to avoid health-related problems that could interfere with job performance.

Although, there is very limited published data regarding the fitness characteristics of police academy cadets, this population can be meaningfully viewed in comparison with other populations. A number of components of physical fitness were average or below average at the start of the academy when compared with Cooper standards or age-specific general population norms. Sit-and-reach flexibility ranked below the 15th percentile (10), upper-body strength was at the 50th percentile (1), which is similar to military recruits (37), but 24% lower compared with the SWAT population (26), hand grip strength was in the 25th–74th percentile (1) lower than firefighter recruits (28), and core endurance (sit-ups) was in the 40th percentile (10). Only 3 of the 11 markers of physical fitness were ranked above the 50th percentile for Cooper norms. Vertical jump was in the 65th percentile (10), which was 37% higher than the SWAT population (26), upper-body endurance (push-up) was in the 75th percentile (10), and lower-body power (40-yard dash) was in the 70th percentile (1).

As expected for a population with diverse ages and mixed sex, there is a wide range of initial physical fitness characteristics that could be improved. It would seem advantageous to implement a preacademy strength and conditioning program as a means to improve the preparedness to undergo

a demanding physical training program (13,17). Knapik et al. (13) demonstrated that low-fit recruits, who completed a pre-conditioning program before basic combat training, showed reduced attrition and tended to have lower injury risk, compared with recruits of similar low fitness who did not pre-condition. In addition, Shell (32) states that entry-level law enforcement academies have training programs with extensive hours of physical training, but these programs lack the scientific base or formal progression for new recruits to follow. There is a lack of appropriate instruction on how to maintain personal fitness and wellness as a police officer. A suggestion to address this problem might be to provide a preacademy training program that addresses physical and wellness education before entrance into the academy to develop health management skills as early as possible in a police officer's career.

Although, it is not known as to what level the cadets had engaged in physical training directly before the academy, they clearly had potential for improvement. Relatively untrained subjects typically respond dramatically to training (5,25). Specific adaptations to anaerobic training (muscular strength and endurance, hypertrophy, power, and motor skill performance) are specific to the stimulus applied by the training program (5,14). Initial fitness improvements seen from an increase in neural recruitment and rate of firing typically take 6–8 weeks in relatively untrained populations (5,25) after which muscular adaptations, such as increase in muscle size or fiber type transitions begin to take place (15). Therefore, it is likely that the gains demonstrated in the current research are more likely due to neurological efficiencies than actual changes in muscle function or structure. For maximal benefits, i.e., long-term positive adaptations from a training program, neuromuscular improvements, and muscular and structural changes should be encouraged through proper periodization (5,14).

Carlson and Jaenen (9) identified some specific beneficial areas of focus for entry-level tactical athletes (i.e., police cadets), including aerobic capacity, muscular strength and endurance, balance, and anaerobic power. On review of the academy training program, there was a strong emphasis on bodyweight training and running to develop base conditioning. It is the current authors' suggestion that base conditioning could be addressed in a preacademy training program. This would allow for the opportunity to include more weight-based resistance training (similar to strength and conditioning programs for athletes allowing for individual progressive overload) that would result in greater improvements in overall strength (15,20,37). If law enforcement officers require strength, agility, speed, and power (2,6,12,24,37), then cadets would benefit from incorporating exercises that heighten improvements in these targeted attributes. With this in mind, police academy cadets should be trained like athletes preparing for competition using a progressively structured physical training curriculum (30,19).

A comprehensive literature search was performed for this study, however, very little published literature was found

that examined physical fitness specifically in police academy settings. There was some evidence that low levels of physical fitness can predispose cadets to injuries and future health problems (29). Regali (27) investigated the relationship between physical fitness and athletic injuries in a population of 244 men and 23 women police cadets. This study found that men (age 20–29) demonstrated lower levels of maximum strength in their upper body than other age groups. More recently, research by Ligestad and Van Den Tillaar (16) demonstrated gains in maximal strength across a 3-year academy program, specifically, improvements in bench press and pull-ups. Perhaps with a longer time frame, cadets in this study would also see significant improvements in strength that traditionally take longer to develop.

Boyce et al. (8) demonstrated the importance of appropriate minimum fitness standards for cadets. Their research held that strength, if high in the beginning of a law enforcement career, will continue to remain high for the next 12 years. Although, our study's cadets did get slightly stronger (measured by 1RM bench press in the first 8 weeks), gains realized in the first half of the academy were not maintained and actually began to return to week-1 strength levels toward the end of the 16 weeks. This was not the case for Roberts et al. (28) whose firefighter recruits showed a strong tendency to improve muscular strength during a 16-week academy.

The state level fitness standards for the cadets in this study were developed by MCOLES (21) in 2004 when there was a trend toward making larger applicant pools for academies in terms of age and sex. Instead of the required physical tests reflecting the physical occupational tasks of police officers, the tests were specifically chosen to reflect general fitness levels of the cadets. The standards were set at an “average” level of fitness (when compared with Cooper Norms and US Army data) and the passing rate for the state was 94% (21).

Owing to the observational study design, there are possible concerns regarding control of participant preparation, either before testing or during the training program, to include a lack of monitored (nutritional intake and hydration) and/or prescribed (rest and recovery) variables. There was no documentation of previous exercise history or monitoring of exercise undertaken independently during the program. The findings of the present study have evidenced a significant increase in lower-body power when assessed by the 40-yard dash, but this increase in power was not demonstrated by the Wingate test. This may be due to the cadet's familiarity with sprinting, or willingness to perform maximally while running 5–6 seconds vs. cycling for 30 seconds. Whatever the case, there is a divergence in findings related to lower-body power output capacity. Finally, no comparative aerobic capacity test was conducted.

In conclusion, although it is clear that although the physical training for a traditional or tactical athlete is similar, the 2 populations are quite delineated in their job requirements (35). A law enforcement officer must perform highly physical and

mental engaging activities such as shooting under duress, reacting to stress (or attack) instinctively (i.e., trained muscle memory), and making critical decisions in high stress circumstances with good judgment (i.e., ability to think clearly in a life or death situation). Therefore, appropriate training should result in an individual who can function in extremely stressful situations and have the required physical fitness to perform optimally in such environments.

PRACTICAL APPLICATIONS

The baseline characteristics provided by this research can be used to help professionals tailor training programs for incoming cadet populations. The inclusion of a preacademy physical training program is highly recommended. Although, cadets were able to pass the required state physical fitness tests at the end of the academy, training programs could easily benefit from proper implementation of periodization. Specifically, improvements in physical fitness should continue during the second 8-week block, and specificity of training should include more functional and job specific training tasks. Although, all aspects of fitness should be targeted, those directly related to reported occupational demands, such as strength, power, and flexibility, could be advantageous. Finally, the inclusion of a strength and conditioning professional, ideally with a Tactical Strength and Conditioning-Facilitator certification to design and administer a periodized training program, would seem advantageous for this unique population.

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