pISSN 2394-6032 | eISSN 2394-6040

DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20240246

Original Research Article

An evidence-based approach to physical conditioning in American cadet law enforcement academies

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Received: 08 August 2023
Revised: 04 January 2024
Accepted: 11 January 2024

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ABSTRACT

Background: Law enforcement physical fitness training is not standardized in the United States; instead, there is heavy reliance on training officers or other LEOs with an interest in exercise. This study aimed to evaluate performance outcomes between a traditionally designed physical conditioning program and an evidence-based conditioning program for law enforcement cadets.
Methods: Two metropolitan state law enforcement training centers in the southeast United States volunteered to participate in this investigation. Each program lasted 12 weeks and consisted of 5 days/week of physical training. The experimental group (n=46) was provided with an evidence-based physical conditioning program consisting of anaerobic and aerobic conditioning, agility, power, movement quality, defensive tactics, and muscular endurance.
Results: The control group participants (n=18) were assigned to a traditional instructor-led physical training program consisting of calisthenics and running. Of the 14 fitness variables measured, the intervention group displayed improvements in 10 variables, whereas the control group improved 6 variables.
Conclusions: The results of this study encourage law enforcement departments to make provisions for modifications to enhance traditional cadet physical training programs, with consultation from strength and conditioning subject matter experts.

Keywords: Law enforcement, Police, Physical fitness, Exercise, Health

INTRODUCTION

Avoidable injuries and physical impairments account for a substantial portion of health issues among law enforcement officers (LEO). According to the United States Labor Bureau of Labor Statistics, LEOs have a higher risk of work-related injuries or illnesses than many other occupations.[1] These risks are not restricted to career LEOs as the risks are also serious for LEO cadets at training academies. Cadet physical training is associated with many musculoskeletal injuries.[2] Teyhan and colleagues further demonstrated that overuse accounts for the majority of injuries observed in the tactical operators.[2] Previous research has highlighted the association between poor fitness, specifically aerobic capacity, and the attrition rate among LEO recruits.[3,4] The combination of under-recruitment, sub-optimal attrition rate, and work-related injuries has led LEO departments to evaluate potential changes to policies for physical training with upcoming cadet classes.

The diversity of occupational tasks of LEOs ranges from sedentary with long periods of inactivity to highly demanding and potentially life-threatening activities. It has been estimated that 80-90% of a police officer's workday is composed of sedentary behaviors, such as sitting, standing, and slow walking.[5] However, when LEOs respond to a situation, they must physically exert themselves with over 70% of their maximal effort.[5] It is not uncommon for LEOs to experience unpredictable and stressful bursts of intense physical activity. This sudden bout of physical activity places high demands on the cardiovascular and musculoskeletal systems.[6] Several of the duties in this occupation (e.g., subject apprehension, hand-to-hand combat, and forceable entry) require substantial cardiorespiratory and muscular fitness.[7,8] Furthermore, LEOs are required to carry heavy external loads daily, upwards of 23 kg depending on the unit and situation.[5] Although an LEO's physical demands are diverse, typical cadet physical training programs are not occupationally specific; instead, they focus on a general population plan.

Law enforcement physical fitness training is not standardized in the United States. Instead, training officers or other LEOs with an interest in exercise are given the burden of making decisions regarding physical training. Typically, cadet fitness programs are embedded in police academies, with 3 to 5 sessions per week for 30 to 60 minutes each.[9] However, these programs often incorporate fundamental elements of cardiovascular training (running, marching, jumping, stair climbing), muscle fitness (push-ups, squats, lunges), and flexibility (dynamic stretches and static stretches).[10]

Commonly, LEO-lead programs do not follow best practices, rely heavily on instructors' previous experiences, rarely address acute or chronic injuries, and may not optimally improve occupational readiness. Additionally, resources for injury reduction and occupational readiness programming for LEOs are limited. Recently, research has begun to emerge on cadets and career LEOs fitness abilities[11] and several investigations have profiled LEO cadets.[12,13] Lockie et al compared fitness assessments between cadets and career LEOs based on years of service.[14] The researchers reported that the greater the number of years of service, the lower their fitness level.[14] This finding has been supported throughout other LEO populations, including the United States state troopers and Portuguese LEOs.[15,16] Although years of service are likely linked with poor physical fitness conditions among LEOs, there are little to no financial resources allocated to address this issue, highlighting the need for different approaches to injury prevention and fitness programming with LEOs at different stages of their careers.

Currently, there is a gap in the research and practice of cost-efficient programs addressing injury prevention and occupational readiness for LEOs. The first steps to encouraging a positive culture shift among policy makers and departents to prioritizing officers' health and wellness is within the the police academy structure.

Objective

The purpose of this pilot study was to evaluate performance outcomes between a traditionally designed physical conditioning program and an evidence-based conditioning program for law enforcement cadets.

METHODS

Participants

This study was approved by the Institutional Review Board of Sponsoring University (H19098). The participants were LEO cadets (n=64) enrolled at state-funded Public Safety Training Centers throughout a southern state. Two training centers were utilized in this study: the intervention group (n=46) and the control group (n=18). Men comprise over 85% of the LEO workforce[35], and the two training centers tested appropriately represented the male/female LEO ratio (intervention, n=12; control, n=4). There were no differences in recruiting physical characteristics from either training center age (p=0.68), height (p=0.10), body mass (p=0.65), body mass index (BMI) (p=0.17), waist circumference (p=0.77), body fat percentage (BF%) (p=0.06), systolic blood pressure (sBP) (p=0.73), and diastolic blood pressure (dBP) (p=0.90).

Physical training

Both academies had the same entry qualifications and graduating standards and lasted 12 weeks with physical training (PT) 5 days a week starting in September and ending in December 2021. The training centers were limited in their physical training capabilities, both of which performed PT without the aid of equipment. PT occurred in the morning each day of the week, starting at 0730 h and lasting approximately 30 min. Training outcomes of interest included anaerobic conditioning, aerobic conditioning, agility, power, movement quality, muscular endurance, and defensive tactics.

Intervention training center

The intervention group was provided a physical training program designed by certified exercise specialists that targeted training outcomes and demands that are specific to LEOs. The PT focused on an undulating program from the National Strength and Conditioning Association's (NSCA) Tactical Athlete approach.[5] The researchers educated training center instructors on the potential effects and risks of program implementation. An informational packet was provided outlining the daily workouts with exercise references for each movement. The implementation of this training packet was at the instructors' discretion. Table 1 outlines the tentative physical training programs.

The academy's physical training program was divided into five two-week training cycles. Weeks 1 and 12 were excluded from these cycles because they were not full training weeks and consisted of physical assessments.

Each cycle progressed in volume and intensity throughout the academy, according to the NSCA standards.[5] Cadet academies are stressful programs that include designed punitive physical training, so traditional training programming models often do not fit perfectly. In light of this, Week 9 occurred during a national holiday, during which cadets had time off, therefore this was altered during the academy as a deload week. Additionally, punitive exercises were recommended to the instructors based on the training day, and the exercises performed during morning physical training to reduce overuse injuries (e.g., if push-ups were performed in morning PT, punitive exercises such as wall-sits or sprints would be recommended that day instead of more push-ups).

A dynamic warm-up was conducted at the start of each training day. Two options were provided on the day of training. For run-based training days (Mondays and Wednesdays), the dynamic warm-up consisted of ankle circles, ankle skips, hamstring sweeps, quadriceps reaches, hip circles, high knees, butt kicks, A-skip variations, B-skip variations, and backward run. During non-run training days (Tuesday, Thursday, and Friday), the dynamic warm-up consisted of ankle circles, ankle skips, jogging, hamstring sweeps, quadriceps reaches, hip circles, the world's greatest, lateral lunges, shoulder mobilization (YWTA's), towel-assisted dead bugs, and bridges. For training days with defensive tactics, instructors were encouraged to perform warm-ups as they would normally, in addition to the provided dynamic warm-up.

Cooldown exercises were provided for the entire program upon completion of each training session. Based on the structure and focus of the training day, the cooldown exercise selection varied slightly to allow for proper cooling of the worked muscle. The remainder of the cooldown consisted of a couch stretch, downward dog, back twist, butterfly, functional movement screen (FMS) movements, deep breathing, and body scanning. Body scanning is a form of meditation that can improve introspective awareness to help individuals cope with stress, manage emotions, and provide better insight into their minds and bodies.[17] Each participant was provided with individualized corrective exercises based on their FMS test assessment scores at the start of the academy. These exercises were encouraged during warm-ups, cooldowns, and throughout the academic training day as movement breaks. The performance of these corrective exercises was at the discretion of the cadets and instructors.

Control group training

The control group did not receive any physical training instructions or program adjustments from researchers. Traditional instructor-led sessions were conducted for the entire academy. Table 2 provides an overview of the control group's tentative academic physical training program provided by the lead instructor at the training center.

Physical assessments

Physical fitness assessments were conducted at the beginning (Week 1) and end (Week 12) of the academic training at both locations.

Anthropometrics

Height and body mass were measured without shoes and in the standard-issued department uniform with a portable stadiometer and digital scale, respectively. Waist circumference was measured at the umbilicus using a plastic tape measure. Body fat percentage (BF%) was estimated using a dual-frequency (50 kHz) foot-to-foot bioelectrical impedance analyzer (Tanita DC-240). Participants were asked to arrive euhydrated and abstain from vigorous exercise for 24 hours before testing according to the manufacturer's instructions.

Blood pressure

Blood pressure was measured using national guidelines, with at least three minutes of seated rest in a chair with back support, feet flat on the floor, and arms supported at heart level with measurments taken using an automated arm cuff.[18]

FMS mobility screen

This test was selected to quantify the movement quality and potential injury risk.[19] Eight tests evaluated squat, hurdle step, in-line lunge, shoulder mobility, ankle mobility, active straight leg raise, stability push-up, and rotary stability with an ordinal scale of 0-3 (0=pain, 1=cannot perform, 2=can perform but with compensatory movement, 3=optimal performance). Seven of the tests were utilized for scoring, with ankle mobility withheld from the scoring system. All test administrators held the minimum FMS-1 certification during data collection.

Muscular power

A vertical jump was used to assess lower-body power. Jump distance was measured using a switch mat (Just Jump System). The participants were instructed to jump with maximal effort and were allowed to use their arms during countermovement. Lower body power was calculated using the following prediction equation: Power (Watts)=[(60.7 x jump height (cm)) + 45.3 x body weight (kg))] – 2055.[33]

Handgrip strength

Handgrip strength was assessed using a hand dynamometer. Maximal isometric grip strength was measured to the nearest 1 kg. Measurements taken with the Jamar Hydraulic Hand Dynamometer have good to excellent test-retest reliability ($r>0.80$, $p<0.05$) and concurrent validity ($r=0.99$, $p<0.05$).[32]

Agility

Agility was determined by the time to completion (measured to the nearest 0.01 s) of a T-drill as reported by a digital timing system (Brower TCi Timing System). Given the time constraints of the academy, participants were allowed only one attempt at each time point.

Muscular endurance

Core muscular endurance was measured using the isometric plank test time (measured to the nearest 0.01 s). The standard starting position was with hands unclasped and forearms parallel to each other, with elbows stacked underneath the shoulder joints. The push-up technique was not modified between the sexes. The standard starting position was with the unclasped hands being shoulder-width apart, extended elbows, extended knees, and maintenance of neutral spine. The push-ups were performed on a metronome at 80 beats per minute for a maximum of 2 min. Participants were instructed to touch their chest with a plastic block (height: 12.7 cm) to indicate that the appropriate depth had been reached for each repetition. Maintenance of proper technique was ensured by a test administrator. The test was terminated upon volitional fatigue or a 3rd verbal warning of improper technique.

Anaerobic endurance

A 300-yard shuttle run was used to assess anaerobic capacity. Cones were placed 25 yards apart, and participants ran back and forth, totaling six round trips per the NSCA guidelines.[5] The time was recorded to the nearest 0.1 seconds.

Statistical approach

All data are reported as the mean±standard deviation (SD) and demographics as frequencies. The Shapiro–Wilk test was used to assess the normality of the data distribution. Independent-sample *t*-tests were conducted on both groups to determine potential pre-intervention differences between the two groups. Paired-sample *t*-tests were used to compare the results of the intervention for all variables of interest within each group. Significance was set at $p<0.05$ for all tests. Practical significance was assessed using Cohen's *d* effect size statistics and Hopkins' scale of magnitude.[20] Data IBM SPSS Version 27.0 (SPSS, Inc., Chicago, IL) was used for all analyses.

Table 1: Overview of the provided physical training program.

Weeks	Monday	Tuesday	Wednesday	Thursday	Friday
1	N/A	Cadet orientation no PT	Physical assessments	Exercise Introduction 1. Squats 2. Plank 3. Towel hinges 4. Mountain climbers 5. Flutter kicks 6. Supermans 7. Push-ups 8. Reverse lunges 9. Tiger hold 10. Reacher rows	Formation run introduction formation and easy pacing
2-3	Formation run instructor pace LSD	Calisthenics 20:30s W:R ratio 1. Squats 2. Up-downs 3. Plank 4. Push-ups 5. Supermans 6. Mountain climbers	Agility/anaerobic 1. ACC-stops 2. ACC-Backpedal 3. ACC-cone rounding 4. 1:30 min run intervals	Calisthenics Circuit 1. Towel hinges 2. Push-ups 3. Lunges 4. Reacher rows	Defensive tactics
4-5	Formation run instructor pace fartlek	Calisthenics 30:30s W:R Ratio 1. Towel squats w/rows 2. Burpees 3. Plank up-downs 4. Reacher rows 5. Push-ups 6. Jumping jacks	Agility/anaerobic 1. ACC-stop 2. ACC-backpedal 3. ACC-Cone rounding 4. Open steps 5. Karaoke steps 6. Side shuffles 7. 1:15 min run intervals	Calisthenics circuit 1. Overhead towel-hinges 2. Push-ups/flutter kicks 3. Overhead towel-lunges 4. Reverse snow angels	Defensive tactics

Continued.

Weeks	Monday	Tuesday	Wednesday	Thursday	Friday
6-7	Formation run steady state directional changes	Calisthenics 20:30s W:R ratio 1. Squat jumps 2. 8c body builders 3. Push-ups 4. Supermans 5. Tiger hold 6. Mountain climbers	Agility/anaerobic 1. ACC - Backpedal 2. ACC-cone rounding 3. Open steps 4. Karaoke steps 5. Side shuffle 6. Cone weaves 7. 10 out 5 back drill 8. Side shuffle/sprint 9. 1:15 min run intervals	Calisthenics Circuit 1. Broad jumps 2. Push-ups/flutter kicks 3. Towel lunges 4. Supermans run after round completion	Defensive tactics
8-9	Formation run LSD pace increase	Calisthenics 30:30s W:R ratio 1. Squat-broad jumps 2. 8c body builders 3. Tiger hold 4. Swimmers 5. Inchworm/Push-Ups 6. Side planks	Agility/anaerobic 1. Prone start/ACC-stop 2. ACC-cone rounding 3. Side shuffle 4. Cone weave to sprint 5. 5-10-15 drill 6. Figure 8 drill 7. T-drill 8. 1 min run intervals	Calisthenics circuit 1. Up-down/broad jump 2. Push-ups/flutter kicks 3. Runners lunges 4. Ground elbow drives Interval run between stations	Defensive tactics
10-11	Formation run instructor pace fartlek	Calisthenics 30:20s W:R ratio 1. Burpee squat jumps 2. Reverse snow angels 3. Tiger walks 4. Inch worms/push-ups 5. Jumping jacks 6. Plank twists	Agility/anaerobic 1. Supine to ACC 2. ACC-cone rounding 3. Side shuffles 4. 5-10-15 drill 5. Figure 8 drill 6. W-Pattern drill 7. T-drill 8. 1minute run intervals	Calisthenics circuit 1. Skier jumps 2. Push-ups/flutter kicks 3. Towel hinges 4. Squat holds/side steps interval run between stations	Defensive tactics
12	Rest	Physical Assessments	N/A	N/A	N/A

Note: LSD- Long slow distance; W:R ratio- work: rest ratio; ACC- Acceleration; 8c- 8-count.

Table 2: Overview of traditional training program.

Phase	Monday	Tuesday	Wednesday	Thursday	Friday
I	Formation run: 1.5 miles	4 laps, 3 sets of 10 after 1st, 2nd and 3rd lap: push-ups, sit-ups, flutter kicks, air squats	Formation Run: 1.5 miles	4 laps, 3 Sets of 10 after 1st, 2nd and 3rd Lap: Push-Ups, Sit-Ups, Flutter Kicks, Air Squats	Formation Run: 1.5 miles
II	Formation run: 1.75 miles	4 laps, 3 sets of 10 after 1st, 2nd and 3rd lap: push-ups, sit-ups, flutter kicks, air squats	Formation Run: 1.75 miles	4 laps, 3 Sets of 10 after 1st, 2nd and 3rd Lap: Push-Ups, Sit-Ups, Flutter Kicks, Air Squats	Formation Run: 1.5 miles
III	DT PT: Break Falls, Tactical Stand and Base, Pole Runs, and other various movements	3 Stations: 1. Push-ups 2. Flutter Kicks 3. Air Squats 30 yards apart, 60 yards in total. Sprint 60 yards after Air Squats. Rep Scheme: 10, 9, 8, 7, 6, 5, 4, 3, 2, 1.	Ability Groups 2 miles run	6-10-18-10-6 Push-ups/Stand and Base/Air Squats/ Tactical Hop-Ups-Sprint 20 yards down and back after each round (40-yard sprint in total). Must finish with a sprint	Free Run: 2 miles

RESULTS

Pre-intervention comparisons

Significant, small-to-moderate effects and pre-intervention differences were noted in 3 of 16 variables: FMS, T-Drill, and 300-Shuttle. Comparing the intervention to the control group pre scores were better with the FMS (intervention 13.61±2.04; control 14.67±1.37), T-Drill (intervention 14.68±1.75; control 13.59±1.44), and 300 Shuttle (intervention 78.78±10.82; control 72.39±9.27). No significant differences were observed in any of the other variables.

Within-group pre-post comparisons

Intervention

Significant pre-posttest comparisons were noted for 10 of the 14 variables (Table 5). Posttest waist circumference was lower (p<0.01; Mean Difference [MD]: -2.55±4.03 cm) than at baseline, with a small-to-moderate effect (d=-0.64, 95% CI [-0.95, -0.31]). Posttest body weight was lower (p<0.01; MD: -1.78±3.08 kg) than at baseline, with a small-to-moderate effect (d=-0.58). Posttest BMI was lower (p<0.01; MD: -0.57±0.96 kg/m^2) than baseline with a small-to-moderate effect (d=-0.60). Posttest SBP was lower (p=0.02; MD: -3.47±9.30 mmHg) than baseline with a trivial-to-moderate effect (d=-0.38). Post-FMS was improved (p<0.01; MD: 1.92±1.87 au) compared to baseline with a moderate-to-large effect (d=1.03). Posttest CMJ was improved (p<0.01; MD: 1.87±2.96 cm) compared to baseline with a small-to-moderate effect (d=0.64). Posttest plank was improved (p<0.01; MD: 69.27±76.76 s) compared to pre with a moderate-to-large effect (d=0.91). Posttest push-ups were improved (p<0.01; MD: 3.72±6.79 reps) compared to pre with a small-to-moderate effect (d=0.55). Post T-Drill was improved (p<0.01; MD: -0.90±0.95 s) compared to pre with a moderate-to-large effect (d=-0.95). Post 300-Shuttle run was improved (p=0.02; MD: -3.59±9.80 s) compared to pre with a small effect (d=-0.37). No statistical differences were observed in BF% (p=0.92), BPD (p=0.38), LB power (p=0.29), or HGS (p=0.71).

Control

Significant pre-post comparisons were noted for 6 of the 14 variables, with improvements seen in these variables following the intervention (Table 6). Post Waist was lower (p=0.03; MD: -1.61±2.84 cm) than Pre, with a small-to-large effect (d=-0.57). Post Weight was lower (p=0.01; MD: -1.94±2.69 kg) than Pre, with a moderate-to-large effect (d=-0.73). Post BMI was lower (p=0.01; MD: -0.64±0.90 kg/m^2) than Pre with a moderate-to-large effect (d=-0.72). Post-push-up performance was improved (p=0.01; MD: 6.44±7.34 reps) compared to Pre with a moderate-to-large effect (d=0.88). Post plank was improved (p<0.01; MD: 47.33±36.01 s) compared to pre, with a moderate-to-large effect (d=1.32). Post 300-Shuttle run was improved (p=0.01; MD: -2.61±3.70 s) compared to Pre, with a small-to-large effect (d=-0.71). No statistical differences were observed for BF% (p=0.12), BPS (p=0.36), BPD (p=0.50), FMS (p=0.62), CMJ (p=0.64), LB power (p=0.35), HG (p=0.82), or T-drill (p=0.25).

Table 3: Demographics of the law enforcement cadet participants.

Variables	Intervention n=46 (%)	Control n=18 (%)	Total n=64 (%)
Gender, N (%)			
Male	34 (73.9)	14 (77.8)	48 (75.0)
Female	12 (26.1)	4 (22.2)	16 (25.0)
Age (years), mean±SD	28.6±8.3	27.7±8.2	28.4±8.2
Male	29.3±8.9 (34.0)	27.1±8.3 (14.0)	28.7±8.7 (48.0)
Female	26.8±5.8 (12.0)	29.5±8.7 (4.0)	27.4±6.4 (16.0)
Height (cm), mean±SD	172.2±10.2	176.7±8.2	173.5±9.8
Male	175.6±8.0 (34.0)	178.0±5.7 (14.0)	176.9±7.6 (48.0)
Female	162.6±9.7 (12.0)	165.4±3.9 (4.0)	163.3±8.5 (16.0)
Ethnicity/race, N (%)			
White	27 (58.7)	13 (72.2)	40 (62.5)
African American	15 (32.6)	1 (5.6)	16 (25.0)
Hispanic/Latino-a	3 (6.5)	3 (16.7)	6 (9.4)
Asian American	1 (2.2)	1 (5.6)	2 (3.1)

Group A, intervention group; Group B, control group.

Table 4: Average percent (%) changes (Δ) from baseline testing to post-academy testing.

Variables	Intervention (%Δ) (n=46)			Control (%Δ) (n=18)		
	x̄±SD	Min	Max	x̄±SD	Min	Max
Waist (cm)	-2.65±4.42	-22.22	6.94	-1.54±2.96	-5.94	4.00
Weight (kg)	-1.67±2.89	-9.04	4.41	-1.94±3.16	-6.00	5.79
BMI (kg/m^2)	-1.68±2.86	-8.93	4.44	-1.97±3.17	-6.13	5.91

Continued.

Variables	Intervention (%Δ) (n=46)			Control (%Δ) (n=18)		
	x̄±SD	Min	Max	x̄±SD	Min	Max
Body fat (%)	1.03±9.94	-38.87	21.05	5.55±11.75	-14.06	34.94
SBP (mmHg)	-2.56±7.04	-18.95	10.34	-1.13±5.57	-11.04	8.00
DBP (mmHg)	-1.23±9.67	-29.67	16.18	1.96±8.51	-13.33	18.87
CMJ (cm)	4.79±7.01	-11.44	24.48	1.53±7.68	-10.11	20.77
LB power (watts)	1.14±4.62	-9.28	11.82	-0.67±6.04	-8.10	11.50
HGS (kg)	2.06±12.74	-24.07	28.13	-0.44±9.77	-20.83	16.67
Pushups (#)	31.16±56.90	-46.43	233.33	48.33±70.12	-23.08	300.00
Plank (sec)	102.55±111.68	-14.53	566.67	61.71±51.09	11.43	206.45

Note: Group A- intervention group; group B- control group; BMI- body mass index; SBP- systolic blood pressure; DBP- diastolic blood pressure; FMS- functional movement systems; CMJ- counter-movement jump; LB power- lower body power; HGS- handgrip strength; Shuttle run- 300-yard shuttle run.

Table 5: Intervention Group A paired t-test results (n=46).

Variables	Baseline (x̄±SD)	Post-test (x̄±SD)	Mean difference (x̄±SD)	t	P	Cohen's d
Waist (cm)	92.85±13.73	90.30±13.46	-2.55±4.03	-4.282	0.001**	-0.631
Weight (kg)	89.74±21.21	87.96±19.42	-1.78±3.08	-3.915	0.000**	-0.577
BMI (kg/m^2)	30.03±5.13	29.46±4.72	-0.57±.95	-4.028	0.000**	-0.594
Body fat (%)	29.27±8.79	29.22±8.34	-.05±3.03	-.107	0.915	-0.016
SBP (mmHg)	131.54±17.75	128.07±19.02	-3.47±9.30	-2.538	0.015*	-0.374
DBP (mmHg)	76.57±10.00	75.54±12.26	-1.03±7.76	-0.893	0.377	-0.132
FMS (score)	13.61±2.04	15.52±2.08	1.91±1.87	6.932	0.000**	10.022
CMJ (cm)	45.41±10.69	47.28±10.04	1.87±2.95	4.287	0.000**	0.632
Lower body power (watts)	4766.66±1087.45	4799.55±1025.57	32.89±208.37	1.071	0.290	0.158
HGS (kg)	84.39±20.26	85.00±18.30	0.61±11.05	0.374	0.710	0.055
Pushups (#)	24.59±12.52	28.30±11.41	3.71±6.79	3.714	0.001*	0.548
Plank (sec)	79.60±34.51	148.90±86.12	69.30±76.76	6.121	0.000**	0.902
T-Drill (sec)	14.86±1.75	13.96±1.50	-0.90±.95	-6.390	0.000**	-0.942
Shuttle run (sec)	78.78±10.82	75.19±13.86	-3.59±9.79	-2.483	0.017*	-0.366

Note: **Significance at the 0.01 level (2-tailed); *Significance at the 0.05 level (2-tailed); BMI- body mass index; SBP- systolic blood pressure; DBP- diastolic blood pressure; FMS- Functional Movement Systems; CMJ- counter-movement jump; HGS- handgrip strength; Shuttle run- 300-yard shuttle run.

Table 6: Control Group B paired t-test results (n=18).

Variables	Baseline (x̄±SD)	Post-test (x̄±SD)	Mean difference (x̄±SD)	t	P	Cohen's d
Waist (cm)	94.03±15.83	92.42±14.84	-1.61±2.84	-2.405	0.028*	-0.567
Weight (kg)	87.08±20.06	85.14±18.73	-1.94±2.69	-3.066	0.007*	-0.723
BMI (kg/m^2)	27.87±6.34	27.23±5.80	-0.64±.90	-3.045	0.007*	-0.718
Body fat (%)	24.33±10.00	25.40±10.68	1.07±2.76	1.637	0.120	0.386
SBP (mmHg)	133.17±12.40	131.44±12.00	-1.73±7.66	-0.954	0.354	-0.225
DBP (mmHg)	76.94±10.28	78.00±9.19	1.06±6.41	0.698	0.494	0.165
FMS (score)	14.67±1.37	14.89±2.00	0.22±1.83	0.514	0.614	0.121
CMJ (cm)	47.19±10.40	47.57±9.57	0.38±3.36	0.485	0.634	0.114
Lower body power (watts)	4754.24±1054.81	4689.43±936.76	-64.82±285.43	-0.963	0.349	-0.227
HGS (kg)	90.61±18.73	90.11±20.51	-0.50±9.17	-0.231	0.820	-0.055
Pushups (#)	25.44±13.00	31.90±7.75	6.44±7.34	3.724	0.002*	0.878
Plank (sec)	81.61±25.99	128.94±45.28	47.33±36.01	5.576	0.000**	1.314
T-Drill (sec)	13.59±1.44	13.36±1.69	-0.23±.82	-1.198	0.247	-0.282
Shuttle run (sec)	72.39±9.27	69.78±8.03	-2.61±3.70	-2.997	0.008*	-0.706

Note: **Significance at the 0.01 level (2-tailed); *Significance at the 0.05 level (2-tailed); BMI- body mass index; SBP- systolic blood pressure; DBP- diastolic blood pressure; FMS- Functional Movement Systems; CMJ- counter-movement jump; LB Power, lower body power; HGS- handgrip strength; Shuttle run- 300-yard shuttle run.

DISCUSSION

The current study aimed to determine whether evidence-based physical training programs can reduce injuries and improve occupational readiness among LEO cadets. The 12-week program resulted in multiple health and fitness improvements. The results of this study encourage law enforcement departments to make provisions for modifications to enhance traditional cadet physical training programs, and consultation with strength and conditioning subject matter experts.

The traditional program and evidence-based intervention both yielded significant improvements in waist circumference, body mass, BMI, push-ups, plank hold, and shuttle runs. This finding is consistent with previous research on the positive impact of police academies on fitness variables.[21] Additionally, this study supports previous research that training programs that follow the principles of strength and conditioning positively impact fitness outcome variables.[9] It is imperative that training programs for tactical operators enhance general health, reflect respective occupational demands, and further proper training habits for LEOs.[5] Strategic planning of physical training programs can elicit increased capability to safely perform the physical aspects of occupational tasks.

Previous research has suggested that increased adiposity and BMI may have a detrimental impact on LEO health and occupational performance.[15,22] In the current study, both programs had a small but significant positive impact on cadets' BMI but no impact on their body composition. Stojkovic et al. noted a high percentage of cadets entering law enforcement who were overweight or obese and further suggested that physical training is appropriate for overweight and obese individuals.[23] Additionally, Crawley et al. emphasized the importance of establishing healthy practices to promote weight management throughout an officer's career. [9] Although no differences were found in body mass/weight changes, the emphasis on the maintenance of a healthy weight should be instilled during the cadet training academy.

Maintaining mobility can lead to less general pain and longer careers.[24] The FMS was designed to assess the quality of fundamental movement patterns and aid in the identification of an individual's physical limitations or asymmetries.[25] O'Connor and colleagues suggested an inverse relationship between FMS scores and injury rates.[19] Initially, the intervention group elicited surprisingly worse FMS scores than the control group. This may suggest that the intervention group cadets were, on average, at an increased risk for musculoskeletal injuries (i.e.,<14 score) compared with their control group counterparts. Individualized FMS corrective exercises were provided to the intervention group for voluntary performance. As expected, only the intervention group showed measurable improvement in movement ability as categorized by the FMS score. This finding may provide insight into the feasibility of improving the cadets' movement quality in a relatively short timeframe. Additionally, these results may encourage departments to incorporate mobility and flexibility training for LEO cadets as a tool to identify potentially compromised exposure points with greater risk of injury.

HGS is considered a reliable indicator of overall strength and health[27] and is positively correlated with LEO occupational performance.[28] Neither of the groups displayed notable improvements in HGS. This may be due, in part, to the lack of equipment available to train this aspect of strength. Training academies are encouraged to incorporate training methods that utilize HGS as a secondary target (e.g., kettlebell carries or battle rope exercises) as these exercises may assist in the maintenance or improvement of HGS.

Muscular endurance improved in both groups after the 12 weeks of training. It was anticipated that the control group would have increased their number of push-ups due to the traditional military-style exercise program that primarily utilized running and push-ups. The intervention group also incorporated push-ups as a circuit station. The volume was considerably lower among the intervention group, yet notable improvements were still observed. Both groups improved their plank hold test times following academy completion. Planks are an indicator of core stability endurance and low core strength is associated with low back pain.[29] Improving core strength can help to mitigate low back pain in this population.[34]

LEOs may be required to produce explosive vertical movements during pursuits (e.g., clearing obstacles and bounding upstairs). The intervention group displayed improvement in jump height following the 12-week program, which was not matched by the control group. This is in line with previous research on targeted training programs for LB power.[30] This supports specific programming for occupation tasks, such as power in the cadet training program, as traditional programming does not typically address this aspect of fitness. Working with a strength and conditioning specialist to progress power movements throughout the academy was beneficial, increasing muscular power and mitigating injuries. Although not a focused outcome, intervention instructors noted a lower injury rate; however, future research is needed to explore this impact.

The intervention group showed improvements in agility time, whereas the control group did not. This led to an initial erasing of the difference between the groups, highlighting the importance of training agility in law enforcement cadets. These findings were comparable to those of previous research on a 6-week intervention, with an improvement of approximately 5%.[30] Attention to this training outcome is valuable as LEOs may engage in pursuits and physical alterations that require forward, backward and lateral movement. Performing agility drills incorrectly can contribute to increasing injuries, therefore consultation, supervision, and progression as determined by a strength and conditioning specialist is imperative.[5]

Regarding the shuttle run, the intervention group improved by 4.4%, and the control group improved by 3.3%. It is important to note that the intervention group displayed worse (i.e., slower) shuttle run times than the control group at baseline. Post-testing yielded no differences between the groups. This reflects the greater improvement in the intervention group, which ultimately led to the removal of significance in group differences. Both training methods resulted in improvements from baseline; however, the inclusion of interval running may have contributed to greater improvements in the intervention group. Traditional LEO cadet training programs often use non-occupationally specific long-distance running as the main training modality, which often results in increased running injuries (e.g., shin splits and ankle sprains) among the predominantly previously non-physically trained cadets. In contrast, shorter distances at a greater intensity may more closely mimic occupational demands during pursuit runs.[31]

The intervention group started with worse FMS scores, T-drill times, and shuttle times than the control group. Differences were not observed between the groups after the intervention. Only the intervention group displayed higher post-intervention FMS scores, although the difference was not mathematically significant. The control group exhibited improvement in the 300-yard shuttle test; however, there was no difference between the groups' post-test results. Therefore, these data may suggest that the intervention group improved fitness variables that are more desirable for optimal occupational performance.[21]

Limitations

This study has some limitations that need to be acknowledged. First, it is important to acknowledge that the fitness assessment results may be impacted by individual cadet readiness (i.e., physical and mental preparedness). Physically, a cadet may have been dehydrated, sore, unsure of instructions, intolerant of ambient temperature, not rested, or have a varied physical training age from their peers. Separately, a cadet may have not been mentally prepared, and as a result, altered their typical level of effort during training sessions or assessments.

Additionally, some observed improvements in the force production capabilities of cadets were likely derived from the neural training effect. The term *neural training effect* refers to neuromuscular adaptations that occur during the earliest phase of strength training: learning the correct muscle activation pattern for voluntary contractions. This aspect of primary training is specific to each voluntary task (e.g., the magnitude of change in T-drill time vs. 1.5-mile run time). The extent of the physical training of law enforcement cadets is often unclear. Therefore, practitioners should consider the impact of neural training effects when interpreting baseline and initial post-testing data. Lastly, environmental and psychosocial factors may have influenced the study, such as the training officer's coaching style, experience, verbal encouragement, social desirability, and exercise leadership.

CONCLUSION

Overall, evidence-based strength and conditioning can be effectively applied to cadet academies and implemented by LEO instructors, as soon by these encouraging results. Traditional cadet training exercise programs that mainly focus on cardiovascular fitness should be replaced with physical conditioning programs that address all components of fitness in consultation with a strength and conditioning specialist. This shift in training focus would provide support to a variety of challenges that LEOs face in the line of duty. Departments and practitioners are encouraged to quantify health and fitness variables among their tactical operators. Access to these data retrospectively will provide invaluable insight into health status, respective progression or regression, and the effectiveness of department exercise initiatives.

ACKNOWLEDGEMENTS

The authors would like to express their appreciation to the instructors and cadets of the Georgia Public Safety Training Center for their assistance with and participation in this study.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Melton BF, Nagel T, Lanham S, Anglin D, Ryan G. An evidence-based approach to physical conditioning in American cadet law enforcement academies. Int J Community Med Public Health 2024;11:614-24.