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Original Research

The Impact of Formal Strength and Conditioning on the Fitness of Law Enforcement Recruits: A Retrospective Cohort Study

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ABSTRACT

International Journal of Exercise Science 13(4): 1615-1629, 2020. Research involving law enforcement populations has suggested better fitness could enhance job task performance and reduce injuries. Academy training should lead to improvements in recruit fitness. The aim of this study was to investigate the impact of a strength and conditioning program on fitness among law enforcement recruits. Twenty-six recruits (23 males, three females) completed a 27-week academy, which incorporated 3-4 physical training sessions per week. Fitness assessment occurred during pre- (week 0), mid- (week 14), and post-testing (week 27) time points. The fitness assessments included: vertical jump, one-minute push-ups, one-minute sit-ups, posterior chain strength measured by a leg/back dynamometer, grip strength, and aerobic fitness measured by the 20-m multistage shuttle run (MSR). A repeated measures ANOVA with Bonferroni post hoc tests determined any significant changes in fitness between time points, with alpha set at $p < .05$. Due to the small sample size of females, statistical analysis was only conducted on male recruits. Overall, significant main effects ($p < .001$) were observed in all fitness assessments except for grip strength. The results detailed general improvements in fitness. However, push-up and MSR scores decreased from mid- to post-test, while sit-ups did not change. Posterior chain strength and the vertical jump improved from mid- to post-test. The data indicated that the strength and conditioning program positively influenced the fitness of recruits. An increased focus on skill-specific work in the second-half of academy may have contributed to the plateaus in muscular endurance and aerobic fitness, and improvement of lower-body strength and power.

KEY WORDS: Cadet, physical training, tactical

INTRODUCTION

Law enforcement officers need to possess an adequate level of muscular and aerobic fitness to perform essential job functions (10). Although officers may be sedentary for long periods of time, they also may be required to perform bursts of maximal exertion to keep themselves, their colleagues, and the public safe (53). Previous research findings suggest that low fitness scores may be linked to an increased risk of musculoskeletal injuries in law enforcement populations (13, 23, 45, 51). As such, given that these infrequent maximal exertion tasks are often critical, sometimes lifesaving aspects of the job, and that lower levels of fitness are associated with an increased risk of injury, the need to develop and sustain optimal fitness for law enforcement personnel is paramount (9, 30). Law enforcement fitness development can begin during the academy training period.

Academy training is used by law enforcement agencies to physically and mentally prepare recruits for their job demands (9, 23, 28, 30, 47). During this period, law enforcement recruits will learn the necessary skills, procedures, and legal requirements for their occupation, and the expected patterns of behavior, values, and ethics (5, 36). An important component of academy training for recruits is the development of physical fitness. Physical training is common practice for most law enforcement academies, as it is used to develop the underlying physical characteristics needed for the job (28). This development is important, as superior fitness has been related to enhanced law enforcement-specific job task performance (4, 11, 28). For example, Lockie et al. (28) found that the 99OC related to performance in general fitness tests such as sit-ups, pull-ups, and the 201-m and 2.4-km runs related to running, obstacle, and fence clearance tasks (r = ±0.127-0.315). Beck et al. (4) detailed that change-of-direction speed measured by a figure-8 tests (r = 0.57) and relative aerobic capacity (r = -0.65) correlated with occupational physical ability test performance in university campus law enforcement officers. The occupational physical ability incorporated running, stair ascent and descent, barrier clearance, and a body drag (4). Dawes et al. (11) detailed that officers who performed better in an occupational ability test, including tasks such as running, obstacle clearance, crawling, pushing and dragging, tended to have a greater vertical jump, and complete more sit-ups in one minute and more shuttles in the 20-m multistage shuttle run (MSR). Accordingly, recruits that can improve their fitness during the academy could also become more effective at the physical tasks they will perform while on duty.

Research completed across various law enforcement recruit populations has shown favorable results linking periodized training programs to improved muscular strength, muscular endurance, anaerobic power, and cardiovascular fitness (9, 10, 22) . However, Crawley et al. (10) discovered that the largest fitness gains occurred in the first half of the training program and then began to slow in the second half. Crawley et al. (10) hypothesized that the rapid initial gains in the first 6-8 weeks of exercise training were due to increased neuromuscular efficiency. After these initial weeks of training, fitness gains resulting from neuromuscular adaptations

decelerate and the primary contributor of increases in fitness switch from neuromuscular efficiency to muscular adaptations involving muscle structure and function (10).

There may be other reasons that contribute to plateaus in fitness improvements for recruits over the entirety of academy training. As stated, law enforcement academies have many foci during training (5, 36). Lockie et al. (30) discussed that depending on their structure, certain academies may not meet the recommended standards for number of training sessions per week to improve muscular strength or aerobic fitness. This may occur as academy staff need to ensure recruits obtain all the other skills and knowledge needed for the job, which could take time away from physical training (18). Another issue is the toll that physical training could take on recruits during academy. This has been referred to as Program Induced Cumulative Overload (PICO). This is where the cumulative workload placed on recruits from both physical training and day-to-day tasks leads to decreased performance, fatigue, and an increase in injury rate and/or illness (44). It has been speculated that recruits are more susceptible to PICO compared to incumbent personnel due to the increased training load in attempt to meet a standard fitness level (44). Accordingly, it is important to detail how fitness changes over the course of a typical law enforcement training academy. If general fitness measures tend to plateau following initial improvements, this could provide information for training staff to make appropriate modifications to their program.

The aim of this study was to investigate the impact of a formal strength and conditioning program during a 27-week academy on the fitness of law enforcement recruits. A further component of this study was to examine if fitness improved from initial to mid-testing, and again from mid- to post-testing. This study is important, as many law enforcement training academies do not have a physical training program that follows the structure of the program presented in this study. Administrative organizations for law enforcement academies often provide general recommendations for physical training, to allow for greater flexibility in training implementation (48). This is because of the many aspects of law enforcement training (e.g. legal and organizational procedures, defensive tactics, skill-based training) that must be covered during academy (9, 23, 28, 30, 47), and academy timetables can often be fluid. Changes in training foci, such as a greater emphasis on skill-based training during certain times of academy (18), could also affect the fitness of recruits. As recruits will commence work once they graduate, it is important to ascertain a structured strength and conditioning program can improve fitness throughout the academy. Further to this, fitness standards and training protocols need to be developed and contextualized to each agencies' specific population and needs (41). Accordingly, a retrospective cohort study design was employed using data collected by a USA-based law enforcement agency as part of their normal procedures and was not originally collected for research purposes. The recruits from which the data were collected followed a routine fitness program provided as part of their physical training with fitness assessments conducted at three time points; pre- (week 0), mid- (week 14), and post-testing (week 27) time points. It was hypothesized that greater fitness changes would be demonstrated

in recruits for the first half of the 27-week program; however, fitness changes would plateau in the second half of the program.

METHODS

Participants

As stated, a retrospective analysis of recruits from one academy class from one agency was conducted. Data from 26 recruits (age = 28.00 ± 6.46 years; height = 176.05 ± 6.37 cm; body mass = 79.76 ± 9.19 kg) were provided to the researchers and analyzed in this study. This included 23 males (age = 28.43 ± 6.65 years; height = 177.25 ± 5.63 cm; body mass = 80.80 ± 8.32 kg) and 3 females (age = 24.67 ± 4.04 years; height = 166.83 ± 3.89 cm; body mass = 71.82 ± 13.67 kg). Based on the archival nature of this analysis, ethics approval was obtained by the University of Colorado: Colorado Springs International Review Board (IRB Protocol 15-074), and by the Bond University Human Research Ethics Committee (BUHREC protocol RO1927) for the use of pre-existing data. The data were released for data analysis via gatekeeper approvals from the associated law enforcement agency. This research was conducted in accordance to the ethical standards of the International Journal of Exercise Science (42), and the recommendations of the Declaration of Helsinki (55).

Protocol

The training academy was located in the Rocky Mountain region of the USA. All fitness testing was conducted indoors first thing in the morning when recruits reported to academy at 0615 (6:15am). Fitness testing occurred at initial (week 0), mid (week 14), and final (week 27) points during the 27-week fitness training program. The fitness assessments were conducted by law enforcement officers who were also Tactical Strength and Conditioning Facilitators. These tests were part of the law enforcement organizations normal testing procedures, and included: vertical jump, one-minute push-up and sit-up test, isometric posterior chain strength, isometric grip strength, and a 20-m multistage shuttle run (MSR) test. Prior to each test the recruits completed a dynamic warm-up, which included general and specific movements relative to testing (or the training sessions). This warm-up consisted of ankle grabs, knee grabs, Frankenstein walks, butt kicks, lunges, skipping, side shuffles, falling starts, push-up sprints, planks, thrusters, push-ups, Romanian deadlifts, and side straddle hops. The same warm-up was used before each exercise routine as per training program which will be described.

Vertical Jump: Vertical jump height provides an indirect measure of power (26, 35), and has been used previously in law enforcement populations (11, 13, 14, 29, 31, 39, 43). Jump height was measured using a 69-cm x 69-cm Just Jump electrical contact operated mat (ProBotics Inc, Huntsville, AL). The software for the mat calculated jump height by measuring the time that the recruit's feet were not in contact with the mat (i.e. flight time). The instructions given to the recruits were to step on the mat and to perform a countermovement arm swing and jump as high as possible. Each recruit had three attempts and the best of the three attempts was recorded to the nearest 0.5 inch (1.27 cm) before being converted to metric units.

Push-up Test: The one-minute push-up test has commonly been used to measure muscular endurance of the upper-body in law enforcement populations (6, 8, 29, 30, 43). To begin this test, recruits would start in the up position with only their hands and feet contacting the floor. The hands were positioned slightly wider than shoulder-width apart with fingers pointing forward. One repetition was defined as the recruit's ability to bend at the elbows to lower themselves to a partner's fist placed directly below the recruit's chest. The recruits were to complete as many repetitions as possible in one minute as measured by a stop watch following a "go" command. Recruits were permitted to rest in the upright starting position if required and the test was terminated with failure of technique or after the one-minute time period had passed.

Sit-up Test: The one-minute sit-up test has been used in law enforcement populations to measure abdominal muscular endurance (15, 29, 30, 43). Although there are limitations with the sit-up as an exercise (2, 3, 17), this is still a common test used for record for different law enforcement agencies (6, 8-10, 15, 29, 30, 43, 51). Thus, sit-ups were appropriate to use in this study. Recruits were instructed to begin the test starting in a supine position, with knees bent, feet flat on the ground with a partner anchoring, and arms crossed over the chest with hands to each contralateral shoulder. To perform a sit-up, the recruit flexed at the trunk, raised their shoulders from the ground until their elbows touched their knees. The test was commenced on a "go" command and timed using a stopwatch. Recruits completed their maximum number of sit-ups within the one-minute time period.

Isometric Posterior Chain Strength: To determine isometric strength of the posterior chain, a leg/back chain dynamometer (Medico Inc., Phoenix, AZ) was used. The leg/back chain dynamometer has been used to assess strength in other law enforcement populations (12, 15), and this equipment has been recommended for use in individuals with a limited training background (37). The dynamometer was calibrated within 0.05 kg prior to assessment using an industrial portable hanging scale. The recruit was positioned so their arms were extended and both hands were on the handle positioned at the mid-thigh (knee flexion angle of approximately 110°) (12, 15). Recruits were instructed to maintain good spinal posture, straight arms and feet flat on the base of the dynamometer, and then to pull the handle upward as hard as possible, attempting to extend through the hips and knees. Recruits were given one attempt which was recorded to the nearest pound. This score was then converted to kg. Time constraints within testing limited the number of attempts for the recruits, although the provision of one attempt was standard practice within this agency.

Grip Strength: Grip strength was measured by using a handgrip dynamometer (Takei Scientific Instruments, Japan), and the hand grip dynamometer has been used previously in assessing strength of law enforcement personnel (15, 20, 34, 46). The dynamometer was adjusted to fit the first metacarpal and middle four fingers of the recruit's dominant hand to be in contact with the handle. The testing arm was fully extended and held at shoulder height. Recruits were given one attempt on each hand to squeeze the dynamometer as hard as possible. The score was then recorded to the nearest kg.

20-m Multistage Shuttle Run (MSR): The 20-m MSR has been used previously in tactical populations to measure aerobic fitness (11, 15, 32, 34, 40, 47). For this study, the 20-m distance was marked by two lines on a hardwood gymnasium floor. Recruits were instructed to run back and forth between these lines cued by pre-recorded auditory cues (beeps). As the stage increased the time allocated to achieve each shuttle progressively decreased, requiring recruits to run faster with each subsequent level. The initial speed was set at 8.5 km/hr and increased by 0.5 km/hr with each progressive stage. The test was terminated when a recruit failed to reach the next line for two consecutive beeps, or until volitional fatigue. The test was scored according the final stage and shuttle achieve and was then converted into number of shuttles completed.

Fitness Training Program: As part of academy, recruits followed a strength and conditioning program for a total of 27 weeks (18). Physical training was completed first thing in the morning at 0615 (6:15am), and training sessions typically lasted for 45 minutes. Recruits were able to eat (snacks, not a full meal) prior to the physical training session. This was not structured, but left to personal preference for the recruit. The fitness training program consisted of resistance training, metabolic conditioning, and circuit/combined training. Each session consisted of a different session type targeting a specific training stimulus such as resistance training (push-ups, deadlifts, pull-ups, body-weight squats, front squat, push press, clean/front squat, bent over rows, burpee pull-ups, kettle bell swings, box jumps, and lunges), metabolic conditioning (sprints/beep test, jump rope, battle rope, wall throws with ball, sit ups, and 3-mile run) and circuit/combined training (strength + sprints, and a MMA conditioning circuit). An example of the daily training program is provided in Table 1. Loading in resistance exercises was individualized for each recruit such that they could complete the target repetitions for the exercise.

Table 1. Sample training week for recruits.

Day	Tuesday	Wednesday	Thursday	Friday
Exercise Routine	3 x Power Clean/Front Squat, 5 x Bent Over Rows, 7 x Push-ups	Burpee Pullups for Maximum Repetitions	10 x Sprints, 10 x Suicide Sprints, Beep Test	21 x 15 x 9 Wall Throws with Ball / Broad Jump Burpees / Kettlebell Swings / Front Squats

Recruits completed these exercises 4 days a week for the first 14 weeks. Defensive tactics training was then completed around this time, and physical training sessions were reduced to 3 days per week after week 14. Part of the reason why one physical training session was removed was because specific academic and technical skills training increased. All training sessions were supervised by agency staff. However, in the last two weeks of academy, staff were more 'hands off' to encourage recruits to design their own physical training programs (18). This was done as an educational tool for recruits to learn effective ways to design fitness training programs, as they would be essentially left to themselves once they graduated and started active duty.

Statistical Analysis

All statistical tests were performed using Statistics Package for Social Sciences (SPSS) Version 24.0 (IBM Corporation, New York, USA). Statistical analysis was only carried out on male recruit

datasets (n = 23) due to the low sample of female recruits (n = 3). The sexes were considered separately as numerous studies have documented sex differences in the performance of a range of fitness tests in law enforcement populations (6, 8, 15, 30-32). Further to this, the training response of females to physical training in the occupational training environment can be different to males (19, 21, 49), so it is important to consider the sexes separately. Numerous studies have also noted the need for more female-specific law enforcement data and research (6, 25, 29, 31, 43). As a result, female data was included for descriptive purposes. This is notable, as once recruits graduate and become sworn officers, they will all have the same job tasks regardless of sex (28). Normal distribution at each time point was assessed by Shapiro-Wilk's test ($p > .05$). Mauchly's Test of Sphericity was used to assess to determine if the assumption of sphericity was violated. Six one-way repeated measure analysis of variance (ANOVA) with Bonferroni post hoc assessments were used to determine if significant differences between trials for each fitness test existed. Statistical significance was defined *a priori* as $p < .05$.

RESULTS

The data for the males is shown in Figure 1A, while females are shown in Figure 1B. To reiterate, statistical analyses were only conducted on the male data, but the female data has been included for descriptive purposes. There was a significant main effect for vertical jump height ($F(2, 44) = 10.281$, $p \leq .001$, partial $\eta^2 = .318$). Post hoc analyses indicated that vertical jump height did not significantly change from pre to mid-test, but did significantly ($p < .05$) increase from the mid to post-test. Overall, vertical jump significantly increased from the pre- to post-test ($p < .05$). The data from the three female recruits appeared to mirror the results from the males.

There was a significant main effect for the number of push-ups ($F(2, 44) = 14.216$, $p < .001$, partial $\eta^2 = .393$) and sit-ups ($F(2, 44) = 41.136$, $p < .001$, partial $\eta^2 = .652$) completed in one minute. The number of push-ups and sit-ups completed significantly ($p < .001$) increased from pre- to mid-test. However, the number of push-ups significantly decreased ($p < .05$) from the mid- to post-test. Sit-up repetitions did not significantly change from mid- to post-test ($p = .278$). Overall, there was not a significant ($p = .166$) improvement from pre- to post-tests for push-ups, but there was for sit-ups ($p \leq .001$). The performance of the female recruits in the push-up and sit-up tests appeared similar to the males.

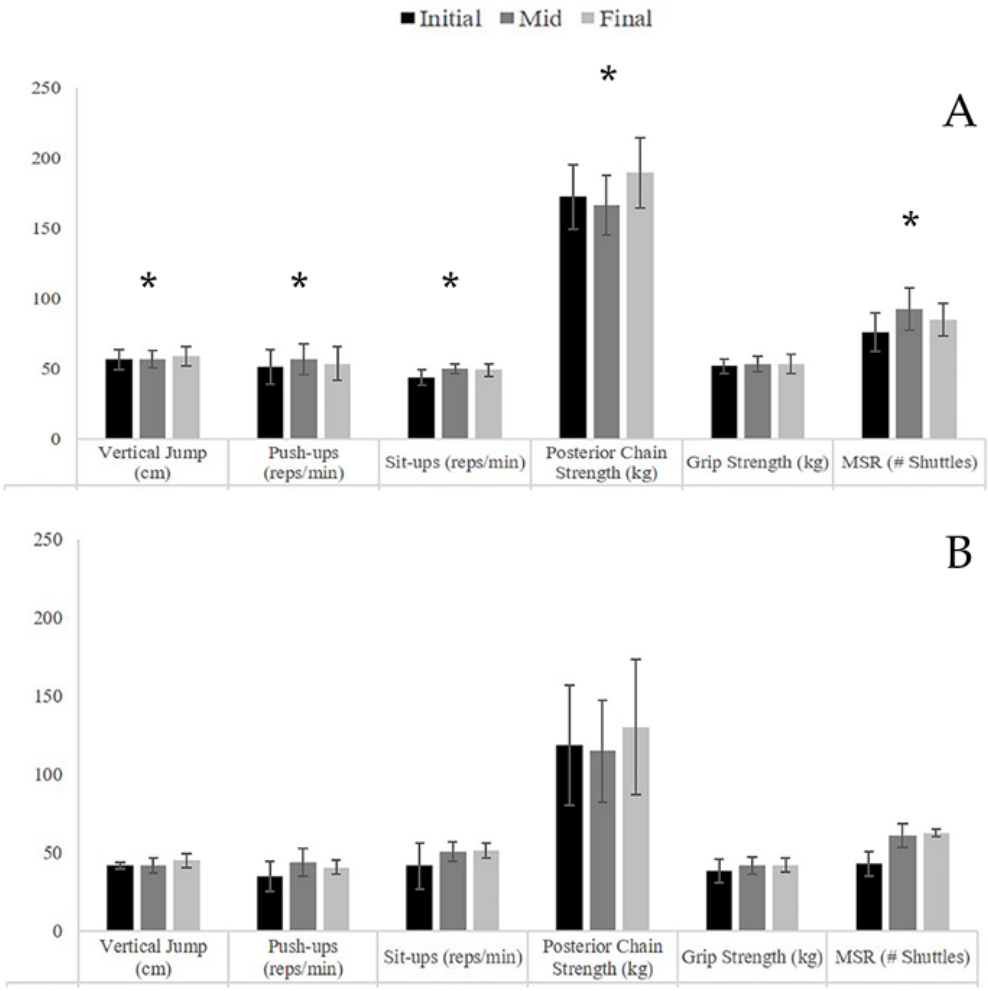

Figure 1. Male (n = 23; 1A) and female (n = 3; 1B) recruit fitness parameters from the initial (week 0), mid (week 14), and final (week 27) assessment periods in a 27-week law enforcement training academy.
* Indicates a significant ($p < .05$) main effect for the repeated measures ANOVA.

Mauchly's test of sphericity indicated that the assumption of sphericity had been violated ($\chi^2(2) = 8.008$, $p = .018$) for posterior chain strength. Epsilon (ε) was calculated per Huynh-Feldt, and was used to correct the one-way repeated ANOVA. Following this adjustment, there was a significant main effect for posterior chain strength ($F(1.608, 35.368) = 19.688$, $p \leq .001$, partial $\eta^2 = .472$). A significant ($p < .001$) increase in posterior chain strength from the mid- to post-test was observed. Overall, there was a significant ($p < .05$) increase from the pre- to post-test for posterior chain strength. There was not a significant main effect for grip strength for the male recruits ($F(2, 44) = 2.143$, $p = .129$, partial $\eta^2 = .089$). This trends for the isometric strength tests was also seen in the female recruits.

There was a significant main effect for the number of shuttles run during the MSR ($F(2, 44) = 35.293$, $p \leq .001$, partial $\eta^2 = .616$). The number of MSR shuttles completed significantly ($p < .001$) increased from the initial to mid assessment, but significantly decreased ($p < .001$) from the mid to the final assessment. However, there was still a significant improvement ($p < 0.001$) in scores

between the initial and final assessment. When descriptively analyzing the female MSR scores, it can be seen that the number of shuttles ran improved for each subsequent assessment.

DISCUSSION

The aim of this study was to investigate the impact of a strength and conditioning program on the fitness (muscular power, endurance, and strength, aerobic capacity) of law enforcement recruits attending a 27-week training academy. It was further investigated whether there were improvements in fitness from pre- (week 0) to mid-testing (week 14), and mid- to post-testing (week 27). This determined whether recruits could continually improve fitness over a 27-week academy considering the stress associated with law enforcement training (5, 27), and the shifting of training emphases (i.e. greater time allocated to skill training) (18). This study is essential for demonstrating the potential value of structured strength and conditioning for law enforcement recruits. The results indicated that the strength and conditioning program improved most of the fitness parameters measured in this study. However, for some of the fitness measurements (push-ups, sit-ups, MST), there was a significant improvement from pre- to post-test, but not from mid- to post-test. For others (vertical jump and posterior chain strength), there were improvements from mid- to post-test. The data presented in this study have practical applications for training staff, and how they could program within the context of the many training demands for law enforcement recruits.

The results from this study indicated that vertical jump height did not change from pre- to mid-test for either males (pre- and mid-test = ~57 cm) or females (pre- and mid-test = ~42 cm). However, there was a net increase in vertical jump height from pre- to post-test for male (jump height = ~59 cm) and female (jump height = ~45 cm) recruits. The training program involved both strength and power exercises (18). Previous research has shown that resistance training can improve lower-body power in athletic populations (52), so improvements in the magnitude and rate of force development during a jump could have contributed to the adaptations seen in this study. However, improvements in coordination can also positively influence vertical jump height. There can be a lag time between changes in strength and performance measures such as a jump, as the individual needs to learn how to use any changes in strength (1, 54). This concept is notable when considering the results for posterior chain strength.

For both the male (pre-test = ~172 kg; mid-test = ~166 kg) and female (pre-test = ~119 kg; mid-test = ~115 kg) recruits, posterior chain strength as measured by a leg/back dynamometer actually got worse from pre- to mid-test. However, there was a significant net increase in posterior chain strength for male recruits from pre- to post-test (pre-test = ~172 kg; post-test = ~189 kg), which was also the case for the females (pre-test = ~119 kg; mid-test = ~130 kg). Previous research has shown that recruits can improve their maximal strength in training academies of various duration (9, 10, 22). The program from this study featured some form of resistance training 2-3 times per week throughout the 27 weeks (18), which meant there was a consistent application of strength training. The strength adaptations shown for the recruits in this study could also have been influenced by the lag time that can feature with neuromuscular developments (1, 54). Nonetheless, it is important for law enforcement recruits to graduate from

academy with enhanced strength and power. Better performance in a one-repetition maximum hexagonal bar deadlift has been related to a faster 75-kg body drag in male and female civilians (24) A greater vertical jump has been related faster obstacle course performance (11), a 75-kg body drag (39), performance in the 75-yard pursuit run (a foot pursuit simulation) (50), and likelihood of academy graduation (13). A recruit with greater lower-body strength and power as measured by posterior chain strength and the vertical jump, respectively, could potentially perform better at their job tasks. The formal strength and conditioning used in this study appeared to be effective at achieving this for the recruits in this study. Therefore, providing 3-4 sessions of appropriately periodized strength and conditioning each week for the duration of an academy can enhance the lower-body strength and power of law enforcement recruits.

It should be noted, however, that the other measure of isometric strength in this study did not appear to significantly change for the recruits. Grip strength did not significantly improve for the male recruits during academy (pre-test = ~52 kg; mid-test = ~54 kg; post-test =~54 kg). There was as an ~4 kg change in grip strength from pre- to mid-test for the female recruits, but no change from mid- to post-test (pre-test = ~38 kg; mid-test = ~42 kg; post-test =~42 kg). It could be expected that grip strength would improve with the consistent resistance training applied in this study (18), given that every time a recruit grips a bar or dumbbell they should be developing this quality. However, the recruits in this study did have a grip strength that compared favorably to recruits from other research. When splitting recruits into groups according to waist circumference and adjusting the means according to sex, Lockie et al. (34) found a range of approximately 37-42 kg for right- and left-hand grip strength. The male recruits were stronger than those from Lockie et al. (34), while the female recruits were very similar. It is plausible that the recruits in this study already had above-average grip strength prior to academy, so their ceiling for improvement may have been lower. Nonetheless, given that greater grip strength has been linked to reduced injury risk and marksmanship in law enforcement recruits (46), academy staff should ensure this strength quality is adequately developed in their recruits. Training staff may need to consider how they could directly target grip strength.

For both the push-up test (pre-test = ~52 repetitions; mid-test = ~57 repetitions; post-test = ~54 repetitions) and MSR (pre-test = ~76 shuttles; mid-test = ~93 shuttles; post-test = ~85 shuttles), male recruits significantly improved from pre- to mid-test, but then significantly decreased from mid- to post-test. The three females in this study produced similar results, except with smaller changes from mid- to post-test (push-ups: pre-test = ~35 repetitions; mid-test = ~44 repetitions; post-test = ~41 repetitions; MSR: pre-test = ~43 shuttles; mid-test = ~61 shuttles; post-test = ~63 shuttles). For the sit-up test, performance improved for the male (pre-test = ~44 repetitions; mid-test = ~50 repetitions; post-test = ~49 repetitions) and female (pre-test = ~42 repetitions; mid-test = ~51 repetitions; post-test = ~52 repetitions) recruits from pre- to mid-test, but then did not change from mid- to post-test. Traditionally, muscular endurance and aerobic fitness are a focus in law enforcement training (7, 18, 38, 47). Given the stress associated with muscular endurance and aerobic exercise, these tests could be affected by the cumulative effects of fatigue due to the demands associated with learning policing skills and physical training (9). Left unregulated, the body may not be able to adapt or maintain the continued training load potentially leading to PICO (44). However, the staff from the agency in this study did take this into account, reducing

the number of physical training sessions from 4 to 3 per week in response to changes in training foci. Further to this, the net improvements in lower-body strength (posterior chain strength) and power (vertical jump) may indicate that the recruits were not experiencing PICO to the extent that is affected their ability to produce maximal force. These results may also be indicative of the greater focus on job skills that had a greater emphasis on anaerobic fitness (16). When combined with the physical training program, the recruits were better able to enhance their lower-body strength and power above that of muscular endurance and aerobic fitness. Nevertheless, given that numerous studies have linked muscular endurance and aerobic fitness to job task performance (4, 11, 28) and academy graduation (13, 23, 45, 51), training staff should ensure recruits experience a net improvement during academy. This could involve monitoring the workload of recruits so they do not encounter PICO, or prescribing exercises that could allow for maintenance of muscular endurance and aerobic fitness.

Although improved fitness has been linked to reduced injury risk (13, 23, 45, 51) and enhanced job task performance (4, 11, 28), it is important to consider that the main purpose of physical training during academy. Physical training is predominantly used to help recruits achieve an adequate amount of fitness to support the physical demands of policing. Thus, while improving fitness is a key concern, once recruits are adequately fit the training focus of the academy is generally on improving job skills, as opposed to maximizing fitness test scores. This has been shown by Cocke et al. (9), who noted that training typically becomes more occupationally relevant later in the program. The shift towards more law enforcement-specific tasks over the second period of the training at the academy was also a part of this study, and led to the reduction of one physical training session per week after week 14 (18). In addition to this, the training staff also allowed recruits to develop some of their own programs in the final weeks of academy, in an effort to educate the recruits as to program design and training approaches. While this may not have provided the most optimal conditions for fitness development, what was of greater importance was the education of recruits. This is important, as several studies have indicated that the fitness of officers tends to decline once they enter the workforce (33, 43). Nonetheless, the results of this research what can be seen is that the strength and conditioning program did positively influence the fitness of law enforcement recruits.

There are study limitations that should be detailed. The other aspects of academy training were not catalogued (e.g. defensive tactics, skill-based training), and each would impose their own stress on recruits. Furthermore, it is plausible skills training could influence fitness as it involves physical activity (28). Learning effects could have also contributed to the improved performance of the fitness tests, such as recruits having greater familiarity with the leg/back chain dynamometer. Nonetheless, if recruits have learnt how to exert force more effectively, then this should still benefit their job task performance (12). This study only used the sample of male law enforcement recruits for the primary statistical analysis, and descriptively analyzed the three females. More analysis is required in female law enforcement populations, especially regarding their responses to training. This is especially important as many agencies want to hire and retain more females (30). This study only analyzed one class of recruits. It is important to analyze how different classes respond to strength and conditioning programs within academy training, considering that recruits across different classes can vary in their physical fitness (30). Lastly,

fitness characteristics of recruits can vary across different agencies (41). As a result, changes in fitness as a result of academy training should also be analyzed specific to different agencies.

In conclusion, this study highlighted the benefits to recruits receiving appropriately periodized strength and conditioning training at a law enforcement academy agency. All the fitness parameters, except for grip strength, improved from pre- to post-testing. Lower-body strength (posterior chain strength) and power (vertical jump) improved from mid- to post-testing. Although there was a net increase, muscular endurance (push-ups, sit-ups) and aerobic fitness (MSR) improve from pre- to mid-testing, but then did not improve or slightly declined at post-testing. These results may have occurred to a greater emphasis on skills training during academy, in addition to changes in the physical training program (a reduction of one session per week over the second half of academy, inclusion of educational aspects of physical training). Law enforcement training staff should attempt to utilize properly structured strength and conditioning programs during academy to enhance the fitness of their recruits.

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