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Original Research

The Effects of Traditional versus Ability-Based Physical Training on the Health and Fitness of Custody Assistant Recruits

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ABSTRACT

International Journal of Exercise Science 15(3): 1641-1660, 2022. This study investigated traditional training (TT) versus ability-based training (ABT) in custody assistant recruits. Retrospective analysis was conducted on two recruit classes who completed an 8-week academy. The TT group (18 males, 13 females) followed a physical training model where recruits completed the same exercises with the same intensity; the ABT group (17 males, 12 females) had exercises tailored towards their ability. Pre- and post-academy, recruits were assessed in: body mass; body fat percentage (BF%); resting heart rate (RHR); blood pressure (BP); waist circumference (WC); waist-to-hip ratio (WHR); grip strength; push-ups; sit-ups; YMCA step test recovery HR; 201-m run; and 2.4-km run. Independent samples t-tests evaluated between-class pre-test differences, with significance set at $p \leq 0.05$. Paired samples t-tests ($p \leq 0.05$) detected within-group training changes. Change scores were calculated for each variable; independent samples t-tests ($p \leq 0.05$) compared change scores between groups. The TT group had lower BF%, BP, and WC; and were superior in sit-ups and the 2.4-km run before training. After academy, the TT recruits improved WHR, grip strength, recovery HR, 201-m run, and 2.4-km run, but increased diastolic BP. The ABT recruits decreased BF%, RHR, and WC, and improved push-ups, sit-ups, recovery HR, 201-m run, and the 2.4-km run. ABT recruits had greater positive changes in BF%, RHR, diastolic BP, and sit-ups. TT and ABT recruits generally experienced favorable fitness changes; the degree of positive change tended to be greater for ABT recruits for select tests. Coupled with the diastolic BP increase for TT recruits, this may provide evidence for ABT.

KEY WORDS: Academy training, aerobic fitness, blood pressure, body composition, civilian jailer, correctional, law enforcement, muscular endurance, tactical, YMCA step test

INTRODUCTION

A civilian jailer, detention officer, or custody assistant (CA) is an important law enforcement job position (39, 40, 46, 52). CAs work within custody detention, jails, or lockup facilities, and their primary job tasks are associated with assisting law enforcement officers in these locations (39, 40, 46, 52). Their job tasks include office work, inmate supervision, searching of cells, responding to alarms, and physical confrontations with inmates (20, 21). Tasks such as office work and inmate supervision are relatively low-intensity and almost sedentary. However, any physical altercation with an inmate could be very strenuous for the CA. As an example, Lockie et al. (25) analyzed a defensive tactics training scenario involving CA recruits that simulated a physical altercation with an inmate (the role of the inmate was played by a training staff member). Recruits achieved a mean heart rate (HR) in excess of 90% of their age-predicted maximum, providing evidence of the potential high-intensity demands of working in correctional facilities. Accordingly, it is essential that the CA has the physical capacity to complete tasks such as these in order to ensure their safety, and the safety of their colleagues and other inmates.

Previous research in law enforcement personnel has indicated that physical fitness can influence job task performance (10, 31, 44, 45, 60). To provide specific examples that could have application to CA recruits, Lockie et al. (44) found that greater grip strength significantly correlated (r = -0.599) with a faster 74.84-kg body drag over 9.75 m in law enforcement recruits. Lockie et al. (45) also analyzed a body drag with the same conditions and found that the 75-yard pursuit run (a measure of anaerobic capacity) related to a faster drag in recruits (r = 0.11). Greater muscular endurance (measured by push-ups and sit-ups completed in 60 s) and aerobic fitness (measured by 2.4-km run time) also related to performance in obstacle courses, fence climbs, and foot pursuit simulations (31, 45). Although the job tasks of patrol officers and CAs are different, these studies indicate the potential benefits of fitness relative to demanding job tasks. Accordingly, agencies often include physical training as part of a CA training academy.

A training academy training is generally used by law enforcement agencies to physically and mentally prepare recruits for the occupation (7, 27, 31, 36, 42, 59). During academy, recruits learn the skills and procedures needed for their job, and their expected behaviors, values, and ethics (1, 42, 49). Structured physical training is typically an important component of the academy, as it is used to develop the underlying physical characteristics needed for important job tasks (31, 42). However, many academies use a paramilitary, 'one-size-fits-all' physical training model (5, 26, 27, 51, 59). This traditional training (TT) approach has the belief that all recruits should complete the same exercises with the same intensity. TT is often implemented as the expectation for law enforcement personnel is that once they are working, they all have the same job tasks regardless of the underlying fitness, sex, age, or ability of the individual. There is also the socialization aspect of physical training which can be encouraged with TT (1), and this may override what may be considered best practice for improving fitness (26).

Nevertheless, the TT approach may not be optimal for encouraging fitness and performance improvements or injury prevention for all recruits (59). The TT approach could also be a

contributing factor as to why some recruits may voluntarily separate from academy, especially if they are unable to either tolerate or recover from the imposed exercise stress (27). It should be acknowledged that the training academies for patrol officer and CA recruits are different, notwithstanding the different job tasks that are taught (i.e., patrol vs. custody). A patrol officer recruit may complete an academy that lasts 27 weeks (42). A CA recruit may only need to complete an 8-week training academy (52), which could reduce the chance of voluntary separation, overtraining, or injury, regardless of the physical training approach. Nonetheless, it could be expected that an ability-based training (ABT) approach would be more appropriate for a CA recruit training academy (5, 26, 36, 51, 52, 59).

ABT is a model whereby exercises are tailored towards the fitness and abilities of the individual, relative to their strengths, limitations, and physiological responses to exercise (26). While this seems like it should be common practice, as noted this is not often the approach during a law enforcement training academy (26). ABT could be even more pertinent for CA recruits; Lockie et al. (40) demonstrated that there is a wide range of fitness capabilities in this population. A contributing factor to this is that candidates for custody positions may not need to complete fitness testing during the hiring process, which could mean a wider selection pool for agencies (35). Indeed, there are a higher number of females in CA recruit classes (~36%) (40), compared to patrol officer classes (~16%) (36). Given the numerous law enforcement studies that have shown female personnel tend to have lesser fitness than males (2, 6, 12, 28, 32-34, 36, 38, 41, 43, 46), this could mean that CA recruit classes may have more individuals with lesser fitness than your typical law enforcement officer recruit classes. As further evidence of fitness diversity, Moreno et al. (52) detailed the effect aerobic fitness had on CA recruit HR responses during circuit training. Recruits with lower aerobic fitness, as measured by the YMCA step test, tended to spend less time in lighter training zones and more time in vigorous training zones (52). This meant that recruits with lesser aerobic fitness found the circuit training sessions harder than recruits with better aerobic fitness. This would seem to suggest that ABT should be the standard approach within a CA training academy. However, there has been no analysis of this in the literature.

The purpose of this study was to analyze whether an ABT program could lead to greater gains in health and fitness compared to a TT approach. Health (body composition, resting HR [RHR], blood pressure [BP]) and fitness (flexibility, muscular strength and endurance, anaerobic and aerobic capacity) was measured by tests common to custody personnel (39, 40, 46, 52, 62). Similar to previous law enforcement research (7, 59), the study involved retrospective analysis of two recruit classes who completed different physical training programs administered by the agency staff. Both programs utilized circuit training and aerobic conditioning; however, the ABT program featured exercise modifications targeted towards the abilities of individual recruits. It was hypothesized that the CA recruits who completed the ABT program would have superior changes in health and fitness relative to the TT program recruits.

METHODS

Participants

Retrospective analysis of CA recruit data from two academy classes belonging to one law enforcement agency was conducted, which comprised 60 recruits. The class that completed TT group had 18 males (age: 27.89 ± 8.02 years; body mass = 79.06 ± 11.49 kg) and 13 females (age: 28.07 ± 8.14 years; body mass: 65.04 ± 10.40 kg); the ABT class had 17 males (age: 29.00 ± 10.18 years; body mass = 84.44 ± 11.77 kg) and 12 females (age: 29.42 ± 7.74 years; body mass = 64.09 ± 7.67 kg). The size of the recruit classes was typical for the law enforcement agency featured in this study (40). Height data were not provided in the data sets, but this is not uncommon in previous first responder research (4, 58, 59). Recruits were included in the sample if there were available data sets. Exclusion criterion were data sets with clearly incorrect data entry. This was a convenience sample of de-identified data provided by the agency, and the researchers had no control of the final sample size used in this investigation. As secondary data was utilized in this study, G*Power software (v3.1.9.2, Universität Kiel, Germany) was used to confirm post hoc that the sample size of 60 (with groups of 31 and 29 participants) was sufficient for an independent t-test analysis such that data could be interpreted with a small effect level of 0.6 (19), and a power level of 0.74 when significance was set at 0.05 (14). Based on the archival nature of this analysis, the institutional ethics committee approved the use of pre-existing data (HSR-17-18-370). Even though this study utilized existing data, the research was still conducted in agreement with the ethical standards of the International Journal of Exercise Science (55). The study also followed the recommendations of the Declaration of Helsinki (69).

Protocol

The two cohorts completed their academy within a calendar year in southern California. Pre-testing for all tests, except the 201-m (220-yard) and 2.4-km (1.5-mile) run, was conducted indoors on a basketball court at the agencies' training facility in the week prior to the training academy. Testing occurred between 9:00am-2:00pm depending on recruit availability. The 201-m and 2.4-km runs were conducted in the first week of the training academy on an outdoor dirt athletics track between 5:00am-7:00am as part of a physical training session. Due to timetable and location limitations, post-testing was conducted outdoors on an open concrete area in the last week of the 8-week training academy between 5:00am-7:00am, except for the two runs completed on the same track. Testing had to occur in the final week because as soon as the recruits graduated, they were assigned to their respective correctional facility. Recruits wore their physical training attire (cotton t-shirt, shorts, and athletic shoes) during both testing occasions. The data were collected by staff working for the law enforcement agency and were all trained by a certified Tactical Strength and Conditioning Facilitator. RHR and BP were recorded first, followed by age, height, body mass, and fat mass percentage (FM%). The recruits then completed a testing circuit that included waist and hip measurements, sit-and-reach, and grip strength. The recruits completed push-ups and sit-ups as a group, before concluding with the YMCA step test. The methods for each test are presented in the chronological order they were completed within the session.

RHR and BP were recorded after the recruits were seated quietly for approximately 5-10 minutes. Electronic BP monitors (Omron Healthcare, Kyoto, Japan) were used by staff due to ease of use, consistency, and need for time management (62). Recruits were seated with their feet flat on the floor and their left arm in a relaxed but supported position at heart level. Clothing was repositioned so that the cuff could be placed on bare skin without any compression above the cuff. The cuff position was above the crease of the elbow and encircled approximately 75-100% of the arm (53). The training staff member then followed the directions on the device. RHR (measured in beats per minute; bpm), systolic BP, and diastolic BP were recorded. BP was measured in millimeters of mercury (mmHg).

Recruits self-reported their age to staff. Height was measured using a portable stadiometer (Seca 217, Hamburg, Germany). Although height was required to calculate FM%, it was not included in the data set provided to the researchers. Body mass and FM% was recorded by electronic digital scales, which included bioelectrical impedance analysis (BIA) (Model HBF-510, Omron Healthcare, Kyoto, Japan). This BIA protocol has been used in previous law enforcement research to measure FM%, and the same protocols were adopted (29). The recruit's age, height in cm, and sex were entered into the device, and the recruit wore no shoes or socks. Recruits stepped onto the scale with their feet positioned on the foot and heel electrodes, and they held the display unit with both hands positioned on the electrodes on the handles until their body mass was displayed on the screen. The unit was a tetrapolar device, where impedance was measured through the legs, lower trunk, arms, and upper trunk via eight electrodes (3). Once the recruit's feet and hands were positioned on the appropriate electrodes, they stood upright and extended their arms so they were parallel to the ground (29). The BIA was completed when the recruit's body mass was displayed again. Proprietary equations from the device provided measurements of body mass and FM% (3, 29).

Waist circumference is an indicator of body fat distribution (63). Further, waist circumference and waist-to-hip ratio (WHR) has been used to assess body composition in law enforcement recruits (47). Procedures described by Lockie et al. (47) were adopted by the CA recruit training staff. A thin-line metric tape measure (Lufkin, Apex Tool Group, Maryland) was used to measure waist and hip circumference for all recruits. Waist circumference was measured in cm at the narrowest part of the waist just superior to the naval. Hip circumference was measured at the greatest posterior extension of the hip. WHR was calculated by dividing waist circumference by hip circumference. Waist circumference and WHR were considered for analysis in this study (47).

Grip strength provided a measure of upper-body strength (67) and was measured by a hand grip dynamometer (Takei Scientific Instruments, Japan). Recruits kept their testing arm by their side when standing throughout the assessment and squeezed the handle as hard as possible for approximately 2 s (12, 29, 32, 46, 47). Two attempts were completed for each hand and results were recorded to the nearest kg, with the left hand tested first. The best score for each hand was summed together to provide the combined grip strength score.

Upper-body muscular endurance was assessed via a 60-s push-up test, with established procedures adopted (31, 46, 47). A staff member placed a fist on the floor directly under the recruit's chest to ensure they descended to an appropriate depth, and they also counted the repetitions. Although there are limitations with this approach, this ensured recruits descended to the required depth (46). All female recruits were partnered with a female staff member. On the start command, a staff member began the stopwatch and the recruit flexed their elbows and lowered themselves until their chests contacted the other staff member's fist before they extended their elbows to return to the start position. Recruits performed as many push-ups as possible in 60 s, with the recorded result being the number of correctly completed repetitions.

Abdominal muscular endurance was assessed via a 60-s sit-up test, with established procedures again adopted (27, 32, 35, 47). The recruit laid on their back with their knees flexed to 90°, heels flat on the ground, and arms crossed over the chest. The feet were held in place by a staff member who counted the repetitions. On the start command, the recruit raised their shoulders from the ground while keeping their arms crossed over the chest and touched their elbows to their knees. The recruit then descended back down until their shoulder blades contacted the ground. Recruits completed as many repetitions as possible in 60 s, with the recorded result being the number of correctly completed repetitions.

The YMCA step test was administered as a fitness assessment to measure aerobic capacity (24, 70). This test has been previously used to assess aerobic fitness in CA recruits, with the established procedures used by the current staff (52). The test was performed with approximately ~31-cm (12-inch) high bleacher seats used for the step for both pre- and post-testing. It was not possible to standardize the step height for each individual recruit in the context of this training academy (52). Recruits completed the step test in groups of 6-8, such that they could be paired up with a staff member to measure their recovery HR. To complete the YMCA step test, recruits continuously stepped in time to a 96-bpm metronome for 3 minutes. The beat was played from an iPad handheld device (Apple Inc., Cupertino, California) connected to a portable speaker (ION Block Rocker, Cumberland, Rhode Island) positioned on a higher bleacher seat in front of the recruits. Following the 3 minutes, recruits immediately sat on the step while recovery HR was manually taken by a staff member via the carotid or radial artery for 60 s (24, 52).

As noted, the 201-m and 2.4-km runs were completed within a physical training session in the first and last week of academy, for pre- and post-testing respectively. The 201-m run has been previously used to assess anaerobic capacity in CA recruits (36, 40). The distance was marked on a 400-m athletics track, and the recruits were instructed to run the distance as quickly as possible. Recruits completed the run in groups of 8-12 recruits, and time was recorded to the nearest 0.1 s by a handheld stopwatch by one of the staff. The 2.4-km run has been used to assess aerobic capacity in CA recruits (39-41). Recruits completed six laps around the 400-m track and ran this distance as quickly as possible. Again, recruits completed the run in groups of 8-12 recruits, and time was recorded to the nearest 0.1 s by a handheld stopwatch by a staff member.

The training academy for CA recruits was conducted over 8 weeks. Within these 8 weeks, both the TT and ABT groups completed 15 physical training sessions administrated by the agency staff. Physical training sessions were conducted at the training academy or a nearby junior college depending on facility availability. The sessions included aerobic conditioning or circuit training, which is shown in Table 1. All physical training sessions were conducted first thing in the morning (start time between 5:00am-7:00am) in accordance with the academy schedule. Both the TT and ABT groups also completed defensive tactics training throughout academy, and this training was consistent for both classes. Defensive tactics training was used to physically prepare recruits for potentially life-threatening conflict with noncompliant inmates (25). Although defensive tactics was not part of the physical training program, due to the demands associated with this training (9, 25), it was important to note the frequency of this training. All physical training sessions were preceded by a dynamic warm-up (5).

Table 1. Number of days completed for each training modality (aerobic conditioning, circuit training, and defensive tactics) for the TT and ABT groups.

Week #	Aerobic Conditioning	Circuit Training	Defensive Tactics
Week 1	1	1	1
Week 2	1	1	2
Week 3	1	1	1
Week 4	2	0	2
Week 5	1	1	1
Week 6	2	0	2
Week 7	0	1	0
Week 8	0	2	0

The agency did not provide the researchers with the exact exercises performed by the TT and ABT groups in each physical training sessions. This was because the staff had to be flexible with their programs due to changes in equipment and location availability. The is a limitation in the context of this study, but this commonly occurs for law enforcement agencies who often have restrictions with staffing, training locations, and equipment availability (26, 65). Nonetheless, the agency did provide background to the training completed by the recruit classes. The aerobic conditioning sessions for the TT group was focused on formation running, whereby all recruits completed runs over the same distance with the same pace (43). Including warm-up and cool-down, aerobic conditioning sessions typically occurred over 60 minutes. The distances covered depended on location and recruit behavior during the session but was generally around 2-4 miles (~3-6 km). The circuit training sessions used in the TT programs was similar to those presented by Moreno et al. (52). The exercises typically focused on body weight exercises which required minimal to no equipment. For example, exercises within a session included:

- 50-m jog
- Submaximal effort sprints
- Body weight side lunges
- Body weight walking lunges
- Bear crawl

- Duck walks
- Side stepping/squat shuffling

As described by Moreno et al. (52), work periods were approximately 60 s in length, with between-exercise transition/recovery times of around 30 s. The total time for circuit training sessions was approximately 60 minutes. Exact times for each circuit cannot be detailed, as the staff adapted responded to the behavior of recruits (52). This was done because of the nature of the training sessions, whether to encourage maximum effort, or implement stress inoculation.

The ABT group also completed aerobic conditioning and circuit training. However, the physical training program considered the fitness and abilities of the individual recruits. The aerobic conditioning sessions used interval training similar to that presented by Cesario et al. (5). To provide an example, the layout for an interval running session using the box drill is shown in Figure 1. Cesario et al. (5) described this drill in detail, but it will be briefly described here. Firstly, recruits were split into 3 groups based on their 2.4-km run time. The fittest group (fastest 2.4-km run times) were positioned on the outside of the grid. Recruits with intermediate fitness were positioned in the middle, while the least fit recruits (slowest 2.4-km run times) were positioned on the inside. All groups began the drill at the start marker and were instructed to run the longer distances hard (i.e., faster running pace), while using the short sides for recovery (i.e., slower running pace). The hard runs were to take approximately 15 seconds to complete, and due to the different fitness levels between the groups, most recruits should be able to complete the intervals around the same time. Two rotations about the grid were completed for a set, and depending on the goal of the session, 5-8 sets (with 2 minutes recovery between sets) were completed. Over the course of the academy, staff could use their best judgment to move recruits up or down between the groups depending on their performance during training sessions.

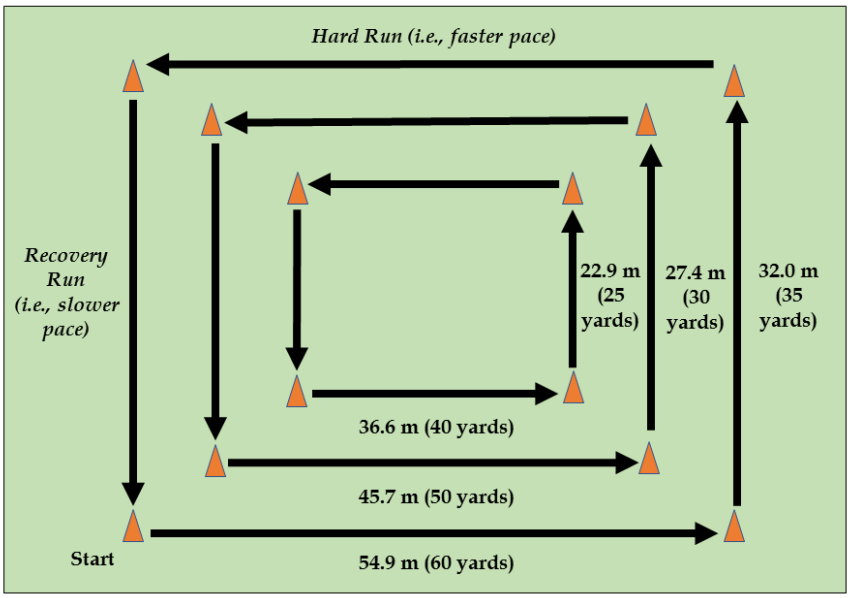

Figure 1. Box drill layout for an ability-based interval training session (5).

The circuit training sessions were adapted from that presented by Moreno et al. (51). Moreno et al. (51) described the session and individual exercises/stations in detail, which included:

- Squat
- Ability-Based Pull-up
- Step-Ups
- Ability-Based Push-up
- Farmer's Walk

The session was designed to alternate between lower- and upper-body exercises so they could be performed effectively within sequence, and recruits were worked with a partner when they cycled through the stations. The stations were designed with a 60-s work: 30-s transition/recovery period. The transition period allowed recruits time to move to the next station and prepare any required equipment. For the lower-body exercises (squat, step-ups, and farmer's walk), load was provided by ammunition cans or sandbags (depending on the available equipment). Recruits selected a load appropriate for their ability. For the pull-ups or push-ups, recruits either used their body weight, received assistance from their partner if required, or for the push-up, received manual external resistance from their partner if appropriate (51).

Statistical Analysis

Statistical analyses were processed using the Statistics Package for Social Sciences (Version 27; IBM Corporation, New York, USA). Firstly, the sexes were combined within the TT and ABT groups, as all recruits (regardless of sex) need to attain the same standards to graduate academy. This approach has been adopted in previous studies (2, 6, 27, 33, 38, 47, 48). Descriptive statistics (mean ± standard deviation [SD]) were calculated for the pre- and post-test data. The data analysis conducted in this study was based on the work by Cocke et al. (7). This was because the investigators had no control over the allocation of participants to the TT and ABT groups, as this was dictated by the human resources department at the law enforcement agency (36). As will be detailed in the results, this meant that there could be great differences in the health and fitness of recruits between the two classes. Accordingly, independent samples t-tests evaluated whether there were differences between the pre-test data for the classes in the health and fitness measures. The alpha level was set at $p \leq 0.05$. Levene's test for equality of variances were checked to determine whether equal variances were to be assumed or not assumed. If there were differences between the groups in the pre-test data, paired samples t-tests ($p \leq 0.05$) were used to detect whether there were within-group changes between the pre- and post-test data. In order to make between-group comparisons, change scores were calculated for each variable for the TT and ABT groups (7). Change scores were calculated as the difference between the post-test and pre-test data (7). Independent samples t-tests compared the change scores between the groups ($p \leq 0.05$). Levene's test for equality of variances was again checked to determine whether equal variances were to be assumed for each variable or not.ude the computer software used, and the alpha-level used for the determination of significance.

RESULTS

The descriptive data for the TT and ABT groups is shown in Table 2. The order of the data presented follow this general grouping: body composition (body mass, FM%, waist circumference, and WHR); clinical measures (RHR and BP); and physical fitness measures (grip strength, push-ups, sit-ups, and YMCA step test recovery HR). With regards to the between-group comparisons for the pre-test data, equal variances were assumed for all variables except grip strength and sit-ups. Prior to training the TT group had significantly lower FM% ($p < 0.001$), waist circumference ($p = 0.037$), systolic BP ($p = 0.001$), and diastolic BP ($p < 0.001$) when compared to the ABT group. The TT group also completed more sit-ups ($p = 0.002$) and were faster in the 2.4-km run ($p = 0.019$).

Table 2. Descriptive (mean ± SD) data for the traditional training (TT) and ability-based training (ABT) CA recruit groups pre- and post-training academy for body mass, fat mass percentage, resting heart rate (RHR), waist circumference (WC), waist-to-hip ratio, systolic and diastolic blood pressure (BP), grip strength, push-ups, sit-ups, YMCA step test recovery heart rate (HR), 201-m run time, and 2.4-km run time.

	TT Group (n = 31)			ABT Group (n = 29)		
	Pre	Post	p	Pre	Post	p
Body Mass (kg)	73.76 ± 13.05	74.23 ± 12.75	0.295	76.02 ±14.36	76.95 ± 14.49*	0.003
Fat Mass Percentage (%)	20.70 ± 6.02	20.31 ± 5.87	0.409	32.14 ± 7.04§	29.91 ± 7.26*	< 0.001
WC (cm)	82.26 ± 9.08	79.27 ± 14.32	0.168	87.67 ± 8.97§	84.89 ± 9.74	0.008
Waist-to-Hip Ratio	0.87 ± 0.07	0.81 ± 0.12*	0.007	0.85 ± 0.08	0.85 ± 0.07	0.640
RHR (bpm)	74.53 ± 10.89	77.97 ± 9.10	0.099	78.66 ± 14.12	71.52 ± 7.72*	0.007
Systolic BP (mmHg)	123.71 ± 15.12	120.32 ± 7.80	0.192	138.93 ± 18.12§	137.79 ± 18.04	0.515
Diastolic BP (mmHg)	72.90 ± 9.16	78.52 ± 5.98*	0.004	86.56 ± 7.37§	85.33 ± 10.30	0.435
Grip Strength (kg)	73.85 ± 16.86	78.00 ± 19.28*	0.027	71.20 ± 22.19	69.59 ± 24.46	0.168
Push-ups (repetitions)	38.35 ± 18.11	40.23 ± 13.90	0.162	30.14 ± 15.12	34.21 ± 13.25*	0.014
Sit-ups (repetitions)	37.55 ± 8.76	36.74 ± 7.78	0.406	31.10 ± 6.44§	33.93 ± 7.45*	0.025
YMCA Recovery HR (bpm)	129.16 ± 20.23	105.97 ± 13.53*	< 0.001	137.03 ± 17.70	108.21 ± 8.54*	< 0.001
201-m Run (s)	35.13 ± 6.83	32.97 ± 4.56*	0.021	39.79 ± 18.41	32.14 ± 4.08*	0.017
2.4-km Run (min:s)	12:55 ± 2:35	11:42 ± 1:39*	< 0.001	14:37 ± 2:27§	13:05 ± 1:33*	< 0.001

§ Significantly ($p \leq 0.05$) different from the TT pre-test data.
* Significant ($p \leq 0.05$) change from pre- to post-test.

Based on these results, each group was analyzed separately to determine whether there were changes to health and fitness following academy training. Firstly, the TT group significantly decreased their WHR (p = 0.007). With regards to fitness, the TT group increased grip strength (p = 0.027), decreased YMCA step test recovery HR (p < 0.001), and were faster in the 201-m (p = 0.021) and 2.4-km (p < 0.001) runs. However, the TT also displayed increases in their diastolic BP (p = 0.004). For the ABT group, the recruits significantly increased their body mass following academy (p = 0.003). However, they decreased their FM% (p < 0.001), RHR (p = 0.007), and waist circumference (p = 0.008). ABT recruits also completed more push-up (p = 0.014) and sit-up (p = 0.025) repetitions, decreased their YMCA step test recovery HR (p < 0.001), and were faster in the 201-m (p = 0.017) and 2.4-km (p < 0.001) runs.

Change score data were used to analyze between-group differences following the training protocols, and these are shown in Table 3. Equal variances were assumed for all variables except grip strength. When compared to the TT group, the ABT group had greater positive changes in FM% (p = 0.004), RHR (p = 0.001), and sit-ups (p = 0.020). The TT recruits had more favorable changes in WHR (p = 0.024) and grip strength (p = 0.009), and a less favorable change in diastolic BP (p = 0.006).

Table 3. Change score data (mean ± SD) for the traditional training (TT) and ability-based training (ABT) CA recruit groups for body mass, fat mass percentage, waist circumference (WC), waist-to-hip ratio, resting heart rate (RHR), systolic and diastolic blood pressure (BP), grip strength, push-ups, sit-ups, YMCA step test recovery heart rate (HR), 201-m run time, and 2.4-km run time.

	TT (n = 31)	ABT (n = 29)	p
Body Mass (kg)	0.47 ± 2.39	0.92 ± 1.52	0.394
Fat Mass Percentage (%)	-0.39 ± 2.48	-2.23 ± 2.14*	0.004
WC (cm)	-2.98 ± 11.75	-2.77 ± 5.08	0.930
Waist-to-Hip Ratio	-0.07 ± 0.13	-0.01 ± 0.06*	0.024
RHR (bpm)	3.43 ± 11.02	-7.14 ± 13.11*	0.001
Systolic BP (mmHg)	-3.39 ± 14.12	-1.14 ± 9.16	0.477
Diastolic BP (mmHg)	5.61 ± 9.94	-1.22 ± 8.01*	0.006
Grip Strength (kg)	4.15 ± 9.97	-1.61 ± 6.14*	0.009
Push-ups (repetitions)	1.87 ± 7.27	4.07 ± 8.37	0.281
Sit-ups (repetitions)	-0.81 ± 5.33	2.83 ± 6.43*	0.020
YMCA Step Test Recovery HR (bpm)	-23.19 ± 22.80	-28.83 ± 18.45	0.299
201-m Run (s)	-2.17 ± 4.88	-7.66 ± 16.32	0.083
2.4-km Run (min:s)	-1:14 ± 1:18	-1:33 ± 1:50	0.442

* Significantly ($p \leq 0.05$) different from the TT group.

DISCUSSION

This study investigated the effects of TT and ABT on the health and fitness of CA recruits during academy. It was hypothesized that the recruits who completed ABT would experience greater health and fitness improvements than the TT recruits. This hypothesis was proven partially correct. Firstly, similar to previous law enforcement research (7), the investigators did not

control recruit allocation to each academy class. The law enforcement agencies' human resources department was responsible for allocating recruits to an academy class (36). This resulted in the TT group generally displaying superior health and fitness compared to the ABT group. This is a limitation, as the ceiling for improvement in the TT recruits would likely be lower, although this could reinforce the importance of ABT. Nonetheless, the current data indicated that TT and ABT could improve the health and fitness of CA recruits. However, the change scores, in addition to the increase in diastolic BP for the TT group following academy, may provide some evidence for ABT. The results from this research have implications for training staff regarding how they implement physical training for their custody personnel.

With regards to body composition, the TT recruits did not experience a significant change in body mass, FM%, or waist circumference. The TT recruits did significantly decrease their WHR, which given that waist circumference did not change may have been due to reduced hip circumference (i.e., reduced fat or muscle mass about the hip). As a greater WHR can be an indicator of cardiovascular disease (13), and this disease is common within law enforcement personnel (71), this type of change following academy could be perceived as a positive result for the TT recruits. Within the ABT group, the recruits experienced a significant increase in body mass, but a significant decrease in FM%. Waist circumference also decreased following academy in the ABT recruits. The combination of decreased FM% and waist circumference would suggest a decrease in body fat for ABT recruits, which should benefit physical performance (i.e., in fitness tests and demanding job tasks) (11, 29, 47), and also reduce health risks (i.e., cardiovascular disease) (64). The combination of increased body mass, along with decreased FM%, may suggest an increase in LBM for the recruits. However, this would need to be confirmed with further studies. It would be beneficial for future studies to measure whether there are positive changes in lean body mass following either TT or ABT. The use of other body composition equipment (e.g., InBody BIA technology) could allow for more detailed analyses of body composition and lean body mass (23, 68). Nonetheless, the results indicated that both TT and ABT had some positive impact on body composition in CA recruits.

With regards to the clinical measures, the TT recruits did not experience a significant change in RHR, and neither group had a significant change in systolic BP. The ABT recruits did have a greater systolic BP compared to the TT recruits, and would be classified as Stage 1 Hypertension both pre- and post-academy (61). It would behoove these recruits to attempt to improve their BP profile to reduce their risks of cardiovascular disease (16). Nonetheless, the ABT recruits experienced a significant decrease in RHR, and the change was pronounced compared to the TT recruits. Decreased RHR is indicative of improved fitness, and this could benefit job task performance for CA recruits. For example, research in firefighters has associated RHR as a measure of fitness with faster performance in ability tests incorporating tasks such as stair climbs, hose drags, and victim drags (50, 56). Additionally, lower RHR is associated with decreased cardiovascular disease risk (15). The results from the current research suggest that ABT was effective in reducing RHR in CA recruits.

What was interesting to note was the increase in diastolic blood pressure for the TT recruits. Diastolic BP is the pressure in the arteries when the heart relaxes (i.e., when the heart receives blood and oxygen). A CA training academy can be a stressful process (demonstrated by elevated HR responses in training scenarios) (30), so the recruits may have had a physiological response to the environment they were in. This could also be an indication of poorer recovery or systemic fatigue from the physical training (in addition to other challenging aspects of academy, such as defensive tactics training). Systemic fatigue has been linked to training plateaus that occur in longer term (27-week) law enforcement training academies, due to the cumulative stress of the academy process (42). It should be noted that the TT recruits were still in the normal diastolic BP range, while the ABT recruits were in the elevated range (61). Nevertheless, law enforcement personnel are at high risk of cardiovascular disease (71), and elevated BP is an indicator of this disease (16). Given that the job itself will contribute to increased cardiovascular disease risk (through factors such as stress, shift work, lack of sleep, and dietary choices) (18, 71), it is less than ideal for the training academy to contribute to an elevation in diastolic BP. The stress associated with TT could have contributed to this for the CA recruits in this group.

Both the TT and ABT groups experienced positive changes in fitness. However, there were differences in some of the fitness tests where improvements occurred. The TT recruits improved their grip strength, while the ABT recruits did not. Grip strength is needed during inmate restraint (20, 21) and body or casualty drags (44). Accordingly, even with the ability-based modifications, there may be something lacking within the ABT program that led to grip strength not changing within the ABT recruits. Strength training may require a greater focus within the ability-based program. Although potentially limited by equipment (26), the use of traditional resistance training exercises (e.g., power cleans, front squats, bent over rows) could be adopted in ability-based training for CA recruits. Indeed, these exercises were used in a training program for law enforcement recruits that was detailed by Lockie et al. (42), which led to improvements in maximal isometric posterior chain strength. Nonetheless, the ABT group did improve their muscular endurance as measured by push-ups and sit-ups, with the between-group difference in sit-up change scores also being significant. Training for muscular endurance is a common focus of law enforcement physical training programs (36), which was also the case for the agency in this research. Muscular endurance is important for job tasks that holding, pushing, and wrestling, such as inmate restraint (21). The ability-based modifications, especially for push-ups (51), likely contributed to the results found in this study. In the TT program, if an exercise like the push-up was programmed, the expectation was that every recruit should do this exercise even if they may not have the capacity to do so. This would especially be an issue for female recruits, as numerous studies have shown female law enforcement personal tend to perform fewer push-up repetitions compared to males (2, 6, 12, 32, 33, 36, 46). As a result, within the ABT program the push-up exercise was modified such that recruits who could not perform a push-up could receive assistance such that they moved through the full range of motion (51). Further, for recruits who could perform push-ups successfully, manual resistance could be applied such that the individual would have to produce more force in the exercise (51, 65). ABT may be required to encourage greater improvements in push-up and sit-up tests in CA recruits. This may have been very pertinent for the TT recruits, as they reported to academy with superior

muscular endurance, significantly so for sit-ups. Training tailored towards their abilities may have been needed to provide a greater stimulus for further adaptations in muscular endurance.

Aerobic conditioning is often a major focus of law enforcement training academies (27, 36, 37). One of the reasons for this is that aerobic capacity is essential for many job tasks required in custody, including responding to alarms, extended cell searches, and inmate pursuit and restraint (20, 21). Anaerobic conditioning would also contribute to these tasks, especially for high-intensity actions completed over shorter durations (e.g., inmate restraint) (20, 21). Accordingly, both the TT and ABT recruits improved aerobic and anaerobic fitness, as shown by decreases in YMCA step test recovery HR, 201-m run time, and 2.4-km run time. There were also no significant differences between the change scores for these tests. The program structure followed by both the TT and ABT groups allowed for these adaptations to occur. Indeed, the consistent application of aerobic training stress for both groups, in line with recommended standards (including defensive tactics training, ~3 vigorous cardiorespiratory training sessions per week) (17), contributed to these improvements in anaerobic (201-m run) and aerobic (YMCA step test recovery HR, 2.4-km run) capacity. However, what should also be considered is the time associated with an aerobic conditioning exercise. The interval running drill used by the ABT recruits and detailed by Cesario et al. (5) was more time-efficient than the formation runs more consistently performed by the TT recruits. This supported the findings of Orr et al. (59) who likewise found the ABT sessions to be more time-efficient. Given the time constraints surround law enforcement training academies (26), staff should consider using more ABT training methods for greater efficiency of training. This could allow for the programming of other modalities to target different physical qualities important for custody personnel (e.g., maximal strength, flexibility) (20, 21).

One of the major benefits of ABT in law enforcement recruits is reductions in injury risk (59), and potentially reduced likelihood of separation from academy due to voluntary resignation (27). It should be stated that all recruits from the TT and ABT groups graduated from academy. The shorter duration of the CA recruit academy could mitigate the risk of injury and academy separation for these recruits. Nonetheless, as noted through the discussion there were some notable differences in the change score comparisons for the TT and ABT groups. The ABT recruits did have greater positive changes in FM%, RHR, and sit-ups. Further, the implementation of ABT for CA recruits has greater importance given the number of females in each class, and how females tend to display lesser fitness compared to males (2, 6, 12, 28, 32-34, 36, 38, 41, 43, 46). As there are no sex-specific standards for CA recruits relative to graduation or job performance as all individuals are required to complete the same job regardless of sex (2, 6, 27, 33, 38, 47, 48), this can influence how physical training is typically implemented (i.e., the TT approach). ABT should help to mitigate any increased risk of injury experienced by female recruits if they are forced to work above their current capacity (22, 57, 66). As previously stated, it should be acknowledged that the TT recruits entered academy with generally higher levels of fitness, so their ceiling for improvement may have been less. Nevertheless, these data further highlighted the importance of ABT. Fitter recruits likely require different training stimuli to experience fitness improvements. Moreno et al. (52) noted that within the same circuit training

sessions, fitter CA recruits tended not to spend as much time working at a higher intensity compared to less fit recruits. As TT tends to be tailored towards the less fit members of a group (in order to make sure everyone can do some form of training), fitter recruits may not receive enough of a stimulus to improve physical performance. The reinforces the importance of ABT not just for the less fit members of an academy class, but also for the more highly fit recruits.

There are limitations to the current study that should be acknowledged. It was not possible to control the recruits in each class, so they had different health and fitness characteristics prior to academy. This was unavoidable due to the hiring practices of this agency (36), and why this study was modelled off Cocke et al. (7). The researchers did not control the TT and ABT programs, and these needed to be flexible within the context of the academy. It would have been beneficial to have greater control over each session for consistency, but this was not possible given the logistics for this law enforcement agency with regards to personnel, class timetable issues, and available locations and equipment (26). Similarly, pre- and post-testing had to be conducted in different locations for both classes. This could have affected the post-testing data; however, this was also unavoidable, as this agency ran multiple patrol officer and CA classes at once, so training locations were at a premium. The CA recruits in this study were from the one agency. The health and fitness profile (and effects of training) of law enforcement personnel from other agencies may be different (54). In addition to FM%, including lean body mass measurements could be incorporated into future studies to further investigate the effects of CA recruit training. Given the grip strength results for the ABT group, it would have also been useful to include more structured resistance training in both the TT and ABT. Indeed, structured strength and resistance training has been used in other law enforcement academy research studies (7, 8, 42). Future research should investigate the effects of structured resistance training with an ability-based focus in CA recruits.

In conclusion, this study showed that CA recruits who completed TT or ABT experienced improvements in health and fitness measures. Although the TT group tended to have superior health and fitness prior to academy, some of the adaptations were specific to each protocol. TT recruits decreased WHR, increased grip strength, and decreased YMCA step test recovery HR, 201-m run time, and 2.4-km run time. However, TT may have contributed to a diastolic BP increase in recruits, which could be indicative of poorer recovery or systemic fatigue. ABT recruits increased body mass, decreased FM%, waist circumference, and RHR, increased push-up and sit-up repetitions in 60 s, and decreased YMCA step test recovery HR, 201-m run time, and 2.4-km run time. Some of the change scores from pre- to post-test were also more pronounced for the ABT recruits (FM%, RHR, and sit-ups), although the TT group had greater change scores for WHR and grip strength. Nevertheless, given the job demands experienced by CAs, law enforcement training staff should explore the use of ABT in their academies. Even for the TT recruits who had better muscular endurance (among other health and fitness qualities) prior to academy, ABT could allow for further adaptations due to a more individualized stimulus. Furthermore, ABT could be a more time-efficient training approach, which adds value beyond just the improvement of health and fitness for CA recruits.

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