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The Use of 2 Conditioning Programs and the Fitness Characteristics of Police Academy Cadets

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Context: Police academy training must physically prepare cadets for the rigors of their occupational tasks to prevent injury and allow them to adequately perform their duties.

Objective: To compare the effects of 2 physical training programs on multiple fitness measures in police cadets.

Design: Cohort study.

Setting: Police training academy.

Patients or Other Participants: We collected data from 70 male (age = 27.4 ± 5.9 years, body weight = 85.4 ± 11.8 kg) and 20 female (age = 30.5 ± 5.8 years, body weight = 62.8 ± 11.0 kg) police cadets and analyzed data from 61 male cadets (age = 27.5 ± 5.5 years, body weight = 87.7 ± 13.2 kg).

Intervention(s): Participants completed one of two 6-month training programs. The randomized training group (RTG; n = 50), comprising 4 separate and sequential groups (n = 13, n = 11, n = 13, n = 13), completed a randomized training program that incorporated various strength and endurance exercises chosen on the day of training. The periodized group (PG; n = 11) completed a periodized training program that alternated specific phases of training.

Main Outcome Measure(s): Anthropometric fitness measures were body weight, fat mass, and lean body mass. Muscular and metabolic fitness measures were 1-repetition maximum bench press, push-up and sit-up repetitions performed in 1 minute, vertical jump, 300-m sprint, and 2.4-km run.

Results: The RTG demonstrated improvements in all outcome measures between pretraining and posttraining; however, the improvements varied among the 4 individual RTGs. Conversely, the PG displayed improvements in only 3 outcome measures (push-ups, sit-ups, and 300-m sprint) but approached the level of significance set for this study ($P < .01$) in body weight, fat mass, and 1-repetition maximum bench press.

Conclusions: Regardless of format, physical training programs can improve the fitness of tactical athletes. In general, physical fitness measures appeared to improve more in the RTG than in the PG. However, this observation varied among groups, and injury rates were not compared.

Key Words: physical fitness, periodized training, police cadets, tactical athletes

Key Points

- A conditioning stimulus, whether a randomized training program (RTP) or a periodized training program (PTG), had the potential to increase fitness measures in police cadets.
- An RTP may be a more effective means of optimizing anthropometric measures, increasing power, and enhancing aerobic run performance than a PTG focusing on single performance measures.
- Potential differences in injury risks between the RTP and PTG should be investigated.

Police recruits must undergo training in preparation for their duties as police officers. However, researchers[1–3] have shown that trainees in the general tactical population are at a high risk of injury during this initial training. The risk of injury is greater for trainees than for fully trained tactical personnel because the former are adjusting to the new physical demands required when transitioning from members of the civilian public to tactical personnel. For example, carrying heavy external loads, such as body armor or equipment belts, can impair balance, hasten muscular fatigue, alter gait patterns, and affect postural alignment.[4] This load-carriage requirement alone is associated with an increased risk of injury.[5,6] Furthermore, in this population, investigators[7] have found that less fit trainees were at a greater risk of injury than their more fit counterparts.

Fully trained police officers, along with other tactical personnel, serve in physically demanding occupations and are exposed to various occupational dangers each day.[8] The inability to physically fulfill their occupational duties may have serious implications not only for their personal health but also for the general public who rely on these personnel for safety and protection.[8] Arvey et al[9] analyzed records and conducted surveys of police officers to examine the frequency and importance of tasks that they face in the line of duty. Some of the most commonly reported tasks were carrying a heavy equipment belt for the duration of their shift and wrestling or grappling with suspects.[9] Characteristics that were rated as highly important included having sufficient grip strength to fire a weapon and being able to quickly jump to 1 side to avoid a thrown object or speeding car.[9] All of these tasks are physical, and a certain level of physical fitness is required to adequately perform each task.

The estimated cost of recruiting and training a new trainee police officer is around A$85 000 (approximately US $64 000).[10] Thus, loss of trainees to injury is very costly and may result in missed training time. Whereas new police trainees must be adequately physically conditioned to perform these occupational tasks, their conditioning needs to be conducted in a manner that does not cause injuries.

The physical conditioning of military trainees is well documented[11–15]; however, research on optimal conditioning programs for law enforcement personnel is limited. Therefore, the purpose of our study was to evaluate and compare the effectiveness of 2 voluntary 6-month training programs: a randomized training program with a workout-of-the-day style and a periodized training program, based on the results achieved in police cadets across various anthropometric and fitness performance measures.

METHODS

Participants

Data collected by the staff of a police training academy in the United States were released with consent from that organization for the purpose of conducting this retrospective cohort study. All identifying information was removed before we received these data. Retrospective data for 5 cohorts of recruits undergoing a 6-month police training program at the academy were investigated. We collected data for 90 police cadets. Of the participating cadets, 78% (n = 70) were male (age = 27.4 ± 5.9 years [range = 21–44 years], body weight = 85.4 ± 11.8 kg [range = 62–117 kg]) and 22% (n = 20) were female (age = 30.5 ± 5.8 years [range = 23–40 years], body weight = 62.8 ± 11.0 kg [range = 45–84 kg]). To be included, participants had to be cadets in the selected training academy and free from injury. Cadets were excluded if they had completed some aspect of the training program and were returning to training after injury, academic failure, or any other reason (eg, missed a fitness assessment).

Cadets in the academy followed 1 of 2 program types, either a randomized training program or a periodized training program. The randomized training program was used by the academy staff for 4 of the 5 academy classes before the development of a periodized training program. The first randomized training group (RTG1) contained 18 cadets (89% male, n = 16); the second (RTG2), 14 cadets (79% male, n = 11); the third (RTG3), 15 cadets (100% male, n = 15); and the fourth (RTG4), 18 cadets (83% male, n = 15). One class consisting of 25 cadets (52% male, n = 13) completed a periodized training program (periodized group [PG]) over the data-capture period. Cadets typically purchased their meals from the local area. This variation, which was uncontrolled, was anticipated to have been similar across groups.

The University of Colorado–Colorado Springs Institutional Review Board and the Bond University Human Research Ethics Committee approved this archival data study.

Procedures

The randomized training program was similar to a training program with a workout-of-the-day style that incorporated strength and endurance exercises spontaneously selected on the day of the training session with a focus on improving fitness-assessment performance. Typical exercises included high repetitions of push-ups, sit-ups, chin-ups, and metabolic-conditioning–styled high-intensity training. The periodized training approach used an alternating focus, with particular phases to increase endurance, hypertrophy, strength, or power for general health and physical conditioning rather than the fitness assessments specifically. Unloading phases were also included in the program to help transition among different foci. A 2-week maintenance phase was completed after the final data collection for the periodized program. An outline of the periodized program is presented in Table 1.

Table 1. Outline of the Periodized Training Program

Date	Phase
January 21–25	Testing
January 28–February 1	Endurance
February 4–8	Endurance
February 11–15	Endurance and hypertrophy
February 18–22	Endurance and hypertrophy
February 25–March 1	Unload
March 4–8	Hypertrophy
March 11–15	Endurance and hypertrophy
March 18–22	Retest and unload/transition
March 25–29	Strength and hypertrophy
April 1–5	Strength and hypertrophy
April 8–12	Unload/transition
April 15–19	Endurance
April 22–26	Hypertrophy and endurance
April 29–May 4	Hypertrophy and strength
May 6–11	Strength
May 13–17	Unload and strength
May 20–24	Power and strength
May 27–31	Power, strength and power
June 3–7	Strength/power and unload/transition
June 10–14	Strength and power
June 17–21	Strength and power
June 24–28	Strength and power
July 1–5	Testing
July 8–20	Maintenance

All fitness-training sessions, regardless of approach, began with a warmup lasting approximately 10 minutes that included activities of increasing intensity and stretching and concluded with a cooldown lasting approximately 10 minutes that included a general focus on static stretching. The total length of each session was approximately 60 minutes.

The dependent variables were anthropometric (body weight, lean body mass, fat mass), muscular fitness (1-repetition maximum [RM] bench press, maximum push-up and sit-up repetitions performed in 1 minute, vertical jump), and metabolic fitness (anaerobic 300-m sprint, aerobic 2.4-km run) measures. Data were collected during the first week of the program and at the completion of the 6-month program by the same trained physical training and education staff posted to the academy. The order of assessment for the dependent variables followed the order presented in this subsection.

Anthropometric Measures. Body weight (kg) measurements were collected using a beam scale (Cardinal; Detecto Scale Co, Webb City, MO). Body fat estimations were obtained using the 3-site skinfold assessment protocol recommended by the American

College of Sports Medicine.[16] For male cadets, duplicate measures of the chest, abdomen, and thigh were taken on the right side of the body using Lange skinfold calipers (Beta Technology Inc, Cambridge, MD). The first measurement was taken at the chest by measuring a diagonal fold located approximately one-half the distance between the axillary line and the nipple. The second measurement was taken at the abdomen by measuring the thickness of a vertical skinfold located 2 cm to the right of the umbilicus. The third skinfold measurement was taken at the thigh by measuring the thickness of a vertical skinfold located on the anterior midline of the thigh, midway between the proximal border of the patella and the hip. Three measurements were taken at each site, and the averages of these measurements were recorded to the nearest centimeter. The tester rotated among these sites in the same order as described to allow time for the skin to regain normal texture and thickness before the next measurement. The primary investigator calculated the lean body mass and fat mass of each cadet based on the provided measurements for weight and body composition.

For female cadets, the same outlined protocol[16] was used for skinfold measurement sites, including the triceps, supra-ilium, and thigh. The triceps measurement was obtained by measuring the thickness of the vertical fold located on the posterior midline of the upper arm, halfway between the acromion and olecranon process. The supra-ilium measurement was obtained from the diagonal fold just above the iliac crest in line with the anterior axilla. The thigh measurement was taken in the same manner as for the men. The 3 measurements were taken 3 times in a rotating fashion, and the lean body mass and fat mass were calculated for each female cadet.

Muscular Fitness Measures. Upper body muscular strength was measured using the 1-RM bench press based on previously described protocols.[17] Each cadet was instructed to perform a specific warmup of 5 to 10 repetitions with a light (12- to 15-RM) to moderate (8- to 12-RM) load. Two additional, heavier ($\leq$6-RM) warmup sets of 2 to 5 repetitions were performed before the first 1-RM attempt. Cadets were required to achieve their 1-RM within 3 to 5 attempts to minimize the effects of fatigue on their performance. The final weight lifted successfully was recorded as the 1-RM.

Upper body muscular endurance was measured using the 1-minute push-up test. All cadets were required to begin the test in the standard "up" position with the body rigid and straight, the hands positioned slightly wider than shoulder-width apart, and the fingers pointed forward. Next, partners placed a fist on the floor directly under the cadets' chests. On the "go" command, the tester began the stopwatch, and participants bent their elbows, lowered themselves until their chests contacted their partners' fists, and extended their elbows until returning to the "up" position. The cadets performed as many push-ups as possible using this technique in the time allotted.

Muscular endurance for the abdominal muscles was measured via a 1-minute sit-up test.[18] The testers instructed cadets to lie on their backs with their knees bent, heels flat on the mat or ground, hands interlocked behind their heads, and a partner anchoring them to the ground by holding their feet. Next, they were instructed to perform as many correct sit-ups as possible within the allotted timeframe.

Vertical-jump height was measured using a Vertec apparatus (Vertec Scientific Ltd, Aldermaston, United Kingdom). After determining their standing upward-reach height, testers instructed the cadets to perform a rapid countermovement jump with an arm-swing jump as high as possible and to attempt to displace the horizontal plastic fins on the device. The best of 3 attempts was selected, and maximal jump height was recorded to the nearest 0.5 in (1.3 cm), with scores subsequently converted to centimeters. Peak power output was calculated using the equation described by Sayers et al.[19] This equation is considered more valid than that of Harman et al[20] for estimating peak power from a vertical jump.[19]

Metabolic Fitness Measures. Before performing the 300-m sprint, the cadets were instructed to perform light jogging or walking at a self-selected pace near the starting point of the run course and self-directed flexibility drills (range-of-motion stretches for the lower limbs, trunk, and upper limbs). When the warmup was completed, cadets were instructed to run at maximal speed for 300 m on a predetermined course around a city block. This course was selected based on its location, distance, and minimal change in terrain grade. One test trial was allowed at maximal speed, and times for each participant were recorded to the nearest 0.10 second on a handheld stopwatch.

The 2.4-km run was performed using a 1.2-km course on the city blocks surrounding the training academy. This course was similarly selected based on its location, distance, and minimal change in terrain grade. Cadets were instructed to begin running and to cover the 2.4-km distance as fast as possible. At completion, their times were recorded on a handheld stopwatch to the nearest 0.10 second. The 2.4-km run was completed last, with approximately 30 to 45 minutes allotted between the completion of the other assessments and the run assessment. No fatiguing lower body assessments were performed within 60 to 90 minutes of the 2.4-km run.

Statistical Analysis

All results and scores were collated in an Excel spreadsheet (version 2010; Microsoft Corporation, Redmond, WA). These data were deidentified and provided to the researchers. Before analysis, the data were manually cleaned by removing all data for participants who did not fully complete each data-collection assessment at pretraining or posttraining. Basic descriptive statistics were conducted to profile the demographic and anthropometric measurements. Paired *t* tests were used to detect if pretraining-posttraining changes occurred within groups for each measure. Effect sizes for pretraining and posttraining changes within groups were calculated as mean change divided by the standard deviation at baseline. Independent *t* tests were conducted to compare differences in changes between the aggregated RTG and the PG and to determine if differences existed between groups at pretraining and posttraining. For the reported results of the independent-samples *t* test, we considered and adjusted for the unbalanced design (ie, unequal sample sizes) by using the formula based on an assumption of inequality of variances, as recommended by Sheskin.[21] Effect sizes for between-groups differences were calculated as the mean

Table 2. Pretraining and Posttraining Measures by Program (Mean ± SD)

Measure	Randomized Training Group (n = 50)		Periodized Training Group (n = 11)	
	Pretraining	Posttraining	Pretraining	Posttraining
Body weight, kg	86.98 ± 12.83	85.36 ± 11.99	91.07 ± 15.15	87.64 ± 13.63
Fat mass, %	17.80 ± 5.69	14.46 ± 4.45	16.66 ± 6.18	13.51 ± 4.06
Lean body mass, kg	71.02 ± 8.03	72.65 ± 8.06	75.37 ± 9.98	75.60 ± 10.80
Bench press, kg	88.45 ± 23.69	101.09 ± 21.61	106.20 ± 15.15	113.02 ± 20.07
Push-up, repetitions	48.96 ± 15.15	70.56 ± 11.99	53.45 ± 14.40	70.18 ± 13.67
Sit-up, repetitions	33.96 ± 9.02	46.44 ± 5.40	42.27 ± 8.51	51.82 ± 5.23
Vertical jump, cm	55.32 ± 10.68	62.69 ± 8.64	64.54 ± 8.59	64.31 ± 9.22
Power, W	5235.01 ± 866.29	5608.97 ± 707.13	5979.54 ± 762.59	5810.48 ± 934.87
Aerobic 2.4-km run, min	12.54 ± 1.41	11.12 ± 1.17	11.49 ± 1.41	10.94 ± 1.19
Anaerobic 300-m sprint, s	53.36 ± 4.98	48.23 ± 3.96	51.75 ± 4.18	49.81 ± 4.02

difference divided by the pooled standard deviation. Given that data were collected from several different cadet cohorts, we conducted an analysis of variance to determine if differences existed among the individual RTG cohorts and between the RTG and PG cohorts. We set the α level a priori at .01. This more stringent α level was chosen to control the family-wise error rate that would otherwise accompany the large number of statistical tests performed. Statistical analysis was performed using SPSS (version 22; IBM Corporation, Armonk, NY).

RESULTS

Given the heterogeneity in the numbers of female participants across the different groups (ranging from 0 in RTG3 to 12 [48%] in PG), data from these participants were excluded from the analysis. Cleaning led to the removal of data for 9 more cadets: 7 in the RTG and 2 in the PG. Therefore, the statistical analysis was performed on full data for 61 male police cadets, of whom 82% (n = 50) completed randomized training and 18% (n = 11) completed periodized training. The means and standard deviations for all anthropometric and fitness measures for the RTG as an aggregated whole and for the PG are presented in Table 2.

Within-Group Changes

The RTG improved in all areas of performance (all $P \leq .002$), but the PG improved only in the push-ups, sit-ups, and 300-m sprint (all $P < .001$; Table 3). Although the PG did reduce body weight ($P = .039$) and fat mass ($P = .014$) and improve in bench press ($P = .022$), the levels of significance for these changes were below the α level set a priori for this study.

Aggregated Randomized Training Groups Versus the Periodized Training Group

The change scores between groups are shown in Table 4. The RTG improved more than the PG for vertical jump (RTG mean change = 7.37 ± 5.91 cm, PG mean change = –0.23 ± 3.80 cm; $P < .001$), power (RTG mean change = 373.97 ± 377.90 W, PG mean change = –169.06 ± 313.83 W; $P < .001$), and 300-m sprints (RTG mean change = –5.13 ± 3.35 s, PG mean change = –1.94 ± 1.32 s; $P < .001$).

Considering this, the pretraining RTG vertical-jump scores (55.32 ± 10.68 cm) were lower than the PG scores (64.53 ± 8.60 kg; $P = .007$; Figure 1), and the posttraining PG vertical-jump scores (64.31 ± 9.22 cm) were still higher than, but not different from, the RTG scores (62.69 ± 8.64 cm; $P = .62$; Figure 1). Similarly, pretraining 300-m scores were faster in the PG (51.75 ± 4.18 seconds; Table 2) than in the RTG (53.36 ± 4.98 seconds; Table 2) but not different ($P = .28$). In addition, whereas we did not observe differences between the RTG and the PG for pretraining sit-up scores (RTG mean = 33.96 ± 9.02 repetitions, PG mean = 42.27 ± 8.51 repetitions; $P = .01$; Figure 1), we observed differences between the RTG (46.44 ± 5.40 repetitions)

Table 3. Change Scores for Within-Program Performance

Measure	Randomized Training Group			Periodized Training Group		
	Difference, Mean ± SD	95% Confidence Interval	Effect Size	Difference, Mean ± SD	95% Confidence Interval	Effect Size
Body weight, kg	−1.62 ± 3.46[a]	−2.60, −0.64	−0.13	−3.43 ± 4.80[b]	−6.66, −0.20	−0.23
Fat mass, %	−3.35 ± 3.06[a]	−4.22, −2.48	−0.59	−3.15 ± 3.51[b]	−5.51, −0.80	−0.51
Lean body mass, kg	1.62 ± 2.85[a]	0.82, 2.43	0.20	0.23 ± 3.72	2.27, −2.74	0.02
Bench press, kg	12.64 ± 12.18[a]	9.17, 16.10	0.53	6.82 ± 8.38[b]	1.19, 12.45	0.45
Push-up, repetitions	21.60 ± 11.95[a]	18.20, 25.00	1.43	16.73 ± 7.48[a]	11.70, 21.76	1.16
Sit-up, repetitions	12.48 ± 7.28[a]	10.41, 14.54	1.38	9.55 ± 5.75[a]	5.68, 13.41	1.12
Vertical jump, cm	7.37 ± 5.91[a]	5.69, 9.04	0.69	−0.23 ± 3.80	−2.79, 2.32	0.02
Power, W	373.97 ± 377.90[a]	266.57, 481.36	0.43	−169.06 ± 313.83	−379.89, 41.77	0.22
Aerobic 2.4-km run, min	−1.42 ± 0.94[a]	−1.68, −1.15	−1.01	−0.54 ± 0.96	1.18, −0.10	−0.38
Anaerobic 300-m sprint, s	−5.13 ± 3.35[a]	−6.10, −4.18	−1.03	−1.94 ± 1.32[a]	−2.82, −1.05	−0.46

[a] Indicates a difference between pretraining and posttraining measures ($P < .01$).
[b] Indicates a difference between pretraining and posttraining measures between $P = .01$ and $P < .05$, but it did not achieve the significance level for this study.

Table 4. Change Scores for Between-Programs Performance

Measures	Mean ± SD	95% Confidence Interval	Effect Size
Body weight, kg	3.99 ± 8.26	−3.32, 11.29	0.48
Fat mass, %	−0.19 ± 3.12	−2.65, 2.26	−0.06
Lean body mass, kg	3.06 ± 6.68	−2.62, 8.74	0.46
Bench press, kg	12.80 ± 25.85	−1.21, 26.81	0.50
Push-up, repetitions	4.87 ± 11.38	−0.96, 10.71	0.43
Sit-up, repetitions	2.93 ± 7.08	−1.31, 7.17	0.41
Vertical jump, cm[a]	7.60 ± 6.29	6.66, 10.54	1.21
Power, W[a]	543.02 ± 421.13	313.79, 772.26	1.29
Aerobic 2.4-km run, min[b]	−0.88 ± 1.00	−1.55, −0.20	−0.88
Anaerobic 300-m sprint, s[a]	−3.19 ± 3.32	−4.45, −1.94	−0.96

[a] Indicates a difference between groups ($P < .01$).
[b] Indicates a difference between groups between $P = .01$ and $P < .05$, but it did not achieve the significance level for this study.

and the PG (51.82 ± 5.23 repetitions) for posttraining scores ($P = .008$; Figure 1).

Finally, the pretraining bench-press scores were lower in the RTG (88.45 ± 23.69 kg) than in the PG (106.20 ± 15.15 kg) at pretraining ($P < .005$; Figure 1). However, when groups were compared, we did not observe differences ($P = .71$), and the PG pretraining scores were still higher than the RTG posttraining scores (101.09 ± 21.61 kg; Table 2).

Randomized Training Groups as Individual Classes Versus the Periodized Group

The supplementary analysis that we conducted to profile and investigate both the differences among the individual RTGs and the differences between individual RTGs and the PG are shown in Tables 5 and 6, respectively. Whereas aggregated RTG scores showed that the RTG program led to improvements within groups in all areas assessed, we did not observe this improvement when each RTG was reviewed individually (Table 6). Similarly, when comparing the RTG groups with each other and the PG, we noted some variations across the groups (Figure 2). For example, RTG1 improved in the sit-up more than the other RTGs and the PG (all $P < .01$; Figure 3), although the only difference in push-up scores was between the RTG4 and the PG ($P < .001$; Figure 3).

DISCUSSION

The aim of this retrospective cohort study was to evaluate the effectiveness of 2 physical training programs in improving multiple measures of fitness in police academy cadets. We found that both programs resulted in trends toward improvement in nearly all outcome measures after a 6-month training period. However, the effect of the training program, whether it used exercises spontaneously selected on the day of the workout or a periodized program, varied.

Anthropometric Measures

Training programs should help participants maintain a healthy body weight and fat mass, as these may lead to improved health, wellbeing, and career longevity. Researchers[22,23] have shown a correlation between a high fat mass and an increased risk of injury in tactical populations. Our results demonstrated that the randomized training program produced more desirable outcomes across the 3 anthropometric measures, reducing body weight and fat mass and increasing lean body mass, when compared with

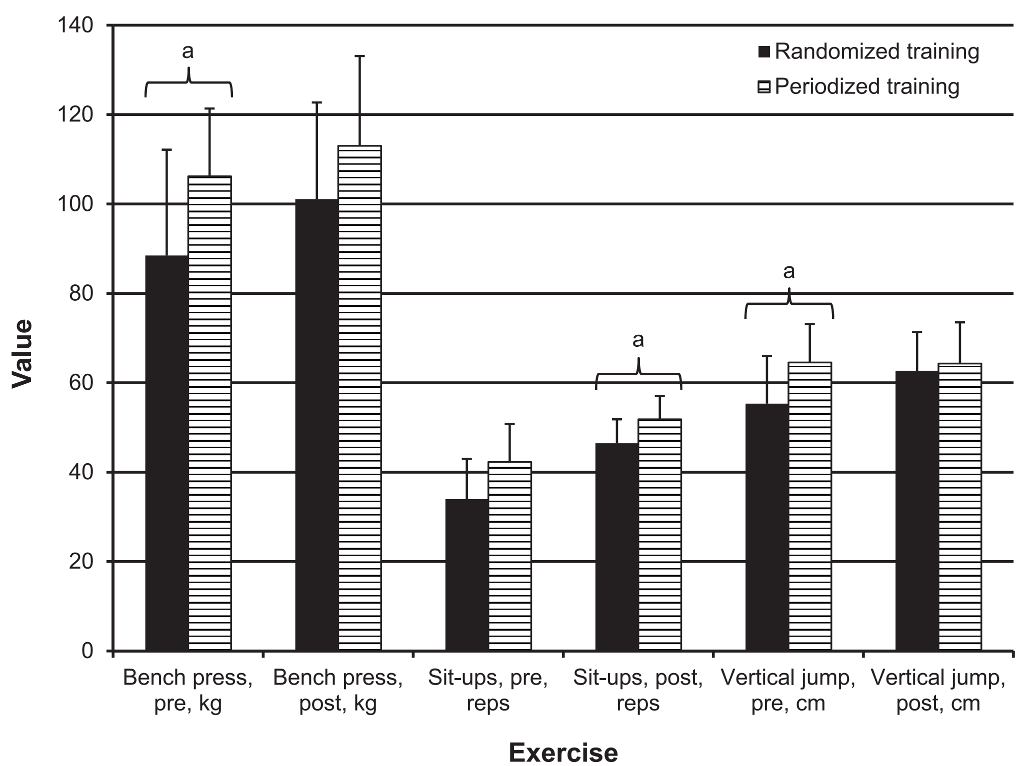

Figure 1. Differences (mean ± standard deviation) in pretraining (pre) and posttraining (post) bench-press, sit-up, and vertical-jump scores for the aggregated randomized training groups and the periodized training group. [a] Indicates difference between groups ($P < .01$).

Table 5. All Pretraining and Posttraining Measures for Each Randomized Training Group and the Periodized Group (Mean ± SD) Extended on Next Page

Measure	Randomized Training Group			
	1 (n = 13)		2 (n = 11)	
	Pretraining	Posttraining	Pretraining	Posttraining
Body weight, kg	87.48 ± 18.72	85.45 ± 16.59	88.68 ± 8.92	86.74 ± 7.25
Fat mass, %	20.05 ± 6.36	15.22 ± 4.89	16.36 ± 6.51	14.72 ± 5.49
Lean body mass, kg	69.03 ± 9.96	71.86 ± 10.74	73.76 ± 5.06	73.75 ± 5.26
Bench press, kg	81.64 ± 20.90	87.78 ± 18.03	91.74 ± 26.61	106.20 ± 25.06
Push-up, repetitions	41.38 ± 14.12	62.46 ± 12.10	50.64 ± 16.02	70.18 ± 9.62
Sit-up, repetitions	24.08 ± 9.27	44.69 ± 5.36	35.73 ± 4.24	44.18 ± 3.60
Vertical jump, cm	51.09 ± 9.19	58.42 ± 9.11	57.96 ± 10.72	61.77 ± 9.23
Power, W	5001.00 ± 1057.97	5354.06 ± 921.67	5471.73 ± 532.17	5615.21 ± 583.03
Aerobic 2.4-km run, min	13.08 ± 1.46	11.22 ± 1.20	12.80 ± 1.40	12.08 ± 0.96
Anaerobic 300-m sprint, s	52.24 ± 3.45	46.32 ± 3.07	52.94 ± 6.93	48.40 ± 5.16

the periodized training. Whereas the PG did result in decreases in both body weight and fat mass, these decreases were not different (Table 3). Therefore, we observed no differences between the 2 programs (Table 4) or among the individual RTG programs (Figure 4). Furthermore, not all RTG groups improved (Table 6).

Investigators examining the effects of a training program on anthropometric measures in tactical populations have reported mixed results. Heinrich et al,[24] who also studied changes in body weight and fat mass as outcome measures, compared a circuit-training program with a traditional training program in active-duty military personnel. In contrast to our findings, they concluded that neither training program produced changes in body weight or fat mass.[24] However, their study[24] was shorter (2 months) and focused mainly on weight-training exercises, whereas our study lasted 6 months and included programs that varied in weight and aerobic training. Similarly, Kraemer et al[25] studied the effects of 4 training programs (endurance-based only, resistance-based only, a combination of endurance and whole-body resistance, and a combination of endurance and only upper body resistance) on body weight and fat mass. Their programs lasted 3 months, and the 3 endurance-training programs resulted in decreased fat mass; however, only the resistance-based–only program resulted in a decrease in body weight.[25] Finally, an integral consideration when discussing body weight is the effect of diet and nutritional intake. The training programs that we considered did not aim to control or modify diet in any way, so this may have altered their anthropometric measures.

Muscular Fitness Measures

We observed increases in push-up and sit-up repetitions in 1 minute between pretraining and posttraining for both the RTG and PG. The 1-RM bench press improved scores in the aggregated RTG but not in the PG. Similarly, not all individual RTG scores differed for the 1-RM bench press. These results suggest that some variability existed in increases of 1-RM bench press. A potential reason for this observation was the number of training sessions that included bench-press exercises at a heavy, near-maximal intensity. No details were available of how often very heavy loads were lifted, whereas push-ups and sit-ups, which require no equipment, are known to be more commonly performed in tactical populations.

Researchers[24,25] commonly use 1-RM bench press, push-up repetitions, and sit-up repetitions as outcome measures when investigating training effects on tactical populations, and our results were consistent with previous studies. Heinrich et al[24] and Kraemer et al[25] included timed push-up and sit-up repetitions as outcome measures, and the former[24] also used 1-RM bench press as an outcome. The circuit-training group improved push-up performance and 1-RM bench press, but sit-up performance was not different for either group.[24] In their study of the effects of 4 training programs, Kraemer et al[25] reported that push-up perfor-

Table 6. Change Scores for Performance Between the Individual Randomized Training Groups and the Periodized Training Group (Mean ± SD)

Measure	Randomized Training Group				Periodized Training Group
	1 (n = 13)	2 (n = 11)	3 (n = 13)	4 (n = 13)	(n = 11)
Body weight, kg	−2.03 ± 3.45	−1.94 ± 4.11[a]	−2.13 ± 3.33[b]	−0.41 ± 3.11	−3.43 ± 4.80[b]
Fat mass, %	−2.20 ± 1.34[a]	−0.74 ± 1.19	−1.96 ± 1.34[a]	−1.06 ± 1.28[a]	−3.15 ± 3.51[b]
Lean body mass, kg	6.23 ± 1.98[a]	−0.01 ± 2.64	1.89 ± 3.19	1.53 ± 3.01	0.23 ± 3.72
Bench press change, kg	13.46 ± 9.57[b]	14.46 ± 7.35	−10.49 ± 11.27[a]	19.76 ± 15.28[a]	6.82 ± 8.38[b]
Push-up, repetitions	21.08 ± 13.14[a]	19.55 ± 9.77[a]	30.85 ± 9.80[a]	14.61 ± 9.22[a]	16.73 ± 7.48[a]
Sit-up, repetitions	20.62 ± 7.17[a]	8.45 ± 4.46[a]	10.77 ± 4.53[a]	9.46 ± 5.33[a]	9.55 ± 5.75[a]
Vertical jump, cm	7.33 ± 3.45[a]	3.81 ± 3.68[a]	14.65 ± 2.77[a]	3.13 ± 4.80[b]	-0.23 ± 3.80
Power, W	353.1 ± 318[a]	143.48 ± 186.35[b]	793.08 ± 214.86[a]	170.79 ± 350.28	−169.06 ± 313.83
Aerobic 2.4-km run, min	−1.86 ± 1.06[a]	0.72 ± 1.01[b]	−1.35 ± 0.65[a]	−1.64 ± 0.71[a]	−0.54 ± 0.96
Anaerobic 300-m sprint, s	−5.93 ± 3.35[a]	4.54 ± 2.79[a]	−2.82 ± 3.56	−7.15 ± 3.65[a]	−1.94 ± 1.32[a]

[a] Indicates a difference between groups ($P < .01$).
[b] Indicates a difference between groups between $P = .01$ and $P < .05$, but it did not achieve the significance level for this study.

Table 5. Extended From Previous Page

Randomized Training Group				Periodized Training Group (n = 11)	
3 (n = 13)		4 (n = 13)			
Pretraining	Posttraining	Pretraining	Posttraining	Pretraining	Posttraining
82.17 ± 9.36	80.03 ± 8.72	89.86 ± 11.46	89.44 ± 11.88	91.07 ± 15.15	87.64 ± 13.63
17.56 ± 4.84	13.25 ± 3.85	17.02 ± 5.00	14.68 ± 3.85	16.66 ± 6.18	13.51 ± 4.06
67.37 ± 4.90	69.26 ± 6.22	74.36 ± 9.01	75.88 ± 7.90	75.37 ± 9.98	75.60 ± 10.80
83.74 ± 20.93	94.23 ± 16.46	97.20 ± 25.68	116.96 ± 15.74	106.20 ± 15.15	113.02 ± 20.07
47.23 ± 15.59	78.08 ± 14.13	56.85 ± 12.04	71.46 ± 5.52	53.45 ± 14.40	70.18 ± 13.67
38.08 ± 7.45	48.85 ± 6.90	38.23 ± 5.36	47.69 ± 3.97	42.27 ± 8.51	51.82 ± 5.23
48.16 ± 8.21	62.82 ± 8.34	64.48 ± 6.76	67.60 ± 5.85	64.54 ± 8.59	64.31 ± 9.22
4582.85 ± 574.69	5375.92 ± 568.32	5920.87 ± 545.63	6091.67 ± 452.06	5979.54 ± 762.59	5810.48 ± 934.87
11.86 ± 9.36	10.51 ± 8.72	12.47 ± 0.97	10.83 ± 0.79	11.49 ± 1.41	10.94 ± 1.19
52.90 ± 4.84	50.08 ± 3.85	55.31 ± 4.44	48.15 ± 1.41	51.75 ± 4.18	49.81 ± 4.02

mance improved in all 4 groups, and sit-up performance improved in 3 groups. This shows that measures commonly associated with muscular strength and endurance can be improved with various approaches to training programs, including both the randomized style and periodized style implemented by the training academy; however, some variability would exist.

In another earlier study that was more similar to our study, Knapik et al[26] employed a periodized training program for military trainees. They also used 1-hour training sessions, but the programs were performed for only 7 weeks.[26] In addition, they included a control group that performed a traditional basic-training program.[26] Outcome measures included timed push-up and sit-up repetitions, and whereas the experimental group performed better on the push-up test than did the control group, both groups had similar outcomes on the sit-up test after training.[26] Therefore, their results differed from ours. In our study, push-up and sit-up performance increased in both groups but did not differ between groups in general (Table 4); however, we observed differences among RTG groups for sit-up improvements. One possible reason for the difference in results between the studies was the program schedule. Police cadets in our study performed 1-hour training sessions 5 days per week, whereas the military trainees in the previous study[26] performed 1-hour training sessions at least once and sometimes more than once each day. In addition, the incidental conditioning, such as carrying a load when doing tasks, may have increased their conditioning stimulus.

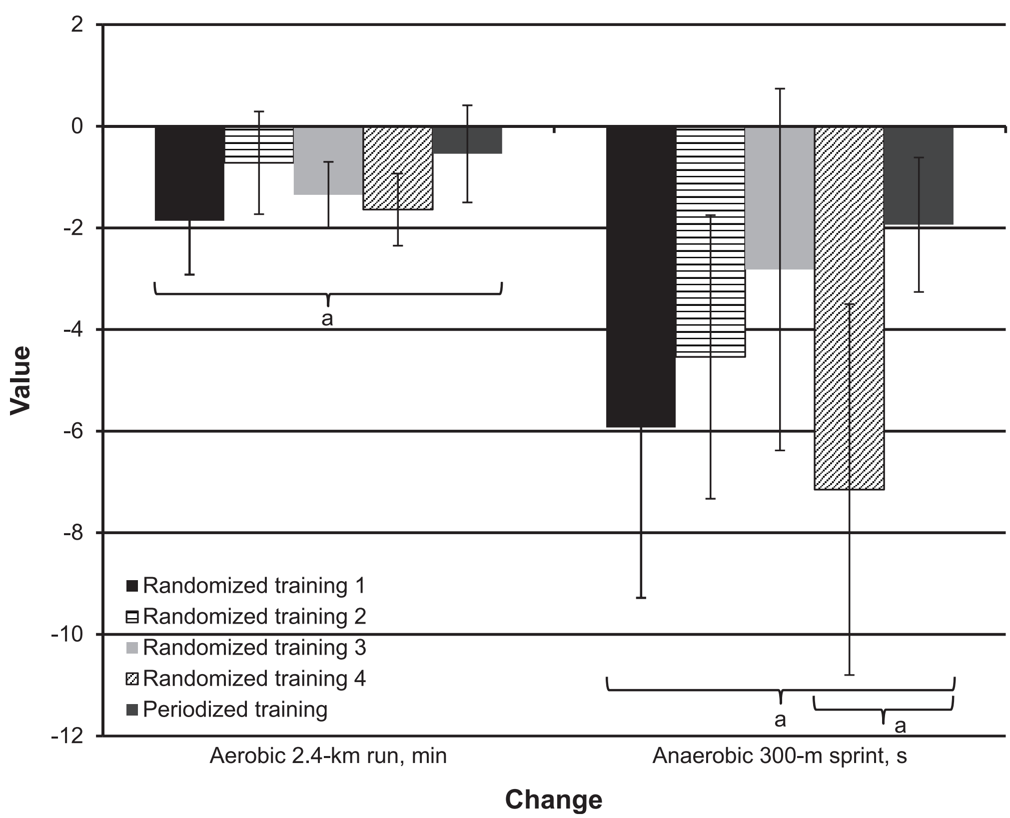

Figure 2. Differences (mean ± standard deviation) between the individual randomized training groups and the periodized group for the aerobic 2.4-km run and anaerobic 300-m sprint measures. [a] Indicates difference ($P < .01$).

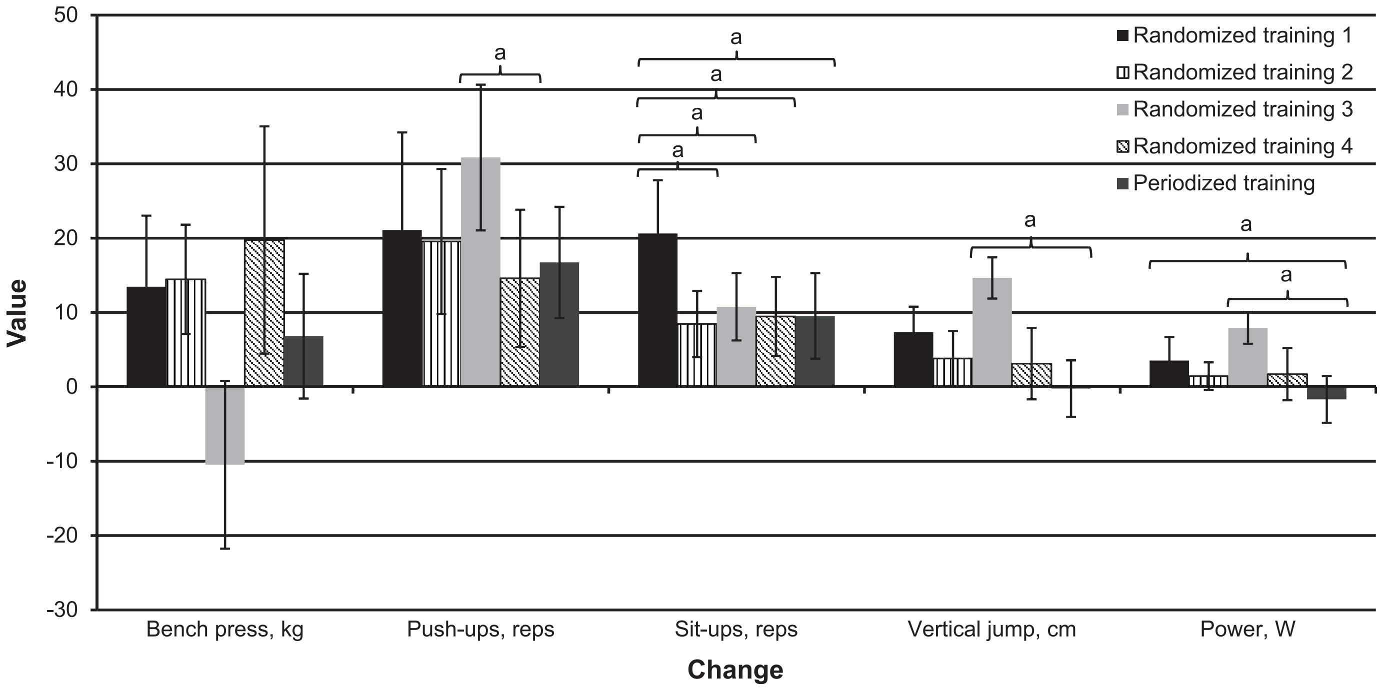

Figure 3. Differences (mean ± standard deviation) between the individual randomized training groups and the periodized group for the bench-press, push-up, sit-up, vertical-jump, and power measures. [a] Indicates difference ($P < .01$).

In our study, the PG lost power as measured by the vertical jump and predicted by the power equation of Sayers et al.[19] This observation was important because the periodized phase of training focused specifically on power. Therefore, the PG started at a higher level of power than the RTG and, although no longer different, still jumped higher than the RTG at posttraining. These results suggest a ceiling effect may have occurred, whereby the PG would not have been expected to improve measurably because participants may have started training at near-optimal levels.

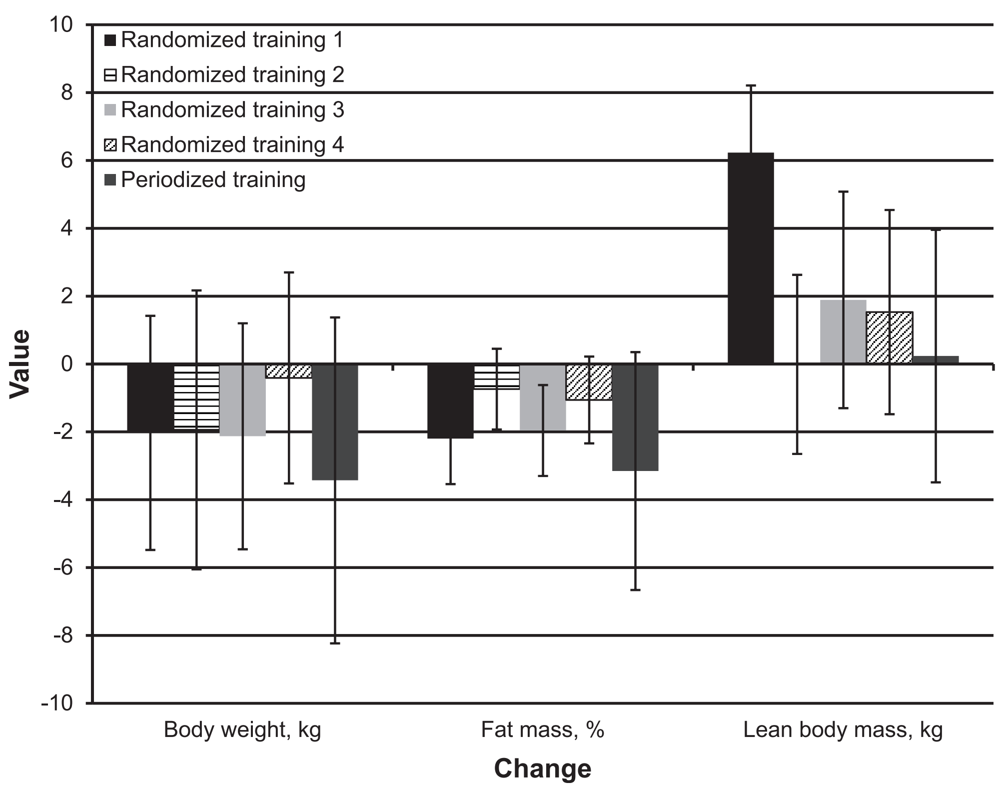

Figure 4. Differences (mean ± standard deviation) between the individual randomized training group and the periodized training group in body weight, fat mass, and lean body mass measures.

Metabolic Fitness Measures

We observed that the times to completion in an anaerobic 300-m sprint and an aerobic 2.4-km run were decreased for the aggregated RTG, but this observation was not consistent across all 4 groups. The PG improved in the 300-m sprint but not in the 2.4-km run. None of the studies used for comparison[24–26] included a short-distance anaerobic sprint as an outcome measure; however, all 3 used a longer aerobic run.

Knapik et al,[26] who employed a periodized approach as we did, included a 3.2-km run as an outcome measure. Both their intervention group and PG improved similarly in the aerobic 3.2-km run, and no difference existed between groups at posttraining.[26] This result has some similarities with and differences from our study. Whereas we did not observe differences between groups (Table 4), only the RTG improved in the aerobic 2.4-km run (Table 3). Heinrich et al[24] and Kraemer et al[25] also used a 3.2-km aerobic run as an outcome measure. However, the authors of both studies determined that their training groups improved. Heinrich et al[24] reported that the circuit-training intervention group improved run times at posttraining compared with their traditional training group. Kraemer et al[25] observed that 3 of their 4 intervention groups (those including endurance training) had improvements in run times at posttraining. Whereas training programs in all the cited studies tended toward improvement in metabolic fitness, periodized training programs did not appear to provide additional benefit over traditional programs for improving this specific measure in tactical populations. A potential reason may have been the final block period of training, which focused on strength and power just before testing (Table 1).

Strengths and Limitations

Our study had several strengths. First, each training program was performed over 6 months, whereas other researchers[24–26] investigated much shorter training durations. This longer duration allowed results to accumulate and enabled us to more adequately assess the differences in outcomes between the training styles. Second, we used a variety of outcome measures, including anthropometrics and muscular and metabolic fitness. The variety of outcome measures enabled us to examine the effects of a training program on individual health and well-being across different profiles and aspects of health. Third, the variety of outcome measures has been used commonly in previous studies, allowing more direct comparison between our results and those of other researchers.

A notable limitation of our study was the lack of information on the injury rates associated with the 2 approaches over the duration of training. Periodized training has often been used in the training of military personnel, as it has been shown to produce outcomes similar to other types of training but with a reduced rate of injury.[13] The built-in unloading phases that the periodized training program uses for recovery and to transition focus in training may unload musculoskeletal structures, allowing adequate recovery time and reducing the rate and risk of injuries.[27,28] Another limitation was the relatively small sample size of the PG; nearly 3 times as many participants completed the randomized training (n = 50) as the periodized training (n = 11). Whereas our statistical analysis was expected to mitigate this limitation, a larger study with more evenly distributed sample sizes between groups might have narrowed the differences observed. The differences in the intents of the 2 programs was another limitation. The randomized program focused specifically on passing the final fitness assessments, so all conditioning and exercises were directed toward this outcome. Conversely, the intent of the periodized program was to progressively increase all measures of fitness in the police cadets to prepare them for future occupational tasks. Finally, given that the data were analyzed retrospectively, we had no opportunity to either randomize the groups or capture personal physical training conducted during nonacademy hours.

Future studies of the optimal conditioning programs for tactical personnel are needed. They should include injury rates and types (ie, acute musculoskeletal, overuse) as outcome measures to determine if 1 training program adequately prepares trainees without increasing the risk of injury. Researchers may also consider performing a long-term follow-up with their participants (6 or 12 months posttraining) to determine if the training programs provided any lasting effects or if their participants are continuing to exercise and maintain adequate fitness levels after completing their initial tactical training.

CONCLUSIONS

Physical training programs can improve the fitness of tactical athletes, such as police officers, regardless of format. Our results suggested that a program including a variety of randomly selected workout exercises may better improve specific fitness measures over the short term than a specifically structured training program that focuses on individual areas of performance. An important caveat, however, is the potential injury risk associated with the randomized programs. Whereas periodized programs have been shown to reduce the injury rates in tactical trainees because they incorporate unloading phases to allow adequate rest, further research is required to investigate whether randomized programs may lead to a higher risk of injury. Similarly, the long-term fitness and health outcomes of a randomized versus periodized approach are needed, as these trainees ultimately are being prepared for careers as police officers and not merely to pass their initial fitness assessments.

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