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EVALUATION OF PHYSICAL FITNESS PROGRAMS FOR POLICE OFFICERS*

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INTRODUCTION

In September 1975 an experimental program evaluating the effects of various exercise programs on police officers was implemented in Dallas, Texas. The experimental program was predicated upon several questions concerning the physical fitness of police officers. What are the fitness needs of police officers? How do the levels of fitness for police officers compare with other occupational groups? What are the factors involved in implementing exercise programs for police departments of various sizes, locations, and financial structures? Some of these questions are subjects of other papers (1,2). It is the purpose of this paper to document the physiological changes incurred with various physical training programs implemented for police officers of different ages and job descriptions. The physical fitness needs of the young patrolman differ from those of the middle-aged administrative officer. As shown in the previous paper by Pollock and Gettman (1), a higher number of risk factors for coronary heart disease was observed for the middle-aged officers. Their needs are primarily in the area of developing good cardiovascular function and reducing the risk of coronary heart disease. The younger patrolmen often are faced with greater physical challenges such as apprehending suspects and calming disturbances. Their needs are in the areas of increased strength and muscular endurance as well as improved cardiovascular function. For these reasons, various programs of running and weight training were designed to evaluate their physiological effects on police officers.

METHODOLOGY

Selection of Participants

Three different experiments were designed. Experiments 1 and 2 involved young officers, aged 22 to 35 years; 29 from a relatively small suburban police department of Richardson, Texas; 3 officers from the Texas Department of Public Safety; and 130 officers from the Dallas Police Department. Experiment 3 included 31 middle-aged (36 to 55 years) officers from the Dallas Police Department.

The officers were volunteers and were required to complete various medical and physical fitness evaluations before being allowed to participate in the exercise programs. All officers completed a medical history questionnaire (which was reviewed by a physician) and then evaluated by a Bruce maximal treadmill stress test (3) monitored for electrocardiogram (ECG) and blood pressure. The test progressed in three minute stages until the individual reached a voluntary maximal endpoint. The following lists the stages used in the Bruce treadmill test:

Stage	Speed (mph)	Grade (%)
1	1.7	10
2	2.5	12
3	3.4	14
4	4.2	16
5	5.0	18
6	5.5	20

Officers who exhibited abnormal ECG or blood pressure results on this "screening" test as determined by the physician were asked to consult their private physician and were not selected for the study. Only healthy and previously sedentary officers were selected for subsequent fitness evaluations and exercise participation. The comprehensive physical fitness evaluation included cardiovascular, pulmonary, body composition, blood, and motor ability tests. Specific items within each test are listed in the previous paper (1) and will be described in detail in the following section.

Physical Fitness Testing

Prior to the first visit to the laboratory for testing, each participating officer was required to abstain from eating, drinking, and smoking for 14 hours. Upon arriving at the laboratory a 15 ml blood sample was drawn for analysis of serum lipids (cholesterol and triglycerides) and serum glucose. A second sample was drawn on a separate day for comparison and if the two samples did not agree, a third analysis was required.

Resting cardiovascular (CV) function was assessed by seating each officer in a quiet room for a 10 minute period and then recording his resting heart rate and blood pressure. Heart rate was counted for one minute using a stethoscope and blood pressure was measured using a mercury sphygmomanometer. Submaximal CV function was measured by heart recovery from a three minute step test (4). Each officer performed the three minute test by stepping up and down on a 12 inch bench at a rate of 24 trips per minute. Immediately after completing the three minutes of stepping, the officer was seated and his recovery heart rate was counted for one full minute (0:05 to 1:05 into recovery).

In addition to the initial screening test, maximum cardiorespiratory function was assessed a second time by a treadmill test during which the individual was asked to perform "all out." The young officers were tested using a treadmill running protocol described by Åstrand (5) as modified by Pollock et al. (6). The speed of running remained the same throughout the test but the grade of the treadmill changed 2.5% progressively every two or three minutes. The middle-aged officers were tested a second time using the same Bruce treadmill test protocol (3) described previously. The maximum amount of time performed in the treadmill test is considered a measure of working capacity, i.e., the longer one performs in the standard protocol, the more fit the individual. During the second treadmill tests maximum oxygen intake ($\dot{V}O_2$ max), maximum heart rate (MHR), and maximal pulmonary ventilation ($\dot{V}_E$ max) measures were monitored. Metabolic procedures and calculations described by Consolazio et al. (7) were followed.

Body composition was analyzed by various measurements of body weight, girths, and skinfold fat. Body weight was measured to the nearest 10 grams on an Acme scale and later converted to pounds for statistical analysis. Skinfold fat measures were determined to the nearest 0.5 mm with a Lange caliper and included the chest, axilla, triceps, abdomen, hip, and thigh locations. Recommendations published by the Committee on Nutritional Anthropometry of the Food and Nutrition Board of the National Research Council were followed in obtaining skinfold data (8). Girth measures were taken to the nearest 0.1 cm with a Lufkin steel tape at the shoulder, chest, abdomen, waist, gluteal, thigh, bicep, and forearm locations. Specific recommendations on the exact locations for obtaining skinfold and girth measures are shown by Behnke and Wilmore (9). Body density was calculated for the young officers using the skinfold formula D = 1.08847 - (.007123 axilla) - (.004834 chest) - (.005513 triceps) reported by Pascale et al. (10). The formula D = 1.10185 - (.00072 chest) - (.00046 axilla) - (.001 gluteal girth) + (.00227 forearm girth) involving both skinfold and girth measures reported by Pollock et al. (11) was used to calculate body denstiy for the middle-aged officers. Body density was converted to percent body fat using the formula (fat = 4.95 ÷ D - 4.5) reported by Siri (12).

Vital capacity (VC) of the lungs and forced expiratory volume of air expelled in one second (FEV_1) were measured using a rolling seal spirometer (Ohio Medical Model 842). The procedures outlined by Kory et al. (13) and W. E. Collins, Inc. (14) were followed. FEV_1 was expressed as percentage of VC in the results (FEV_1 ÷ VC).

Various motor ability field tests were administered to represent areas of physical fitness that may enhance the performance of a police officer when challenged physically. Flexibility of the back and legs was determined by the sit and reach test (15). The total number of pushups and the number of bent-knee situps performed in one minute were used as measures of muscular endurance (15). Strength was represented by the one-repetition maximum bench press since it correlates well with total body strength (16). Power was described by the vertical jump test (17) and agility was represented by the Illinois Agility Run (18).

In addition to the above field tests, participating officers in the Richardson Police Department (RPD) were asked to perform the field test devised by that department. The field test had been used by the RPD for the past two years as a screening physical fitness test for applicants to the department. It consists of four parts each of which is timed

separately and then added to obtain a total score for the entire test. The first phase of the test is an obstacle course which included a three- and a six-foot wall to climb, a tunnel to crawl through, a six-inch beam to walk, and a 12 foot high horrizontal ladder to cross using the hand-over-hand technique. The second phase is called the body drag and involves running 65 feet, picking up a 160 pound dummy and dragging it 65 feet back to the start. The third phase is a stair run which includes two trips up and down two flights of stairs. The final phase is termed a "street chase" and consists of running 440 yards around a grass field area. The RPD feels that these items relate to the job requirements of their patrolmen.

Physical Fitness Programs

The exercise program for the young officers in Experiment 1 involved 20 weeks of jogging. The officers exercised 3 days per week for approximately 45 minutes per exercise session. The first 15 minutes of the workout was devoted to a warm-up period involving various stretching and calisthenic exercises. The remaining 30 minutes included a program of walking and jogging. Initially, the walking and jogging distances were equal but the training progressed throughout the 20 weeks in such a fashion that the individuals walked less and jogged longer distances. Some of the officers remained at equal distances of walking and jogging but increased their speed of running throughout the 20 weeks. Other officers alternated days of fast running at short distances with days of slower jogging at longer distances. For the purpose of presenting results in this paper, all of these participants were combined into one group called "young runners."

The participants in Experiment 2 also trained 3 days per week, 45 minutes per session for 20 weeks. However, after completing the standard warm-up exercises, they exercised 30 minutes in a program of weight training. The weights were adjusted so that each individual was working at 50% of his maximum strength and the repetitions progressed from 10 to 15 per set throughout the 20 weeks. The individual moved in a continuous fashion from one exercise to another with a minimum of 30 seconds rest between sets. Each set of the 8 weight training exercises was performed twice. The object in the weight training experiment was to determine if both cardiovascular and strength benefits could be obtained.

Experiment 3 involved middle-aged officers who trained in a program of progressive jogging similar to the first program described in Experiment 1. They performed the same warm-up exercises and then participated in a walking and jogging routine.

All officers in the above exercise programs trained at approximately 90% of their maximum heart rates during the 30 minute program following the warm-up. To insure that each officer exercised at this intensity, his heart rate was recorded (19) at the middle (15 minutes) and end (30 minutes) of each workout. In order to quantify the training of the running programs, the distances and times for walking and jogging segments were recorded for each workout. For example, an individual may have recorded 0.75 mile walking in 12 minutes and 2.0 miles jogging in 18 minutes. In this way, the energy cost for the total workout could be calculated. The weight training program was quantified by recording the number of repetitions and weight used for each exercise. For example, a person may have recorded 2 sets of 15 repetitions in the bench press exercise using 120 pounds.

All three experiments included control groups which consisted of volunteer officers who were asked to remain sedentary for the 20 week experimental period. After the 20 week experiments were completed, the control groups were provided the opportunity to exercise.

Several officers "dropped out" of the project and the actual number of those completing the program is less than described earlier. The reasons for dropping out of the program are not discussed here but will be the subject of another paper.

Data Processing

Means (averages) and standard deviations (variability) were calculated by computer on all the measurements taken before and after the 20 week training programs. Initial differences among the control and training groups were compared by analysis of variance (ANOVA). The analysis of covariance (ANCOVA) was used to determine the significant changes among the groups from before (T_1) to after (T_2) the training with T_1 scores being the covariates. A probability of 0.05 was used as the significance level in the statistical comparisons.

RESULTS AND DISCUSSION

A description in terms of average age, height, and weight of the participants in the various programs is presented in Table 1. The 82 officers in the young age category averaged 29 to 30 years and the 18 officers in the middle-aged groups averaged 40 to 41 years of age. All groups were approximately the same height (70 to 71 inches) but the middle-aged officers were about 10 to 20 pounds heavier compared to the younger officers. This was mainly due to the higher amount of body fat in the middle-aged officers.

The effects of the programs on resting heart rate, blood pressure, and recovery heart rate from the three minute step test are shown in Table 2. When comparing the runners with their respective control groups, resting heart rate was significantly lowered through 20 weeks of running. The young runners lowered their resting heart rates by 5 beats/min and the middle-aged runners by 8 beats/min. A similar observation was made for the recovery heart rate from the step test. The lowering of resting heart rate and recovery heart rate from submaximal work through exercise programs of running has been shown in other studies (20-23). As a result of training, the heart is stronger, pumps more blood per beat, is more efficient and therefore does not beat as rapidly at rest and during submaximal work. The weight training program did not provide a statistically significant reduction in resting or recovery heart rate; although a trend for a lower step test heart rate was seen. Thus, the weight training program used in this study did not affect significantly resting or submaximal cardiovascular function. The sedentary control groups showed no changes in the above variables. The resting blood pressures were normal and did not change for any of the exercise or control groups. This also has been observed in other studies particularly when the blood pressures are normal initially (20-23).

The results of the maximum cardiorespiratory testing are presented in Table 3. The significant effects of the exercise programs on the young and middle-aged runners are again quite evident. Treadmill performance time and maximum oxygen intake ($\dot{V}O_2$ max) were significantly improved

in those groups. The weight training group improved significantly in treadmill time but not in $\dot{V}O_2$ max. Little evidence is available showing the effects of weight training on cardiorespiratory function. This study agrees with Allen et al. (24) who showed no changes in $\dot{V}O_2$ max with weight training but contradicts the results by Wilmore et al. (25) who reported small but statistically significant improvements in $\dot{V}O_2$ max during weight training for women. The results in this study with men show no changes in $\dot{V}O_2$ max but improvements in treadmill running time. This in in agreement with a recent study by Wilmore (personal communication) conducted on young men. The improved running performance is probably explained by the increased leg strength gained through the weight training. It is well known that treadmill performance time and $\dot{V}O_2$ max are improved through programs of running (20-23) and are reflective of improvement in maximum cardiorespiratory function. Having an increased working capacity would be desirable for an officer since he would be able to run faster and longer if required to chase a suspect. Having an increased ability to take in and utilize oxygen is also a desirable outcome of training. This indicates that many functions of the body are enhanced and the individual is in a better state of total health.

The results of the body composition measures are shown in Table 4. Body weight did not change in the young runners but percent body fat showed a significant reduction. The significant reduction in the sum of six skinfold measures further supports the loss of body fat. This means that the lean body mass of the runners increased since total body weight remained the same. The increase in lean body mass is particularly evident for the weight trainers. They gained an average of one pound of body weight while losing a significant amount of fat. Weight training stimulates the deposition of protein in the muscle and therefore results in an increase of lean body mass (25). The middle-aged runners reduced in body weight, percent fat, and total skinfold fat. The waist girths for both the young and middle-aged training groups were also significantly reduced. The change in body composition through various programs of exercise is in agreement with other investigations (20-23,26-27).

The results of the motor ability field tests are shown in Table 5. The number of situps performed in one minute, the total number of pushups, and the one-repetition maximum bench press were improved significantly in the young runners and weight trainers. Of particular interest was the large increase in upper body performance (pushups and bench press) exhibited by the weight trainers. This reflects the specificity of improvement in performance as it relates to the type of training. Although a definite trend in improvement of motor ability was seen with the middle-aged runners, none of the changes were statistically significant. The changes observed in the young exercisers were reflective of muscular endurance and strength improvements and are partially explainable by the warm-up program required of all exercisers. Included within the warm-up calisthenics were pushups and situps as well as various stretching exercises. Improvements in flexibility, power, and agility were expected but not observed; however, the previous paper (1) showed that the young officers had good levels of flexibility before the training programs were implemented. It is difficult to improve upon a fitness element that is already well-developed.

The results from the Richardson Police Department field testing are presented in Table 6. Average times for each of the four parts of the

test are presented along with the total time for the entire test. Although a definite trend in improvement was seen for the training group the only statistically significant changes observed were in the 440 yd run and total time. The environmental temperature was significantly higher during the final testing session and could have affected the results. In any case, the specificity of running training is reflected through improvement in the 440 yd running performance test. The obstacle course, body drag, and stair run items of the test require short bursts of intense activity. This type of training was not included in the Richardson training program. Perhaps the inclusion of weight training and sprinting or other specific exercises relating to the obstacle course, body drag, and stair run would have produced even more changes than were observed in those tests. If these items are considered highly related to job performance by the police departments, then specific exercises that affect these physical tasks should be provided. A comprehensive program of weight training, sprinting, and distance running would seem to be the optimal program.

Blood and lung volume measures are summarized in Table 7. All values were within the normal range for serum lipids (cholesterol and triglycerides), glucose, lung vital capacity, and forced expiratory volume for one second and did not change significantly for any of the groups. This lack of change for these variables has also been observed in past studies (19-20). The cholesterol and triglyceride changes for the middle-aged runners appear to be significant; however, the average drop in those variables was due mainly to one individual who initially had very high values and then subsequently lowered them toward normal levels. Milesis (28) also observed a significant lowering of serum lipids through training in certain individuals who started with abnormally high levels.

SUMMARY

The various exercise programs implemented within the police departments significantly affected the participating officers. The physiological changes observed on the young and middle-aged runners were in desirable directions resulting in improved working capacity, cardiovascular function, body composition, and muscular endurance and strength. The weight training program did not affect cardiovascular function but significantly improved treadmill running performance, body composition, strength, and muscular endurance measures. Based on these results, it was concluded that future programs for police officers should include a combination of running, strength training, and motor ability development.

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Table 1. Physical characteristics of participants in Police Physical Fitness Programs.

Group	Age (yr) $\bar{X}$	Age (yr) SD	Height in(cm) $\bar{X}$	Height in(cm) SD	Weight lb(kg) $\bar{X}$	Weight lb(kg) SD
Young Controls n = 23	30.0	4.0	70.9 (180.1)	3.1 (7.9)	186 (84.56)	23 (10.6)
Young Runners n = 48	29.4	3.0	70.4 (178.8)	2.4 (6.1)	179 (81.42)	22 (10.4)
Young Weight Trainers n = 11	28.9	3.6	70.9 (180.1)	1.0 (2.5)	188 (85.47)	28 (12.7)
Middle-Aged Runners n = 11	41.3	5.0	70.8 (179.8)	1.2 (3.0)	198 (90.02)	24 (10.7)
Middle-Aged Controls n = 7	39.9	3.8	71.0 (180.3)	2.4 (6.1)	202 (91.92)	21 (9.6)

Table 2. Effects of exercise programs on cardiovascular function of police officers.

Group	Variable	Test Conditions: Before Training $\bar{X} \pm SD$	After Training $\bar{X} \pm SD$	Mean Difference
Young Controls n = 23	Rest HR[a] (beats/min)	63 ± 7	66 ± 7	+3
	Rest SBP[b] (mmHg)	123 ± 9	119 ± 7	-4
	Rest DBP[c] (mmHg)	83 ± 8	80 ± 7	-3
	Step Test HR[d] (beats/min)	109 ± 18	110 ± 13	+1
Young Runners n = 48	Rest HR (beats/min)	64 ± 9	59 ± 7	-5*
	Rest SBP (mmHg)	121 ± 8	118 ± 8	-3
	Rest DBP (mmHg)	81 ± 7	78 ± 7	-3
	Step Test HR (beats/min)	108 ± 13	95 ± 11	-13*
Young Weight Trainers n = 11	Rest HR (beats/min)	64 ± 10	63 ± 9	-1
	Rest SBP (mmHg)	125 ± 7	119 ± 6	-6
	Rest DBP (mmHg)	84 ± 3	82 ± 4	-2
	Step Test HR (beats/min)	109 ± 26	103 ± 23	-6
Middle-Aged Runners n = 11	Rest HR (beats/min)	70 ± 10	62 ± 13	-8*
	Rest SBP (mmHg)	123 ± 5	120 ± 10	-3
	Rest DBP (mmHg)	87 ± 7	83 ± 10	-4
	Step Test HR (beats/min)	115 ± 13	94 ± 11	-21*
Middle-Aged Controls n = 7	Rest HR (beats/min)	63 ± 8	64 ± 9	+1
	Rest SBP (mmHg)	129 ± 9	125 ± 11	-4
	Rest DBP (mmHg)	84 ± 10	86 ± 11	+2
	Step Test HR (beats/min)	113 ± 21	108 ± 17	-5

[a] Rest HR = Resting heart rate
[b] Rest SBP = Resting systolic blood pressure
[c] Rest DBP = Resting diastolic blood pressure
[d] Step Test HR = Recovery heart rate from three minute step test
* Significant improvement when compared to control group

Table 3. Effects of exercise programs on maximum cardiorespiratory function of police officers

Group	Variable	Test Conditions: Before Training $\bar{X} \pm SD$	After Training $\bar{X} \pm SD$	Mean Difference
Young Controls n = 23	Treadmill Time[a] (min:sec)	7:17 ± 0:51	6.58 ± 0:47	-0:19
	$\dot{V}O_2$ max[b] (ml/kg•min)	39.5 ± 3.7	38.0 ± 3.6	-1.5
	Max HR (beats/min)	192 ± 11	191 ± 10	-1
	$\dot{V}_E$ max BTPS[c] (L/min)	108.7 ± 14.6	110.6 ± 14.2	+1.9
Young Runners n = 48	Treadmill Time (min:sec)	7:48 ± 0:46	10:05 ± 1:02	+2:17*
	$\dot{V}O_2$ max (ml/kg•min)	41.1 ± 3.9	46.4 ± 4.5	+5.3*
	Max HR (beats/min)	193 ± 8	189 ± 7	-4*
	$\dot{V}_E$ max BTPS (L/min)	110.6 ± 14.8	118.8 ± 15.9	+8.2*
Young Weight Trainers n = 11	Treadmill Time (min:sec)	7:22 ± 0:52	8:05 ± 1:09	+0:43*
	$\dot{V}O_2$ max (ml/kg•min)	40.0 ± 4.9	41.4 ± 4.5	+1.4
	Max HR (beats/min)	195 ± 10	191 ± 11	-4*
	$\dot{V}_E$ max BTPS (L/min)	108.6 ± 13.2	110.1 ± 14.6	+1.5
Middle-Aged Runners n = 9	Treadmill Time (min:sec)	9:46 ± 0:35	11:05 ± 0:47	+1:19*
	$\dot{V}O_2$ max (ml/kg•min)	33.6 ± 2.2	40.2 ± 3.8	+6.6*
	Max HR (beats/min)	182 ± 3	177 ± 4	-5*
	$\dot{V}_E$ max BTPS (L/min)	110.9 ± 16.1	113.3 ± 17.6	+2.4
Middle-Aged Controls n = 7	Treadmill Time (min:sec)	10:03 ± 1:02	10:23 ± 0:22	+0:20
	$\dot{V}O_2$ max (ml/kg•min)	34.1 ± 4.7	35.8 ± 4.2	+1.7
	Max HR (beats/min)	180 ± 11	185 ± 10	+5
	$\dot{V}_E$ max BTPS (L/min)	107.5 ± 14.8	113.1 ± 9.9	+5.6

[a] Treadmill protocols differed between young and middle-aged men
[b] $\dot{V}O_2$ max = Maximum oxygen intake
[c] $\dot{V}_E$ max BTPS = Maximum pulmonary ventilation; body temperature, pressure, saturated
* Significant improvement when compared to control group

Table 4. Effects of exercise programs on body composition of police officers

Group	Variable	Test Conditions: Before Training $\bar{X} \pm SD$	After Training $\bar{X} \pm SD$	Mean Difference
Young Controls n = 23	Weight (lb)	186 ± 23	185 ± 22	-1
	Body Fat (%)	19.4 ± 3.4	19.8 ± 3.5	+0.4
	Sum 6 Skinfolds (mm)	133 ± 30	138 ± 30	+5
	Shoulder Girth (in)	46.6 ± 2.7	47.2 ± 2.8	+0.6
	Waist Girth (in)	37.1 ± 3.1	37.4 ± 3.2	+0.3
Young Runners n = 48	Weight (lb)	179 ± 22	179 ± 23	0
	Body Fat (%)	18.9 ± 4.0	17.1 ± 3.5	-1.8*
	Sum 6 Skinfolds (mm)	131 ± 34	116 ± 30	-15*
	Shoulder Girth (in)	46.1 ± 2.1	46.1 ± 2.0	0
	Waist Girth (in)	36.2 ± 2.9	35.7 ± 2.9	-0.5*
Young Weight Trainers n = 11	Weight (lb)	188 ± 28	189 ± 14	+1
	Body Fat (%)	18.3 ± 5.7	17.2 ± 5.4	-1.1*
	Sum 6 Skinfolds (mm)	132 ± 50	119 ± 48	-13*
	Shoulder Girth (in)	46.8 ± 2.4	47.7 ± 2.6	+0.9
	Waist Girth (in)	36.8 ± 4.1	36.4 ± 4.2	-0.4*
Middle-Aged Runners n = 11	Weight (lb)	198 ± 24	190 ± 24	-8*
	Body Fat (%)	25.2 ± 5.7	22.7 ± 6.0	-2.5*
	Sum 6 Skinfolds (mm)	135 ± 33	117 ± 35	-18*
	Waist Girth (in)	39.2 ± 3.4	37.8 ± 3.5	-1.4*
Middle-Aged Controls n = 7	Weight (lb)	202 ± 21	201 ± 24	-1
	Body Fat (%)	26.7 ± 5.2	26.8 ± 4.6	+0.1
	Sum 6 Skinfolds (mm)	145 ± 40	147 ± 39	+2
	Waist Girth (in)	39.7 ± 3.5	39.7 ± 3.5	0

* Significant change when compared to control group

Table 5. Effects of exercise programs on strength, muscular endurance, and motor ability of police officers.

Group	Variable	Test Conditions		
		Before Training $\bar{X} \pm SD$	After Training $\bar{X} \pm SD$	Mean Difference
Young Controls n = 23	Flexibility (in)	17.5 ± 2.8	16.8 ± 3.7	-0.7
	Situps (#)	33 ± 6	30 ± 7	-3
	Pushups (#)	20 ± 5	20 ± 5	0
	Bench Press (lb)	145 ± 30	142 ± 24	-3
	Vertical Jump (in)	17.9 ± 2.2	17.5 ± 2.6	-0.4
	Agility (sec)	18.5 ± 1.1	19.0 ± 0.9	+0.5
Young Runners n = 48	Flexibility (in)	17.6 ± 3.1	17.2 ± 3.8	-0.4
	Situps (#)	35 ± 7	37 ± 6	+2*
	Pushups (#)	21 ± 8	29 ± 9	+8*
	Bench Press (lb)	152 ± 18	164 ± 24	+12*
	Vertical Jump (in)	17.8 ± 2.3	17.2 ± 3.1	-0.6
	Agility (sec)	18.5 ± 0.9	18.6 ± 1.0	+0.1
Young Weight Trainers n = 11	Flexibility (in)	20.1 ± 2.9	18.0 ± 3.2	-2.1
	Situps (#)	34 ± 6	38 ± 6	+4*
	Pushups (#)	22 ± 8	32 ± 11	+10*
	Bench Press (lb)	150 ± 24	203 ± 48	+53*
	Vertical Jump (in)	17.0 ± 2.1	17.1 ± 2.6	+0.1
	Agility (sec)	18.8 ± 1.2	19.6 ± 1.7	+0.8
Middle-Aged Runners n = 11	Flexibility (in)	13.7 ± 3.7	14.3 ± 3.4	+0.6
	Situps (#)	23 ± 7	31 ± 5	+8
	Pushups (#)	15 ± 7	21 ± 7	+6
	Bench Press (lb)	146 ± 13	158 ± 19	+12
Middle-Aged Controls n = 7	Flexibility (in)	13.8 ± 5.8	14.8 ± 5.0	+1.0
	Situps (#)	28 ± 8	30 ± 7	+2
	Pushups (#)	14 ± 5	16 ± 7	+2
	Bench Press (lb)	155 ± 20	154 ± 15	-1

* Significant improvement when compared to control group

Table 6. Effects of endurance training on Richardson Police Department field test.

Group	Variable	Test Conditions		
		Before Training $\bar{X} \pm SD$	After Training $\bar{X} \pm SD$	Mean Difference
Control (n=5)	Obstacle Course (min:sec)	0:50 ± 0:06	0:54 ± 0:10	+0:04
	Body Drag (min:sec)	0:23 ± 0:03	0:22 ± 0:03	-0:01
	Stair Run (min:sec)	0:46 ± 0:04	0:47 ± 0:04	+0:01
	440 yd Run (min:sec)	1:58 ± 0:28	2:11 ± 0:22	+0:13
	Total Time (min:sec)	3:57 ± 0:36	4:09 ± 0:36	+0:12
Training (n=11)	Obstacle Course (min:sec)	0:49 ± 0:10	0:46 ± 0:07	-0:03
	Body Drag (min:sec)	0:24 ± 0:04	0:22 ± 0:05	-0:02
	Stair Run (min:sec)	0:48 ± 0:05	0:45 ± 0:04	-0:03
	440 yd Run (min:sec)	1:43 ± 0:13	1:39 ± 0:15	-0:04*
	Total Time (min:sec)	3:44 ± 0:24	3:32 ± 0:21	-0:12*

* Significant improvement when compared to control group.

Table 7. Effects of exercise programs on serum lipids, glucose, and lung volumes of police officers

Group	Variable	Test Conditions		
		Before Training $\bar{X} \pm SD$	After Training $\bar{X} \pm SD$	Mean Difference
Young Controls n = 23	Cholesterol (mg %)	196 ± 35	202 ± 33	+6
	Triglyceride (mg %)	133 ± 75	140 ± 69	+7
	Glucose (mg %)	82 ± 6	85 ± 8	+3
	Vital Capacity (L)	5.70 ± 0.90	5.44 ± 0.87	-0.26
	FEV_1 (%)[a]	80 ± 5	79 ± 5	-1
Young Runners n = 48	Cholesterol (mm %)	198 ± 47	200 ± 44	+2
	Triglyceride (mg %)	115 ± 63	107 ± 52	-8
	Glucose (mg %)	83 ± 5	86 ± 4	+3
	Vital Capacity (L)	5.66 ± 0.92	5.47 ± 0.89	-0.19
	FEV_1 (%)	81 ± 4	81 ± 5	0
Young Weight Trainers n = 11	Cholesterol (mg %)	189 ± 13	184 ± 16	-5
	Triglyceride (mg %)	84 ± 22	99 ± 38	+15
	Glucose (mg %)	83 ± 7	87 ± 8	+4
	Vital Capacity (L)	5.93 ± 0.75	5.70 ± 0.76	-0.23
	FEV_1 (%)	79 ± 5	81 ± 6	+2
Middle-Aged Runners n = 11	Cholesterol (mg %)	264 ± 53	219 ± 37	-45
	Triglyceride (mg %)	215 ± 220	145 ± 104	-70
	Glucose (mg %)	85 ± 10	85 ± 7	0
	Vital Capacity (L)	4.71 ± 0.65	5.27 ± 0.58	+0.56
	FEV_1 (%)	80 ± 8	79 ± 6	-1
Middle-Aged Controls n = 7	Cholesterol (mg %)	225 ± 24	214 ± 21	-11
	Triglyceride (mg %)	128 ± 29	146 ± 31	+18
	Glucose (mg %)	82 ± 5	87 ± 5	+5
	Vital Capacity (L)	4.92 ± 0.68	5.48 ± 0.90	+0.56
	FEV_1 (%)	81 ± 3	80 ± 4	-1

[a] FEV_1 (%) = Forced expiratory volume for one second ÷ Vital Capacity

END