Development of Methods and Programs To
Promote Physical Fitness Among Police Officers

Report 2

Methods Police Departments Can Utilize To Determine the Need for Physical Fitness Programs: Recommended Program Implementation

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Methods Police Departments Can Utilize To Determine the Need for Physical Fitness Programs: Recommended Program Implementation

by

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INTRODUCTION

In recent years scientific interest and concern about the relationship of coronary heart disease (CHD) and physical fitness, and the relationship of other physiological and socio/psychological benefits of exercise, has increased significantly. Numerous population studies have been conducted on various age and occupational groups to determine the value of physical activity as a means of preserving or enhancing health. These would include studies of London transport employees,(1) Los Angeles City civil service employees,(2) farmers,(3) postal workers,(4) and railroad workers(5) to name a few. Additionally, studies to determine the physiological effects of exercise training have been conducted on sedentary men 49 to 65 years of age,(6) track athletes 40 to 75 years of age,(7) and numerous other individuals who voluntarily and individually participate in exercise training.(8)

As extensive as the general literature is on physical fitness, few references could be found regarding physical fitness and the police. This is unfortunate considering the fact that the sedentary nature of police work, coupled with shift work, job-related stress, and numerous other factors contribute to a high rate of coronary heart disease among police officers.(9) To a certain extent the police have been and are cognizant of the need for their members to be physically fit. In the year 1900, at the seventh annual convention of the Police Chiefs of the United States and Canada, the conference program contained information promoting physical fitness for police officers.(10) In 1924, the National Committee on Police Welfare conducted a nationwide survey to determine the types of sports and recreation programs and facilities existing in police agencies.(11)

The related studies and past and present interest of the police, however, have not provided a systematic determination of what the fitness and programmatic needs of the police are. A clinical and analytical examination of the physiological fitness of police deputies was conducted by the Los Angeles County Sheriff's Department,(12) but the study did not include a consideration of the socio/psychological effects of exercise, nor did it consider different approaches to implement, organize and administer police fitness programs. The lack of much evidence concerning fitness standards and programs for the police indicated the need for further inquiry and provided the impetus for the undertaking of the research conducted.

The police are enigmatic in terms of their apparent attitudes and practices relative to physical fitness. There is universal agreement that there are times when on-the-job physical requirements are extremely high and that the patrol officer has to be capable of performing these physical feats when the occasion arises. Yet, available indicators point to the generalization that after the completion of recruit training, individual police officers show little initiative to keep themselves prepared to perform the varied physical requirements of the job. Furthermore, few police administrators have approached this problem programmatically.

Consequently, what is needed in the field of law enforcement is the systematic development and evaluation of programs and methods that can be used to ensure a high level of physical fitness among police personnel. This is the objective

of this project.

To accomplish the project objective, three broad areas relative to physical fitness and physical fitness programming were investigated. First, a variety of exercise programs were designed and conducted in controlled environments to assess the physiological effects of exercise on selected police personnel. Particular attention was given to the cardiovascular condition of the subjects since heart and circulatory diseases are two of the leading causes of non-accidental disability retirement among police officers.

Secondly, socio/psychological factors were assessed in terms of how these factors influence an individual's decision to participate in a fitness program, how they influence the degree of the individual's adherence to a fitness program, and how they influence the overall effectiveness of a fitness program.

The third area investigated in this study was a survey of the type and quality of physical fitness programs already in existence in various police departments. Information relative to the nature of the programs, methods of program organization and administration, levels of participation, legal aspects such as liability, and measures of effectiveness will be obtained. In conjunction with the national survey of police agencies, a survey of police officers was conducted for the purpose of obtaining individualistic responses to a number of questions which impact on the effectiveness of fitness programming and fitness program administration.

This is one of four reports produced in connection with this project and deals with measures police departments can use to determine the need for physical fitness programs and recommended program implementation. Other reports deal with the nature of specific exercise programs conducted by the Institute of Aerobics Research and; the experience of police departments in relation to the issue of physical fitness. The final report will be a manual including program guidelines for police administrators concerning the relevance of fitness programs, their organization, implementation and evaluation.

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CHAPTER 1

PRINCIPLES OF EXERCISE AND TERMINOLOGY

In recent years, physical fitness has taken still another beneficial aspect to human health in its relationship to the prevention of coronary heart disease. Coronary heart disease involves the deposition of fatty plaques in the major vessels of the heart. These plaques compromise the blood flow to the heart muscle, and if this condition becomes severe, the heart can develop a fatal arrhythmia or heart attack. Coronary heart disease has been related to several risk factors. These include high serum lipids (cholesterol and triglycerides), excessive body fat, elevated blood pressure (hypertension), smoking, elevated blood sugar (glucose) and uric acid, excessive emotional stress, physical activity, and family history.(1,5,7,9-11)

Although there are some conflicting views, recent studies by Morris et al. (13), Paffenbarger and Hale(14), and Cooper et al.(4) have placed strong evidence in favor of the role that exercise plays in preventive medicine. Morris et al.(13), in studying the leisure-time habits of over 16,000 male executive grade civil servants from 40 to 64 years of age, concluded that vigorous exercise apparently protected them against sudden fatal heart attacks and other first clinical attacks of coronary heart disease. The study by Paffenbarger and Hale(14) on 6,351 longshoremen, 35 to 75 years of age, indicated that the workers classified in a high caloric output job task had significantly lower death rates from coronary heart disease than those in a low energy cost job. Cooper et al.(4) in a cross-sectional study on 3,000 men, found a significant relationship between level of cardiorespiratory fitness and selected risk factors and fitness variables (serum cholesterol, triglycerides, glucose

and uric acid, systolic blood pressure, percent body fat and weight, resting heart rate, and forced vital capacity). Thus, through the reduction of risk factors associated with coronary heart disease, an officer who exercises and becomes physically fit may be indirectly protecting himself from heart disease.

In the context of this report a police officer with good physical fitness is considered to be one who possesses an efficient cardiovascular-respiratory system (good aerobic capacity), moderate to low levels of body fat, and adequate muscular strength, endurance, and flexibility. With these characteristics an officer would possess the means to accomplish daily tasks, both occupational and recreational without undue fatigue or risk of injury.

There are three basic components of physical fitness: cardiorespiratory fitness (CR), body compisition, and musculoskeletal fitness. CR fitness, or aerobic capacity, involves the body's ability to transport and utilize oxygen. One of the main objectives of an aerobics program is to increase the maximum amount of oxygen that the body can process within a given time. The aerobic process depends on the oxygen transport system, which includes the lung's ability to take in large amounts of air and diffuse it into the bloodstream, the heart's ability to pump large amounts of blood to the tissues, and the tissues' (cells') ability to utilize the oxygen. The magnitude of improvement in aerobic capacity depends upon the total work accomplished, i.e. the energy cost of the activity involved. The energy cost, however, is dependent upon several variables, namely the intensity, duration, and frequency of the work(15). Other factors such as the regularity of the work, the mode of the work, as well as the age of the individual doing the work all influence the improvement in

CR fitness(16-18). With adequate intensity, duration, and frequency of training an officer will experience the "training effect"(3), whereby the organ systems of the CR system collectively operate to provide more effective transportation and utilization of oxygen and elimination of waste products.

Intensity, duration, and frequency in relation to the total work done in an activity also have a direct influence on the body composition of an individual. Body composition is divided into two components: lean tissue (bone, muscle, and body fluides) and fat tissue. Percent fat is the percentage that the fat weight is of the total body weight.

Through the process of becoming physically fit, one can alter body composition (percent fat) (2). The major factor in this alteration is related to the number consumed. Thus, by expending calories through some physical activity in addition to those expended to maintain body functions and by reducing the caloric intake, once can achieve a negative caloric balance. As a result, the body is forced to obtain the additional energy it requires from fat breakdown, thus reducing the fat content of the body.

Physical activity is a major factor in fat reduction in that it can maintain or even increase the lean tissue weight while fat weight is reduced. A study by Zuti and Golding(19) has shown that dieting alone can reduce body weight, but the net percent fat loss is reduced because of a decrease in muscle mass with the decrease in fat. (Muscle is catabolized by the body for energy as is fat.) Ideally, a reduced calorie intake should be combined with an exercise program to lose body fat as well as weight. After, a desired level of body fat is achieved, regular exercise coupled with a sensible diet can maintain satisfactory body composition.

The third component of physical fitness, musculoskeletal fitness (MS), encompasses two major areas: a) muscle strength and endurance and, b) flexibility. Muscle strength and endurance are interrelated and the development of either or both is dependent upon the training regimen involved. Muscular strength is the muscles' ability to generate a force against some resistance and is proportional to the cross-sectional area of the muscle or muscle group involved. Strength is developed through two major types of training: isotonic, which involves muscle shortening and lengthening with a corresponding movement of a related limb, and isometric, which involves muscular contractions but no movement of limb.

Muscular endurance is the ability of a muscle or muscle group to maintain repeated contractions of equal force until fatigue causes cessation. It is interrelated with strength in that the stronger muscle generally has more endurance.

With regard to the development of strength and endurance, isometric resistance training develops strength with little or no endurance improvements, while isotonic resistance training when done correctly (exercising through the full range of motion of the muscle group involved) increases strength as well as endurance. Depending upon the combination of resistances and repetitions employed, isotonic training can develop strength or endurance. Generally, high resistance with low repetitions increases strength, while, conversely, greater repetitions and lower weights, increase endurance. Obviously, a compromise in approach will develop adequate strength and endurance.

When training for either strength or endurance, the overload principle is imperative for improvement. Simply, the overload principle involves increases in resistance and/or number of repetitions as the muscle adapts. However, once adequate strength and endurance are achieved, fewer workouts are necessary to maintain that level.

While muscular strength and endurance are critical to MS fitness, the ability of the MS system to move through a full range of motion is imperative. Flexibility can be defined as the ability of a joint or group of joints to move through a full range of motion. This range is affected by two factors: the boney structures comprising the joint and the extensibility of the surrounding ligaments, tendons, and muscles. It is obvious, therefore, that improvements in flexibility depend upon the development of the extensibility of these ligaments, tendons, and muscles.

Two types of stretching are employed to develop flexibility. These are static and ballistic. Ballistic stretching (stretching through momentum of movement) has its value primarily in warm-up of the entire body but could be harmful if not done properly. Static stretching (firm, steady stretch), however, involves less chance of muscle soreness and applies more specific stretching to a particular area. Research has shown(12) that flexibility reduces injury, enhances skill, and allows for more graceful movement.

In addition to stretching, several other factors have been associated with flexibility. These include the degree of activity, age, sex, and environmental temperature(6).

Two general principles that are important to consider when developing an exercise program include the warm-up and cool-down. A general warm-up program of several minutes involving calisthentics, jogging, and stretching provides several benefits. By warming-up, the internal temperature of the body is raised. This condition allows for an increased rate of biochemical reactions involving the production of energy for exercise. Also, circulation and respiration are stimulated. All of these factors not only accelerate the adaptive process of the CR system, but also render the MS system more flexible, stronger, and better prepared for work.

After physical activity has been completed, a gradual cool-down greatly benefits the recovery process. Walking or jogging during the cooling-down period enables the body to better maintain uniform circulation, and thus more efficient removal of biochemical waste products, some of which are associated with muscle discomforts.

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CHAPTER 2

REVIEW OF LITERATURE CONCERNING EXERCISE AND PHYSICAL FITNESS

Cardiorespiratory Fitness

The overall determinant of endurance fitness is the ability of the body to transport oxygen from the atmosphere to the sites of biochemical activity in the working muscle. Aerobic capacity or maximum oxygen intake (VO_2 max) is the parameter commonly used to evaluate the oxygen transport system of the body. Improvement in cardiorespiratory or endurance fitness is dependent upon the total work or energy cost of the exercise program. Energy cost can be measured by the number of calories expended and is dependent upon the intensity, duration, and frequency of the exercise program. In addition, improvement is related to the initial level of fitness, status of health, mode of exercise, regularity of exercise, and age. These factors should be considered in designing an exercise program to meet the needs, interests, and abilities of the police personnel involved in training regimens. How much exercise is needed and how much each of these factors contributes has been the topic of many studies.(18,28,31,32,35, 46,52,56,74,77,78,87,88) These factors will be discussed in relation to changes in VO_2 max, body composition, and resting heart rate. Results concerning other changes in cardiorespiratory parameters are discussed elsewhere(56).

Intensity

Improvement in cardiorespiratory fitness is relative to the level of energy expenditure per minute or intensity of training. Because of the linear relationship between heart rate and oxygen intake, intensity can be expressed as either percentage of maximum heart rate or VO_2 max (See Figure 1). Technique and

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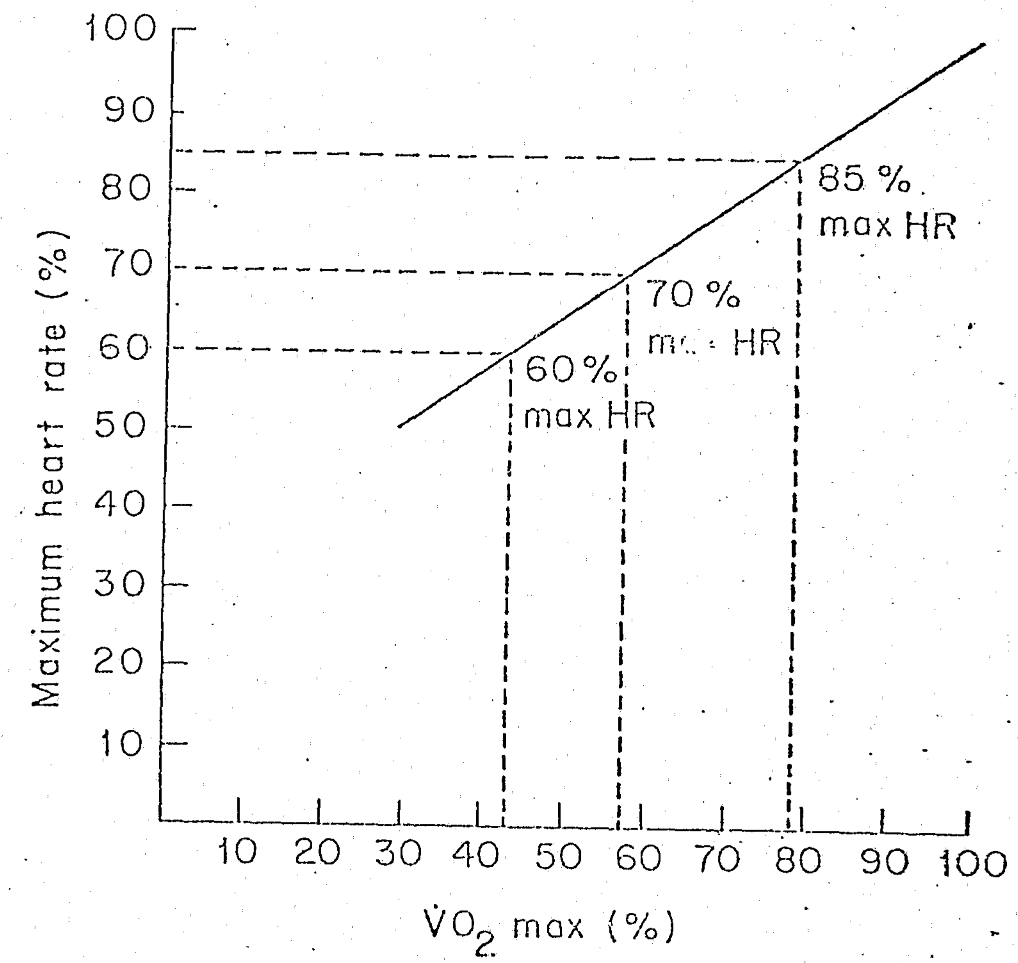

Figure 1. The relationship between percentages of maximum heart rate and oxygen intake (VO_2 max).

calculation of intensity by heart rate are discussed in Chapter 4.

A certain level of intensity is required to elicit improvements in aerobic capacity. This level is generally referred to as threshold of intensity. The threshold varies according to age, level of fitness, health, etc. In general, however, activities low in intensity or energy expenditure such as golf, bowling, and other game activities which are too intermittent show little or no improvement in cardiorespiratory function, whereas, excellent improvements result from moderate to high intensity activities such as running, fast walking, bicycling, and swimming. More specific information on the energy cost of various activities is listed in Chapter 4 under exercise prescription.

Many studies have been conducted to determine the threshold of intensity. Karvonen et al. (35) found no significant improvement in VO_2 max in a group of young men trained below 135 beats/min, but the group whose sustained heart rate was above 153 beats/min improved significantly. Hollmann and Venrath(32), in a similar study conducted on a bicycle ergometer, found that heart rate values of 130 beats/min or more were needed to stimulate a cardiorespiratory improvement. The data suggest that the threshold level for young men is at a heart rate equal to approximately 60 percent of their maximum heart rate.

In addition, a positive relationship exists between intensity of training and improvement in VO_2 max. Sharkey and Holleman(75) walked young men on a treadmill three times per week for six weeks at heart rates of 120, 150, and 180 beats/min and found a direct relationship between the magnitude of improvement in VO_2 max and intensity of training. Gledhill and Eynon(28) further

substantiated the value of intensity as a stimulus for eliciting a training effect by training 36 college students on bicycle ergometers for 20 min, five days per week, for five weeks. The subjects maintained heart rates of 120, 135, or 150 beats/min. All groups improved in VO_2 max, maximum performance, and heart rate at a workload of 1500 kpm/min. When the groups were subdivided into low and high fitness levels, the high fitness group showed no improvement in VO_2 max and performance time at training heart rates of 120 beats/min, while the low fitness group did improve, emphasizing that training stimulus threshold has a wide range and is dependent on initial level of fitness. Thus, some improvement can be expected for low fitness groups who exercise at heart rates as low as 120 beats/min. More physically fit individuals usually must train harder to elicit improvement.

Duration

Duration is the amount of time that the prescribed intensity load should be performed to elicit the desired training response and, thus, is highly interrelated with intensity. Usually high intensity programs are of shorter duration and low to moderate intensity programs are of longer duration.

Improvements in VO_2 max have been found with programs of very short duration. Shephard(77) found improvements in VO_2 max after a training program which lasted only ten minutes per day and Hollmann and Venrath(32) found improvements in ten subjects who did stationary running ten minutes per day.

Several investigations have shown a significant relationship between duration of training and magnitude of improvement in VO_2 max. Olree et al.(52)

trained young men for 20, 40, or 60 minutes on a bicycle ergometer and found the longer duration programs to produce significantly more improvements. Wilmore et al. (87) conducted a jogging program for middle-aged men of 12 or 24 minutes per day, three times per week for ten weeks. Both groups improved significantly in VO_2 max with the 24 minute group showing more improvement than the 12 minute group. Recently Milesis et al.(46) trained men for 15, 30, or 45 minutes per day, three days per week at 85 to 90 percent of maximum. Figure 2 shows that all three exercise groups improved significantly in VO_2 max with the magnitude of improvement related to duration of exercise. Yeager and Brynteson(89) trained young women on a bicycle ergometer for 10, 20, or 30 minutes per day, three days per week for six weeks and found similar results.

Sharkey(74) studied the interaction of intensity and duration of training on the development of cardiorespiratory endurance. Thirty-six college men were randomly assigned to programs which included three levels of training intensity (130, 150, and 170 beats/minute) and two levels of duration (7,500 and 15,000 kpm total work). The subjects trained on bicycle ergometers three days per week for six weeks. No significant intensity, duration, or interaction effects were revealed, possibly due to the fact that all groups performed exactly the same amount of work, thus showing the importance that total work output has on developing fitness.

Shephard(77) investigated various combinations of intensity, duration, and frequency. A group of 39 sedentary men trained at 96, 79, and 39 percent of VO_2 max, five, three, and one days per week, for 20, 10, and 15 minutes per session for ten sessions. The results indicated that the main factor influencing

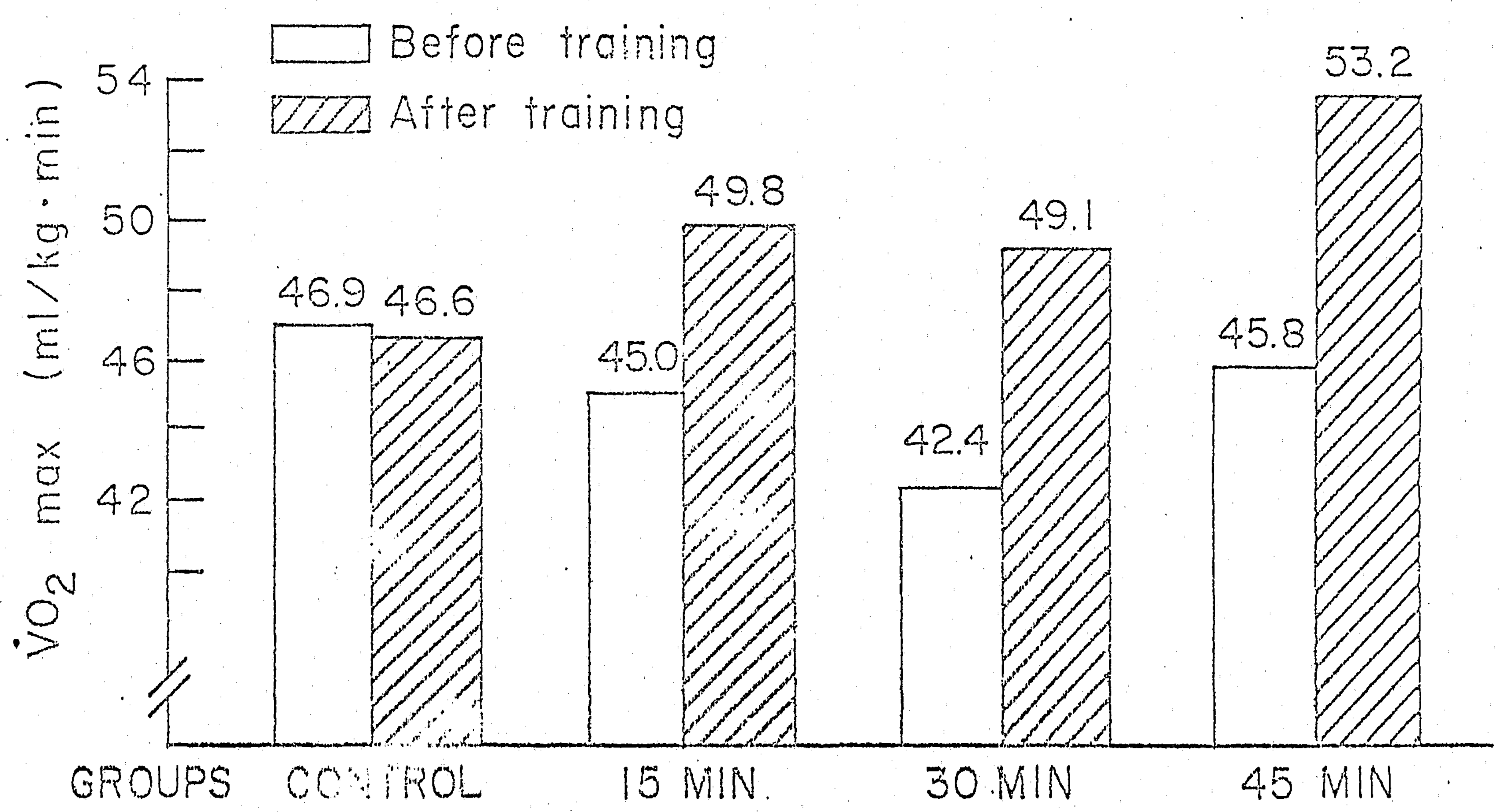

Figure 2. Effects of training duration on maximum oxygen intake ($\dot{V}O_2$ max) (46).

the extent of training achieved was the intensity of effort relative to the subject's initial VO_2 max. Improvement was also influenced by the frequency of exercise and marginally by its duration. The most effective regime involved the combination of maximum intensity, frequency, and duration of exercise. Davies and Knibbs(18) trained young men at 80, 50, and 30 percent of VO_2 max for eight weeks. Their results agreed with those of Shephard(77) in that greater improvement in VO_2 max was achieved with the higher intensity programs. The groups working at or below 50 percent of VO_2 max did not improve significantly.

Pollock et al. (58) trained 2 groups of men 45 min/day, two days per week, at 80 and 90 percent of maximum heart rate for 20 weeks. To equalize the total energy cost between the two groups, the 80 percent group exercised for a longer duration. Both groups improved significantly in cardiorespiratory function, but differences in intensity had little effect indicating that lower intensity work may achieve a similar result as higher intensity work if the total work or energy cost is equalized.

Frequency

How often one should train is dependent upon the needs and goals of that individual. Many athletes train twice a day, but exercising that often is not necessary for most individuals to reach an optimal level of fitness. Numerous studies have sought to evaluate frequency of training by attempting to control the number of total training sessions in various programs and/or total work output. These investigations generally show no difference in improvement with frequency of training.

Hill(31) trained 24 men, 20 to 44 years of age for three or five days per week. At the end of eight weeks both groups were re-evaluated and showed a significant improvement in VO_2 max. At this stage of the experiment, the five days per week group showed significantly more improvement. In an attempt to equalize total training sessions, the three days per week group continued to train another five weeks while the five day group stopped. Upon completion of this segment of training, the three day group's data equalled that of the five day group's program at the end of their eight weeks. Sidney et al. (78) found similar results for groups training two, or four days per week when total work was held constant. Another group training just one day per week showed little advantage over no training at all.

Because exercise should not terminate after a few weeks, but continue throughout life, frequency of training should be evaluated by equalizing the total number of weeks, not the total number of workouts. When weeks of training were held constant instead of total number of exercise sessions, results generally showed improvements in VO_2 max with higher frequencies of training (59,62,63,67).

Pollock et al.(63) compared results of six running programs conducted two, three, or four days per week for 20 weeks. As shown in Table 1, the four days per week groups showed significantly more improvement than two and three days per week groups. There was no significant difference between the two and three days per week groups in improvement of VO_2 max. A more recent investigation completed by Pollock et al. (unpublished data) showed a three days per week program to have a greater improvement in VO_2 max if compared to the two days per week groups in Table 1.

TABLE 1. Cardiorespiratory results of running frequency

Frequency (Days/Week)	VO_2 max (% Improved)	Resting Heart Rate (% Improved)
Control	0.0%	0.0%
2 days	17.0%	8.6%
3 days	16.0%	11.1%
4 days	22.0%	11.9%

Data on 148 previously sedentary men, ages 28-64. Subjects ran 30 to 45 minutes a day for 20 weeks (63).

Gettman et al.(27) trained men 20 to 35 years of age, one, three, or five days per week, 30 minutes per day for 20 weeks. Figure 3 shows significant improvements in VO_2 max in direct proportion to frequency of training. The resting heart rate values showed the same relationship.

Thus, it can be concluded that exercising only one day per week shows minimal improvements in cardiorespiratory fitness. Two and three day programs elicit moderate improvements, while four and five day programs show a more significant improvement. Using this information, programs which emphasize exercising three to five times per week are recommended.

Regularity of Training

Closely related to frequency of training is the consistency of training and its subsequent effect on cardiorespiratory function. Cureton and Phillips (17), using equal eight-week periods of training, nontraining, and retraining, found significant improvement, decrement, and improvement, respectively, in cardiorespiratory efficiency. Michael and Gallon(45) and Fardy(26) followed the training of college basketball and soccer players over the course of a

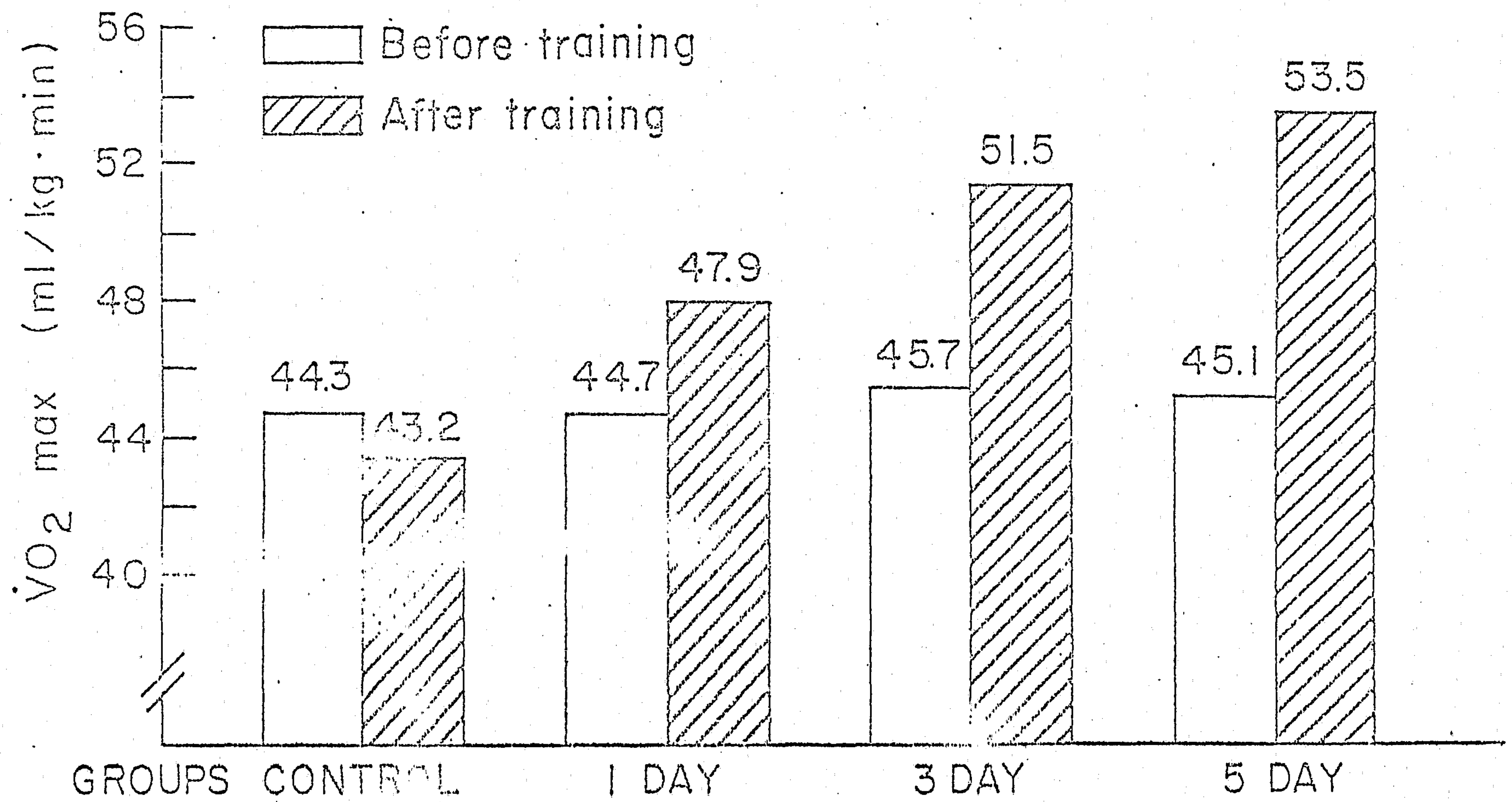

Figure 3. Effects of training frequency on maximum oxygen intake ($\dot{V}O_2$ max) (27)

season, with subsequent periods of nontraining. Both groups of athletes showed increases in efficiency during the season, followed by significant reductions during the nontraining period. Williams and Edwards(84) found similar results when studying the effect of variant training regimens on cardiorespiratory efficiency of young college men. Drinkwater and Horvath (21) studied female high school track athletes and found that after three months of nontraining, the cardiorespiratory fitness of the athletes decreased to the level of nonathletic girls of similar age.

Bed rest studies have shown decrements in physical working capacity and related cardiorespiratory parameters. Saltin et al.(72) confined five subjects to bed for 20 days, followed by a 60 day training period. Cardiorespiratory efficiency values decreased during bed rest and improved steadily with training. Heart rate response to a submaximal test increased up to 30 beats/minute after bed rest and decreased significantly with training.

Roskamm(71) trained 18 subjects daily for four weeks and showed a 20 percent increase in cardiorespiratory fitness. At this point one group (Group I) continued training every third day and the other group (Group II) stopped training. Group I maintained their level of fitness while Group II began to lose their level of working performance within two weeks. See Figure 4. It is apparent from this review that training effects are both gained or lost rather quickly, and regular, continual stimulation is necessary to maintain cardiorespiratory efficiency.

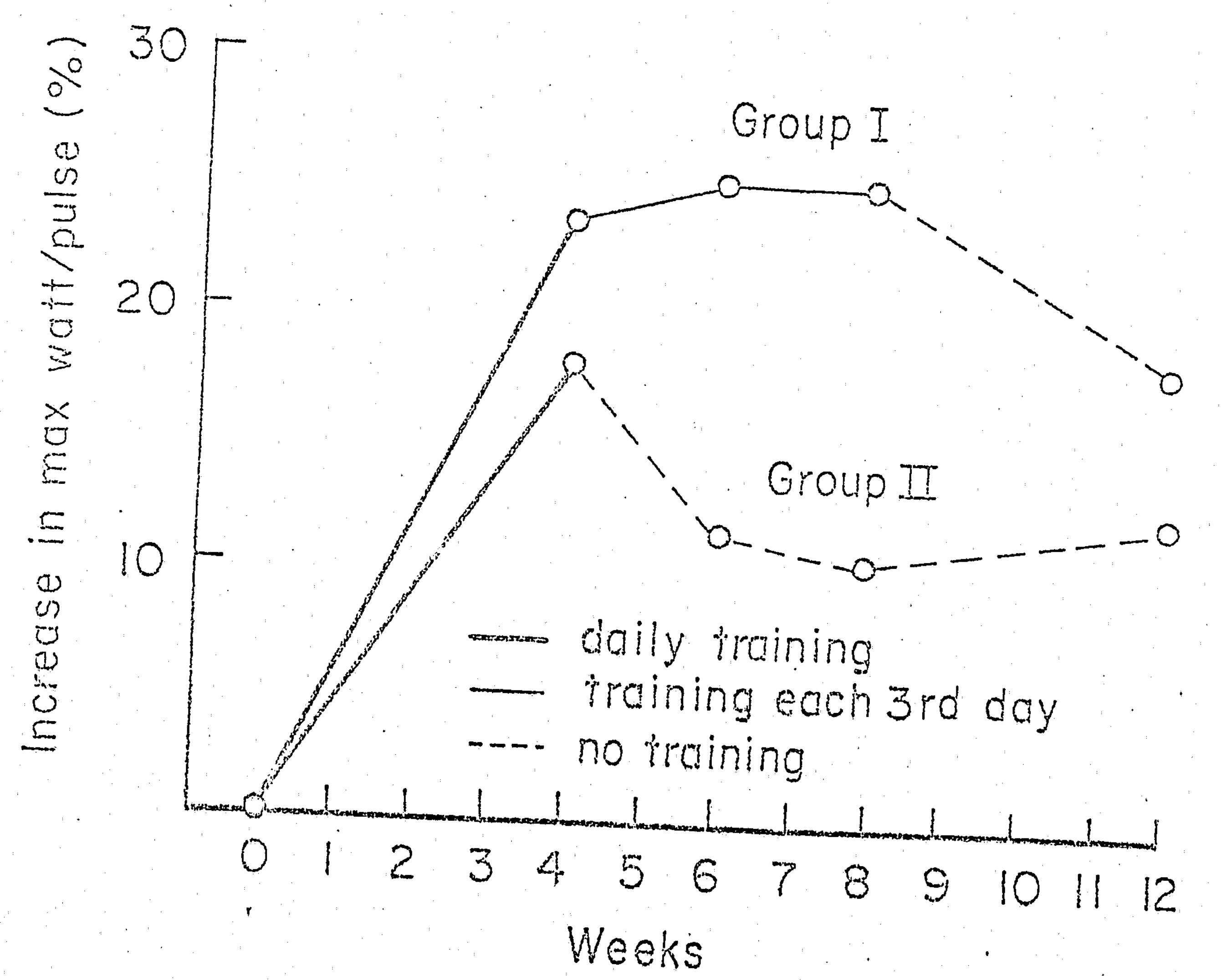

Figure 4. Increase in maximum watt/pulse compared with the initial value (71)

Maintenance of Fitness

Once an optimal level of fitness is reached, programs of lower frequency, intensity, or duration may be initiated to maintain a certain level of fitness. Roskamm(71) in the investigation reviewed above found that training every third day was enough to maintain cardiorespiratory fitness. Kendrick et al.(38), in an attempt to determine the effects of different magnitudes of nontraining, re-evaluated 22 middle-aged men after a 12-week nontraining period. Subjects originally trained eight miles per week for 20 weeks, and were subsequently divided into the following three subgroups: group A continued to train eight miles per week, group B trained three miles per week, and group C was inactive. The results showed group A to maintain and/or improve their level of efficiency, while groups B and C regressed significantly. Group C lost approximately 50 percent of its original improvement. Siegel et al. (79) trained nine sedentary middle-aged men 12 minutes, three days per week for 15 weeks and found an increase in VO_2 max of 19 percent. After completion of the program, five subjects continued to train once a week for another 14-week period. At this time their VO_2 max had decreased to six percent above the initial control level. The remaining four subjects who abstained from training fell below their original control values. Kilbom(39), in a review of how physical fitness can be maintained, recommended that exercising at least two days per week is preferable.

Pollock et al.(57) in an effort to determine if cardiorespiratory fitness can be maintained through an exercise regimen of decreased intensity and increased duration trained 14 men for 30 minutes three days per week, for 20 weeks at a high intensity (94 percent of maximum heart rate - 179 beats/minute)

followed by six weeks of lower intensity work (84 percent of maximum heart rate - 166 beats/minute). Five of the 14 subjects stopped training during the last six weeks. The energy cost of the two phases was equalized by extending the duration of training during the latter six week period. The subjects improved significantly in VO_2 max during the first 20 weeks. The nine subjects who continued training, but at a lower intensity for the six additional weeks maintained the level of fitness achieved during the first 20 weeks, but the five subjects who stopped training during the last six weeks decreased significantly. See Figure 5. This study supported the concept that cardiorespiratory fitness can be maintained by decreasing intensity and increasing the duration sufficiently to equalize the total calorie expenditure.

Modes of Training

Previous sections of this review have been concerned primarily with endurance activities such as running and cycling. However, other activities such as walking, swimming, skiing, dancing, and sports of varying degrees of intensity and aerobic demand may improve cardiorespiratory fitness. Many investigators have sought to determine the relative value of these other activities as well as jogging and cycling in producing cardiorespiratory fitness changes. As previously shown, certain quantities and combinations of intensity, duration, and frequency are necessary to produce and maintain a training effect.

In addition, the total amount of work or energy cost of an activity is an important consideration. Theoretically, the training effect should occur equally if these factors are held constant. To investigate this, Corbin et al.(15)

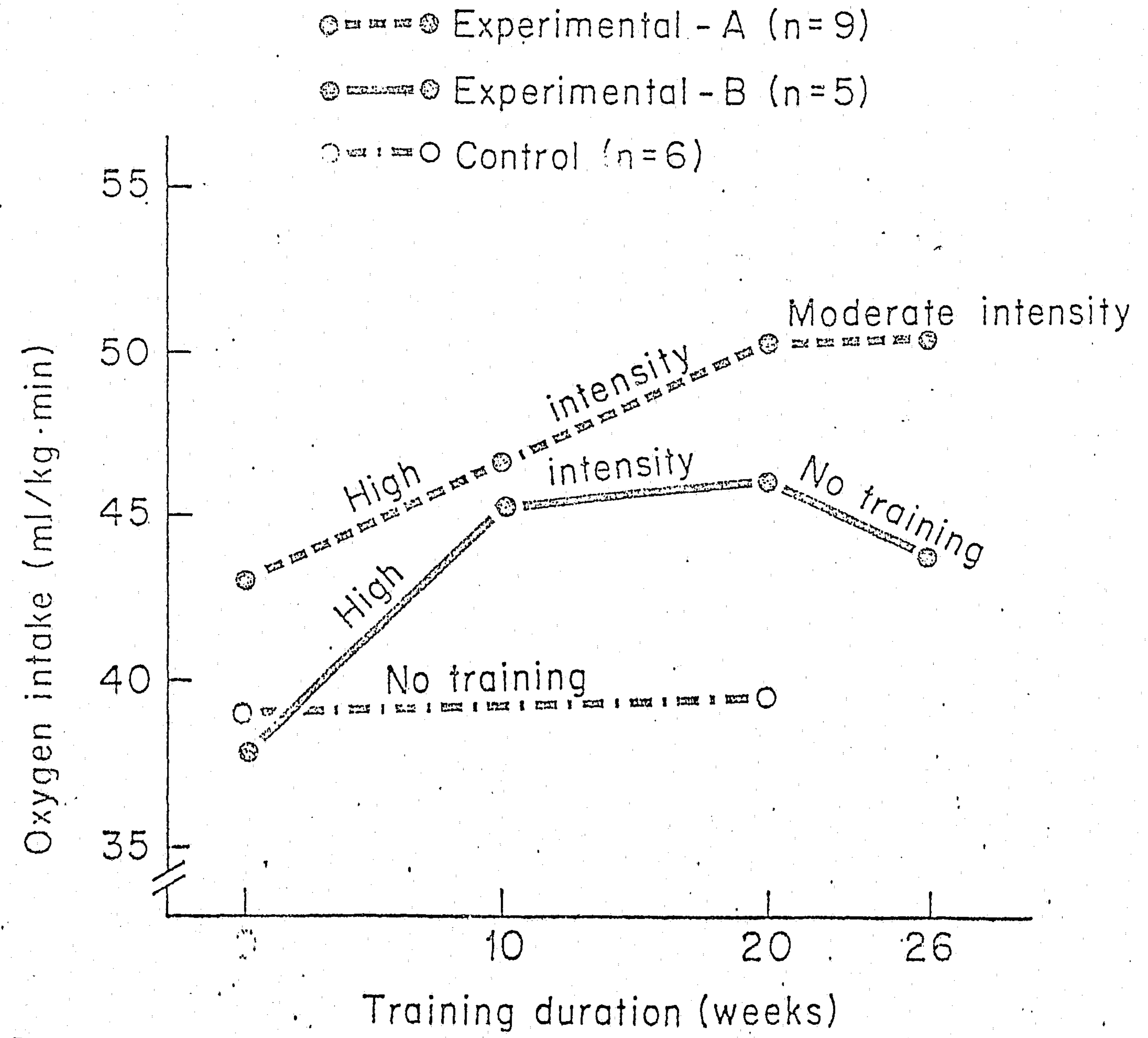

FIGURE 5. Effects of high intensity (94% max HR) followed by moderate intensity (84% max HR) training on the development and maintenance of maximum oxygen intake (57).

compared the effects of running, walking (treadmill), and bicycling (ergometer) training regimens on college men. Each group trained for 20 minutes, five days per week, for ten weeks, at heart rates of approximately 150 to 160 beats/minute. In general, they found running and bicycling to be superior training modes when compared to walking. Pollock et al.(61), Figure 6, in a similar experiment conducted with middle-aged men, found all three modes of training to be equally effective in producing a significant cardiorespiratory improvement. In this study, the subjects trained for 30 minutes, three days per week, for 20 weeks, at 85 to 90 percent of maximum heart rate (approximately 175 beats/minute). Wilmore et al.(86) compared the effect on aerobic capacity of tennis, bicycling, and jogging. Each group exercised three days/week for 45 min/day for 20 weeks at approximately 85 percent of maximum heart rate or 75 percent of VO_2 max. All three groups improved significantly in cardio-respiratory fitness (jogging - 14.8%, bicycling - 13.3%, and tennis - 5.7%) with the jogging and bicycling groups improving substantially more than the tennis group.

Some people cannot exercise in the conventional manner of walking and running due to illness, injury, orthopedic problems, etc. Thus, exercise programs must be adjusted to meet these special needs. Pollock et al. (64) conducted a study with eight sedentary disabled men and 11 sedentary normal men and found that cardiorespiratory improvement could be achieved through arm pedalling on a modified bicycle ergometer.

In general, high energy cost activities, such as running, walking, bicycling, swimming, and cross-country skiing show signficant increases

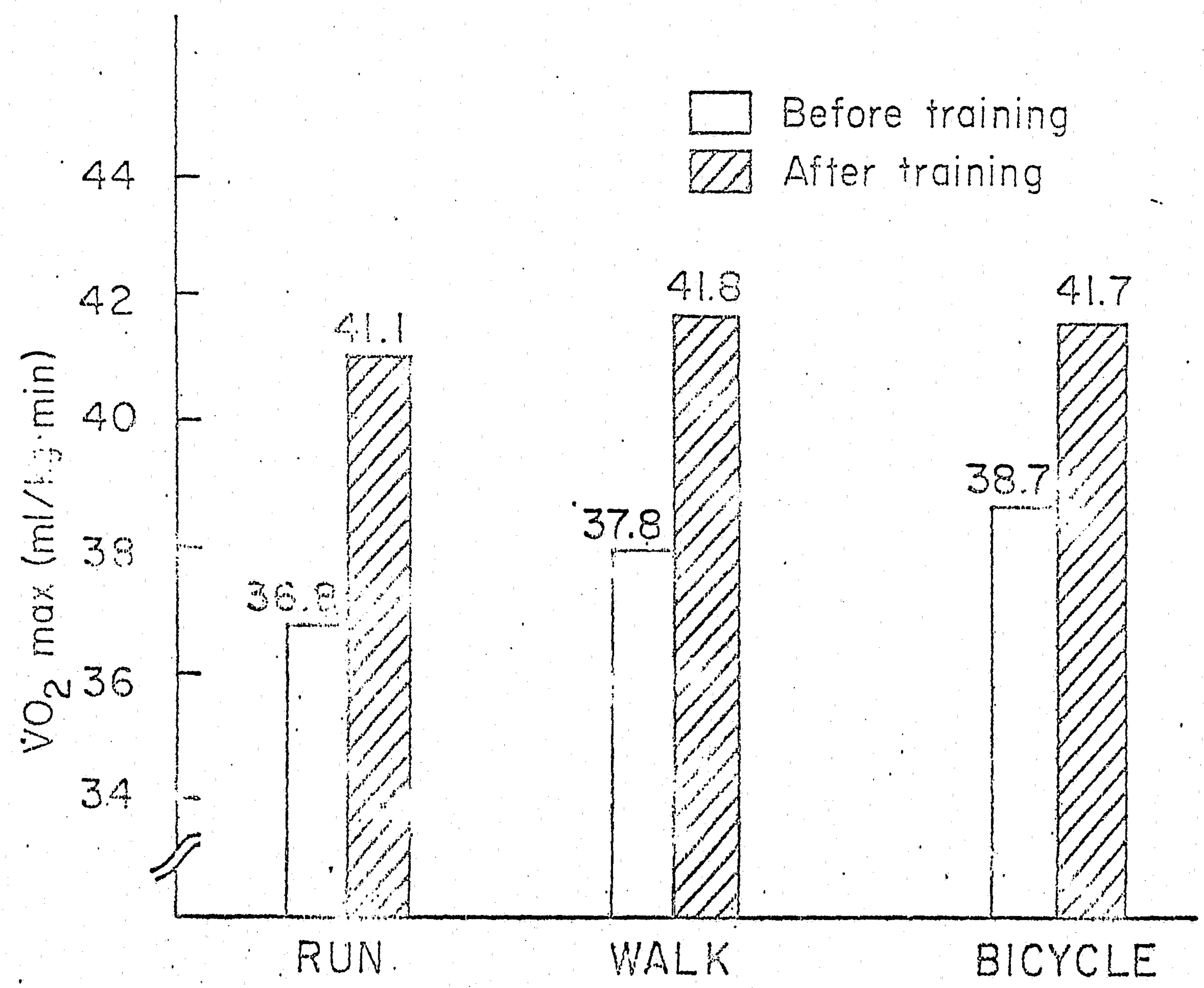

Figure 6. Effect of training mode on maximum oxygen intake ($\dot{V}O_2$ max) (ül)

in cardiorespiratory efficiency. In contrast, low energy cost activities, such as moderate calisthenics, golf, and various organized game activities show little or no effect. Although weight lifting, per se, is a high energy cost activity, and phases of other sports such as baseball have high energy cost components (running), they are considered to have little or no effect on cardiorespiratory function. This results from the high energy cost component being too intermittent; thus, the total energy cost of the activity in relation to total time would be considered quite low. Other activities(55) producing significant cardiorespiratory effects include dancing, rope skipping, tennis, soccer, basketball, wrestling, football, handball, and a combination of sport activities and running. Cooper(13,14) has emphasized the concept regarding the variety of modes of training for eliciting a training response. He devised a system whereby activities are given point values in respect to their energy cost, thus a variety of activities may be interchanged within a fitness training program.

Types of Training Programs - Interval vs Continuous

Shephard lists four distinct types of training programs(76). These are: (1) Continuous Running in which the individual exercises at a moderate and relatively steady intensity for long periods (ranging from fifteen minutes to several hours); (2) Brief-interval Running in which the individual undertakes short bursts of maximum activity (approximately 30 sec to 1 min), interspersed with recovery periods of corresponding length when only light activity is allowed; (3) Prolonged-interval Running where the intervals are prolonged to 2 1/2 minutes and the recovery periods are correspondingly extended; and, (4) Circuit

Training in which the individual moves around the circuit to various gymnasium exercises - pushups, running on the spot, etc.

The literature pertaining to the comparison of interval versus continuous running programs reveals conflicting results. To date, there is no good scientific evidence supporting one program over the other.

Initial Level of Fitness

The concept of percentage of improvement attained in certain physical fitness parameters being related to one's initial level of fitness was proposed in the early work of Muller(49). He conducted a series of experiments dealing with the improvement in strength and concluded that the percentage of improvement was directly related to initial strength and its relative distance from a proposed level of improvement. This concept has also been true in training studies dealing with cardiorespiratory parameters. Sharkey(74) noted that the magnitude of change was inversely related to the initial level of fitness.

Resting heart rate is reduced with training, with the magnitude of change dependent on the initial level. Most studies show a reduction in resting heart rate to the mid to lower 60's. The data for endurance athletes show average resting heart rates 10 to 15 beats/minute lower than for the moderately trained groups, although it is not clear whether this difference may be due to genetic factors, training, or both.

Age

Longitudinal and cross-sectional studies indicate that cardiorespiratory function decreased with age. Robinson(69) showed that men tend to peak in aerobic capacity between 17 and 20 years of age and steadily decrease over the subsequent years. At age 75, aerobic capacity is less than 50 percent of the original peak value. Robinson et al.(70) measured VO_2 max on a group of subjects at age 18 to 22 years; then again at ages 40 to 44 and 49 to 53 years. At age 40 to 44 VO_2 max had declined 25 percent, and had continued to decrease when re-evaluated at age 49 to 53. Skinner(80) has suggested an approximate 21 to 30 percent decrease in VO_2 max over a 30 to 40 year range.

Many researchers have tried to determine if aging affects the trainability of persons as they get older. Saltin et al. (73) found improvement in VO_2 max at ages 29 to 63 and concluded that although a training effect occurs as readily in middle-aged and old men as in young, the absolute change is less. Therefore, there appears to be some aging effect. Pollock et al. (60) trained 22 men, aged 49 to 65 years in a walk-jog program 30 min, three days per week for 20 weeks and found an 18 percent increase in VO_2 max. These results are in agreement with those of Kasch et al. (36) with middle-aged men, 39-60 years. Benestad(3) found no change in cardiorespiratory function in older subjects who trained daily for five to six weeks. deVries(19) found improvements in subjects aged 52 to 88 years who participated in a low intensity exercise program, but the relative change was considered less when compared to younger subjects. Tzankoff et al.(82) found significant improvements in VO_2 max with men aged 44-66 years.

The aerobic capacity of middle-aged and older endurance athletes is markedly superior in every age category to that of untrained individuals. Figure 7 shows the differences in VO_2 max and resting heart rate among different athletes and sedentary men (55). The age reduction mentioned earlier also appears in the trained groups and becomes particularly evident after age 60. Can this reduction in VO_2 max be explained by age itself or are training factors also apparent? The evidence at hand supports both concepts. Young endurance runners will train 100 to 200 miles per week (sometimes less if purely interval training is used); whereas the middle-aged and older runners rarely accomplish this. In data collected from the 1971 National Master's AAU track and field meet and subsequent laboratory evaluations conducted by Pollock, Miller, and Wilmore(66) the average number of miles trained per week was 40, 40, 30, and 20 for the fourth, fifteh, sixth, and seventh decades, respectively. In addition, most of these men were prior college athletes, but had not trained all their lives. Most of the older athletes had been sedentary for many years and had been back in training for only five to ten years. Grimby's and Saltin's (29) data on middle-aged and older athletes who had trained all their lives show them to be above the aging curve in VO_2 max at all ages. Other data of Pollock et al. (65), on men who had been training for 5.5 years, show significantly higher VO_2 max values than for men completing their first six months of training, but these are lower than for the aforementioned athletic groups. With the increase in Master's competition and the probability of men and women training for competition throughout their lifetime, future data should provide more insight into the aging process and its effects on fitness parameters.

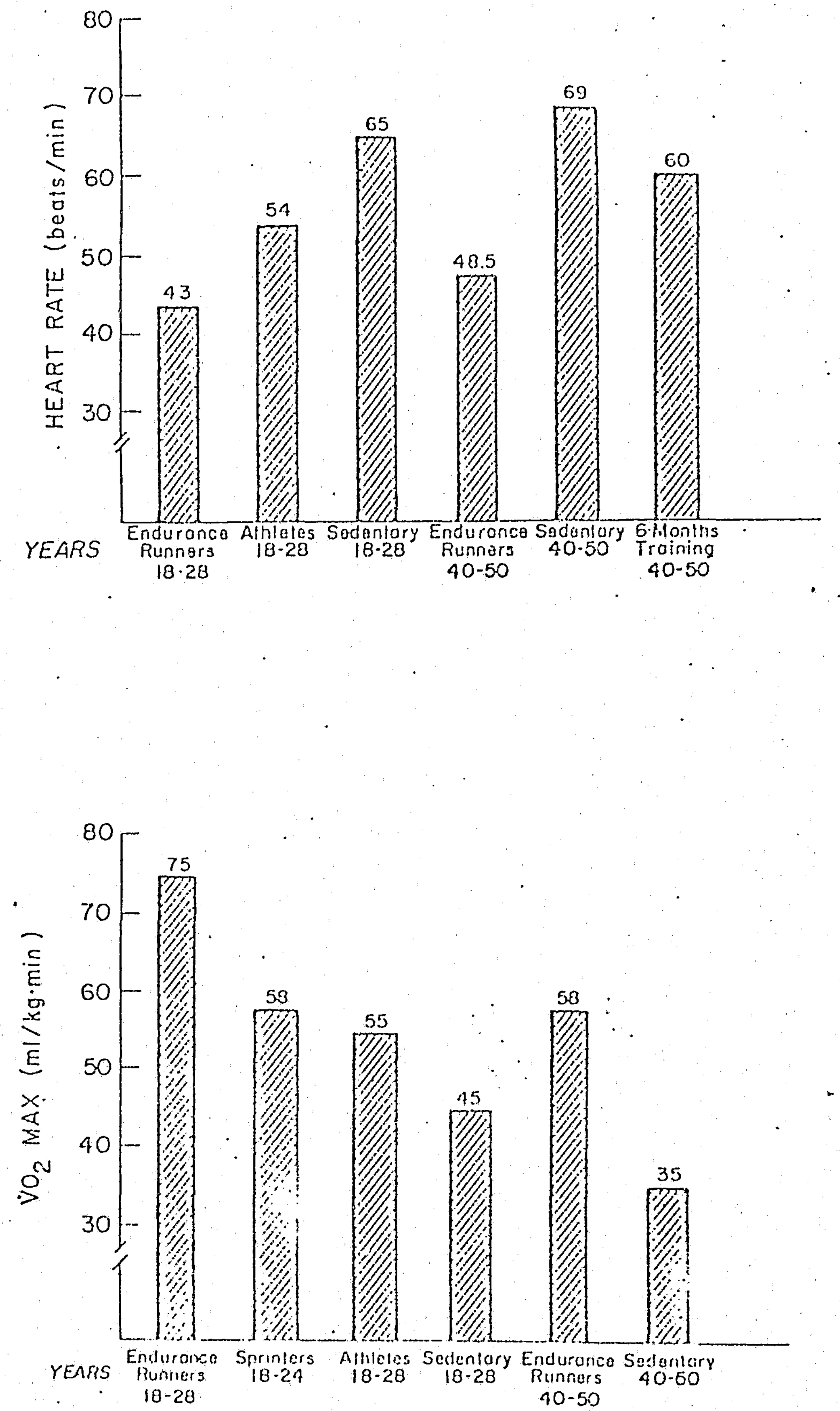

Figure 7. Comparison of resting heart rate and maximum oxygen intake ($\dot{V}O_2$ max) among young and middle-aged men with various fitness levels (55)

Environmental Factors

Heat

When exposed to heat or during muscular work, the heat content of the body tends to increase. When the total heat load of the body exceeds the limit of thermoregulatory compensation, various incapacities occur such as heat cramps, heat exhaustion, and heat stroke. Optimal function requires that the body temperature be maintained between 36.5 and 39.5°C. The capacity to perform physical work in the heat varies greatly among individuals. In general, the extent of the performance decrement is influenced by the capabilities and limitations of the individual, the level of thermal stress, and the specific demands of the task being performed. Caplan and Lindsay(10) found that in deep mine drilling operations, efficiency decreased 25 percent when the environmental heat load was increased from an effective temperature of 85°F to 91.5°F. At 96°F efficiency was 50 percent, and at 98.5°F output was reduced 75 percent. Brouha et al. (6,7) observed a progressively increasing cardiac cost during work as the environmental temperature increased. For a 15-minute work and 20-minute recovery period, the total number of heart beats more than doubled when the thermal load was increased from an effective temperature to 75°F to 90°F.

Acclimatization to heat and physical training greatly enhances the ability to tolerate work in heat(8). Improvement in heat tolerance is associated with increased sweat production and a lowered skin and body temperature(88). The increased sweat rate provides the possibility for a more effective cooling of the skin through evaporative heat loss, and the resultant lowered skin temperature provides for a better cooling of the blood through the skin. Buskirk and Bass(8) list the following characteristics of heat acclimatization:

1) Heat acclimatization begins with the first exposure, progresses rapidly with subsequent exposure, and is well developed in about seven days.

2) It can be induced by short intermittent bouts of exercise in the heat, e.g., of from two to four hours daily.

3) Athletes in good physical condition acclimatize more rapidly than nonconditioned people and are capable of more work in the heat.

4) Daily work, if progressively increased in the heat, leads to early development of maximal performance capacity. Overexertion on the first exposure may result in disability, which in turn inhibits the acclimatization process.

5) Acclimatization to warm conditions will facilitate acclimatization to hot conditions but will not confer complete acclimatization to hot conditions. Acclimatization to hot conditions will facilitate performance under warm conditions.

6) The general pattern of acclimatization is similar for work of different intensity and duration.

7) Acclimatization to hot dry climates enhances performance capability in hot, wet climates and vice versa.

8) Inadequate water and salt replacement can retard the acclimatization process.

9) Acclimatization to heat is retained for about two weeks with no exposure. Thereafter, loss of acclimatization is highly individual. Athletes who stay in good physical condition should retain heat acclimatization best.

When exercising in hot and humid environments, certain precautions should be followed. Buskirk and Bass(8) and Murphy and Ashe(50) make the following recommendations:

1) Wear light, loose porous clothing.

2) Take adequate amounts of water and salt.

3) Exercise during the cool part of the day.

4) Allow at least two weeks for acclimatization.

5) Reduce work load during periods of extreme thermal stress.

Cold

In general, few problems are posed by exercising in the cold other than the psychological disadvantage of being uncomfortable. When subjected to a cool environment, the first thermoregulatory response is a constriction of the skin blood vessels, thus reducing heat loss through the skin. As man becomes progressively colder, shivering is activated to increase metabolic heat production. Exercise further increases heat production and overrides the necessity to shiver. The combination of greatly increased heat production due to exercise and reduced heat loss due to excess clothing result in a positive heat load. Positive heat load can be reduced by removing layers of clothing during progressive exercise in the cold.

Altitude and Hypoxia

The Mexico Olympics in 1968 focused attention on the relationship between altitude (hypoxia) and physical performance. The Olympic stadium was 7,350 feet above sea level, with an average barometric pressure of 580 mmHg. The percentage composition of the atmosphere remains essentially unchanged over the range of altitudes and is approximately 20.93% oxygen, 0.03% carbon dioxide, and the balance nitrogen and other inert gases. There is a logarithmic decrement in the total ambient pressure with altitude, so that at eighteen thousand feet, it is only a little more than a quarter of the sea level reading (197 mmHg). This decline in total pressure reduces the partial pressure of oxygen in inspired gas. Within the alveoli, both water vapor and carbon dioxide remain at relatively fixed partial pressures (47 and 35-40 mmHg, respectively), and consequently the partial pressure of oxygen is reduced even more.

The reduced oxygen partial pressure in arterial blood decreases the quantity of oxygen transported to the working muscles, thus limiting the capacity for physical work. Maximal aerobic capacity shows a linear decrease with increasing altitude amounting to approximately 3.2 percent in unconditioned men and 1.9 percent for conditioned men for every 1000 feet above 5,000 feet(9).

It has been proposed that the change associated with conditioning, training, and acclimatization in altitude would enhance aerobic capacity and improve performance times at sea level. Faulkner et al. reported on three investigations (23,24) where, 1) five well-conditioned male runners trained for ten days at an elevation of 7872 ft; 2) four well-conditioned male runners and 1 swimmer trained for 23 days at 7544 ft. elevation; and 3) 15 male college swimmers trained at the altitude of 7380 ft. for 14 days. These studies showed improved performance in two stages. The first improvement was observed after the first few days when the athlete had learned to adjust his pace to the new altitude conditions (acclimatization). The second improvement overlapped the first then tended to level off by the end of the second week. The amount of improvement in the second stage of adaptation appeared to depend in part on the degree to which the athlete was trained pre-altitude.

The compensatory mechanisms acquired in acclimatization to altitude are: 1) an increase in pulmonary ventilation; 2) an increased hemoglobin concentration in the blood; and 3) morphological and functional changes in the tissues (increased capillarization, myoglobin content, modified enzyme activity(2). The well-trained individual is not acclimatized to high altitude any sooner or any more effectively than the untrained individual.

Opinions differ concerning the question whether or not the performance capacity at sea level is improved following exposure to high altitude. Buskirk et al. (9) and Consolazio(12) state that their subjects who trained at high altitude for four weeks or more did not attain any better VO_2 max results than usual when they returned to sea level. Buskirk et al. (9) conclude that there is little evidence to indicate that performance on return from altitude is better than before going to high altitude, if training remains relatively constant.

When exercising at high altitude, a period of at least three weeks is necessary for acclimatization. There is no evidence to suggest that it is necessary to take it easy during the initial period of exposure to high altitude (2). However, due to the lower oxygen pressure, one is forced to accept a slower tempo, and the intensity and duration of training activities must be reduced.

Body Composition

Reduction in body weight and fat occurs in response to physical training and has been documented in numerous scientific investigations (5,27,46,47,63). The principle involved in reducing body fat is based on the increased number of calories the body burns during physical training. Continuous, moderate, rhythmic type activities, like running, burn a large number of calories(54) and place the body into negative caloric balance, i.e., more calories are expended than are input. The end result is that the body utilizes its stores of fat to make up the deficit, hence a reduction in body fat (weight). About 3500 calories are contained in a pound of fat; therefore, 3500 calories must be expended through exercise to lose a pound of fat. An individual can lose a pound of fat in less than 12 days by expending an extra 300 calories per day through exercise. The speed with which the exercise is performed determines the amount of time required per day to burn 300 calories. For example, a moderate jog for most people would expend about 10 calories per minute; therefore, jogging about 30 minutes would expend 300 calories.

Dieting alone is not an effective way to reduce fatness as is shown in several investigations(4,53). Although dieting will cause a reduction in weight, 65 percent of the weight loss is from loss of muscle mass and only 35 percent from fat loss. Therefore, the percent body fat, which is the proportion of body weight that is fat tissue and is the true indicator of body leanness-fatness, can remain approximately the same in response to weight loss by dieting alone. In contrast, in exercise programs with food intake remaining constant, significant reductions in percent fat along with increases in muscle mass occur. The concurrent loss of fat and gain in muscle can balance each other and result in only a slight change in overall body weight, but a significant decrease in percent body fat. A calorie-restricted diet along with an exercise program is recommended when weight and fat reduction are desired.

The futility of diet alone is contrasted with the effectiveness of an exercise program in Figure 8. Several important points are noted therein(34). First, the sedentary free-eating animals, which represent the typical non-dieting physically inactive American adult, were the heaviest and the fattest. Second, the sedentary paired-weight animals, which were physically inactive, but restricted in food to match the body weight of the runners, were considerably fatter than the runners even though the body weight for both groups was the same.

When comparing trained and untrained individuals with the same average heights and weights, a greater proportion of the weight of the physically active individual is in the form of lean tissue. Welham and Behnke(83) compared a group of professional football players with a group of naval personnel and found that although the football players were heavier, most of them had less body fat than the naval personnel. Costill and Fox(16) measured six skinfold fat sites on a group of competitive marathon runners and on a group of college professors who were the same age and weight. The sedentary faculty men had more than twice as much fat (16.3%) as the athletes (7.5%). Pollock et al. (68) found similar results in a comparison between a group of world class distance runners and a group of sedentary men matched for age and body weight.

Because changes in body weight and body fat are related to energy expenditure of a program, the regimens with greater combinations of frequency, duration, and intensity tend to show greater magnitude of change. Pollock(55) compared body weight and fat of young middle-aged men of various fitness levels. As Figure 9 shows, the men involved in the highest energy cost programs, endurance runners,

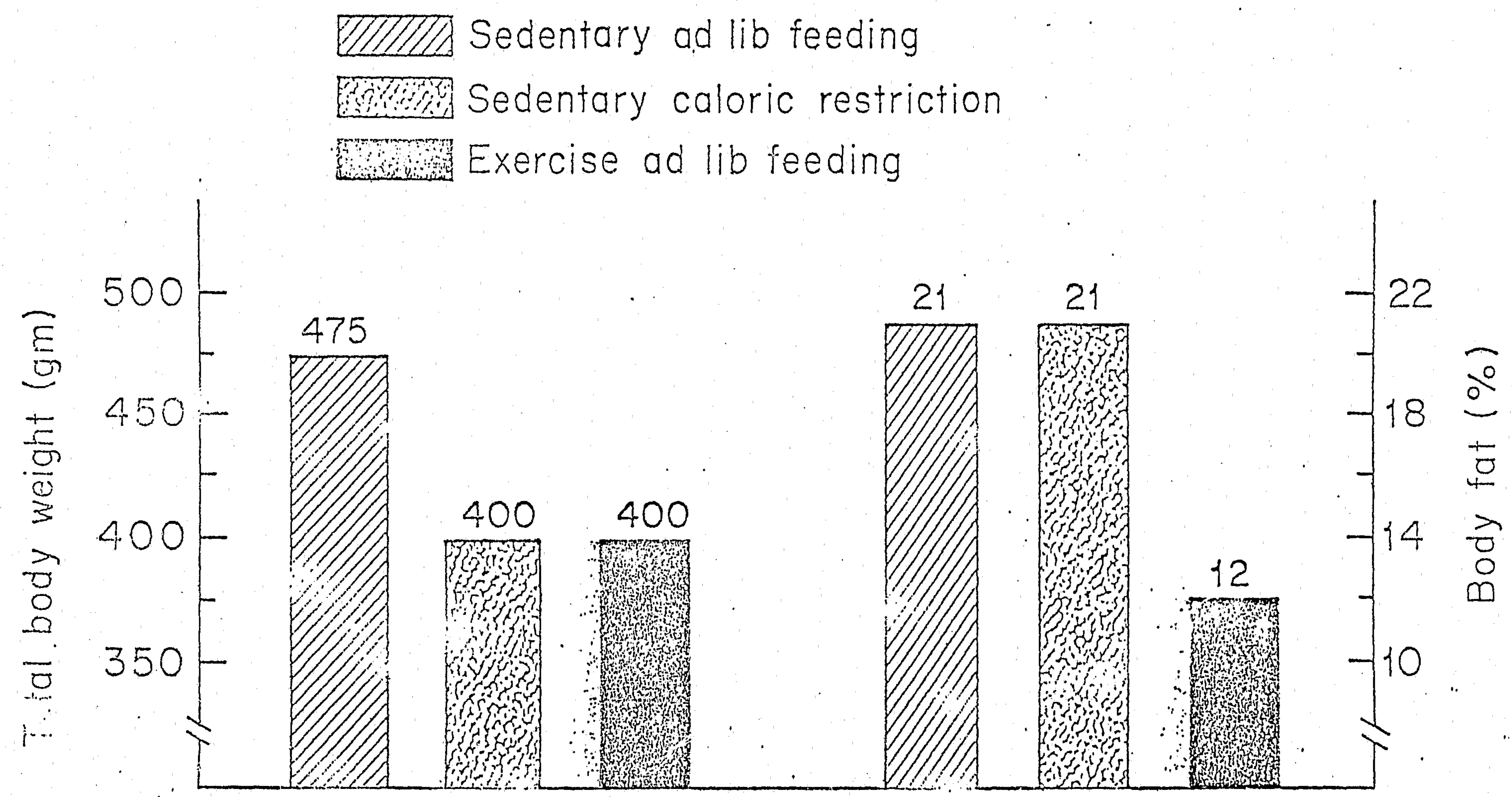

Figure 8. Effects of 15 weeks of daily exercise on body composition of adult male rats (34)

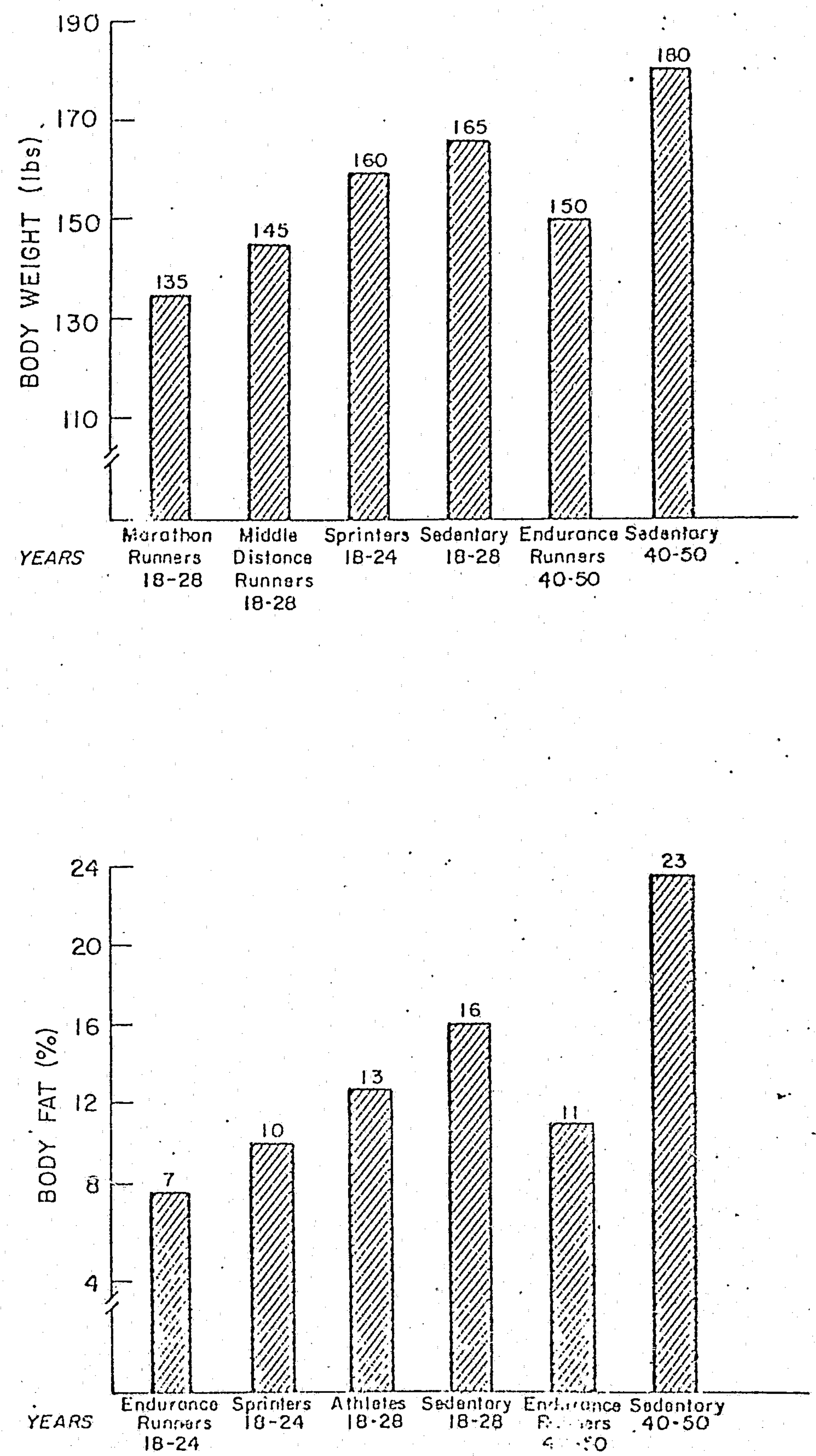

Figure 9. Comparison of body weight and fat among young and middle-aged men with various fitness levels (55)

had the lowest body weight and fat.

Pollock et al. (63) combined data from studies conducted on middle-aged men training two, three, and four days per week and found that exercising approximately 30 minutes two times per week was not sufficient to reduce body fat and weight. However, training three and four days per week for 30 minutes caused significant reductions in body weight and body fat. Skinner et al.(81) found that exercising a minimum of three times per week, approximately 40 minutes per session, for a period of six months was effective in decreasing body fat in sedentary middle-aged men. Milesis et al.(46) found body fat reductions in groups training 15, 30, and 45 minutes per day, three days per week for 20 weeks. Wilmore et al.(87) investigated the body composition changes with a ten week jogging program on 55 men, aged 17 to 59. Small, but significant, reductions in body fat and weight resulted from this moderate exercise program. Therefore, it can be concluded that programs of at least 30 minutes, three days per week are necessary for losing body weight and fat.

Moody et al.(47) viewed the effects of exercise on overweight college women. Eleven females participated in a walk-jog program six days per week for an eight week period. No attempt was made to control diet. Energy expenditure was approximately 500 calories per day. Body weight and body fat as shown in Figure 10 decreased significantly.

Boileau et al.(5) formed two groups of sedentary college men based on their relative fatness as follows: obese, 25-46 percent fatness (N=8), lean, 10-20 percent fatness (N=15). All subjects walked or ran on a treadmill 60 minutes

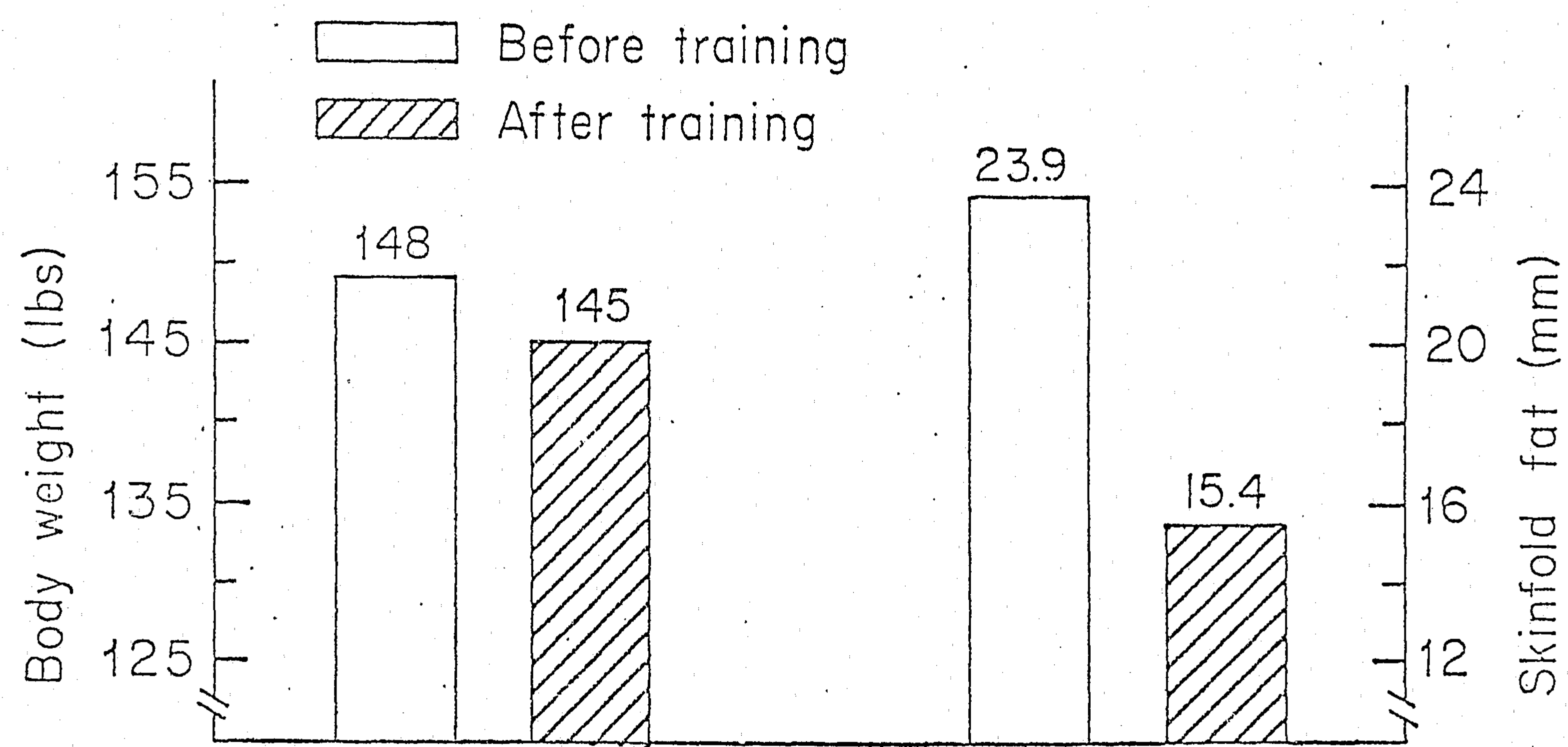

Figure 10. Effects of training on body weight and skinfold fat (47)

per day, five days per week for nine weeks. The approximate energy expenditure was 600 calories per exercise session. Significant reductions in body fat were found for both groups with greater reductions in the obese subjects. Gwinup(30) exercised 11 obese women daily for one year or longer with no dietary restrictions. Periods of walking each day were progressibely increased. No weight loss occurred until walking exceeded 30 minutes daily. Weight loss paralleled length of time spent walking.

Some investigators have used progressive weight training as the means of decreasing body fat. In an experiment by Wilmore(85), 47 women and 26 men volunteered to participate in a 10-week period of intensive weight training, with an average attendance of 40 minutes per session, two days per week. Both men and women increased in lean body weight and decreased their absolute and relative body fat. Significant reductions in five of the seven skinfolds occurred for the women, but only in one for the men. Mayhew and Gross(43) evaluated the effects of high resistance weight training on body composition of 17 college women training 40 minutes per session, three times weekly for nine weeks. Significant increases in lean body mass were found with relative body fat decreasing. Most weight training programs change percent body fat by increasing muscle weight rather than decreasing fat weight.

In summary, fat reduction results achieved from exercise programs depend on the frequency, duration, and intensity of exercise. Two days per week of exercise does not seem to be adequate in reducing fat. Reductions in fat have been found with three days per week programs, but exercising four or more days

per week if desirable. The ket to fat reduction seems to be in total energy cost, i.e., the number of calories burned during exercise. Activities of higher intensity such as jogging, cycling, or swimming burn more calories per minute and thus would be more desirable in fat reduction than low intensity activities. Duration is an important consideration. Research indicates that at least 30 minutes per exercise session is desirable for body weight and fat loss. Weight training is not as desirable for fat reduction as endurance activities because the fat weight changes only slightly.

Flexibility

Flexibility is defined as the range of possible motion in a joint or group of joints(20). For example, the flexibility of the elbow joint is movement from full flexion to full extension. The ability to touch one's toes primarily depends on the flexibility of the hip joint, spinal column, and rear leg muscles.

Joint range of movement is limited by two factors: (1) bony structures of the joint; and (2) extensibility of the surrounding ligaments, tendons, and muscles. The bony structure of a joint basically cannot be altered but the extensibility of ligaments, tendons, and muscles can be greatly affected by stretching exercises. Stretching these tissues gradually lengthens them and the joint range of movement is therefore improved.

Flexibility is specific to a joint, that is, good flexibility in the hip and spine does not necessarily imply good flexibility in any other joint. However, general stretching exercises will enhance both simple and complex movements of the body, thereby improving the flexibility of many joints.

Benefits derived from flexibility exercise are described by Melograno and Klinzing(44) and include:

1. Injury Reduction - the chance of overstretching and injuring a muscle is lessened when the muscle possesses great extensibility.
2. Muscle Relaxation - tight, stiff muscles from inactivity are relaxed by stretching.
3. Skill Enhancement - sufficient flexibility is needed in certain joints before skills can be mastered (e.g., shoulder flexibility is necessary for proper serving techniques in tennis).
4. Graceful movement - coordination of common movements is enhanced by having flexible joints. Individuals who lack flexibility move stiffly while walking, running, lifting, or reaching. This leads to inefficiency of movement.

There are two methods of stretching to promote flexibility in the body. The first, ballistic stretching, involves bouncy, jerky movements where a body part is put into motion and the momentum carries it through to the muscles' stretched limit. Ballistic stretching is often discouraged because it tends to cause soreness in the muscles the day following the stretch(20). There is some experimental evidence indicating that a "stretch reflex" occurs in the muscles from ballistic stretching. The "stretch reflex" causes the muscles to contract and resist the stretch thus resulting in small muscle spasms which eventually lead to soreness. The second mthod, statis stretching, is recommended because a firm, steady stretch inhibits the "stretch flex" in the muscles with its

delayed soreness, yet improves muscle extensibility. In addition, if muscle soreness already exists, static stretching may be used to relieve it. The basic components of yoga involve static stretching and therefore flexibility training.

There is an advantage in using some ballistic stretching for warm-up purposes so long as the movements are slow and not fast or jerky. This should help prevent injury and excessive muscle soreness. Some soreness should be expected in the early stages of any conditioning program, but with the proper precautions and adaptation the soreness will disappear.

The notion that weight training decreases flexibility is not true. Many investigators have shown that there are no harmful effects of weight training on flexibility if the movements are performed through the joints' full range of movement(20). Also flexibility exercises should be integrated into the program. However, if the weight training involves a small range of motion and the exercises are performed incorrectly, flexibility can then actually be decreased.

Factors affecting flexibility have been summarized by deVries(20):

1. Activity - Active individuals tend to be more flexible than inactive individuals. Connective tissues shorten from disuse, thus, range of motion is decreased.
2. Age - Flexibility usually decreases with age partly because connective tissue shortens with age and partly because people become more sedentary.
3. Sex - Females are generally more flexible than males due to some joint structure differences (for example, in the hip) and greater muscle extensibility.

4. Temperature - Warming a muscle and joint will increase range of motion 10 to 20 percent.

Muscular Strength and Endurance

Strength is defined as the force a muscle group can exert against a resistance in one maximum effort(33). Muscular strength is proportional to the cross-sectional dimension of the muscle or muscle group being studied. The larger the muscle the greater the strength. There are basically two types of muscular contractions used when examining strength. One type is static or isometric contraction when the muscle may be contracting maximally but the limb does not move. The other type is dynamic or isotonic contraction. Here the length of the muscle changes during the contraction as the limb goes through a range of motion. Actually, there are two types of isotonic contractions: concentric and eccentric. Concentric contraction means the muscle shortens and usually positive work against gravity is done (example, biceps curl exercise). Eccentric contraction refers to the muscle lengthening and negative work is performed (example, letting the weight down from the biceps curl position).

Muscular endurance is defined as repeated contractions against the same resistance until local fatigue factors interfere with continuation. Performing situps or pushups until they can no longer be performed constitutes muscular endurance. Energy stores in the muscle cells plus the supply of blood to the muscles limit muscular endurance exercise. Strength of the muscles is also inherent in the ability to perform muscle endurance activities. Generally, the stronger the muscle the better the muscle endurance also.

While isometric exercise (pushing against immovable objects) may improve strength at the specific angles of training, it does little or nothing for circulation, muscular endurance, or flexibility. Isometric training for developing strength generally involves one maximal (or near-maximal) muscle contraction held four to six seconds. However, six to ten repetitions of this procedure will result in the best development of strength for isometric training. Isotonic exercise involves repeated contractions through a full range of movement in the joints and promotes circulation through the muscles. Therefore, strength, muscular endurance, and flexibility are promoted through isotonic training.

Strength training of high intensity using both isometric and isotonic methods generally increases muscle mass. The stimulus of the large weight resistance causes muscle mass to increase. This is called hypertrophy and is due to the increase in muscle fiber size primarily from the increase in proteins deposited in the cells. In addition to the increase in muscle size, isotonic training causes an increased number of capillaries to be used in the muscle. More blood supply is therefore available to the cells. Energy stores inside the cells are also increased through isotonic training thereby improving the function of the muscles. The actual speed of muscle contraction is increased with strength training regimens, i.e., faster movements are possible. The power of the muscles is therefore improved since power is defined as the work of the muscles done at a high rate of speed. Thus, muscular endurance is improved through isotonic training, when there is a better blood supply and more energy stores available for muscle cell use. There have been claims that traditional weight training programs do not improve the cardiorespiratory system and therefore do not affect aerobic capacity. However, this question is now open for further research, particularly if the strength training protocol calls for minimal rest between sets of exercises and the total workout time is performed in a continuous manner.

The converse to muscle hypertrophy is atrophy or wasting away. If muscles are not used regularly, their size and function diminish. A good example of this is the observable deterioration of muscles on a limb that has had a cast for several weeks. The muscle cells decrease in size (protein is lost), the energy stores inside the cells are reduced, and the blood supply to the muscle is lessened.

Weight training on an every other day basis will result in strength gains that average two to six percent each week (1,41). The day between weight training workouts is benefitical for recuperating from the strenuous work. Apparently, muscle proteins are built up during the day of rest and waste products from the workout are removed. The person is then adequately prepared to work hard the following day in a regular workout session.

In order to improve muscular strength and endurance, the principle of overload must be followed. Overload means that the amount of weight or resistance must be gradually increased each week. When this extra work is gradually introduced, the muscles respond physiologically by adding more protein, energy stores and blood supply. Thus, their function is improved. The introduction of the overload stress must be gradual to allow the muscles to adapt and improve. If the overload stress is too great, the muscles fatigue rapidly and performance is reduced.

In addition to the overload principle, a high intensity effort must be developed by the muscles in order to cause maximum improvements in muscular strength and endurance. To improve strength, the weight resistance must be very high and just a few repetitions of movement performed. To improve muscular endurance, the weight resistance must be low and many repetitions of the exercise performed. In both cases, the efforts are near maximum but in the strength emphasis program the muscles are required to produce great force in four to six repetitions. In the muscular endurance program, the muscles are required to release large amounts of energy in the cells for repeated contractions of 15 to 20 repetitions. If time permits, three sets of exercises will give better results than one or two.

Mathews and Fox(42) have made some interesting observations concerning strength training. Individual differences in body type influence the growth in muscle girth. Persons of the mesomorphic type (muscular, and large bones, with wide shoulders, and narrow hips) respond the most to muscular training. Ectomorphs (lean, small bones, with narrow shoulders, and hips) respond less. Ectomorphic types of people increase strength, however, without the large increases in muscle size. An obese person is generally classified as an endomorph (narrow shoulders and wide hips). Mesomorphs can also be heavy and obese. Through a strength training program it is possible for an obese person to improve in muscle strength without large increases in girth. This is partially due to a concomitant loss in fat.

Plateaus in strength gains occur during training programs. That is, there is a rise in strength through training, then a level is reached where strength stays the same for a while. This usually indicates that the muscles have adapted to the resistance being lifted. After the adaptation and the introduction of a new overload resistance, another rise in strength occurs, and so on. Plateaus in training also may be due to fatigue and "going stale." The latter is a term used to describe psychological boredom of repetitive training and is best prevented by offering variety in the training. By just changing the workouts slightly or doing a few new exercises the boredom of the same day-after-day regimen is prevented.

After a certain level of strength is acquired, it may be maintained by fewer workouts. It is generally agreed that strength, once attained, subsides at slower rates than it develops(42). One or two workouts a week may be all that is needed to maintain strength levels. However, this area is open for further research.

Strength and Muscle Endurance Relationships

Clarke(11) has summarized relationships between strength and muscular endurance. These relationships are listed below:

1. The amount of weight resistance required to exhaust a muscle during repetitive contractions depends on the strength of the individual. In other words, stronger persons need to lift more weight when training for muscular endurance. Therefore, individuals with greatest muscular strength have greatest absolute muscular endurance also.
2. There appears to be a specific combination of load (weight resistance) and speed of movement which produces maximum work output. Slow contractions with high weight resistance result

in great strength gains, whereas fast contractions with low weight resistance result in muscular endurance improvements. In order for the total work output to be the same in both conditions, the number of repetitions has to be much larger for the endurance situation.
3. Fatiguing a muscle reduces its ability to apply tension. Strength drops off rapidly with fatigue. There is a close relationship between strength and muscular endurance. The faster a person can recover from an exhaustive endurance exercise, the faster strength is recovered.

Types of Strength Training

There are generally five groups of strength or weight trainers. The first, weight lifters, comprise a small group of athletes interested in competing in two Olympic lifts - the snatch, and jerk. They train with maximal poundages and do not exceed three repetitions per exercise set.

Secondly, the power lifters are concerned with the development of brute strength. They compete in the bench press, squat, and dead lifts all of which involve large amounts of weight. Their training includes extremely heavy weights with low repetitions per set and many sets per exercise.

The third, body builders, are interested in physique. They develop great definition (how the muscles look) by performing several sets of an exercise with a high number of repetitions in each set. This engorges the muscles with blood increasing their size (the so called "pumping effect").

The fourth group, athletes, use specific weight training programs to develop strength in the movement characteristics of their sport.

Finally, there are those of us who simply use weight training programs to keep in good muscle tone and wish to derive a few benefits from all of the previous four groups. Lifting weight increases blood pressure and could be dangerous to perform for many middle-aged men. A weight training regimen is recommended as an adjunct to an aerobics program and used for long-term maintenance of muscular strength and endurance.

Warm-Up and Cool-Down

Warm-Up

There are two classifications of warm-up to define: (1) specific - this includes practicing or rehearsing a specific event (such as swinging a baseball bat before batting); and (2) general - this usually includes exercise that is unrelated to the competitive event.

The latter classification (general warm-up) is most important in physical fitness programs. General body warm-up is just that - increasing the internal (or core) body temperature through various exercises such as stretching, calisthenics, jogging, etc. Specific warm-up exercises are described in Chapter 4.

Increasing the internal temperature of the body is very important to the metabolism of the muscles and nerves. The chemical reactions within the cells speed up. For each degree of increase in body temperature, the metabolic rate

increases three percent(2). This means that nerve messages will travel faster and muscle fibers will contract and relax faster. The muscles are therefore stronger after warm-up and recover quicker after exertion.

Increasing internal temperature through warm-up exercises also affects circulation. The blood vessels in the muscles dilate allowing more blood to flow to the cells, thus more nutrients can be delivered to the cells and more waste products removed. Hemoglobin, the oxygen carrying compound in the blood, gives up more oxygen to the muscle cells when the blood temperature is increased. Myoglobin, the oxygen storing compound inside the muscle cell, also releases more oxygen when the surrounding temperature is increased.

During a general body warm-up, blood flow through the lungs is increased. The exchange of oxygen and carbon dioxide is enhanced, thus increasing the oxygen supply and carbon dioxide release. As a result, the efficiency of the cardiorespiratory system is increased.

The above physiological phenomena result when the body is actively warmed-up. That is, the body is actively moved and many muscles are used. This active warm-up is more desirable than passive warm-up where muscles are heated by means of hot baths, showers, towels, and diathermy. Although the latter are somewhat beneficial, they should not be confused with active warm-up. An external heating source actually diverts blood flow from the muscle to the skin to combat the additional heat being introduced to the local area. The decreased circulation to the muscle can result in weakness and fatigue. Active warm-up promotes circulation inside the muscle.

The optimal active warm-up time has been recommended by deVries(20) to be ten to 15 minutes. This should result in a rise of one to two degrees F in the muscles' internal temperature. The time factor can vary due to several factors, including the individual's level of fitness, the activity, the temperature and humidity of the environment, the clothes worn, and the intensity of warm-up. A rule of thumb to follow for intensity and duration of warm-up under normal environmental conditions is to exercise until perspiration is evident. Wearing warm clothing will speed up the warm-up and retain the heat for several minutes. Warm clothing (rubber suits, etc.) should be avoided in warm, humid environments.

Muscle injury and soreness often are the result of an improper warm-up. Strenuous exertion without previous warm-up, can cause muscle strains and in some cases a muscle tear. The muscles usually injured are the antagonists (opposite) of the strong contracting muscles. These "cold" antagonistic muscles relax slowly and incompletely when the agonists (prime movers) contract and thus retard free movement(48).

Several studies have demonstrated that improvements in physical performance (such as running, jumping, and throwing) are significant following warm-up. These studies support the physiological principles explained previously and are summarized in an article by Neuberger(51).

Cool-down

Just as the warm-up serves to gradually increase the internal body temperature, the cool-down after a workout serves to gradually lower body

temperature. An active cool-down (such as walking) prevents blood from pooling in the legs(14) and circulation back to the heart is promoted. This amplified circulation will rid muscles of the fluid build-up and metabolic wastes that result from the muscular contractions in the workout. The fluid build-up and metabolic wastes are primarily responsible for the muscle soreness that occurs after a very strenuous exertion. It is recommended that an active cool-down of walking and stretching be continued for five to ten minutes after a strenuous workout.

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CHAPTER 3

MEDICAL SCREENING AND FITNESS EVALUATION

Importance and Need for Medical Screening and Fitness Evaluation

Several reasons exist for evaluating the physical fitness level of police officers before they start an exercise program. The most obvious reason is perhaps explained from a medical safety standpoint and is best summarized by the American College of Sports Medicine:

> For the sedentary individual there is a serious risk in the sudden, unregulated and injudicious use of strenuous exercise. But it is a risk that can be minimized and perhaps even eliminated through proper preliminary testing and the individualized prescribing of exercise programs (1).

The minimization of such risk is achieved in part by undergoing a medical screening examination. Medical screening includes a record of personal health history, family health history, present medication and treatment, diet analysis, smoking history, and physical activity patterns in order to assess the risk of testing and exercising. The procedure identifies past and present health status and determines if a person is a high risk for coronary heart disease (CHD)(22). A high risk individual is classified as one who is older than 35 years and has a majority of risk factors established by the American Heart Association (2,12,13). The risk factors include high blood pressure, elevated blood fats (cholesterol and triglycerides), cigarette smoking, obesity, physical inactivity, elevated blood sugar and uric acid, family history, and excessive emotional stress. Medical screening is an obvious protective practice

for both the exercise participant and program director in preventing medical complications and injury during activity. This is particularly important for officers older than 40 years of age since they have been found to be at higher-than-average risk (19). The officers under age 40 appear to be of average risk; however, medical screening is of no less importance with young officers.

In addition to medical screening, fitness evaluation tests are required prior to initiating an exercise program. Fitness evaluation is primarily the assessment of the functional capacity of the body through testing the cardiorespiratory system during exercise stress. The evaluation also includes the determination of body composition, flexibility, muscular strength and endurance, and pulmonary function. The results of the fitness evaluation are used to determine the present medical-health and level of fitness status of the individual police officer and as a basis for exercise prescription. Also, the results are used as a baseline for future comparisons. With respect to this latter statement physical fitness tests are excellent motivators for individuals in that they provide objective measures of benefits reaped from regular exercise programs.

Medical Screening

A thorough and detailed explanation of the medical examination is available in the textbook edited by Larson (16). Generally, the medical examination should include the following:

1. Comprehensive medical history questionnaire covering family health history and current health habits such as smoking, alcohol intake, physical activity, and medications. Special emphasis should be placed

on primary risk factors of coronary heart disease (CHD), i.e., high blood pressure, smoking, high blood fat levels (cholesterol and triglycerides), obesity, physical inactivity, and family history of CHD. An example of the questionnaire used by the Institute for Aerobics Research is presented in Appendix A.

2. The following laboratory tests are recommended if the budget is adequate:

   a. Chest X-ray
   b. Physical inspection of the spine and limbs for bone and joint abnormalities and of the neck, chest, abdomen, eyes, ears, nose, and throat.
   c. Auscultation (listening) of heart and lung sounds for identification of possible cardiac murmurs, dysrhythmias, or chronic lung disease.
   d. Measurement of resting heart rate, blood pressure, and respiration.
   e. Chemical analysis of blood for levels of serum cholesterol, triglycerides, glucose, and uric acid.
   f. Resting 12-lead electrocardiogram (ECG).
   g. Exercise stress ECG.
   h. Height and weight.

3. The following tests are suggested as minimal medical screening devices if the budget is limited:

   a. Physical inspection for limitations and handicaps.
   b. Heart rate and blood pressure measurement.
   c. Resting 12-lead ECG.
   d. Height and weight.

Guidelines for Fitness Testing

Informed Consent

An explanation of all tests and exercise procedures to the participant is mandatory before administering a fitness evaluation; the participant must be aware of what is required and potential risks. An informed consent form explains these factors, and a participant must sign this form prior to any testing. An example of an informed consent document is included in Appendix A.

Emergency Procedures

The knowledge of emergency procedures is essential when conducting fitness evaluations. All personnel involved with the program must be informed of such procedures, trained in cardiopulmonary resuscitation and basic first aid, and be able to determine the severity of the emergency and the appropriate response. All personnel have assigned duties in an emergency and should practice these duties regularly to insure teamwork and reduce confusion during an actual emergency. The procedures for action during an emergency should be typed and posted and should be continually updated. The most recent information concerning cardiopulmonary resuscitation and first aid procedures should be reviewed frequently with the staff. The equipment on hand for emergencies should include a resuscitator, a defibrillator, and a basic first aid kit. A telepone code system is recommended to expedite communication with the referring physician, hospital, or clinic personnel.

Contraindications to Exercise Testing

Certain absolute conditions exist under which persons should not be exercise stress tested. If through the medical history questionnaire or any other means a non-physician discovers that an officer has any of the conditions listed below, the officer should be referred to a physician:

1. Circulatory insufficiency (congestive heart failure)
2. Myocardial infarction (heart attack)
3. Myocarditis (inflamation of heart muscle)
4. Angina pectoris (chest pain)
5. Pulmonary embolism (blood clot in lungs)
6. Aneurysm (weak spot in wall of artery or heart)
7. Infectious disease
8. Vein inflammation
9. Heart arrhythmias
10. Heart valve disease

Other relative conditions exist under which persons may be tested with certain precautions. These conditions are listed and discussed elsewhere (1). In general, officers with a questionable medical history and/or medical problem also should be referred to a physician prior to beginning an exercise program. The same procedure should be followed for persons over 35 years of age and those under 35 who are considered a high risk for CHD.

Types of Tests

The types of tests given in a fitness evaluation depend on four major factors:

1. Time - If large numbers of officers must be tested in a short period of time, the tests are limited to the field type. If adequate time is available, then more sophisticated laboratory tests can be administered.

2. Funds - The equipment required in laboratory testing is usually complex and expensive. Therefore, only a limited amount of equipment is usually available.

3. Personnel - Ideally, only qualified individuals trained in exercise testing such as physical educators and exercise physiologists should administer laboratory stress tests. However, certain field tests can be administered by police personnel if the exercise participants are low risk and under the age of 35.

4. Population - Young officers under the age of 35 are generally healthy and may be tested in a variety of ways with low risk. Caution must be emphasized with persons over age 35 or participants found to be high risk through medical screening.

The major categories of fitness evaluations described in this chapter include the following:

1. Cardiovascular - Respiratory
   a. Resting
      (1) heart rate (sitting)
      (2) blood pressure (sitting)
      (3) 12-lead electrocardiogram
   b. Submaximal - three minute step test
   c. Maximal stress test
      (1) oxygen intake
      (2) treadmill time
      (3) electrocardiogram
      (4) heart rate
2. Pulmonary Function (spirometry)
   a. Vital capacity
   b. Forced expiratory volume for one second

3. Body Composition
   a. Height and weight
   b. Skinfold fat
   c. Percent body fat
   d. Lean body weight
   e. Girth measures
4. Blood (serum)
   a. Cholesterol
   b. Triglycerides
   c. Glucose
   d. Uric Acid
5. Motor Ability
   a. Flexibility
   b. Muscular strength
   c. Muscular endurance
   d. Power
   e. Agility

Some of the fitness tests such as resting heart rate, resting blood pressure, 12-lead ECG, stress ECG, height, weight and blood analysis are also included within the medical screening. The following descriptions of the physical fitness tests are divided into Laboratory and Field Procedures for the purpose of providing moderate to high and low budget recommendations.

<u>Laboratory Procedures</u>

Cardiovascular-Respiratory Tests

The required procedures before administering a maximum cardiovascular-respiratory (CR) stress test involve the monitoring of resting electro-

cardiogram, heart rate, and blood pressure. The equipment for such procedures includes an electrocardiogram recorder with patient cables, a stethoscope, sphygmomanometer (blood pressure recorder), stretcher bed, and arm chair. Resting measurements including a standard 12-lead electrocardiogram, heart rate, and blood pressure should be made in the supine, standing, and sitting positions before giving an exercise test. The monitoring of such tests is illustrated in Photographs 1 and 2. Norms for resting heart rate and blood pressure measured 10 minutes after being seated in a quiet room are presented in Tables 1 and 2, respectively.

The exercise stress test follows the resting measures and special reference is made to the publication (1) by the American College of Sports Medicine (ACSM) for guidelines on graded exercise stress testing. The exercise test may employ treadmill (high expense), bicycle ergometer (medium expense), or bench stepping (low-cost) procedures. For low risk officers under age 35, the 1.5 mile field test may be used as the CR stress test; however, for individuals over 35 and/or high risk, the laboratory tests are recommended. The laboratory CR test should be a maximal test of a graded, multistage design; i.e., the test should start at a low level of intensity and progress gradually to high levels of intensity until the participant reaches a voluntary maximal endpoint. The electrocardiogram, heart rate, and blood pressure must be monitored throughout the exercise test (see Photograph 3) and during a recovery period of at least five minutes following the exercise. The test is continued until the individual reaches a voluntary maximal endpoint or until contraindications dictate that he stop. Those contraindications are the following (1):

Table 1. Police officer standards for resting heart rate*

Fitness Category	Age Groups		
	20-29 yrs (n=88) Heart Rate (beats/min)	30-39 yrs (n=85) Heart Rate (beats/min)	40-52 yrs (n=30) Heart Rate (beats/min)
Excellent	44 and below	44 and below	48 and below
Good	45 to 58	45 to 61	49 to 62
Average	59 to 66	62 to 69	63 to 69
Below Average	67 to 69	70 to 85	70 to 83
Poor	80 and above	86 and above	84 and above

* Measured 10 minutes after being seated in a quiet room.

CONTINUED

1 OF 3

Table 2. Police officer standards for resting blood pressure*

Fitness Category	Age Groups: 20-29 yrs (n=88) Systolic BP (mmHg)	20-29 yrs (n=88) Diastolic BP (mmHg)	30-39 yrs (n=85) Systolic BP (mmHg)	30-39 yrs (n=85) Diastolic BP (mmHg)	40-52 yrs (n=30) Systolic BP (mmHg)	40-52 yrs (n=30) Diastolic BP (mmhg)
Excellent	105 and below	67 and below	98 and below	63 and below	101 and below	69 and below
Good	106 to 118	68 to 78	99 to 116	64 to 78	102 to 117	70 to 81
Average	119 to 124	79 to 83	117 to 125	79 to 86	118 to 124	82 to 87
Below Average	125 to 137	84 to 94	126 to 143	87 to 100	125 to 140	88 to 99
Poor	138 and above	95 and above	144 and above	101 and above	141 and above	100 and above

* Measured 10 minutes after being seated in a quiet room.

1. Dizziness
2. Chest pain
3. Intolerable fatigue or pain
4. Mental confusion
5. Pallor
6. Distressful breathing
7. Nausea
8. Definite fall in systolic blood pressure
9. ECG changes:
   a. S-T segment depression
   b. Arrhythmias

The most popular stress tests involve walking and/or running on a motorized treadmill. The treadmill is preferred because walking and running are familiar activities, and minimal time is required to adjust to the treadmill. Cycling and climbing stairs (bench stepping), strangely enough, are unfamiliar activities to Americans; and local pain in the leg muscles often causes a participant to stop prematurely.

A recommended procedure for treadmill stress testing is the Bruce protocol (6). The protocol is presented in Figure 1 and involves starting at a low level of intensity (1.7 mph and 10 percent grade) and gradually progressing in speed and grade every three minutes. When large numbers of officers are to be tested, this protocol is quite practical because it is a short efficient test. This test also can be used as a timed performance test and has a good relationship with maximum oxygen intake ($\dot{V}O_2$ max).

An optional, but important evaluation of CR function is the measurement of $\dot{V}O_2$ max or aerobic capacity. Optimal fitness ultimately depends

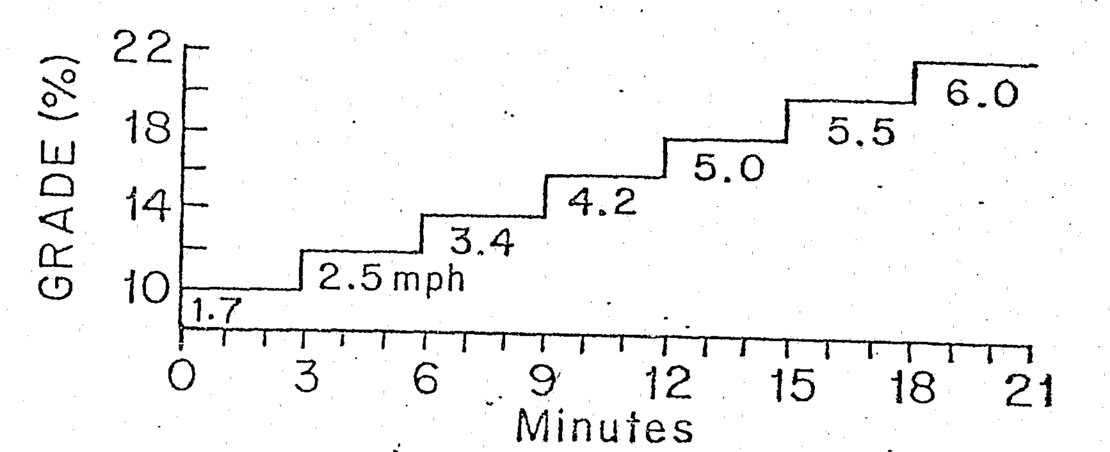

Figure 1. The Bruce protocol for treadmill stress testing (6)

on the ability of the body to take in, transport, deliver, and use oxygen. This ability, obviously involves the lungs, blood, heart, and the muscles performing the work. The $\dot{V}O_2$ max test is sophisticated and requires complex equipment (see Photograph 4), but is recommended if budgets are adequate and qualified personnel are available to conduct the test. Åstrand and Rodahl (3) and Consolazio et al. (8) have explained in detail the principles of measuring oxygen intake.

Maximum oxygen intake can be measured during the Bruce protocol described previously, or, from a practical standpoint, can be estimated from the performance time on the Bruce treadmill test as shown in Table 3. Results from the study conducted on police officers are presented by age decades. For example, if an officer 32 years of age continued for 10:37 on the Bruce test his predicted $\dot{V}O_2$ max would be 40.2 ml/kg•min and this would place him in the "good" fitness category for his age group. Other and more practical tests like the step test, 1.5 mile run, and 12 minute run, also can be used to predict maximum oxygen intake. Thus, the Bruce test and other similar tests can be used as an electrocardiogram stress test, a physical performance time test, and a measure of functional capacity (maximum oxygen intake prediction).

Submaximal Cardiovascular-Respiratory Tests

Less sophisticated than treadmill stress tests, but still valuable as CR function tests are the submaximal bicycle ergometer and bench step protocols. The purpose of the submaximal work capacity test on the bicycle ergometer is to assess the response of the heart to different workloads. Heart rate is measured at two or three different workloads, and the amount of work that an individual is capable of doing at heart rates of 150 and 170 beats per minute are determined. This physical work capacity (PWC) test is described by Ribisl (21) and is

Table 3. Estimation of maximum oxygen intake ($\dot{V}O_2$ max) fitness classifications from Bruce treadmill performance test (6).

Fitness	Age Groups					
	20-29 yrs (n=88)		30-39 yrs (n=85)		40-52 yrs (n=47)	
	Treadmill Time (min:sec)	$\dot{V}O_2$ max (ml/kg•min)	Treadmill Time (min:sec)	$\dot{V}O_2$ max (ml/kg•min)	Treadmill Time (min:sec)	$\dot{V}O_2$ max (ml/kg•min)
Excellent	13:12 & above	52.9 & above	12:22 & above	47.4 & above	11:02 & above	40.1 & above
Good	11:24 to 13:11	44.8 to 52.8	10:37 to 12:21	40.2 to 47.3	9:34 to 11:01	34.3 to 40.0
Average	10:30 to 11:23	40.8 to 44.7	9:44 to 10:36	36.6 to 40.1	8:49 to 9:33	31.4 to 34.2
Below Average	8:42 to 10:29	32.8 to 40.7	7:59 to 9:43	29.3 to 36.5	7:21 to 8:48	25.6 to 31.3
Poor	8:41 & below	32.7 & below	7:58 & below	29.2 & below	7:20 & below	25.5 & below

called the PWC-150 or PWC-170. In addition to assessing physical working capacity, the bicycle test also can be used to predict maximum oxygen intake as explained by Åstrand and Rodahl (3). The advantages of this test are that equipment needs are minimal (bicycle ergometer, metronome, timer, and stethoscope); the equipment is inexpensive and portable; and the protocol is easy to administer. If possible, this test should also be ECG and blood pressure monitored.

Low budgets in many cases will prohibit the purchase of treadmills and bicycle ergometers. In these instances, CR function can be assessed by using a very practical, low cost step test protocol. Kasch and Boyer (14) have developed a three-minute step test that requires the following minimum equipment:

1. A 12-inch bench for stepping
2. Clock with sweep second hand or stopwatch for timing test and counting heart rate.
3. A metronome to help subject maintain cadence in proper stepping rate.
4. Stethoscope to count heart rate during recovery period.

The purpose of the step test is to measure the heart rate in the recovery period following three minutes of stepping; the results can be used to estimate maximum oxygen intake as shown in Table 4. The rate of stepping is 24 steps per minute. Immediately after the three minutes of stepping, the officer sits down. A 60-second heart rate starting five seconds after the completion of stepping is counted. The average heart rate ranges for the different age groups of police officers are shown in Table 4. For an officer 32 years of age with a step test heart rate of 102 beats/min the $\dot{V}O_2$ max prediction would be 40.2 ml/kg•min

Table 4. Estimation of maximum oxygen intake ($\dot{V}O_2$ max) fitness classifications from Kasch and Boyer's three minute step test (14).

Fitness	Age Groups					
	20-29 yrs (n=87)		30-39 yrs (n=85)		40-52 yrs (n=29)	
	Step Test HR (beats/min)	$\dot{V}O_2$ max (ml/kg•min)	Step Test HR (beats/min)	$\dot{V}O_2$ max (ml/kg•min)	Step Test HR (beats/min)	$\dot{V}O_2$ max (ml/kg•min)
Excellent	69 & below	52.9 & above	73 & below	47.4 & above	71 & below	40.1 & above
Good	97 to 70	44.8 to 52.8	102 to 74	40.2 to 47.3	103 to 72	34.3 to 40.0
Average	111 to 98	40.8 to 44.7	117 to 103	36.6 to 40.1	117 to 102	31.4 to 34.2
Below Average	139 to 112	32.8 to 40.7	147 to 118	29.3 to 36.5	148 to 118	25.6 to 31.3
Poor	140 & above	32.7 & below	148 & above	29.2 & below	149 & above	25.5 & below

which would classify the officer in the "good" fitness category. Although the step test is easy to administer and results are easily obtained, its estimation of $\dot{V}O_2$ max is less accurate when compared to other exercise tests such as the bicycle and treadmill tests.

Sharkey (23) has developed a five minute step test to estimate maximum oxygen intake and, therefore, to assess fitness and physical working capacity. Recovery heart rate is counted for 15 seconds after the step test and a calculator chart is used to determine the fitness score. The calculator chart is very convenient to use, and, in fact, is designed so that an individual may administer and score the test himself. The calculator chart is available through the U.S. Department of Agriculture: Forest Service.

Pulmonary Function Tests

Basic lung function and capacity are assessed by measures of vital capacity (VC) and forced expiratory volume for one second (FEV_1). Spirometry equipment of medium expense is needed for such assessment and procedures outlined by W.E. Collins, Inc. (7) and Kory et al. (15) are recommended. Norms by decade for VC and FEV_1 are presented in Table 5. Vital capacity is related to body size; therefore, lung function is evaluated with more emphasis on FEV_1 (%). For example, a relatively small 32 year old officer may have a small vital capacity of 3.5 liters yet have a "good" rating of 83% for FEV_1 (%). Care must be taken when using these pulmonary measures as fitness tests.

Blood

If feasible, it is desirable to obtain a 15 ml blood sample from the antecubital vein for analysis of serum lipids (cholesterol and triglycerides), glucose, and uric acid. The sample should be drawn

Table 5. Police officer standards for pulmonary function tests.

Fitness Category	20-29 yrs (n=89)			30-39 yrs (n=85)			40-52 yrs (n=29)		
	Vital Capacity (L)	FEV_1* (L)	FEV ÷ VC** (%)	Vital Capacity (L)	FEV_1 (L)	FEV ÷ VC (%)	Vital Capacity (L)	FEV_1 (L)	FEV ÷ VC (%)
Excellent	7.69 and above	6.58 and above	86 and above	7.32 and above	6.13 and above	84 and above	6.29 and above	5.03 and above	80 and above
Good	6.26 to 7.68	5.06 to 6.57	81 to 85	5.87 to 7.31	4.74 to 6.12	81 to 83	5.26 to 6.28	4.09 to 5.02	78 to 79
Average	5.55 to 6.25	4.31 to 5.05	78 to 80	5.14 to 5.86	4.05 to 4.73	79 to 80	4.75 to 5.25	3.62 to 4.08	76 to 77
Below Average	4.13 to 5.54	2.80 to 4.30	68 to 77	3.68 to 5.13	2.66 to 4.04	72 to 78	3.72 to 4.74	2.69 to 3.61	72 to 75
Poor	4.12 and below	2.79 and below	67 and below	3.67 and below	2.65 and below	71 and below	3.71 and below	2.68 and below	71 and below

* FEV_1 (L) = liters of forced expiratory volume for one second.

** FEV_1 ÷ VC (%) = percentage of FEV_1 to vital capacity (VC).

after a standard 14 hour fast during which no food is allowed except water. These variables have been related both to levels of fitness and coronary heart disease risk (10). Norms for police officers are presented in Table 6. Unless a department already has the blood analysis equipment or is large enough to make the cost feasible, it is recommended that the blood be analyzed at a local medical laboratory.

<u>Field Test Procedures</u>

Cardiovascular-Respiratory Tests

The best field tests of CR function are the 1.5 mile and 12 minute run tests described by Cooper (9). The time required to run 1.5 miles or the distance covered in 12 minutes is recorded in the tests and then evaluated using Table 7. In addition, $\dot{V}O_2$ max can be predicted from the test results. For example, a 32 year old officer who runs the 1.5 mile test in 11:01 or 1.64 miles in the 12 minute test would have a predicted $\dot{V}O_2$ max of 48.0 ml/kg•min and would be classified in the "good" fitness category. Advantages of these field tests are that large groups of officers can be tested in a short period of time and the tests are highly correlated with aerobic capacity (9). The disadvantage is that a track or large running area of known distance is required. These field tests are not recommended for high risk persons or as initial screening tests for officers over the age of 35. After these types of individuals have been screened and medically cleared by a physician, the above field tests can be used as additional fitness tests and as motivators to show progress through an exercise program. A six week starter program is recommended prior to the administration of a 1.5 mile or 12 minute test.

Table 6. Police officer standards for blood variables*

Fitness Category	20-29 yrs (n=89) Chol.[a] (mg%)	20-29 yrs (n=89) Trig.[b] (mg%)	20-29 yrs (n=89) Glu.[c] (mg%)	20-29 yrs (n=89) UA[d] (mg%)	30-39 yrs (n=85) Chol. (mg%)	30-39 yrs (n=85) Trig. (mg%)	30-39 yrs (n=85) Glu. (mg%)	30-39 yrs (n=85) UA (mg%)	40-52 yrs (n=30) Chol. (mg%)	40-52 yrs (n=30) Trig. (mg%)	40-52 yrs (n=30) Glu. (mg%)	40-52 yrs (n=30) UA (mg%)
Excellent	< 102	28	67	3.7	< 116	35	67	3.6	< 143	33	66	3.8
Good	103-167	29-66	68-78	3.8-5.6	117-194	36-104	68-80	3.7-5.8	144-218	34-78	67-80	3.9-5.6
Average	168-199	67-104	79-83	5.7-6.5	195-233	105-173	81-86	5.9-6.9	219-255	79-209	81-87	5.7-6.5
Below Average	200-264	105-181	84-93	6.6-8.4	234-311	174-311	87-98	7.0-9.1	256-329	210-341	88-102	6.6-8.4
Poor	> 265	182	94	8.5	> 312	312	99	9.2	> 330	342	103	8.5

* Sample drawn after a standard 14-hour fast during which no food is allowed except water.

a = Cholesterol

b = Triglycerides

c = Glucose

d = Uric Acid

Table 7. Estimation of maximum oxygen intake ($\dot{V}O_2$ max) and fitness classifications from Cooper's 1.5 mile and 12 minute run tests (9).*

Fitness Category	Under 30 yrs			30-39 yrs			40-49 yrs		
	1.5 mile (min:sec)	12-min (miles)	$\dot{V}O_2$ max (ml/kg•min)	1.5 mile (min:sec)	12-min (miles)	$\dot{V}O_2$ max (ml/kg•min	1.5 mile (min:sec)	12 min (miles)	$\dot{V}O_2$ max (ml/kg•min)
Excellent	Below 10:15	Above 1.75	Above 51.6	Below 11:00	Above 1.65	Above 48.1	Below 11:30	Above 1.55	Above 45.1
Good	12:00 to 10:16	1.50 to 1.74	42.6 to 51.5	13:00 to 11:01	1.40 to 1.64	39.2 to 48.0	14:00 to 11:31	1.30 to 1.54	35.5 to 45.0
Average	14:30 to 12:01	1.25 to 1.49	33.8 to 42.5	15:30 to 13:01	1.15 to 1.39	30.2 to 39.1	16:30 to 14:01	1.05 to 1.29	26.5 to 35.4
Below Average	16:30 to 14:31	1.0 to 1.24	25.0 to 33.7	17:30 to 15:31	0.95 to 1.14	25.0 to 30.1	18:30 to 16:31	0.85 to 1.04	25.0 to 26.4
Poor	16:31 and Above	0.9 and Below	24.9 and Below	17:31 and Above	0.94 and Below	24.9 and Below	18:31 and Above	0.84 and Below	24.9 and Below

* Table adapted from Cooper (9), pages 28-31.

The starter program gives the officers a chance to get their legs partially conditioned and learn to pace themselves. Starter programs are described in Chapter 4.

Body Composition

Body composition assessment refers to the classification of the total body weight into two main components - fat weight and lean weight. The amount of fat (percent of total body weight) in the body is related to heart disease, diabetes, cirrhosis of the liver, hernia, intestinal obstruction, and other health hazards. Thus it is recommended that percent body fat be maintained at a reasonable standard. The standard for men over age 35 is below 19 percent and for men under age 35, below 16 percent. Body composition is measured most accurately by underwater weighing. Through this technique, body density is calculated and converted to percent fat. The technique is a complex, expensive system with sophisticated procedures and is impractical for most situations. Thus, body composition must be estimated from simple field tests involving skinfold fat or body dimension measures. Specific recommendations on the exact locations for obtaining skinfold and girth measures are shown by Behnke and Wilmore (4).

Skinfold fat determinations involve the measurement of a double layer of skin and the underlying layer of fat by using special calipers that are calibrated to provide a constant tension throughout their range of motion. The Lange caliper (available through Cambridge Scientific Industries, Cambridge, Maryland) meets this specification and is relatively inexpensive. In measuring skinfold thicknesses, it is important to locate the exact site, pinch the skinfold firmly with the thumb and

forefinger, and place the caliper at a constant distance from the thumb and forefinger holding the site (see Photograph 5). Small differences among individuals exist in the thickness of skin; therefore, the above technique actually estimates individual differences in the fat layer.

A common formula used to estimate percent body fat for young men from three skinfold sites has been reported by Pascale et al (18). A conversion table is presented in Table 8. The scoring of percent fat is summarized as follows:

1. The three skinfold sites are measured to the nearest 0.5 millimeter.
2. The axilla measurement is a vertical skinfold at the middle of the side, level of the fifth rib, and directly in line with the middle of the armpit.
3. The chest location is found over the lateral border of the pectoralis major muscle midway between the nipple and shoulder crease, and on a line running diagonally between the shoulder and opposite hip.
4. The triceps site is located on the back of the arm, over the belly of the triceps muscle, and midway between the top of the shoulder and the elbow joint.
5. All measures are taken on the right side of the body.
6. The conversion factors for the three measurements are found in Table 8, and are summed. The total is subtracted from the constant 1.08847 to obtain density.
7. The density is converted to percent fat by using the values noted on Table 8 in the inset, which are based on the formula by Brožek et al. (5).

TABLE 8. Skinfold conversion table for prediction of per cent body fat in males (18)

mm	Axilla	Chest	Tricep
1	.00071	.00048	.00055
2	.00142	.00097	.00110
3	.00214	.00145	.00165
4	.00285	.00193	.00220
5	.00356	.00242	.00276
6	.00427	.00290	.00331
7	.00499	.00338	.00386
8	.00570	.00387	.00441
9	.00641	.00435	.00496
10	.00712	.00483	.00551
11	.00783	.00532	.00606
12	.00855	.00580	.00662
13	.00926	.00628	.00717
14	.00997	.00677	.00772
15	.01068	.00725	.00827
16	.01140	.00773	.00882
17	.01211	.00822	.00937
18	.01282	.00870	.00992
19	.01353	.00918	.01048
20	.01425	.00967	.01103
21	.01496	.01015	.01158
22	.01567	.01063	.01213
23	.01638	.01112	.01268
24	.01710	.01160	.01323
25	.01781	.01208	.01378
26	.01852	.01257	.01433
27	.01923	.01305	.01489
28	.01994	.01354	.01544
29	.02066	.01402	.01599
30	.02137	.01450	.01654
31	.02208	.01498	.01709
32	.02279	.01547	.01764
33	.02351	.01595	.01819
34	.02422	.01644	.01874
35	.02493	.01692	.01930
36	.02564	.01740	.01985
37	.02636	.01788	.02040
38	.02707	.01837	.02095
39	.02778	.01885	.02150
40	.02849	.01934	.02205
41	.02920	.01982	.02260
42	.02992	.02030	.02316
43	.03063	.02079	.02371
44	.03134	.02127	.02426
45	.03205	.02175	.02481
46	.03277	.02244	.02436
47	.03348	.02272	.02591
48	.03419	.02320	.02648
49	.03490	.02369	.02701
50	.03562	.02417	.02756

Density	% Fat (3)	Density	% Fat (3)
1.0000	42.8	1.0525	20.0
1.0025	41.7	1.0550	19.0
1.0050	40.5	1.0575	17.9
1.0075	39.4	1.0600	16.9
1.0100	38.3	1.0625	15.9
1.0125	37.2	1.0650	14.9
1.0150	36.0	1.0675	13.9
1.0175	34.9	1.0700	12.9
1.0200	33.8	1.0725	11.9
1.0225	32.7	1.0750	10.9
1.0250	31.6	1.0775	9.9
1.0275	30.6	1.0800	8.9
1.0300	29.5	1.0825	8.0
1.0325	28.4	1.0850	7.0
1.0350	27.3	1.0875	6.0
1.0375	26.3	1.0900	5.1
1.0400	25.2	1.0925	4.1
1.0425	24.2	1.0950	3.2
1.0450	23.1	1.0975	2.2
1.0475	22.0	1.1000	1.2
1.0500	21.0		

Skinfolds in millimeters

Axilla ______10______ mm

Chest ______11______ mm

Triceps ______12______ mm

Skinfold Conversions

Axilla ______.00712______

Chest + ______.00532______

Triceps + ______.00662______

Total ______.01906______

Subtract above total from 1.08847 to get body density

1.08847

– ______.01906______ Total

= ______1.06941______ Density

Circle percent fat corresponding to density on table above.

Another practical method for estimating percent fat for young men is presented in Table 9. Wilmore and Behnke (25) have reported a simple formula using body weight and waist girth measured at the umbilicus level. A metal or cloth tape measure is used to determine waist girth measured to the nearest half inch. The conversion factors are found for both body weight and waist girth and are added and subtracted to obtain lean body weight. Fat weight and percent body fat then are calculated as shown in the example in Table 9.

Pollock et al. (20) have reported a more accurate formula for predicting the body fat of middle-aged men using skinfold and girth measures. A conversion table for this formula is presented in Table 10. The chest and axilla skinfolds are taken to the nearest 0.5 mm and the gluteal and forearm girths are taken to the nearest 0.1 cm. The scoring for percent fat is summarized as follows:

1. The axilla skinfold conversion is subtracted from the chest skinfold conversion to result in answer "a".
2. The gluteal girth conversion is subtracted from answer "a" to result in answer "b".
3. The forearm girth conversion is added to answer "b" to result in answer "c".
4. Answer "c" value is actually equal to body density (D).
5. Density is then converted to percent body fat using the Siri Formula (24):

$$\% \text{ Fat} = \frac{4.95}{D} - 4.5 \quad x \ 100$$

In the example on Table 10, the calcuated percent body fat was 22.6.

TABLE 9. Conversion table for estimation of percent fat (25)

Lean Body Weight (LBW) = 98.42 = [1.082 (Body Weight) - 4.15 (Waist Girth)]
% Fat = [(Body Weight - Lean Body Weight x 100] ÷ Body Weight

NAME EXAMPLE

DATE

ACTUAL MEASUREMENTS

1. Body Weight 166 lb
2. Waist Girth 33 in

CONVERSION

Add the Constant to the Body Weight conversion factor (cf); subtract the Waist Girth conversion factor (cf) from the subtotal to get Lean Body Weight (LBW); subtract the LBW from Body Weight to get Fat Weight. Finally calculate percent fat from the formula below.

CALCULATION

	Constant +	98.42
1.	Body Weight cf +	178.53
	Subtotal =	276.95
2.	Waist Girth cf -	136.95
	LBW =	140.00
3.	Body Weight =	166.00
	LBW -	140.00
	Fat Weight =	26.00
4.	Percent Fat =	(Fat Wt x 100) / (Body Wt)
	Percent Fat =	(26.00 x 100) / (166)
	Percent Fat =	15.6

BODY WEIGHT		cf	WAIST GIRTH		cf
100	-	108.20	25.0	-	103.75
105	-	113.61	25.5	-	105.83
110	-	119.02	26.0	-	107.90
115	-	124.43	26.5	-	109.98
120	-	129.84	27.0	-	112.05
125	-	135.25	27.5	-	114.13
130	-	140.66	28.0	-	116.20
135	-	146.07	28.5	-	118.28
140	-	151.48	29.0	-	120.35
145	-	156.89	29.5	-	122.43
150	-	162.30	30.0	-	124.50
155	-	167.71	30.5	-	126.58
160	-	173.12	31.0	-	128.65
165	-	178.53	31.5	-	130.73
170	-	183.94	32.0	-	132.80
175	-	189.36	32.5	-	134.88
180	-	194.76	33.0	-	136.95
185	-	200.17	33.5	-	139.03
190	-	205.58	34.0	-	141.10
195	-	210.99	34.5	-	143.18
200	-	216.40	35.0	-	145.25
205	-	221.81	35.5	-	147.33
210	-	227.22	36.0	-	149.40
215	-	232.63	36.5	-	151.48
220	-	238.04	37.0	-	153.55
225	-	243.45	37.5	-	155.63
230	-	248.86	38.0	-	157.70
235	-	254.27	38.5	-	159.78
240	-	259.68	39.0	-	161.85
245	-	265.09	39.5	-	163.93
250	-	270.50	40.0	-	166.00

TABLE 10. Conversion Table for Prediction of Percent Body Fat (20)

NAME Example

MIDDLE-AGED MEN

CHEST SKNFLD mm	CONV. FACTOR	AXILLA SKNFLD mm	CONV. FACTOR	GLUTEAL cm	CONV. FACTOR	FOREARM cm	CONV. FACTOR
1	1.10113	1	.00046	75	.075	17.5	.03973
2	1.10041	2	.00092	76	.076	18.0	.04086
3	1.09969	3	.00138	77	.077	18.5	.04200
4	1.09897	4	.00184	78	.078	19.0	.04313
5	1.09825	5	.00230	79	.079	19.5	.04427
6	1.09753	6	.00276	80	.080	20.0	.04540
7	1.09681	7	.00322	81	.081	20.5	.04654
8	1.09609	8	.00368	82	.082	21.0	.04767
9	1.09537	9	.00414	83	.083	21.5	.04881
10	1.09465	10	.00460	84	.084	22.0	.04994
11	1.09393	11	.00506	85	.085	22.5	.05108
12	1.09321	12	.00552	86	.086	23.0	.05221
13	1.09249	13	.00598	87	.087	23.5	.05335
14	1.09177	14	.00644	88	.088	24.0	.05448
15	1.09105	15	.00690	89	.089	24.5	.05562
16	1.09033	16	.00736	90	.090	25.0	.05675
17	1.08961	17	.00782	91	.091	25.5	.05789
18	1.08889	18	.00828	92	.092	26.0	.05902
19	1.08817	19	.00874	93	.093	26.5	.06016
20	1.08745	20	.00920	94	.094	27.0	.06129
21	1.08673	21	.00966	95	.095	27.5	.06243
22	1.08601	22	.01012	96	.096	28.0	.06356
23	1.08529	23	.01058	97	.097	28.5	.06470
24	1.08457	24	.01104	98	.098	29.0	.06583
25	1.08385	25	.01150	99	.099	29.5	.06697
26	1.08313	26	.01196	100	.100	30.0	.06810
27	1.08241	27	.01242	101	.101	30.5	.06924
28	1.08169	28	.01288	102	.102	31.0	.07037
29	1.08097	29	.01334	103	.103	31.5	.07151
30	1.08025	30	.01380	104	.104	32.0	.07264
31	1.07953	31	.01426	105	.105	32.5	.07378
32	1.07881	32	.01472	106	.106	33.0	.07491
33	1.07809	33	.01518	107	.107	33.5	.07605
34	1.07737	34	.01564	108	.108	34.0	.07718
35	1.07665	35	.01610	109	.109	34.5	.07832
36	1.07593	36	.01656	110	.110	35.0	.07945
37	1.07521	37	.01702	111	.111	35.5	.08059
38	1.07449	38	.01748	112	.112	36.0	.08172
39	1.07377	39	.01794	113	.113	36.5	.08286
40	1.07305	40	.01840	114	.114	37.0	.08399
41	1.07233	41	.01886	115	.115	37.5	.08513
42	1.07161	42	.01932	116	.116	38.0	.08626
43	1.07089	43	.01978	117	.117	38.5	.08740
44	1.07017	44	.02024	118	.118	39.0	.08853
45	1.06945	45	.02070	119	.119	39.5	.08967
46	1.06873	46	.02116	120	.120	40.0	.09080
47	1.06801	47	.02162	121	.121	40.5	.09194
48	1.06729	48	.02208	122	.122	41.0	.09307
49	1.06657	49	.02254	123	.123	41.5	.09421
50	1.06585	50	.02300	124	.124	42.0	.09534

Personal Measurements

CHEST 15 mm
AXILLA 12 mm
GLUTEAL 95 cm
FOREARM 25 cm

Conversions

CHEST 1.09105
\-
AXILLA 0.00552
\-
GLUTEAL 0.095
\+
FOREARM 0.05675
=
DENSITY 1.04728

$$* \% \text{ Fat} = \left(\frac{4.95}{D} - 4.5\right)$$

Example:

$$\% \text{ Fat} = \left(\frac{4.95}{1.04728} - 4.5\right)$$

% Fat = 22.6

* Formula from Siri (24)

DENSITY = 1.10185 - 0.00072 * CHEST - 0.00046 * AXILLA - 0.001 * GLUTEAL + 0.00227 * FOREA

Percent body fat norms by decade for police officers are presented in Table 11. The underwater weight technique was used to calculate the values for men 20 to 29 years of age and the Pollock et al. (20) formula was used for men over 30 years of age. The values for men over age 30 are much higher within each fitness category when compared to men under age 30. The desirable percent body fat standards recommended for men under age 30 and over age 30 are 16% and 19% or lower, respectively.

Motor Ability

Flexibility - Flexibility is included in total fitness assessment because of the widespread problems of low back pain and joint soreness. Many of these problems are related to sedentary living. Flexibility is defined as the range of possible movement in a joint or group of joints. It is necessary to determine the functional ability of the joints to move through a full range of motion.

No general flexibility test measures the flexibility of all joints; however, the trunk flexion or the sit and reach test serves as an important measure of hip and back flexibility. Primarily, the elasticity of the muscles in the back of the legs and trunk is tested in the sit and reach position. The subject sits on the floor or mat with legs extended at right angles to a taped line or box as shown in Figure 2. The heels touch the near edge of the tape or box and are eight inches apart. A yardstick is placed between the legs of the subject and rests on the floor with the 15 inch mark on the near edge of the tape or is placed on top of the box with the 15 inch mark on the edge of the box. The subject slowly reaches forward with both hands as far as possible

Table 11. Police officer standards for percent body fat.

Fitness Category	Age Groups: 20-29 yrs (n=89)* Body Fat[a] (%)	30-39 yrs (n=85)** Body Fat[b] (%)	40-52 yrs (n=30)** Body Fat[b] (%)
Excellent	6.7 and below	13.8 and below	16.8 and below
Good	6.8 to 17.3	13.9 to 21.5	16.9 to 22.9
Average	17.4 to 22.6	21.6 to 25.4	23.0 to 26.0
Below Average	22.7 to 33.2	25.5 to 33.0	26.1 to 32.2
Poor	33.3 and above	33.1 and above	32.3 and above

* Desirable body fat = 16% or lower

** Desirable body fat = 19% or lower

a = Body fat measured by underwater weight technique

b = Body fat estimated by Pollock et al. (20) formula

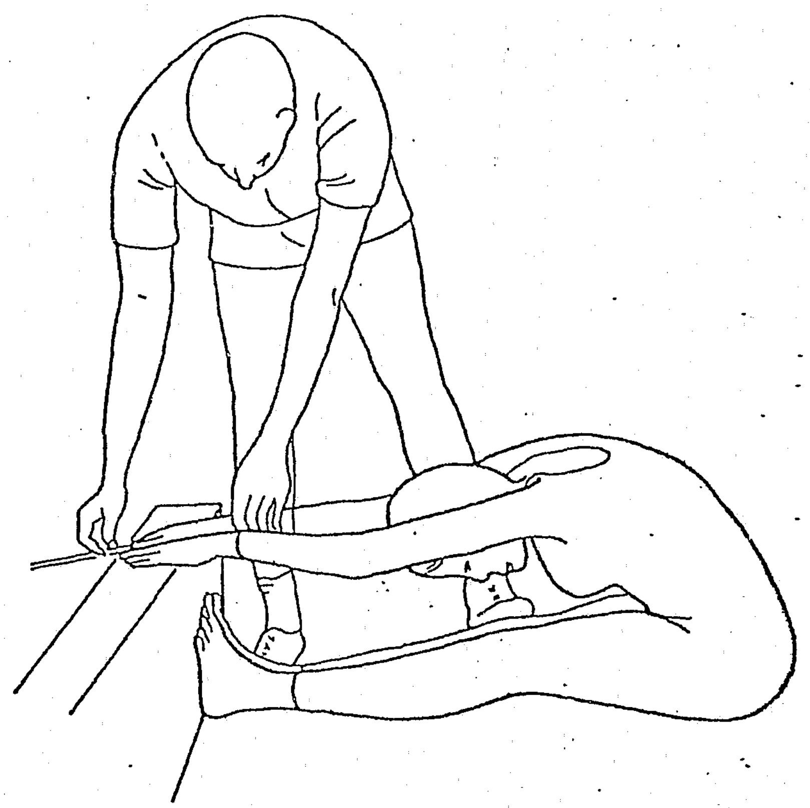

Figure 2. The sit and reach test for hip and back flexibility (17)

and holds the position momentarily. The distance reached on the yardstick by the fingertips is recorded. The best of three trials is considered as the flexibility score and can be compared to the norms in Table 12. Prior to actual test administration, the officer should warm-up slowly by practicing the test.

Strength - Muscular strength is defined as the amount of tension a muscle can exhibit in one maximal contraction. The true measurement of total body muscular strength is difficult since so many muscle groups as well as different methods of testing strength are involved. A dynamic strength test through the full range of motion which correlates well with a total body strength criterion is the one repetition maximum bench press. The equipment required includes either a barbell set with a special bench or the bench press station on a Universal Gym apparatus. The procedures for this test involve the following.

1. Estimate the weight that an individual can press in one maximal effort.
2. Load the weights to about two-thirds of the estimated maximum weight.
3. Instruct the individual to press this weight once for an easy warm-up.
4. Increase the loading of the weights in ten pound increments to maximum. If barbells are used, five pound increments are recommended as the individual gets closer to maximum. Instruct the person to lift each additional weight increment for one repetition and then load the next increment. The first three

Table 12. Police officer standards for flexibility*

Fitness Category	Age Groups		
	20-29 yrs (n=81) Flexibility (in)	30-39 yrs (n=84) Flexibility (in)	40-52 yrs (n=28) Flexibility (in)
Excellent	25.9 and above	26.4 and above	23.3 and above
Good	19.7 to 25.8	19.2 to 26.3	16.3 to 23.2
Average	16.6 to 19.6	15.6 to 19.1	12.8 to 16.2
Below Average	10.5 to 16.5	8.4 to 15.5	5.7 to 12.7
Poor	10.4 and below	8.3 and below	5.6 and below

* Sit and reach test (17)

to four repetitions serve as warm-up lifts in order to prevent muscle injury and to prepare the person for a maximal lift on the fifth or sixth effort.

5. The score for this test is the maximum number of pounds lifted in one repetition.

Norms for police officers on the one repetition maximum bench press are presented in Table 13. Because body weight is related to strength, additional norms on young men are provided in Table 14, according to body weight classifications. For example, a person weighing 166 pounds and bench pressing 180 pounds is rated in the good category. Norms in Table 14 are based on results from college-aged males and would apply primarily to police officers under age 30.

Muscular Endurance - Muscular endurance is defined as the ability to contract the muscle repeatedly over a period of time. Low levels of muscular endurance indicate inefficiency in movement and a low capacity to perform work. Two tests of muscular endurance which are easy to administer are the pushup and one-minute timed situp tests. The correct technique for administering the pushup test is demonstrated in Photographs 6 and 7. The administrator places his fist on the floor below the officer's chest. The officer must keep his back straight at all times and from the up position lower himself to the floor until his chest touches the administrator's hand and then push to the up position again. The total number of correct pushups are recorded and compared to the police officer standards shown in Table 15.

In the situp test, the officer starts by lying on his back, knees bent, heels flat on the floor, and hands interlocked behind the neck.

Table 13. Police officer standards for one-repetition maximum bench press

Fitness Category	Age Groups 20-29 yrs (n=81) Bench Press (lb)	 30-39 yrs (n=83) Bench Press (lb)	 40-52 yrs (n=28) Bench Press (lb)
Excellent	227 and above	201 and above	188 and above
Good	174 to 226	161 to 200	150 to 187
Average	147 to 173	141 to 160	132 to 149
Below Average	94 to 146	100 to 140	95 to 131
Poor	93 and below	99 and below	94 and below

TABLE 14. One repetition maximum bench press norms* for college-aged men.

Fitness Category	Body weight classifications (lbs) 120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-above
	Pounds Lifted							
Excellent	170-150	175-155	185-165	195-175	205-185	215-195	225-205	235-215
Good	145-130	150-135	160-145	170-155	180-165	190-175	200-185	210-195
Average	125-110	130-115	140-125	150-135	160-145	170-155	180-165	190-175
Below Average	105-90	110-95	120-105	130-115	140-125	150-135	160-145	170-155
Poor	85-70	90-75	100-85	110-95	120-105	130-115	140-125	150-135

* Adapted from data provided by R.A. Berger, Temple University.

Table 15. Police officer standards for the pushup test

Fitness Category	Age Groups		
	20-29 yrs (n=79) Pushups (repetitions)	30-39 yrs (n=83) Pushups (repetitions)	40-52 yrs (n=28) Pushups (repetitions)
Excellent	43 and above	37 and above	28 and above
Good	28 to 42	23 to 36	18 to 27
Average	20 to 27	17 to 22	13 to 17
Below Average	5 to 19	3 to 16	2 to 12
Poor	4 and below	2 and below	1 and below

A partner holds the feet down. The officer then performs as many correct situps (see Figure 3) as possible in one minute. In the up position, the officer should touch his elbows to his knees and then return to a full lying position before starting the next situp. This test indicates the endurance of the abdominal muscle group, an area of important concern to the middle-aged male. Norms for this test are shown in Table 16.

Power - Power, in physical fitness terms, is defined as the ability to release maximum force in the fastest possible time. The vertical jump test has been used commonly as a measure of power. A yard stick, measuring tape, smooth wall or a specially made vertical jump board are required for the test. Chalk dust is placed on the fingers of one hand as a means for marking the jump. The officer stands with one side toward the measuring device and reaches upward as high as possible. This is recorded as the "reach" distance. The performer then jumps as high as possible and touches the measuring device at the height of his jump. The test is scored as the number of inches, measured to the nearest half-inch, between the "reach" and jump marks. The best of three trials is recorded as the score. Standards for young officers are presented in Table 17. The test was not given to officers over age 35.

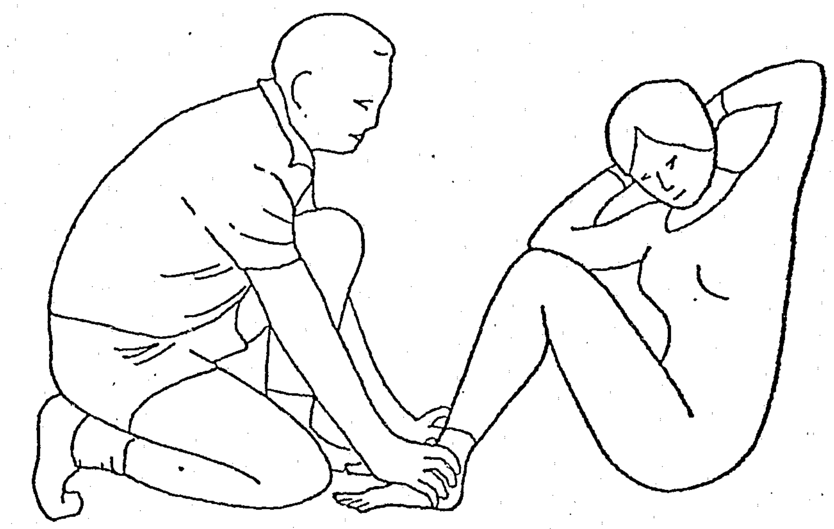

Figure 3. One minute situp test

Table 16. Police officer standards for the one-minute situp test

Fitness Category	Age Groups		
	20-29 yrs (n=81) Situps (reps/min)	30-39 yrs (n=83) Situps (reps/min)	40-52 yrs (n=28) Situps (reps/min)
Excellent	51 and above	45 and above	39 and above
Good	40 to 50	34 to 44	26 to 38
Average	35 to 39	29 to 33	19 to 25
Below Average	24 to 34	18 to 28	6 to 18
Poor	23 and below	17 and below	5 and below

Table 17. Police officer standards for vertical jump power test.

Fitness Category	Age Groups 20-29 yrs (n=80) Vertical Jump (ins)	30-35 yrs (n=64) Vertical Jump (ins)
Excellent	25.0 and above	26.0 and above
Good	20.0 to 24.5	20.0 to 25.5
Average	17.5 to 19.5	16.5 to 19.5
Below Average	12.5 to 17.0	10.0 to 16.0
Poor	12.0 and below	9.5 and below

Agility - An agility run test reflects the ability to change directions and speed quickly. Several basic movements have been combined into one test in the figure-eight Illinois Agility Run. The test is described in detail by Cureton (11).

As shown in Photograph 8, the officer starts from a flat prone position with hands on the starting line and then reacts to the starting signal. The course consists of the following:

1. Sprint 30 feet, stride stop and place at least one foot over the boundry line, turn and sprint back 30 feet.
2. Left turn around chair on starting line and zig-zag in a figure-eight fashion around the chairs up and back (see Photograph 9).
3. Sprint 30 feet up and back as described in Step 1 above except finish with a dash over the starting line.

The total time to negotiate the course is recorded to the nearest 0.1 second. Gym shoes must be worn for the test and a warmup is required. Practicing the course by a slow jog is recommended as a warmup procedure.

The best of two time trials is used as the agility score with at least five minutes of rest allowed between trials.

Norms on the agility run test for police officers are presented in Table 18. The test was not given to officers over age 35.

Table 18. Police officer standards for Illinois Agility Run Test (11)

Fitness Category	Age Groups 20-29 yrs (n=75) Agility Time (sec)	30-35 yrs (n=60) Agility Time (sec)
Excellent	16.1 and below	16.2 and below
Good	16.2 to 17.7	16.3 to 18.1
Average	17.8 to 18.6	18.2 to 19.1
Below Average	18.7 to 20.2	19.2 to 21.0
Poor	20.3 and above	21.1 and above

Discussion of Results

All test results should be explained carefully to each officer with opportunity for discussion. Strengths as well as weaknesses should be pointed out before an exercise prescription is given. A rating scale or profile chart is an excellent way of summarizing test results and presenting them visually to the officer for interpretation. Tables 19 to 24 show examples of how a fitness profile may be presented to officers of different ages. Space is also provided for recording actual scores on each table.

The profile is used to indicate the officer's initial level of fitness but more importantly is used to show progress through a prescribed exercise program. Retesting then becomes an important requirement in the evaluation process. One of the most important impacts on an officer's attitude toward exercise is to be able to show progress as a result of the hard work required in an exercise program.

<u>Summary</u>

The medical screening examination helps to assure the health and safety practices of the program. The complete fitness profile including cardiovascular-respiratory, body composition, and motor ability measures identifies the level of fitness for an individual, enables proper exercise prescription, and demonstrates the progress that is possible through a systematic, supervised program.

Table 19. Fitness Profile Chart for Police Officers, Ages 20-29 Years.

NAME____________________________________AGE______HEIGHT_________WEIGHT__________

Fitness Category	Resting Heart Rate beats/min	Bruce Treadmill Time min:sec	Maximum Oxygen Intake ml/kg•min	Three-Min. Step Test H.R. beats/min	1.5 Mile Run min:sec	12-min Run miles	Body Fat %
Excellent	Below 44	Above 13:12	Above 52.9	Below 69	Below 10:15	Above 1.75	Below 6.7
Good	45 58	13:11 11:24	52.8 44.8	70 97	10:16 12:00	1.74 1.50	6.8 17.3
Average	59 66	11:23 10:30	44.7 40.8	98 111	12:01 14:30	1.49 1.25	17.4 22.6
Below Average	67 79	10:29 8:42	40.7 32.8	112 139	14:31 16:30	1.24 1.00	22.7 33.2
Poor	80 Above	8:41 Below	32.7 Below	140 Above	16:31 Above	0.99 Below	33.3 Above

DATA COLLECTION FORM

Date

______Test 1 ______ ______ ______ ______ ______ ______ ______

______Test 2 ______ ______ ______ ______ ______ ______ ______

______Test 3 ______ ______ ______ ______ ______ ______ ______

Instructions: Record the individual's scores in the spaces provided above according to date of testing and type of test. Circle the individual's actual score in each test on the profile chart to identify varying levels of fitness.

Table 20. Fitness Profile Chart for Police Officers, Ages 20-29 Years.

NAME__________________________________AGE_______HEIGHT__________WEIGHT__________

Fitness Category	Flexibility (in)	Bench Press (lb)	Pushups (reps)	Situps (reps/min)	Vertical Jump (in)	Agility Run (sec)
Excellent	Above 25.9	Above 227	Above 43	Above 51	Above 25.0	Below 16.1
Good	25.8 19.7	226 174	42 28	50 40	24.5 20.0	16.2 17.7
Average	19.6 16.6	173 147	27 20	39 35	19.5 17.5	17.8 18.6
Below Average	16.5 10.5	146 94	19 5	34 24	17.0 12.5	18.7 20.2
Poor	10.4 Below	93 Below	4 Below	23 Below	12.0 Below	20.3 Above

DATA COLLECTION FORM

Date							
________	Test 1	________	________	________	________	________	________
________	Test 2	________	________	________	________	________	________
________	Test 3	________	________	________	________	________	________

Instructions: Record the individual's scores in the spaces provided above according to date of testing and type of test. Circle the individual's actual score in each test on the profile chart to identify varying levels of fitness.

Table 21. Fitness Profile Chart for Police Officers, Ages 30-39 Years.

NAME_______________________________AGE______HEIGHT________WEIGHT________

Fitness Category	Resting Heart Rate beats/min	Bruce Treadmill Time min:sec	Maximum Oxygen Intake ml/kg•min	Three-Min. Step Test H.R. beats/min	1.5 Mile Run min:sec	12-min Run miles	Body Fat %
Excellent	Below 44	Above 12:22	Above 47.4	Below 73	Below 11:00	Above 1.65	Below 13.8
Good	45 61	12:21 10:37	47.3 40.2	74 102	11:01 13:00	1.64 1.40	13.9 21.5
Average	62 69	10:36 9:44	40.1 36.6	103 117	13:01 15:30	1.39 1.15	21.6 25.4
Below Average	70 85	9:43 7:59	36.5 29.3	118 147	15:31 17:30	1.14 0.95	25.5 33.0
Poor	86 Above	7:58 Below	29.2 Below	148 Above	17:31 Above	0.94 Below	33.1 Above

DATA COLLECTION FORM

Date

_______Test 1 ________ ________ ________ ________ ________ ________ ________

_______Test 2 ________ ________ ________ ________ ________ ________ ________

_______Test 3 ________ ________ ________ ________ ________ ________ ________

Instructions: Record the individual's scores in the spaces provided above according to date of testing and type of test. Circle the individual's actual score in each test on the profile chart to identify varying levels of fitness.

Table 22. Fitness Profile Chart for Police Officers, Ages 30-39 Years.

NAME____________________ AGE______ HEIGHT________ WEIGHT________

Fitness Category	Flexibility (in)	Bench Press (lb)	Pushups (reps)	Situps (reps/min)	Vertical Jump (in)	Agility Run (sec)
Excellent	Above 26.4	Above 201	Above 37	Above 45	Above 26.0	Below 16.2
Good	26.3 19.2	200 161	36 23	44 34	25.5 20.0	16.3 18.1
Average	19.1 15.6	160 141	22 17	33 29	19.5 16.5	18.2 19.1
Below Average	15.5 8.4	140 100	16 3	28 18	16.0 10.0	19.2 21.0
Poor	8.3 Below	99 Below	2 Below	17 Below	9.5 Below	21.1 Above

DATA COLLECTION FORM

Date							
______	Test 1	______	______	______	______	______	______
______	Test 2	______	______	______	______	______	______
______	Test 3	______	______	______	______	______	______

Instructions: Record the individual's scores in the spaces provided above according to date of testing and type of test. Circle the individual's actual score in each test on the profile chart to identify varying levels of fitness.

Table 23. Fitness Profile Chart for Police Officers, Ages 40-52 Years.

NAME________________________________AGE______HEIGHT__________WEIGHT__________

Fitness Category	Resting Heart Rate beats/min	Bruce Treadmill Time min:sec	Maximum Oxygen Intake ml/kg•min	Three-Min. Step Test H.R. beats/min	1.5 Mile Run min:sec	12-min Run miles	Body Fat %
Excellent	Below 48	Above 11:02	Above 40.1	Below 71	Below 11:30	Above 1.55	Below 16.8
Good	49 62	11:01 9:34	40.0 34.3	72 102	11:31 14:00	1.54 1.30	16.9 22.9
Average	63 69	9:33 8:49	34.2 31.4	103 117	14:01 16:30	1.29 1.05	23.0 26.0
Below Average	70 83	8:48 7:21	31.3 25.6	118 148	16:31 18:30	1.04 0.85	26.1 32.2
Poor	84 Above	7:20 Below	25.5 Below	149 Above	18:31 Above	0.84 Below	32.3 Above

DATA COLLECTION FORM

Date

______Test 1 ______ ______ ______ ______ ______ ______ ______

______Test 2 ______ ______ ______ ______ ______ ______ ______

______Test 3 ______ ______ ______ ______ ______ ______ ______

Instructions: Record the individual's scores in the spaces provided above according to date of testing and type of test. Circle the individual's actual score in each test on the profile chart to identify varying levels of fitness.

Table 24. Fitness Profile Chart for Police Officers, Ages 40-52 Years.

NAME______________________________AGE______HEIGHT_________WEIGHT_________

Fitness Category	Flexibility (in)	Bench Press (lb)	Pushups (reps)	Situps (reps/min)
Excellent	Above 23.3	Above 188	Above 28	Above 39
Good	23.2 16.3	187 150	27 18	38 26
Average	16.2 12.8	149 132	17 13	25 19
Below Average	12.7 5.7	131 95	12 2	18 6
Poor	5.6 Below	94 Below	1 Below	5 Below

DATA COLLECTION FORM

Date					
________	Test 1	________	________	________	________
________	Test 2	________	________	________	________
________	Test 3	________	________	________	________

Instructions: Record the individual's scores in the spaces provided above according to date of testing and type of test. Circle the individual's actual score in each test on the profile chart to identify varying levels of fitness.

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CHAPTER 4

THE EXERCISE PRESCRIPTION

Guidelines and Preliminary Considerations

Exercise prescription is dependent on needs (job description, likes and dislikes, etc.), goals, physical and health status, age, available time, and equipment and facilities. These factors vary greatly among police; therefore, the individual approach to exercise prescription is recommended (1,3,5,6,11,12,14,17). Officers in the field have a greater need for muscular strength exercises than the police executive. Thus, training for the field officer should emphasize both cardiorespiratory endurance training and muscular strength exercises.

As an officer gets older the need for a preventive health program becomes more evident. Results shown from the recent study conducted on 213 police officers showed them to be lower than average in cardio-respiratory fitness and higher in body fat than the average person. Their coronary risk factor profile for prediction of coronary heart disease became significantly higher with age. Lack of regular physical training was apparent in most police officers studied. Thus, as an officer gets older, emphasis should be placed more on the development and maintenance of cardiorespiratory fitness. The initial experience with endurance maintenance should be of low to moderate intensity and progression which allows for gradual adaptation. On the basis of exper-ience with adult programs, the abrupt approach can result in discouraging future motivation for participation in endurance activities. Improper prescription also can lead to undue muscle strain or soreness, orthopedic problems, undue fatigue, and risk of precipitating a heart attack. The latter is rare and occurs mainly with middle-aged and older participants. Most incidents have occurred because of the lack of previous medical clearance and evaluation, incorrect exercise prescription, inadequate supervision, or an extreme climatic condition such as excess heat and humidity.

The intent of the programs recommended in this section is directed toward the police officer who would like an exercise program to develop and maintain cardiorespiratory fitness, and desirable body fat composition and muscle tone. The following guidelines are geared to the healthy officer who is not physically disabled, and has approximately one hour of time available 3 to 5 days per week.

The following guidelines are suggested in the exercise prescription process:

Preliminary Suggestions

1. Adequate medical information available to assess health status properly.
2. Information concerning the present status of physical fitness and exercise habits.
3. Needs and objectives of the individual for being in an exercise program.
4. Realistic short-term and long-term goals.
5. Advice on proper attire and equipment for an exercise program.

Suggestions for Initial Phases of an Exercise Program

1. Proper education of persons as to the principles of exercise, exercise prescription, and methods of monitoring and recording exercise experiences.
2. Adequate physical leadership in the early stages of the exercise program to assure proper implementation and progress.
3. Education and leadership are the keys to a successful exercise program.

Long-Term Suggestions

1. Reevaluations are necessary for reassessing status of health, physical fitness, and exercise prescription.
2. Reevaluations are also important in the education and motivation processes.

The program can begin as soon as the health and fitness status and needs and objectives of the officers are determined. Having this information plus knowing the participants' activity interests and available time, the type and quantity of exercise may be determined. It is important for the initial exercise experience to be enjoyable, refreshing, and not too demanding either physiologically or time-wise. The slow gradual approach to initiating an exercise program will help culture a more positive attitude toward physical activity and enhance the probability of long-term adherence. Also, if the prescribed program is too demanding then adherence is not very likely.

Cardiorespiratory Endurance and Weight Reduction

The research findings reported in Chapter 2 described the amount of work necessary to develop and maintain an optimal level of cardiorespiratory endurance. Within certain limits the total energy cost (calories utilized) of a training regimen is the important factor in the development of cardiorespiratory endurance, and weight reduction and control (13). This energy cost amounts to approximately 900 to 1500 calories per week or 300 to 500 calories per exercise session. Table 1 emphasizes the importance of frequency, intensity, and duration of training in attaining a certain level of calorie expenditure and gives general recommendations for exercise prescription.

Table 1. Recommendations for exercise prescription

1.	Frequency	3 to 5 days/week
2.	Intensity	60% to 90% of maximum heart rate 50% to 80% of maximum oxygen intake
3.	Duration	15 to 60 minutes (continuous)
4.	Mode-Activity	Run, jog, walk, bicycle, swim
5.	Initial Level of Fitness	High = higher work load Low = lower work load

These recommendations are designed for the needs of the average police officer and not for highly trained endurance athletes, persons of low and/or poor health status, or severely handicapped individuals. Competitive runners usually exercise daily and cover approximately 100 miles per week. On the other extreme, certain debilitating diseases, such as coronary heart disease and arthritis, may greatly limit individuals in their initial stages of training.

1. Frequency - Exercise should be performed on a regular basis from three to five days per week. Although programs of sufficient intensity and duration show some cardiorespiratory improvements with less than three days per week training, no body weight or fat losses are found. Also, improvement in cardiorespiratory endurance is only minimal to modest in programs of less than three days per week (usually less than ten percent). Participants in one or two days per week programs often complain that the workout sessions are too intermittent and break the continuity of the training regimen. Another common complaint is that, "It seemed as though I was starting anew each time I came out." Our experience has shown that these types of complaints often lead to dropouts in a program. Under unusual conditions, if time and available

space are important considerations, then one or two days per week regimens may be advisable and serve a temporary purpose.

Conditioning every other day is recommended when initiating an endurance exercise regimen. Daily exercise often becomes too demanding initially and does not allow enough time between workouts for the musculoskeletal system to adapt properly. This nonadaptive state generally leads to undue muscle soreness, fatigue, and possible injury. This guideline may seem to contradict the research findings reported in Chapter 2 and the recommendations for exercise prescription shown in Table 1, however, the data from young men running 30 minutes, five days per week, or 45 minutes, three days per week showed them to incur injuries at a significantly higher rate than three days per week programs of 15 and 30 minute durations (15). In fact, the men in the three days per week programs had little or no injury problems. Most of the injuries that did occur concerned problems of the knee, shin, ankle, or foot.

Officers who are considered at a low level of fitness and whose initial programs are restricted to five to 15 minutes per session may want to exercise twice each day (6). An example of this special condition is a participant who is placed into a walking program of low intensity and short duration. In this case an officer may adapt better to shorter, but more frequent exercise sessions. Another substitute to exercising every other day is to alternate the regular exercise session with days of very mild activity. For officers who are initiating a jog-walk program, stretching and moderate warm-up exercises (calisthenics) for ten to 15 minutes followed by a continuous walk for 20 to 30 minutes on alternate days are recommended.

Participants can begin to increase their frequency of training to a daily basis after several weeks or months of conditioning. The point in time at which this increase in frequency can be accommodated properly is an individual matter and is dependent upon age and initial level of fitness. Generally, persons of older ages and lower fitness levels are more prone to musculo-skeletal problems.

2. Intensity-Duration - Although intensity and duration are separate entities in themselves, it is difficult to discuss intensity without mentioning its interaction with duration (13). As mentioned in Chapter 2 exercise regimens of lower intensity (less calorie expenditure), but with a longer duration period showed similar improvements as the higher and shorter duration regimens; the total calorie expenditures were approximately equal for both programs. The caloric difference between running a mile in eight minutes and running a mile in nine minutes is minimal; therefore, running a little extra time at the slower pace will offset the extra calories burned at the faster pace. The important concept is that a certain amount of total work should be completed in an exercise session (total calories), and the manner in which it is accomplished can vary.

The above-mentioned concept has important implications for exercise prescription for adults, and it should be remembered that low intensity - longer duration types of programs are generally recommended for beginners. This recommendation is particularly true for those officers showing a poor performance and/or presence of coronary heart disease on their initial evaluation. The important point is to prescribe a regimen at a low intensity so that the participant can accomplish a sufficient amount of work. Initially the prescription may call for a moderate to brisk walk for 20 to 30 minutes duration.

Table 1 outlines a certain minimal threshold of intensity which is necessary for improving cardiorespiratory function. As was mentioned in Chapter 2 under research findings, programs of less intensity than 60

percent of maximum capacity will show improvements in persons with low initial levels of fitness. These officers generally will qualify for fitness classifications I or II, as listed in Table 2. Special starter programs of less than 60 percent intensity are recommended for these individuals.

The training-duration will vary from day to day and from activity to activity. The important factor is to design a program that meets the criteria for improving and maintaining a sufficient level of physical fitness, is ejoyable (tolerable), and will fit into time demands.

The level of training intensity that can be tolerated will vary greatly depending on status of fitness and health, age, experience, and general ability. Long distance runners may tolerate two to three hours of continuous running at 80 to 90 percent of maximum capacity, but most beginners cannot perform a continuous effort at this level for more than a few minutes. In order for beginners to accomplish 20 to 30 minutes of continuous training, they must choose the proper intensity level. The proper intensity level for beginners will range from 60 to 70 percent of maximum capacity (brisk walking programs) to 70 to 80 percent of maximum capacity (combinations of walking and jogging). Most persons in fitness categories I and II (Table 2) will start with a walking program; and those in categories III and above, a combination walk-jog routine.

The walk-jog routine, or low intensity - moderate intensity periods of work if performing another mode of activity will have a peak intensity of 85 to 90 percent of maximum capacity and a low intensity of 50 to 65 percent. The average intensity level will range between 70 and 80 percent of maximum capacity (6). Experience has shown that an intensity level of 50 to 60 percent of maximum can be tolerated comfortably for 20 to 30 minutes by most persons and can be classified as low to moderate

TABLE 2. Fitness classifications for exercise prescription for various levels of cardiorespiratory endurance

		Mode of Estimating Maximum Oxygen Intake		
Fitness Category	Max O_2 Intake (ml/kg•min)	Bruce Test[a] (min:sec)	1.5 Mile Run (min:sec)	Step Test[b] HR Count
I. Poor	31.5 and below	8:59 and below	15:01 and above	130 and above
II. Below Average	31.6 to 35.0	9:00 to 9:29	15:00 to 13:29	129 to 120
III. Average	35.1 to 42.5	9:30 to 10:59	13:30 to 12:01	119 to 95
IV. Good	42.6 to 51.5	11:00 to 13:59	12:00 to 9:31	94 to 85
V. Excellent	51.6 and above	14:00 and above	9:30 and below	84 and below

[a] Bruce treadmill test (2).

[b] Kasch and Boyer step test (9). For description of tests see Chapter 3.

work. Intensity levels ranging from 70 to 85 percent are considered as moderate work and above 90 percent of maximum capacity, as high intensity work (13). The results of the initial tolerance test is important in placing the participant at a correct and safe level of intensity (6,11,14,17).

Upon initiating an endurance training regimen, most officers notice the training effect rather quickly. They usually experience the ability to perform more total work in subsequent exercise session. The increased total work is a result of the ability of the participant to increase the training duration and/or to tolerate a greater work intensity. The increased average intensity is a function of a higher peak intensity level and/or an increase in the ratio of high to low bouts of work; for example, a participant in a walk-jog routine can tolerate longer periods of jogging interspersed with shorter amounts of walking. As these adaptations to training occur, changes in the exercise prescription are recommended. Periodic reevaluations will help in determining a new status of physical fitness and facilitate proper exercise prescription.

How is exercise intensity determined and how can it be estimated during an exercise session? As mentioned in Chapter 3 under evaluation procedures, intensity at various levels of effort as well as the ability to utilize oxygen (calories expended) are measured during a graded exercise test.

Heart rate and oxygen intake have a linear relationship (See Figure 1) (5). Thus, heart rate is an excellent means for estimating intensity of training. Because of the impracticality of measuring oxygen intake and the ease in monitoring heart rate, the heart rate standard is recommended for general use.

To make an accurate estimation of intensity of training, it is necessary to know both resting and maximum heart rates (8). Maximum

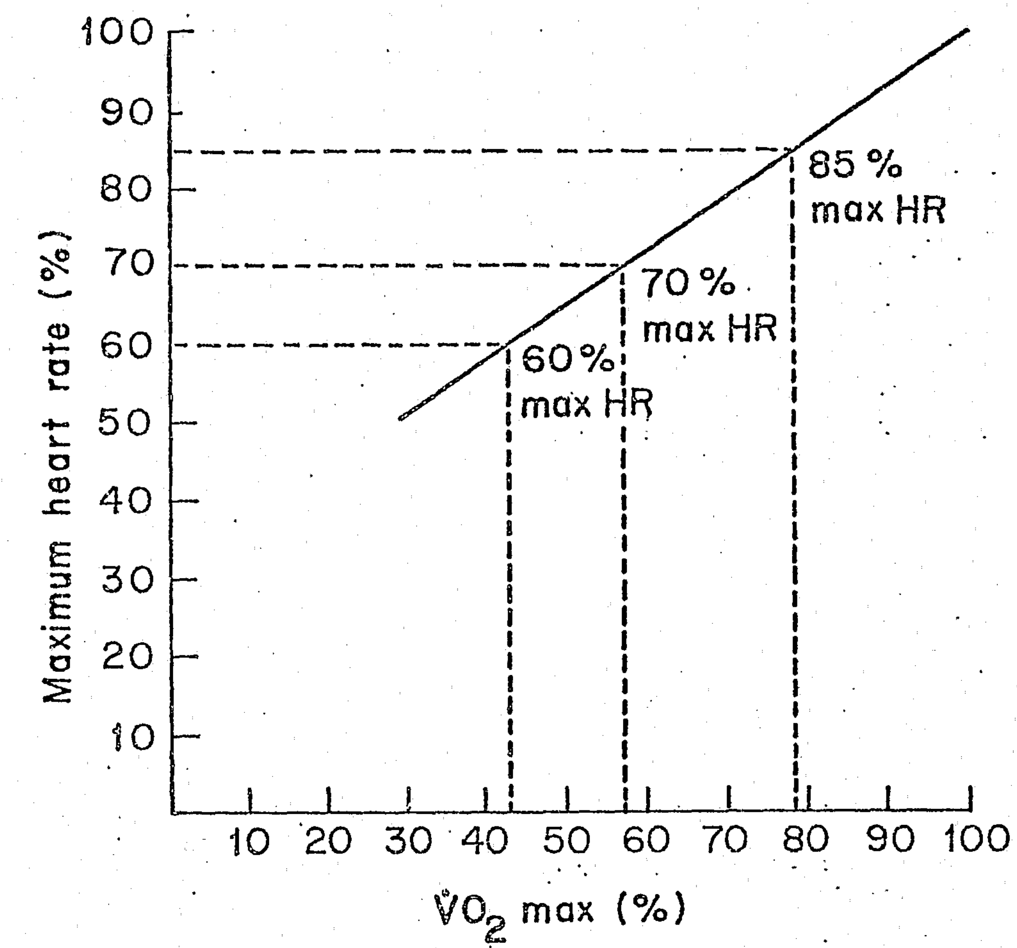


FIGURE 1.

heart rate can be determined by using the highest heart rate found on a maximum graded exercise test, after a difficult bout of endurance exercise or by subtracting one's age from 220 (5). See Figure 2 for an example of calculating percent of maximum heart rate. The first method of estimating maximum heart rate is preferred because that heart rate is usually attained while qualified personnel are evaluating the performance of an officer. The second method is to count the heart rate after an all-out 12 minute run or similar endurance type field test (1.5 mile run). This type of test is not recommended for beginners or persons suspected of being coronary prone (4). The third method of determining maximum heart rate is the least accurate, but may be used as a rule of thumb. The inaccuracy of the third method stems from the variability of maximum heart rate at any given age. For example, the maximum heart rate of a man 50 years of age averages approximately 170 beats per minute, but in fact could vary from below 140 to over 200 beats per minute. Resting heart rate should be counted in the morning for 30 seconds while in a sitting position and before eating or smoking.

Estimating exercise heart rate during training usually is accomplished by counting the pulse rate immediately after stopping by means of the palpation technique (12). This technique is applied by placing the tips of the first two fingers lightly on the carotid artery (adjacent to the voice box) or the heel of the hand over the left side of the chest (at the apex of the heart) and by counting the pulsations. The pulse at the radial artery (wrist area) is generally more difficult to count after exercise and, thus, is not recommended. A few persons will not be able to count the pulse in this manner and will need to revert to the use of a stethoscope.

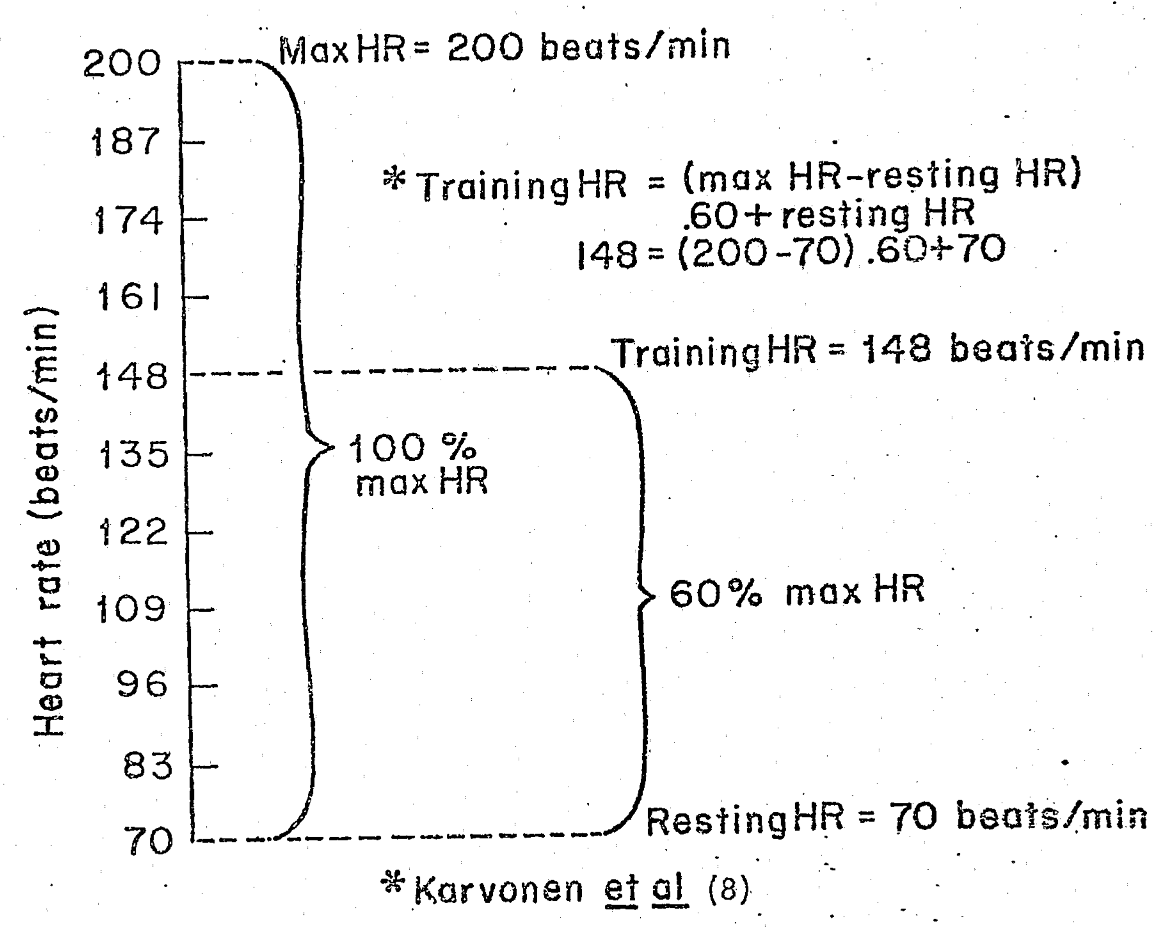


FIGURE 2.

Heart rate begins to decelerate soon after cessation of exercising (usually after only 15 seconds); thus, the count should begin as soon as possible. It is recommended to count the pulse for ten seconds and to complete it within 15 seconds after completion of exercise. Only two to four seconds are needed to situate the hand properly and to feel the heart beat rhythm. Thus, by counting beats per ten seconds, it is possible to complete the count within 15 seconds and to avoid errors resulting from the deceleration of the heart beat.

A wrist watch, wall clock, or stopwatch can be used for determining heart rate; however, a stopwatch will be the most accurate. The stopwatch facilitates starting the count more quickly as well as general counting accuracy. After establishing the heart rate rhythm, the count can start on a full beat with the first count being zero (can only start this way when using stopwatch). If the count does not end on an even beat, then one-half beat is added to the last full count. This counting detail is important with this technique because each one beat error in counting results in a six beat per minute error.

Another heart rate counting procedure that can be used satisfactorily is to count beats per 15 seconds. This method has some advantages: counting the heart rate over a longer time-span can reduce the errors in counting and multiplying the counted value by four to get beats per minute is easier for the beginner. The disadvantage is the five to ten percent error that may occur with the added counting time.

Each of the techniques requires some experimentation and practice to become proficient. Table 3 is a conversion chart for transforming raw heart rate data to beats per minute.

TABLE 3. Conversion chart for transforming heart rate counted for 10 or 15 seconds to beats per minute.

HEART RATE			
beats/10 sec	beats/min	beats/15 sec	beats/min
15	90	23	92
16	96	24	96
17	102	25	100
18	108	26	104
19	114	27	108
20	120	28	112
21	126	29	116
22	132	30	120
23	138	31	124
24	144	32	128
25	150	33	132
26	156	34	136
27	162	35	140
28	168	36	144
29	174	37	148
30	180	38	152
31	186	39	156
32	192	40	160
33	198	41	164
34	204	42	168
		43	172
		44	176
		45	180
		46	184
		47	188
		48	192
		49	196
		50	200
		51	204

3. Mode of Activity - Many different types of activities can provide adequate stimulation for improving cardiorespiratory function. Chapter 2 emphasized that the total energy cost of a program is an important factor and that as long as various activities are of sufficient intensity and duration, the training effect will occur. Also, activities of similar energy requirements will provide similar training effects (13). In choosing the proper mode of training, the participant should be familiar with the variety of activities that are available. Table 4 categorizes activities by their calorie cost. An activity will vary in intensity depending on the enthusiasm of the participant as well as on the type of activity, e.g., singles or doubles; thus, a range of energy costs is listed in the table.

In general, an activity that expends less than five calories per minute is classified as "low" intensity and is not generally recommended for use in exercise regimens that are designed to develop cardiorespiratory fitness and weight reduction. An exception to this would be a person with a functional capacity in Category I. These officers will improve their functional capacity with low intensity work, but should be encouraged to increase the duration of effort up to 60 minutes. Activities that expend five to ten calories per minute are considered of moderate intensity; activities from 10 to 14 calories per minute, moderate to high intensity; and activities greater than 14 calories per minute, high intensity. These classifications are based upon exercising continuously for up to 60 minutes.

When choosing the proper activity, the officer should take into account level of fitness, physical activity interests, availability of equipment and facilities, geographical location and climate. The

Table 4. Energy cost of various activities[1]

Activity	Calories[2] (cal/min)	Activity	Calories[2] (cal/min)
Archery	3.7 - 5	Skating (Ice or roller)	6 - 10
Back Packing	6 - 13.5	Skiing (Snow)	
Badminton	5 - 11	Downhill	6 - 10
Basketball		Cross-country	7.5 - 15
Non-game	3.7 - 11	Skiing (Water)	6 - 8.5
Game	8.5 - 15	Snow Shoeing	8.5 - 17
Bed Exercise (arm movement supine or sitting)	1.1 - 2.5	Squash	10 - 15
Bicycling (Pleasure or to work)	3.7 - 10	Soccer	6 - 15
Bowling	2.5 - 5	Softball	3.7 - 7.5
Canoeing (Rowing and Kayaking)	3.7 - 10	Stair-climbing	5 - 10
Calisthenics	3.7 - 10	Swimming	5 - 10
Dancing (Social and square)	3.7 - 8.5	Table-tennis	3.7 - 6
Fencing	7.5 - 12	Tennis	5 - 11
Fishing		Volleyball	3.7 - 7.5
(Bank, boat or ice)	2.5 - 5	Walking (See Table 5)	
(Stream, wading)	6 - 7.5		
Football (touch)	7.5 - 12		
Golf			
(Using power cart)	2.5 - 3.7		
(Walking, carrying bag or pulling cart)	5 - 8.5		
Handball	10 - 15		
Hiking (Cross-country)	3.7 - 8.5		
Horseback riding	3.7 - 10		
Horseshoe pitching	2.5 - 3.7		
Hunting, walking			
Small game	3.7 - 8.5		
Big game	3.7 - 17		
Jogging (See Table 5)			
Mountain Climbing	6 - 12		
Paddleball (racquet)	10 - 15		
Sailing	2.5 - 6		
Scuba Diving	6 - 12		
Shuffleboard	2.5 - 3.7		

[1] Energy cost values based on individual 154 pounds of body weight (70 kg).

[2] Calorie: A unit of measure based upon heat production. One calorie equals 200 ml of O_2 consumed.

deconditioned participant should be involved initially in several weeks or months of moderate activity that does not require competition or extreme starting and stopping movements. Under these conditions many participants tend to overdo and become unduely stiff and sore, fatigued, and/or injured. The joints and muscular system are not adequately developed in a beginner to handle such demands; thus, the participant is vulnerable to injury. The need to get in shape to play games is true in most cases. Officers whose screening tests have indicated cardiovascular problems should avoid highly competitive type activities. It is important not to exceed the safe limit of exercise. The starter programs outlined later in this chapter are recommended for beginners.

Participation in a variety of activities is recommended and can be accomplished by interchanging some of the various activities listed in Table 4. Choosing different activities tends to keep a participant interested in endurance exercise over a long term period. For example, one might jog 30 minutes on Monday and Thursday and play handball or basketball on Tuesday and Friday. The important factor is that the officer participates in these activities frequently and with sufficient intensity and duration.

Regardless of the type of physical activity used in a training program each exercise session should begin with a warm-up period and finish with a cool-down period. The warm-up period should be from ten to 15 minutes in duration and include a combination of stretching (flexibility) and light-to-moderate muscular strength and endurance exercises. This warm-up can be followed by five minutes of walking or slow jogging. Suggested stretching and muscular strength and endurance exercises are described later in this chapter.

The cool-down period should allow adequate time for the various bodily processes to readjust to normal. The length of the cool-down period is dependent on the difficulty of the endurance training period, status of physical fitness, and environmental conditions. Officers in better physical condition recover more quickly from vigorous activity. Exercising in a hot and humid environment generally will lengthen the recovery period. The cool-down period normally will last from five to ten minutes and can include a variety of activities such as slow jogging, walking, stretching, and light calisthenics.

Although the emphasis of this section was based upon the variety of activities available for developing and maintaining cardiorespiratory endurance, it must be remembered that such exercise is only a part of a total well-rounded program. Endurance activities are of paramount importance, but adequate flexibility and muscular strength and endurance add to a balanced physical fitness program.

Programs for Cardiorespiratory Fitness

The Aerobics Exercise System

The term "aerobics" was adapted from the word aerobic which refers to the type of metabolism utilizing oxygen in the production of energy for the body. Aerobics is a program of endurance exercises which require a sustained effort, e.g., running, bicycling, swimming, fast walking, and vigorous game-type activities. These types of exercises improve the efficiency of the cardiorespiratory system (heart, lungs, and blood vessels) and thus increase the ability of the body to transport and utilize oxygen.

Dr. Kenneth Cooper (3,4) developed the aerobics program of endurance training. To make this program of training adaptable to the general public, a system of awarding points for various amounts of activity was devised. The point system is based upon the energy cost of the activity, i.e., the amount of oxygen utilized. Thus, the number of points achieved (energy cost) is dependent upon the intensity of the activity and its duration. Cooper suggests that a minimum of 30 points per week is necessary in order to maintain satisfactory cardiorespiratory condition. Thirty aerobic points per week is equal to approximately 30 minutes of walk/jogging, three days per week. The system is unique in that numerous activities can be combined or interchanged to meet the thirty points per week recommendation. The aerobics system is unique in that it can be used by most departments because its use is generally not dependant on size, facilities, location (city or rural), or environmental conditions.

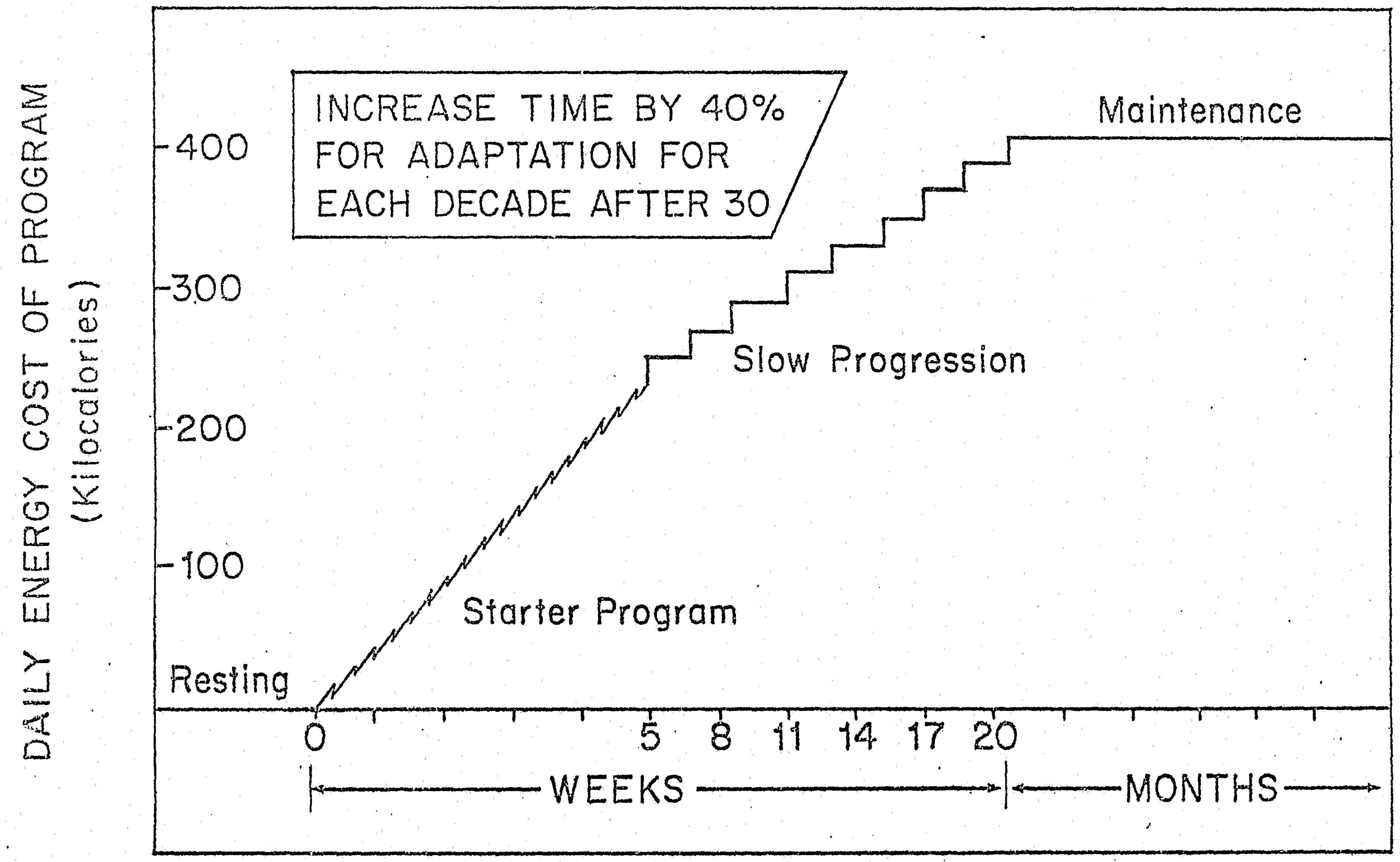
Exercise Prescription for Cardiorespiratory Endurance

As mentioned earlier, in order to prescribe exercise properly, it is necessary to know something about the person's health status and physical fitness level. After undergoing the physical fitness examination (see Chapter 3), the officer may be classified into one of five categories of cardiorespiratory fitness. Table 2 shows the fitness classifications scores achieved on various tests. In order to be classified into the good level of cardiorespiratory fitness, a person should have a functional capacity of approximately 42 ml/kg min of oxygen intake. That level of fitness coincides with about 10:30 (min:sec) on the Bruce treadmill stress test, 12:00 minutes on the 1.5 mile test, and 90 (beats/min) total recovery heart rate on the three-minute step test. Therefore, knowing the initial level of cardiorespiratory fitness will help guide the participant into the correct program.

The exercise prescription usually has three stages of progression: starter, slow progression, and maintenance (see Figure 3). The initial stage of training is classified as a starter program. In this phase the exercise intensity is low and includes a lot of stretching and light calisthenics. The purpose at this stage of the program is to introduce the officer to exercise at a low level and to allow time to adapt properly to the initial weeks of training. If this phase is introduced correctly, the participant will experience a minimum of muscle soreness and can avoid debilitating injuries of the knee, shin, ankle or foot. The latter injuries are common in the initial stages of a jogging program, but can be avoided if the participant takes some preliminary precautions, such as a good starter program, good running shoes, and proper warm-up and conditioning of the legs. Avoiding sharp turns and extremely hard running surfaces are also important safeguards (14).

The duration of the starter program is usually from four to six weeks, but is dependent on the adaptation of the participant to the program. For example, an officer who is classified in a poor or fair fitness level may spend as many as six to ten weeks in a starter program, but a participant scoring in the good to excellent categories may not need to participate in a starter program

The slow progression stage of training differs from the starter phase in that the participant is progressed at a more rapid rate. During this stage, the duration and/or intensity are increased consistently every two to three weeks. How well the person adapts to the present level of training dictates the frequency and magnitude of progression. As a general rule, the older the participant and the lower the initial fitness level, the longer one takes to adapt and progress in a training



EXERCISE PRESCRIPTION: PROGRESSION IN TRAINING

FIGURE 3. Exercise prescription: progression in training

regimen. The adaptation to the training load takes approximately 40 percent longer for each decade in life after age 30. That is, if the progression in distance run is every two weeks for men of 30 to 39 years, then the interval may be three weeks for those of 40 to 49 years and four weeks for the 50 to 59 year-old group.

The maintenance stage of prescription usually occurs after six months to a year of training. At this stage, the participant has reached a satisfactory level of cardiorespiratory fitness and is no longer interested in increasing the training load. At this point further development is usually minimal, but the number of miles or minutes trained per week enables one to maintain fitness.

General Guidelines for Getting Started

In designing an exercise regimen one must select an activity which can be performed on a regular basis. Generally, game-type activities are not recommended in the early stages of training. Prior to becoming involved in game-type activities whereby running will be encountered, fast walking or walk-jog programs are recommended.

Table 4 lists the energy cost of a variety of activities commonly used in recreation and endurance fitness programs. The activities are quantified in terms of calories/minute. These values give inference as to the relative intensity of the effort. To get the total effect of the programs, one must determine the intensity level and multiply this by the total number of minutes of participation. Because games are not played continuously with an even amount of effort, some extrapolation will have to be made to get the intensity level for game-type activities.

Intensity is dependent on how hard the game is played. If in doubt use the average value listed in Table 4. For example, if handball is played for 45 minutes, then the intensity in calories (12.5 cal/min) would be multiplied by the minutes played (45) to get the total calorie expenditure (562.5). The important point here is that the participant counts only the time that was used in participation. Rest breaks and waiting time do not count.

The energy cost of running and walking are listed in Table 5. An endurance training program can be designed from Table 5, but because of the difficulty of knowing the proper pace or sequence of progression, several programs are outlined in subsequent Tables in this chapter. The programs include walking and running routines, stationary running, bench stepping, rope skipping, and various game-type activities, and are designed relative to various levels of fitness.

Although walking and running can be done in a variety of settings, such as running tracks, roads, parks, etc., the course should be a measured distance. This can be accomplished by the use of an odometer from an automobile or bicycle, or use of a measured track. Training on an oval track can get boring over a long period of time, but if available is a good way of getting started. Tracks generally have a smooth running surface and are of a known distance.

Table 6 will help in determining pace for walking and running programs. Speeds range from a slow walk (2.9 mph) to a fast run (12.5 mph). To aid in pacing, reference points of 110 yards or 440 yards are helpful. If carrying a stopwatch or wrist watch with a 60 second sweep hand, pace can be kept very accurately during the entire training program. Monitoring of the program by pace and heart rate response will help as a guide to proper initiation and progression of the training regimen.

Table 5. Energy cost of walking and running [1]

Activity	Calories[2] (cal/min)	Speed mph	Speed min/mile (min:sec)
Walking	2.5	2.00	30:00
	3.0	2.50	24:00
	3.7	3.00	20:00
	4.2	3.50	17:08
	4.9	3.75	16:00
	5.5	4.00	15:00
	7.0	4.50	13:20
	8.3	5.00	12:00
Running	10.1	5.5	10:55
	12.0	6.0	10:00
	14.0	7.0	8:35
	15.6	8.0	7:30
	17.5	9.0	6:40
	19.6	10.0	6:00
	21.7	11.0	5:30
	24.5	12.0	5:00

[1] Energy cost values based on individual 154 pounds of body weight (70 kg)

[2] Calorie: A unit of measure based upon heat production. One calorie equals 200 ml of O_2 consumed.

Table 6. Pacing chart for walking and running program conducted on track measured in 110 yard increments.

Pace 110 yd (sec)	440 yd (min:sec)	mph	Pace 110 yd (sec)	440 yd (min:sec)	mph	Pace 110 yd (sec)	440 yd (min:sec)	mph
18	1:12	12.5	38	2:32	5.9	58	3:52	3.9
19	1:16	11.8	39	2:36	5.8	59	3.56	3.8
20	1:20	11.2	40	2:40	5.6	60	4:00	3.7
21	1:24	10.7	41	2:44	5.5	61	4:04	3.7
22	1:28	10.2	42	2:48	5.4	62	4:08	3.6
23	1:32	9.8	43	2:52	5.2	63	4:12	3.6
24	1:36	9.4	44	2:56	5.1	64	4:16	3.5
25	1:40	9.0	45	3:00	5.0	65	4:20	3.5
26	1:44	8.6	46	3:04	4.9	66	4:24	3.4
27	1:48	8.3	47	3:08	4.8	67	4:28	3.4
28	1:52	8.0	48	3:12	4.7	68	4:32	3.3
29	1:56	7.7	49	3:16	4.6	69	4:36	3.3
30	2:00	7.5	50	3:20	4.5	70	4:40	3.2
31	2:04	7.3	51	3:24	4.4	71	4:44	3.2
32	2:08	7.0	52	3:28	4.3	72	4:48	3.1
33	2:12	6.8	53	3:32	4.2	73	4:52	3.1
34	2:16	6.6	54	3:36	4.2	74	4:56	3.0
35	2:20	6.4	55	3:40	4.1	75	5:00	3.0
36	2:24	6.2	56	3:44	4.0	76	5.04	2.9
37	2:28	6.1	57	3:48	3.9	77	5.08	2.9

Generally officers scoring in fitness categories I and II should begin their endurance training by walking. The walk should be at a comfortable but brisk pace. The initial speed will range from 3.0 to 4.0 mph. Distance (or time) will be approximately 1.5 to 2 miles (30 to 40 minutes). The reason behind this combination of walking speed and distance is to get the participant started at a comfortable pace and at the same time keeping the distance long enough so that one can begin to get an endurance training effect (total calories - aerobic points).

Even though the calorie cost of this regimen is low (125-150 calories), it will allow time for adaptation of most bodily systems and parts. Do not be concerned about not working hard enough. Time, with proper progression and adaptation, will eventually lead to the higher, more demanding levels of training.

Starter and Low-Level Conditioning Programs

Tables 7 to 15 outline various six-week starter programs, and Tables 16 to 24 are 16-week conditioning programs for fitness categories I, II, and III. All tables are developed for ages under 30, between 30 and 39 years, and between 40 and 49 years of age. These tables are taken from the book The New Aerobics (4). Programs for the age group 50 and over are available, but can be found only in The New Aerobics. If an officer is in a very low state of physical condition, the starter programs for under 30 (Tables 7 to 9) , 30 to 39 years of age (Tables 10 to 12), and 40 to 49 years of age (Tables 13 to 15) are recommended. If the starter programs are too easy, then the participant can begin with Tables 16 to 24. Starter programs for swimming and cycling are described in The New Aerobics.

TABLE 7. Walking starter program (under 30 years of age)

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
1	1.0	15:00	5	5
2	1.0	14:00	5	10
3	1.0	13:45	5	10
4	1.5	21:30	5	15
5	1.5	21:00	5	15
6	1.5	20:30	5	15

TABLE 8. Combination walk-jog starter program (under 30 years of age)

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
1	1.0	13:30	5	10
2	1.0	13:00	5	10
3	1.0	12:45	5	10
4	1.0	11:45	5	15
5	1.0	11:00	5	15
6	1.0	10:30	5	15

TABLE 9. Stationary running starter program (under 30 years of age)

Week	Duration (min)	Steps/Min*	Freq/Wk	Points/Wk
1	2:30	70-80	5	4
2	5:00	70-80	5	7½
3	5:00	70-80	5	7½
4	7:30	70-80	5	11¼
5	7:30	70-80	5	11¼
6	10:00	70-80	5	15

* Count only when left foot hits the floor. Feet must be at least eight inches from the floor.

TABLE 10. Walking starter program
(30-39 years of age)

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
1	1.0	17:30	5	5
2	1.0	15:30	5	5
3	1.0	14:15	5	10
4	1.0	14:00	5	10
5	1.5	21:40	5	15
6	1.5	21:15	5	15

TABLE 11. Combination walk-jog starter program
(30-39 years of age)

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
1	1.0	17:30	5	5
2	1.0	15:30	5	5
3	1.0	14:15	5	10
4	1.0	13:30	5	10
5	1.0	11:45	5	15
6	1.0	11:15	5	15

TABLE 12. Stationary running starter program*
(30-39 years of age)

Week	Duration (min)	Steps/Min*	Freq/Wk	Points/Wk
1	2:30	70-80	5	4
2	2:30	70-80	5	4
3	5:00	70-80	5	7½
4	5:00	70-80	5	7½
5	7:30	70-80	5	11¼
6	7:30	70-80	5	11¼

* Count only when left foot hits ground. Feet must be brought at least eight inches from floor.

TABLE 13. Walking starter program
(40-49 years of age)

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
1	1.0	18:00	5	5
2	1.0	16:00	5	5
3	1.5	24:00	5	7 1/2
4	1.5	22:30	5	7 1/2
5	2.0	31:00	5	10
6	2.0	30:00	5	10

TABLE 14. Combination walk-jog starter program
(40-49 years of age)

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
1	1.0	18:00	5	5
2	1.0	16:00	5	5
3	1.0	15:00	5	5
4	1.0	14:15	5	10
5	1.0	13:45	5	10
6	1.0	12:45	5	10

TABLE 15. Stationary running starter program
(40-49 years of age)

Week	Duration (min)	Steps/min*	Freq/Wk	Points/Wk
1	2:30	70-80	5	4
2	2:30	70-80	5	4
3	5:00	70-80	5	7 1/2
4	5:00	70-80	5	7 1/2
5	5:00	70-80	5	7 1/2
6	7:30	70-80	5	11 1/4

* Count only when left foot hits the ground. Feet must be brought at least eight inches from floor.

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If the starter program is too easy or difficult then make an on-the-spot change in the program. Remember, the exercise prescription should be individualized. A satisfactory modification can usually be made by changing the speed or distance slightly (Tables 5 and 6).

The starter programs begin at a low level of conditioning with only five to 15 points earned per week in order to allow for proper adaptation. Through continuous progress training, the 30 point per week level may be achieved by the tenth to 15th week depending on the initial fitness category for the participant. Officers in fitness Categories IV and V usually will progress to the 30 point per week level at a faster rate than participants in Categories I, II, and III.

If the participant wants to play rigorous games such as handball or basketball for a conditioning regimen, he probably should spend several weeks in a walk-jog program first. Vigorous sport activities are more traumatic to the legs and feet than walking and jogging and often leave the unconditioned participant vulnerable to injury. The starter programs are conservative recommendations for beginning an exercise program. If the participant is not significantly overweight and feels that the starter programs are too easy, then he can progress to the seventh week of the conditioning program listed for his fitness category (Tables 16 to 24). A reevaluation at this time can assist the officer in the proper readjustment of his training load. Officers in fitness Categories IV and V should begin with the programs listed in Table 25. More extensive point charts for running, walking, cycling, swimming, stationary running, and other activities are shown in Tables 26 and 27.

TABLE 16. Walking conditioning programs for fitness categories I, II, and III*

Fitness Category I (under 30 years of age)

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
7	2.0	28:00	5	20
8	2.0	27:45	5	20
9	2.0	27:30	5	20
10	2.0	27:30	3	22
	and			
	2.5	33:45	2	
11	2.0	27:30	3	22
	and			
	2.5	33:30	2	
12	2.5	33:15	4	26
	and			
	3.0	41:30	1	
13	2.5	33:15	3	27
	and			
	3.0	41:15	2	
14	2.5	33:00	3	27
	and			
	3.0	40:00	2	
15	3.0	41:00	5	30
16	4.0	55:00	3	33

TABLE 16.(con't.)

Fitness Category II

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
7	2.0	27:30	5	20
8	2.0	27:30	3	22
	and			
	2.5	33:45	2	
9	2.0	27:30	3	22
	and			
	2.5	33:30	2	
10	2.5	33:15	3	27
	and			
	3.0	41:15	2	
11	2.5	33:00	3	27
	and			
	3.0	40:00	2	
12	3.0	41:00	5	30
13	4.0	55:00	3	33

Fitness Category III

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
7	2.5	33:15	4	26
	and			
	3.0	41:30	1	
8	2.5	33:00	3	27
	and			
	3.0	40:00	2	
9	3.0	41:00	5	30
10	4.0	55:00	3	33

* After completing the progressive walking program, use Table 25 to select a 30 point per week conditioning program.

TABLE 17. Combination walk-jog conditioning programs for fitness categories I, II, and III*

Fitness Category I (under 30 years of age)

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
7	1.5	18:30	5	15
8	1.5	17:30	5	15
9	1.5	16:30	4	18
10	1.0	9:30	3	21
	and			
	1.5	15:30	2	
11	1.0	8:45	3	24
	and			
	1.5	14:45	2	
12	1.0	8:30	3	24
	and			
	1.5	14:00	2	
13	1.0	8:15	3	24
	and			
	1.5	13:30	2	
14	1.0	7:55	3	27
	and			
	1.5	13:00	2	
15	1.0	7:45	2	31
	and			
	1.5	12:30	2	
	and			
	2.0	18:00	1	
16	1.5	11:55	2	32
	and			
	2.0	17:00	2	

Fitness Category II

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
7	1.5	17:30	5	15
8	1.5	16:30	4	18
9	1.0	9:30	3	21
	and			
	1.5	15:30	2	
10	1.0	8:45	3	24
	and			
	1.5	14:15	2	
11	1.0	8:15	2	26
	and			
	1.5	13:00	3	
12	1.0	7:45	2	31
	and			
	1.5	12:30	2	
	and			
	2.0	18:00	1	
13	1.5	11:55	2	32
	and			
	2.0	17:00	2	

TABLE 17.(con't.)

Fitness Category III

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
7	1.5	16:30	5	22
8	1.0	9:00	3	24
	and			
	1.5	14:45	2	
9	1.0	7:55	1	32
	and			
	2.0	18:00	3	
10	1.5	11:55	2	32
	and			
	2.0	17:00	2	

* After the progressive walk-jog program, use Table 25 to select a 30 point per week conditioning program.

TABLE 18. Stationary running conditioning program for fitness categories I, II, and III*

Fitness Category I (under 30 years of age)

Week	Duration (min)	Steps/Min**	Freq/Wk	Points/Wk
7	10:00	70-80	5	15
8	12:30	70 80	5	18 3/4
9	12:30	70-80	5	18 3/4
10	15:00	70-80	5	22 1/2
11	15:00	70-80	5	22 1/2
12	10:00	80-90	1	24 1/4
	and			
	17:30	70-80	3	
13	12:30	80-90	3	27
	and			
	15:00	80-90	2	
14	12:30	80-90	3	28
	and			
	15:00	80-90	3	
15	15:00	80-90	5	30
16	15:00	90-100	4	30

TABLE 18. (con't)

Fitness Category II

Week	Duration (min)	Steps/Min**	Freq/Wk	Points/Wk
7	12:30	70-80	5	18 3/4
8	15:00	70-80	5	22 1/2
9	15:00	70-80	5	22 1/2
10	12:30	80-90	3	27
	and			
	15:00	80-90	2	
11	12:30	80-90	2	28
	and			
	15:00	80-90	3	
12	15:00	80-90	5	30
13	15:00	90-100	4	30

Fitness Category III

Week	Duration (min)	Steps/Min**	Freq/Wk	Points/Wk
7	10:00	80-90	1	24¼
	and			
	17:30	70-80	3	
8	12:30	80-90	2	28
	and			
	15:00	80-90	3	
9	15:00	80-90	5	30
10	15:00	90-100	4	30

* After completing the progressive stationary running program, use Table 25 to select a 30 point per week conditioning program.

** Count only when left foot hits the floor. Feet must be brought at least eight inches from the floor.

TABLE 19. Walking conditioning programs for fitness categories I, II, III*

Fitness Category I (30 to 39 years of age)

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
7	1.5	21:00	5	15
8	2.0	28:45	5	20
9	2.0	28:30	5	20
10	2.0	28:00	5	20
11	2.0	28:00	3	22
	and			
	2.5	35:30	2	
12	2.5	35:00	3	27
	and			
	3.0	43:15	2	
13	2.5	34:45	3	27
	and			
	3.0	43:00	2	
14	2	34:30	3	27
	and			
	3.0	43:30	2	
15	3.0	42:30	5	30
16	4.0	56:30	3	33

Fitness Category II

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
7	2.0	28:30	5	20
8	2.0	28:00	5	20
9	2.0	28:00	3	22
	and			
	2.5	35:30	2	
10	2.5	34:45	3	27
	and			
	3.0	43:00	2	
11	2.5	34:30	3	27
	and			
	3.0	42:30	2	
12	3.0	42:30	5	30
13	4.0	56:30	3	33

Fitness Category III

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
7	2.5	35:00	3	27
	and			
	3.0	43:15	2	
8	2.5	34:30	3	27
	and			
	3.0	42:30	2	
9	3.0	42:30	5	30
10	4.0	56:30	3	33

* After completing the progressive walking program, use Table 25 to select a 30 point per week conditioning program.

TABLE 20. Combination walk-jog conditioning programs for fitness categories I, II, III*

Fitness Category I (30 to 39 years of age)

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
7	1.5	19:30	5	15
8	1.5	18:30	5	15
9	1.5	17:30	4	18
10	1.0	10:00	2	19½
	and			
	1.5	16:30	3	
11	1.0	9:30	3	21
	and			
	1.5	15:00	2	
12	1.0	9:00	3	24
	and			
	1.5	14:30	2	
13	1.0	8:30	3	24
	and			
	1.5	14:00	2	
14	1.0	8:15	3	30
	and			
	2.0	19:30	2	
15	1.0	8:00	2	31½
	and			
	1.5	12:55	2	
	and			
	2.5	22:30	1	
16	1.0	8:00	1	34
	and			
	1.5	12:25	2	
	and			
	2.0	18:30	2	

Fitness Category II

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
7	1.5	18:30	5	15
8	1.5	17:00	4	18
9	1.0	10:00	3	21
	and			
	1.5	15:45	2	
10	1.0	9:15	3	24
	and			
	1.5	14:30	2	
11	1.0	8:45	2	26
	and			
	1.5	13:00	3	
12	1.0	8:15	3	30
	and			
	2.0	19:30	2	
13	1.0	8:00	1	34
	and			
	1.5	12:25	2	
	and			
	2.0	18:30	2	

TABLE 20.(con't)

Fitness Category III

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
7	1.5	17:30	4	18
8	1.0	10:00	1	21
	and			
	1.5	15:15	4	
9	1.5	13:15	3	27
	and			
	2.0	19:30	1	
10	1.0	8:00	1	34
	and			
	1.5	12:25	2	
	and			
	2.0	18:30	2	

*After completing the progressive walk-jog program, use Table 25 to select a 30 point per week conditioning program.

TABLE 21. Stationary running conditioning program for fitness categories I, II, and III*

Fitness Category I (30 to 39 years of age)

Week	Duration (min)	Steps/Min**	Freq/Wk	Points/Wk
7	10:00	70-80	5	15
8	10:00	70-80	5	15
9	12:30	70-80	5	18 3/4
10	12:30	70-80	5	18 3/4
11	15:00	70-80	5	22 1/2
12	10:00	80-90	1	24 1/4
	and			
	17:30	70-80	3	
13	10:00	80-90	1	24 1/4
	and			
	17:30	70-80	3	
14	12:30	80-90	2	28
	and			
	15:00	80-90	3	
15	15:00	80-90	5	30
16	15:00	90-100	4	30

TABLE 21.(con't)

Fitness Category II

Week	Duration (min)	Steps/Min**	Freq/Wk	Points/Wk
7	12:30	70-80	5	18 3/4
8	12:30	70-80	5	18 3/4
9	15:00	70-80	5	22 1/2
10	10:00	80-90	1	24 1/4
	and			
	17:30	70-80	3	
11	12:30	80-90	2	28
	and			
	15:00	80-90	3	
12	15:00	80-90	5	30
13	15:00	90-100	4	30

Fitness Category III

Week	Duration (min)	Steps/Min**	Freq/Wk	Points/Wk
7	10:00	80-90	1	24 1/4
	and			
	17:30	70-80	3	
8	12:30	80-90	2	28
	and			
	15:00	80-90	3	
9	15:00	80-90	5	30
10	15:00	90-100	4	30

* After completing the progressive stationary running conditioning program, use Table 25 to select a 30 point per week conditioning program.

** Count only when the left foot hits the floor. Feet must be brought at least eight inches from the floor.

TABEL 22. Walking conditioning programs for fitness Categories I, II, and III*

Fitness Category I (40 to 49 years of age)

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
7	2.5	37:45	5	12 1/2
8	2.5	36:30	5	12 1/2
9	2.0	29:30	3	16
	and			
	2.5	36:00	2	
10	1.5	21:30	3	19
	and			
	2.5	35:30	2	
11	2.0	28:00	3	22
	and			
	2.5	36:00	2	
12	2.5	35:30	4	23
	and			
	3.0	43:45	1	
13	2.0	28:00	2	26
	and			
	3.0	43:00	3	
14	2.5	34:45	3	27
	and			
	3.0	42:45	2	
15	3.0	42:45	5	30
16	4.0	56:45	3	33

Fitness Category II

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
7	2.0	29:30	3	16
	and			
	2.5	36:30	2	
8	1.5	21:30	3	19
	and			
	2.5	35:30	2	
9	2.0	28:00	3	22
	and			
	2.5	36:00	2	
10	2.0	28:00	2	26
	and			
	3.0	43:00	3	
11	2.5	34:45	3	27
	and			
	3.0	42:45	2	
12	3.0	42:45	5	30
13	4.0	56:45	3	33

TABLE 22. (Continued)

Fitness Category III (40 to 49 years of age)

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
7	2.5	35:30	4	23
	and			
	3.0	43:45	1	
8	2.5	34:45	3	27
	and			
	3.0	42:45	2	
9	3.0	42:45	5	30
10	4.0	56:45	3	33

* After completing the progressive walking programs use Table 25 to select a 30 point per week conditioning program.

TABLE 23. Combination walk-jog conditioning programs for Fitness Categories I, II, and III*

Fitness Category I (40 to 49 years of age)

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
7	1.5	20:30	5	15
8	1.5	19:30	5	15
9	1.5	18:30	5	15
10	1.0	10:45	2	19 1/2
	and			
	1.5	17:30	3	
11	1.0	10:15	2	19 1/2
	and			
	1.5	16:30	3	
12	1.0	9:45	3	21
	and			
	1.5	15:30	2	
13	1.0	9:15	3	24
	and			
	1.5	14:55	2	
14	1.0	8:55	3	26
	and			
	2.0	20:30	2	
15	1.0	8:45	2	27
	and			
	1.5	14:00	2	
	and			
	2.0	20:00	1	
16	1.0	8:30	1	34
	and			
	1.5	13:25	2	
	and			
	2.0	19:30	2	

TABLE 23. (Continued)

Fitness Category II (40 to 49 years of age)

Week	Distance (miles)	Time (min)	Freq/Wk	Points/Wk
7	1.5	19:30	5	15
8	1.5	18:00	5	15
9	1.0	10:45	3	18
	and			
	1.5	17:00	2	
10	1.0	10:00	1	21
	and			
	1.5	15:45	4	
11	1.0	9:30	2	26
	and			
	1.5	14:30	3	
12	1.0	9:30	1	32
	and			
	2.0	20:30	4	
13	1.0	8:30	1	34
	and			
	1.5	13:25	2	
	and			
	2.0	19:30	2	

Fitness Category III

Week	Distance (miles	Time (min)	Freq/Wk	Points/Wk
7	1.5	18:30	5	15
8	1.0	10:45	3	18
	and			
	1.5	16:30	2	
9	1.5	14:15	2	26
	and			
	2.0	20:30	2	
10	1.0	8:30	1	34
	and			
	1.5	13:25	2	
	and			
	2.0	19:30	2	

* After completion of the progressive walk-jog program, use Table 25 to select a 30 point per week conditioning program.

TABLE 24. Stationary running program for fitness Categories I, II, and III*

Fitness Category I (40 to 49 years of age)

Week	Duration (min)	Steps/min**	Freq/Wk	Points/Wk
7	7:30	70-80	5	11 1/4
8	10:00	70-80	5	15
9	10:00	70-80	5	15
10	12:30	70-80	5	18 3/4
11	12:30	70-80	5	18 3/4
12	15:00	70-80	5	22 1/2
13	10:00	80-90	1	24 1/4
	and			
	17:30	70-80	3	
14	12:30	80-90	2	28
	and			
	15:00	80-90	3	
15	17:30	70-80	4	27
16	20:00	80-90	3	30

Fitness Category II

Week	Duration (min)	Steps/min**	Freq/Wk	Points/Wk
7	10:00	70-80	5	15
8	12:30	70-80	5	18 3/4
9	12:30	70-80	5	18 3/4
10	10:00	80-90	1	24 1/4
	and			
	17:30	70-80	3	
11	12:30	80-90	2	28
	and			
	15:00	80-90	3	
12	17:30	70-80	4	27
13	20:00	80-90	3	30

Fitness Category III

Week	Duration (min)	Steps/min**	Freq/Wk	Points/Wk
7	15:00	70-80	5	22 1/2
8	12:30	80-90	2	28
	and			
	15:00	80-90	3	
9	17:30	70-80	4	27
10	20:00	80-90	3	30

* After completing the progressive stationary running program use Table 25 to select a 30 point per week conditioning program

** Count only when the left foot hits the floor. Feet must be brought at least eight inches from the floor.

TABLE 25. Suggested conditioning programs for fitness for categories IV and V.

	Distance (miles)	Time (min) Requirement	Freq/Wk	Points/Wk
Walking	2.0	24:00-29:00	8	32
	or			
	3.0	36:00-43:30	5	30
	or			
	4.0	58:00-79:59	5	35
	or			
	4.0	48:00-58:00	3	33
Running	1.0	6:30- 7:59	6	30
	or			
	1.5	12:00-14:59	5	30
	or			
	1.5	9:45-11:59	4	30
	or			
	2.0	16:00-19:59	4	36
	or			
	2.0	13:00-15:59	3	33
Cycling	5.0	15:00-19:59	6	30
	or			
	6.0	18:00-23:59	5	30
	or			
	7.0	21:00-27:59	4	36
	or			
	8.0	35:00-31:59	3	31
	Yards			
Swimming	500	8:20-12:59	8	32
	or			
	600	10:00-14:59	6	30
	or			
	800	13:20-19:59	4	30
	or			
	1000	16:40-24:59	3	31 1/2

TABLE 25. (Continued)

Suggested conditioning programs for fitness for Categories IV and V.

	Duration (min)	Steps/Min*	Freq/Wk	Points/Wk
Stationary Running	10:00 in am	70-80	5	30
	and			
	10:00 in pm	70-80		
	or			
	15:00	70-80	7	30
	or			
	15:00	80-90	5	30
	or			
	20:00	70-80	4	32

* Count only when the left foot hits the floor. Feet must be brought at least eight inches from the floor.

	Duration	Freq/Wk	Points/Wk
Handball Basketball Squash	40:00*	5	30
	or		
	50:00	4	30
	or		
	70:00	3	30

* Continuous exercise; do not count breaks and time-outs.

Maintenance Programs for Cardiorespiratory Fitness and Weight Control.

Upon completion of the six-week starter and other programs outlined in Tables 7-25 a substantial improvement in fitness should have been attained. To maintain fitness a specific program should be designed that will have similar aerobic point value (calorie cost) as the initial program and also satisfy the needs of the participant over a long time span. For many, walking and jogging may become boring and thus variety should be introduced into their program. The important thing is that participation in activities that are enjoyed are more likely to be continued.

Check over the list of activities in Table 4 to see which ones best meet your interest and can still give the calorie output necessary for maintenance. Fitness is not stored but must be practiced continually. The guidelines for frequency, intensity, and duration of training do not change and should be taken into consideration when selecting activities for participation.

If goals have not been met or further development is required, then added calorie expenditure (aerobic points) is needed. For example, ideal weight may not be attained in a sixteen-week program, thus the program design should increase calorie output. Usually added frequency of training of up to five or six days per week will greatly increase the total energy expenditure. The addition of one extra 400 calorie (20 aerobic points) workout per week to the training regimen will decrease one pound of body fat every nine weeks. If this is matched by a similar reduction in food intake it will amount to a reduction of 12 pounds in a year.

Earlier in this chapter, cardiac rehabilitation was mentioned briefly. Although many of the guidelines and exercise prescriptions used in this chapter can be readily adapted for use in cardiac rehabilitation programs, officers with high risk of coronary heart disease or with diagnosed CHD should be exercised only after having an examination by a physician and according to his recommendations. Cardiac rehabilitation programs generally are conducted under the supervision of a medical doctor or highly trained paramedical team.

Programs for Muscular Strength and Endurance, and Flexibility

As described in Chapter 2, muscular strength and endurance are developed by using the overload principle, that is applying more tension on the muscle than is normally used. Muscular strength is best developed by using heavy weights (maximum tension applied) with few repetitions and muscular endurance by using lighter loads along with a greater number of repetitions. Actually both strength and endurnace can be developed under each condition, but each system favors a more specific type of development.

Muscular strength and endurance can be developed by means of either isometric (static) or isotonic (going through the full range of motion) exercise. Although both types of training have their advantages and disadvantages, isotonic exercises are recomended for the development and maintenance of muscular strength and endurance. Isotonic exercises should be rhythmical, follow through the full range of motion, and not impede normal forced breathing. Lifting heavy weights impedes blood circulation and breathing and can be potentially dangerous for persons with high blood pressure, coronary heart disease and other circulatory problems (10). Therefore, the use of lighter weights is recommended.

It has already been stated that the emphasis of the exercise prescription should be based on a good endurance conditioning program which is supplemented by an exercise routine to develop and maintain muscular strength, endurance, and flexibility. It is felt that this type of training program best meets the needs of police officers. Therefore, as an adjunct to the previously described aerobics program a series of exercises to develop and maintain muscular strength, endurance, and flexibility for most of the major muscle groups of the body are outlined.

The exercise routines are divided into the following categories: upper body, trunk, and lower back stretching (1 through 6); leg stretching (7 through 12); and, muscular strength and endurance. Many of the exercises have several options from which to choose. In the first two categories (stretching exercises) some of the alternate exercises are more advanced and should be used only after the original exercise has been mastered. The muscular strength and endurance exercises offer options depending on whether or not weight training equipment is available.

The stretching exercises should be included as part of the warm-up routine prior to starting the aerobics phase of the program. The muscular strength and endurance routine can be used either after the stretching routine or after the aerobic phase.

Prior to starting the aforementioned routines make sure you are familiar with the described starting position, movement, and suggested repetitions. The training load has been designed to give the participant a moderate amount of muscular strength and endurance. This is considered the safest and most sensible manner to approach flexibility, and muscular strength and endurance training.

To help avoid muscle soreness in weight training exercises, the starting weight should be light (approximately 50% of maximum that can be lifted in one repetition). After a few weeks of training 60 to 70% of maximum can be attained. As soon as the required number of repetitions can be easily managed then more weight can be added. This is usually accomplished by adding 5 pounds of weight for arm and 10 pounds for leg exercises. For those participants who want to place more emphasis on strength development, a different training load and added sets would be necessary. The texts by Rasch (16) or Hooks (7) are recommended for more advance weight training programs.

Table 26. Supplemental point chart for running and walking

1.0 Mile	
19:59---14:30 min	1
14:29---12:00 min	2
11:59---10:00 min	3
9:59----8:00 min	4
7:59----6:31 min	5
6:30----5:45 min	6
under----5:45 min	7

1.5 Miles	
29:59---21:45 min	1 1/2
21:44---18:00 min	3
17:59---15:00 min	4 1/2
14:59---12:00 min	6
11:59----9:45 min	7 1/2
9:44----8:40 min	9
under----8:40 min	10 1/2

2.0 Miles	
40:00 min or longer	1*
39:59---29:00 min	2
28:59---24:00 min	4
23:59---20:00 min	7
19:59---16:00 min	9
15:59---13:00 min	11
12:59---11:30 min	13
under---11:30 min	15

2.5 Miles	
50:00 min or longer	1*
49:59---36:15 min	2 1/2
36:14---30:00 min	5
29:59---25:00 min	9
24:59---20:00 min	11 1/2
19:59---16:15 min	14

3.0 Miles	
1 hr or longer	1 1/2*
59:59---43:30 min	3
43:29---36:00 min	6
35:59---30:00 min	11
29:59---24:00 min	14
23:59---19:30 min	17
19:29---17:15 min	20
under---17:15 min	23

3.5 Miles	
1 hr 10:00 min or longer	1 1/2*
1 hr 9:59--50:45 min	3 1/2
50:44---42:00 min	7
41:59---35:00 min	13
34:59---28:00 min	16 1/2
27:59---22:45 min	20
22:44---20:10 min	23 1/2
under---20:10 min	27

4.0 Miles	
1 hr 20:00 min or longer	4*
1 hr 19:59--58:00 min	7
57:59---48:00 min	11
47:59---40:00 min	15
39:59---32:00 min	19
31:59---26:00 min	23
25:59---23:00 min	27
under---23:00 min	31

4.5 Miles	
1 hr 30:00 min or longer	4 1/2*
1 hr 29:59--1 hr 5:15 min	8
1 hr 5:14--54:00 min	12 1/2
53:59---45:00 min	17
44:59---36:00 min	21 1/2
35:59---29:15 min	26
29:14---25:55 min	30 1/2
under---25:55 min	33

5.0 Miles	
1 hr 40:00 min or longer	5*
1 hr 39:59--1 hr 12:30 min	9
1 hr 12:29--1 hr	14
59:59---50:00 min	19
49:59---40:00 min	24
39:59---32:30 min	29
32:29---28:45 min	34
under---28:45 min	39

6.0 Miles	
2 hrs or longer	6*
1 hr 59:59--1 hr 27:00 min	11
1 hr 26:59--1 hr 12:00 min	17
1 hr 11:59--1 hr	23
59:59---48:00 min	29
47:59---39:00 min	35
38:59---34:30 min	41
under---34:30 min	47

7.0 Miles	
2 hrs 20:00 min or longer	7*
2 hrs 19:59--1 hr 41:30 min	13
1 hr 41:29--1 hr 24:00 min	20
1 hr 23:59--1 hr 10:00 min	27
1 hr 9:59--56 min	34
55:59---45:30 min	41
45:29---40:15 min	48
under---40:15 min	55

8.0 Miles	
2 hrs 40:00 min or longer	8*
2 hrs 39:59--1 hr 56:00 min	15
1 hr 55:59--1 hr 36:00 min	23
1 hr 35:59--1 hr 20:00 min	31
1 hr 19:59--1 hr 4:00 min	39
1 hr 3:59--52:00 min	47
51:59---46:00 min	55
under---46:00 min	63

9.0 Miles	
3 hrs or longer	9*
2 hrs 59:59--2 hrs 10:30 min	17
2 hrs 10:29--1 hr 48:00 min	26
1 hr 47:59--1 hr 30:00 min	35
1 hr 29:59--1 hr 12:00 min	44
1 hr 11:59--48:30 min	53
58:29---41:45 min	62
under---51:45 min	71

10.0 Miles	
3 hrs 20:00 min or longer	10*
3 hrs 19:59--2 hrs 25:00 min	19
2 hrs 24:59--2 hrs	29
1 hr 59:59--1 hr 40:00 min	39
1 hr 39:59--1 hr 20:00 min	49
1 hr 19:59--1 hr 5:00 min	59
1 hr 4:59--57:30 min	69
under 57:30 min	79

*Exercise of sufficient duration to be of cardiovascular benefit. At this speed, ordinarily no training effect would occur. However, the duration is of such extent that a training effect does begin to occur.

TABLE 27. Supplemental point chart for other aerobic activities

CYCLING

2 Miles	Points	6 Miles	Points
12 min or longer	0	36 min or longer	1*
11:59-8:00	1	35:59-24:00 min	3
7:59-6:00	2	23:59-18:00	6
Under 6:00	3	under 18:00	9

3 Miles	Points	8 Miles	Points
18 min or longer	0	48 min or longer	3 1/2*
17:59-12:00 min	1 1/2	47:59-32:00 min	6 1/2
11:59- 9:00	3	31:59-24:00 min	10 1/2
under 9:00	4 1/2	under 24:00 min	14 1/2

4 Miles	Points	10 Miles	Points
24 min or longer	0	60 min or longer	5 1/2*
23:59-16:00 min	2	59:59-40:00 min	8 1/2
15:59-12:00 min	4	39:59-30:00 min	13 1/2
under 12:00 min	6	under 30:00 min	18 1/2

5 Miles	Points
30 min or longer	1*
29:59-20:00 min	2 1/2
19:59-15:00 min	5
under 15:00 min	7 1/2

* Exercise of sufficient duration to be of cardiovascular benefit. At this speed, ordinarily no training effect would occur. However, the duration is of such extent that a training effect does begin to occur.

TABLE 27. (Continued)

SWIMMING

200 Yards	Points	600 Yards	Points
6:40 min or longer	0	20:00 min or longer	1 1/2*
6:39-5:00 min	1	19:59-15:00 min	4
4:59-3:20 min	1 1/2	14:59-10:00 min	5
under 3:20 min	2 1/2	under 10:00 min	7 1/2
300 Yards	**Points**	**700 Yards**	**Points**
10:00 min or longer	1*	23:20 min or longer	1 1/2*
9:59-7:30 min	1 1/2	23:19-17:30 min	4 1/2
7:29-5:00 min	2 1/2	17:29-11:40 min	6
under 5:00 min	3 1/2	under 11:40 min	8 1/2
400 Yards	**Points**	**800 Yards**	**Points**
13:20 min or longer	1*	26:40 min or longer	2 1/4*
13:19-10:00 min	2 1/2	26:39-20:00 min	5 3/4
9:59- 6:40 min	3 1/2	19:59-13:20 min	7 1/4
under 6:40 min	5	under 13:20 min	10 3/4
500 Yards	**Points**	**1000 Yards**	**Points**
16:40 min or longer	1*	33:20 min or longer	4*
16:39-12:30 min	3	33:19-25:00 min	8 1/4
12:29- 8:20 min	4	24:59-16:40 min	10 1/2
under 8:20 min	6	under 16:40 min	14 1/2

* Exercise of sufficient duration to be of cardiovascular benefit. At this speed, ordinarily no training effect would occur. However, the duration is of such extent that a training effect does begin to occur.

HANDBALL/BASKETBALL/SQUASH*

Duration	Points	Duration	Points
10	1 1/2	55	8 1/4
15	2 1/4	60	9
20	3	65	9 3/4
25	3 3/4	70	10 1/2
30	4 1/2	75	11 1/4
35	5 1/4	80	12
40	6	85	12 3/4
45	6 3/4	90	13 1/2
50	7 1/2		

* Continuous exercise. Do not include breaks, time-outs, etc.

TABLE 27. (continued)

STATIONARY RUNNING

Time	*60-70 Steps/Min	Points	*70-80 Steps/Min	Points	*80-90 Steps/Min	Points
2:30			175-200	3/4	200-225	1
5:00	300-350	1 1/4	350-400	1 1/2	400-450	2
7:30			525-600	2 1/4	600-675	3
10:00	600-700	2 1/2	700-800	3	800-900	4
12:30			785-1000	3 3/4	1000-1125	5
15:00	900-1050	3 3/4	1050-1200	4 1/2	1200-1350	6
17:30			1225-1400	6 1/4	1400-1575	8 1/2
20:00	1200-1400	7	1400-1600	8	1600-1800	10

* Count only when the left foot hits the floor. Feet must be brought at least eight inches from the floor.

ROPE SKIPPING

Minutes	Points
5	1 1/2
10	3
15	4 1/2

Skip with both feet together or step over the rope alternating one foot at a time

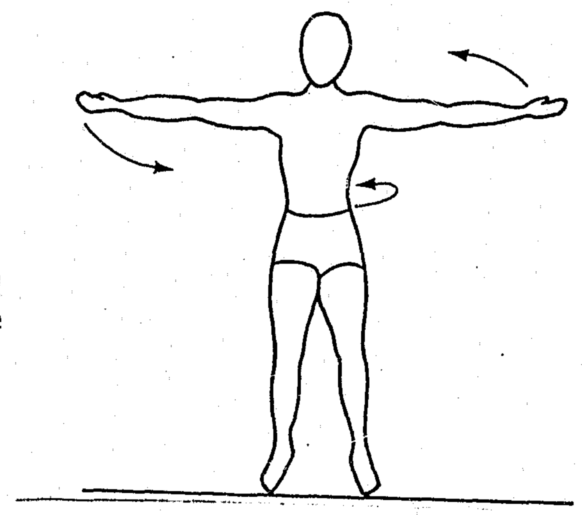
VOLLEYBALL Minutes	Points	WRESTLING Minutes	Points
15	1	5	2
30	2	10	4
60	4	15	6

BENCH STEPPING (7 in step)

Stepping Rate (per min)	Time (min)	Points
30	6:30	1 1/2
	9:45	2 1/4
	13:00	3
35	6:00	2
	9:00	3
	12:00	4
40	5:00	2 1/2
	7:30	3 3/4
	10:00	5

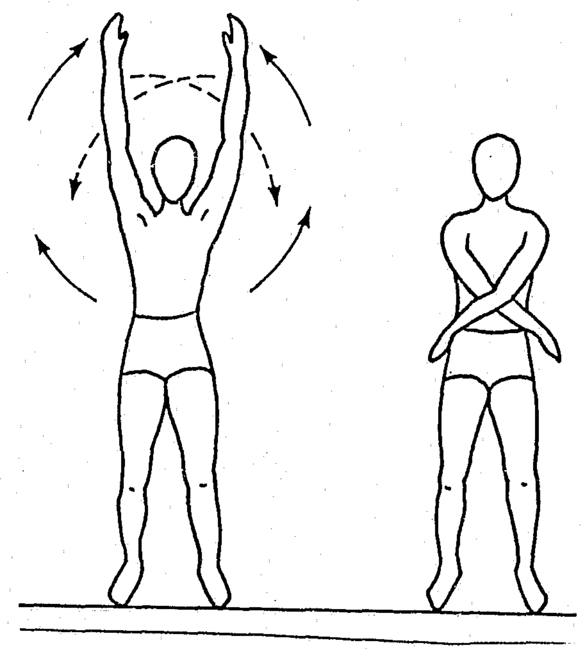
UPPER BODY, TRUNK, AND LOWER BACK STRETCHING EXERCISES

1. Trunk Rotation



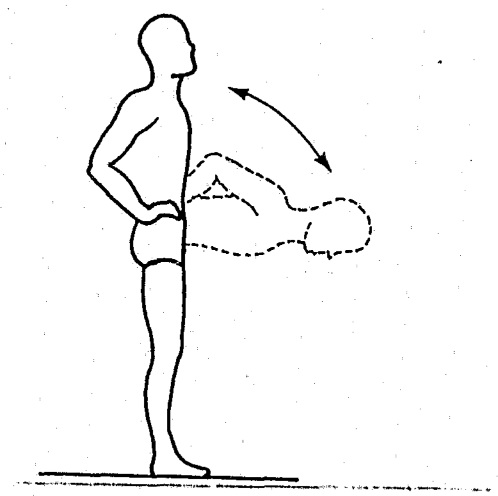
Purpose: To stretch muscles in the back, sides, and shoulder girdle.
Starting Position: Stand astride with feet pointed forward; raise arms to shoulder level. May use bar to increase stretch to the deltoid muscle and waist.
Movement: Twist trunk to the right; avoid lifting heels. Repeat 3 to 4 times before twisting to left side.
Repetitions: 10

2. Double Arm Circles and Toe Raises



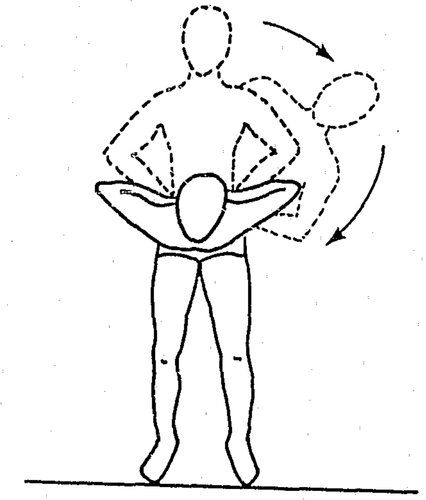
Purpose: To stretch muscles of the shoulder girdle and to strengthen muscles of the feet.
Starting Position: Stand with feet about 12 inches apart and arms at sides.
Movement: Swing arms upward and around, making large circles. As arms are raised and crossed overhead, rise on toes.
Repetitions: 10 to 15

3A. Forward Bend



Purpose: To stretch muscles of the buttocks and posterior leg.
Starting Position: Stand astride with hands on hips.
Movement: Slowly bend forward to a 90 degree angle; return slowly to starting position; keep back flat.
Repetitions: 10

3B. Abdominal Churn

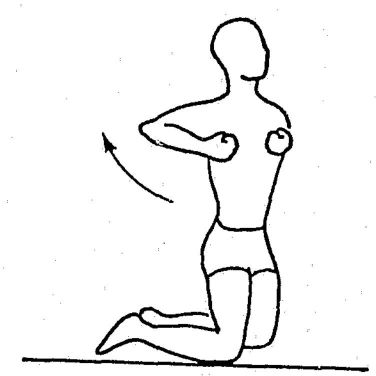


Purpose: To stretch muscles of the buttocks, abdomen, and posterior leg.
Starting Position: Stand astride with hands on hips.
Movement: Lower trunk sideward to left; rotate to forward position and to right; return to upright position. Repeat and reverse direction after 2 rotations.
Repetitions: 5 to 8

3C. Bar Hang

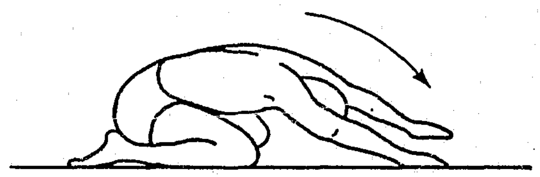
Purpose: To stretch muscles of arms, shoulders, back, trunk, hips, and pelvic regions. Good general body stretcher.
Starting Position: Hang from bar with arms straight.
Repetitions: 1 for up to 60 seconds

4. Shoulder and Chest Stretch



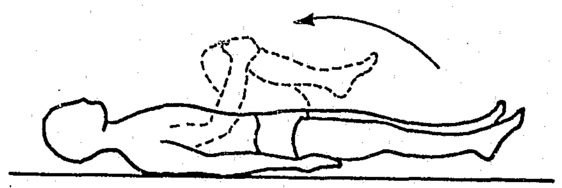
Purpose: To stretch muscles of the chest and shoulders.
Starting Position: Stand astride or kneel with arms at shoulder level and elbows bent.
Movement: Slowly force elbows backward and return to starting position.
Repetitions: 10 to 15

5A. Lower Back Stretch



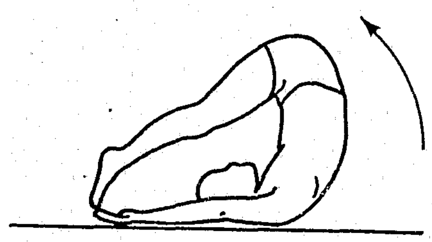
<u>Purpose</u>: To stretch muscles in the lower back.
<u>Starting Position</u>: Crouch on hands and knees.
<u>Movement</u>: Slowly rock back until buttocks touch heels; emphasize rounding back; return to starting position.
<u>Repetitions</u>: 10

5B. Alternate Lower Back Stretch



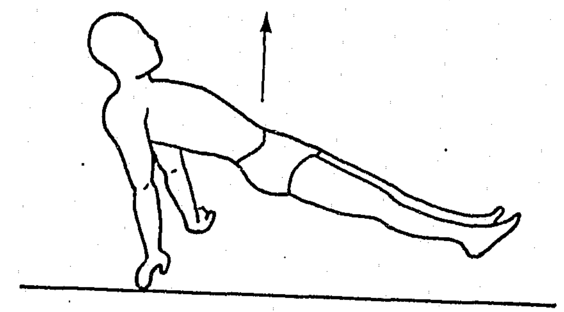
<u>Purpose</u>: To stretch muscles in the lower back and buttocks.
<u>Starting Position</u>: Lie on back with the legs extended or stand erect.
<u>Movement</u>: Lift and bend one leg; grasp the knee and keep the opposite leg flat; pull knee to chest. Repeat with alternate leg.
<u>Repetitions</u>: 10

5C. Advanced Lower Back and Hamstring Stretch



<u>Purpose</u>: To stretch muscles of the lower back and hamstring muscles.
<u>Starting Position</u>: Lie on back with legs bent.
<u>Movement</u>: Keep knees together and slowly bring them over the head; straighten the legs and touch the toes to the floor; return to starting position.
<u>Repetitions</u>: 5 to 10

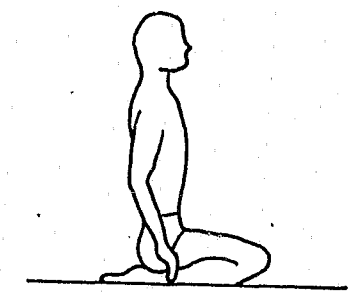
6. Inverted Stretch



<u>Purpose</u>: To stretch and strengthen the anterior hip, buttocks, and abdominal muscles.
<u>Starting Position</u>: Sit with arms at side.
<u>Movement</u>: Support body with heels and arms and raise trunk as high as possible.
<u>Repetitions</u>: 10

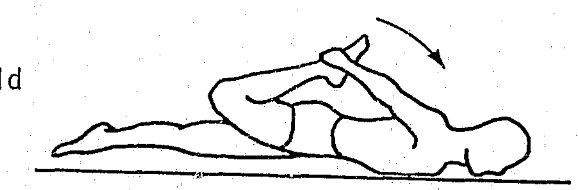
LEG STRETCHING EXERCISES

7A. Front Leg Stretch



<u>Purpose</u>: To stretch the muscles in the anterior leg.
<u>Starting Position</u>: Kneel with tops of ankles and feet flat on the ground.
<u>Movement</u>: Lean backward slowly; keep the back straight; maintain tension on muscles for 30 to 60 seconds.
<u>Repetitions</u>: 1 to 2

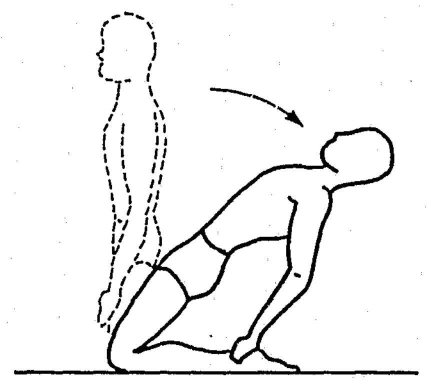
7B. Front Leg Stretch



<u>Purpose</u>: To stretch the muscles of the anterior thigh and hip.
<u>Starting Position</u>: Lie on the ground with face down or stand erect.
<u>Movement</u>: Pull the ankle to the hip slowly; hold for 3 counts and release the ankle. Use same procedure for other side.
<u>Note</u>: If difficulty is encountered in assuming starting position, ask for assistance.
<u>Repetitions</u>: 5 to 10

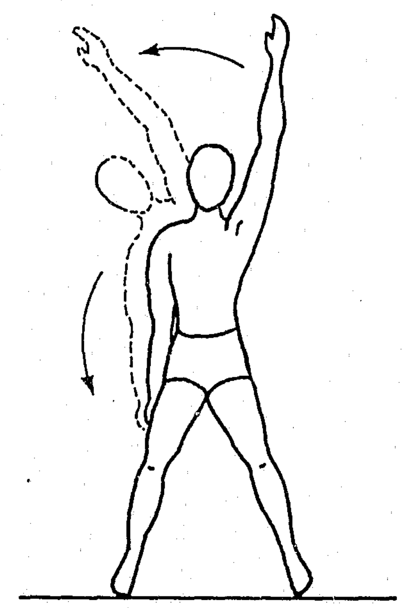
7C. Advanced Front Leg Stretch

Purpose: To stretch the muscles of the anterior thigh.
Starting Position: Kneel with feet turned outward.
Movement: Lean backward slowly; put constant tension on muscles; use arms to control the movement; hold backward position for 30 to 60 seconds.
Repetitions: 1 to 2



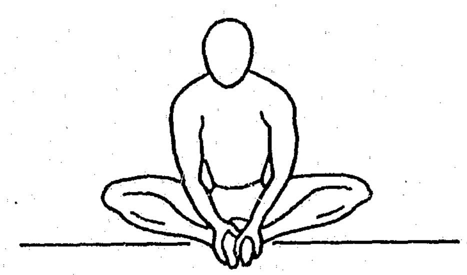
8. Side Stretch

Purpose: To stretch the medial muscles of the thigh and the lateral muscles of the trunk and thorax.
Starting Position: Stand erect with one arm extended upward and the other relaxed at the side; place feet apart at more than shoulder width.
Movement: Bend trunk directly to the right with the left arm stretching overhead; keep both feet flat. Use same procedure for other side.
Repetitions: 5 to 10



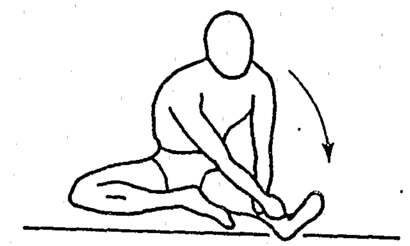
9. Groin Stretch

Purpose: To stretch the groin muscles.
Starting Position: Sit with knees bent outward and the bottoms of the feet together.
Movement: Grasp ankles and pull the upper body as close as possible to the feet. Hold stretch for 30 to 60 seconds. Repeat with other leg.
Repetitions: 1 to 2



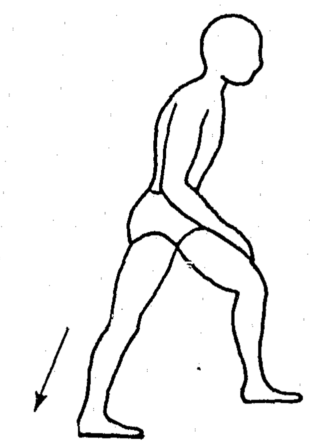
10. Hamstring Stretch

Purpose: To stretch the muscles in the posterior leg and thigh.
Starting Position: Sit on ground with one leg extended straightforward; place the other leg forward with the knee bent and the sole touching the inner thigh of the extended leg.
Movement: Bend forward and attempt to touch the head to the knee; hold stretch for 30 to 60 seconds. Repeat with other leg.
Repetitions: 1 to 2



11A. Calf Stretcher

Purpose: To stretch the posterior leg and ankle muscles.
Starting Position: Stand in forward stride position with the forward knee partially flexed and the rear leg fully extended; keep feet pointed forward and heels flat on the ground.
Movement: Lean trunk forward until a continuous stretch occurs in the rear calf; hold stretch for 30 to 60 seconds. Repeat with other leg.
Repetitions: 1 to 2



11B. Calf Stretcher

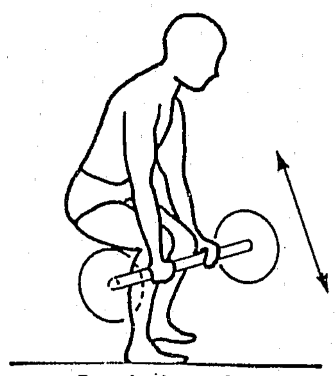
Purpose: To stretch the posterior leg muscles.
Starting Position: Stand in upright position with the balls of the feet on the edge of a step.
Movement: Slowly lower heels and hold for 30 to 60 seconds; raise heels and rise on toes.
Repetitions: 1 to 2

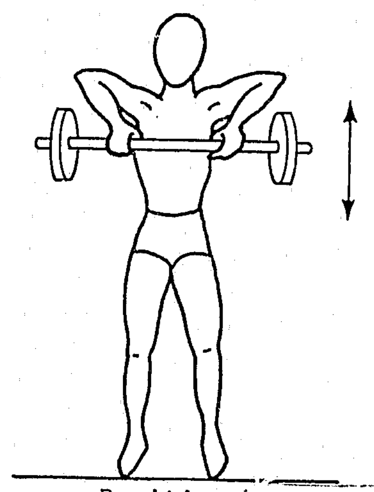
MUSCULAR STRENGTH AND ENDURANCE EXERCISES

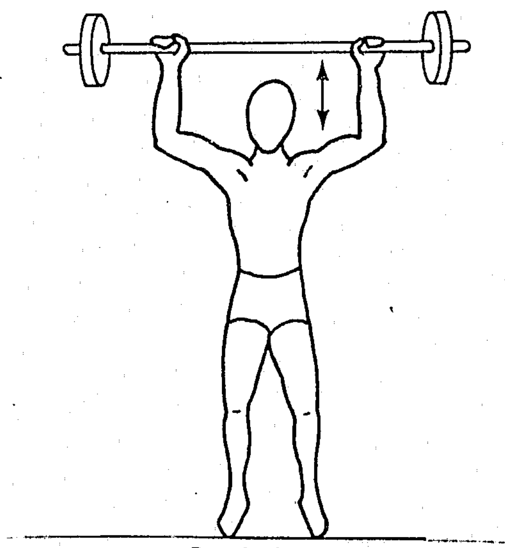
Two options will be illustrated for each of the following routines. The first option (A) will utilize weights; the second (B) stresses the same muscle group, but without utilizing weights.

12A. Weight Training Warm-Up

Purpose: To utilize all of the major muscle groups in a warm-up routine prior to concentrating on specific muscle groups.
Starting Position: Place feet astride; bend knees; keep back straight; hold a bar with an overhand grip. (Position A)
Movement: Straighten legs with back still straight; raise elbows to shoulder height or higher (Position B); lower elbows next to the trunk and keep the weight at chest level; press the weight over the head and fully extend arms (Position C); return weight to floor.
Repetitions: 8 to 10

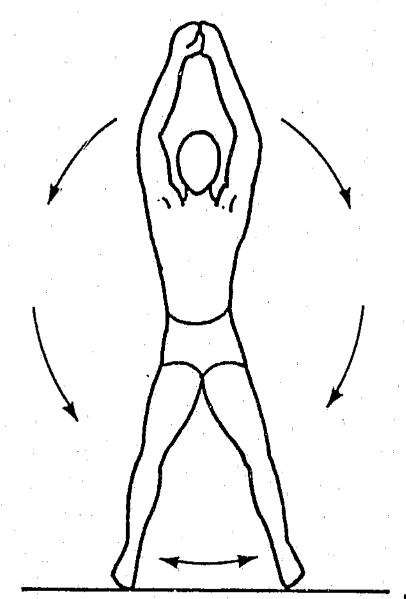

Position A.


Position B.


Position C.

12B. Jumping Jacks

Purpose: To utilize all of the major muscle groups in a warm-up routine prior to concentrating on specific muscle groups.
Starting Position: Stand erect with feet together and arms at the side.
Movement: Swing arms upward until over head and spread feet apart in one movement; in second movement, return to starting position.
Repetitions: 20

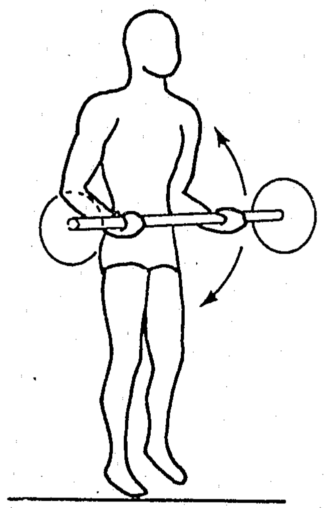


13. Military Press

Purpose: To strengthen the shoulder, upper back, and arm muscles.
Starting Position: Support weight at shoulder level with an overhead grip.
Movement: Push weight directly overhead; keep the back and knees straight; return the weight slowly to starting position.
Repetitions: 10 to 12

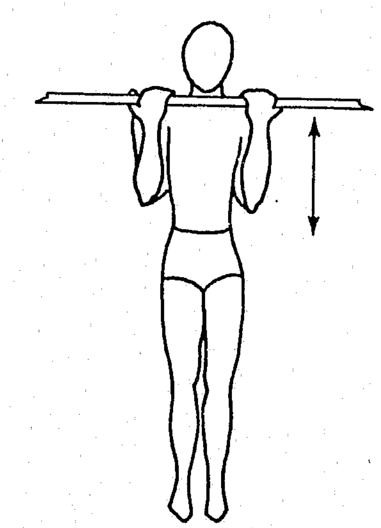
14A. Curl

Purpose: To strengthen the anterior arm muscles.
Starting Position: Hold weight with a palms-up grip; keep arms straight.
Movement: Bend arms and bring weight up to chest; return slowly.
Repetitions: 10 to 12



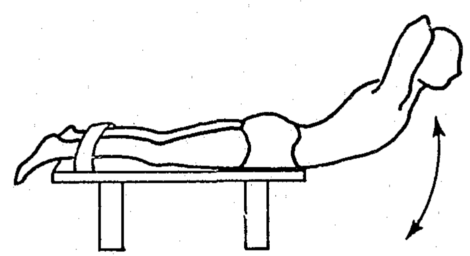
14B. Pull-Up

Purpose: To strengthen the anterior arm, upper back, and shoulder muscles.
Starting Position: Place hands about 18 inches apart on overhead bar with either a palms-in or a palms-out grip; keep arms straight in order to support the body.
Movement: Pull body up so chin comes above the bar; slowly lower the body to starting position.
Repetitions: Progress to 10 to 15



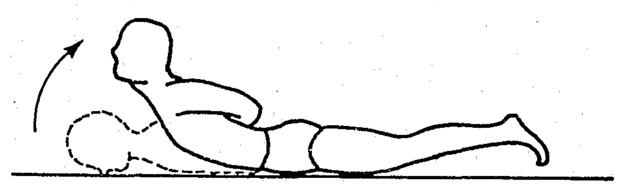
18A. Back Hyperextension

<u>Purpose</u>: To strengthen the lower back muscles.
<u>Starting Position</u>: Lie on a bench with the face down; extend the body from above the waist over the edge of the bench; strap or hold the feet to the other end of the bench.
<u>Movement</u>: Lift head and trunk; slowly lower head and trunk.
<u>Note</u>: Do not hyperextend.
<u>Repetitions</u>: Progress to 10 to 15.



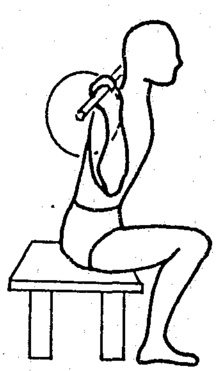
18B. Back Tightener

<u>Purpose</u>: To strengthen the lower back muscles.
<u>Starting Position</u>: Lie on floor with face down; fold hands over lower back area.
<u>Movement</u>: Raise head and chest and tense the gluteal and lower back muscles.
<u>Caution</u>: Do not hyperextend; just raise head and chest slightly off the floor; concentrate mainly on tensing gluteal muscles.
<u>Repetitions</u>: 10 to 15



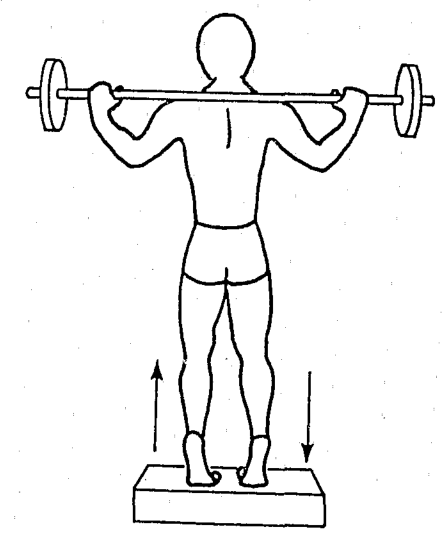
19. Squat

<u>Purpose</u>: To strengthen the anterior thigh and buttock muscles.
<u>Starting Position</u>: Stand erect with feet astride and support weight on shoulders with palms-up grip.
<u>Movement</u>: Keep the back straight and bend knees into a squat position; return to the standing position.
<u>Note:</u> Do half squat if knees are weak.
<u>Repetitions</u>: 10 to 12



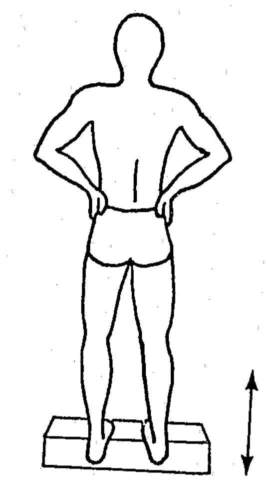
20A. Heel Raises

<u>Purpose</u>: To strengthen the calf muscles.
<u>Starting Position</u>: Place feet astride and hold weight on shoulders with a palms-up grip.
<u>Movement</u>: Raise to a toe position; lower body.
<u>Note</u>: A board may be placed under the toes to increase the range of motion.
<u>Repetition</u>: 10 to 15



20B. Heel Raises

<u>Purpose</u>: To strengthen the calf muscles.
<u>Starting Position</u>: Place feet astride and use arms for balance if necessary.
<u>Movement</u>: Raise to a toe position; lower body.
<u>Note</u>: A board may be placed under the toes to increase the range of motion.
<u>Repetition</u>: 10 to 15



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CHAPTER 5

PROGRAM IMPLEMENTATION

Several factors are important to consider in implementing a physical fitness program for police; namely, program staff, evaluation, exercise prescription, leadership and supervision, motivation, and education. These factors interrelate and help make a police fitness program comprehensive, safe, and practical.

The PROGRAM STAFF should include a medical director, program director, exercise leader(s), and technician(s). The medical director should be a licensed physician and assume the leadership role in the interpretation of medical information. The physician should work closely with the program director in determining the status of health of each individual being tested and in helping to disseminate this information to each of the participants. It is the responsibility of the medical director to see that the evaluation and activity phases of the program are conducted in a safe manner.

The program director should be an exercise specialist, highly trained in the areas of evaluation, program development and implementation, and exercise physiology. This training can be obtained through graduate programs specializing in exercise physiology and physical fitness programs, workshops, and special training programs. The program director must work with the physician in setting up adequate exercise testing procedures; prescribing proper exercise; leading and supervising the program in a safe and efficient manner according to the needs of the participants; and providing educational input so that the participant will understand the need for testing, exercise prescription, and a physical fitness program.

The program director will coordinate his efforts with the medical director and provide a good program with highly trained exercise leaders and technicians.

The exercise leader should be well trained in exercise physiology and in leading activity programs. It is important for the exercise leader to have rapport with the people in the program and the ability to conduct programs on an individual or group basis. The exercise leader should work directly with the program director in order to provide adequate leadership and supervision to the participants.

Exercise technicians must be well trained in administering tests and will assist the physician and/or program director in testing. For a more detailed explanation of the role and competencies necessary for various personnel in the adult fitness program staff, see Guidelines for Graded Exercise Testing and Exercise Prescription developed by the American College of Sports Medicine (8).

The EVALUATION process is concerned with obtaining certain preliminary information as well as administering a comprehensive testing program. See Chapter 3 of this report for details concerning the evaluation process. Preliminary information includes such items as a physical examination, consultation with a family physician, completion of a medical history questionnaire, explanation and signing of an informed consent form, and, if possible, an exercise stress test. For those individuals who are asymptomatic, apparently low risk in relation to coronary heart disease, and under the age of 35, a complete physical examination and stress test may not be required (8). In all cases, some preliminary screening is required so that an adequate exercise prescription can be determined. A signed informed consent form for both stress testing and program implementation is necessary (8,29). Participants should understand the nature of the tests and the program and the potential value and risk that may be involved. Also, participants should not be forced, coerced, or inadequately advised with the objective of obtaining better performance on a test or increasing adherence to the program. Such procedure violates human rights and is against policy established by the federal government (National Institutes of Health) and most professional organizations. Further explanation of informed consent and examples of forms used by various organizations can be found in the literature (8,12,29). An example of an informed consent of stress testing at the Institute for Aerobics Research is shown in Appendix A.

The basic testing program should assess cardiorespiratory fitness, body composition, certain blood values, muscular strength and endurance, and flexibility. Testing is important because it serves as a base of comparison for later evaluations. Cardiorespiratory fitness tests should include resting heart rate, blood pressure, a standard 12-lead electrocardiogram (ECG), and an exercise test to at least 85% of predicted maximum heart rate (7). The exercise test should be ECG and blood-pressure monitored (7,8,29). An exercise stress test is important because of its diagnostic value in assessing the presence of coronary heart disease; it also gives the program director some baseline information for determining an adequate exercise prescription (3,7,8,12,29). The use of less sophisticated tests for cardiorespiratory fitness may be used on young, low risk officers (8,11). In this case, a submaximal bicycle test, three-minute bench step test, or 12-minute run field test may be used (4,11). Usually 4 to 6 weeks of preliminary endurance training is recommended prior to the use of the 12-minute run test.

Body composition encompasses a determination of percent body fat as well as a subsequent determination of ideal weight (2,21,25). This can be determined by use of a skinfold fat caliper and steel tape. Blood measures should include serum cholesterol, triglycerides, and glucose values. Muscular strength and endurance tests should relate to the major muscle groups of the body. A one-repetition bench press appears to be a good field measure of total body strength (11). Also, maximum push-ups and timed, one-minute, bent-legged sit-ups are used regularly for assessing muscular endurance (11). The measurement of flexibility is particularly important. Because of the importance of the lower back region, the sit and reach test is recommended (11).

This battery of tests offers a comprehensive testing program for police. If time, money, and equipment are available, other tests can be included. For example, the assessement of maximum oxygen intake is an excellent test, but is considered a luxury in an evaluation program. Maximum oxygen intake can be estimated accurately with time on the treadmill, heart rate response to a submaximal bicycle or bench step test, and the 12-minute run test (3,4,11,23). After undergoing adequate screening and evaluations, the participants are ready for the exercise prescription.

<u>EXERCISE PRESCRIPTION</u> is dependent on needs (job description, likes and dislikes, etc.), goals, physical and health status, age, available time, and equipment and facilities. These factors vary greatly among police; therefore, the individual approach to exercise prescription is recommended (1,4,8,12,18,29). Officers in the field have a greater need for muscular strength exercises than the police executive. Thus, training for the field officer should emphasize both cardiorespiratory endurance training and muscular strength exercises.

As an officer gets older the need for a preventive health program becomes more evident. The results from this project (Promoting Physical Fitness among Police Officers Final Report I - Results, Chapter 4) showed that police officers 20-29 years of age were of average risk for coronary heart disease, and officers over 30 years of age were at higher risk. Thus coronary risk factor profile for prediction of coronary heart disease became significantly higher with age and a need for a preventive health program was shown. Lack of regular physical training was apparent in most police officers studied. Thus, as an officer gets older, emphasis should be placed more on the development and maintenance of cardiorespiratory fitness. The initial experience with endurance training should be of low to moderate intensity and progression which allows for gradual adaptation. On the basis of experience with adult programs, the abrupt approach can result in discouraging future motivation for participation in endurance activities. Improper prescription also can lead to undue muscle strain or soreness, orthopedic problems, undue fatigue, and risk of precipitating a heart attack. The latter is rare and occurs mainly with middle-aged and older participants. Most incidents have occurred because of the lack of previous medical clearance and evaluation, incorrect exercise prescription, inadequate supervision, or an extreme climatic condition such as excess heat and humidity.

These guidelines are directed toward the average policeman who would like an exercise program to develop and maintain cardio-respiratory fitness, and desirable body fat composition and muscle tone. The following guidelines are geared to the healthy officer who is not physically disabled, and has approximately one hour of time available 3 to 5 days per week. The program director must consider several factors in prescribing exercise: frequency, intensity, and duration of training;

mode of activity; and initial level of physical fitness (4,5,13,19). In general, for the purpose of developing and maintaining a good cardio-respiratory system and keeping the body composition in proper proportions, the prescription should include a frequency of 3 to 5 days per week, intensity between 60 and 90% of maximum, and duration of 15 to 45 minutes. The mode of activity can be any sustained endurance type such as fast walking, running, bicycling, or swimming. Game activities also are good modes of activity if they are a sustained effort and not too intermittent. The initial level of fitness is quite important because persons with low levels do not adapt as well to exercise regimens and thus should have programs of lower intensity and longer duration. Listed below are some findings observed during exercise programs over the past ten years:

1. Improvements in physical fitness are related directly to frequency, intensity, and duration of training (19,27).

2. If the intensity is between 70 and 90% of maximum, the frequency between 2 and 5 days per week, and duration of 30 to 45 minutes, a significant cardiorespiratory response to exercise can be attained (14-17,20).

3. If diet is held constant, body weight and fat changes do not occur in programs of less than 3 days per week (14,15,17,20).

4. Intensity and duration are interrelated and, in general, the total energy expenditure of the program is the most important factor. If participants work at a higher intensity such as in a running program, then the duration does not need to be as great as for a moderate intensity program (4,17,19). For middle-aged and older individuals, a moderate intensity program of longer duration is recommended (4,5).

5. If the first four items are taken into consideration, the mode of activity appears to be independent of the training effect (4,22).

6. Older people with lower levels of fitness take longer to adapt to exercise. If given the proper adaptation period, they can progress to a satisfactory level of physical fitness (24).

7. Recent results show a significantly higher incidence of injury due to musculoskeletal problems for beginning runners due to increased frequency and duration of training. Thus, a recommended program for beginners is to intersperse a day of rest between days of activity and to limit duration to 15 to 30 minutes. The exception to this recommendation is if participants are engaged in a moderate walking program (26).

These seven findings, plus the results shown in Chapter 4, should give better inference to the program director as to the rationale for the exercise prescription recommended for police officers.

Each exercise session should include a 10 to 15 minute warmup followed by a 15 to 45 minute endurance activity period and conclude with a 5 to 10 minute cool-down (4,5). An exception to this would be the officer in the field who needs an extra 10 to 15 minutes for strength training. In prescribing exercise, it is best to think of a program as initially developmental in nature and progressing to a maintenance regimen (4,5). Those having a lower level on the fitness scale require a longer developmental period. A starter program for the developmental phase should include low to moderate intensity activities, and stretching and low to moderate intensity calisthenics. After the participants have adapted to that level of activity, the exercise requirements should be progressed. The increase in workload should occur each week or two weeks until the participants reach the maintenance level of fitness. Low fit or older individuals require longer adaptation periods and slower progression periods. After age 30, it is estimated that the

increase in time for adaptation is approximately 40% per decade; that is, if 30-year old participants progress every 2 weeks, the 40-year old group advances approximately every 3 weeks, and the over 50 individuals, every 4 weeks. In general, the starter program will last from 5 to 10 weeks, followed by a 3 to 5 month slow progression period, and reaching the maintenance program in 6 months to a year.

Record keeping for quantifying the program is another important phase of the exercise prescription. Appendix B shows an example of an exercise log form used at the Aerobics Center, Dallas, Texas. A form similar to this was used in the study on police officers. The log lists a variety of exercises which the participant can record, and thus, the aerobic point (oxygen cost) values of the program can be evaluated. For ease of use, the aerobic point system can be computerized, which facilitates data quantification and feedback to the program director and participant.

<u>LEADERSHIP</u> and <u>SUPERVISION</u> are extremely important in the implementation of a physical training program. Without proper leadership on-the-spot counseling as to program modification and special considerations due to injury cannot be properly assessed. Many of the guidelines for proper exercise prescription have been developed for average persons and do not allow for individual differences within a group of participants (4,28). Therefore, on-the-spot guidance is essential. Such counseling also serves as a motivator in that the participants see the staff actively engaged in the program.

Part of the leadership aspect of directing and leading a program is to show physical leadership. That is, the staff should look the part, have good health practices (non-smoker), and participate regularly. The leader does not have to be the best fit person in the program but regular participation will gain the respect of the other officers.

Officers should be taught to monitor their own programs, specifically to pace themselves and to count their heart rate properly. In a run-walk type program, participants usually are training on a known distance course and can pace themselves with a stopwatch or wrist watch with a sweep second hand. The accuracy of keeping pace can be improved by providing known distance reference points every 100 to 110 yards. Heart rate is easy to count and relates well to oxygen costs (6). The participants should count the heart rate as quickly as possible after cessation of exercise before the heart rate begins to decrease (10). The best method for assessing heart rate is to count beats per 10 seconds at either the carotid artery (neck area) or by placing the palm of the hand over the apex of the heart. With concentration and practice, this method has proved to be very accurate (18).

In general, walking programs range from 50 to 75% of maximum heart rate and jogging-running programs, from 80 to 95% of maximum. Programs that sustain the heart rate over 90% of maximum are considered to be high intensity work (17). Most people jog at approximately 85% of maximum heart rate. The percent of maximum heart rate should be determined by subtracting the resting heart rate from the maximum heart rate (18). Failure to take the resting heart rate into consideration may cause the energy cost of the activity to be overestimated (6).

Evaluation and exercise prescription often are overemphasized in relation to the LEADERSHIP and MOTIVATION phases of the program. The best adherence rates to exercise programs are attained through these latter two phases. It is not difficult to motivate people to exercise for a few weeks or months in order to develop significant improvements in their physical fitness status; but it is difficult to motivate people to exercise for a lifetime. The aspects of motivation which have tended

to be successful are good supervision, proper exercise prescription, individualized exercise prescription, group participation, setting realistic, intermittent goals, periodic evaluation, variety in the program, desirable environment, low-key competition for motivation, periodic awards, and education.

Proper exercise prescription not only makes a program more enjoyable and tolerable for the participants, but also decreases attrition due to injury and discouragement. Although many participants enjoy exercising alone, training in groups usually adds to adherence. Periodic evaluations are important and should be scheduled 8 to 10 weeks after initiating the program, at 6 months, and at one year intervals. Such evaluations should focus attention on the improvement in fitness and health as well as the adaptation of the body to exercise.

There are many methods which can be used to attain physical fitness (4,5,19). Therefore, participation in a variety of activities is recommended and can be accomplished by interchanging various activities. Choosing different activities tends to keep a participant interested in endurance exercise over a long term period. For example, one might jog 30 minutes on Monday and Thursday and play handball or basketball on Tuesday and Friday. Also, running through the woods or in parks rather than around the track appears to make exercise more interesting. Likewise, many exercise leaders use music in conjunction with their exercise programs. The important factor is that the person participates in these activities frequently and with sufficient intensity and duration.

Giving back to the participant a monthly record on total aerobic points acts as a motivator for program continuation. Using the exercise log as described above and quantifying the aerobic points for the participant helps give continual feedback.

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APPENDIX A.

MEDICAL HISTORY QUESTIONNAIRE AND INFORMED CONSENT

MEDICAL HISTORY QUESTIONNAIRE

Institute for Aerobics Research
11811 Preston Road
Dallas, Texas 75230

This is your medical history form for your visit to The Institute for Aerobics Research. All information will be kept confidentail. The doctor or exercise physiologist you see at the Institute will use this information in his evaluation of your health. You will want to make it as accurate and complete as possible, yet free of meaningless details. Please fill out this form carefully and thoroughly. Then check it over to be sure you haven't left out anything.

Note: Please **print** all responses so that your data will be compatible with computer storage and analysis.

THE AEROBICS CENTER DALLAS, TEXAS

Name ______________________ Exam Date ______________ ,19 ____

195-A

When dates are required, please use numbers to represent the months as follows:

January 01	May 05	September 09
February 02	June 06	October 10
March 03	July 07	November 11
April 04	August 08	December 12

For addresses, please use the official Post Office two-letter abbreviations listed below.

Abbreviations for States (and Territories)

AL	Alabama	NE	Nebraska
AK	Alaska	NV	Nevada
AZ	Arizona	NH	New Hampshire
AR	Arkansas	NJ	New Jersey
CA	California	NM	New Mexico
CZ	Canal Zone (Panama)	NY	New York
CO	Colorado	NC	North Carolina
CT	Connecticut	ND	North Dakota
DE	Delaware	OH	Ohio
FL	Florida	OK	Oklahoma
GA	Georgia	OR	Oregon
GU	Guam	PA	Pennsylvania
HI	Hawaii	PR	Puerto Rico
ID	Idaho	RI	Rhode Island
IL	Illinois	SC	South Carolina
IN	Indiana	SD	South Dakota
IA	Iowa	TN	Tennessee
KS	Kansas	TX	Texas
KY	Kentucky	UT	Utah
LA	Louisiana	VT	Vermont
ME	Maine	VA	Virginia
MD	Maryland	VI	Virgin Islands
MA	Massachusetts	WA	Washington (state)
MI	Michigan	DC	Washington, D. C.
MN	Minnesota	WV	West Virginia
MS	Mississippi	WI	Wisconsin
MO	Missouri	WY	Wyoming
MT	Montana		

195-B

Institute for Aerobics Research
11811 Preston Road
Dallas, Texas 75230

Patient Medical History Form

DO NOT WRITE IN THIS SPACE! FOR OFFICE USE ONLY.
PATIENT NUMBER | VISIT | CARD | FORM | CLINIC
0 1 M 0 2 B

All information is private and confidential. Please Print.

I. GENERAL INFORMATION

☐ Mr. NAME
☐ Ms.
☐ Miss ________ FIRST ________ MIDDLE ________ LAST
☐ Mrs.
☐ Dr.

ADDRESS
________ NUMBER AND STREET

02 ________ CITY ____ STATE ____ ZIP CODE

________ COUNTRY (IF OUTSIDE U.S.A.)

HOME PHONE ( ) AREA CODE ____ - ____
SOCIAL SECURITY NUMBER ____ - ____ - ____
03 DATE OF BIRTH MONTH DAY YEAR
TODAY'S DATE MONTH DAY YEAR

FAMILY PHYSICIAN
Dr. ________ FIRST NAME, IF KNOWN ____ INITIAL ________ LAST NAME

DOCTOR'S ADDRESS (if known)
________ NUMBER AND STREET

04 ________ CITY ____ STATE ____ ZIP CODE
PHONE ( ) AREA CODE ____ - ____

May we send a copy of your consult to your physician? Yes ☐ No ☐

MARITAL STATUS
Single ☐ Married ☐ Divorced ☐ Widowed ☐ Separated ☐

SEX
Male ☐ Female ☐ PRESENT AGE ____

EDUCATION (Check highest level attained)
☐ Grade School ☐ High School ☐ College Graduate
☐ Junior High School ☐ Two-year College (or 4-year college; degree not completed) ☐ Postgraduate School

OCCUPATION
____

FOR OFFICE USE ONLY
OCCUP CODE ☐

EMPLOYER (use abbreviations if necessary)
05 ________

EMPLOYER'S ADDRESS
________ NUMBER AND STREET

06 ________ CITY ____ STATE ____ ZIP CODE
BUSINESS PHONE ( ) AREA CODE ____ - ____

What is/are your purpose(s) in coming to the Institute?
☐ To participate in a research study.
☐ To determine my current level of physical fitness and to receive recommendations for an exercise program.
☐ Other (please explain): ________

07 ________

PLEASE PRINT

195-C

Medical History

DO NOT WRITE IN THIS SPACE! FOR OFFICE USE ONLY.
PATIENT NUMBER | VISIT | CARD | FORM | CLINIC
1 0 M 0 2 B

PRESENT HISTORY

Check the box in front of those questions to which your answer is yes. Leave others blank.

10
- ☐ Has a doctor ever said that your blood pressure was too high or too low?
- ☐ Do you ever have pain in your heart or chest?
- ☐ Are you often bothered by a thumping of the heart?
- ☐ Does your heart often race like mad?
- ☐ Do you ever notice extra heart beats or skipped beats?
- ☐ Are your ankles often badly swollen?
- ☐ Do cold hands or feet trouble you even in hot weather?
- ☐ Has a doctor ever said that you had or have heart trouble, an abnormal electrocardiogram (ECG or EKG), heart attack, or coronary?
- ☐ Do you suffer from frequent cramps in your legs?
- ☐ Do you often have difficulty breathing?
- ☐ Do you get out of breath long before anyone else?
- ☐ Do you sometimes get out of breath when sitting still or sleeping?
- ☐ Has a doctor ever told you your cholesterol level was high?

Comments:
11 ________
12 ________
13 ________

Do you now have or have you recently had:

14
- ☐ A chronic, recurrent or morning cough?
- ☐ Any episode of coughing up blood?
- ☐ Increased anxiety or depression?
- ☐ Problems with recurrent fatigue, trouble sleeping or increased irritability?
- ☐ Migraine or recurrent headaches?
- ☐ Swollen or painful knees or ankles?
- ☐ Swollen, stiff or painful joints?
- ☐ Pain in your legs after walking short distances?
- ☐ Back pain?
- ☐ Kidney problems such as passing stones, burning, increased frequency, decreased force of stream of difficulty in starting or stopping your stream?
- ☐ Prostate trouble (men only)?
- ☐ Any stomach or intestinal problems such as recurrent heartburn, ulcers, constipation or diarrhea?
- ☐ Any significant vision or hearing problem?
- ☐ Any recent change in a wart or mole?
- ☐ Glaucoma or increased pressure in the eyes?
- ☐ Exposure to loud noises for long periods?

Comments:
15 ________

WOMEN ONLY answer the following:

16
- ☐ Do you have any menstrual period problems?
- ☐ Do you have problems with recurrent itching or discharge?
- ☐ Did you have any significant childbirth problems?
- ☐ Do you have any breast discharges or lumps?
- ☐ Do you sometimes lose urine when you cough, sneeze or laugh?

Please give number of: Pregnancies ____ Living children ____ First day of last menstrual period MONTH DAY YEAR

Date of last pelvic exam and/or Paps smear: month ____ year 19 ____ Results: Normal ☐ Abnormal ☐

Comments:
17 ________

PLEASE PRINT

195-D

Medical History

MEN and WC

List any pres

List any self-

Date of last cc

Date of last ch

Date of last ele

Date of last de

List any other

List hospitaliza

List any drug al

Have you ever ha

34
- ☐ Heart A
- ☐ Rheuma
- ☐ Heart m
- ☐ Diseases
- ☐ Varicose
- ☐ Arthritis
- ☐ Diabetes
- ☐ Phlebitis
- ☐ Dizziness
- ☐ Epilepsy
- ☐ Strokes
- ☐ Diphther
- ☐ Scarlet fe
- ☐ Infectiou
- ☐ Anemia

Comments:

DO NOT WRITE IN THIS SPACE: FOR OFFICE USE ONLY.

PATIENT NUMBER	VISIT	CARD	FORM	CLINIC
		2 5	M 0 2	B

MEN and WOMEN answer the following:

List any prescribed medications you are now taking:

25

List any self-prescribed medications or dietary supplements you are now taking:

26

27

Date of last complete physical examination:	month 19 year	never ☐	can't remember ☐	Normal ☐	Abnormal ☐
Date of last chest x-ray:	month 19 year	never ☐	can't remember ☐	Normal ☐	Abnormal ☐
Date of last electrocardiogram:	month 19 year	never ☐	can't remember ☐	Normal ☐	Abnormal ☐
Date of last dental check-up:	month 19 year	never ☐	can't remember ☐	Normal ☐	Abnormal ☐

List any other medical or diagnostic test you have had in the past two years:

28

29

List hospitalizations including dates of and reasons for hospitalization:

30

31

32

List any drug allergies:

33

PAST HISTORY

Have you ever had:

34

- ☐ Heart Attack, how many years ago?_____
- ☐ Rheumatic Fever
- ☐ Heart murmur
- ☐ Diseases of the arteries
- ☐ Varicose veins
- ☐ Arthritis of legs or arms
- ☐ Diabetes or abnormal blood sugar test
- ☐ Phlebitis
- ☐ Dizziness or fainting spells
- ☐ Epilepsy or fits
- ☐ Strokes
- ☐ Diphtheria
- ☐ Scarlet fever
- ☐ Infectious mononucleosis
- ☐ Anemia
- ☐ Thyroid problems
- ☐ Pneumonia
- ☐ Bronchitis
- ☐ Asthma
- ☐ Abnormal chest x-ray
- ☐ Other lung diseases
- ☐ Injuries to back, arms, legs or joints
- ☐ Broken bones
- ☐ Jaundice or gallbladder problems
- ☐ Polio
- ☐ Urinary tract infections, kidney stones, or prostate problems.
- ☐ Any nervous or emotional problems

Comments:

35

195-E

DO NOT WRITE IN THIS SPACE: FOR OFFICE USE ONLY.

PATIENT NUMBER	VISIT	CARD	FORM	CLINIC
		4 0	M 0 2	B

FAMILY MEDICAL HISTORY

40

FATHER: Alive ☐ Deceased ☐ Current age __ Age at death __ General health now: Cause of death or reason for poor health now: excellent ☐ good ☐ fair ☐ poor ☐ don't know ☐

MOTHER: Alive ☐ Deceased ☐ Current age __ Age at death __ General health now: Cause of death or reason for poor health now: excellent ☐ good ☐ fair ☐ poor ☐ don't know ☐

41

SIBLINGS: No. of brothers __ No. of sisters __ Age range __–__ Health Problems: __

42

FAMILIAL DISEASES: Have any of your blood relatives had any of the following? Include grandparents, aunts, and uncles, but exclude cousins, relatives by marriage, and half relatives.

- ☐ Heart attacks under age 50
- ☐ Strokes under age 50
- ☐ High blood pressure
- ☐ Elevated cholesterol
- ☐ Diabetes
- ☐ Asthma or hay fever
- ☐ Congenital heart disease
- ☐ Heart operations
- ☐ Glaucoma
- ☐ Obesity (20 or more lbs. overweight)
- ☐ Leukemia or cancer under age 60

Comments:

43

OTHER HEART DISEASES RISK FACTORS

SMOKING

44

Have you ever smoked cigarettes, cigars or a pipe? yes ☐ no ☐

If no, skip to Diet section.

Do you smoke presently? yes ☐ no ☐

If you did or do smoke cigarettes, how many per day? __ Age you started: __

If you did or do smoke cigars, how many per day? __ Age you started: __

If you did or do smoke a pipe, how many pipefuls per day? __ Age you started: __

If you have quit smoking, when was it? MONTH 19 YEAR

DIET

45

What do you consider a good weight for yourself? __ pounds

What is the most you have ever weighed? (including when pregnant) __ lbs. At what age? __ yrs.

Weight: Now __ lbs. One year ago __ lbs. At age 21 __ lbs.

Number of meals you usually eat per day. ☐

Average number of eggs you usually eat per week: __ (Do not count those in cooking and baking, cakes, casseroles, etc.)

Number of times per week you usually eat:

Beef	__	Fish	__	Desserts	__
Pork	__	Fowl	__	French fried foods	__

Number of servings (cups, glasses or containers) per week you usually consume of:

Homogenized (whole) milk	__	Buttermilk	__
Skim (non-fat) milk	__	Tea (iced or hot)	__
Two percent (2% fat) milk	__	Coffee	__

Do you ever drink alcoholic beverages? yes ☐ no ☐

If yes, what is your approximate intake of these beverages?

	None	Occasional	Often	If often, how many drinks per week?
Beer	☐	☐	☐	__
Wine	☐	☐	☐	__
Hard Liquor	☐	☐	☐	__

At any time in the past were you a heavy drinker (consumption of 6 oz. of hard liquor per day or more)? yes ☐ no ☐

Comments:

46

195-F

EXERCISE

50 Are you
Do you r
If yes
What
Do you p
Are you
If ye
Have you
If yes, yo
Do you f
If ye

51 In which

In which

52 What acti

53 Comments

Explain any other

Medical History

DO NOT WRITE IN THIS SPACE: FOR OFFICE USE ONLY.

PATIENT NUMBER	VISIT	CARD	FORM	CLINIC
		5 0	M 0 2	B

EXERCISE

50 Are you currently involved in a regular exercise program? yes ☐ no ☐

Do you regularly walk or run one or more miles continuously? yes ☐ no ☐ don't know ☐

If yes, average no. of miles you cover per workout or day: ____ miles

What is your average time per mile? ____ minutes: seconds don't know ☐

Do you practice weight lifting or home calisthenics? yes ☐ no ☐

Are you now involved in the Aerobics program? yes ☐ no ☐

If yes, your average Aerobics points per week: ____

Have you taken in the past 6 months: ☐ 12 minute test ☐ 1.5 mile ☐ neither

If yes, your miles in 12 minutes: ____ or your time for 1.5 miles: ____ minutes : seconds

Do you frequently participate in competitive sports? yes ☐ no ☐

If yes, which one or ones?

☐ Golf ☐ Bowling ☐ Tennis ☐ Handball ☐ Soccer

☐ Basketball ☐ Volleyball ☐ Football ☐ Baseball ☐ Track

☐ Other ____

Average number of times per month ____

51 In which of the following high school or college athletics did you participate?

☐ None ☐ Football ☐ Basketball ☐ Baseball ☐ Soccer

☐ Track ☐ Swimming ☐ Tennis ☐ Wrestling ☐ Golf

☐ Other ____

In which of the following high school or college athletics did you earn a varsity letter?

☐ None ☐ Football ☐ Basketball ☐ Baseball ☐ Soccer

☐ Track ☐ Swimming ☐ Tennis ☐ Wrestling ☐ Golf

☐ Other ____

52 What activity or activities would you prefer in a regular exercise program for yourself?

☐ Walking and/or running ☐ Bicycling (outdoors) ☐ Swimming

☐ Stationary running ☐ Stationary cycling ☐ Tennis

☐ Jumping rope ☐ Handball, basketball or squash

☐ Other ____

53 Comments: ____

Explain any other significant medical problems that you consider important for us to know:

55 ____

56 ____

57 ____

58 ____

59 ____

60 ____

61 ____

PLEASE PRINT

INFORMED CONSENT FOR EXERCISE TESTING

INSTITUTE FOR AEROBICS RESEARCH
11811 Preston Road
Dallas, Texas 75230

The undersigned hereby voluntarily consents to engage in a maximum exercise test to determine maximum oxygen intake and cardiovascular function. The test will be monitored continuously by an electrocardiogram recording and oscilloscope. This test will facilitate evaluation of cardiopulmonary function and assist the physician or exercise physiologist in prescribing or evaluating exercise programs. It is my understanding that I will be questioned and examined by a physician prior to taking the test and will be given a resting electrocardiogram to exclude contraindications to such testing.

Exercise testing will be performed by running, walking, swimming or riding a bicycle, with the workload increasing every few minutes until fatigue or breathlessness or other symptoms dictate cessation of the test. Blood pressure and electrocardiogram will be monitored by a physician or trained exercise physiologist. In the latter case, a physician will be readily available in case of emergency.

There exists the possibility that certain changes may occur during the progress of the test. These changes could include abnormal heart beats, abnormal blood pressure and in rare instances a "heart attack". Professional care in selection and supervision of individuals provides appropriate precaution against such problems.

The benefits of such testing are the scientific assessment of working capacity and the clinical appraisal of health hazards which will facilitate prescription of conditioning-rehabilitative exercise. Records will be held in strict confidence from non-medical people (such as employers and insurance agents) unless consent is obtained. The welfare of persons being tested is safeguarded by professional care and by the availability of emergency treatment should it be necessary.

Finally, I permit registration of my name for possible follow-up purposes in the future.

Further, the undersigned releases and discharges the Institute for Aerobics Research and the International Association of Chiefs of Police, their officers, agents, staff, faculty, physicians, technicians and any others connected therewith from all claims or damages whatsoever that the undersigned or his representatives may have arising from, or incident to this test.

Signed____________________

Witness____________________

Date____________________

Physician or Exercise Physiologist Supervising Test

____

APPENDIX B.

EXERCISE LOG

INSTIT[illegible] [illegible] AEROBICS RESE[illegible]
11811 PRESTON ROAD DALLAS, TEXAS 75230 (214) 661-3374

NAME (LAST, FIRST) | PROJECT | AGE | HEIGHT | SEX | MONTH | YEAR | GROUP | NUMBER

DEFINITION OF CODES

MODE:
TRK = Track or field
TML = Treadmill
BIK = Stationary cycling

WEEK:
Week number in training stu[illegible]

WO:
Workout number in current w[illegible]k (e.g. 1, 2, 3, 4, 5)

INT:
Intensity of workout inter[illegible]
H = High (e.g. jog/[illegible]un)
L = Low (e.g. walk/jog)

DISTANCE:
For Track: distance of one interval
For Treadmill: speed of treadmill in miles/hour
For Bike: load in kilogram-meters/min. (e.g. 300, 600, etc.)

PACE:
Time for one interval

REPS:
Number of repetitions of an interval

TIME:
For Track: leave blank
For Treadmill or Bike: total time at pace

HR:
Ten second heart rate times six taken at the middle and end of workout

WEIGHT:
Body weight to nearest ¼ pound prior to workout

TOTAL TIME:
Total time of entire workout

MODE	WEEK	WO	INT	DISTANCE	PACE	REPS	TIME	INT	DISTANCE	PACE	REPS	TIME	MID-HR	END-HR	WEIGHT	TOTAL TIME

(continue on back side)

END