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AN EVALUATION OF THE CANADIAN FORCES TWO-MILE WALK AS A TEST OF AEROBIC FITNESS IN MALES OVER 45 YEARS OF AGE

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ABSTRACT

The Canadian Forces (CF) two-mile walk was evaluated as a test of aerobic fitness for males over 45 years of age. Twelve male subjects aged 46-61 years were first classified into one of four categories of fitness based on predicted values of minimum oxygen uptake (VO_2 max) determined by a submaximal bicycle ergometer test. Subsequently the same individuals performed the CF two-mile walk test and their performances were categorized according to the times listed as standards in the Canadian Forces Administrative Order (CFAO) 50-1. Since VO_2 max is accepted criterion of aerobic fitness, it was possible to evaluate the two-mile walk by comparison. The results indicate that the two-mile walk test considerably overestimates fitness and, from theoretical considerations, it is suggested that the walking times in CFAO 50-1 should be reduced by approximately four minutes.

This study also examined the two-mile walk as a means of improving aerobic fitness in males over 45 years of age. Heart rates recorded by telemetry during the walk reached a training level (60% or more of cardiac reserve) in ten of the subjects for at least ten minutes. By this criterion, walking at 4-5 mph for two miles three times a week should improve aerobic fitness in sedentary males over 45 years of age.

INTRODUCTION

Physical fitness is an important aspect of total health for all Canadians and is an increasingly significant part of preventive medicine as males approach the age of 45 when coronary heart disease becomes a major cause of death. The aspect of physical fitness most closely correlated with susceptibility to coronary heart disease is aerobic fitness, which can be defined in terms of maximum oxygen uptake (VO_2 max). Maximum oxygen uptake is expressed in millilitres of oxygen consumed per kilogram of body weight per minute and can be measured in the laboratory using a device such as the bicycle ergometer. Four categories of VO_2 max using the standards of Cooper (1968) for males age 25 and incorporating the Astrand (1960) age correction are shown in Figure 1, for ages 45 to 60.

Although laboratory measurement of VO_2 max provides the most accurate measure of aerobic fitness, performance tests are often used when evaluating large populations. These performance tests are designed to correlate well with laboratory determinations of VO_2 max. The Canadian Forces use a two-mile walk to assess physical fitness in personnel over age 45 and performance standards for the two-mile walk from Canadian Forces Administrative Order (CFAO) 50-1 are shown in Table 1. One objective of the present study was to evaluate the two-mile walk as a test of physical fitness for males over 45 years of age by comparing it to the bicycle ergometer test.

Many older individuals have a rather sedentary lifestyle and do not realize the benefits of regular exercise. Since, for a variety of reasons, they are often unwilling to run, swim or ride a bicycle, walking may be the only form of exercise which is appropriate. The second objective of this study was to examine walking as a form of exercise to improve aerobic fitness in males over age 45 and, in particular, to determine the intensity and duration of a walk necessary to achieve a training effect.

METHOD

Twelve healthy males from the Institute agreed to act as subjects in the experiment. All were over 45 years of age and none of them were active in a regular strenuous exercise program. After an initial medical examination VO_2 max was predicted from submaximal exercise performed using the MONARK bicycle ergometer. A submaximal test was chosen to reduce the risk to older subjects and, as a further safeguard, heart rate and rhythm were monitored throughout the test using a Cambridge electrocardiogram (ECG) recorder and three chest electrodes. The equipment used is shown in Figure 2. After a pre-exercise ECG was recorded, the subject was allowed a three minute warmup at a light workload

to accustom him to the pedalling cadence (50 rpm). He then stopped pedalling and a mouthpiece and noseclips were fitted to permit collection and analysis of the expired gas by Beckman medical gas analyzers and a Tissot 350 litre chain-compensated gasometer. Two five-minute workloads were used for the actual test, with the second workload set to produce a heart rate that was 70% of maximum heart rate predicted from age. After exercise ceased, heart rate and rhythm were monitored during a five-minute recovery period. Heart rate and oxygen consumption during the final two minutes of exercise were used to predict $\dot{V}O_2$ max according to the nomogram of Astrand and Rhyming (1954). Maximum energy expenditure (kcal/hr) was calculated using five kilo-calories as the energy equivalent of one litre of oxygen.

For the two-mile walk subjects walked a measured course on the level road surface around the Institute. This distance was covered twice by each individual on two days separated by at least a week. All testing was conducted between 0800 and 1000 hours to avoid extreme temperatures which may have significantly influenced performance. A Siemens Telecust telemetry receiver incorporating an oscilloscope, pulse meter and ECG recorder was used to monitor heart rates throughout the test. Three chest electrodes were placed on each subject and were attached to a Siemens Telecust transmitter strapped around the waist. With the subject thus prepared for the walk, body weight and leg length (distance from the top of the iliac crest to the floor) were recorded. All subjects were asked to walk as quickly as possible at a pace they could maintain over the entire two miles. Total walking time, walking speed and heart rate at five intervals during the walk (see Figure 4) were recorded.

RESULTS

The results are shown in Table 2. Values of $\dot{V}O_2$ max predicted by the bicycle ergometer test placed four individuals in the "good" fitness category, seven in the "fair" and one in the "poor" category. When the fastest walking time was used to categorize aerobic fitness according to the CFAO 50-1 standards, ten of the 12 subjects were ranked as "excellent" and the other two as "good". It appears that the fitness category indicated by the walk is consistently one or two levels higher than that established by the bicycle ergometer test.

Heart rates measured during the fastest walk for each subject are shown in Figure 4. The mean heart rate at 0.54 miles was 126 bpm and this had increased to 152 bpm at the end of the two-mile distance. By the end of the walk all subjects had heart rates

greater than 70% of their maximum predicted from age. Heart rates above 60% of cardiac reserve, 0.6 (max HR - resting HR) + resting HR, are shown in Figure 4 by a solid line. Over the last mile ten subjects had heart rates which were above 60% of cardiac reserve. Walking speeds ranged from 4.2 to 5.0 mph.

The energy expenditure for each of the 24 walking tests was calculated from body weight and walking speed using the formula of Givoni and Goldman (1971). These values were expressed as a percent of VO_2 max for each individual and were plotted against the mean heart rate observed during the walk. Figure 5 shows that a linear relationship exists between the two parameters ($r = 0.62$, $p<0.05$).

DISCUSSION

In individuals over age 45, exercising to a maximal heart rate is associated with some risk of a serious cardiac event. For this reason, VO_2 max in this study was predicted from submaximal exercise on the bicycle ergometer. Since prediction of VO_2 max from a submaximal test correlates well with its direct measurement (Glassford et al, 1965), determinations of VO_2 max in this study can be considered to be valid estimates of aerobic fitness.

The Canadian Forces make use of the two-mile walk as a means of assessing physical fitness in personnel over 45 years of age. The observation that all of the subjects in this study attained heart rates during their walk that were above 70% of their maximum heart rates suggests that the two-mile walk can be used to estimate aerobic fitness provided the subject puts forth a maximum, or near maximum, effort. On the other hand, the fitness categories indicated by the two-mile walk were at least one level higher than those established by the bicycle ergometer test. It was also noted that the fitness categories of "good" and "excellent" indicated by the walk test were high in view of the mainly sedentary lifestyle of the twelve subjects. These discrepancies suggest that the walking times allowed in CFAO 50-1 are too liberal and are not an accurate measure of fitness for individuals over 45 years of age.

Although data is available for only 12 subjects, it is possible from theoretical considerations to estimate how much the existing standards should be altered to make the two-mile walk more compatible with the bicycle ergometer test. A sample calculation is given in Appendix A. Calculations for ages 45 to 60 years indicate that decreasing the walking times in CFAO 50-1 by approximately four minutes would give the two tests a closer correlation (Table 1). When corrected walking times are calculated for individuals in the "excellent" category of VO_2 max, these speeds exceed the limits

imposed by body structure. Therefore, some other test such as the 1.5-mile run or the bicycle ergometer test would be required to adequately stress and thus identify individuals in a truly "excellent" category of aerobic fitness.

Two parameters, intensity and duration, were considered when evaluating the two-mile walk as a form of exercise to improve aerobic fitness. According to Karvonen (1959) the intensity of exercise must be sufficient to produce and maintain a heart rate which is at least 60% of cardiac reserve. Cooper (1970) suggested ten minutes as the minimum time required for exercise of this intensity to be of benefit to the cardiovascular system. Using these combined criteria, 10 of the 12 subjects received aerobic training from their best effort on the two-mile walk. For the average sedentary male over 45 years of age a significant increase in aerobic fitness would be realized if two miles of brisk walking at 4.2 - 5 mph was performed three times per week.

RECOMMENDATION

It is recommended that, to make the two-mile walk a more accurate measure of aerobic fitness in males over 45 years of age, the walking times should be reduced by about four minutes. To identify those individuals in the truly "excellent" or level 5 fitness category it is suggested that a running test is more practical.

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TABLE 1

EXISTING (CFAO 50-1) AND CORRECTED TIMES FOR THE TWO-MILE WALK

Fitness Category	40 to 44 years	45 to 49 years	50 to 54 years	55 years and over
Level 1	Over 38:00 (over 34:00)	Over 39:30 (over 35:30)	Over 41:15 (over 37:15)	Over 43:00 (over 39:00)
Level 2	38:00 to 33:31 (34:00 to 29:31)	39:30 to 35:08 (35:30 to 31:08)	41:15 to 37:01 (37:15 to 33:01)	43:00 to 38:46 (39:00 to 34:46)
Level 3	33:30 to 28:01 (29:30 to 24:01)	35:07 to 29:31 (31:07 to 25:31)	37:00 to 31:16 (33:00 to 27:16)	38:45 to 33:01 (34:45 to 29:01)
Level 4	28:00 to 24.31 (24:00 to 20:31)	29:30 to 26:16 (25:30 to 22:16)	31:15 to 27:16 (27:15 to 23:16)	33:00 to 29:01 (29:00 to 25:01)
Level 5	under 24:31 (under 20:31)	under 26:16 (under 22:16)	under 27:16 (under 23:16)	under 29:01 (under 25:01)

Walking times are in minutes and seconds; corrected times are shown in parentheses.

TABLE 2

A COMPARISON OF CATEGORIES OF AEROBIC FITNESS ASSESSED BY THE BICYCLE ERGOMETER TEST AND BY THE TWO-MILE WALK

		Bicycle ergometer test		Walk #1		Walk #2	
Subj	Age (yrs)	VO_2 max (ml/kg-min)	Category (Figure 1)	Time (min)	Category (CFAO 50-1)	Time (min)	Category (CFAO 50-1)
1	50	31.4	fair	27.80	good	29.57	good
2	50	37.1	good	23.98	excellent	24.02	excellent
3	52	29.0	fair	27.58	good	23.72	excellent
4	51	22.6	poor	29.48	good	28.40	excellent
5	51	31.7	fair	29.57	good	25.40	excellent
6	61	32.7	good	25.08	excellent	24.76	excellent
7	53	35.5	good	26.21	excellent	25.03	excellent
8	56	25.2	fair	29.33	good	25.70	excellent
9	46	37.7	good	27.91	good	25.24	excellent
10	56	26.2	fair	28.67	excellent	27.58	excellent
11	53	24.7	fair	24.63	excellent	24.19	excellent
12	50	29.1	fair	26.5	excellent	25.80	excellent

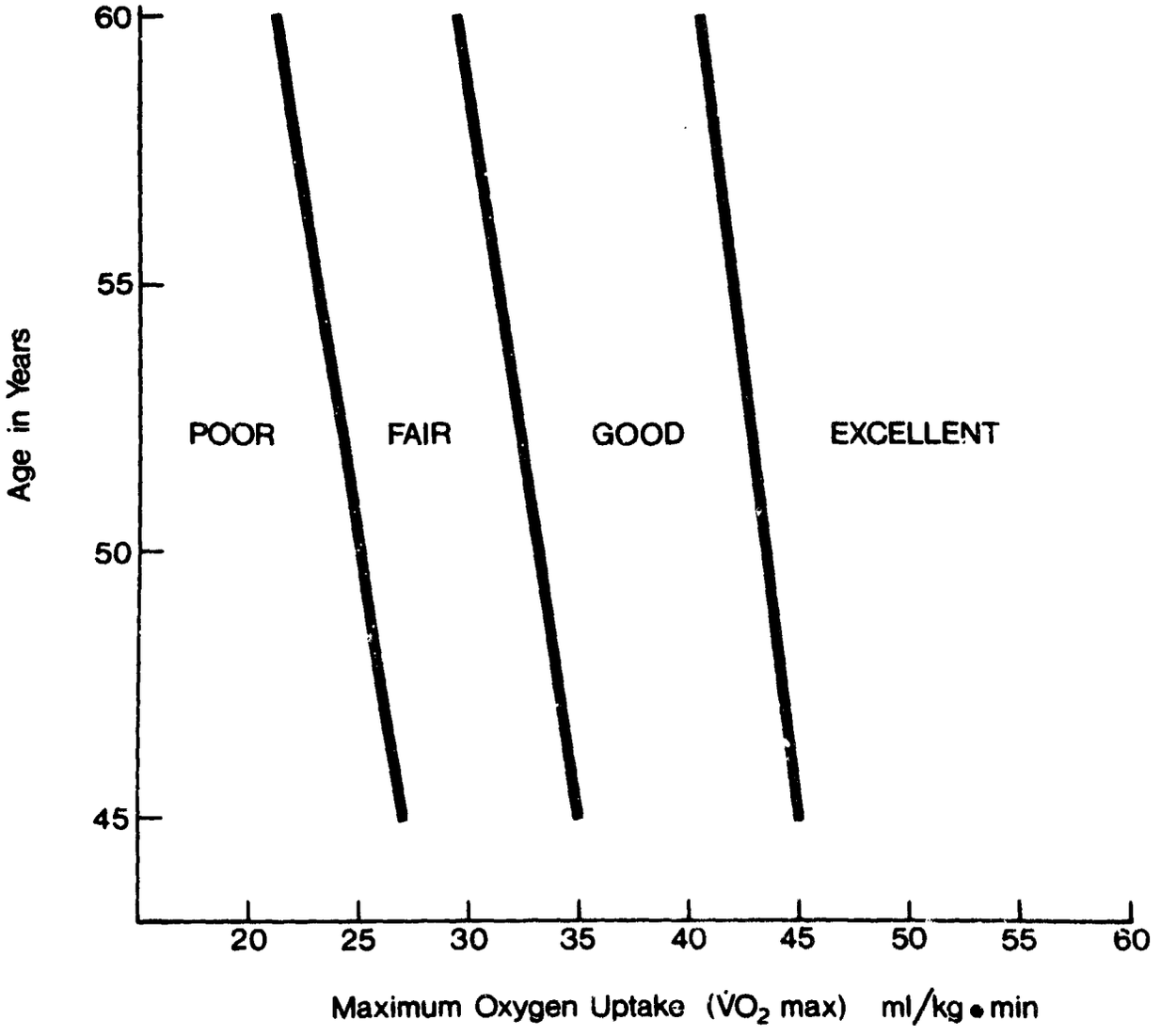

Figure 1: Categories of maximum oxygen uptake ($\dot{V}O_2$ max) based on the standards of Cooper for age 25 and incorporating the Astrand age correlation.

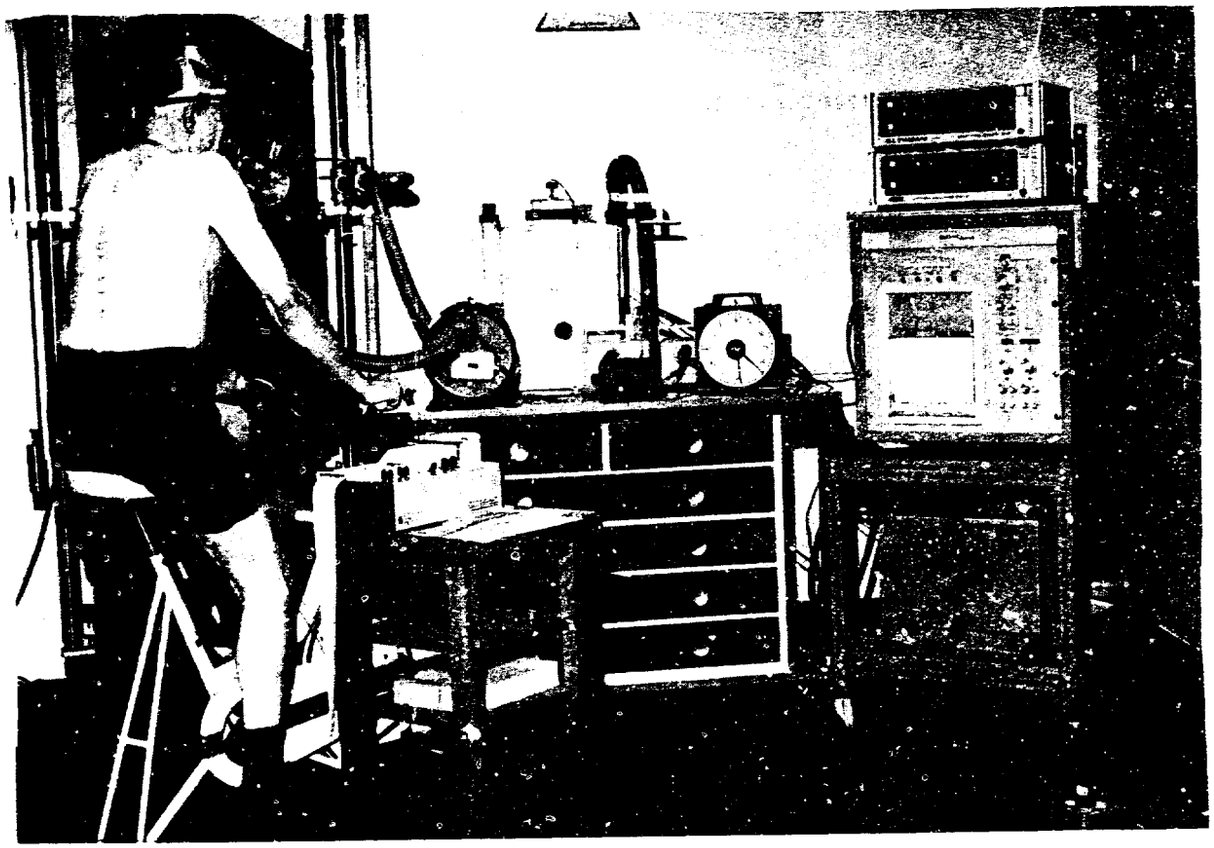

Figure 2: $\dot{V}O_2$ measurement and ECG monitoring during the bicycle ergometer tests in the laboratory.

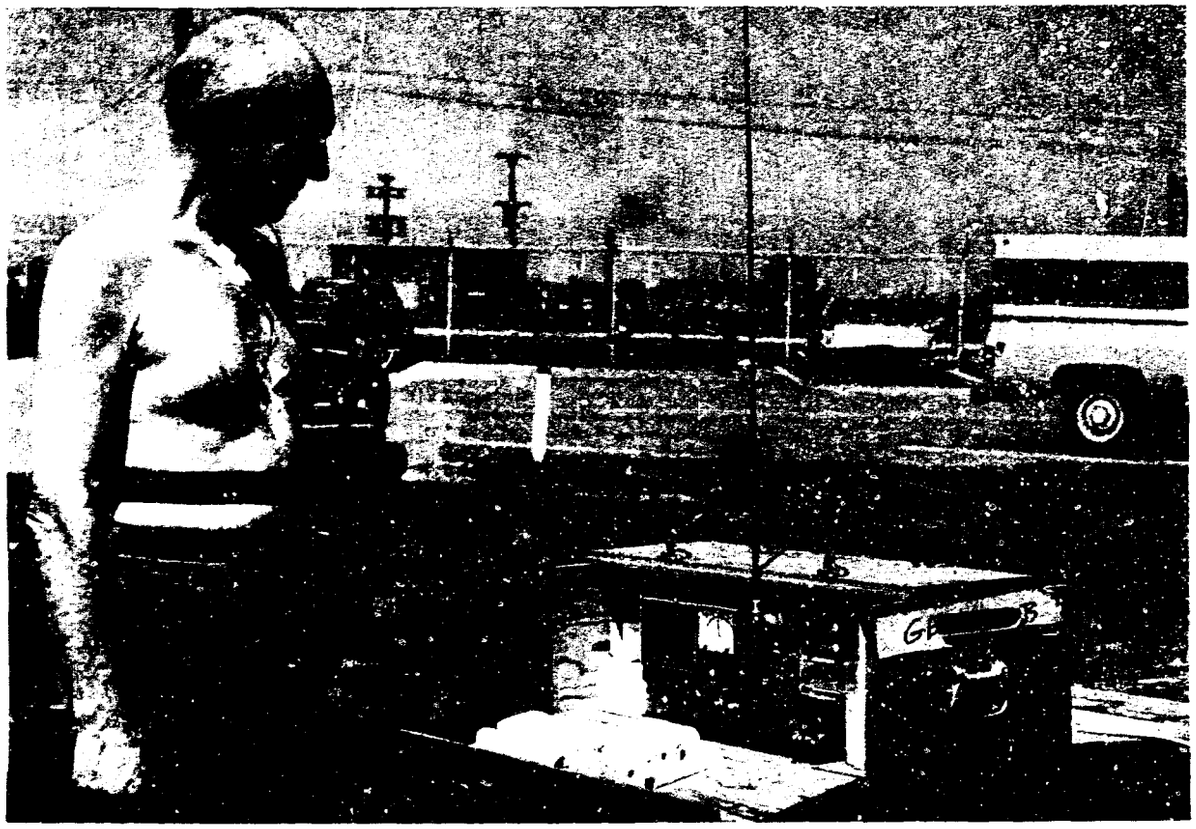

Figure 3: Heart rate monitoring by radio telemetry during the outdoor walk.

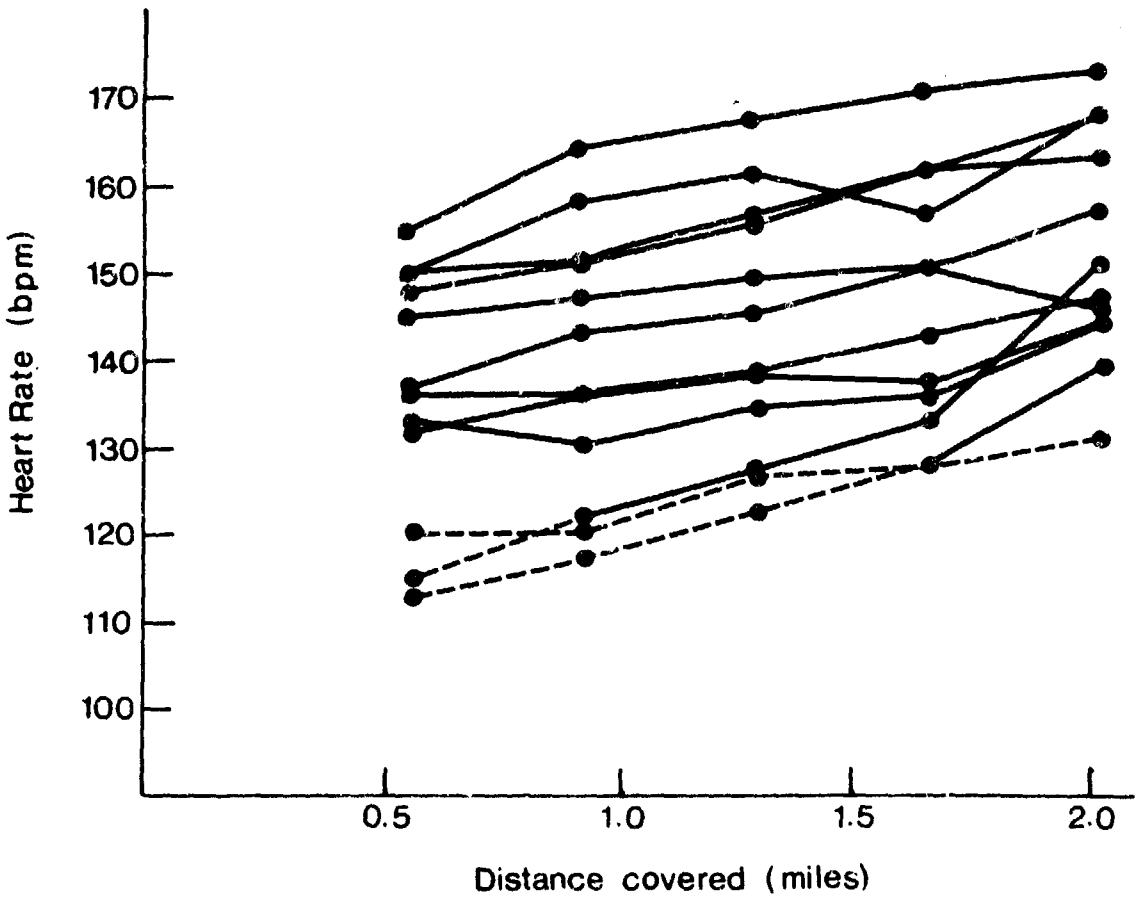

Figure 4: Heart rate plotted against distance covered for the best walk time. Solid lines indicate heart rates greater than 60 percent of cardiac reserve.

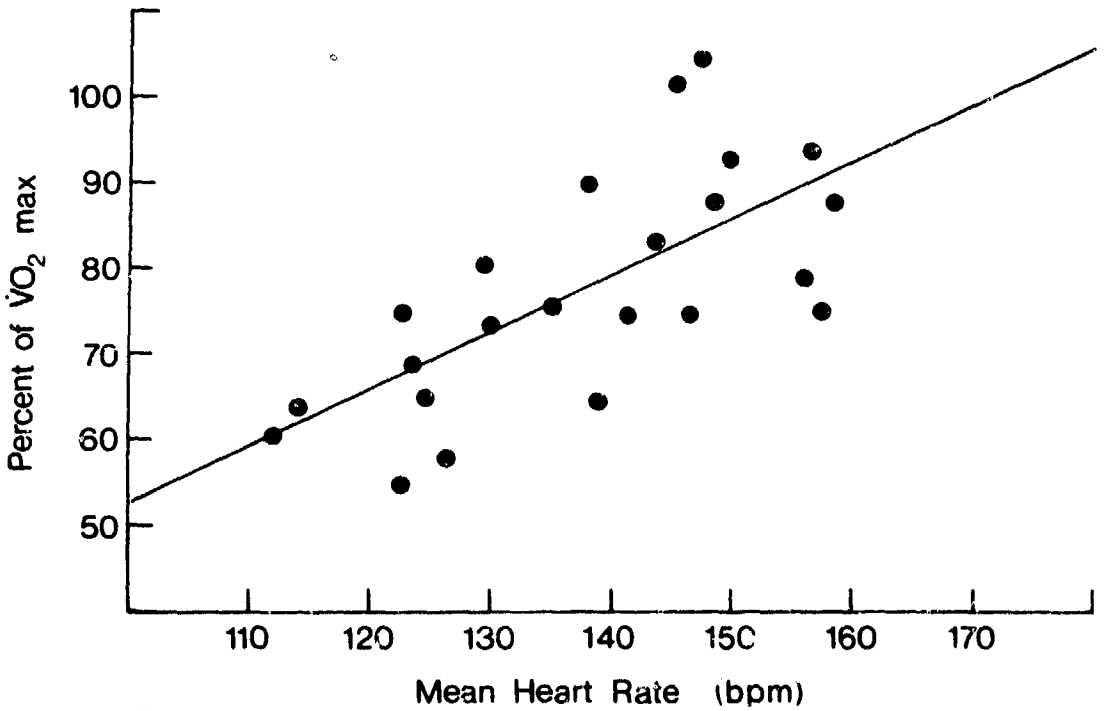

Figure 5: Percent of $\dot{V}O_2$ max plotted against mean heart rate for all 24 two-mile walks.

APPENDIX A

CALCULATION OF CORRECTION TO EXISTING (CFAO 50-1)

STANDARD FOR THE TWO MILE WALK TEST

Example: - subject age 50
- weight (w) 70 kg

1. Predict maximum heart rate.

$$220 - \text{age}$$
$$= 220 - 50$$
$$= 170 \text{ bpm}$$

2. Take 70% of maximum heart rate.*

$$170 \times .7$$
$$= 119 \text{ bpm}$$

3. Use regression equation from Figure 5 to find % of VO_2 max at mean H.R. of 119 bpm.

$$\%VO_2 \text{ max} = 0.664 \text{ (mean H.R.)} - 13.845$$
$$= 0.664 \text{ (119)} - 13.845$$
$$= 65.2\%$$

4. From Figure 1 extract VO_2 max necessary to attain the "GOOD" fitness category for age 50.

$$= 33 \text{ ml/kg. min}$$

5. Convert VO_2 max value to maximum energy expenditure (1 litre O_2 is equivalent to 5 kcal).

$$M = \frac{VO_2 \text{ max} \times W \times 60}{1000}$$
$$= \frac{33 \times 70 \times 60 \times 5}{1000}$$
$$= 693 \text{ kcal/hr}$$

6. Take 65.2% of maximum energy expenditure.

$$M_1 = 693 \times .652$$
$$= 451.84 \text{ kcal/hr}$$

* It is generally accepted that, to constitute a valid test of aerobic fitness, exercise must produce a heart rate of at least 70% of maximum.

** The existing performance standard (CFAO 50-1) for this same individual is 31.26 m/n.

7. Calculate velocity using the equation of Givoni and Goldman (1971).

$$M_1 = W\left|2.3 + 0.32\ (V-2.5)^{1.65}\right|$$
$$V = 7.2 \text{ km/hr}$$

8. Convert velocity to time for the two-mile walk.**

$$\text{time} = \frac{60}{V} \times 3.2206$$
$$= \frac{60}{7.2} \times 3.2206$$
$$= 26.80 \text{ min.}$$

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13. ABSTRACT

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