Changes in Cardiovascular Fitness Following Physical Fitness Classes

Jonathan E. Rodnick, MD, and Alan Frischer, MPH
San Francisco, California

A program aimed at improving cardiovascular fitness was evaluated. This program involved 298 volunteer middle-aged participants who initially had a bicycle ergometry test to calculate fitness. Other measurements included body fat (estimated by skin fold measurements) and a rating of coronary-prone personality.

The participants were given their results and then offered a six-week fitness class consisting of both didactic and exercise segments. After six months, bicycle ergometry was repeated. During this period, mean calculated maximum oxygen uptake (a measure of fitness with a "normal" range of 20 mL/kg/min to 60 mL/kg/min) improved from 38.0 to 39.6 mL/kg/min (*t* test, P = .0001). Classifying this according to a cardiovascular fitness rating based on age and sex, with 5 being excellent fitness to 1 being very poor fitness, the mean fitness rating went from 3.08 to 3.31 (*t* test, P = .0001). There was no change in weight or percentage of body fat.

Both those who attended the fitness classes and those who did not attend improved equally. Those who did not attend classes had higher ratings on a coronary-prone personality scale compared with those attending classes. In some groups, it appears that significant improvement in cardiovascular fitness may be initiated with a five-minute, office-based bicycle test.

Exercise is frequently recommended to reduce cardiovascular risks and improve psychological status. A review of 50 population studies shows that although lack of exercise itself may not be a major risk factor for cardiovascular disease, engaging in regular exercise will frequently decrease blood pressure, serum cholesterol and weight, and raise high-density lipoproteins.[1,2] Further, physical fitness has been shown to be an important independent risk factor for myocardial infarction when other risk factors (such as above-average cholesterol levels, blood pressure readings, or smoking) are present.[3]

The issue of how to improve an individual's cardiovascular fitness was addressed as part of a larger health promotion program. Participants in this program were offered a series of six introductory fitness classes. This report will address the question of whether attendance at these classes results in a significant improvement in cardiovascular fitness according to measurements taken six months later.

From the Division of Family and Community Medicine, University of California, San Francisco. Requests for reprints should be addressed to Dr. Jonathan E. Rodnick, Division of Family and Community Medicine, University of California, San Francisco, 400 Parnassus, AC-9, San Francisco, CA 94143.

Figure 1. Subject on bicycle ergometer. Heart rate is being monitored by a pulse meter with chest electrode

Methods

Over 500 people were recruited into a three-year health promotion program. Most participants were charged for the cost of testing and education—fees were on a sliding scale from $25 to $125. As part of the program's initial screening, many parameters were measured, including cholesterol, blood pressure, and weight. In addition, an estimate of the coronary-prone personality was derived by asking individuals to rate themselves from 1 (low) to 7 (high) on five attributes—time urgency, competitiveness, orientation toward goals, immersion in tasks, and speed with which tasks were completed. Other questionnaires were used to assess health risks (a Health Hazard Appraisal)[4] and stresses (the Holmes and Rahe Social Readjustment Rating Scale).[5]

During the second year of the program, individuals were encouraged to participate in a physical fitness screening consisting of (1) a questionnaire regarding exercise habits in which they rated their daily exercise from 1 (sedentary) to 4 (vigorous), with examples given for each value; (2) an estimate of percentage of body fat using skin calipers; and (3) measurement of cardiovascular fitness using bicycle ergometry, which involved pedaling a stationary bicycle for five minutes with a standard pedal resistance (Figure 1). An estimate of maximum oxygen uptake (MVO_2) was then calculated from the heart rate achieved, weight, sex, and age, using the tables and methods of Astrand and Rodahl.[6] The MVO_2 represents the milliliters of oxygen removed from the inspired air per minute and it is a measure of cardiovascular fitness.

At a subsequent small-group session, participants were given their results, told how they compare with the norms, and encouraged to come to a series of two-hour, evening physical fitness classes that were offered weekly over a six-week period. The classes were taught by a college physical education instructor and were one-half lecture and one-half basic aerobic exercise. A target zone for pulse rate (70 to 80 percent of maximum predicted pulse) was emphasized, and individuals were encouraged to monitor their pulses during exercise. Approximately six months later, participants were recontacted, and the questionnaire and measurements, including the bicycle ergometry, were repeated. Figure 2 displays the study's time scale and numbers of participants.

Results

Four hundred ninety-five individuals filled out the exercise questionnaire and underwent ergometry testing. Subsequently, 247 individuals took at least one exercise class, 123 took three or more, but only 36 took five or six classes. After six months, 315 individuals returned for follow-up testing. Because of missing data elements, complete before and after measurements are available for only 298 individuals. These individuals have an average age of 45.2 years, 61 percent were female, and over 90 percent were employed. In analyzing changes in reported exercise habits, as well as the changes in the other variables, individuals who did not return for the final testing have been necessar-

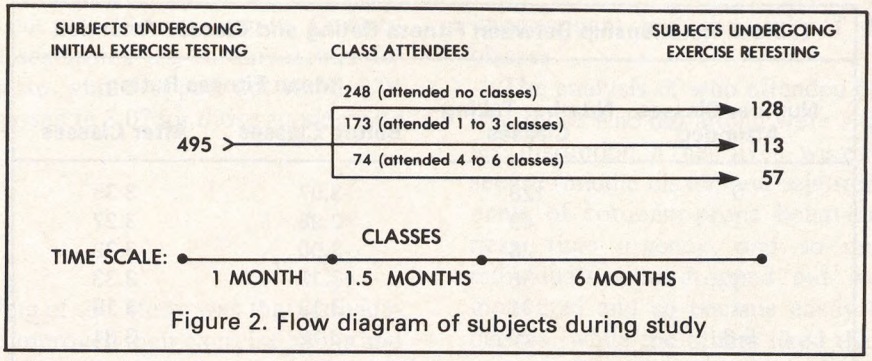

Figure 2. Flow diagram of subjects during study

Table 1. Fitness Rating. Classification of Maximal Oxygen Uptake (MVO_2)*

Age (years)	Excellent (5)	Good (4)	Average (3)	Poor (2)	Very Poor (1)
Female					
20-29	49+	44-48	35-43	34-28	27 and less
30-39	48+	42-47	34-41	33-27	26 and less
40-49	46+	41-45	40-32	31-25	24 and less
50-65+	42+	37-41	36-29	28-21	20 and less
Male					
20-29	57+	56-52	51-44	43-38	37 and less
30-39	52+	51-48	47-40	39-34	33 and less
40-49	48+	47-44	43-36	35-30	29 and less
50-59	44+	43-40	39-32	31-25	24 and less
60-69+	40+	39-36	35-27	26-21	20 and less

*In mL/kg/min

ily excluded.

The 298 participants self-reported a mean for exercise habits before (1 = sedentary to 4 = regular, vigorous exercise) of 2.55 ± .95, and subsequently 2.81 ± .92 six months later. This change is significant ($t = 3.25$, $P = .001$, two-sided test).

At the initial measurement, before classes, 3.8 percent had a body fat estimated at 10 percent or less, 27.0 percent had body fat estimated at 15 percent or less. Overall, the calculated mean was 19.0 percent body fat. At the second measurement, 3.7 percent had an estimated body fat of 10 percent or less, and 28.2 percent had 15 percent or less body fat. The mean was 18.3 percent, not a significant difference.

The mean initial calculated MVO_2 of the 298 individuals who took both ergometry tests was an oxygen uptake of 38.0 mL/kg/min, which improved to 39.6 mL/kg/min on the second testing, a significant improvement ($t = 5.8$, $P = .0001$, two-sided test). Because the same calculated maximal oxygen uptake can mean someone is in excellent shape (if they are older or female) or in poor shape (if they are young or male), a conversion of MVO_2 was done based on age and sex to a fitness rating from 1 (very poor) to 5 (excellent). Table 1 was used to correct for age and sex.[7]

The mean fitness rating at the initial testing was 3.08, which improved to 3.31 at the second testing. Using the t test, this change is a significant, $P = .0001$.

As noted in Table 2, individuals improved in their fitness rating regardless of whether they took classes. The mean change was .28 for those taking no classes ($N = 128$), .25 for those taking one to three classes ($N = 113$), and .10 for those taking four to six classes ($N = 57$). Those taking classes were not in significantly better initial shape (which would have inhibited their improvement). Mean initial fitness ratings were 3.07 for those taking no classes, 3.05 for those taking one to three classes, and 3.12 for those taking four to six classes.

Table 2. Relationship Between Fitness Rating and Classes Attended

Number Classes Attended	Number Taking Classes	Mean Fitness Rating	
		Before Classes	After Classes
0	128	3.07	3.35
1	49	2.98	3.27
2	28	3.00	3.32
3	36	3.19	3.33
4	31	3.13	3.16
5-6	26	3.12	3.31

Table 3. Values of Parameters by Number of Classes Attended (N = 495)

Parameters	Classes Attended		
	None	1 to 3	4 to 6
N (participants)	248	173	74
Educational level (1 = low, 7 = high)	3.7	4.2	4.9
Income (1 = low, 7 = high)	3.2	3.3	3.7
Average age (years)	43.1	43.7	47.9
Holmes and Rahe score (higher = more life changes)	174	160	143
Coronary-prone behavior (10 = low, 30 = high)	21.1	20.5	20.1
Initial fitness rating (1 = very poor, 5 = excellent)	3.07	3.05	3.12
Cigarettes smoked per day	2.6	1.9	0.5
Serum cholesterol (mg/dL)	219	216	231
Health hazard appraisal Risk age minus true age	−2.3	−2.5	−3.1

To determine whether those who took fitness classes differed from those who did not, several demographic and psychosocial variables were compared for the attendees and nonattendees (Table 3). The number of participants is greater than the figure used earlier, as Table 3 includes those who did not take the final fitness measurements (and thus were excluded from analysis of change). As can be noted, individuals who attended more classes tended to be older, to have higher educational levels, slightly higher family incomes, and fewer life changes. They were not in better health initially, but did have somewhat lower overall health risks (Health Hazard Appraisal risk age), primarily because of a lower rate of cigarette smoking.

As part of the initial testing, coronary-prone behavior was assessed through a five-item questionnaire. Those who took no classes scored significantly higher, rating themselves as having more characteristics of coronary-prone behavior, than those who came to four to six classes ($t = 3.88$, $P = .001$).

Those individuals who took the first exercise testing and then did not take classes or did not return for the final test were not significantly different on any exercise-related variable from those who stayed with the program. For instance, the mean initial calculated MVO_2 for those staying with the program was 38.0 mL/kg/min and for

those dropping out was 38.6 mL/kg/min. Correcting for age and sex (using the cardiovascular fitness rating), those who dropped out rated 3.06 (N = 120) as opposed to 3.07 for those staying with the program.

Discussion

The key finding of this study was that individuals significantly improved their exercise habits and cardiovascular fitness over the study period. It should be noted that the changes were small ones and resulted in such statistical significance primarily because of the large numbers of participants. For example, the average improvement of MVO_2 of 1.6 mL O_2/kg/min is of uncertain biological significance and individually would be within the error of measurement for the test. The changes in reported exercise habits were in the same direction—improvement from a mean of 2.55 before to 2.81 after indicates that, on average, one individual in four increased his regular exercise. Similarly, the improvement in fitness ratings (a classification measured of cardiovascular fitness) suggests that one individual in four improved his cardiovascular fitness enough to raise his rating one class—from average to good, which translates a mean difference of about 7 mL O_2/kg/min (a much more significant change for an individual).

Surprisingly, attendance at fitness classes did not make any difference in the fitness improvement; in fact, those not going to any classes improved somewhat more than those going to four to six classes. The classes were basic ones, and those in much better or much worse shape might not have wished to continue; however, those discontinuing or not attending classes were not significantly different from those continuing.

It is unlikely there would be improvement in two bicycle ergometer measurements eight months apart without an accompanying overall change in activity level. According to Astrand and Rodahl,[4] the test is quite reliable. Improvement comes not from experience with the testing, but through an increased activity level. Reported exercise habits also improved significantly during the period. It should be noted that the second test was done long enough after the completion of classes (six months) to minimize any direct improvement in fitness derived from the classes themselves. These facts reinforce the subjective and objective fitness improvement and the lack of direct effect of classes.

The analysis of who attended classes indicates that those who did attend were slightly older, had less disruption in their lives, were more financially secure (middle class), and reported fewer components of coronary-prone behavior—competitiveness, time urgency, and so on. Perhaps the individuals who dropped out were more self-motivated and so became easily bored with the classes, while the others liked the social support and noncompetitive exercise. (There was no correlation between the coronary-prone behavior rating and the change in cardiovascular fitness.) Certainly the differences in the variables measured between class attendees and nonattendees do not appear to be enough to be able to predict who will take classes; nor can the variables measured predict who will change.

As it does not appear to be affected by classes, the improvement in fitness results from other factors. The bicycle ergometry and the communication of the test findings to the individuals are the major remaining interventions. Unfortunately, it is impossible to use a control group to ascertain cardiovascular fitness without bicycle ergometry or similar tests. Other possibilities for the improvement include a high level of motivation in this group as well as participation in a research study (Hawthorne effect). This group was self-selected, although participants were recruited from all walks of life. The results cannot be generalized to other, presumably less motivated, populations. However, the authors lean toward the conclusion that a simple office fitness evaluation technique, along with subsequent individual patient education, can be an important factor in motivation for exercise and deserves further study.

References

1. Taylor HL: Physical activity: Is it still a risk factor? Prev Med 1983; 12:20-24
2. Cohen LS, Mock MB, Ringqvist I: Physical Conditioning and Cardiovascular Rehabilitation. New York, John Wiley & Sons, 1981
3. Peters RK, Cady LD Jr, Bischoff DP: Physical fitness and subsequent myocardial infarction in health workers. JAMA 1983; 249:3052-3056
4. Hall JH, Zwemer JD: Prospective Medicine. Indianapolis, Methodist Hospital of Indiana, 1979
5. Holmes TH, Rahe RM: The social readjustment rating scale. J Psychosom Res 1967; 21:213-218
6. Astrand PO, Rodahl K: Textbook of Work Physiology. New York, McGraw-Hill, 1970, pp 615-626
7. Exercise Testing and Training of Apparently Healthy Individuals. A Handbook for Physicians. Dallas, American Heart Association, 1972