

A Microcomputer-Assisted Exercise Prescription for Use by Family Physicians

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Family physicians frequently advise their patients on choosing and implementing regular programs of exercise. This report describes techniques of submaximal aerobic fitness assessment and microcomputer-assisted exercise prescription suitable for use in office-based practice. A submaximal bench step test is used for the estimation of aerobic fitness. A BASIC program operating on a Macintosh provides calculations of fitness levels and produces an individualized exercise prescription. While obviously not suitable for every patient, this approach is practical for young to middle-aged low-risk individuals interested in beginning regular training programs.

Increased evidence suggests that regular physical activity produces substantial physical and emotional benefits.¹⁻³ In fact, the US Public Health Service has included physical fitness and exercise as one of the 15 areas of greatest importance for improving the health of the public.^{4,5} Advertising in the mass media promotes the glamour and desirability of physical fitness. Unfortunately the otherwise healthy adult who does not have a regular program of physical exercise may have unrealistic goals or exceed his or her own physical capacity and even incur injury. Family physicians are often called upon to advise their patients on the choice of exercise programs and the patient's suitability to begin such a program.⁶ There is a need for formal training in the area of exercise prescription and for the development of methods of physical fitness assessment that can be utilized in the physician's office. Some specific guidance is already available.⁷⁻¹²

AEROBIC FITNESS ASSESSMENT

The initial step in recommending an exercise regimen is to assess the patient's current state of physical fitness and limitations. Recommendations for medical screening and evaluation are available,¹³ and more recently a comprehensive text has been published.¹⁴ Ideally every patient

should have a limited physical examination and undergo aerobic fitness testing prior to beginning a training program. This exercise testing is primarily for the purpose of assessing the degree of aerobic fitness and not, in general, for the diagnosis or screening of coronary heart disease. A baseline assessment of aerobic fitness provides information useful in setting the appropriate exercise intensity that will provide for an aerobic training effect. In addition, the baseline assessment can be used to measure subsequent improvement or lack of improvement in aerobic capacity after an exercise program has been undertaken. Formal exercise testing using a treadmill or bicycle ergometer is often not realistic, primarily because of the cost and impracticality of performing graded exercise testing, or stress testing, on every primary care patient.

This paper is not concerned with diagnostic exercise testing on persons with known coronary artery disease or persons at high risk for such disease. Comments are directed only to the evaluation of the asymptomatic, middle-aged man or woman without primary coronary risk factors. Men aged over 40 to 45 years and women aged over 50 to 55 years may be candidates for graded exercise testing based upon age alone.¹⁵ A joint committee of the American College of Cardiology and the American Heart Association has recently published guidelines¹⁶ relevant to the use of exercise testing in the diagnosis and treatment of cardiovascular disease.

THE PROGRAM

The procedure chosen for aerobic fitness assessment is a recently described and validated submaximal bench step

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TABLE 1. SUBMAXIMAL BENCH STEP TEST PROTOCOL

Stage*	Cadence** Rate/min	Time (min)	Estimated METS
1	68	3	4
Rest	—	1	—
2	104	3	7
Rest	—	1	—
3	136	3	10

* Protocol terminated when heart rate reaches 65% of predicted maximum (see text)
 ** Each beat represents a foot movement. Four foot movements are required to completely step onto the box and down onto the floor.
 Note: Modified from Gibson et al¹¹

test.¹⁷ The advantages of this technique include simplicity of administration and a high correlation between the estimated maximal oxygen uptake and directly measured maximal oxygen intake in a graded exercise test protocol. Patients are asked to step on and off a 10-in.-high box for three minutes per stage. Pulse rates are recorded during the last 30 seconds of each stage. A one-minute rest period is allowed between stages. The step test is continued for a maximum of three stages or until the pulse rate reaches 65 percent of the predicted maximum, based upon the formula 220 minus the age in years. Stepping cadence is maintained using a cassette tape recording of computer-generated tones at the appropriate rate.

Table 1 contains a summary of the step-test protocol. Blood pressure at each stage and blood pressure and pulse rate at one minute and three minutes following the exercise test are also recorded, although these data are not included in the later calculations. An estimated maximal oxygen uptake in milliliters per kilogram per minute and in metabolic equivalents (METs*) can be calculated from the step-test data,¹⁷ based upon the highest stage completed and the corresponding pulse rate. The total time required for this test is about 15 minutes. Blood pressure measurements during the exercise test are not mandatory, as the pressure readings do not influence the estimation of aerobic fitness. Blood pressure measurements, if recorded, may provide additional data relevant to a patient's fitness. Only one staff person is required to conduct the exercise test. This individual monitors the heart rate, times the stages, and can help provide cadence and encouragement. A pulse rate monitor attached to the patient's chest, arm, or hand, depending on the model, adds convenience but is not a necessity.

This method is limited in that the resultant maximum oxygen consumption is an estimate, inasmuch as the pa-

*One MET is equivalent to an oxygen intake (V_{O_2}) of 3.5 mL · kg⁻¹ · min⁻¹ and represents the typical energy expenditure at rest.

Patient Information

Name:

Sex (M or F):

Age (in years):

Weight (in kg):

Stage	Blood Pressure	Heart Rate
Resting	<input type="text" value="128/75"/>	<input type="text" value="76"/>
1	<input type="text" value="130/70"/>	<input type="text" value="110"/>
2	<input type="text" value="145/70"/>	<input type="text" value="139"/>
3	<input type="text"/>	<input type="text"/>
Post 1 min	<input type="text" value="140/74"/>	<input type="text" value="120"/>
Post 3 min	<input type="text" value="125/75"/>	<input type="text" value="86"/>

Figure 1. Patient information window for recording information collected during exercise test

tient is not asked to exercise to a maximum effort. In addition, this exercise test is not a screening tool for coronary heart disease and should not be used as such.

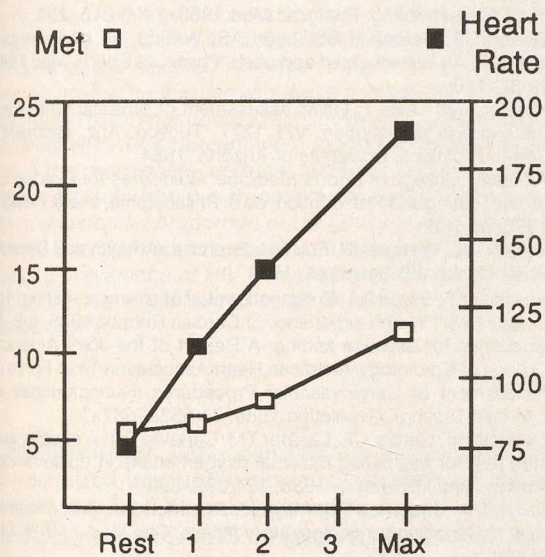
The microcomputer program* for exercise prescription was written using Microsoft BASIC version 2.0 implemented on an Apple Macintosh. The microcomputer was chosen because of its superior graphics capability. Step-test data are entered in one window (Figure 1) with allowance made for editing the data until correct. Once the data are complete, a second menu selection (Figure 2) leads to all calculations and a graphic display showing heart rate and MET levels for completed stages and the predicted maxima for each (Figure 3). An overall level of fitness is reported, based upon the estimated maximal oxygen intake and recommendations of the Canadian Home Fitness Trial.¹⁸ In the example shown in Figure 3, the patient meets the criteria for discontinuing the step test during stage 2; that is, his pulse rate of 139 was greater than 65 percent of his predicted maximal pulse rate (220 - 36 years = 184, 65 percent of which is 120). Stage 3 is therefore omitted. A final menu selection produces a printed exercise prescription, which includes a summary

*Copies of the program listing can be obtained from the first author upon request.

Exercise

- Patient Information
- Calculate VO2 Max
- Printout Exercise Prescription
- Quit to BASIC
- Quit to Desktop

Figure 2. Program options are presented in a menu format during execution



Overall level of fitness is **AVERAGE**

Figure 3. Heart rate and estimated oxygen requirements for each stage of the exercise test are presented in a chart format

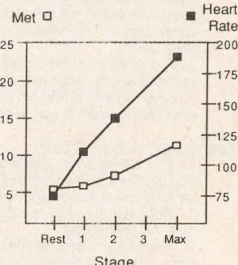
Exercise Prescription

Prepared for: John Doe, male aged 36 years
Date: 12-23-87

Your aerobic fitness has been assessed at our office using a submaximal bench step-test. This test is not a diagnostic maneuver and cannot predict a high or low risk for cardiac disease. It is used to provide a general assessment of your level of physical fitness, and is part of the overall medical evaluation performed by your physician through analysis of your risk factors and other tests. Your physician will explain the values obtained to you.

SUMMARY OF AEROBIC FITNESS TEST

Stage	Blood Pressure	Heart Rate	VO2 ml/kg/min
Resting	128/75	75	3.5
1	130/70	110	16
2	145/70	139	25
3			
Maximum Predicted		187	63
Recovery -1 min	140/74	120	3.5
Recovery -3 min	125/75	86	3.5



Overall level of fitness is **AVERAGE**

RECOMMENDED CONDITIONING EXERCISES:

Running 8 MPH

TARGET ZONE FOR HEART RATE DURING CONDITIONING EXERCISE:

112 to 150 beats per minute or
19 to 25 beats in 10 seconds

Figure 4. A sample of the individualized exercise prescription

heart rate is estimated from the formula 220 minus the age in years, although a possible sex-related bias may cause an underestimation for men.¹⁹

SUMMARY

The microcomputer-based exercise prescription program described offers the advantages of simplicity of administration and operation and individualization for each patient. The exercise prescription becomes a framework around which the family physician can discuss a particular patient's physical fitness program. The record of performance in the submaximal exercise test can be maintained as a baseline for comparison with future assessments. It is important to understand that this approach is not for every patient. The submaximal exercise protocol is neither diagnostic nor prognostic for coronary artery disease. Patients who are above the age limits discussed earlier or who have primary risk factors may require more sophis-

of the fitness test and a recommended exercise protocol (Figure 4). A copy of the exercise prescription can be placed in the patient's chart. This printout is useful for future evaluations. An accompanying instruction sheet offers general advice on physical exercise (Figure 5). Individual exercises are chosen based upon 70 percent of the predicted maximal oxygen intake, using a table of MET levels required by various exercises.^{11,14} Maximum

General Advice About Exercise

Regular aerobic exercise is beneficial in controlling weight, reducing stress, and protecting you from heart disease. You have received an individualized exercise prescription with our recommendation for appropriate types of exercise. Also, there is a guideline as to the intensity of the exercise as measured by your pulse rate while performing the exercise. The following additional points need to be mentioned:

Frequency: Begin exercising three times a week. Gradually increase the frequency to 4-5 times per week. In general, it offers no advantage to exercise more often than 4-5 times per week.

Routine:

1. Warm up with 5-10 minutes of stretching, bending movements, or with the recommended conditioning exercise at a very slow pace.
2. The period of conditioning exercise, about 15 minutes initially, gradually increasing to about 30 minutes of continuous activity. Aim for a pulse rate within the target zone. If your pulse rate is too slow, increase speed slightly. If your pulse rate is too high or if you feel over exerted, slow down.
3. A cool-down of 5-10 minutes with stretching, bending, or walking. If your pulse rate 5 minutes after finishing the condition exercise, e.g. running, is over 120 beats per minute or 20 beats in 10 seconds, you are exercising too hard and need to slow down.

Important points to remember:

1. Exercise does not need to cause pain to be beneficial.
2. Go slowly at first; there is no such thing as instant fitness. There will be a period of four to six weeks before results are evident.
3. Recruit a friend or spouse to exercise with you and exercise in your own neighborhood.
4. If your training schedule is interrupted for more than 4-5 consecutive days, resume exercising at a lower intensity.
5. If walking or jogging, wear identification.

Relax - enjoy the time you spend making your body healthier

Figure 5. General guidelines on exercise accompany the individual exercise prescription

ticated exercise testing under medical supervision; but for a large number of young to middle-aged asymptomatic patients interested in beginning a physical training program, this approach is practical.

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