SUBMAXIMAL BENCH STEP TEST

EQUIPMENT

- Step—41.3 cm (16.25 in) high for men and women
- Metronome
- Stopwatch
- Individual data sheets

STEP BOX

Stair stepping is an easy and inexpensive alternative to using an exercise ergometer, since it enables you to easily calculate work and power. You can make a step box from two-by-fours and plywood. A longer bench allows several subjects to be tested at the same time. Some protocols call for different heights for men and women. In this case, the box or bench can be made in a way that allows it to be simply rotated from the male height to the female height. You can also use a supplemental step to shorten the step for women. Take care to measure accurately, since any error in step height modifies the amount of work accomplished and thus the metabolic response. Work and power during step testing can easily be calculated knowing body weight and the step rate and height.

$$\text{Work (kg} \cdot \text{m)} = \text{body weight} \times \text{distance} \cdot \text{step}^{-1} \times \text{steps} \cdot \text{min}^{-1} \times \text{min}$$

$$\text{Power (kg} \cdot \text{m} \cdot \text{min}^{-1}) = \text{body weight} \times \text{distance} \cdot \text{step}^{-1} \times \text{steps} \cdot \text{min}^{-1}$$

QUEENS COLLEGE STEP TEST

Step testing is convenient for both indoor and outdoor settings and for use with either one person or multiple people. Step tests come in many types, and perhaps one of the most popular is the Queens College Step Test (3, 4). Like most step tests, this test uses the measurement of recovery heart rate to estimate the subject's level of fitness (recall that heart rate returns to resting values more quickly following submaximal exercise in fitter people than it does in those who are less fit). Many of the available step tests were developed to estimate the fitness necessary for firefighting and other physically demanding occupations, but they are no longer used for occupational screening because participants sometimes used drugs (e.g., beta-blockers) to lower their heart rate and thus inflate their apparent fitness (you would not have been able to get one of these jobs unless your estimated $\dot{V}O_2$max was greater than 45 $ml \cdot kg^{-1} \cdot min^{-1}$ [8]). The test remains useful, however, especially for groups of individuals participating in an exercise program.

Step 1: Since the accuracy of the test relies on the heart rate response, try to eliminate factors that might alter this outcome measure. Ideally, subjects will have avoided exercise for the previous 24 h, fasted for at least 2 h, and avoided the use of foods and drugs that alter heart rate (e.g., coffee, soda, energy drinks, diet pills, beta-blockers).

Step 2: Pair up with another student and find an appropriate space in which to conduct the test. Either you or your partner will start as the tester, and the other person will serve as the subject. You will then reverse these roles.

Step 3: Have the subject sit on the bench step and rest for 3 min, after which the tester should palpate the radial pulse for 15 s and record the resting HR.

Step 4: Set the metronome at 88 beats $\cdot$ min^{-1} to allow the subject to make contact with a foot on each beep in an up-up-down-down manner. This cadence results in the necessary 22 steps $\cdot$ min^{-1} necessary for the test on women. For men, set the metronome at 96 beats $\cdot$ min^{-1} and thus 24 steps $\cdot$ min^{-1}.

Step 5: When the subject is ready, begin the 3 min test and start the stopwatch (see figure 7.3*a*).

Step 6: To avoid muscle fatigue, the subject should switch the leading leg at least once during the test.

Step 7: After exactly 3 min of stepping, the subject should stop. The tester should palpate for the radial pulse (see figure 7.3*b*). Begin counting at exactly 3:05 and count for 15 s (i.e., to 3:20).

Step 8: Calculate the predicted $\dot{V}O_2max$ by using the recovery HR in the equations below, where HR is beats $\cdot$ min^{-1}.

Men: $\dot{V}O_2max$ (ml $\cdot$ kg^{-1} $\cdot$ min^{-1}) = 111.33 - (0.42 × HR)

Women: $\dot{V}O_2max$ (ml $\cdot$ kg^{-1} $\cdot$ min^{-1}) = 65.81 - (0.1847 × HR)

Step 9: Record your own data on the individual data sheet and on the group data sheet. Include your percentile rank from table 7.1.

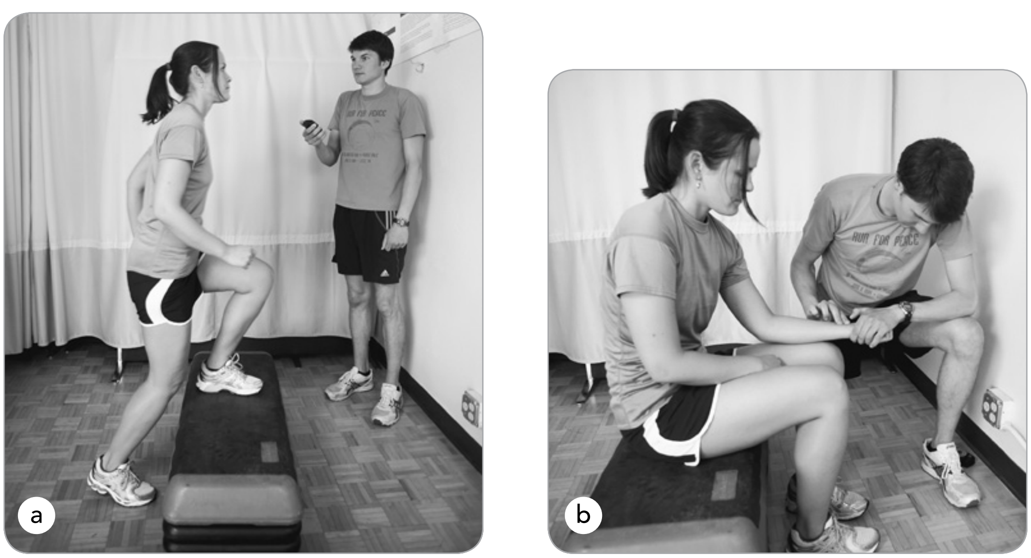

Figure 7.3 Step test: *(a)* starting position and *(b)* taking the pulse at the conclusion of the test.

Table 7.1 Percentile Values for Maximal Aerobic Power ($\dot{V}O_2max$, $ml \cdot kg^{-1} \cdot min^{-1}$) by Age and Sex

%	20-29 y	30-39 y	40-49 y	50-59 y	60-69 y	70-79 y	Rank
Men							
99	61.2	58.3	57.0	54.3	51.1	49.7	Superior
95	56.2	54.3	52.9	49.7	46.1	42.4	
90	54.0	52.5	51.1	46.8	43.2	39.5	Excellent
85	52.5	50.7	48.5	44.6	41.0	38.1	
80	51.1	47.5	46.8	43.3	39.5	36.0	
75	49.2	47.5	45.4	41.8	38.1	34.4	Good
70	48.2	46.8	44.2	41.0	36.7	33.0	
65	46.8	45.3	43.9	39.5	35.9	32.3	
60	45.7	44.4	42.4	38.3	35.0	30.9	
55	45.3	43.9	41.0	38.1	33.9	30.2	Fair
50	43.9	42.4	40.4	36.7	33.1	29.4	
45	43.1	41.4	39.5	36.6	32.3	28.5	
40	42.2	41.0	38.4	35.2	31.4	28.0	
35	41.0	39.5	37.6	33.9	30.6	27.1	Poor
30	40.3	38.5	36.7	33.2	29.4	26.0	
25	39.5	37.6	35.7	32.3	28.7	25.1	
20	38.1	36.7	34.6	31.1	27.4	23.7	
15	36.7	35.2	33.4	29.8	25.9	22.2	Very Poor
10	35.2	33.8	31.8	28.4	24.1	20.8	
5	32.3	31.1	29.4	25.8	22.1	19.3	
1	26.6	26.6	25.1	21.3	18.6	17.9	
Women							
99	55.0	52.5	51.1	45.3	42.4	42.4	Superior
95	50.2	46.9	45.2	39.9	36.9	36.7	
90	47.5	44.7	42.4	38.1	34.6	33.5	Excellent
85	45.3	42.5	40.0	36.7	33.0	32.0	
80	44.0	41.0	38.9	35.2	32.3	30.2	
75	43.4	40.3	38.1	34.1	31.0	29.4	Good
70	41.1	38.8	36.7	32.9	30.2	28.4	
65	40.6	38.1	35.6	32.3	29.4	27.6	
60	39.5	36.7	35.1	31.4	29.1	26.6	
55	38.1	36.7	33.8	30.9	28.3	26.0	Fair
50	37.4	35.2	33.3	30.2	27.5	25.1	
45	36.7	34.5	32.3	29.4	26.9	24.6	
40	35.5	33.8	31.6	28.7	26.6	23.8	
35	34.6	32.4	30.9	28.0	25.4	22.9	Poor
30	33.8	32.3	29.7	27.3	24.9	22.2	
25	32.4	30.9	29.4	26.6	24.2	21.9	
20	31.6	29.9	28.0	25.5	23.7	21.2	
15	30.5	28.9	26.7	24.6	22.8	20.8	Very Poor
10	29.4	27.4	25.6	23.7	21.7	19.3	
5	26.4	25.5	24.1	21.9	20.1	17.9	
1	22.6	22.7	20.8	19.3	18.1	16.4	

Adapted, by permission, from Cooper Institute, *Physical fitness assessments and norms for adults and law enforcement* (Dallas, TX: The Cooper Institute), 24. For more information: www.cooperinstitute.org.

QUESTION SET 7.1

1. Complete the individual and group data sheets with the data collected in today's lab.
2. If the step test were being used for occupational screening and required a fitness score of 45 $ml \cdot kg^{-1} \cdot min^{-1}$, how many of your labmates would be able to get the job?
3. Do you think that using a fitness score as a screening tool for physically taxing occupations is fair to all participants? Why or why not? If yes, which occupations? Why?
4. In what other settings do you see a step test being useful? Why?

Find the case studies for this laboratory online at www.HumanKinetics.com/LaboratoryManualForExercisePhysiology.

Laboratory Activity 7.1 Individual Data Sheet

Name or ID number: ________________________________ Date: ____________

Tester: ____ Time: ____________

Sex: M / F (circle one) Age: __________ y Height: __________ in. __________ cm

Temperature: ________ °F __________ °C Weight: ____________ lb __________ kg

Barometric pressure: ____________ mmHg Relative humidity: ____________________ %

Raw Data

Age-predicted HRmax: ________ beats · min^{-1}

Resting 15 s pulse: ________ Resting HR: ________ beats · min^{-1}

3:05 to 3:20 pulse count: ________ Recovery HR: ________ beats · min^{-1}

$\dot{V}O_2$max Determination

Men

$$111.33 - (0.42 \times \underset{\text{Recovery HR (beats}\cdot\text{min}^{-1})}{\underline{\hspace{4cm}}}) = \underset{\dot{V}O_2\text{max (ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1})}{\underline{\hspace{4cm}}}$$

Women

$$65.81 - (0.1847 \times \underset{\text{Recovery HR (beats}\cdot\text{min}^{-1})}{\underline{\hspace{4cm}}}) = \underset{\dot{V}O_2\text{max (ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1})}{\underline{\hspace{4cm}}}$$

Percentile rank: ________

$\dot{V}O_2$max classification: ________