

## The Single Stage Treadmill Walking Test (Ebbeling et al.1991).

The single stage treadmill walking test is a submaximal aerobic fitness test that estimates VO<sub>2</sub> max. It is suitable for low risk, apparently healthy, non-athletic adults 20-59 years of age. The walking pace required throughout the test also makes it appropriate for participants who experience problems such as knee pain when exercising at a jogging pace. The test can be administered to moderate sized groups of participants with low to moderate fitness levels and requires only a treadmill and a HR monitor.

### Protocol:

The walking speed for the test is individually determined based on the participant's gender, age, and fitness level

1. Estimate the participant's age-predicted HRmax (220-age) \_\_\_\_\_ bpm then calculate; 50% \_\_\_\_\_ bpm and 70% \_\_\_\_\_ bpm of his/her HRmax.
2. Have the participant warm-up for 4 minutes at a 0% grade and a walking speed that brings the HR to between 50% and 70% of his/her HRmax. (The recommended walking speed is from 3.4 to 4 mph). If the HR is not in this range after the first minute, adjust the speed accordingly.
3. Following the warm-up, keep the participant at the same speed for an additional 4 minutes at a grade of 5%, then record the steady-state HR (SS HR) from the average of the final 30 sec of the last two minutes at the 5% grade. (Note; to achieve steady-state, the HR from the last two minutes must not differ by more than 5 bpm. If the HR differs by more than 5 bpm, extend the test by an additional minute and record the SS HR from the new final two minutes.) SS HR = \_\_\_\_\_ bpm.
4. Enter this SS HR into the equation below to estimate VO<sub>2</sub> max (ml·kg<sup>-1</sup>·min<sup>-1</sup>).
5. Allow the participant to cool down at a slow walk and 0% grade for 2-5 min.

Estimated VO<sub>2</sub> max (ml·kg<sup>-1</sup>·min<sup>-1</sup>) =

15.1 +21.8 (speed in mph) - 0.327 (SS HR in bpm) - 0.263 (speed x age in years) + 0.00504 (SS HR in bpm x age in years) + 5.98 (gender; female = 0, male = 1)

15.1 +21.8 (\_\_\_\_\_) - 0.327 (\_\_\_\_\_) - 0.263 (\_\_\_\_X \_\_\_\_\_) + 0.00504 (\_\_\_\_ X \_\_\_\_\_) + 5.98 (\_\_\_\_\_)

= \_\_\_\_\_ (ml·kg<sup>-1</sup>·min<sup>-1</sup>)

**Example:** A 30 year old male walked at 3.6 mph at a grade of 5 % with a SS HR of 159 bpm. (HRmax = 190 bpm; 50% HRmax = 95 bpm; 70 % HRmax = 133 bpm):

Estimated VO<sub>2</sub> max =

15.1 +21.8 (3.6) - 0.327 (159) - 0.263 (3.6 x 30) + 0.00504 (159 x 30) + 5.98 (1) = 43.2 (ml·kg<sup>-1</sup>·min<sup>-1</sup>)

To obtain the Health Benefit Zone Rating from Figure 7-12, multiply the estimated VO<sub>2</sub> max by10.

**Health Benefit Zone Rating: Good**

## The YMCA Cycle Ergometer Submaximal Test (Golding et al.1989)

This submaximal exercise test uses a cycle ergometer to estimate  $\text{VO}_2$  max for men and women. The protocol uses three or more consecutive 3-min workloads that are designed to raise the HR to between 110 bpm and a HR that is near 85% of the age-predicted HRmax for two consecutive workloads.

The starting pedaling rate is 50 rpm and the initial workload is  $150 \text{ kpm}\cdot\text{min}^{-1}$  (25W). The HR during the last minute of the first workload determines the loading sequence of subsequent workloads. For example if the HR is 80-89 bpm or 90-100 bpm, the respective workloads for the second stage would be 600 or 450  $\text{kpm}\cdot\text{min}^{-1}$  respectively. Note: One watt (W) = 6  $\text{kpm}\cdot\text{min}^{-1}$ . The subsequent workloads are then set according to the progression in each column:

1 <sup>st</sup> WorkLoad	150 $\text{kpm}\cdot\text{min}^{-1}$ ( 0.5 kp) (25 W)			
	HR < 80 bpm	HR 80-89 bpm	HR 90-100 bpm	HR > 100 bpm
2 <sup>nd</sup> WorkLoad	750 $\text{kpm}\cdot\text{min}^{-1}$ (2.5 kp) (125 W)	600 $\text{kpm}\cdot\text{min}^{-1}$ (2.0 kp) (100 W)	450 $\text{kpm}\cdot\text{min}^{-1}$ (1.5 kp) (75 W)	300 $\text{kpm}\cdot\text{min}^{-1}$ (1.0 kp) (50 W)
3 <sup>rd</sup> WorkLoad	900 $\text{kpm}\cdot\text{min}^{-1}$ (3.0 kp) (150 W)	750 $\text{kpm}\cdot\text{min}^{-1}$ (2.5 kp) (125 W)	600 $\text{kpm}\cdot\text{min}^{-1}$ (2.0 kp) (100 W)	450 $\text{kpm}\cdot\text{min}^{-1}$ (1.5 kp) (75 W)
4 <sup>th</sup> WorkLoad	1050 $\text{kpm}\cdot\text{min}^{-1}$ (3.5 kp) (175 W)	900 $\text{kpm}\cdot\text{min}^{-1}$ (3.0 kp) (150 W)	750 $\text{kpm}\cdot\text{min}^{-1}$ (2.5 kp) (125 W)	600 $\text{kpm}\cdot\text{min}^{-1}$ (2.0 kp) (100 W)
etc	etc	etc	etc	etc

### Protocol:

1. Estimate the participant's age-predicted HRmax ( $220 - \text{age}$ ) \_\_\_\_\_ then calculate 85% \_\_\_\_\_ of HRmax.
2. Set the first work load at 150 kgm/min (0.5 kp).
3. If the HR in the third minute is;
  - < 80 bpm , set the second load at 750 kgm (2.5 kp);
  - 80-89 bpm, set the second load at 600 kgm (2.0 kp);
  - 90-100 bpm, set the second load at 450 kgm (1.5 kp);
  - 100 bpm set the second load at 300 kgm (1.0 kp)
4. Set the third and fourth (if required) workloads according to the progression in the columns. Measure the HR during the last 30 seconds of minutes 2 and 3 at each workload. If these HR differ by more than 5 bpm, extend the workload an extra minute until the HR stabilizes. The test is terminated when the participant's steady-state HR is within 10 beats of 85% HRmax.

HR at Second Last Workload ( $\text{HR}_1$ ) = \_\_\_\_\_ (bpm)

HR at Last Workload ( $\text{HR}_2$ ) = \_\_\_\_\_ (bpm)

5. Calculate the oxygen cost (VO<sub>2</sub>) of the last two workloads using the equation:

$$\text{VO}_2 \text{ (ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}\text{)} = [(\text{Watts } \textit{divided by} \text{ Body mass (kg)} \times 10.8)] + 3.5 + 3.5$$

$$\text{VO}_2 \text{ at } \underline{\text{Second Last Workload}} \text{ (SM}_1\text{)} = [(\text{_____}) \textit{ divided by} (\text{_____}) \times 10.8] + 3.5 + 3.5$$

$$= \text{_____ (ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}\text{)}$$

$$\text{VO}_2 \text{ at } \underline{\text{Last Workload}} \text{ (SM}_2\text{)} = [(\text{_____}) \textit{ divided by} (\text{_____}) \times 10.8] + 3.5 + 3.5$$

$$= \text{_____ (ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}\text{)}$$

6. From these two oxygen cost (VO<sub>2</sub>) values estimate the VO<sub>2</sub> max (ml·kg<sup>-1</sup>·min<sup>-1</sup>) using the equations for the multistage model to calculate the slope of the line based on the HR response to the last two workloads.

$$\text{Slope (b)} = [(\text{SM}_2 - \text{SM}_1)] \textit{ divided by} [(\text{HR}_2 - \text{HR}_1)] = \text{_____}$$

$$\text{VO}_2 \text{ max} = \text{SM}_2 + \text{b (HR max - HR}_2\text{)} = \text{_____ (ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}\text{)}$$

**Example:** A 20 year old female who weighed 62 kg completed the YMCA Cycle Ergometer Test. (Age-predicted HRmax = 200 bpm; 85 % of HRmax = 170 bpm). Following are her test results:

Workload	kpm·min <sup>-1</sup>	Watts	Time	HR (bpm)
1	150	25	0 - 1	86
			1 - 2	90
			2 - 3	92
2	450	75	3 - 4	120
			4 - 5	135
			5 - 6	139
3	600	100	6 - 7	151
			7 - 8	159
			8 - 9	163

$$\text{HR}_1 = (135 + 139)/2 = 137 \text{ bpm}$$

$$\text{HR}_2 = (159 + 163)/2 = 161 \text{ bpm}$$

$$\text{SM}_1 = [(75/62) \times 10.8] + 3.5 + 3.5 = 20.06 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$$

$$\text{SM}_2 = [(100/62) \times 10.8] + 3.5 + 3.5 = 24.42 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$$

$$\text{Slope (b)} = [(\text{SM}_2 - \text{SM}_1)] \textit{ divided by} [(\text{HR}_2 - \text{HR}_1)] = [(24.42 - 20.06)] \textit{ divided by} [(161 - 137)] = .182$$

$$\begin{aligned} \text{Estimated VO}_2 \text{ max} &= \text{SM}_2 + \text{b (HR max - HR}_2\text{)} = 24.42 + .182 (200 - 161) \\ &= \underline{31.5} \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1} \end{aligned}$$

To obtain the Health Benefit Zone Rating from Figure 7-12, multiply the estimated VO<sub>2</sub> max by 10.

**Health Benefit Zone Rating:** Needs Improvement