

Bruce treadmill test protocol

The Bruce treadmill test protocol was designed in 1963 by Robert. A. Bruce, MD, as non-invasive test to assess patients with suspected heart disease. In a clinical setting, the Bruce treadmill test is sometimes called a [stress test](#) or exercise tolerance test.

Today, the Bruce Protocol is also one common method for estimating [VO2 max](#) in athletes. VO2 max, or maximal oxygen uptake, is one factor that can determine an athlete's capacity to perform sustained exercise and is linked to aerobic endurance. VO2 max refers to the maximum amount of oxygen that an individual can utilize during intense or maximal exercise. It is measured as "milliliters of oxygen used in one minute per kilogram of body weight" (ml/kg/min).

The Bruce Treadmill Test is an indirect test that estimates VO2 max using a formula rather than using direct measurements that require the collection and measurement of the volume and oxygen concentration of inhaled and exhaled air. This determines how much oxygen the athlete is using.

The Bruce Protocol

The Bruce Protocol is a maximal exercise test where the athlete works to complete exhaustion as the treadmill speed and incline is increased every three minutes (See chart). The length of time on the treadmill is the test score and can be used to estimate the VO2 max value. During the test, heart rate, blood pressure and [ratings of perceived exertion](#) are often also collected.

Bruce Treadmill Test Stages

Stage 1 = 1.7 mph at 10% Grade
Stage 2 = 2.5 mph at 12% Grade
Stage 3 = 3.4 mph at 14% Grade
Stage 4 = 4.2 mph at 16% Grade
Stage 5 = 5.0 mph at 18% Grade
Stage 6 = 5.5 mph at 20% Grade
Stage 7 = 6.0 mph at 22% Grade
Stage 8 = 6.5 mph at 24% Grade
Stage 9 = 7.0 mph at 26% Grade

The Bruce Protocol Formula for Estimating VO2 Max

- For Men $VO_2 \text{ max} = 14.8 - (1.379 \times T) + (0.451 \times T^2) - (0.012 \times T^3)$
- For Women $VO_2 \text{ max} = 4.38 \times T - 3.9$
- T = Total time on the treadmill measured as a fraction of a minute (ie: A test time of 9 minutes 30 seconds would be written as T=9.5).

Because this is a maximal exercise test, it should not be performed without a physician's approval and without reasonable safety accommodations and supervision.

Bruce Protocol Norms for Men

VO2 Max Norms for Men - Measured in ml/kg/min						
Age	Very Poor	Poor	Fair	Good	Excellent	Superior
13-19	<35.0	35.0-38.3	38.4-45.1	45.2-50.9	51.0-55.9	>55.9
20-29	<33.0	33.0-36.4	36.5-42.4	42.5-46.4	46.5-52.4	>52.4
30-39	<31.5	31.5-35.4	35.5-40.9	41.0-44.9	45.0-49.4	>49.4
40-49	<30.2	30.2-33.5	33.6-38.9	39.0-43.7	43.8-48.0	>48.0
50-59	<26.1	26.1-30.9	31.0-35.7	35.8-40.9	41.0-45.3	>45.3
60+	<20.5	20.5-26.0	26.1-32.2	32.3-36.4	36.5-44.2	>44.2

Also See: [VO2 Max Norms for Women](#)

VO2 Max Norms for Women

VO2 Max values for Women as measured in ml/kg/min						
Age	Very Poor	Poor	Fair	Good	Excellent	Superior
13-19	<25.0	25.0-30.9	31.0-34.9	35.0-38.9	39.0-41.9	>41.9
20-29	<23.6	23.6-28.9	29.0-32.9	33.0-36.9	37.0-41.0	>41.0
30-39	<22.8	22.8-26.9	27.0-31.4	31.5-35.6	35.7-40.0	>40.0
40-49	<21.0	21.0-24.4	24.5-28.9	29.0-32.8	32.9-36.9	>36.9
50-59	<20.2	20.2-22.7	22.8-26.9	27.0-31.4	31.5-35.7	>35.7
60+	<17.5	17.5-20.1	20.2-24.4	24.5-30.2	30.3-31.4	>31.4