

VO2 Max

Fitness can be measured by the volume of oxygen you can consume while exercising at your maximum capacity. **VO2 max is the maximum amount of oxygen in milliliters that one can use in one minute** per kilogram of body weight. As you increase the intensity of your workout, the amount of oxygen you consume increases. However, a point is reached where exercise intensity can continue to increase without a rise in oxygen consumption. That is your VO2 max.

VO2 max is one of the best predictors of longevity and lower risk of all-cause and disease-specific mortality, regardless of sex or race. Those who are fit have higher VO2 max values and can exercise more intensely than those who are not as well-conditioned. VO2 max is not a predictor of performance, but does indicate an individual might have great potential for endurance activities. Many factors, like lactate threshold, motivation, and mental toughness, determine performance. Two athletes might have the same VO2 max, but one may reach it at a faster speed than the other. The athlete who reaches their VO2 max at a faster speed will perform better in endurance activities like running, biking, and swimming.

You can increase your VO2 max by working out at an intensity that raises your heart rate to between 65% and 85% of its maximum for at least 20 minutes, three to five times a week. Although you can increase your VO2 max, it is largely determined by your genes. The average individual can increase their VO2 max by 5% - 20% with training. The largest increase ever recorded was 60%. For some individuals, training seems to make little difference in their VO2 max.

VO2 max decreases with age. The average rate of decline is about 1% per year after the age of 25. Training can slow the rate of decline, but it becomes less effective after the age of 50. Untrained females typically have a VO2 max of 20% - 25% lower than an untrained male. With elite athletes, this gap closes to about 10%. If you adjust for fat-free mass in elite athletes for males and females, the difference almost disappears, with both groups having a very similar VO2 max.

Why VO2 Max Varies for Women - VO2 max varies by the amount of body fat and muscle you have, since your heart is sending blood to this inactive tissue as well as your active muscles. Even if you are very fit, women have more essential body fat than men, and on average, less muscle. Women also usually have lower hemoglobin levels than men, meaning the same volume of blood is less able to carry oxygen to the tissues. They have less total blood volume overall, smaller hearts and lungs, and less cardiac output. While there are elite female athletes who have high VO2 max scores, the average woman is considered at a higher fitness level with a VO2 max score that is less than for men at that level.

Measuring an accurate VO2 max requires an all-out effort performed under strict protocol in a sports performance lab. An estimate can be obtained using many methods and then taking that data and entering it into a simple formula. A few of the most common tests for estimating VO2 max are the mile walk, mile run, 1.5-mile run, pacer test, and the 12-minute walk/run Cooper test. **If you are in shape, the Cooper Test and 1.5-mile run are the most accurate. If you are not in shape, then the mile or walked mile can be used.** Smartwatches can also give a good estimate of VO2 max, but all runs and devices are just estimates. The worst-case scenario is that these formulas are .90 accurate and usually around .95 accurate.

Cooper Test - 5% - 10% Margin of error

1.5 Mile - 5% - 10% Margin of error

20m Shuttle Run - 5% - 10% Margin of error

1 Mile Run Test - 8% - 12% Margin of error

1 Mile Walk Test - 8% - 14% Margin of error

Apple Watch VO2 - 5% - 10% Margin of error

How do you compare to the general population?

Female

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

Male

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

What is the VO2 max of elite athletes?

Athlete	Event	VO2 Max
Oskar Svendsen	Cycling	97.5
Espen Harald Bjerke	Cross country skier (Best finish 4 th place)	96.0
Greg LeMond	Cyclist (3-time winner of Tour de France)	92.5
John Ngugi	5 times world cross country champ	85.0
Dave Bedford	10 K World Record holder	85.0
Steve Prefontaine	1 mile in 3:54.6	84.4
Lance Armstrong	Cyclist (6-time winner of Tour de France)	84.0
Steve Scott	1 mile in 3:47	80.0
Bill Rodgers	Marathon runner (2:09:27) average 4:57 mile	78.5

Females

Joan Benoit	Marathon runner (2:24:52) average 5:31 mile	78.6
Bente Skari	Cross-country skier	76.6
Charlotte Kalla	Cross-country skier	74.0
Rosa Mota	Marathon runner (2:23:29) average 5:29 mile	67.2