



Understanding Health & Fitness Education Series 2b

Are you Aerobic Fit? Do you have good aerobic fitness?

Look at your Heart Rate

Low Resting Heart Rate and Faster Exercise Recovery Heart Rate are easy to measure signs of fitness

Heart rate

Heart rate is a quantitative measure of heart's work. At rest a healthy heart of an average individual beats approximately 70-100 beats per minute. A conditioned heart beats much less at rest, only 40 to 50 beats per minute or even less and less at workloads compared to someone who is unconditioned. Heart rate variability is a quality measure of heart's work. The lower the resting heart rate the higher the heart rate variability, and thus the better the quality of heart's functions. You can see yourself improving from exercise if your heart rate is lower at the same workloads that you were previously doing - it is a sign that you heart is more efficient. Another good sign of heart efficiency is if your recovery heart rate is quicker after exercise.

Fast Recovery Heart Rate is a good thing

Heart rate should be able to drop 12 beats within first minute of exercise recovery

Recovery Heart Rate

Your Recovery Heart Rate, the speed at which your heart rate returns to normal after exercise, can indicate how fit you are as well as a physical cardiac condition and the risk of certain diseases. For instance, according to the a study in the New England Journal of Medicine people whose heart rate recovery time is long are at a higher risk of death than people with shorter recovery times regardless of physical condition or other risk factors. The first minute of recovery is the most crucial. After exercise, your heart rate experiences an abrupt drop during the first minute. In this study a heart rate decrease of 12 beats or less in the first minute as abnormal. The study also reported that people with an abnormal decline in heart rate had a greater chance of mortality in the subsequent six years due to heart problems. Some suggest possible abnormality if less than or equal to 18 beats. Additionally the National Emergency Medicine Association suggests measuring heart rate recovery rates is one way to tell whether an exercise program is effective. People in better cardiovascular condition tend to have lower heart rates during peak exercise, and return to their resting heart rate more quickly after physical activity.

Subtract your 2-minute heart rate from the heart rate you took immediately after vigorous exercise. The faster your heart rate recovers (or slows down) after 2 minutes the fitter and healthier your heart. See if your 2 Minute Exercise Recovery is:

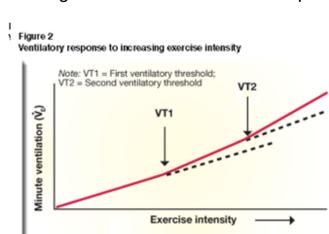
- Less than 22: Your biological age is slightly older than your calendar age.
- 22-52: Your biological age is about the same as your calendar age.
- 53-58: Your biological age is slightly younger than your calendar age.
- 59-65: Your biological age is moderately younger than your calendar age.
- 66 or more: Your biological age is a lot younger than your calendar age.

An easy way to judge exercise intensity and fitness is to use a RPE scale

Rated Perceived Exertion (RPE) is a subjective measure of how s person feels during physical activity. It is a great way to judge an activity. It is a total body observation of heart rate, increased breathing, and muscle fatigue. The RPE scale runs from 0 – 10. The numbers in the RPE chart relate to phrases used to rate how easy or difficult you find an activity (cardiovascular, strength, sport, etc). An easy way to understand if you are getting fitter after training for sometime is to evaluate if the same activity at the same level has the same RPE. If the RPE is lower you are getting fitter. Example: Walking at 4 mph at 5% grade was a RPE of 6 (DIFFICULT) and now is an RPE of 4 (SOMEWHAT HARD). This difference suggests that you are know fitter. Most people who are unfit do not have the tolerance to reach an RPE of 6.

RPE	Talking	Breathing	%VO Max
1	Normal	Normal	35
2	Normal	Normal	45
3 Moderate	Easy	Comfortable	55
4 VT-1 Somewhat Hard	Somewhat Difficult	Noticeable	65
5-VT2 Hard	Difficult	Deep but Steady	75
6-VT2	Difficult-Very Difficult-Lactic Acid	Deep and Somewhat Rapid	85
7-VT3	Very Difficult	Deep and Rapid	90
8-VT3	Extremely Difficult	Very Deep and Very	95
9	No	Very Deep and Very	98
10	Impossible	Breathlessness	100

MORE DETAILS about the RPE chart: WHAT IS THE DIFFERENCE BETWEEN VT1, VT2 AND VO2 MAX? VT1 is called the First Ventilatory Threshold. It is a marker of intensity that can be heard in a person's breathing at a point where lactate begins to accumulate in the blood. As the intensity of the exercise begins to increase, VT1 can be identified at the point where the breathing rate begins to increase. A person who is at VT1 can no longer talk comfortably while exercising. VT2 is called the Second Ventilatory Threshold. It is a higher marker of intensity that can also be heard in the person's breathing. At VT2, the lactate has quickly accumulated in the blood and the person needs to breath heavily and can no longer speak at this intensity. At this point, the exercise duration will also decrease due to the intensity level. This marker can also be called the anaerobic threshold or lactate threshold. VO2 max is the maximal consumption of oxygen. VT3 occurs just before VO2 Max. It is the maximum capacity of the body to transport and use oxygen during exercise and reflects a person's physical fitness. Measuring VO2 max is a laboratory procedure that requires equipment to measure the amount of oxygen consumed and the amount of carbon dioxide expelled. This test will take an individual to the absolute maximum exercise intensity that he or she can achieve; maximum heart rate can also be measured at this point. A reconditioned individual has a lower VO2max than someone who is conditioned. As an individual becomes more conditioned, his or her VO2 max will increase. A sedentary person will reach VT1, VT2 and VO2max at a much lower intensity of exercise than a more physically active person. For example, an extremely reconditioned person may reach his or her VT1 just while walking. Conversely, a more conditioned person will reach these markers at a higher intensity of exercise. For example, he or she may reach VT1 at a running speed of 6 miles per hour. TRAINING: You can use the RPE chart in your training. If you want to do high intensity interval training then you should work between VT-1 (somewhat difficult) and into VT-2 (difficult-very difficult) for the high portion of the interval. During the recovery portion work between a 2-3 RPE. You can see based on the chart when you are doing HIIT your breathing can become shallow and rapid.



Ratings of perceived exertion (RPE) correlate fairly well with this three-zone model:

- "moderate" to "somewhat hard" (RPE = 3–4, 0-to-10 scale) below VT1
- "hard" (RPE = 5–6, 0-to-10 scale) between VT1 and VT2
- "very hard" to "extremely hard" (RPE = 7–10, 0-to-10 scale) above VT2 VT3

Aerobic Exercise Tests

HOW IS AEROBIC (CARDIOVASCULAR) FITNESS MEASURED? Exercise Tests

Easy Effort

An easy way to determine how aerobically fit you are that I suggest to clients is just walk a mile as fast as you can. If you can walk a mile in 15 minutes (4 mph) you have a fair level of aerobic ability. Another easy way is to climb stairs fast. If you can climb four flights of stair fast (steps) without being out of breathe and not having to stop you have fair level of aerobic ability. Actual measurement of VO2 max outside of a clinical setting can be extremely risky, due to scope of practice issues, as well as the need for the emergency equipment required. In a health and fitness setting VO2 max is typically estimated through sub-maximal field tests (see below).

AEROBIC CAPACITY SUB-MAXIMAL FIELD TESTS

Moderate Effort

There are sub-maximal, field tests that allows an estimate of your aerobic fitness. You can do a three-minute step test (link), the Cooper 1.5 mile run test (link), or the Cooper 12 minute run test (link) without any complex equipment. I recommend the Cooper Test because it is a safe walking test. You can use your results to get an idea how fit you are by using the VO2 Max chart below.

AEROBIC CAPACITY MAXIMAL TESTS

Maximal Effort

The most accurate way to know your aerobic fitness is to get close to your maximal effort (arduous test). The higher the VO2 max score the higher the level of fitness. In actuality, there are very few people who can voluntarily work hard enough to reach their VO2 max. This is because VO2 max is exactly what it means maximal work output, just before complete physiological crash, and not voluntarily sustainable for any meaningful period of time. It is typically done in a laboratory setting on a treadmill or bike ergometer where respiratory gases are measured. According to the RPE chart it is a RPE of 10 (VT3). If you dare push yourself to that level take note of your heart rate (which is your max heart rate) and intensity of work (MET). It is an end point where you cannot do anymore. A MET is a (metabolic equivalent) unit used to estimate the metabolic cost of physical activity. The value of 1 MET is approximately equal to a person's resting energy expenditure. Most activities have MET values. An activity like walking is considered to be 4 METS because it requires an energy expenditure 4 times greater than that required at rest (see METS charts). So if you maxed out at 12 METS you have the VO2 max score of 42 ml/kg/min (1 MET=3.5 ml/kg/min so 12 METS = 42 ml/kg/min). For a 43 year old male that is a good score (see VO2 max chart).(Only attempt if your are very healthy - this is a close estimate) I typically perform VO2 Peak testing on my clients (see below).

VO2 PEAK FIELD TESTS

Hard Effort

I actually prefer having healthy people determine their VO2 peak, which is close to VO2 max. After several incremental stages I have them work to a near maximal level (VT2-VT3) which can be sustained for 3 minutes. It brings them to a point where the muscles burn and they cannot go to a higher level. From this achieved level an estimate of aerobic fitness can be determined by converting intensity (MPH, WATTS) to METs. A Stress Test or Graded Exercise Test is a type of VO2Peak test.

DETERMINING VO2 PEAK

To Determine your VO2 peak find out the MET value that you can sustain for 3 minutes after warming up and doing a few incremental stages. You can also do a standard treadmill protocol (see link) to determine your VO2 Peak. Most cardiovascular machines report MET values on their display or you can walk or run outside and use the chart below to determine your MET level. You can then determine your Cardiorespiratory Fitness by using the classification chart. Example a 50 year old female incrementally works up to her peak running speed of 5.0 mph and was able to sustain that for 3 minutes. She would have a peak MET value of 8.7. According to the chart she would have an above average Peak VO2.

Table 2. Classification of Cardiorespiratory Fitness by Age and Sex*

Age, y	Performance Group				Elite
	Low	Below Average	Above Average	High	
Women					
18-19	<10.0	10-11.0	11.1-12.9	13-14.9	≥15.0
20-29	<8.0	8.0-9.9	10-11.4	11.5-14.2	≥14.3
30-39	<7.7	7.7-9.3	9.4-10.8	10.9-13.6	≥13.7
40-49	<7.4	7.4-8.9	9.0-10.3	10.4-13.2	≥13.3
50-59	<7.0	7.0-8.0	8.1-9.9	10.0-12.9	≥13.0
60-69	<6.0	6.0-6.9	7.0-8.4	8.5-11.0	≥11.1
70-79	<5.0	5.0-5.9	6.0-6.9	7.0-9.9	≥10.0
≥80	<4.4	4.4-5.4	5.5-6.2	6.3-8.3	≥8.4
Men					
18-19	<10.8	10.8-12.9	13.0-13.9	14-16.2	≥16.3
20-29	<10.3	10.3-11.9	12.0-13.6	13.7-15.6	≥15.7
30-39	<10.0	10-11.1	11.2-12.9	13.0-14.9	≥15.0
40-49	<9.8	9.8-10.9	11.0-12.4	12.5-14.6	≥14.7
50-59	<8.2	8.2-9.9	10.0-11.3	11.4-13.9	≥14.0
60-69	<7.0	7.0-8.4	8.5-9.9	10.0-12.9	≥13.0
70-79	<6.0	6.0-6.9	7.0-8.4	8.5-11.4	≥11.5
≥80	<5.1	5.1-6.2	6.3-7.2	7.3-9.9	≥10.0

METS	ACTIVITY
2.5	Walking 2.0 mph
2.8	Walking 2.5 mph
3.3	Walking 3.0 mph
4	Walking 3.5 mph
4.5	Walking 3.7 mph
5	Walking 4.0 mph (15 min/mile)
6	Walking 4.5 mph (13 min/mile)
7	Jogging, general 4.5 mph (13 min/mile)
8.7	Running, 5 mph (12 min/mile)
9	Running, 5.2 mph (11.5 min/mile)
9.4	Running, 5.6 mph (11.0 min/mile)
10.2	Running, 6 mph (10 min/mile)
11.2	Running, 6.7 mph (9 min/mile)
11.5	Running, 7 mph (8.5 min/mile)
12.5	Running, 7.5 mph (8 min/mile)
13.5	Running, 8 mph (7.5 min/mile)
14.1	Running, 8.6 mph (7 min/mile)
15	Running, 9 mph (6.5 min/mile)
16	Running, 10 mph (6 min/mile)

* Ranges are given in increments of 0.1 metabolic equivalent equaling 3.5 ml/kg per minute of oxygen consumption (percentile range) is as follows: low (<25th percentile), below average (25th-49th percentile), above average (50th-74th percentile), high (75th-97.5th percentile), and elite (≥97.7th percentile).

MORE DETAILS A term known as V0-2 peak is a more usable measurement of cardiovascular fitness, as it pertains to the body's ability to perform a maximally sustained aerobic effort. From a heart rate perspective, it is very close to and just prior to something called metabolic acidosis, in which the level of carbon dioxide being produced by the body begins to exceed the amount of oxygen the body can physically take in, which in turn quickly leads to V0-2 Max. The difference is that VO2 peak represents a voluntary maximal effort. Therefore, V0-2 peak is a more usable, real world measurement of cardiovascular fitness. When someone does a STRESS TEST or Graded Exercise Test they are determining VO2 peak.

How Aerobically Fit are You?

Your VO2 Max score allows you to determine your aerobic fitness. See Chart. It is expressed as milliliters of oxygen consumed per minute of exercise per kilogram of body weight or ml/kg/minute.

See table below showing some impressive VO2 Max VO2 results.

Athlete	Event	VO2 Max
Bjorn Daeuble	Cross country skier	90.0
Miguel Indurain	Cyclist (winner of Tour de France)	88.0
John Ngugi	5 times world cross country champ	85.0
Dave Bedford	10km World Record holder	85.0
Steve Prefontaine	1 mile in 3:54.6	84.4
Lance Armstrong	Cyclist (winner of Tour de France)	84.0
Joan Benoit	Marathon runner (2:24:52)	78.6
Bill Rodgers	Marathon runner (2:09:27)	78.5
Sebastian Coe	Middle distance (1 mile WR)	77.0
Grete Waitz	Marathon runner (WR 1980)	73.0
Frank Shorter	Marathon runner	71.0
Derek Clayton	Marathon runner (WR 1969)	69.7

VO2max (mL·kg ⁻¹ ·min ⁻¹) Classifications for Women					
Age (years)	Poor	Fair	Good	Excellent	Superior
20 - 29	≤ 35	36 - 39	40 - 43	44 - 49	50+
30 - 39	≤ 33	34 - 36	37 - 40	41 - 45	46+
40 - 49	≤ 31	32 - 34	35 - 38	39 - 44	45+
50 - 59	≤ 24	25 - 28	29 - 30	31 - 34	35+
60 - 69	≤ 25	26 - 28	29 - 31	32 - 35	36+
70 - 79	≤ 23	24 - 26	27 - 29	30 - 35	36+

VO2max (mL·kg ⁻¹ ·min ⁻¹) Classifications for Men					
Age (years)	Poor	Fair	Good	Excellent	Superior
20 - 29	≤ 41	42 - 45	46 - 50	51 - 55	56+
30 - 39	≤ 40	41 - 43	44 - 47	48 - 53	54+
40 - 49	≤ 37	38 - 41	42 - 45	46 - 52	53+
50 - 59	≤ 34	35 - 37	38 - 42	43 - 49	50+
60 - 69	≤ 30	31 - 34	35 - 38	39 - 45	46+
70 - 79	≤ 27	28 - 30	31 - 35	36 - 41	42+

So if you maxed out at 12 METS you have the VO2 max score of 42 ml/kg/min (1 MET=3.5 ml/kg/min so 12 METS = 42 ml/kg/min). For a 43 year old male that is a good score (see VO2 max chart).