

# AEROBIC CAPACITY

Aerobic capacity is perhaps the most important component of any fitness program. Research indicates that acceptable levels of aerobic capacity are associated with a reduced risk of high blood pressure, coronary heart disease, obesity, diabetes, some forms of cancer, and other health problems in adults. The evidence documenting the health benefits of physical activity has been well described, and this information was the basis for the development of the U.S. physical activity guidelines and other similar public health recommendations for physical activity.

Many terms have been used to describe this dimension of physical fitness, including cardiovascular fitness, cardiorespiratory fitness, cardiorespiratory endurance, aerobic fitness, aerobic work capacity, and physical working capacity. Although defined somewhat differently, these terms can generally be considered synonymous with aerobic capacity. A laboratory measure of maximal oxygen uptake ( $\dot{V}O_2\text{max}$ ) is generally considered to be the best measure of aerobic capacity. Because differences in body size can influence oxygen uptake, aerobic capacity is typically expressed relative to body weight (i.e., milliliters  $O_2$  consumed per kilogram of body weight per minute, or  $\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ ).

The *FITNESSGRAM* program provides three field tests of aerobic capacity (PACER, one-mile run/walk, and walk test). Beginning with version 8.6 and version 9 of the *FITNESSGRAM* software, estimates of aerobic capacity are reported as  $\dot{V}O_2\text{max}$  and expressed as  $\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ . For the one-mile run/walk and the walk test, calculation of aerobic capacity requires the use of BMI (which is calculated from height and weight). Therefore, entry of height and weight are required in order to estimate  $\dot{V}O_2\text{max}$  when these tests are used. High test-retest reliability and accurate estimates of measured  $\dot{V}O_2\text{max}$  have been demonstrated for all measures of aerobic capacity. The following sections provide guidelines for administering and scoring all three tests.

## ***Need Additional Resources?***

For complete information about *FITNESSGRAM*, visit [www.fitnessgram.net](http://www.fitnessgram.net). To order the *FITNESSGRAM* software and related resources, call Human Kinetics at 800-747-4457, or order online at [www.HumanKinetics.com](http://www.HumanKinetics.com). To review the science behind the assessment, please read the Reference Guide, which is available at no cost at [www.fitnessgram.net](http://www.fitnessgram.net).

## Overview of the FITNESSGRAM Aerobic Capacity Standards

The FITNESSGRAM Scientific Advisory Board has worked to ensure that all of the assessments in fitness are scored using health-related standards. The availability of nationally representative data on fitness from the National Health and Nutrition Examination Survey (NHANES) made it possible to develop objective health standards for aerobic fitness when expressed as  $\dot{V}O_2$  max. Detailed information on the development of the standards is provided in the Reference Guide and in a comprehensive research supplement published in the *American Journal of Preventive Medicine*. Several key points associated with the aerobic fitness standards are summarized here:

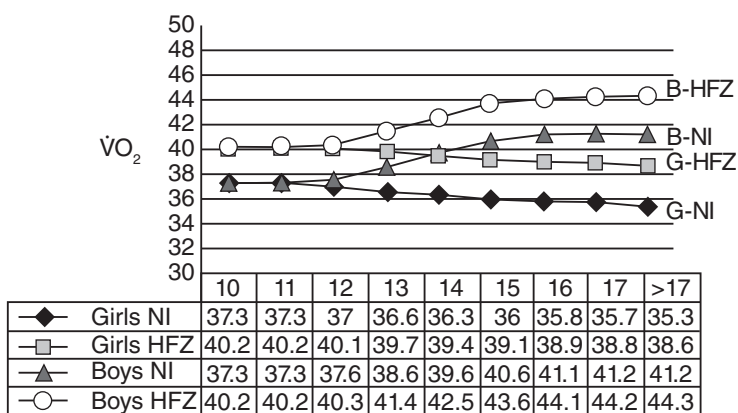
1. Estimates of aerobic capacity are expressed as  $\dot{V}O_2$  max in  $\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ , regardless of what assessment was used. The  $\dot{V}O_2$  max is estimated from equations developed specifically for the PACER or one-mile run/walk. For the one-mile run/walk, time, age, sex, height, and weight need to be entered into the program in order to receive an estimate of  $\dot{V}O_2$  max. For the PACER, laps completed, age, and sex are required in order to receive an estimate of  $\dot{V}O_2$  max.

2. The health-related standards used to evaluate aerobic capacity are age and sex specific and also take into account normal changes during growth and maturation. The values for boys increase with age, while the values for girls decrease with age. These changes do not imply higher expectations for boys and lower expectations for girls. The changes are reflective of the natural developmental trends for boys and girls (boys gain muscle with age while girls tend to gain body fat through adolescence). The lines actually reflect the same relative level of fitness across age for both boys and girls.

3. The new standards are equivalent for 10- and 11-year-old boys and girls. From a developmental perspective, boys and girls are more similar than different at these young ages. As they mature, boys and girls follow different developmental trends, so the fitness standards would follow these tracks.

4. The new standards allow classification into three unique zones (rather than two) with the use of two parallel lines. Students who have scores above the top line for their sex would be classified in the **Healthy Fitness Zone**. A child above this line would be classified as having sufficient fitness for good health. Students who have scores between the two lines would be classified in the **Needs Improvement** and receive a message that they should work to reach the Healthy Fitness Zone. Students below the bottom line would be classified in the **Needs Improvement—Health Risk** zone. This lowest fitness zone would provide youth and parents with an appropriate warning that this low level of fitness increases health risks. The use of three distinct fitness zones makes it possible to provide more specific information about health and potential health risks. Students in the HFZ are provided with feedback to maintain their fitness, while students in the Needs Improvement zone are appropriately warned about possible health risks if their fitness remains low.

Comparison of Boys and Girls



## PACER

### ⇒ Recommended

The PACER (Progressive Aerobic Cardiovascular Endurance Run) is the default aerobic capacity test in *FITNESSGRAM*. The PACER is a multistage fitness test adapted from the 20-meter shuttle run test published by Leger and Lambert (1982) and revised in 1988 (Leger et al.). The test is progressive in intensity—it is easy at the beginning and gets more difficult at the end. The progressive nature of the test provides a built-in warm-up and helps children to pace themselves. The test has also been set to music to create a valid, fun alternative to the customary distance run test for measuring aerobic capacity.

The PACER is recommended for all ages, but its use is strongly recommended for participants in grades K-3. The PACER is recommended for a number of reasons, including the following:

- All students are more likely to have a positive experience in performing the PACER.
- The PACER helps students learn the skill of pacing.
- Students who have a poorer performance will finish first and not be subjected to the embarrassment of being the last person to complete the test.

When you are administering the test to these younger children, the emphasis should be on allowing the children to have a good time while learning how to take this test and pace themselves. Allow children to continue to run as long as they wish and as long as they are still enjoying the activity. The main goal for young children is to allow them the opportunity to experience the assessment and to enjoy it.

### Test Objective

The objective is to run as long as possible with continuous movement back and forth across a 20-meter space at a specified pace that gets faster each minute. A 15-meter version of the PACER test has been developed for teachers with smaller-sized facilities.

### Equipment and Facilities

Administering the PACER requires a flat, nonslip surface at least 20 meters long, CD player with adequate volume, CD with PACER cadence (available for purchase from Human Kinetics), measuring tape, marker cones, pencil, and

a score sheet. Students should wear shoes with nonslip soles. Plan for each student to have a 40- to 60-inch-wide space for run-ning. An outdoor area can be used for this test if you do not have adequate indoor space. There should be a designated area for runners who have finished and for scorekeepers. You may want to paint lines or draw chalk lines to assist students in running in a straight line.

*Note:* Because many gyms are not 20 meters in length, an alternative 15-meter PACER test is now available. The procedures described as follows are the same for the 15-meter distance, but an alternative cadence and scoring sheet are required for tracking the number of laps. The 15-meter PACER test is for use only in elementary schools.

### Test Instructions

- Mark the 20-meter (21-yard, 32-inch) course with marker cones to divide lanes and use a tape or chalk line at each end.
- Make copies of the score sheet for each group of students to be tested.
- Before test day, allow students to listen to several minutes of the cadence CD so that they know what to expect. Students should then be allowed at least two practice sessions.
- Allow students to select a partner. Have students who are being tested line up behind the start line.
- Each student being tested should run across the 20-meter distance and touch the line with a foot by the time the beep sounds. The student should take full weight on the foot that is touching the line. At the sound of the beep, the student turns around and runs back to the other end. If some students get to the line before the beep, they must wait for the beep before running the other direction. Students continue in this manner until they fail to reach the line before the beep for the second time.

( continued )

PACER ( continued )

- A single beep will sound at the end of the time for each lap. A triple beep sounds at the end of each minute. The triple beep serves the same function as the single beep and also alerts the runners that the pace will get faster. Inform students that when the triple beep sounds, they should not stop but should continue the test by turning and running toward the other end of the area.
- Calculation of aerobic capacity requires a score of at least 10 laps (20-meter version).

### When to Stop

The first time a student does not reach the line by the time of the beep, the student stops where he or she is and reverses direction immediately, attempting to get back on pace. The test is completed for a student the next time (second time) he or she fails to reach the line by the time of the beep (the two misses do not have to be consecutive; the test is over after two total misses). Students just completing the test should continue to walk and stretch in the designated cool-down area.

*Note:* A student who remains at one end of the testing area through two beeps (does not run to the other end and back) should be scored as having two misses and the test is over.

### Scoring

In the PACER test, a lap is one 20-meter distance (from one end to the other). The scorer records the lap number (crossing off each lap number) on a PACER score sheet. The recorded score is the total number of laps completed by the student. For ease in administration, it is permissible to count the first miss (not making the line by the time of the beep). It is important to be consistent with all of the students and classes in the method used for counting.

An alternative scoring method is available. This method does not eliminate students when they miss their second beep (Schiemer, 1996). Using the PACER score sheet, establish two different symbols to be used in recording, such as a star for making the line by the time of the beep and a tri-

angle for not making the line. The scorer then draws a star in the circle when the runner makes the line by the time of the beep and a triangle when the runner fails to make the line by the time of the beep, simply making a record of what occurs. The runners can continue to participate until the leader stops the music or until they voluntarily stop running. To determine the score, find the second triangle (or whatever symbol was used). The number associated with the preceding star is the score.

Regardless of the method, the scoring of the PACER test is based on the number of laps completed. It is important to count each individual 15-meter or 20-meter distance as a lap (rather than based on a down-and-back count for the laps).

Criterion standards are not available for students in grades K-3. The object of the test for these younger students is simply to have them participate in the testing process and to complete as many laps as possible. The main goal is to provide the students with the opportunity to experience the PACER and to have a positive experience with the assessment. Nine-year-olds in grade 4 will receive a score, and it will be evaluated against a criterion standard. All 10-year-old students receive a score regardless of grade level.

### Suggestions for Test Administration

■ Both PACER CDs contain 21 levels (1 level per minute for 21 minutes). During the first minute, the 20-meter version allows 9 seconds to run the distance; the 15-meter version allows 6.75 seconds. The lap time decreases by approximately half a second at each successive level. Make certain that students have practiced and understand that the speed will increase each minute.

■ A single beep indicates the end of a lap (one 20-meter distance). The students run from one end to the other between each beep. Caution students not to begin too fast. The beginning speed is very slow. Nine seconds is allowed for running each 20-meter lap during the first minute

( continued )

PACER ( continued )

## FITNESSGRAM

### The PACER Individual Score Sheet A

Teacher \_\_\_\_\_ Class period \_\_\_\_\_ Date \_\_\_\_\_

Lap = one 20-meter length

Level	Laps													
1	1	2	3	4	5	6	7							
	8	9	10	11	12	13	14	15						
	16	17	18	19	20	21	22	23						
	24	25	26	27	28	29	30	31	32					
	33	34	35	36	37	38	39	40	41					
	42	43	44	45	46	47	48	49	50	51				
	52	53	54	55	56	57	58	59	60	61				
	62	63	64	65	66	67	68	69	70	71	72			
	73	74	75	76	77	78	79	80	81	82	83			
	84	85	86	87	88	89	90	91	92	93	94			
	95	96	97	98	99	100	101	102	103	104	105	106		
	107	108	109	110	111	112	113	114	115	116	117	118		
	119	120	121	122	123	124	125	126	127	128	129	130	131	
	132	133	134	135	136	137	138	139	140	141	142	143	144	
	145	146	147	148	149	150	151	152	153	154	155	156	157	

Lane \_\_\_\_\_ Student's signature \_\_\_\_\_ Laps completed \_\_\_\_\_

From *FITNESSGRAM/ACTIVITYGRAM Test Administration Manual, Updated Fourth Edition* by The Cooper Institute, 2010, Champaign, IL: Human Kinetics.

( continued )

PACER ( *continued* )

- Triple beeps at the end of each minute indicate the end of a level and an increase in speed. Students should be alerted that the speed will increase. When students hear the triple beeps they should turn around at the line and immediately continue running. Some students have a tendency to hesitate when they hear the triple beeps.

- A student who cannot reach the line when the beep sounds should be given one more chance to regain the pace. The second time a student cannot reach the line by the time of the beep, his or her test is completed.

- Groups of students may be tested at one time. Adult volunteers may be asked to help record scores. Students may record scores for each other or for younger students.

- Each runner must be allowed a path 40 to 60 inches wide. It may work best to mark the course.

- Using the CD is an efficient method for administering this test item.

## One-Mile Run

### ⇒ *Alternative*

The one-mile run can be used instead of the PACER to provide an estimate of aerobic capacity ( $\text{VO}_2\text{max}$ ). For students who enjoy running and are highly motivated, it is a very good alternative assessment. Scoring of the one-mile run will require the input of a student's height and weight since the calculation of aerobic capacity includes BMI.

### Test Objective

The objective of the assessment is to run a mile at the fastest pace possible (i.e., shortest time). If a student gets tired, it is okay to allow him or her to walk, but encourage the student to try to at least maintain a slow jog throughout the assessment. An aerobic capacity score cannot be obtained for mile times greater than 13:00, and this time would not likely be achieved at a walking pace. If students cannot complete a one-mile jog or run, they should be encouraged to complete the one-mile walk test. Note that the walk test is validated only for those age 13 and older.

### Equipment and Facilities

A flat and accurately measured running course, stopwatch, pencil, and score sheets are required. The course may be a track or any other measured area. The course may be measured using a tape measure or cross country wheel. Caution: If the track is metric or shorter than 440 yards, adjust the running course (1,609.34 meters = 1 mile; 400 meters = 437.4 yards; 1,760 yards = 1 mile).

On a 400-meter track the run should be four laps plus 10 yards.

### Test Instructions

Describe the course to the students, and encourage them to complete the distance in the shortest possible time. Remind them to listen for their time as they cross the line. Also, many students begin too fast and tire out, so it is important to remind them to use appropriate pacing to get an accurate assessment. To initiate the assessments, you can provide a signal of "Ready . . . start." As they cross the finish line, elapsed time should be called out to the participants (or their partners) and then recorded.

### Scoring

The scoring of the one-mile run is based on the total time as well as the child's age, sex, and BMI (obtained from height and weight). The software will use the entered data to estimate the child's aerobic capacity. The score will then be used in the software to determine what fitness zone the child is placed into and what feedback is provided.

Criterion standards are not available for students in grades K-3 (ages 5-9). The object of the test for these younger students is simply to complete the one-mile distance at a comfortable pace and to practice pacing, so it is not necessary to time the run for these students. Nine-year-olds in grade 4 will receive a standard. All 10-year-olds should receive a score regardless of grade level.

( *continued* )



One-Mile Run ( continued )

Remember that the height and weight for each student must be entered in addition to the performance time on the one-mile run. Calculation of aerobic capacity also requires a time less than 13:01. A child scoring above this time will be placed into the Needs Improvement—Health Risk zone since this achievement would result in an estimate of aerobic capacity below the health standard.

### Suggestions for Test Administration

- Call out times as the runners pass the start-and-stop line to assist students in pacing themselves.
- Preparation for the test should include instruction about pacing and practice in pacing. Without instruction, students usually run too fast early in the test and then are forced to walk near the end.
- Results are generally better if a student can maintain a constant pace during most of the test.
- Walking is certainly permitted, but students should be encouraged to complete the assessment at a slow jog rather than a walking pace. If students can't complete a mile, they should be assessed with the one-mile walk test, although that test is validated only for ages 13 and older.
- Have students set a goal before running.
- Students should always warm up before taking the test. They should also cool down by continuing to walk for several minutes after completing the distance. A good suggestion is to have those who have completed the distance do an easy activity (juggle, hula hoop) while waiting for others to complete the distance. This keeps everyone moving and busy and takes the focus off the slower students who will complete the distance last.
- Avoid administering the test under conditions of unusually high temperature or humidity or when

the wind is strong, because these elements may be unsafe or may lead to an invalid estimate of aerobic capacity.

- Counting laps completed and accurately recording the run time can be a problem when a relatively small course is used with younger children. Many techniques are acceptable. Pair the students and have the resting partner count laps and record time for the runner. Older students or parents may be asked to assist in recording results for younger students.



PHOTO © Human Kinetics. Student running.

### Walk Test

⇒ *Alternative*

Another alternative to the PACER test is the one-mile walk test. This test is only for students ages 13 and older since it hasn't been validated with younger samples. The walk test is an excellent alternative assessment because it can be used for a lifetime. Secondary students should learn to do

this test because it is one that they can repeat on their own to self-assess their fitness levels

### Test Objective

The objective is to walk one mile as quickly as possible while maintaining a constant walking pace for the entire distance. The assessment is based on the relative heart rate for a given speed of walking, so the actual pace is not critical. This test is included

( continued )

## Walk Test ( continued )

in *FITNESSGRAM* for use with participants ages 13 years and older. The walk test is an excellent self-assessment skill for everyone to use throughout life.

### Equipment and Facilities

A flat, accurately measured (1 mile) course, two or more stopwatches, pencils, and score sheets are required. Heart rate monitors, if available, make heart rate monitoring much easier. The course may be measured using a tape measure or cross country wheel. Caution: If the track is metric or shorter than 440 yards, adjust the course (1,609.34 meters = 1 mile; 400 meters = 437.4 yards; 1,760 yards = 1 mile). On a 400-meter track the walk should be four laps plus 10 yards.

### Test Instructions

Describe the course to the students, and instruct them to complete the full mile at a steady, brisk walking pace that can be maintained the entire distance. As they cross the finish line, elapsed time should be called to the participants (or their partners). It is possible to test 15 to 30 students at one time by dividing the group. Have each student select a partner; one is the walker and one is the scorer. While one group walks, the scorers count laps and record the finish time.

At the conclusion of the one-mile walk, each student should take a 60-second heart rate count. The scorer can time the 60 seconds, or students can count the time themselves by using a pace clock with a second hand. If using heart rate monitors to determine the heart rate, each participant should start his or her stopwatch at the beginning of the walk and stop it at the end. The last heart rate recorded during the walk should be used as the walking heart rate.

### Scoring

The walk test is based on the relative heart rate in walking a mile at a specific speed. Therefore, it is important to have an accurate measure of the mile walk time (scored in minutes and seconds) as well as a 60-second heart rate. The child's estimated  $\text{VO}_{2\text{max}}$  is calculated using the Rockport Fitness Walking Test equation (Kline et al. 1987; McSwegin et al.



PHOTO © Human Kinetics. Student walking.

1998). The estimate is evaluated using the same aerobic fitness standards as the other assessments.

### Suggestions for Test Administration

- Preparation for the test should include instruction and practice in pacing and in techniques for heart rate monitoring.
- Results are generally better if the student can maintain a constant pace during most of the test.
- Students should always warm up before taking the test. They should also cool down by continuing to walk for several minutes after completing the distance.
- Avoid administering the test under conditions of unusually high temperature or humidity or when the wind is strong, because these elements may cause an invalid estimate of aerobic capacity.