

Walking test

Polar Research Center

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CONTENTS

1	Introduction	1
2	Physiological background	1
3	Validity	1
4	Test in practice and results interpretation	2
5	Limitations	4
6	References	4

1 Introduction

This white paper describes the physiological background, validity, and user feedback of Polar Walking test. This is an easy, safe, reliable, and repeatable field test for testing aerobic fitness level. Polar technology enables real-time guidance through the test and instant feedback based on measured data.

Walking test suits most adults. Because it is physically less demanding than other maximal exertion test, like Running performance test, Walking test is ideal for beginners, occasional and regular trainers, and physically active persons who are not willing or capable to run. The only limitations to take the Walking test are diseases or disabilities that impede brisk walking, or the use of medication that affects heart rate. The test is not recommended to highly-fit individuals who train regularly.

Walking test offers a practical way to check the aerobic fitness level and follow up its development. It's interesting to know aerobic fitness and compare it to people of the same age and gender. The test results show proof of the effects of regular training and daily activity habits on fitness. Knowing the fitness level also motivates people to exercise or be more active physically. Walking test is ideal as a starting point assessment and gives foundation to training plans. Improvements in aerobic fitness require regular exercise training. Thus, it is recommended to take the test at the beginning of a training cycle and every three months to follow up.

2 Physiological background

Walking is a popular leisure-time activity or sport. It is safe, comfortable, low-cost, and a natural way to move and start a physical activity program. The number of

people (aged six years and older) walking for exercise amounts to approximately 111 million in the US (Statista 2022). Walking is one of the most popular sports tracked by Polar customers globally and is getting even more popular within customers of all ages.

Brisk walking is generally accepted as a suitable mode of exercise to evaluate aerobic fitness. It involves large muscle groups and does not require special skills, equipment or facilities. The 2-km walk test (also known as UKK Walk Test) and the 1-mile walk test are widely accepted and used field tests (Laukkanen *et al.* 1992a, Kline *et al.* 1986). From an aerobic fitness assessment point of view, fast walking results in adequate physiological strain in most subjects except those who are very fit. In addition to evaluating aerobic fitness, walking test also reflects the functional capacity of the musculoskeletal system (Sun *et al.* 1998), i.e. the ability to walk fast for 15 minutes.

The 2-km walk test prediction equations for maximal oxygen uptake (VO_{2max}) comprise of walking time, heart rate, age, gender and body mass index (BMI) (Oja *et al.* 1991). While the 2-km walk test is based on the time required to cover a set distance, Polar Walking test focuses on the distance that a person can walk in 15 minutes. All the other variables used to predict aerobic fitness are the same. Distance and speed are the most powerful predictors, but the heart rate during the test and the person's characteristics also play a role in the result. To establish the relation between the 2-km walk test and the 15-minute walk test, at Polar, we compared VO_{2max} estimates resulting from 2-km walks and 15-minute walks. No differences were found.

3 Validity

Evidence shows that the 2-km walk test is valid for estimating cardiorespiratory fitness (Castro-Piñero *et al.* 2021). Previous studies in different populations, such as healthy inactive and moderately active adults, and overweight adults (Laukkanen *et al.* 1992a,b, 1993a, Zakariás *et al.* 2003), support the validity of the test. According to these studies, the 2-km walk test is a safe and feasible test in general population. As such, it is considered a valid option in health-related fitness tests (Laukkanen *et al.* 1992a, Sun *et al.* 1998).

Walking test

Polar Research Center

July 5, 2023

The accuracy of the 2-km test is comparable to most other submaximal tests. The standard error estimate (SEE) has been shown to range between 3.3 and 5.1 ml/kg/min compared to directly measured VO_{2max} (Oja *et al.* 1991). When the walking speed corresponds to 80% of a person's maximum heart rate or higher, the tests shows the most accurate prediction of VO_{2max} (Laukkanen *et al.* 1993b). The 2-km test has also been found to be able to show fitness changes (Laukkanen *et al.* 2000). Moreover, a 2-km walk test conducted without supervision but guided with Polar watch A5 was found accurate in predicting VO_{2max} (Oja *et al.* 2001).

Polar Walking test has been pre-validated against a directly measured VO_{2max} . Twenty-four subjects [13 women with a mean (SD) age of 44.2 (7.5) years, BMI of 24.7 (2.6) kg/m², and 11 men with mean age of 41.1 (7.1) years, BMI of 25.6 (2.6) kg/m² and VO_{2max} of 45.2 (5.7) ml/kg/min] performed Walking test with Polar Pacer Pro on a self-selected route within two weeks after having a laboratory test. The laboratory test included maximal walk-run treadmill protocol with breath-by-breath VO_2 measurements. Mean absolute error of VO_{2max} (SD) was 5.9 (4.8) ml/kg/min showing rather good accuracy. (Oikarinen *et al.* 2023).

4 Test in practice and results interpretation

Walking test is designed to be carried out outdoors on a level and firm surface. Besides heart rate, a Polar wrist unit - typically a watch - measures distance and speed based on a satellite positioning system (GPS). The basic idea is that the user walks briskly for 15 minutes. For that, a route of about two kilometers (or one mile) without any possible hindrances, like traffic lights is ideal. A relatively straight path or track without tall buildings or trees nearby is preferable. Performing the test indoors requires an additional sensor.

A Polar wrist unit guides the user throughout the test (Fig.1), which consists of three phases: warm-up, 15-minute test, and cooldown. The warm up phase prepares users for the test phase, helping them reach a brisk pace they can maintain throughout the test. For maximum reliability, it is crucial to keep a brisk pace, fast enough to cause at least slight sweating and breathlessness. Preferably, the pace during the test

will be as fast as possible. It is also recommended to walk at a steady pace and avoid speeding up or slowing down for the last minutes. Running is not allowed: Polar watch will alert the user if they start to run. A sufficiently high heart rate is a sign of a brisk walk and thus at least 65% of maximal heart rate is recommended. If the heart rate is too low, the watch will alert the user, advising them to walk faster to raise their heart rate. This is why it is important to make sure that user own settings are correct and accurate when taking Walking test with a Polar wrist unit.

Once the test is completed, the resulting VO_{2max} result is calculated by factoring in the walked distance in 15-minute test phase, the heart rate during the test (average heart rate of the last five minutes), and personal characteristics (age, gender, height and weight). The result is expressed in ml/kg/min, which is the standard expression of maximal oxygen uptake (VO_{2max}). Additionally, the watch may display tips on how to perform the test better next time (Fig. 1). For example, if the pace or cadence varied, or if the user ran, a message will suggest to walk steadily next time. If the heart rate was lower than guided, a message will suggest to walk faster next time.



Fig.1. Illustration of real-time guidance (heart rate, time walked) for Walking test in Polar wrist unit (left) and result view (right).

Walking test

Polar Research Center

July 5, 2023

VO_{2max}, in ml/kg/min indicates how many milliliters of oxygen your body is able to transport and use per each kilogram of your body weight in one minute. This result, as any other fitness test result, is most meaningful when comparing individual values and changes. The figure is also used to distribute and classify the fitness level of people of the same age and gender. The fitness level classification in Table 1 is used for interpreting the results.

Table 1. Classification of maximal oxygen uptake to seven fitness levels (Shvartz & Reibold 1990).

MEN / VO_{2max}, ml/kg/min

AGE	1	2	3	4	5	6	7
20-24	<32	32-37	38-43	44-50	51-56	57-62	>62
25-29	<31	31-35	36-42	43-48	49-53	54-59	>59
30-34	<29	29-34	35-40	41-45	46-51	52-56	>56
35-39	<28	28-32	33-38	39-43	44-48	49-54	>54
40-44	<26	26-31	32-35	36-41	42-46	47-51	>51
45-49	<25	25-29	30-34	35-39	40-43	44-48	>48
50-54	<24	24-27	28-32	33-36	37-41	42-46	>46
55-59	<22	22-26	27-30	31-34	35-39	40-43	>43
60-65	<21	21-24	25-28	29-32	33-36	37-40	>40

WOMEN / VO_{2max}, ml/kg/min

AGE	1	2	3	4	5	6	7
20-24	<27	27-31	32-36	37-41	42-46	47-51	>51
25-29	<26	26-30	31-35	36-40	41-44	45-49	>49
30-34	<25	25-29	30-33	34-37	38-42	43-46	>46
35-39	<24	24-27	28-31	32-35	36-40	41-44	>44
40-44	<22	22-25	26-29	30-33	34-37	38-41	>41
45-49	<21	21-23	24-27	28-31	32-35	36-38	>38
50-54	<19	19-22	23-25	26-29	30-32	33-36	>36
55-59	<18	18-20	21-23	24-27	28-30	31-33	>33
60-65	<16	16-18	19-21	22-24	25-27	28-30	>30

According to these charts, Walking test estimates fitness level in comparison to individuals of the same sex and age as follows (Fig.2):

- Class 1: Very low
- Class 2: Low
- Class 3: Fair
- Class 4: Moderate
- Class 5: Good
- Class 6: Very Good
- Class 7: Elite

In the general population, 11% of people belong to classes 1–2 and 6–7, 22% in classes 3 and 5 and 34% in class 4. This corresponds to normal distribution, as the classification was developed in representative samples of healthy individuals from different countries (USA, Canada and 7 European countries).

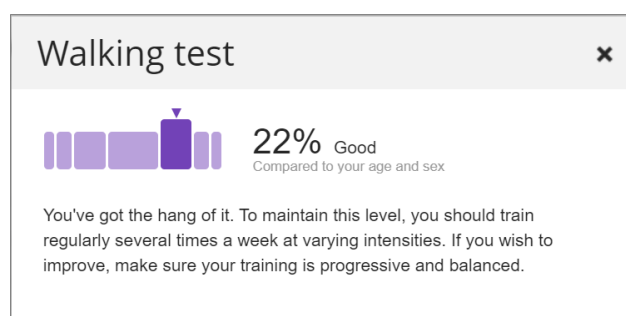


Fig. 2. Walking test fitness level feedback in Polar Flow.

Fitness level is a useful reference when interpreting the results. Because cardiovascular health is related to aerobic fitness, the people in fitness levels 1–3 would obtain lots of health benefits and improve their fitness by getting more daily physical activity or starting regular exercise. Those in level 4 should at least maintain their exercise habits to ensure better health. Having more regular exercise is recommended for improving fitness. People in levels 5–7 are typically training a considerable amount of time; increases in their exercise regime aim at improving performance. Top athletes in endurance sports typically score VO_{2max} values (ml/kg/min) above 70 (men) and 60 (women). Regular exercisers participating occasionally in competitions reach 60–70 (men) and 50–60 (women). Individuals exercising regularly typically have values between 40–60 (men) and 30–50 (women) and sedentary adults below 40 (men) and 30 (women).

Changes in fitness level will be reflected in the test results. In short, the longer the test distance, the lower the heart rate and body weight, the better the test result. Changes in body weight affect the result, because the predicted variable is relative VO_{2max} (milliliters of oxygen per minute per kilogram of weight). As a divisor, weight directly affects the results. This also has a functional significance. As weight decreases, the body is lighter to be moved around.

Walking test

Polar Research Center

July 5, 2023

5 Limitations

Like any other performance test, Walking test requires some preparations and users must follow certain instructions for maximum accuracy and repeatability. Several studies have pointed out a learning effect. Thus, it is recommended to have a practice walk before the very first test to eliminate errors caused by too slow or unsteady walking speed, running, or speeding up in the end.

Walking test is not the most suitable test for persons who have high level of aerobic fitness (VO_{2max} over 60 ml/kg/min in men and 50 in women) and exercise intensively and regularly (Laukkanen *et al.* 1993a). Very fit people are unable to stress their cardiovascular system enough by just walking briskly. Running performance test or other more demanding performance test of aerobic fitness are more suitable for these individuals.

Some medications (treating blood pressure, cardiovascular conditions, asthma, mental health) may affect heart rate and thus, the results achieved in such conditions are not comparable to reference values. However, a user's own results are well comparable if the tests have been done under the same medication.

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