



ONE-MILE STEP COUNT AT WALKING AND RUNNING SPEEDS

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LEARNING OBJECTIVE

- After reading this article, health and fitness professionals will be able to: 1. help clients estimate the number of steps taken while walking or running a mile at different speeds, 2. determine additional walking or running distances required to accumulate 10,000 steps per day, and 3. explain the impact of higher-intensity exercise on the general recommendation of accumulating 10,000 steps per day.

Key words:

Pedometer, Steps per Mile, Predicting 1-Mile Step Count, 10,000 Daily Steps, Physical Activity

Health/fitness professionals are aware of the declining levels of physical activity along with the alarming increase in overweight and obesity rates in the United States and most other developed countries around the world. The obesity epidemic is commonly blamed on overconsumption and sedentary living. Whether our portion sizes have become too large or technological advances have lulled us into a sedentary lifestyle, most Americans do not engage in sufficient daily physical activity to maintain health and recommended body weight (1,2). A direct result of our current way of life is that none of the goals to increase participation in physical activity and fitness specified in Healthy People 2010 are being met (1).

In the last few years, a clear distinction has evolved between physical activity and exercise. Physical activity is bodily movement produced by muscle contraction that significantly in-

creases energy expenditure and is conducive to progressive health benefits (3). Examples of physical activity include walking, taking the stairs, bike riding at a leisurely pace (*e.g.*, 8 to 10 mph), doing household chores, yard work, gardening, dancing, and washing the car by hand. Current physical activity guidelines encourage Americans to participate in moderate physical activity and accumulate a minimum of 30 minutes on most, if not all days of the week (4).

Exercise is a type of physical activity that requires planned and structured activity performed to maintain or improve selected components of fitness (3). Examples of exercise are brisk walking, running, cycling, aerobics, swimming, hiking, and strength training. Exercise is usually viewed as an activity that requires a vigorous intensity effort (*e.g.*, sweating, increased breathing, and heart rate). Current cardiorespiratory exercise recommendations by the American College of Sports Medicine (ACSM) suggest that Americans participate in vigorous intensity activities for at least 20 minutes, 3 days per week (5). Although all exercise is considered physical activity, not all physical activity is viewed as exercise.

There are a variety of physical activities and exercises that can help clients expend energy and produce positive health and/or fitness benefits. Walking, a popular activity, is perhaps the easiest way for people to meet general physical activity guidelines. Most clients can access safe walking areas such as parks, recreational fields, sports complexes, and even shopping malls in times of inclement weather.

Clients can easily and effectively monitor daily walking by wearing a pedometer on a waistband that counts the vertical rise and fall of

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the hip during each step. Health/fitness professionals suggest using a pedometer to track steps per day and develop daily step count goals. General guidelines for improved health recommend accumulating approximately 10,000 steps per day (6,7), although this goal may be difficult to achieve in the early stages of activity by many sedentary and obese clients (8). The 10,000 step recommendation has been most specifically directed at moderate intensity walking. Recommendations for using pedometers to guide more vigorous physical activity have not been presented.

Regardless of exercise intensity, people who monitor daily steps by using a pedometer often want to know how many steps it takes to walk or run 1 mile. Although some pedometers allow individuals to program in an average step length to estimate distance traveled, many pedometers only measure number of steps taken. To date, limited research has examined how height or pace affects step counts and walking distance (9).

OUR OBJECTIVES

Given the need to more accurately quantify the number of steps in a mile for clients wearing pedometers, we set out to determine the number of steps individuals take while walking 1-mile at a 20- and 15-minute pace and while running the same distance at a 12-, 10-, 8-, and 6-minute pace. A second objective was to develop prediction equations to esti-

mate the number of steps men and women take to walk or run a distance of 1 mile at various speeds based on height or leg length.

HOW WE TESTED

Forty-four people were tested at the two walking speeds, and 34 individuals participated in the running protocol. All individuals gave informed consent and were cleared for participation using the Physical Activity Readiness Questionnaire. We measured standing height (inches) and leg length (inches) from the upper edge of the greater trochanter to the floor and body weight (pounds) before testing. The general characteristics of our participants are found in Table 1.

All volunteer participants performed as many of the six different walking/running speeds as they could in a random order on a precalibrated motor-driven treadmill. The fastest speed for each participant was determined if that mile pace had been performed a minimum of 3 times during the previous 15 days. Regardless of fitness levels, at least 23 hours were allowed between all 1-mile exercise bouts.

A Yamax 200 pedometer was used for each test on all participants. To further ascertain the accuracy of the pedometer before each 1-mile walk or run, participants walked or ran for 50 steps on the treadmill at the speed that they performed that particular day. The 50 steps were verbally counted by the person administering the test and cross-checked against the displayed steps on the pedometer. In all instances, the range of steps displayed on the pedometer was between 48 and 52 steps (96% accuracy). At the conclusion of the reliability check, the pedometer was set back to zero, and the participant began the 1-mile walk/run at the designated speed. One-mile step counts were recorded at the conclusion of each mile test.

MILE STEP COUNT AND PREDICTION EQUATIONS

Separate statistical models were used to analyze the walking and running data. The number of steps differed significantly for each pace, for walkers and runners. Within the two exercise modalities (walking and running), the number of steps decreased as pace increased in all cases. Step counts for the speeds tested are provided in Table 2.

TABLE 1: General Characteristics of Participants

Variable	All (n = 44) (Mean ± SD)	Women (n = 25) (Mean ± SD)	Men (n = 19) (Mean ± SD)
Age, years	27.0 ± 9.7	25.8 ± 7.7	28.5 ± 11.7
Body weight, lbs	155.5 ± 42.8	131.5 ± 26.1	185.5 ± 40.8
Height, inches	67.5 ± 4.4	64.5 ± 2.8	71.2 ± 3.0
BMI, kg/m ²	23.7 ± 4.4	22.2 ± 3.7	25.7 ± 4.6

BMI indicates body mass index.

One-Mile Step Count at Walking and Running Speeds

Photo courtesy of Werner W.K. Hoeger, Ed.D., FACSM.



The average number of steps required to run/walk a mile ranged from 1,064 steps for a pace of 6 minutes per mile in men to 2,310 steps for a walk of 20 minutes per mile in women. An interesting finding is that, on average, individuals took more steps while running (jogging) a 12-minute mile than while walking a 15-minute mile (1,951 steps vs. 1,935 steps, respectively). This finding is most likely related to the smaller

TABLE 2: Mean Step Counts (No. Participants) for Walking and Running 1 Mile at Various Speeds

Activity	All	Women	Men
Walking*			
20 minutes	2,252 (44)	2,310 (25)	2,176 (19)
15 minutes	1,935 (44)	1,987 (25)	1,868 (19)
Running*			
12 minutes	1,951 (35)	1,979 (19)	1,919 (16)
10 minutes	1,672 (28)	1,709 (14)	1,635 (14)
8 minutes	1,400 (19)	1,469 (7)	1,360 (12)
6 minutes	1,080 (9)	1,213 (1)	1,064 (8)

* The number of steps decreased significantly ($P < 0.05$) for each pace, for walkers and runners.

TABLE 3: Prediction Equations to Estimate the Number of Steps to Walk or Run a Mile Based on Height (Inches), Speed (Minutes per Mile), and Sex (Walking Only)

Walking	
Women	$\text{steps per mile} = 1,949 + [(63.4 \times \text{pace}) - (14.1 \times \text{height})]$
Men	$\text{steps per mile} = 1,916 + [(63.4 \times \text{pace}) - (14.1 \times \text{height})]$
Running	
Both men and women	$\text{steps per mile} = 1,084 + [(143.6 \times \text{pace}) - (13.5 \times \text{height})]$

distance between steps that people tend to take while jogging at a slower speed (12-minute mile) compared with walking at a 15-minute-per-mile pace. The number of steps that men and women took while walking a mile was significantly different. Thus, two sex-related prediction equations were developed for walking speeds. The number of steps that men and women took while running was significantly different at the faster speeds only, possibly because fewer women completed the faster 8- and 6-minute-per-mile runs. As a result, only one prediction equation was developed for running speeds to be used by both men and women.

We also examined whether height and leg length would influence the number of steps people took while walking a mile. Both height and leg length significantly impacted step count results, but only height impacted step count results for runners. No differences were found in the steps-per-mile predictions using either height or leg length. Thus, Table 3 presents 1-mile step count prediction equations based on pace (minutes per mile) and height (inches). An example of how to use these equations with a client is presented. The following computations are used to estimate the number of steps per mile and the number of miles a male client with a height of 5 ft 10 inches would have to walk to accumulate 10,000 steps if he typically walks at a pace of 16 minutes and 30 seconds per mile:

1. Convert body height to inches. One foot equals 12 inches, so 5 ft 10 inches would be 70 inches $[(5 \times 12) + 10]$.
2. Because 1 minute has 60 seconds, seconds need to be converted to minutes in decimal form (divide seconds by 60), and the minutes are added to it. In our example, a mile walked in 16:30 converts to 16.5 minutes $[16 + (30 / 60)]$.
3. Using the walking equation for men in Table 3, the estimated number of steps to walk a mile is computed as follows:

$$\text{Steps per 1-mile walk} = 1,916 + [(63.4 \times 16.5) - (14.1 \times 70)] = 1,975 \text{ steps.}$$

TABLE 4: Estimated Number of Steps to Walk or Run a Mile Based on Height and Speed for Men and Women

Height	Pace, minutes per mile							
	Walking				Running			
	20	18	16	14	12	10	8	6
Women								
5 ft 0 inch	2,371	2,244	2,117	1,991	1,997	1,710	1,423	1,136
5 ft 2 inches	2,343	2,216	2,089	1,962	1,970	1,683	1,396	1,109
5 ft 4 inches	2,315	2,188	2,061	1,934	1,943	1,656	1,369	1,082
5 ft 6 inches	2,286	2,160	2,033	1,906	1,916	1,629	1,342	1,055
5 ft 8 inches	2,258	2,131	2,005	1,878	1,889	1,602	1,315	1,028
5 ft 10 inches	2,230	2,103	1,976	1,850	1,862	1,575	1,288	1,001
6 ft 0 inch	2,202	2,075	1,948	1,821	1,835	1,548	1,261	974
Men								
5 ft 4 inches	2,282	2,155	2,028	1,901	1,943	1,656	1,369	1,082
5 ft 6 inches	2,253	2,127	2,000	1,873	1,916	1,629	1,342	1,055
5 ft 8 inches	2,225	2,098	1,972	1,845	1,889	1,602	1,315	1,028
5 ft 10 inches	2,197	2,070	1,943	1,817	1,862	1,575	1,288	1,001
6 ft 0 inch	2,169	2,042	1,915	1,788	1,835	1,548	1,261	974
6 ft 2 inches	2,141	2,014	1,887	1,760	1,808	1,521	1,234	947
6 ft 4 inches	2,112	1,986	1,859	1,732	1,781	1,494	1,207	920

4. Without taking into consideration any other daily walking or jogging/running activity, our client would need to walk 5.1 miles (10,000 / 1,975) to accumulate 10,000 steps at a pace of 16 minutes and 30 seconds per mile. Keep in mind, however, that most adults in the United States accumulate between 5,000 and 6,000 steps per day through activities of daily living.

If your client also accumulates this many steps, he would only need to walk an additional 2.0 to 2.5 miles on most days of the week.

Health/fitness professionals need to be aware that there are many different pedometer models, and previous research has shown that variation in accuracy exists among pedometer brands (10). Furthermore, some pedometer models undercount steps in overweight or obese individuals. Pedometer tilt angle, waist circumference, and BMI affect pedometer accuracy (11). The pedometer used in this study was selected because of its accuracy in counting steps in individuals with normal weight. Thus, prediction equations in this study are specific to people with normal weight, and the accuracy of these equations may vary if a different pedometer model is used.

PRACTICAL APPLICATION

Using the prediction equations derived from our data, we developed Table 4 to help clients establish the estimated number of steps required to walk or run a mile at selected speeds. You may post this table in a visible area in your fitness facility or at the workplace to help motivate clients to increase their level of physical activity. Clients who regularly wear a pedometer and do not achieve the recommended 10,000 daily steps through activities of daily living alone may use these tables to determine the additional distance required to achieve this goal through a walking or jogging program.

THUS, PREDICTION EQUATIONS IN THIS STUDY ARE SPECIFIC TO PEOPLE WITH NORMAL WEIGHT, AND THE ACCURACY OF THESE EQUATIONS MAY VARY IF A DIFFERENT PEDOMETER MODEL IS USED.

One-Mile Step Count at Walking and Running Speeds

Currently, healthy adults in the United States average between 5,000 and 6,000 steps per day, (12–14) a range of steps that fall in the “low active” category according to adult activity levels (7). Based on the physical activity recommendation that individuals accumulate 10,000 steps on a nearly daily basis, your client could reach or exceed the remaining steps (e.g., 4,000 to 5,000 steps) by participating in more structured moderate-to-vigorous walking or running activities.

Practitioners can now help their clients reach those remaining steps by specifying the distance to walk or run. It is important to remember that the number of steps taken per mile varies considerably depending on walking or running pace and, to a lesser extent, on sex. The faster a client walks or runs, the fewer the steps it takes to cover the distance. Thus, as health/fitness professionals, we need to be careful not to generalize the 10,000–daily step recommendation to all people. Clients in higher intensity programs take far fewer steps and less time to cover a given distance. Vigorous intensity exercise, however, provides better improvements in aerobic capacity and greater benefits in terms of coronary heart disease risk reduction and overall cardiovascular health (15).

Using a hypothetical example, if we accept a brisk pace of 15 minutes per mile as “moderate-intensity activity” (an equivalent oxygen uptake of 14.2 ml/kg per minute or 4 metabolic equivalents [METs], using ACSM prediction equations (5)), one can easily determine the additional number of steps that a client would need through higher intensity exercise to meet the equivalent of 10,000 steps per day.

For instance, a male client may meet the 10,000 daily step recommendation by accumulating 3,225 steps through activities of daily living and adding another 6,776 steps by walking 3.5 miles at a pace of 15 minutes per mile ($1,936 \times 3.5$). If a second male client accumulates the same number of steps through activities of daily living but chooses to run 3.5 miles at a pace of 8 minutes per mile for exercise (an equivalent oxygen uptake of 43.7 ml/kg per minute or 12.5 METs), he would only accumulate 8,125 daily steps, that is, 3,225 through activities of daily living and 4,900 ($1,400 \times 3.5$) through exercise. Although the second client seems to be short of the 10,000 daily step recommendation, he is meeting the 30-minute guideline of daily physical activity recommended by most national health/fitness organizations, and he is doing so through a high-intensity exercise program. Clients who are pressed for time, and choose to exercise at higher intensities, should not become discouraged if they do not meet the 10,000 daily step guideline. As a health/fitness professional, you can explain this concept to them and encourage them to maintain their current exercise program.

The vast amount of scientific evidence points to the fact that no current drug or medication provides as many health benefits as a regular program of physical activity. Pedometer use will most likely continue to increase in coming years to help people monitor and adhere to physical activity. Being able to quantify

the distance required to accumulate 10,000 daily steps, and understanding the equivalent number of steps taken to meet this goal when exercising at faster speeds, can help clients meet daily activity goals to maintain recommended weight and attain substantial health and fitness benefits.



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CONDENSED VERSION AND BOTTOM LINE

General physical activity guidelines to improve and maintain health encourage adults to accumulate a minimum of 10,000 steps on most days of the week. To estimate how far people need to go to accumulate 10,000 steps, clients often want to know how many steps it takes to walk or run a mile. We tested individuals at a walking pace of 20 and 15 minutes per mile and a running pace of 12, 10, 8, and 6 minutes per mile. The number of steps required to cover a distance of 1 mile varies considerably according to the selected walking or running pace. The average number of steps ranged from 1,064 steps for a pace of 6 minutes per mile in men to 2,310 steps for a walk of 20 minutes per mile in women. One-mile step count prediction equations based on sex, pace, and height were formulated from the various walking and running speeds. Health/fitness professionals, however, should be aware that clients who choose to exercise at higher intensities take far fewer steps and less time to cover a given distance and may actually derive greater health and fitness benefits than those who exercise at lower intensities. Thus, clients who choose to exercise at a high-intensity level may not need to achieve the daily 10,000-step count.

RECOMMENDED READINGS:

The American College of Sports Medicine (ACSM) and the American Heart Association (AHA) have released updated physical activity recommendations for adults and older adults. Read the new guidelines today by visiting www.acsm.org and clicking on "Updated Physical Activity Guidelines."

Physical Activity and Public Health: Updated Recommendation for Adults from the American College of Sports Medicine and the American Heart Association. *Medicine & Science in Sports & Exercise*® 39(8) p.1423-1434, 2007.

Physical Activity and Public Health in Older Adults: Recommendation from the American College of Sports Medicine and the American Heart Association. *Medicine & Science in Sports & Exercise*® 39(8) p. 1435-1445, 2007.



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