



exercise and the heart

Is Brisk Walking an Adequate Aerobic Training Stimulus for Cardiac Patients?*

Kristen J. Quell, BS; John P. Porcari, PhD; Barry A. Franklin, PhD;
Carl Foster, PhD; Richard A. Andreuzzi, MS; and Ryan M. Anthony, MS

Walking is the most common aerobic training modality utilized in cardiac rehabilitation programs. However, it remains unclear whether or not brisk walking is of a sufficient intensity to improve aerobic fitness in this population. In this study, we investigated whether men and women with coronary artery disease can achieve an exercise intensity that is sufficient to induce a training effect, ie, a training heart rate (THR), defined as $\geq 70\%$ of measured maximal heart rate (HRmax), via brisk walking on a flat surface. One hundred forty-two outpatient volunteers from the William Beaumont Hospital Cardiac Rehabilitation Program (Royal Oak, MI) and the University of Wisconsin-La Crosse Exercise and Health Program (La Crosse, WI) were asked to walk one mile as briskly as possible on measured tracks. Heart rate was monitored throughout the walk via radiotelemetry. The percentage of patients within each gender and phase of rehabilitation who attained a THR were assessed using peak or symptom-limited exercise testing to determine the HRmax. All of the women and 90% of the men achieved a THR, averaging $85 \pm 8\%$ and $79 \pm 10\%$ of HRmax, respectively (mean \pm SD). There was no difference in the percentage of phase II or phase III cardiac rehabilitation program patients who achieved a THR. These findings suggest that brisk walking is of a sufficient intensity to elicit a THR in all but the most highly fit patients with coronary disease. Thus, physicians and allied health professionals can prescribe brisk walking on a flat surface to their cardiac patients with confidence that this intensity will achieve cardiorespiratory and health benefits. (CHEST 2002; 122:1852-1856)

Key words: aerobic capacity; brisk walking; cardiac rehabilitation; fitness; threshold exercise intensity; training heart rate

Abbreviations: HRmax = maximal heart rate; MET = metabolic equivalent; mph = miles per hour; RPE = rating of perceived exertion; THR = training heart rate

Research has shown that running, bicycling, and other popular forms of aerobic training provide a sufficient stimulus to improve cardiorespiratory fitness. Much less is known about the aerobic benefits of walking. The few studies that have evaluated

walking as a training modality support the effectiveness of this form of exercise in eliciting an aerobic training response. Porcari et al¹ reported that 91% of apparently healthy untrained women and 83% of men ≥ 50 years old could achieve an aerobic training threshold (defined as $\geq 70\%$ of maximal heart rate [HRmax]) via fast walking. Similarly, Spelman and colleagues² found that healthy, habitual walkers were able to attain at least 70% of HRmax while walking at self-selected paces. Previous studies in healthy individuals have also shown that brisk walking, if undertaken at moderate intensities (eg, three to four miles per hour), can result in improvements in health outcomes and aerobic capacity.^{3,4}

*From the Department of Medicine (Ms. Quell, Dr. Franklin, and Mr. Andreuzzi), Division of Cardiology (Cardiac Rehabilitation), William Beaumont Hospital, Royal Oak, MI; and the Department of Exercise and Sports Science (Drs. Porcari and Foster, and Mr. Anthony), University of Wisconsin-La Crosse, La Crosse, WI. Manuscript received April 16, 2002; revision accepted April 17, 2002.

Correspondence to: Barry A. Franklin, PhD, Beaumont Rehabilitation and Health Center, Cardiac Rehabilitation Department, 746 Purdy St, Birmingham, MI 48009; e-mail: bfranklin@beaumont.edu

Walking is the most common form of physical conditioning in most exercise-based cardiac rehabilitation programs. However, age-related losses in calf and quadriceps strength coupled with orthopedic or musculoskeletal limitations may limit how fast patients can walk, and thus hamper their ability to achieve an adequate training intensity.^{5,6} Empiric experience suggests that many older individuals and cardiac patients believe that vigorous exercise (*ie*, jogging or running) is required to achieve a training effect. The present study was designed to determine if brisk walking on level ground could provide an adequate aerobic training stimulus (training heart rate [THR], defined as $\geq 70\%$ of measured HRmax) in men and women with documented coronary artery disease.

MATERIALS AND METHODS

Subjects

We recruited patients from the phase II (early outpatient) and phase III (maintenance) cardiac rehabilitation programs at William Beaumont Hospital (Royal Oak, MI) and the University of Wisconsin-La Crosse to participate in the study protocol, which was approved by the human investigation committees of these respective institutions. Selected low-to-moderate-risk patients were deemed eligible to participate, provided they had undergone a recent (generally within the previous 6 months) maximal graded exercise test to volitional fatigue, and had not had subsequent changes in heart rate-altering medications.

Laboratory Testing Procedures

Patients underwent peak or symptom-limited exercise treadmill testing using primarily Bruce or modified Bruce protocols.⁷ Patients were encouraged to exercise to volitional fatigue or until they experienced limiting symptoms. During each exercise stage and recovery stage, symptoms (*eg*, chest discomfort, shortness of breath, fatigue, dizziness, leg pain), BP, heart rate, ischemic ST-segment depression (defined as ≥ 1 mm of horizontal or downsloping ST-segment depression 80 ms after the J point), cardiac rhythm, and exercise workload were recorded. Aerobic fitness was estimated for each subject, expressed as metabolic equivalents (METs) [1 MET = 3.5 mL O₂/kg/min], based on treadmill speed, grade, and test duration (minutes), using established regression equations for cardiac patients.⁸ Tight gripping of the handrails during treadmill testing was not permitted, as this has been shown to decrease the actual energy expenditure and to increase performance time, resulting in an overestimation of aerobic capacity.⁹ In some instances, balance was facilitated by the subject's finger or palm placement on the handrail.

Field Testing Procedures

Following a preliminary warm-up consisting of stretching exercises and low-level ambulatory activities, each subject was asked to walk one mile as briskly as possible. At the Beaumont testing site, all walks were conducted on a course around the

perimeter of a gymnasium (22 laps per mile); at the La Crosse testing site, the walks were performed on a measured indoor track (8 laps per mile). All of the walks were performed individually and were not paced in any manner. During the walk, heart rate was monitored and recorded each minute using a telemetry ECG system (Vitalcom; Tustin, CA) or a heart rate monitor (Polar; Port Washington, NY) at the Beaumont and La Crosse sites, respectively. At the conclusion of the one-mile walk, subjects were asked to provide a rating of perceived exertion (RPE) using the Borg (6–20) scale.¹⁰

Data Analysis

Because heart rates recorded during the first quarter mile reflect a transition from rest to exercise, and heart rates during the last quarter mile may be influenced by fatigue, heart rates from the middle portion of the walk (*ie*, the entire two middle quarter-mile segments) were averaged and compared with the patient's HRmax during exercise testing. The goal of the analysis was to determine the percentage of cardiac rehabilitation patients that can achieve a THR, defined as $\geq 70\%$ of HRmax. Differences between men and women as well as differences between phase II and phase III patients were also evaluated. A discriminate function analysis was used to identify variables that differentiated between those who did and did not achieve a THR.

RESULTS

A total of 142 patients (28 women and 114 men; mean \pm SD age, 64.2 \pm 9.9 years and 63.4 \pm 9.5 years, respectively) volunteered to participate in the study and completed the protocol without adverse cardiac signs or symptoms. This number included 41 phase II patients and 101 phase III patients. All subjects had a history of angiographically documented coronary artery disease, coronary bypass graft surgery, myocardial infarction, percutaneous transluminal coronary angioplasty/stenting, or combinations thereof. Only 1 of the 142 patients, a woman, was a current cigarette smoker. Medications received by the patients included β -blockers (65%), antiplatelet agents (91%), calcium antagonists (15%), angiotensin-converting enzyme inhibitors (20%), inotropic agents (7%), lipid-lowering medications (68%), nitrates (13%), and diuretics (12%). Descriptive characteristics of the subjects are shown in Table 1.

Of the patients tested, all of the women ($n = 28$) and 90% of the men (103 of 114 patients) achieved

Table 1—Descriptive Characteristics of the Subjects*

Subjects	Age, yr	Height, cm	Weight, kg	Maximal METs†
Women	64.2 \pm 9.9	164.1 \pm 7.7	71.4 \pm 17.5	7.0 \pm 1.6
Men	63.4 \pm 9.5	177.0 \pm 7.1†	86.3 \pm 15.7†	8.9 \pm 1.2†

*Data are presented as mean \pm SD.

†Estimated from the laboratory treadmill exercise test.

‡Significantly different than women ($p < 0.05$).

a THR, averaging $85 \pm 8\%$ and $79 \pm 10\%$ of HRmax, respectively. Table 2 shows the mean (\pm SD) data from the one-mile walk test. There was no significant difference in the percentage of phase II or phase III patients who achieved a THR (88% and 91%, respectively). Only 3 of the 142 patients tested averaged $< 65\%$ HRmax during the walk. Estimated maximal METs was the only significant discriminating factor between those men who did ($n = 103$) and did not ($n = 11$) attain a THR (8.8 vs 10.4, respectively; $p < 0.05$). However, there was a tendency for HRmax to be higher (145 ± 22 beats/min vs 133 ± 23 beats/min, respectively; $p = 0.08$) and RPE to be lower (11.4 ± 2.1 vs 12.0 ± 1.2 , respectively; $p = 0.16$) in those men who did not attain a THR. The lower RPE values were particularly evident in the phase II men (9.8 ± 2.1 vs 11.6 ± 1.2 , respectively); however, the difference did not reach statistical significance ($p = 0.20$).

DISCUSSION

The results of this study corroborate previous research in healthy adults and suggest that most cardiac patients can use walking on a flat surface to provide an aerobic training stimulus. All of the women in the present study and 90% of the men (regardless of the rehabilitation phase, phase II or phase III) achieved a THR with brisk walking, defined as $\geq 70\%$ of HRmax.

The threshold value of 70% HRmax used in the current investigation is consistent with the minimal effective training intensities identified in previous reports,^{1,2,11} including a recent analysis of 23 studies of aerobically trained cardiac patients,¹² and is slightly above the minimal threshold range (55 to 64% HRmax) recommended by the American College of Sports Medicine for improving cardiorespiratory fitness in individuals who are quite unfit.¹³ Although the threshold intensity for

improving aerobic fitness can be quite variable, particularly at the lower end of the continuum, it is largely dependent on the initial fitness level of the individual patient.^{11,12} Exercise intensities for outpatient cardiac rehabilitation participants are generally prescribed in the range 60 to 80% of aerobic capacity, which approximates 70 to 85% HRmax.^{8,14,15} Provided that exercise is performed above the lower end of this range, the total volume of exercise arguably becomes the most important determinant of benefits, with low-to-moderate intensity/long-duration programs showing comparable benefits to higher-intensity/shorter-duration programs.¹⁶ Because a goal for many cardiac rehabilitation patients is to reduce body weight and fat stores, exercise prescriptions that utilize more moderate intensities and an extended duration are often preferred. Additionally, these training regimens are associated with a reduced cardiovascular^{17,18} and orthopedic risk,¹⁹ and an improved exercise adherence.^{20,21}

Relative to exercise benefits, increased cardiorespiratory fitness has traditionally been emphasized more than the potential for improved health and disease prevention. Consequently, many persons consider exercise as being synonymous with vigorous physical activity, like jogging or running. A major goal of our study was to dispel the notion that patients with heart disease must jog or run in order to attain a THR. We found that women and men who walked at average speeds of 2.9 ± 0.5 miles per hour (mph) [range, 2.2 to 4.5 mph] and 3.3 ± 0.5 mph (range, 2.2 to 4.5 mph) respectively, generally achieved a THR. These speeds should be readily attainable for the majority of patients in cardiac rehabilitation programs, regardless of the setting (*ie*, traditional supervised vs home-based).

Although a small number of our patients (men only) failed to achieve a THR (11 of 142 patients), it is likely that substantial health benefits would still have been realized from their attained exercise intensities, provided that the frequency and duration of training were appropriate. Research has shown that numerous health benefits can be derived at more moderate exercise intensities, that is, at intensities below those commonly prescribed for cardiorespiratory conditioning (*ie*, $< 70\%$ HRmax). These include favorable changes in bone density, glucose tolerance, and coronary risk factors, as well as a reduction in cardiovascular-related mortality.^{22,23}

The only variable that differentiated between those subjects who achieved a THR vs those who did not was the estimated maximal MET capacity. In the current study, those men who failed to reach a THR tended to

Table 2—Results of 1-Mile Walk Test*

Variables	Women	Men
1-mile walk time, min:s	20:12 \pm 3:48	17:48 \pm 3:31†
Heart rate during 1-mile walk, beats/min	105 \pm 14	104 \pm 14
HRmax from graded exercise test, beats/min	125 \pm 23	132 \pm 23
HRmax attained, %	85 \pm 8	79 \pm 10†
RPE during 1-mile walk (6-20 scale)	13.4 \pm 1.8	12.0 \pm 1.5†

*Data are presented as mean \pm SD.

†Significantly different than women ($p < 0.05$).

have an aerobic capacity > 10 METs, as previously reported in healthy adults.¹ There is clearly a biomechanical ceiling as to how fast a given individual can walk, and since somatic oxygen consumption is related to walking velocity,²⁴ more highly fit individuals are limited in their ability to increase exercise intensity sufficiently to reach a training threshold.

Although it did not reach statistical significance, there was a strong tendency for men in the phase II program who failed to achieve a THR to walk at a lower RPE value as compared with their counterparts who achieved a THR. This trend was not apparent in the previously trained phase III men. All of the subjects were given similar instructions, that is, to walk the mile as briskly as possible. It is possible that a small number of men in the phase II program who did not achieve a THR, especially novice exercisers, may have lacked the confidence to engage in unconventionally vigorous physical activity.

There are several potential limitations of this study. Our subjects were predominantly male (114 of 142 patients, 80%), yet approximated the ratio of men to women (4:1) who are typically referred to exercise-based cardiac rehabilitation programs.²⁵ Because most subjects were already exercising on a regular basis (*ie*, phase III patients [101 of 142 patients, 71%]), this should serve to increase the generalizability of our findings. Exercise capacity in METs was also estimated, not directly measured using gas exchange techniques. The use of the Bruce treadmill protocol, with its incremental stages, may have resulted in an overestimation of maximal METs.²⁶ Nevertheless, the relative threshold intensity for aerobic training (*ie*, 70% HRmax) would remain unchanged,⁸ but simply reflect a lower absolute metabolic load or oxygen uptake.

In summary, the present findings suggest that physicians and allied health professionals can prescribe brisk walking on a flat surface to their cardiac patients with confidence that this intensity will achieve cardiorespiratory and health benefits. Furthermore, these results serve to discount the lingering notion that cardiac patients need to participate in vigorous exercise such as jogging or running in order to benefit from an exercise training program. Although some studies suggest an even lower training threshold than the one used in the present study (*ie*, < 70% HRmax), especially in extremely deconditioned subjects,^{11,12} if individuals can regularly attain a training intensity of at least 70% HRmax via brisk walking, it is likely that they will achieve improved aerobic fitness. These findings may be especially relevant for the inactive patient in whom

the subjective discomfort of vigorous physical training may serve as a deterrent to long-term compliance with exercise therapy.

REFERENCES

- 1 Porcari JP, McCarron R, Kline G, et al. Is fast walking an adequate aerobic training stimulus for 30 to 69 year-old men and women? *Phys Sports Med* 1987; 1:119-129
- 2 Spelman CC, Pate RR, Macera CA, et al. Self-selected exercise intensity of habitual walkers. *Med Sci Sports Exerc* 1993; 25:1174-1179
- 3 Suter E, Marti B, Gutzwiller F. Jogging or walking: comparison of health effects. *Ann Epidemiol* 1994; 4:375-381
- 4 Pate RR, Pratt M, Blair SN, et al. Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA* 1995; 273:402-407
- 5 Bendall MJ, Bassey EJ, Pearson MB. Factors affecting walking speed of elderly people. *Age Ageing* 1989; 18:327-332
- 6 Gibbs J, Hughes S, Dunlop D, et al. Predictors of change in walking velocity in older adults. *J Am Geriatr Soc* 1996; 44:126-132
- 7 Bruce RA, Kusumi F, Hosmer D. Maximal oxygen intake and nomographic assessment of functional aerobic impairment in cardiovascular disease. *Am Heart J* 1973; 85:546-562
- 8 American College of Sports Medicine. ACSM's guidelines for exercise testing, and prescription. 6th ed. In: Franklin BA, Whaley MH, Howley ET, eds. Baltimore, MD: Lippincott Williams and Wilkins, 2000.
- 9 Ragg KE, Murray TP, Karbonit LM, et al. Errors in predicting functional capacity from a treadmill exercise stress test. *Am Heart J* 1980; 100:581-583
- 10 Borg G. Psychophysical bases of perceived exertion. *Med Sci Sports Exerc* 1982; 14:377-381
- 11 Swain DP, Franklin BA. VO_2 reserve and the minimal intensity for improving cardiorespiratory fitness. *Med Sci Sports Exerc* 2002; 34:152-157
- 12 Swain DP, Franklin BA. Is there a threshold intensity for aerobic training in cardiac patients? *Med Sci Sports Exerc* 2002; 34:1071-1075
- 13 Pollock ML, Gaesser GA, Butcher JD, et al. ACSM Position Stand: the recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. *Med Sci Sports Exerc* 1998; 30:975-991
- 14 Franklin BA, Gordon S, Timmis GC. Amount of exercise necessary for the patient with coronary artery disease. *Am J Cardiol* 1992; 69:1426-1432
- 15 Londeree BR, Ames SA. Trend analysis of the % VO_2 max - HR regression. *Med Sci Sports Exerc* 1976; 8:123-125
- 16 Blumenthal JA, Rejewski WJ, Walsh-Riddle M, et al. Comparison of high- and low-intensity exercise training early after acute myocardial infarction. *Am J Cardiol* 1988; 61:26-30
- 17 Hossack KF, Hartwig R. Cardiac arrest associated with supervised cardiac rehabilitation. *J Cardiac Rehabil* 1982; 2:402-408
- 18 Foster C, Porcari JP. The risks of exercise training. *J Cardiol Rehabil* 2001; 21:347-352
- 19 Pollock ML, Miller HS Jr, Janeway R, et al. Effects of walking on body composition and cardiovascular function of middle-aged men. *J Appl Physiol* 1971; 30:126-130
- 20 Pollock ML. Prescribing exercise for fitness and adherence. In: Dishman RK, ed. Exercise adherence: its impact on public health. Champaign, IL: Human Kinetics Books, 1988; 259-277

- 21 Dishman RK, Sallis JF, Orenstein DR. The determinants of physical activity and exercise. *Public Health Rep* 1985; 100:158-171
- 22 Blair SN, Kohl HW III, Paffenbarger RS Jr, et al. Physical fitness and all-cause mortality: a prospective study of healthy men and women. *JAMA* 1989; 262:2395-2401
- 23 Vanhees L, Fagard R, Thijs L, et al. Prognostic significance of peak exercise capacity in patients with coronary artery disease. *J Am Coll Cardiol* 1994; 23:358-363

- 24 Bubb WJ, Martin AD, Howley ET. Predicting oxygen uptake during level walking at speeds of 80-130 m/min. *J Cardiopulm Rehabil* 1985; 5:462-465
- 25 Froelicher VF, Herbert W, Myers J, et al. How cardiac rehabilitation is being influenced by changes in health-care delivery. *J Cardiopulm Rehabil* 1996; 16:151-159
- 26 Myers J, Buchanan N, Walsh D, et al. Comparison of the ramp vs standard exercise protocols. *J Am Coll Cardiol* 1991; 17:1334-1342

NetWorks

NetWorks Make the Difference...
You Can Too!

NetWorks are interdisciplinary, special interest groups providing the opportunity for personal involvement in the ACCP. NetWorks provide an outlet for action on a national level, establishing forums for advocacy, leadership, communication, and education. You can help make a difference by becoming involved in any one of the ACCP NetWorks. For more details on NetWorks, visit ChestNet at www.chestnet.org/sections/networks/.

Are you NetWorked yet?
Join the NetWork of your choice today!

e-mail: networks@chestnet.org

phone: Marla Brichta: 847-498-8364

Ellyn Shapiro: 847-498-8332

