



Exercise and Cardiovascular Health

Jonathan Myers, PhD



Over the past 4 decades, numerous scientific reports have examined the relationships between physical activity, physical fitness, and cardiovascular health. Expert panels, convened by organizations such as the Centers for Disease Control and Prevention (CDC), the American College of Sports Medicine (ACSM), and the American Heart Association (AHA),¹⁻³ along with the 1996 US Surgeon General's Report on Physical Activity and Health,⁴ reinforced scientific evidence linking regular physical activity to various measures of cardiovascular health. The prevailing view in these reports is that more active or fit individuals tend to develop less coronary heart disease (CHD) than their sedentary counterparts. If CHD develops in active or fit individuals, it occurs at a later age and tends to be less severe.

As many as 250 000 deaths per year in the United States are attributable to a lack of regular physical activity. In addition, studies that followed large groups of individuals for many years have documented the protective effects of physical activity for a number of noncardiovascular chronic diseases, such as non-insulin-dependent diabetes, hypertension, osteoporosis, and colon cancer.⁴ In contrast, we see a higher rate of cardiovascular events

and a higher death rate in those individuals with low levels of physical fitness.^{1,4} Even midlife increases in physical activity, through change in occupation or recreational activities, are associated with a decrease in mortality.⁵ Despite this evidence, however, the vast majority of adults in the United States remains effectively sedentary; less than one-third of Americans meets the minimal recommendations for activity as outlined by the CDC, ACSM, and AHA expert panels.

What Are the Benefits of Exercise?

A sedentary lifestyle is one of the 5 major risk factors (along with high blood pressure, abnormal values for blood lipids, smoking, and obesity) for cardiovascular disease, as outlined by the AHA. Evidence from many scientific studies shows that reducing these risk factors decreases the chance of having a heart attack or experiencing another cardiac event, such as a stroke, and reduces the possibility of needing a coronary revascularization procedure (bypass surgery or coronary angioplasty). Regular exercise has a favorable effect on many of the established risk factors for cardiovascular disease. For example, exercise promotes weight reduction and can help reduce

blood pressure. Exercise can reduce "bad" cholesterol levels in the blood (the low-density lipoprotein [LDL] level), as well as total cholesterol, and can raise the "good" cholesterol (the high-density lipoprotein level [HDL]). In diabetic patients, regular activity favorably affects the body's ability to use insulin to control glucose levels in the blood. Although the effect of an exercise program on any single risk factor may generally be small, the effect of continued, moderate exercise on overall cardiovascular risk, when com-

BENEFITS OF REGULAR EXERCISE ON CARDIOVASCULAR RISK FACTORS

- Increase in exercise tolerance
- Reduction in body weight
- Reduction in blood pressure
- Reduction in bad (LDL and total) cholesterol
- Increase in good (HDL) cholesterol
- Increase in insulin sensitivity

From the Cardiology Division, VA Palo Alto Health Care System, Stanford University, Palo Alto, Calif.
Correspondence to Jonathan Myers, PhD, Cardiology 111-C, VA Palo Alto Health Care System, 3801 Miranda Ave, Palo Alto, CA 94304. E-mail drj993@aol.com

(*Circulation*. 2003;107:e2-e5.)

© 2003 American Heart Association, Inc.

Circulation is available at <http://www.circulationaha.org>

DOI: 10.1161/01.CIR.0000048890.59383.8D

bined with other lifestyle modifications (such as proper nutrition, smoking cessation, and medication use), can be dramatic.

There are a number of physiological benefits of exercise; 2 examples are improvements in muscular function and strength and improvement in the body's ability to take in and use oxygen (maximal oxygen consumption or aerobic capacity). As one's ability to transport and use oxygen improves, regular daily activities can be performed with less fatigue. This is particularly important for patients with cardiovascular disease, whose exercise capacity is typically lower than that of healthy individuals. There is also evidence that exercise training improves the capacity of the blood vessels to dilate in response to exercise or hormones, consistent with better vascular wall function and an improved ability to provide oxygen to the muscles during exercise. Studies measuring muscular strength and flexibility before and after exercise programs suggest that there are improvements in bone health and ability to perform daily activities, as well as a lower likelihood of developing back pain and of disability, particularly in older age groups.

Patients with newly diagnosed heart disease who participate in an exercise program report an earlier return to work and improvements in other measures of quality of life, such as more self-confidence, lower stress, and less anxiety. Importantly, by combining controlled studies, researchers have found that for heart attack patients who participated in a formal exercise program, the death rate is reduced by 20% to 25%. This is strong evidence in support of physical activity for patients with heart disease. Although the benefits of exercise are unquestionable, it should be noted that exercise programs alone for patients with heart disease have not convincingly shown improvement in the heart's pumping ability or the diameter of the coronary vessels that supply oxygen to the heart muscle.

How Much Exercise Is Enough?

In 1996, the release of the Surgeon General's Report on Physical Activity and Health provided a springboard for the larg-

est government effort to date to promote physical activity among Americans. This historic turning point redefined exercise as a key component to health promotion and disease prevention, and on the basis of this report, the Federal government mounted a multi-year educational campaign. The Surgeon General's Report, a joint CDC/ACSM consensus statement, and a National Institutes of Health report agreed that the benefits mentioned above will generally occur by engaging in at least 30 minutes of modest activity on most, preferably all, days of the week. Modest activity is defined as any activity that is similar in intensity to brisk walking at a rate of about 3 to 4 miles per hour. These activities can include any other form of occupational or recreational activity that is dynamic in nature and of similar intensity, such as cycling, yard work, and swimming. This amount of exercise equates to approximately five to seven 30-minute sessions per week at an intensity equivalent to 3 to 6 METs (multiples of the resting metabolic rate*), or approximately 600 to 1200 calories expended per week.

Note that the specific phrase "...30 minutes of accumulated activity..." is used in the above-mentioned reports. It has been shown that repeated intermittent or shorter bouts of activity (such as 10 minutes) that include occupational

*One MET is the amount of energy required at rest, equal to approximately 70 calories per hour; 3 METs represents an exercise intensity equivalent to 3 times the metabolic rate at rest.

and recreational activity or the tasks of daily living have similar cardiovascular and other health benefits if performed at the moderate intensity level with an accumulated duration of at least 30 minutes per day. People who already meet these standards will receive additional benefits from more vigorous activity.

Average MET Levels and Caloric Costs for Common Activities

Activity	METs	Calories/ Hour
Walking 2.0 mph	2.5	175
Walking 3.0 mph	3.5	245
Golf (with cart)	2.5	175
Golf (without cart)	4.9	340
Calisthenics (no weights)	4.0	280
Gardening	4.4	310
Cycling (leisurely)	4.0	280
Cycling (moderately)	5.7	400
Swimming (slowly)	4.5	315
Swimming (fast)	7.0	490
Climbing hills		
No load	6.9	480
With 5 kg load	7.5	525
Tennis (singles)	7.5	525
Tennis (doubles)	6.0	420
Running (10 min mile)	10.2	710
Running (7.5 min/mile)	13.2	930

Many of the studies documenting the benefits of exercise typically use

RECOMMENDATION FOR PHYSICAL ACTIVITY FROM THE CDC/ACSM CONSENSUS STATEMENT AND SURGEON GENERAL'S REPORT

Every American adult should participate in 30 minutes or more of moderate intensity activity on most, and preferably all, days of the week.

- Moderate activities: activities comparable to walking briskly at about 3 to 4 miles per hour; may include wide variety of occupational or recreational activities, including yard work, household tasks, cycling, swimming, etc.
- Thirty minutes of moderate activity daily equates to 600 to 1200 calories of energy expended per week.

programs consisting of 30 to 60 minutes of continuous exercise 3 days per week at an intensity corresponding to 60% to 75% of the individual's heart rate reserve. It is not usually necessary, however, for healthy adults to measure heart rate diligently because substantial health benefits can occur through modest levels of daily activity, irrespective of the specific exercise intensity. In fact, researchers estimate that as much as a 30% to 40% reduction in cardiovascular events is possible if most Americans were simply to meet the government recommendations for activity.

Estimation of Exercise Intensity Using Heart Rate Reserve

$$\frac{(\text{Maximal heart rate}^* - \text{resting heart rate}) \times \text{desired exercise intensity}^\dagger}{\text{resting heart rate}}$$

Example:

$$\begin{aligned} \text{Maximal heart rate} &= 150 \text{ beats/min} \\ - \text{Resting heart rate} &= 70 \text{ beats/min} \\ &= 80 \text{ beats/min} \\ \times \text{Desired intensity} &= 60\% (0.60) \\ &= 48 \text{ beats/min} \\ + \text{Resting heart rate} &= 70 \text{ beats/min} \\ = \text{Training heart rate} &= 118 \text{ beats/min} \end{aligned}$$

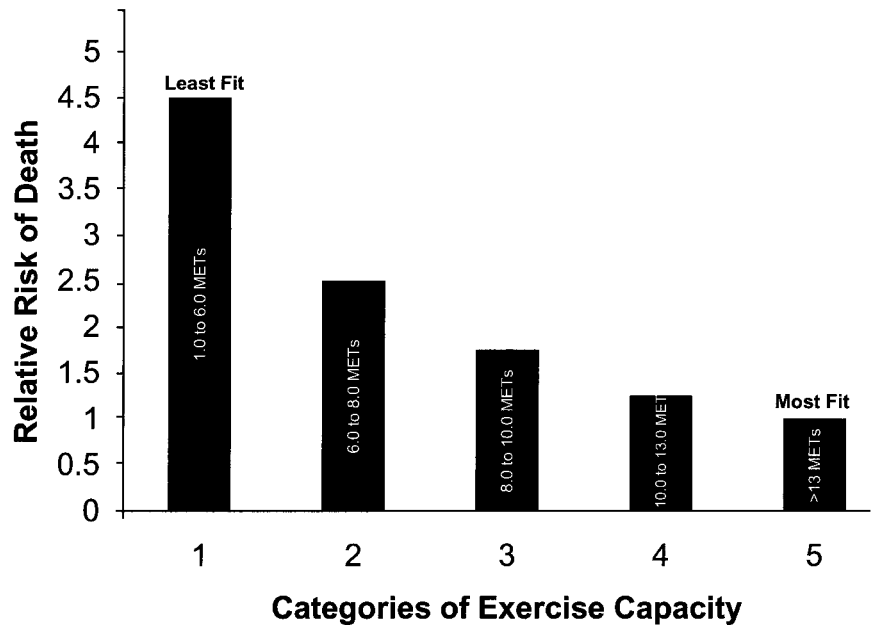
A reasonable training heart rate for this individual would be 115 to 120 beats/min

*Although maximal heart rate range is commonly determined by a formula such as $220 - \text{age}$, such estimates are not very accurate; maximal heart rate can only be determined accurately from a maximal exercise test.

†Desired exercise intensity is usually 60% to 80%.

Physical Fitness and Mortality

One need not be a marathon runner or an elite athlete to derive significant benefits from physical activity. In fact, the Surgeon General's physical activity recommendations seem surprisingly modest. One reason for this is that the greatest gains in terms of mortality are achieved when an individual goes from being sedentary to becoming moderately active. Studies show that less is gained when an individual goes from being moderately active to very active. In a study per-



Age-adjusted mortality rates in healthy men categorized by level of fitness. The range of values for exercise capacity (METs) for each category are represented within each bar (modified from reference 6).

formed among US veterans, subjects were classified into 5 categories according to fitness level. The largest gains in terms of mortality were achieved between the lowest fitness group and the next lowest fitness group. The researchers studied 6213 men over a 6-year period and compared the risks of death (after allowing for age adjustment) by gradients of physical fitness.⁶ The Figure shows the relative risks associated with the different categories (1 to 5, lowest to highest) of fitness measured. Healthy adults who are the least fit have a mortality risk that is 4.5 times that of the most fit. Surprisingly, an individual's fitness level was a more important predictor of death than established risk factors such as smoking, high blood pressure, high cholesterol, and diabetes. This study, along with others, underscores the fact that fitness and daily activity levels have a strong influence on the incidence of heart disease and overall mortality.

What Are the Risks of Exercise?

During exercise, there is a transient increase in the risk of having a

cardiac-related complication (for example, a heart attack or serious heart rhythm disorder). However, this risk is extremely small. For adults without existing heart disease, the risk of a cardiac event or complication ranges between 1 in 400 000–800 000 hours of exercise. For patients with existing heart disease, an event can occur an average of once in 62 000 hours.^{2,3} Importantly, the risk of a cardiac event is significantly lower among regular exercisers. Evidence suggests that a sedentary person's risk is nearly 50 times higher than the risk for a person who exercises about 5 times per week. Stated simply, individuals who exercise regularly are much less likely to experience a problem during exercise. Moreover, contrary to popular view, the majority of heart attacks (approximately 90%) occur in the resting state, not during physical activity.

Exercise is therefore considered to be extremely safe. Nevertheless, it is a good idea to be aware of the warning signs or symptoms that may indicate a problem: chest discomfort

(pain or pressure in the chest, jaw, or neck, possibly radiating into the shoulder, arm, or back), unusual shortness of breath, dizziness or light-headedness, and heart rhythm abnormalities (sensations of heart beat skipping, palpitations, or thumping). If one of these symptoms occurs, medical attention should be sought immediately (see also Cardiology Patient Page by Ornato JP, Hand MM. Warning signs of a heart attack. *Circulation*. 2001;104:1212-1213).

How Should You Begin if You Want to Become More Physically Active?

First, if you currently have heart disease or are over 45 years of age and have 2 or more risk factors (immediate family member with heart disease before age 55, cigarette smoking, high blood pressure, abnormal cholesterol levels, diabetes, sedentary lifestyle, or obesity), you should consult your physician before starting any type of exer-

cise.² Clearly, most people can derive significant benefits from integrating a half hour of moderate activity into their day. If you know you simply cannot or will not set aside a half hour of activity on a given day, then try to work more activities into the day by taking the stairs rather than the elevator, or try walking rather than driving a short distance to the store. Try to work several shorter periods of activity, such as 10 minutes, into your schedule. The most important thing is to get started. There is mounting evidence in the scientific literature that physical activity and physical fitness have a powerful influence on a host of chronic diseases, a fact underscored by the recent Surgeon General's report on Physical Activity and Health.⁴ Reducing the risk of heart disease through greater physical activity could have an enormous impact on health in the United States.

References

1. Pate RR, Pratt MP, Blair SN, et al. Physical activity and public health: a rec-

ommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA*, 1995; 273:402-407.

2. American College of Sports Medicine. *Guidelines for Exercise Testing and Prescription*. 6th ed. Baltimore, Md: Lippincott Williams & Wilkins; 2000.
3. Fletcher GF, Balady GJ, Amsterdam EA, et al. Exercise standards for testing and training: a statement for healthcare professionals from the American Heart Association. *Circulation*. 2001;104:1694-1740.
4. US Public Health Service, Office of the Surgeon General. *Physical Activity and Health: A Report of the Surgeon General*. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion; 1996.
5. Paffenbarger RS, Hyde RT, Wing AL, et al. The association of changes in physical-activity level and other lifestyle characteristics with mortality among men. *N Engl J Med*. 1993;328:538-545.
6. Myers J, Prakash M, Froelicher V, et al. Exercise capacity and mortality among men referred for exercise testing. *N Engl J Med*. 2002;346:793-801.

Exercise and Cardiovascular Health Jonathan Myers

Circulation. 2003;107:e2-e5

doi: 10.1161/01.CIR.0000048890.59383.8D

Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

Copyright © 2003 American Heart Association, Inc. All rights reserved.

Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the
World Wide Web at:

<http://circ.ahajournals.org/content/107/1/e2>

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in *Circulation* can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the [Permissions and Rights Question and Answer](#) document.

Reprints: Information about reprints can be found online at:
<http://www.lww.com/reprints>

Subscriptions: Information about subscribing to *Circulation* is online at:
<http://circ.ahajournals.org/subscriptions/>