Physical Inactivity
An Easily Modified Risk Factor?

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The classic modifiable risk factors for the development of coronary heart disease (CHD), derived from the Framingham Heart Study and other long-term epidemiological studies, are increased blood pressure, elevated plasma cholesterol, and cigarette smoking. However, evidence has been accumulating for many years suggesting that physical inactivity or the lack of exercise is also a potent force in this field. The pioneering studies by Morris et al from England\textsuperscript{1,2} and Paffenbarger et al from the United States\textsuperscript{3,4} demonstrated the importance of physical activity in reducing the risk of CHD. In 1953, Morris et al\textsuperscript{1} studied longshoremen according to their levels of physical activity. They found that coronary death rates were lower in the middle- and high-activity groups than in the low-activity group.\textsuperscript{2} Subsequently, Paffenbarger et al\textsuperscript{3} used a questionnaire to determine the activity index of a large sample of Harvard University alumni and found a progressive decline in both fatal and nonfatal coronary events with an increasing activity index up to 2000 kcal/wk. Further activity had little additional effect on the incidence of CHD.\textsuperscript{2} In 1970, Paffenbarger et al\textsuperscript{4} examined the prevalence of CHD in San Francisco, Calif, longshoremen according to their levels of physical activity. They found that coronary death rates were lower in the middle- and high-activity groups than in the low-activity group.\textsuperscript{3} Subsequently, Paffenbarger et al\textsuperscript{4} used a questionnaire to determine the activity index of a large sample of Harvard University alumni and found a progressive decline in both fatal and nonfatal coronary events with an increasing activity index up to 2000 kcal/wk. Further activity had little additional effect on the incidence of CHD. For their similar independent studies, these 2 investigators were awarded the first International Olympic Committee (IOC) Olympic Prize in 1996. Since their seminal findings, numerous epidemiological studies comparing groups of physically inactive subjects with active subjects have been published. Most of these studies have been reviewed\textsuperscript{5} and subjected to meta-analysis.\textsuperscript{6} Powell et al\textsuperscript{5} examined all studies published in the English language that contained adequate data to determine a relative risk or odds ratio for CHD at different amounts of physical activity. From this analysis, they concluded that “physical activity is inversely and causally related to the incidence of CHD.” Berlin and Colditz\textsuperscript{6} performed a meta-analysis on the studies reviewed by Powell et al\textsuperscript{5} and included results from studies published after that article. They found a summary relative risk of death from CHD of 1.9 (95\% CI 1.6 to 2.2) for physically inactive compared with active occupations.

In 1992, the American Heart Association published a position statement on exercise that stated, “There is a relation between physical inactivity and cardiovascular mortality, and inactivity is a risk factor for the development of coronary artery disease.”\textsuperscript{7} Also in 1995, the Centers for Disease Control and Prevention (CDC) and the American College of Sports Medicine (ACSM) came to a similar conclusion that increased physical activity had a protective effect against the development of CHD. In a joint statement, they recommended that “Every US adult should accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all days of the week.”\textsuperscript{8} In 1996, the first Surgeon General’s report to address physical activity and health was published by the US Department of Health and Human Services.\textsuperscript{9} The effort for producing this consensus document was led by the CDC and the President’s Council on Physical Fitness, with contributions from the Office of Chronic Disease Prevention, the National Heart, Lung, and Blood Institute (NHLBI), the AHA, the ACSM, and the American Alliance for Health, Physical Education, Recreation, and Dance. In this report,\textsuperscript{9} it is stated that “regular physical activity or cardiorespiratory fitness decreases the risk of cardiovascular disease mortality in general and of coronary heart disease in particular.” The Surgeon General’s report also stated that most adults who performed a moderate amount of physical activity (eg, 30 minutes of brisk walking or raking leaves, 15 minutes of running, or 45 minutes of playing volleyball) on a daily basis could significantly improve their health and quality of life.

The Honolulu Heart Program was established in the mid-1960s with the Framingham Heart Study used as a model. The first major study\textsuperscript{10} to emerge from the Honolulu Heart Program was on the increasing prevalence of heart disease and stroke in Japanese men living in Japan, Hawaii, and California and demonstrated the importance of lifestyle in development of CHD. From this same cohort, it was recently reported that walking in nonsmoking retired men (61 to 81 years old) carried a reduced risk of death from all causes.\textsuperscript{11} In addition, there was a trend for decreased mortality from CHD and stroke. The latest article from this program is published in this issue of Circulation\textsuperscript{12} and examines the effects of walking on morbidity and mortality from CHD in older men 71 to 93 years of age. The distance walked was determined at baseline in the Honolulu Heart Program, and the men were...
followed up for the development of CHD over a 2- to 4-year period. It was found that men who walked <0.25 mile/d had a 2-fold greater risk of CHD than those who walked >1.5 mile/d. Also men who walked 0.25 to 1.5 mile/d had a greater risk than men who walked longer distances. In addition, when distance walked was modeled as a continuous variable, the risk of CHD was reduced by 15% for every 0.5-mile/d increase in walking distance. The findings were not changed when adjusted for age and other risk factors, including smoking, total and HDL plasma cholesterol, hypertension, and diabetes. Adjustments were also made for medications such as aspirin and β-blockers and for an index of functional capacity derived from various measures of physical function, including hand strength, balance, and agility.

Evidence that genetic factors do not account for mortality differences with physical activity has been provided from a prospective cohort study in Finland, where a large group of twins were followed up for 17 years. Among the entire group, those who at baseline did the equivalent of 30 minutes of vigorous walking ≥6 times per month (conditioning exercisers) had a 43% reduction in age- and sex-adjusted death compared with the sedentary group. An even greater reduction (56%) was observed among twin pairs in which 1 twin was a conditioning exerciser.

The studies from the Honolulu Heart Program emphasize the importance of physical activity (participation in regular exercise) in contrast to physical fitness as determined by maximal oxygen uptake (V̇O₂ max) during graded treadmill exercise) in contrast to physical fitness as determined by twin was a conditioning exerciser.

A recent 19% reduction (56%) was observed among twin pairs in which 1 twin was a conditioning exerciser.

The studies from the Honolulu Heart Program emphasize the importance of physical activity (participation in regular exercise) in contrast to physical fitness as determined by maximal oxygen uptake (V̇O₂ max) during graded treadmill exercise). In a large cohort study in Dallas, Tex, those in the lowest quintile for physical fitness had a higher rate of all-cause mortality. and those who improved from the lowest age-related quintile of physical fitness to a higher quintile reduced their mortality risk by 44%. It has been suggested that cardiovascular fitness is a better indicator of physical activity than self-reported data. However, a 17-year follow-up of 4999 men aged 40 to 59 years in 1970/1971 in Copenhagen, Denmark, found that being very fit (highest V̇O₂ max quintile) but sedentary provided no protection against CHD or all-cause mortality. Conversely, a lower risk of mortality was associated with being unfit (lowest V̇O₂ max quintile) but active than with being unfit and sedentary. In the Harvard alumni, Paffenbarger et al found that there was a 4-fold increase of CHD in former varsity athletes whose physical activity dropped to <500 kcal/wk and was no better than inactive nonathletes (<5 h/wk intramural sports). These observations on fitness verses activity may be particularly relevant in elderly subjects. Data from a population of >2000 people >55 years from Sonoma, Calif, indicate that self-reported physical activity is poorly correlated with V̇O₂ max. This suggests that the beneficial effect of physical activity in the elderly may be the result of metabolic changes, which are not always reflected by improvements in cardiovascular performance.

Recently, increased physical activity has been shown to be a key factor in enabling people to attain old age without disability or becoming institutionalized. Among the aged, concerns about disability or institutionalization may be greater than their fear of death. Leveille et al found that among the most physically active of 1097 elderly adults studied at baseline and followed prospectively for 10 years, there was a 2-fold increase in the likelihood of dying without disability compared with those who were sedentary.

Four broad categories of possible mechanisms for the beneficial effects of exercise have been identified. The first is an antiatherogenic effect that includes an improved plasma lipid profile (increased HDL and decreased LDL and triglycerides), loss of body fat, increased sensitivity to insulin, and reduced blood pressure. The second is a reduced risk of thrombosis due to favorable changes in platelet adhesiveness, fibrinolysis, fibrinogen levels, and blood viscosity. The third is a reduced risk of myocardial ischemia due to a decreased myocardial oxygen demand and an increase in coronary blood flow during exercise. The increased coronary flow results from an increased vasodilator capacity. Also, recent evidence on reversal of endothelial dysfunction and improved exercise capacity with low-intensity exercise training (<4 METS) in patients with chronic heart failure may be quite relevant in the primary prevention of CHD. The fourth mechanism is a reduced occurrence of lethal ventricular arrhythmias due to increased vagal tone and reduced adrenergic activity during rest and exercise. Such adaptations of the autonomic nervous system with increased physical activity may account for an overall reduction in the risk of sudden death with habitual exercise.

The numerous articles in popular health magazines, the proliferation of health clubs, and the large numbers of participants in marathons and triathlons give the impression that the proportion of the US adult population deriving adequate physical activity is increasing markedly. However, for the majority, the opposite trend seems to be the case. According to the 1996 report of the Surgeon General, it is estimated that as many as 250,000 deaths per year in the United States are attributable to a lack of regular physical activity. The report found that 25% of all adults are sedentary, and >60% do not achieve the recommended amount of regular physical activity. The latest figures (1996) from the CDC showed that for the older (65 to 74 years old) population, the proportions who were inactive ranged seasonally from 33% in July to 56% in February. The adoption of exercise habits by the patient is a major challenge for physicians and other health professionals. It is a well-known problem that the intent to exercise often does not translate into adoption of exercise behavior. Physicians are in a strong position to influence the physical activity of their patients. In a survey conducted by the Perrier Corporation in 1979, 43% of inactive adults stated that a recommendation from their doctor would have influenced their involvement in sport.

These important behavioral issues led to the first NHLBI funding of a multicenter activity counseling trial to test the efficacy of 3 different interventions, delivered in clinical settings by a healthcare educator, to sustain an increase in physical activity by patients for ≥2 years. Participants in the standard-care group received physician advice consistent with national recommendations for physical activity counseling by physicians. The other 2 interventions were simplified from several empirically tested psychological theories of health behavior change. The staff-assisted program included an interactive, mail-based component linked to a low-cost...
incentive system. The staff-counseling program provided substantially more interpersonal contact and counseling. This study of 874 sedentary adults without serious health problems concluded last month, and final results will be published later this year.

From a public health standpoint, the findings that exercise is beneficial at any age, does not need to be strenuous or prolonged, includes activities at work and at home, and does not have to be done every day are extremely encouraging. As personal computers invade our lives and society becomes increasingly successful at reducing our need to move, opportunities for everyone to become more physically active should be given a high priority. Encouragement from physicians is of particular importance in this endeavor. Physical activity may not add many years to life but, more importantly, may add life to years. Thus, increasing the level of moderate physical activity may be a simple and low-cost solution to the spiraling costs of caring for our burgeoning elderly population.

References

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