

## Active Lifestyle and Diabetes

Jonathan Myers, PhD; J. Edwin Atwood, MD; Victor Froelicher, MD

The evidence demonstrating that physical inactivity plays a role in the development of several chronic diseases continues to grow. Since the 1950s, numerous scientific reports have examined the relationships between physical activity, physical fitness, and health outcomes. Expert panels convened by organizations such as the Centers for Disease Control and Prevention, the American College of Sports Medicine, and the American Heart Association,<sup>1-3</sup> along with the US Surgeon General's report on physical activity and health,<sup>4</sup> have reinforced the association between regular physical activity and health. These reports support the concept that more active or fit individuals tend to experience less coronary heart disease (CHD) and have lower mortality rates than their sedentary counterparts, and when they do acquire CHD, it occurs at a later age and tends to be less severe. The increasing incidence of type 2 diabetes over the last decade, along with the established link between diabetes and cardiovascular disease, has generated interest in the effects of physical activity on insulin sensitivity, glycemic control, and the incidence of diabetes. In this issue of *Circulation*, Tanasescu et al<sup>5</sup> add to the evidence that physical activity reduces cardiovascular mortality in those with existing diabetes. Despite the scientific evidence and the organizational efforts, these messages have not reached the public, because physical activity is vastly underutilized in the management of diabetes, and the majority of individuals remain sedentary or do too little exercise to achieve health benefits.<sup>2,3</sup>

---

### See p 2435

---

The study by Tanasescu et al<sup>5</sup> examined the relationship between physical activity, risk of cardiovascular disease (CVD), and mortality in a large cohort of men with type 2 diabetes. The strengths of the study include its prospective design, size, and consideration of lifestyle changes by repeat measurements every 2 years. They studied 2803 men free from physical impairment with diabetes at age 30 or older in the Health Professionals' Follow-Up Study. The highest quintile of total physical activity had 33% less CVD and 42% fewer deaths than the lowest quintile. Walking was associated with reduced risk of mortality and walking pace was inversely associated with CVD, fatal CVD, and total mortality,

independent of walking hours. Importantly, because marked decreases in risk were associated simply with walking or similar modest levels of activity (eg, there were >70% reductions in CVD among those engaging in the equivalent of walking an hour 4 to 7 times/wk), the results confirm previous studies demonstrating that significant health benefits can be by achieved by modest exercise levels.

### Association Between Physical Activity and Health

It is estimated that 250 000 deaths per year in the United States are attributable to lack of regular physical activity.<sup>6</sup> Ongoing prospective studies have provided consistent evidence documenting the protective effects of activity for a number of chronic diseases, including CHD, type 2 diabetes, hypertension, osteoporosis, and site-specific cancers.<sup>1-5</sup> In contrast, low levels of physical fitness are consistently associated with higher cardiovascular and all-cause mortality rates. Moreover, midlife increases in physical activity, through change in occupation or recreational activities, are associated with a decrease in mortality rates.<sup>7</sup>

The landmark epidemiological work of Paffenbarger and associates among Harvard alumni, along with 10- to 20-year follow-up studies among British Civil Servants and US cohorts of railroad workers, physicians, and nurses, as well as other target populations,<sup>8-12</sup> have combined to provide convincing evidence in support of physical activity. A consistent finding is that the largest health benefits appear to occur through engaging in moderate activity levels. Moderate is generally defined as activity performed at an intensity of 3 to 6 METs, roughly equivalent to brisk walking for most adults. When expressed as kcals/wk (including walking, stair climbing, or recreational activities), >40% reductions in mortality can be achieved by expending 1000 to 2000 kcals/wk, equivalent to three to five 1-hour sessions of moderate activity.

### Association Between Physical Fitness and Health

Because physical fitness is related to physical activity patterns, physical activity guidelines often consider fitness a surrogate measure of activity. The relative strength of fitness as compared with activity pattern and its association with morbidity and mortality has been the topic of recent debate. Studying the independent effects of activity and fitness is difficult because although the 2 are clearly linked, the latter carries an important genetic component; that is, some people remain comparatively fit without engaging in a great deal of physical activity. Studies have been performed in which exercise capacity was measured among large samples, and it has been demonstrated that higher levels of fitness are independently associated with lower rates of CHD, all-cause

---

The opinions expressed in this editorial are not necessarily those of the editors or of the American Heart Association.

From the Cardiology Division, VA Palo Alto Health Care System and Stanford University, Palo Alto, Calif (J.M., V.F.); and Walter Reed USA Army Medical Clinic, Washington, DC (J.E.A.).

Correspondence to Jonathan Myers, PhD, Cardiology 111C, VA Palo Alto HCS, 3801 Miranda Ave, Palo Alto, CA 94304. E-mail drj993@aol.com

(*Circulation* 2003;107:2392-2394.)

© 2003 American Heart Association, Inc.

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

DOI: 10.1161/01.CIR.0000067882.00596.FC

mortality, or other chronic diseases, including cancer and diabetes.

Blair and associates<sup>13</sup> assessed fitness by treadmill performance in a healthy cohort of 10 244 men and 3120 women and followed them for 110 482 person-years for all-cause mortality. A gradient was observed, with age-adjusted mortality higher as fitness decreased. This issue has also been addressed in patients referred for exercise testing for clinical reasons. Over the last 5 years, cohorts from the Mayo Clinic, Cleveland Clinic, and the Veterans Administration have documented the importance of exercise capacity as a predictor of mortality among clinically-referred populations. These clinically-based studies confirm the observations from the Cooper Clinic, Framingham, and the Lipid Research Clinics Trial among asymptomatic populations, underscoring the fact that fitness level has a strong and independent influence on the incidence of cardiovascular and all-cause morbidity and mortality.

## Exercise and Diabetes

### Prevention of Diabetes

Several lines of evidence support the concept that physical activity contributes to the prevention of diabetes. First, type 2 diabetes is linked to adult onset weight gain and a sedentary lifestyle. Along with family history, the strongest predisposing factor for type 2 diabetes is obesity. However, physical inactivity increases the risk of diabetes independent of obesity. In addition, physically active societies have a lower incidence of diabetes than less active societies, and cross-sectional studies have demonstrated inverse associations between the prevalence of type 2 diabetes and physical activity. This inverse association has been largely attributed to the fact that exercise increases insulin sensitivity, improves glucose tolerance, and promotes weight loss.

A study among 5990 University of Pennsylvania alumni assessed the incidence of diabetes over nearly 100 000 person-years of follow-up.<sup>14</sup> It was observed that leisure time physical activity was inversely related to the development of type 2 diabetes. In addition, the protective effect of activity was strongest in persons at the highest risk for diabetes. Hu et al<sup>12</sup> sought to clarify the role of moderate-intensity activity such as walking on the risk of developing type 2 diabetes. More than 70 000 females from the Nurses Health Study who did not have diabetes or other illnesses at baseline were considered. Risk of type 2 diabetes by quintile of metabolic equivalent score, based on time spent per week on each of 8 common physical activities, was calculated. Over 8 years and more than 500 000 person-years follow-up, they documented 1419 incident cases of type 2 diabetes. After adjusting for age and other covariates, the relative risks of developing type 2 diabetes decreased progressively as activity pattern increased, with the most active group demonstrating a 50% reduction in risk compared with the least active group. Among women who did not perform vigorous activity, a similar pattern for reduction of diabetes incidence was observed after simply quantifying energy expenditure from walking. Faster usual walking pace was independently associated with decreased risk. Similar findings were also reported from the Nurses'

Health cohort using engagement in moderate-to-vigorous physical activity for at least half an hour per day considered as part of a healthy lifestyle.<sup>15</sup> At the Cooper Clinic, data from 8633 nondiabetic men who had been examined at least twice were studied to determine whether fitness was associated with risk for impaired fasting glucose and type 2 diabetes.<sup>16</sup> After adjustment for age, parental diabetes, and other risk factors, men in the low-fitness group at baseline had twice the risk for impaired fasting glucose and a 4-fold risk for diabetes compared with those in the high-fitness group over a mean follow-up of 6 years. The findings of these 4 studies, just highlights from the available literature, document an association between physical inactivity or poor fitness and the development of diabetes, and support the hypothesis that type 2 diabetes can be prevented by the adoption of a healthier lifestyle, including exercise.

### Exercise and Prevention of CVD and Death in Diabetics

Because CVD underlies the majority (roughly 75%) of deaths due to diabetes, the well-established role of exercise in preventing cardiovascular death also has the potential to impact mortality in those with existing diabetes. Hu and colleagues<sup>17</sup> used data from the Nurses' Health Study to determine whether physical activity decreased risk for cardiovascular disease among diabetic women. In 5125 female nurses with diabetes, physical activity was first assessed in 1980 and was updated incrementally by questionnaire until 1992. During >31 000 person-years follow-up, 323 new cases of cardiovascular disease were documented. After adjusting for age and other risk factors, relative risks declined in parallel with average hours of moderate or vigorous activity per week. In separate analyses, levels of physical activity were inversely associated with coronary heart disease and ischemic stroke. Faster usual walking pace was independently associated with lower risk.

Batty et al<sup>18</sup> examined the relation of 2 indices of physical activity (walking pace and leisure activity) to total mortality, CHD, and other cardiovascular diseases in a 25-year follow-up of 6408 male British Civil Servants who underwent an oral glucose tolerance test at study entry. The 2 indices of physical activity were inversely related to all-cause, CHD, and other cardiovascular disease mortality in both normoglycemic men and men with diabetes or impaired glucose tolerance (IGT). The gradient of the activity-mortality association was steeper in individuals with diabetes/IGT in comparison to the normoglycemic men, with the linear trend across activity levels for CHD risk differing markedly in the analyses of both walking pace and leisure activity.

Researchers at the Cooper Clinic evaluated the association of low fitness and physical inactivity with mortality in men with type 2 diabetes.<sup>19</sup> A prospective cohort of 1263 men with type 2 diabetes who received a thorough medical examination was studied. Fitness was measured by a maximal exercise test, and physical activity was self-reported at baseline. During a 12-year follow-up, 180 patients died. After adjustment for age and other baseline risk factors, men in the low-fitness group had an adjusted risk for all-cause mortality of 2 times that of fit men. Diabetic men who reported being

physically inactive had an adjusted risk for mortality that was 2 times higher than that in men who reported being physically active.

### Interventional Trials

It is important to note that all of the studies discussed above were observational studies without randomization to an exercise or a control group. One notable, recent randomized trial from Denmark included exercise (one half hour of brisk walking 3 to 5 times a week) as part of a multifactorial approach to diabetic management.<sup>20</sup> Eighty patients were randomly assigned to receive conventional treatment in accordance with national guidelines and 80 to receive intensive treatment, with a stepwise implementation of behavior modification and pharmacological therapy. Over a mean 8-year follow-up, the case management group reduced cardiovascular and microvascular events by about 50%. Further randomized interventional studies like this are needed to convince healthcare professionals and patients of the importance of exercise as an important part of disease prevention and management.

### Summary

The findings of Tanasescu et al<sup>5</sup> in the current issue and the sampling of a rich scientific literature regarding diabetes, physical activity, and fitness demonstrate convincingly that a lifestyle of physical activity is associated with reduced risk of CVD, cardiovascular death, and total mortality in men and women with type 2 diabetes. Moreover, the available data suggest that regular exercise reduces the risk of developing diabetes. The latter is important because the diagnosis of diabetes is often delayed for years after the onset of the disease. Surprisingly, although physical activity has an important place in the treatment of type 2 diabetes, it is an underutilized therapy for the condition. The well-established benefits of exercise on cardiovascular health lend themselves ideally to the type 2 diabetic: Over 60% of type 2 diabetics have hypertension, and both an atherogenic lipid profile and obesity are part of the recognized syndrome underlying diabetes. Moreover, several metabolic effects of exercise underlie the mortality benefits specific to diabetes. These include better glucose control, reduction in triglycerides, and weight loss. We now have data to support this contention from the recent Danish randomized trial of a case management strategy for diabetes, including an exercise prescription, reporting a 50% reduction in complications associated with diabetes.<sup>20</sup> The findings of Tanasescu et al<sup>5</sup> and other recent studies should encourage healthcare providers to recognize physical activity as part of the standard treatment for patients with glucose intolerance or established diabetes.

### References

1. American College of Sports Medicine. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness in healthy adults. *Med Sci Sports Exerc.* 1998;30:975–991.
2. Fletcher GF, Balady G, 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.
3. Pate RR, Pratt MP, 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.
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. Tanasescu M, Leitzmann MF, Rimm EB, et al. Physical activity in relation to cardiovascular disease and total mortality among men with type 2 diabetes. *Circulation.* 2003;107:2435–2439.
6. Hahn RA, Teutsh SM, Rothenberg RB, et al. Excess deaths from nine chronic diseases in the United States. *JAMA.* 1986;264:2654–2659.
7. 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.
8. Paffenbarger RS, Hyde RT, Wing AL, et al. Physical activity, all-cause mortality, and longevity of college alumni. *N Engl J Med.* 1986;314:605–613.
9. Morris JN, Kagan A, Pattison DC, et al. Incidence and prediction of ischaemic heart disease in London busmen. *Lancet.* 1966;2:552–559.
10. Slattery ML, Jacobs DR Jr, Nichaman MZ. Leisure time physical activity and coronary heart disease death: the US railroad study. *Circulation.* 1989;79:304–311.
11. Manson JE, Nathan DM, Krolewski AS, et al. A prospective study of exercise and incidence of diabetes among US male physicians. *JAMA.* 1992;268:63–67.
12. Hu FB, Sigal RJ, Rich-Edwards JW, et al. Walking compared with vigorous physical activity and risk of type 2 diabetes in women: a prospective study. *JAMA.* 1999;282:1433–1439.
13. 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.
14. Helmrich S, Ragland DR, Leung RW, et al. Physical activity and reduced occurrence of non-insulin-dependent diabetes mellitus. *N Engl J Med.* 1991;325:147–152.
15. Hu FB, Manson JE, Stampfer MJ, et al. Diet, lifestyle, and the risk of type 2 diabetes mellitus in women. *N Engl J Med.* 2001;345:790–797.
16. Wei M, Gibbons LW, Mitchell TL, et al. The association between cardiorespiratory fitness and impaired fasting glucose and type 2 diabetes mellitus in men. *Ann Intern Med.* 1999;130:89–96.
17. Hu FB, Stampfer MJ, Solomon C, et al. Physical activity and risk for cardiovascular events in diabetic women. *Ann Intern Med.* 2001;134:96–105.
18. Batty GD, Shipley MJ, Marmot M, et al. Physical activity and cause-specific mortality in men with type 2 diabetes/impaired glucose tolerance: evidence from the Whitehall study. *Diabet Med.* 2002;19:580–588.
19. Wei M, Gibbons LW, Kampert JB, et al. Low cardiorespiratory fitness and physical inactivity as predictors of mortality in men with type 2 diabetes. *Ann Intern Med.* 2000;132:605–611.
20. Gaede P, Vedel P, Larsen N, et al. Multifactorial intervention and cardiovascular disease in patients with type 2 diabetes. *N Engl J Med.* 2003;348:383–393.

KEY WORDS: Editorials ■ diabetes mellitus ■ exercise ■ epidemiology