



## The “Weekend Warrior” and Risk of Mortality

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Physical activity improves health, and current recommendations encourage daily exercise. However, little is known about any health benefits associated with infrequent bouts of exercise (e.g., 1–2 episodes/week) that generate the recommended energy expenditure. The authors conducted a prospective cohort study among 8,421 men (mean age, 66 years) in the Harvard Alumni Health Study, without major chronic diseases, who provided details about physical activity on mailed questionnaires in 1988 and 1993. Men were classified as “sedentary” (expending <500 kcal/week), “insufficiently active” (500–999 kcal/week), “weekend warriors” ( $\geq 1,000$  kcal/week from sports/recreation 1–2 times/week), or “regularly active” (all others expending  $\geq 1,000$  kcal/week). Between 1988 and 1997, 1,234 men died. The multivariate relative risks for mortality among the sedentary, insufficiently active, weekend warriors, and regularly active men were 1.00 (referent), 0.75 (95% confidence interval (CI): 0.62, 0.91), 0.85 (95% CI: 0.65, 1.11), and 0.64 (95% CI: 0.55, 0.73), respectively. In stratified analysis, among men without major risk factors, weekend warriors had a lower risk of dying, compared with sedentary men (relative risk = 0.41, 95% CI: 0.21, 0.81). This was not seen among men with at least one major risk factor (corresponding relative risk = 1.02, 95% CI: 0.75, 1.38). These results suggest that regular physical activity generating 1,000 kcal/week or more should be recommended for lowering mortality rates. However, among those with no major risk factors, even 1–2 episodes/week generating 1,000 kcal/week or more can postpone mortality.

exercise; mortality; motor activity; physical fitness

Abbreviations: ACSM, American College of Sports Medicine; CDC, Centers for Disease Control and Prevention; CI, confidence interval.

*There is a time for everything, and a season for every activity under heaven.*

—Ecclesiastes 3:1

These words of King Solomon, written around 940 BC, may have garnered widespread support then, but the average person living in a developed country today is likely to disagree. For example, by some estimates, the average time spent at work in the United States grew by 163 hours/year, or approximately 1 month more, between 1969 and 1987 (1). Lack of time is a commonly cited barrier to exercise (2); unfortunately, current physical activity guidelines require a nonconsequential time commitment (at least 30 minutes of moderate-intensity activity most days of the week or at least 20 minutes of vigorous-intensity activity on at least 3 days/

week, generating approximately  $\geq 1,000$  kcal/week) (3, 4). Some individuals may choose to compress their exercise into fewer days, such as during weekends only, giving rise to the colloquial term “weekend warriors.” Although weekend warriors exercise only once or twice a week, each activity session can be prolonged, generating sufficient energy expenditure to fall within current guidelines. However, national surveys, which tend to emphasize the weekly frequency of physical activity in their analyses of physical activity trends, would not count “weekend warriors” as being regularly active (5) or achieving recommended levels of activity (6). Little is known about whether health benefits are associated with such an activity pattern, so we investigated this question in relation to all-cause mortality.

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## MATERIALS AND METHODS

### Participants

The Harvard Alumni Health Study is an ongoing study of men who matriculated as undergraduates at Harvard University between 1916 and 1950. This study is approved by the Human Subjects Committee, Harvard School of Public Health. Since 1962, alumni have periodically returned mailed questionnaires on their health habits and health status. For this analysis, 12,805 men who returned a survey in 1988 were eligible. We excluded men reporting prevalent cardiovascular disease, cancer, or diabetes in 1988 ( $n = 3,942$ ), since these diseases may alter activity levels, and men with missing physical activity information ( $n = 442$ ), leaving 8,421 men.

### Assessment of physical activity and other predictors of mortality

On the 1988 questionnaire, men reported their daily walking and stair climbing. They also listed the sports and recreational activities undertaken in the past week and the frequency and duration of participation (7). This assessment of physical activity has been shown to be reliable and valid (8–10). On the basis of the energy cost of each activity (11), we estimated the energy expended on walking, climbing stairs, and all sports and recreational activities. We then divided men into four groups, decided a priori, based on their physical activity pattern: 1) "sedentary," expending less than 500 kcal/week on all reported activities; 2) "insufficiently active," expending 500–999 kcal/week in these same activities; 3) "weekend warriors," expending 1,000 kcal/week or more by participating in sports and recreational activities 1–2 times/week; and 4) "regularly active," all others expending 1,000 kcal/week or more on all reported activities. (As an approximate equivalent, 500 kcal/week can be translated to about 75 minutes/week of brisk walking; 1,000 kcal/week, about 150 minutes/week of brisk walking.) Groups 1 and 2 were separated because some studies have reported lower mortality rates among individuals not quite fulfilling current recommendations for 1,000 kcal/week of energy expenditure (12).

On the same questionnaire, men also reported their age, weight, height, cigarette smoking, diet, history of hypertension, and high cholesterol, as well as parental history of early mortality (age <65 years). All data, except for diet and parental history, were updated on another health questionnaire in 1993.

### Ascertainment of mortality

We followed men after the return of the 1988 questionnaire through 1997 for mortality and obtained copies of official death certificates. Mortality follow-up is greater than 99 percent complete (13).

### Statistical analyses

We first examined the baseline characteristics of the men according to the four different physical activity patterns. We

then used proportional hazards regression (14, 15) to estimate the relative risks of mortality associated with these physical activity patterns. The four activity patterns were entered as three indicator variables in a single regression model. Initially, we adjusted the relative risks for differences in age only. We then also controlled for cigarette smoking, alcohol consumption, red meat intake, vegetable intake, vitamin/mineral supplements, and early parental mortality. All variables were assessed at baseline in 1988 and updated in 1993 using time-dependent analyses, except for diet, use of supplements, and parental history. Finally, we examined two subgroups of men separately: 1) low-risk men who had none of these risk factors—smoking, overweight (body mass index of  $\geq 25$  kg/m<sup>2</sup>), history of hypertension, and hypercholesterolemia; and 2) high-risk men who had at least one risk factor.

## RESULTS

At baseline, 17 percent of alumni were classified as "sedentary"; 13 percent, "insufficiently active"; 7 percent, "weekend warriors"; and 62 percent, "regularly active." Among the weekend warriors, 22 percent reported one session of physical activity per week; 78 percent, two. Each activity session lasted a median of 86 (interquartile range, 45–135) minutes. The most common activities undertaken by weekend warriors were tennis (38 percent), golf (13 percent), and gardening (9 percent).

Table 1 shows the baseline characteristics of men, according to their physical activity pattern. The mean age of all the men at baseline was 66.3 years, with weekend warriors being the youngest. In general, the two most active groups had a better health profile than the two least active groups did. The exceptions were weight and diet: Weekend warriors were the heaviest; they also were least likely to take vitamin/mineral supplements, most likely to eat red meat, and least likely to eat vegetables.

During follow-up, 1,234 men died. In age-adjusted analyses, weekend warriors were not at significantly lower risk of follow-up, but regularly active men were (table 2). Additional adjustment for smoking, diet, vitamin/mineral supplements, and early parental mortality yielded similar findings. Regularly active men had a statistically significant, 36 percent lower risk compared with sedentary men. In multivariate analyses, the mortality rates among insufficiently active men and weekend warriors did not differ significantly ( $p = 0.40$ ), while the mortality rate among regularly active men was significantly lower than that among weekend warriors ( $p = 0.03$ ).

We then examined the association between physical activity pattern and mortality rates separately among low-risk men and high-risk men (figure 1). Low-risk men (34 percent) had none of the following risk factors at baseline; high-risk men (66 percent) had at least one: smoking, overweight (body mass index of  $\geq 25$  kg/m<sup>2</sup>), history of hypertension, and hypercholesterolemia. In both subgroups, regularly active men were at significantly lower risk of dying during follow-up compared with sedentary men. Among low-risk men, weekend warriors also experienced lower risk of mortality than did sedentary men. However, this did not hold

**TABLE 1. Baseline characteristics, by physical activity pattern, of men in the Harvard Alumni Health Study, 1988–1997**

Characteristic	Physical activity pattern*			
	Sedentary (n = 1,453)	Insufficiently active (n = 1,127)	Weekend warrior (n = 580)	Regularly active (n = 5,261)
Age, years (mean (SD)†)	68.4 (9.0)	66.2 (7.7)	64.7 (7.2)	65.9 (7.3)
Energy expenditure, kcal/week (median (interquartile range))	210 (98–350)	742 (644–858)	2,360 (1,803–3,177)	2,766 (1,734–4,486)
Body mass index, kg/m <sup>2</sup> (mean (SD))	25.1 (3.5)	24.7 (3.1)	25.3 (2.8)	24.5 (2.7)
Current smokers (%)	12.7	11.4	9.9	6.3
Consuming alcohol daily (%)	37.3	39.5	44.3	43.5
Taking vitamin/mineral supplements (%)	44.3	43.6	37.2	46.3
Consuming <1 serving/week of red meat (%)	19.9	21.8	17.1	24.9
Consuming ≥3 servings/day of vegetables (%)	13.5	12.4	11.2	15.1
History of hypertension (%)	30.2	26.3	23.1	26.1
History of hypercholesterolemia (%)	17.2	20.2	16.9	19.0
Early parental mortality (<65 years) (%)	33.3	31.6	29.3	33.1

\* “Physical activity pattern” is defined as follows: “sedentary” (men expending <500 kcal/week in walking, climbing stairs, and sports/recreation); “insufficiently active” (men expending 500–999 kcal/week in these same activities); “weekend warrior” (men expending ≥1,000 kcal/week by participation in sports/recreation 1–2 times/week); and “regularly active” (all other men expending ≥1,000 kcal/week in walking, climbing stairs, and sports/recreation). Both weekend warrior and regularly active groups meet the Centers for Disease Control and Prevention/American College of Sports Medicine physical activity recommendation with respect to energy expenditure, that is, at least 1,000 kcal/week (Pate et al. JAMA 1995;273:402–7) (3).

† SD, standard deviation.

for weekend warriors in the high-risk group. Among low-risk men, the multivariate relative risks of all-cause mortality associated with sedentary men, insufficiently active men, weekend warriors, and regularly active men were 1.00 (referent), 0.56 (95 percent confidence interval (CI): 0.40,

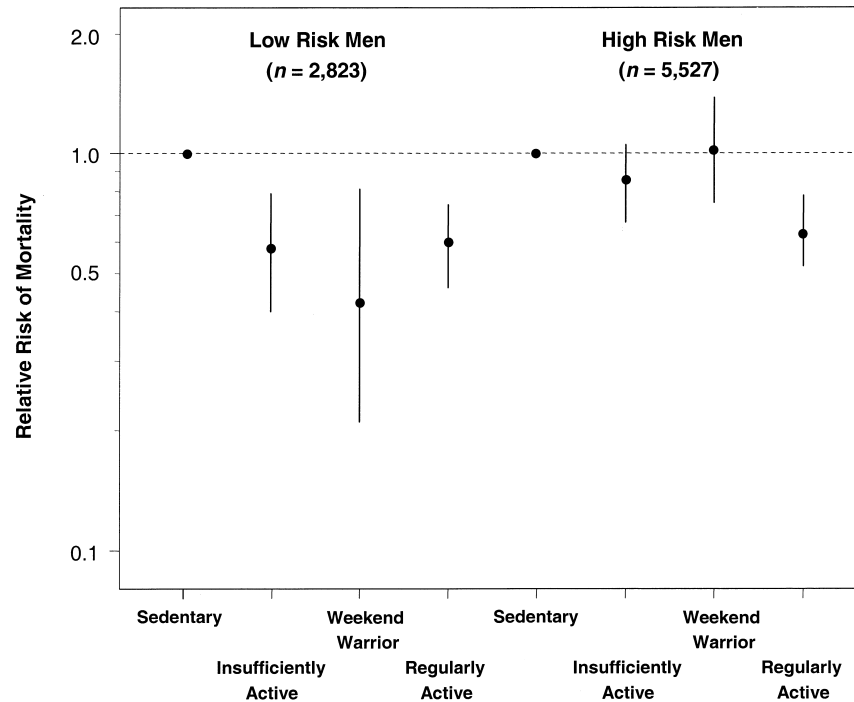
0.79), 0.41 (95 percent CI: 0.21, 0.81), and 0.58 (95 percent CI: 0.46, 0.74), respectively. For high-risk men, they were 1.00 (referent), 0.84 (95 percent CI: 0.67, 1.05), 1.02 (95 percent CI: 0.75, 1.38), and 0.61 (95 percent CI: 0.52, 0.78), respectively.

**TABLE 2. Relative risks of mortality according to physical activity pattern, Harvard Alumni Health Study, 1988–1997**

Physical activity pattern*	No. of men	No. of deaths	Age-adjusted relative risk	95% confidence interval	Multivariate-adjusted relative risk†	95% confidence interval
Sedentary	1,453	346	1.00	Referent	1.00	Referent
Insufficiently active	1,127	191	0.75	0.63, 0.90	0.75	0.62, 0.91
Weekend warrior	580	73	0.82	0.63, 1.07	0.85	0.65, 1.11
Regularly active	5,261	624	0.61	0.53, 0.69	0.64	0.55, 0.73

\* “Physical activity pattern” is defined as follows: “sedentary” (men expending <500 kcal/week in walking, climbing stairs, and sports/recreation); “insufficiently active” (men expending 500–999 kcal/week in these same activities); “weekend warrior” (men expending ≥1,000 kcal/week by participation in sports/recreation 1–2 times/week); and “regularly active” (all other men expending ≥1,000 kcal/week in walking, climbing stairs, and sports/recreation). Both weekend warrior and regularly active groups meet the Centers for Disease Control and Prevention/American College of Sports Medicine physical activity recommendation with respect to energy expenditure, that is, at least 1,000 kcal/week (Pate et al. JAMA 1995;273:402–7) (3). The numbers of men and deaths are distributed according to the physical activity pattern at baseline.

† Adjusted for age, cigarette smoking (never, past, or current), alcohol consumption (never, 1–3 drinks/week, 4–6 drinks/week, or daily), red meat intake (<3 servings/month, 1–2 servings/week, or ≥3 servings/week), vegetable intake (<1 serving/day, 1–2 servings/day, or ≥3 servings/day), vitamin/mineral supplements, and early parental mortality (both no or yes).



**FIGURE 1.** Relative risks of mortality according to physical activity pattern among low-risk men and high-risk men, Harvard Alumni Health Study, 1988–1997. Lines represent 95% confidence intervals. Relative risks are adjusted for age, cigarette smoking (never, past, or current), alcohol consumption (never, 1–3 drinks/week, 4–6 drinks/week, or daily), red meat intake (<3 servings/month, 1–2 servings/week, or  $\geq 3$  servings/week), vegetable intake (<1 serving/day, 1–2 servings/day, or  $\geq 3$  servings/day), vitamin/mineral supplements, and early parental mortality (both no or yes). “Physical activity pattern” is defined as follows: “sedentary” (men expending <500 kcal/week in walking, climbing stairs, and sports/recreation); “insufficiently active” (men expending 500–999 kcal/week in these same activities); “weekend warrior” (men expending  $\geq 1,000$  kcal/week by participation in sports/recreation 1–2 times/week); and “regularly active” (all other men expending  $\geq 1,000$  kcal/week in walking, climbing stairs, and sports/recreation). Both weekend warrior and regularly active groups meet the Centers for Disease Control and Prevention/American College of Sports Medicine physical activity recommendation with respect to energy expenditure, that is, at least 1,000 kcal/week (Pate et al. JAMA 1995;273:402–7) (3). Low-risk men had none of the following risk factors at baseline, but high-risk men had at least one: cigarette smoking, overweight (body mass index of  $\geq 25$  kg/m<sup>2</sup>), history of hypertension, and hypercholesterolemia.

## DISCUSSION

Physical activity clearly is associated with health benefits (4, 16, 17), and current recommendations encourage daily exercise (3, 4). Unfortunately, lack of time is a common barrier to exercise (2). Little is known about any health benefits associated with the so-called weekend warrior pattern—an exercise pattern that generates sufficient energy to satisfy current physical activity recommendations ( $\geq 1,000$  kcal/week) but over 1–2 sessions/week—instead of the recommended most days of the week. The present study suggests that a pattern of regular physical activity generating 1,000 kcal/week or more should be recommended for lowering mortality rates. However, among low-risk men without major risk factors, even 1–2 episodes/week of physical activity that generate 1,000 kcal/week or more can postpone mortality.

High-risk men may not benefit from sporadic physical activity, such as the weekend warrior pattern, because some beneficial effects of physical activity are short-lived. Hypertensive men and women, aged 60–69 years, experienced

decreases in systolic blood pressure immediately after a bout of exercise. However, the reductions were no longer sustained by 180 minutes postexercise (18). Some acute effects may also be augmented by chronic, regular activity. Among men with hypertriglyceridemia, fasting triglyceride levels were lower on the morning after a bout of exercise than after a day without exercise. Over a 4-day period, when men walked daily, progressive decreases in fasting triglyceride levels occurred (19). Thus, high-risk men who are not regularly active may not experience the full benefits of physical activity.

The present analyses add to earlier findings from the Harvard Alumni Health Study, which had shown physical activity to be associated with lower risk of premature mortality and chronic diseases (20–24). Additionally, the data indicated that changing from an inactive to active way of life could postpone mortality (25). Previous analyses also supported the notion that physical activity can be accumulated in shorter bouts (instead of a single session) in the day (13). The present analyses extend previous findings in showing that regular physical activity is preferable for post-

poning mortality. However, among low-risk men, if all they can find time for is 1–2 episodes/week of activity that generate the requisite energy expenditure, even this is helpful.

It should be noted that less stringent requirements for physical activity do not guarantee greater participation in this behavior. The determinants of physical activity are complex and likely to include personal (e.g., demographic, psychological), behavioral, and environmental (e.g., physical, social, cultural, time) factors (26). Although lack of time is often given as a reason for not exercising, this can represent a true barrier, a perceived barrier, a lack of time management skills, or merely an excuse.

To our knowledge, this is the first study to examine clinical endpoints among persons colloquially called “weekend warriors.” In a nonrandomized trial, 55 healthy Finnish men were asked to play an 18-hole round of golf twice a week for 20 weeks; they averaged 10 hours/week of play (27). Compared with sedentary controls, significant improvements occurred among golfers in adiposity, physical fitness, and lipid profile. These data suggest that less frequent bouts of activity, which are more easily scheduled into a busy lifestyle, can have some health benefits if sufficient energy is expended. One concern with sporadic physical activity is that risk of musculoskeletal injuries may be higher. Unfortunately, neither the Finnish study nor the present study collected data regarding injuries. Other studies have shown that the risk of musculoskeletal injuries increases with higher intensity and total duration of physical activity (28, 29). However, when the same activities are performed for the same total duration per week, it is unknown whether the risk of injury differs between those who exercise 1–2 times/week, compared with more frequently.

One issue that needs discussion concerns how much total physical activity we need for health. There is some confusion because of two apparently contradictory recommendations from the Centers for Disease Control and Prevention (CDC)/American College of Sports Medicine (ACSM) and the Institute of Medicine. The CDC/ACSM recommendation, released in 1995, calls for at least 30 minutes of moderate-intensity physical activity most days of the week (3). This recommendation was developed with an emphasis on health-related outcomes but with no particular focus on weight control. In contrast, the 2002 Institute of Medicine guideline of 60 minutes/day of moderate-intensity activity emphasized weight control and was part of a larger recommendation for healthy diet (30). The findings from the present study add to the overall evidence that the CDC/ACSM recommendation can decrease the risk of premature mortality. Two recent randomized clinical trials also showed that the CDC/ACSM recommendation is sufficient for weight loss in overweight persons, provided caloric intake is restricted (31), and for prevention of weight gain, in the absence of dietary change (32).

The strengths of the present study include extensive information on physical activity (including details on type, frequency, and duration) that was updated over time. We also collected information on many variables that could confound the relation between physical activity and mortality. However, several limitations exist. Participants

were older and likely to be retired; thus, they might not truly be “weekend” warriors. Additionally, they were men of higher socioeconomic status who likely possessed healthier behaviors. It is unclear how generalizable the present findings may be to those who are younger, women, and persons with different socioeconomic backgrounds (although physical activity also has been shown to benefit women and minorities (33)). Although detailed, the physical activity information was self-reported. Nonetheless, such self-reports have been shown to be reliable and valid (8–10). Additionally, we estimated the energy expended on physical activities using a widely used compendium developed with data primarily from young to middle-aged men (11). However, because the data were collected prospectively, any bias should be toward the null. The present analyses controlled for several potential confounders, but because this is an observational study, confounding cannot be completely eliminated. There also were relatively few weekend warriors, which limited the statistical power of the analyses. Finally, it is possible that the findings reflect decreased activity levels among men who were in poor health. We tried to minimize this bias by excluding men with cardiovascular disease, cancer, and diabetes.

In conclusion, the present observations suggest that a pattern of regular physical activity generating 1,000 kcal/week or more should be recommended for lowering mortality rates. However, among men without major risk factors, even 1–2 episodes/week of physical activity that generate 1,000 kcal/week or more can postpone mortality. Thus, for individuals with no major risk factors who are too busy for daily exercise, this may offer a measure of encouragement.

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This is report no. LXXXV in a series on chronic disease in former college students.

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