# EFFECTS OF WALKING ON MORTALITY AMONG NONSMOKING RETIRED MEN

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## ABSTRACT

***Background*** The potential benefit of low-intensity activity in terms of longevity among older men has not been clearly documented. We examined the association between walking and mortality in a cohort of retired men who were nonsmokers and physically capable of participating in low-intensity activities on a daily basis.

***Methods*** We studied 707 nonsmoking retired men, 61 to 81 years of age, who were enrolled in the Honolulu Heart Program. The distance walked (miles per day) was recorded at a base-line examination, which took place between 1980 and 1982. Data on overall mortality (from any cause) were collected over a 12-year period of follow-up.

***Results*** During the follow-up period, there were 208 deaths. After adjustment for age, the mortality rate among the men who walked less than 1 mile (1.6 km) per day was nearly twice that among those who walked more than 2 miles (3.2 km) per day (40.5 percent vs. 23.8 percent, $P = 0.001$). The cumulative incidence of death after 12 years for the most active walkers was reached in less than 7 years among the men who were least active. The distance walked remained inversely related to mortality after adjustment for overall measures of activity and other risk factors ($P = 0.01$).

***Conclusions*** Our findings in older physically capable men indicate that regular walking is associated with a lower overall mortality rate. Encouraging elderly people to walk may benefit their health. (N Engl J Med 1998;338:94-9.)



THE benefits of low-intensity activity in reducing the risk of cardiovascular disease and increasing longevity have not been clearly identified.[1-6] Even less is known about the effects of such activities in older people. We undertook this study to examine the association between walking and mortality after adjustment for several concomitant risk factors. Special attention was given to a cohort of older nonsmoking men who were retired and physically capable of participating in low-intensity activities on a daily basis.

## METHODS

### Study Population and Procedures

Since 1965, the Honolulu Heart Program has followed 8006 men of Japanese ancestry living on the island of Oahu, Hawaii, for the development of cardiovascular disease and cause-specific mortality.[7,8] At the time of study enrollment, when the subjects were 45 to 68 years old, they received a complete physical examination. The procedures followed were in accordance with institutional guidelines and approved by the Kuakini Medical Center Research and Institutional Review Committee. Informed consent was obtained from the study participants.

The follow-up period for this study began at the time of a base-line examination, which occurred between 1980 and 1982, when walking was first assessed. The sample comprised 1379 members of a cohort of men who were among the original participants in the Cooperative Lipoprotein Phenotyping Study.[9] That study and the sample included in this report have been described elsewhere.[10]

After the base-line examination, 12 years of follow-up were available in which to assess the relation between the distance walked and the risk of death on the basis of comprehensive surveillance of death certificates, hospital admissions, and obituary notices. As of 1990, 62 of the 8006 men in the original cohort had moved off the island of Oahu, resulting in an out-migration rate of about 1 per 1000 men per year. The current survival status of only five men is unknown.

At the time the follow-up began (1980 to 1982), the men were asked about the average distance they walked per day. Overall measures of activity at a variety of intensities were also assessed by recording the number of hours per day spent at each of five levels of activity with the use of questionnaires similar to those of the Framingham[4] and Puerto Rico[11] heart studies. The five levels of activity were basal (sleeping or lying down), sedentary (sitting or standing), slight (e.g., casual walking), moderate (e.g., light carpentry or gardening), and heavy (e.g., lifting or shoveling).

Only physically capable men were included in this study. Such men were included for follow-up if they reported undertaking at least one hour of slight, moderate, or heavy activity on a daily basis. All the men also indicated that they were retired. Men who were working full time or part time and those seeking employment were excluded from follow-up. In addition, because cigarette smoking is known to confound the relation between physical activity and mortality,[12-15] only nonsmoking men were included in the study. After the exclusions, 707 men, 61 to 81 years old, remained in the study sample; their average age (±SD) was 68.9±5.1 years.

### Statistical Analysis

To help isolate the independent effect of the distance walked on overall mortality, the statistical analysis included adjustments

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for several possible risk factors. These included age, concentrations of total and high-density lipoprotein (HDL) cholesterol, blood pressure, whether there was diabetes (on the basis of the medical history or the use of insulin or oral hypoglycemic therapy), and alcohol intake. With the use of 24-hour dietary-recall methods,[16] nutritional risk factors were recorded, including total calories consumed per day, the percentage of calories from fat, protein, and carbohydrates, and the strength of the subjects' preference for a Japanese diet (calculated as a percentage of foods consumed). Further description of the risk factors is provided elsewhere.[7,8,16]

Efforts to examine the effects of the distance walked per day on mortality also included adjustments for an overall physical-activity index calculated as a weighted sum of the number of hours spent at each of the five activity levels. In general, the higher values of the index corresponded to more active lifestyles, whereas lower indexes corresponded to lifestyles that were more sedentary.[4,11,15,17] The physical-activity index provided a means of isolating an independent relation between walking and mortality by adjusting for the overall intensity of activity that might coexist with the various distances walked.

To describe the way the distance walked might vary with the overall physical-activity index and other confounding risk factors, we calculated age-adjusted means for each of the factors across the ranges of distances walked (in miles per day). The procedures for adjustment were based on analysis-of-covariance methods that used general linear and logistic-regression models.[18]

Among the ranges of distance walked, the cumulative incidence of mortality was also derived from estimated Kaplan–Meier survival curves[19] and calculated as a cumulative percentage of deaths across the 12 years of follow-up. Proportional-hazards regression models[20] were also used to examine the independent effect of walking on the risk of death and to provide estimates of the relative risk among the ranges of distance walked. All reported P values were based on two-sided tests of significance.

## RESULTS

Among the 707 men included in this study, the average (±SD) distance walked was 1.8±1.3 miles (2.9±2.1 km) per day. All the men participated in at least 1 hour of slight activity on a daily basis (4.5±1.8 hours on average). Most of the men (589) participated in at least 1 hour of moderate daily activity (2.9±1.7 hours on average), whereas only 45 reported undertaking any heavy activity on a daily basis (1.5±0.9 hours on average).

During the 12 years of follow-up, there were 208 deaths. Thirty-three were due to coronary heart disease, 19 to stroke, 68 to cancer, and 88 to other causes. The median time to death was seven years.

Table 1 shows the unadjusted and age-adjusted cumulative mortality over the 12-year follow-up period among the men according to the range of distance walked per day. For the men who walked less than 1 mile (1.6 km) per day, the unadjusted mortality rate was 43.1 deaths per 100 men. For the men who walked more than 2 miles (3.2 km) per day, the unadjusted mortality was more than halved (21.5 per 100). The 12-year cumulative mortality rate was significantly lower among the men who walked a mile or more per day than among those who walked shorter distances (P<0.001). Adjustment for age had a negligible effect on the observed incidence of death. When the distance walked was modeled as a continuous variable, it was positively related to a decreased risk of death (P<0.001 without adjustment for age and P=0.002 after adjustment for age).

**TABLE 1.** UNADJUSTED AND AGE-ADJUSTED 12-YEAR CUMULATIVE MORTALITY ACCORDING TO DISTANCE WALKED PER DAY.

| CAUSE OF DEATH AND DISTANCE WALKED (MILES/DAY)* | AGE† | MORTALITY RATE | |
|---|---|---|---|
| | | UNADJUSTED | AGE-ADJUSTED |
| | yr | % (no. of deaths/ total no.) | % |
| All causes | | | |
| 0.0–0.9 | 69.8±5.2 | 43.1 (65/151) | 40.5 |
| 1.0–2.0 | 69.0±5.1 | 27.7 (105/379)‡ | 27.4§ |
| 2.1–8.0 | 67.9±4.6 | 21.5 (38/177)‡ | 23.8¶ |
| P value for trend | | <0.001 | 0.002 |
| Coronary heart disease or stroke‖ | | | |
| 0.0–0.9 | 69.3±5.0 | 6.6 (8/122) | 6.2 |
| 1.0–2.0 | 68.9±5.1 | 5.6 (18/321) | 5.5 |
| 2.1–8.0 | 67.9±4.6 | 2.1 (3/145) | 2.3 |
| P value for trend | | 0.102 | 0.143 |
| Cancer** | | | |
| 0.0–0.9 | 69.6±5.2 | 13.4 (19/142) | 12.8 |
| 1.0–2.0 | 68.8±5.0 | 9.4 (34/361) | 9.4 |
| 2.1–8.0 | 67.7±4.4 | 5.3 (9/169)†† | 5.6‡‡ |
| P value for trend | | 0.008 | 0.013 |

*To convert distances to kilometers, multiply by 1.609.

†Mean (±SD) ages are those at the base-line examination (1980–1982).

‡P<0.001 for the comparison with the men who walked less than 1 mile per day.

§P=0.003 for the comparison with the men who walked less than 1 mile per day.

¶P=0.001 for the comparison with the men who walked less than 1 mile per day.

‖Preexisting cases of coronary heart disease and stroke were excluded from cause-specific follow-up.

**Preexisting cases of cancer were excluded from cause-specific follow-up.

††P=0.01 for the comparison with the men who walked less than 1 mile per day.

‡‡P=0.02 for the comparison with the men who walked less than 1 mile per day.

The effects of walking on death due to coronary heart disease could not be adequately distinguished from its effects on death due to stroke, since mortality from each cause occurred too infrequently in the study sample. Nevertheless, walking appeared to protect against these events, although the findings were not statistically significant. After the exclusion of the men with known coronary heart disease and stroke at the base-line examination, 6.6 percent of those who walked the least died of one of these causes in the course of follow-up, as compared with 2.1 percent of the men who walked more than two miles per day.

Cancer was the most common cause of death; 13.4 percent of the men who walked less than one mile per day died of cancer, as compared with 5.3

percent of those who walked more than two miles per day. The difference in the risk of cancer between these groups was statistically significant both with and without adjustment for age ($P=0.01$ and $P=0.02$, respectively).

Figure 1 shows the overall cumulative incidence of mortality from all causes over time according to ranges of distance walked per day. Throughout most of the follow-up period there is a clear ordering of the incidence curves across the ranges of distance walked. Men who walked the least (<1 mile per day) had the highest incidence of death, followed by the men who walked 1 to 2 miles per day and those who walked more than 2 miles per day. The cumulative incidence of death in 12 years among the most active walkers was reached in less than 7 years among the men who were least active.

Table 2 shows the associations between the other risk factors and the distance walked. As expected, the trend for the physical-activity index was significant ($P<0.001$). In contrast, the distance walked per day was unrelated to total cholesterol concentration, blood pressure, or alcohol intake. The body-mass index (the weight in kilograms divided by the square of the height in meters) and the concentration of HDL cholesterol increased, however, and the percentage of men with diabetes tended to decrease with increases in the distance walked, although the trends were not significant. The distance walked was unrelated to the nutritional variables.

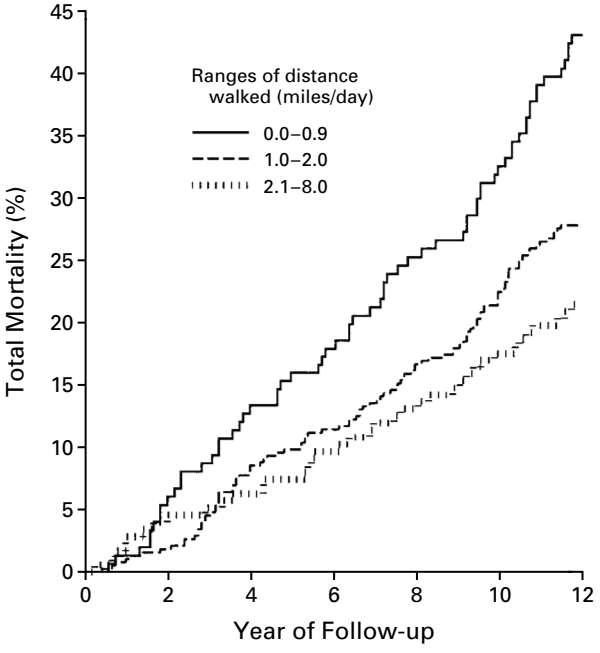


**Figure 1.** Cumulative Mortality According to Year of Follow-up and Distance Walked per Day.
To convert distances to kilometers, multiply by 1.609.

To help determine whether the risk of death could be attributed to an association between walking and the other risk factors listed in Table 2, proportional-hazards regression models were estimated to control for possible confounding influences of these factors. The results of these analyses are shown in Table 3, with comparisons of the expected risks of death for the ranges of distance walked per day.

After adjustment for risk factors, the risk of death among the men who walked less than one mile per day was 1.8 times that among the men who walked more than two miles per day ($P=0.009$). The risk of death among the men who walked the least (<1 mile per day) was 50 percent greater than it was among the men who walked 1 to 2 miles per day ($P=0.008$). The risk of death among the men who walked 1 to 2 miles per day was also greater than that among the men who walked longer distances (>2 miles per day), although the difference was not statistically significant.

In addition to selecting men who were physically capable, we also attempted to control for possible influences of preexisting illness and subclinical disease by excluding the men who died within a year after follow-up began. The exclusions did little to alter the findings.

The distance walked had a significant inverse relation with the risk of death from cancer but not with the risk of death from coronary heart disease or stroke. After adjustment for risk factors, the risk of death from cancer among the men who walked the least was 2.4 times that among those who walked the most ($P=0.03$).

## DISCUSSION

In this study we investigated the effects of low-intensity activity (walking) on overall mortality in a cohort of nonsmoking, physically capable older men who participated in the Honolulu Heart Program. Our results suggest that walking is associated with a lower risk of death among such men.

Although the relative risks appear to be small, the effects of walking on the absolute differences in mortality are actually large. After 12 years of follow-up, 43.1 percent of the men who walked less than one mile per day had died, as compared with 21.5 percent of the men who walked more than two miles per day. To quantify further the effect of walking on mortality, we modeled the distance walked as a continuous variable; the results suggest that the risk of death can be reduced by 19 percent when the distance walked is increased by one mile per day.

In this study we specifically examined the relation between the low-intensity activity of walking and the risk of death among nonsmoking, retired, physically capable men. The purpose of limiting the follow-up to retired men was to reduce potential bias due to the inclusion of men who continued to work

**TABLE 2.** AGE-ADJUSTED RISK FACTORS AT BASE LINE, ACCORDING TO DISTANCE WALKED PER DAY.*

| RISK FACTOR | DISTANCE WALKED† | | |
|---|---|---|---|
| | 0.0–0.9 MILE/DAY | 1.0–2.0 MILES/DAY | 2.1–8.0 MILES/DAY |
| Physical-activity index (metabolic equivalents)‡ | 29.9±3.5 | 30.9±3.2§ | 31.0±2.6 |
| Total cholesterol (mg/dl)‖ | 214±35.1 | 209±34.4 | 214±35.7 |
| HDL cholesterol (mg/dl)‖ | 45.9±12.5 | 46.0±12.2 | 47.8±12.4 |
| Body-mass index** | 23.4±3.1 | 23.7±3.0 | 23.8±2.7 |
| Hypertension (%) | 41.9 | 40.9 | 48.9 |
| Diabetes (%) | 28.9 | 26.0 | 23.5 |
| Total caloric intake (kcal/day) | 1776±566 | 1799±534 | 1790±556 |
| Protein (% of calories) | 16.2±3.9 | 16.6±4.2 | 16.8±4.4 |
| Fat (% of calories) | 30.3±10.3 | 30.1±9.5 | 30.2±10.0 |
| Carbohydrates (% of calories) | 51.4±11.4 | 51.7±10.5 | 51.7±11.5 |
| Preference for Japanese diet (% of foods) | 48.5±19.0 | 47.1±17.6 | 47.1±20.7 |
| Alcohol consumption (g/day) | 12.1±24.5 | 10.5±18.9 | 10.9±21.9 |

*Plus–minus values are means ±SD.

†To convert distances to kilometers, multiply by 1.609.

‡P<0.001 by test for trend.

§P = 0.002 for the comparison with the men who walked less than 1 mile per day.

¶P = 0.003 for the comparison with the men who walked less than 1 mile per day.

‖To convert values to millimoles per liter, multiply by 0.02586.

**The body-mass index was calculated as the weight in kilograms divided by the square of the height in meters.

**TABLE 3.** RELATIVE RISK OF DEATH ACCORDING TO DISTANCE WALKED PER DAY, WITH ADJUSTMENT FOR AGE AND FOR OTHER RISK FACTORS.

| CAUSE OF DEATH AND DISTANCE WALKED (MILES/DAY)* | RELATIVE RISK (95% CI) | |
|---|---|---|
| | AGE-ADJUSTED | RISK FACTOR–ADJUSTED† |
| All deaths | | |
| 0.0–0.9 vs. 2.1–8.0 | 1.9 (1.3–2.9)‡ | 1.8 (1.2–2.7)§ |
| 0.0–0.9 vs. 1.0–2.0 | 1.6 (1.2–2.2)¶ | 1.5 (1.1–2.1)‖ |
| 1.0–2.0 vs. 2.1–8.0 | 1.2 (0.8–1.7) | 1.1 (0.8–1.7) |
| P value for trend | 0.002 | 0.01 |
| Coronary heart disease or stroke** | | |
| 0.0–0.9 vs. 2.1–8.0 | 3.1 (0.8–11.9) | 2.6 (0.7–10.3) |
| 0.0–0.9 vs. 1.0–2.0 | 1.2 (0.5–2.8) | 1.1 (0.4–2.5) |
| 1.0–2.0 vs. 2.1–8.0 | 2.6 (0.8–8.9) | 2.5 (0.7–8.6) |
| P value for trend | 0.14 | 0.32 |
| Cancer†† | | |
| 0.0–0.9 vs. 2.1–8.0 | 2.5 (1.1–5.6)‡‡ | 2.4 (1.1–5.4)§§ |
| 0.0–0.9 vs. 1.0–2.0 | 1.5 (0.9–2.6) | 1.5 (0.9–2.7) |
| 1.0–2.0 vs. 2.1–8.0 | 1.7 (0.8–3.5) | 1.6 (0.8–3.4) |
| P value for trend | 0.01 | 0.02 |

*To convert distances to kilometers, multiply by 1.609.

†Values are the relative risks adjusted for age, total and HDL cholesterol, hypertension, diabetes, alcohol use, the overall physical-activity index, and preference for a Japanese diet (percentage of foods). CI denotes confidence interval.

‡P = 0.001 for the comparison between groups.

§P = 0.009 for the comparison between groups.

¶P = 0.003 for the comparison between groups.

‖P = 0.008 for the comparison between groups.

**Preexisting cases of coronary heart disease and stroke were excluded from cause-specific follow-up.

††Preexisting cases of cancer were excluded from cause-specific follow-up.

‡‡P = 0.02 for the comparison between groups.

§§P = 0.03 for the comparison between groups.

away from home and to focus specifically on activity during retirement. Excluding men who were physically incapable of participating in low-intensity activities on a daily basis also allowed us to focus on men for whom changes in physical activity would be possible. Our inclusion of only men who were physically capable makes it less likely that the levels of activity observed in the Honolulu Heart Program were related to mortality through associations with disability and physical impairment. Even among the men who reported walking at least a half-mile a day, the distance walked continued to be inversely associated with mortality after adjustment for age and the other risk factors (P = 0.04).

The distance walked also appeared to have a beneficial effect on mortality among the men who were excluded from follow-up. In this group, most were still working (455), and a large proportion smoked cigarettes (259). Because of the potential influence of diverse work environments and the confounding effects of cigarette smoking,[12-15] however, the benefits of walking in this sample are harder to evaluate. Although walking was inversely related to total mortality and possibly to death from cancer, associations were weaker than in the sample of men who were retired nonsmokers.

Unfortunately, observational studies often have a limited ability to describe relations between physical activity and the risk of disease because of difficulties in quantifying highly variable behavioral patterns on the basis of self-reported information and individual recall. Selection bias may also exist among older members of the Honolulu cohort, since morbidity and mortality may have removed men who were perhaps less fit, leaving a group of healthy survivors who were more robust.

Documenting the consistency of behavioral patterns over time is also difficult, particularly in those who die before their behavior can be reassessed. Of the original sample of 707 nonsmoking and retired men, however, 422 were reexamined 10 years later (1991 to 1993). Among those who walked the most

at the time of the base-line examination (>2 miles per day), 29 percent (34 of 119) continued to do so after 10 years, and 60 percent (71 of 119) continued to walk a mile or more per day. Among those who walked the least at base line (<1 mile per day), 74 percent (53 of 72) continued to walk less than a mile per day 10 years later. Although levels of activity may be expected to decline as age increases in the more active men, such data suggest that daily walking over a period of 10 years was not uncommon and may be a factor in reducing the risk of early mortality among older men.

Information on specific forms of activity other than walking in the Honolulu Heart Program is also limited. In our sample, only 29 men reported that they jogged. Although data were available on the numbers of flights of stairs climbed, there was no association between climbing stairs and the distance walked or mortality. The numbers of flights of stairs climbed could have little meaning here, since the value of such information might be influenced by the number of stories in a home as well as by physical ability.

Information about the intensity of walking by the men in this study also was not available. Presumably, however, the intensity was less variable and possibly lower in this group of men than it might be in groups that are more heterogeneous. Walking in Hawaii may also be more easily sustained and uniformly practiced throughout the year because of the mild climate. Concomitant high-intensity activity is probably not a confounding factor, since only a few men reported undertaking any heavy activity (45 of 707). After these men were excluded, the associations between walking and mortality remained significant.

Since walking appears to have a positive effect in reducing the risk of death from cancer and cardiovascular disease in addition to its effect on overall mortality, the explanatory mechanisms are probably multifactorial. Presumably, walking reduces the risk of death from coronary heart disease and stroke through mechanisms related to cardiovascular fitness, including effects on hypertension, lipid profiles, and clotting mechanisms. Although such an association would be difficult to observe, the levels of walking in this study may have been associated with healthier lifestyles that were adhered to throughout life. Although the effects of walking on mortality were independent of other risk factors, the men who walked the least may have been more prone to changes over time in risk factors that affect progression to cardiovascular disease (e.g., the development of hypertension) than those who walked greater distances.

In addition to the Honolulu Heart Program, other studies have also focused on the benefits of physical activity in older men and women, particularly in the light of the projected increases in the elderly population into the early part of the next century.[1-6] Of the studies published, however, few controlled for confounding risk factors that are relevant to older retired men, including physical capabilities and the use of alcohol and tobacco. Other studies tended to define activity more broadly or to focus less narrowly on older retired men who were physically capable than our study did. Only the Harvard Alumni Study has addressed the effects of walking on mortality rates.[3] The results of that study indicated that men 35 to 74 years of age who walked 1.3 miles (2.1 km) or more per day had a 22 percent lower risk of death than men who walked less than 0.3 mile (0.5 km) per day. The Harvard investigators, however, did not limit their study to retired nonsmoking men who were physically capable of low-intensity activity.

Of course, the effects on longevity of intentional efforts to increase the distance walked per day by physically capable older men cannot be addressed in our study. Our findings do, however, provide some evidence that mortality is reduced when the distance walked is increased. In the light of previous evidence that active lifestyles reduce the risk of cardiovascular disease and other adverse outcomes in younger and more diverse groups of people, increasing the amount of low-intensity activity is likely to benefit the health of the elderly as well. In addition, compliance with recommendations to increase the time spent in simple activities such as walking, which require only modest amounts of effort, may be easier to achieve than compliance with recommendations of more vigorous exercise.

Supported by a contract (NO1-HC-05102) with the National Heart, Lung, and Blood Institute and by a Research Centers in Minority Institutions Award (P20 RR/AI 11091) from the National Institutes of Health.

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