Effects of Walking on Coronary Heart Disease in Elderly Men

The Honolulu Heart Program

Amy A. Hakim, MS; J. David Curb, MD; Helen Petrovitch, MD; Beatriz L. Rodriguez, MD, PhD; Katsuhiro Yano, MD; G. Webster Ross, MD; L. R. White, MD; Robert D. Abbott, PhD

Background—Effects of walking on the risk of coronary heart disease morbidity and mortality have not been identified in the elderly. The purpose of this study was to determine whether walking is associated with a reduced risk of coronary heart disease in a sample of elderly men.

Methods and Results—For this study, distance walked (mile/d) was examined at a baseline examination that occurred from 1991 to 1993 in the Honolulu Heart Program. Incident coronary heart disease from all causes was observed over a 2- to 4-year follow-up period. Subjects followed up were 2678 physically capable elderly men aged 71 to 93 years. During the course of follow-up, 109 men developed coronary heart disease. Men who walked <0.25 mile/d had a 2-fold increased risk of coronary heart disease versus those who walked >1.5 mile/d (5.1% versus 2.5%; P<0.01). Men who walked 0.25 to 1.5 mile/d were also at a significantly higher risk of coronary heart disease than men who walked longer distances (4.5% versus 2.5%; P<0.05). Adjustment for age and other risk factors failed to alter these findings.

Conclusions—Findings from the Honolulu Heart Program, which targeted physically capable elderly men, suggest that the risk of coronary heart disease is reduced with increases in distance walked. Combined with evidence that suggests that an active lifestyle reduces the risk of cardiovascular disease in younger and more diverse groups, this suggests that important health benefits could be derived by encouraging the elderly to walk. (Circulation. 1999;100:9-13.)

Key Words: exercise ■ cardiovascular diseases ■ aging ■ mortality

Effects of walking on mortality and the risk of cardiovascular disease in the elderly have not been well described, although increasing evidence suggests that the health benefits from walking may be nontrivial.1–4 In a recent report from the Honolulu Heart program,4 retired men who walked >2 mile/d experienced half the mortality (22%) of those who walked <1 mile/d (43%). Walking was also associated with a significantly lower risk of death due to cancer, although relationships with death due to the combined causes of coronary heart disease and stroke were less clear. In addition, associations with total coronary heart disease alone in the Honolulu Heart Program could not be examined because of the limited number of men who were available for follow-up. Effects of walking on the risk of coronary heart disease in the elderly have also not been identified elsewhere. The purpose of this study was to determine, on the basis of additional follow-up of a larger sample of elderly men enrolled in the Honolulu Heart Program, whether the health benefits of walking with regard to total mortality and death due to cancer could be extended to coronary heart disease.

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Methods

From 1965 to 1968, the Honolulu Heart Program began monitoring 8006 men of Japanese ancestry living on the island of Oahu, Hawaii, for the development of coronary heart disease and stroke.5,6 At the time of study enrollment, subjects underwent a complete physical examination, when the men were 45 to 68 years old. During the course of follow-up, subjects underwent repeat examinations as part of a comprehensive follow-up of surviving cohort members. Procedures followed were in accordance with institutional guidelines and approved by an institutional review committee. Informed consent was obtained from the study participants.

Among the series of repeat physical examinations, distance walked (mile/d) was first assessed at the third examination (1980 to 1982) of participants who were enrolled in the Cooperative Lipoprotein Phenotyping Study.7 During that examination, subjects comprised both a select and random sample of surviving members of the entire cohort.8 Among those in the random sample, 707 men were nonsmoking, retired, and physically capable of undertaking ≥1 hour of slight, moderate, or heavy activity. This is the sample that was...
TABLE 1. Percent Incidence of Coronary Heart Disease Based on 2 to 4 Years of Follow-Up According to Distance Walked in Elderly Men Aged 71 to 93 Years

<table>
<thead>
<tr>
<th>Distance Walked, mile/d</th>
<th>Sample Size</th>
<th>Number of Events</th>
<th>Average Age, y</th>
<th>Unadjusted Incidence, %</th>
<th>Age-Adjusted Incidence, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0.25</td>
<td>805</td>
<td>41</td>
<td>78±5</td>
<td>5.1‡</td>
<td>5.0‡</td>
</tr>
<tr>
<td>0.25 to 1.5</td>
<td>1067</td>
<td>48</td>
<td>78±5</td>
<td>4.5†</td>
<td>4.4†</td>
</tr>
<tr>
<td>&gt;1.5</td>
<td>806</td>
<td>20</td>
<td>77±4</td>
<td>2.5</td>
<td>2.6</td>
</tr>
<tr>
<td>Test for trend</td>
<td></td>
<td></td>
<td></td>
<td>P&lt;0.001</td>
<td>P=0.002</td>
</tr>
</tbody>
</table>

*SD.
†Significant difference from men who walked >1.5 mile/d (P<0.05).
‡Significant difference from men who walked >1.5 mile/d (P<0.01).

To describe the way in which distance walked might vary with each of the possible confounding characteristics, age-adjusted mean levels of each of the factors were calculated across ranges of distance walked. Procedures for adjustment were based on ANCOVA methods with linear and logistic regression models. Proportional hazards regression models were used to examine the independent effect of distance walked on the risk of coronary heart disease and to provide estimates of relative risk among the ranges of distance walked. To determine whether there was a dose-response relationship between distance walked and the risk of coronary heart disease, as has been reported elsewhere for total mortality, cardiovascular disease, and death due to cancer, distance walked was also modeled as a continuous variable. The exponential of the resulting regression coefficient, after multiplication by 0.5 mile, was then derived to yield an estimate of the relative risk of coronary heart disease that could be attributed to a 0.5-mile difference in distance walked. Other forms of the relationship between distance walked and the risk of coronary heart disease were also considered. All reported probability values were based on 2-sided tests of significance.

Results

Among the 2678 men considered in the present study, the average distance walked was 1.2±1.4 mile/d. Thirty percent (805) of the men walked <0.25 mile/d, 40% (1067) walked 0.25 to 1.5 mile/d, and 30% (806) walked >1.5 mile/d. Among the men who walked the most, 77% (620 of 806) walked ≥3 mile/d, whereas 5 of 806 walked as much as 8 mile/d.

Table 1 shows the unadjusted and age-adjusted percent incidence of coronary heart disease according to ranges of distance walked per day based on the 2 to 4 years of follow-up. During this period of time, 109 men experienced a coronary event. The median time to occurrence of an event was 2.1 years.

For men who walked >1.5 mile/d, the unadjusted incidence of coronary heart disease was 2.5% (20/806). For men who walked <0.25 mile/d, the incidence was doubled to 5.1% (41/805). Men who walked >1.5 mile/d had a significantly lower risk of coronary heart disease than men who walked 0.25 to 1.5 mile/d (P<0.05) and those who walked shorter distances (P<0.01). The trend for the risk of coronary heart disease to decline with increases in distance walked was also statistically significant when distance walked was modeled as a continuous variable (P<0.001). Here, the exponential of the corresponding regression coefficient (β=−0.334, SE=0.098), after multiplication by 0.5 mile, yields a relative risk of 0.85 (95% CI, 0.77 to 0.93), suggesting that the risk of coronary heart disease is reduced by 15% (95% CI, 7% to 23%) for every 0.5-mile increase in distance walked per day.

described in a previous report from the Honolulu Heart Program that showed that walking had a significant effect on reduction in mortality. Information on distance walked was next collected at an examination that occurred from 1991 to 1993 among 3845 members of the original cohort (>80% of the surviving members who were originally enrolled in the Honolulu Heart Program).

The present study examined the effects of distance walked on coronary heart disease morbidity and mortality among men who participated in the 1991 to 1993 examinations. Only men free of coronary heart disease (including angina pectoris and coronary insufficiency) and capable of undertaking ≥1 hour of slight, moderate, or heavy activity were considered for follow-up. Exclusions based on smoking and retirement status were not made because most men were nonsmokers (93%) and most were retired (95%). Further comment on these factors will appear later. The final sample considered for the present study included 2678 men aged 71 to 93 years when follow-up began.

After the 1991 to 1993 baseline examination, 2 to 4 years of follow-up were available to explore the relationship between distance walked and the risk of coronary heart disease. Herein, coronary heart disease is defined to include unequivocal findings through hospital surveillance of nonfatal myocardial infarction, coronary death, and sudden death within an hour that could not be attributed to another cause. Identification of such events was confirmed by a review of all suspected coronary outcomes by the Honolulu Heart Program Morbidity and Mortality Review Committee. Further description of the definition of coronary heart disease is provided elsewhere.

To help isolate the independent effect of distance walked on coronary heart disease, statistical analysis included adjustments for several possible risk factors that were measured at the time walking was assessed. Factors included age, total and HDL cholesterol, hypertension, diabetes, alcohol intake, and years of childhood lived in Japan. A diagnosis of hypertension was made when either systolic or diastolic blood pressure was ≥140 or 90 mm Hg, respectively, or when a subject was receiving medication for high blood pressure. Diabetes was defined on the basis of medical history or the use of insulin or oral hypoglycemic therapy. On the basis of serum samples collected at the 1991 to 1993 examinations, diabetes was also considered to be present when fasting glucose concentration exceeded 6.9 mmol/L (125 mg/dL) or when the nonfasting level was ≥11.1 mmol/L (200 mg/dL) 2 hours after ingestion of a 200-g glucose challenge. Further description of the risk factors is provided elsewhere. Effects of retirement and smoking status on the relationship between walking and coronary heart disease were also considered.

In addition to the above factors, adjustments were made for a summary measure of physical function based on performance on a battery of tasks that participants were asked to undertake. The battery included tests that measured time to walk 10 feet, ability to walk on toes and heels, hand strength, ability to stand on a chair, and other factors related to physical function. Based on a weighted average of the individual items, a summary measure of physical function was created. The resulting measure is referred to as the performed physical function score. Herein, higher scores represent better physical function than lower scores.
Adjustment for age did little to alter this result or other comparisons in Table 1. More complex forms of the relationship between distance walked and the risk of coronary heart disease (such as a quadratic or a threshold effect) were not apparent or statistically significant.

Table 2 describes how other risk factors that were determined at the 1991 to 1993 examination were associated with distance walked. As might be expected, the performed physical function score increased with increases in distance walked. Men who walked the longest distances (>1.5 mile/d) had significantly higher levels of physical function than those who walked less ($P<0.01$). Levels of total cholesterol were also higher in the men who walked the most but only significantly higher than in men who walked 0.25 to 1.5 mile/d (5.0 versus 4.9 mmol/L [194 versus 190 mg/dL]; $P<0.005$). There was no clear association between distance walked and levels of HDL cholesterol, the percent of men with diabetes, or childhood years lived in Japan.

The percent of men with hypertension appeared to increase with distance walked, but differences between ranges of distance walked were not statistically significant. No clear pattern appeared to exist between the percent of men who smoked cigarettes and distance walked, although men who walked the most (>1.5 mile/d) were significantly more likely to smoke cigarettes than men who walked the least (<0.25 mile/d; $P<0.001$) and significantly less likely to smoke cigarettes versus men who walked 0.25 to 1.5 mile/d ($P<0.05$). Alcohol intake was significantly less in men who walked the most than in men in all other groups of distances walked ($P<0.05$). Although there were significant differences in the percent of men who were retired among the walking groups, differences were modest.

To help determine whether the risk of coronary heart disease could be attributed to an association between walking and the other risk factors, proportional hazards regression models were estimated in an attempt to control for possible confounding influences that might involve these factors. Results are shown in Table 3, with comparisons of the expected risk of coronary heart disease among the ranges of distance walked per day.

After adjustment for age and other risk factors, the risk of coronary heart disease was 2.3 times greater in men who walked <0.25 mile/d compared with men who walked >1.5 mile/d ($P<0.001$). The risk of coronary heart disease in men who walked 0.25 to 1.5 mile/d was double the risk in men who walked farther ($P<0.05$). The difference between men who walked the least (<0.25 mile/d) versus those who walked 0.25 to 1.5 mile/d was not statistically significant. The risk of coronary heart disease decreased with each increase in amount of distance walked ($P=0.002$). The removal of men who smoked cigarettes or who were not retired failed to alter these results appreciably.

### Discussion

In an earlier study from the Honolulu Heart Program, walking in nonsmoking retired men aged 61 to 81 years appeared to be associated with a reduced risk of death due to the combined causes of coronary heart disease and stroke. The association, however, was not statistically significant. An evaluation of the effect of walking on nonfatal events was also not examined because morbidity follow-up was less complete compared with the follow-up available for fatal events. In addition, only 707 men were considered in the previous report. Along with low rates of coronary heart disease that often characterize men of Japanese ancestry, statistical power to detect an important association between walking and death due to cardiovascular disease may have been limited.

The present study used a much larger sample of elderly men in whom coronary heart disease morbidity and mortality is sufficiently common to allow specific consideration of fatal and nonfatal coronary events. Given that the average life expectancy for men of similar age to those in the study sample is ≈9 years, the 2- to 4-year follow-up also represents a large proportion of available life expectancy. The data from the Honolulu Heart Program suggest that walking among elderly men is related to a lower risk of coronary heart disease. Elderly men who walked >1.5 mile/d were at half

### Table 2.

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<tr>
<td></td>
<td>&lt;0.25</td>
<td>0.25 to 1.5</td>
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<tr>
<td>Total cholesterol, mmol/L*</td>
<td>4.9 (0.9)</td>
<td>4.9 (0.8)</td>
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<tr>
<td>HDL cholesterol, mmol/L*</td>
<td>1.3 (0.3)</td>
<td>1.3 (0.4)</td>
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<tr>
<td>Hypertension, %</td>
<td>72.3</td>
<td>74.1</td>
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<tr>
<td>Diabetes, %</td>
<td>26.4</td>
<td>28.9</td>
</tr>
<tr>
<td>Current smoker, %</td>
<td>4.7</td>
<td>10.5</td>
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<tr>
<td>Alcohol intake, L/mo</td>
<td>21.0 (41.9)</td>
<td>21.5 (45.2)</td>
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<tr>
<td>Retired, %</td>
<td>96.8</td>
<td>93.9</td>
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<tr>
<td>Childhood years lived in Japan</td>
<td>2.1 (4.6)</td>
<td>1.6 (4.0)</td>
</tr>
</tbody>
</table>

*SD is shown in parentheses. Significant difference from men who walked >1.5 mile/d: $P<0.05$; $P<0.01$; $P<0.001$.

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*Corresponding units in mg/dL are shown in brackets [mean (SD)].

### Table 3.

<table>
<thead>
<tr>
<th>Comparison Between Ranges of Distance Walked, mile/d</th>
<th>Age-Adjusted Relative Risk</th>
<th>Risk Factor–Adjusted Relative Risk (95% CI)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0.25 vs &gt;1.5</td>
<td>2.2† (1.3–3.7)</td>
<td>2.3$\dagger$ (1.3–4.1)</td>
</tr>
<tr>
<td>0.25 to 1.5 vs &gt;1.5</td>
<td>1.8† (1.1–3.0)</td>
<td>2.1$\dagger$ (1.2–3.6)</td>
</tr>
<tr>
<td>&lt;0.25 vs 0.25 to 1.5</td>
<td>1.2 (0.8–1.8)</td>
<td>1.1 (0.7–1.7)</td>
</tr>
</tbody>
</table>

Test for trend $P=0.002$ $P=0.002$

*Relative risks are adjusted for age, total and HDL cholesterol, hypertension, diabetes, alcohol use, performed physical function score, and number of years lived in Japan during childhood.

†Significant excess of coronary heart disease ($P<0.05$).

$\dagger$Significant excess of coronary heart disease ($P<0.01$).
the risk of developing coronary heart disease as men who walked <0.25 mile/d.

As in the previous report from the Honolulu Heart Program, attempts were made to examine only physically capable men. The exclusion of those who were not physically capable offers the advantage of diminishing the possibility that effects of walking on the development of coronary heart disease could have been achieved through associations with disability and physical impairment. The exclusion of men who reported that they did no walking failed to alter the reported findings. As seen in Table 3, even in men who walked at least 0.25 mile/d, the beneficial effect of walking on coronary heart disease persisted. In the present study, men who walked 0.25 to 1.5 mile/d were at a significantly higher risk of coronary heart disease than men who walked farther.

An additional advantage of studying elderly men in the mild climate of Hawaii is that walking on a continuous basis may be more easily sustained throughout the year. Self-reported activity may also be more consistent with actual behavior, because recall is less likely to be interrupted by long bouts of inclement weather.

Unfortunately, information about the intensity and duration of walking is lacking in the Honolulu Heart Program. This may be less of a drawback in the more homogeneous sample of elderly men in the Honolulu cohort compared with younger groups or in comparisons with samples in which outside activity is often environmentally influenced. Elderly men, particularly those exceeding 70 years of age, would be less likely to undertake vigorous walking as an exercise, and as a result, intensity and duration might be less variable than in more diverse groups. Because most men in the Honolulu sample spent much of their lives in Hawaii (nearly 90% were born in Hawaii), we can speculate that walking in this cohort could reflect a regular and lifelong pattern of behavior as opposed to behaviors that might be more sporadic through migration or because of residence in hostile climates. Although it requires additional study, this might suggest that lifelong behavior may be important in influencing the risk of coronary heart disease as opposed to irregular behavioral patterns. Whether walking can reduce coronary heart disease risk when it is begun later in life in historically sedentary individuals is unclear.

Although the island environment of Hawaii might provide an ideal setting for the study of outdoor activities such as walking, the generalization of findings among Japanese-American men to other groups is important. Unfortunately, only a few studies have examined the effects of walking on death and cardiovascular disease, although published reports suggest that the health benefits from walking that have been observed in the Honolulu Heart Program may also extend to women and younger men. Investigators from the Harvard Alumni Study showed that in men aged 35 to 74 years, walking led to a 21% lower risk of death as distance walked was increased from <0.5 mile to ≥1.3 mile/d. In a recent report from the Nurses Health Study, women were also observed to benefit from walking through an association with a reduced risk of cardiovascular disease.

Although mechanisms through which walking reduces the risk of death and cardiovascular disease are unknown, presumably such an effect is achieved through a variety of indirect pathways that could influence cardiovascular fitness, hypertension, lipid profiles, clotting factors, and other concomitant risk factors. Although the effect of walking on coronary heart disease was independent of major risk factors that were determined at the time walking was assessed, it may be that men who walk are more resistant to acute risk factor changes or transitions into adverse risk factor states. For example, men without hypertension who walk regularly may be less prone to develop hypertension then similar men who are sedentary.

Statistical adjustment for the reported use of β-blockers (12.7%), aspirin use on a regular basis (15.6%), and insulin use (1.8%) also did not explain or alter the relationship between distance walked and the risk of coronary heart disease. Associations between distance walked and the use of each of these medications were also not statistically significant.

In addition, triglyceride levels and a parental history of heart disease (7.8%) had no relationship to distance walked, nor did they influence the findings that are reported herein. Although direct measurement of LDL cholesterol levels was not made, its influence through derivation from the Friedewald formula was comparable to the influence of total cholesterol.

It would appear that walking may simply reflect an overall healthy lifestyle that includes a variety of behaviors that might be associated with good nutrition and an interest in a generally more active pattern of living. Although the effects of walking on reducing the risk of mortality appear to be constant across levels of total caloric intake, the percent of calories from protein, fat, and carbohydrates, and the percent preference for a Japanese diet, a combined attention to nutrition and active lifestyles would seem to be the best way to minimize the risk of cardiovascular disease. Even if walking does not have an independent effect on coronary heart disease, its potential effect through unknown indirect pathways makes it worthy of promotion as a behavior that can prevent or delay the onset of disease. This is especially important because regular walking may be more easily adopted and adhered to in the elderly than more vigorous and stressful exercise. Combined with evidence that suggests that active lifestyles reduce the risk of cardiovascular disease and other adverse outcomes in younger and more diverse groups, this suggests that encouraging the physically capable elderly person to walk and to become active could have important health benefits. It seems prudent that such encouragement should be given as early in life as possible, when good habits are more easily developed.

Acknowledgments
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