Physical Activity and Mortality in Older Men With Diagnosed Coronary Heart Disease

S. Goya Wannamethee, PhD; A. Gerald Shaper, FRCP; M. Walker, MA

Background—We have studied the relations between physical activity, types of physical activity, and changes in physical activity and all-cause mortality in men with established coronary heart disease (CHD).

Methods and Results—In 1992, 12 to 14 years after the initial screening (Q1) of 7735 men 40 to 59 years of age from general practices in 24 British towns, 5934 (91% of available survivors, mean age 63 years) provided further information on physical activity (Q92) and were followed up for 5 years; 963 had a physician’s diagnosis of CHD (myocardial infarction or angina). After exclusions, there were 772 men with established CHD, 131 of whom died of all causes. The lowest risks for all-cause and cardiovascular mortality were seen in light and moderate activity groups (adjusted relative risk compared with inactive/occasionally active: light, 0.42 (0.25, 0.71); moderate, 0.47 (0.24, 0.92); and moderately vigorous/vigorous, 0.63 (0.39, 1.03). Recreational activity of ≥4 hours per weekend, moderate or heavy gardening, and regular walking (>40 min/d) were all associated with a significant reduction in all-cause mortality. Nonsporting activity was more beneficial than sporting activities. Men sedentary at Q1 who began at least light activity by Q92 showed lower mortality rates on follow-up than those who remained sedentary (relative risk 0.58, 95% CI 0.33 to 1.03; P=0.06).

Conclusions—Light or moderate activity in men with established CHD is associated with a significantly lower risk of all-cause mortality. Regular walking and moderate or heavy gardening were sufficient to achieve this benefit.

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Key Words: exercise ■ coronary disease ■ mortality

Leisure-time physical activity is associated with lower all-cause mortality and with lower morbidity and mortality rates from cardiovascular disease in middle-aged and older men.1–6 Maintaining or increasing physical level in late middle age has been shown to be associated with a reduction in mortality rates,3,7 and light activities are sufficient to produce this benefit in older men.3,4 The role of physical activity and the types of physical activity required to achieve benefit in men with established coronary heart disease (CHD) are less well established. Meta-analyses of cardiac rehabilitation programs suggest a significant reduction in mortality rates in patients participating in an exercise program compared with a control group. The independent effects of physical activity are difficult to separate from other aspects of these programs.5–10 and patients ≥65 years of age are usually excluded. The number of “exercise only” trials is small, and most have failed to reach statistical significance.9 In the majority of cardiovascular studies in populations, men with diagnosed CHD are excluded or are included in the large group of subjects with preexisting disease.3 The British Regional Heart Study has previously reported on the effects of physical activity and changes in physical activity on 4-year mortality rates in men with and without a wide range of preexisting cardiovascular disease.3 The beneficial effect of physical activity was seen in both groups. The specific effect of physical activity in men with established CHD was not examined. We examined the relation between physical activity and changes in physical activity over 5 years of follow-up in older men with established CHD and assessed the effects of the common types of physical activity (walking, gardening, and sport) on mortality rates.

Methods
The British Regional Heart Study is a large prospective study of cardiovascular disease involving 7735 men 40 to 59 years of age at screening selected from the age-sex registers of 1 group general practice in each of 24 towns in England, Wales, and Scotland.11 During 1978 to 1980, research nurses administered to each man a standard questionnaire including questions on smoking, alcohol, physical activity, and medical history (Q1). In 1992, 12 to 14 years after screening, a similar but more comprehensive questionnaire (Q92) was posted to surviving participants, now 52 to 73 years of age (average 63 years). In addition to questions on current illness and medication, detailed information was collected on changes in smoking and drinking and in leisure-time physical activity. Of the 6528 surviving and available participants, 5934 (91%) completed the Q92 questionnaire.

Men With Physician-Diagnosed CHD
At Q92 (but not at Q1), the men were asked to describe their present health status: “excellent, good, fair, or poor.” They were asked

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whether a doctor had ever told them that they had angina or myocardial infarction (heart attack, coronary thrombosis), stroke, “other heart trouble,” and a number of other disorders. Men with physician-diagnosed CHD consisted of men with a recall of a physician diagnosis of CHD (heart attack or angina) at Q92 and those who had had a major nonfatal myocardial infarction event before Q92, based on the regular surveillance of general practitioner’s records (n=963). Since men reporting “poor health” have exceptionally high mortality rates and are likely to have limitations in their physical activities, we have excluded them from the analyses (n=116). This report is primarily concerned with men with physician-diagnosed CHD at Q92 who did not report “poor health” (n=847), of whom a further 75 men were excluded for incomplete information on physical activity, leaving 772 men.

Physical Activity
At initial screening (Q1) and 12 to 14 years later (Q92), the men were asked to indicate their usual pattern of physical activity under the headings of regular walking or cycling, recreational activity, and sporting (vigorous) activity. Regular walking and cycling related to weekday journeys that included travel to and from work. Recreational activity included gardening, pleasure walking, and do-it-yourself jobs. Sporting activity included running, golf, swimming, tennis, sailing, and digging. A physical activity (exercise) score was derived for each man on the basis of frequency and type (intensity) of the physical activity. Scores were assigned for each type of activity and duration on the basis of the intensity and energy demands of the activities reported.6,13,14 The total score for each man is not a measure of total time spent in physical activity but is a relative measure of how much physical activity has been carried out. At Q92, the subjects were asked additional questions on how the hours of gardening were spent: light gardening, moderate gardening, and heavy digging. The men were grouped into 4 mutually exclusive groups on the basis of their highest category of intensity of gardening: no gardening, light gardening only, moderate gardening, and heavy gardening (digging).

Physical Activity Index
At both Q1 and Q92, the men were initially grouped into 6 broad categories on the basis of their total score: 1, inactive, score 0 to 2 (n=85); 2, occasional, score 3 to 5 (n=238), regular walking or recreational activity only; 3, light, score 6 to 8 (n=181), more frequent recreational activities, sporting exercise less than once per week, or regular walking plus some recreational activity; 4, moderate, score 9 to 12 (n=100), cycling or very frequent weekend recreational activities plus regular walking or sporting activity once per week; 5, moderately vigorous, score 13 to 20 (n=82), sporting activity at least once per week or frequent cycling plus frequent recreational activities or walking or frequent sporting activities only; 6, vigorous, score ≥21 (n=86), very frequent sporting exercise or frequent sporting exercise plus other recreational activities. The use of the physical activity score has been validated at baseline in men free of preexisting CHD. Mean heart rate and FEV1 decreased significantly with increasing levels of physical activity even after adjusting for potential confounders.6 We have excluded 75 men not providing complete data on physical activity at Q92 and thus our report is based on 772 men. A further 13 men did not provide information on physical activity at screening and thus our analysis of changes in physical activity from Q1 to Q92 is based on 759 men.

Cardiovascular Risk Factors

Smoking
From the combined information at screening and at Q92, the men were classified at Q92 as those who had never smoked, ex-smokers, and current smokers.

Social Class
The longest-held occupation of each man was recorded at screening, and the men were grouped into 1 of 6 social classes I, II, III nonmanual, and III manual, IV and V. Those whose longest occupation was in the Armed Forces formed a separate group.

Body Mass Index
Body mass index (BMI) (weight/height² in kg/m²) was calculated for each man on the basis of reported weight at Q92 and on height measured at screening. Obesity is defined as BMI ≥28 kg/m², the upper fifth of the distribution of BMI in all men at screening.

Indicators of Ill Health at Q92

Chest Pain on Exertion
With the use of the WHO (Rose) chest pain questionnaire for angina or possible myocardial infarction, both possible and definite angina are referred to as “chest pain on exertion.”15

Cardiovascular Surgery
This includes angioplasty, coronary artery bypass operation, and other heart surgery.

Breathlessness
The men were asked 3 questions regarding breathlessness: (1) Do you get short of breath walking with people your own age on level ground? (2) On walking up hills or stairs, do you get more breathless than people your own age? (3) Do you ever have to stop walking because of breathlessness? Those who answered positive to any of these questions were regarded as having breathlessness and those who answered positive to all 3 questions were regarded as having severe breathlessness.

Calf Pain on Walking
The men were asked whether they ever got pain in the calf muscle when (1) walking at an ordinary pace on level ground and (2) walking uphill or hurrying. Calf pain on walking was defined as an affirmative answer to either question. Those who answered yes to question 1 were regarded as having severe calf pain.

Locomotor Disability
This included men reporting difficulty carrying out any 1 of the 6 following activities on their own as a result of a long-term health problem: (1) going up or down stairs, (2) bending down, (3) straightening up, (4) keeping balance, (5) going out of the house, or (6) walking 400 yards.

Follow-Up
All men were followed up for all-cause mortality and for cardiovascular morbidity.6 All deaths in the period to December 1997 have been recorded, and follow-up has been achieved for 99% of the cohort. However, this present report is concerned only with the men who completed the Q92 questionnaire and thus mortality follow-up since Q92 is presented (a follow-up period of 5 years for each man). Information on death was collected through the established “tagging” procedures provided by the National Health Service registers in Southport (England and Wales) and Edinburgh (Scotland).

Statistical Methods
Cox’s proportional hazards model was used to assess the relation between (1) reported physical activity at Q92 and 5-year mortality on follow-up and (2) changes in physical activity from Q1 to Q92 and 5-year mortality and to obtain relative risks adjusting for potential confounders.16 Adjustments for confounding factors and symptoms indicating ill health were based on information obtained at Q92. In the adjustment, smoking (never-smokers, long-term ex-smokers, recent ex-smokers, and current smokers), social class (7 groups), obesity (yes/no), disability (yes/no), diabetes (yes/no), stroke (yes/no), breathlessness (none, mild, severe), chest pain on exertion (yes/no), and calf pain on walking (none, mild, severe) were fitted as categoric variables.
Results

Of the 772 men with diagnosed CHD who did not report “poor health,” 284 (36.8%) had diagnosed angina only, 225 (29.1%) had diagnosed myocardial infarction only, and 263 men (34.1%) had a diagnosis of both myocardial infarction and angina. During the mean follow-up of 5 years, there were 131 deaths from all causes (35.0/1000 person-years), 94 attributed to cardiovascular causes. The mortality rates per 1000 person-years were 29.5 for those with diagnosed angina only, 33.5 for those with myocardial infarction, and 42.6 for those with both.

Because of the small numbers in some categories, we have combined the inactive and occasionally active and also combined the men who did moderately vigorous and vigorous exercise. The Figure shows the age-adjusted rates per 1000 person-years for the 4 physical activity groups, and Table 1 shows the age-adjusted relative risks of death, with the inactive/occasionally active group as reference. The reference group had by far the highest mortality rate. Light and moderately active men showed similar low rates of mortality. Risk increased slightly beyond moderate levels, but these men still showed significantly lower risk than the reference group. Light and moderate levels of activity were associated with a significant reduction in risk of total and cardiovascular mortality even after adjustment for age, social class, smoking, obesity, history of myocardial infarction, diabetes, stroke, and self-rated health status (Table 1). History of myocardial infarction was included in the adjustment because these subjects had a higher risk of death than those with angina only.

The inverse relation between physical activity and mortality rates was seen in men <65 years (n=356; 40 deaths) and in men ≥65 years (n=416; 91 deaths). Adjusted relative risks for the 4 physical activity groups were 1.00, 0.52, 0.84, and 0.59 in men <65 years of age and 1.00, 0.38, 0.35, and 0.65 in men ≥65 years of age.

Assessing Severity: Adjustments for Symptoms

There was little difference between the 4 activity groups in reporting of surgical procedures (eg, angioplasty, CABG, and other heart surgery). However, inactive/occasionally active men showed the highest prevalence of breathlessness on exertion, chest pain on exertion, calf pain on walking, and disability (Table 2). Further adjustment for these factors made little difference in the relations seen. The adjusted relative risk (95% CI) for the 4 physical activity groups were 1.00, 0.44 (0.26 to 0.75), 0.48 (0.24 to 0.96), and 0.67 (0.41, 1.10) for total mortality and 1.00, 0.40 (0.21 to 0.76), 0.51 (0.24, 1.10), and 0.64 (0.36, 1.16) for cardiovascular mortality.

The benefit of light and moderate activity was seen in men with chest pain on exertion or severe breathlessness on exertion (n=450; 94 deaths) and in men without either symptom (n=322; 37 deaths). In men with chest pain, moderately vigorous/vigorous levels conferred only a small benefit. The adjusted relative risks for the four physical activity groups were 1.00, 0.17, 0.54, and 0.48 in men without chest pain or severe breathlessness and 1.00, 0.62, 0.36, and 0.80 in men with chest pain or severe breathlessness.

Types of Physical Activity

We examined the effects of specific types of activity at Q92 on all-cause and cardiovascular mortality rates, adjusting for age, social class, smoking status, obesity, self-rated health status, recall of physician diagnosis of myocardial infarction, stroke, and diabetes (Table 3).

Recreational

Recreational activity during weekends of ≥4-hour duration (cumulative) was associated with a significant reduction in both total and cardiovascular mortality rates.

### TABLE 1. Risk of Mortality Over 5-Year Follow-Up in Relation to Physical Activity at Q92 in 772 Men With Diagnosed CHD

<table>
<thead>
<tr>
<th>Physical Activity Q92</th>
<th>All-Cause Mortality</th>
<th></th>
<th>Cardiovascular Mortality</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Age-Adjusted RR</td>
<td>Fully Adjusted RR</td>
<td>Age-Adjusted RR</td>
</tr>
<tr>
<td>Inactive/occasional</td>
<td>323</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Light</td>
<td>181</td>
<td>0.36 (0.22, 0.60)</td>
<td>0.42 (0.25, 0.71)</td>
<td>0.33 (0.18, 0.62)</td>
</tr>
<tr>
<td>Moderate</td>
<td>100</td>
<td>0.35 (0.18, 0.68)</td>
<td>0.47 (0.24, 0.92)</td>
<td>0.39 (0.19, 0.81)</td>
</tr>
<tr>
<td>Moderate to vigorous/vigorous</td>
<td>168</td>
<td>0.51 (0.32, 0.81)</td>
<td>0.63 (0.39, 1.03)†</td>
<td>0.49 (0.28, 0.86)</td>
</tr>
</tbody>
</table>

Men who reported “poor health” were excluded.
Adjusted for age, smoking, social class, self-rated health status, diabetes, and history of myocardial infarction and stroke.

*P=0.09.
†P=0.07.
Walking
The men were divided into 3 categories of walking (none, \( \leq 40 \text{ min/d} \), and \( >40 \text{ min/d} \)). Regular walking for \( >40 \text{ min/d} \) was associated with a significant reduction in total and cardiovascular mortality rates.

Gardening
The number of men engaged in heavy gardening (digging) was small, but they showed mortality rates similar to those engaged in moderate gardening, and the two groups were combined. Moderate or heavy-intensity gardening but not light gardening was associated with a significant reduction in total and cardiovascular mortality rates.

Sport
Men who reported \( >1 \) sporting activity per month showed a small but nonsignificant reduction in total and cardiovascular mortality rates compared with those who reported none or \( \leq 1 \) per month.

Since these types of activity are not mutually exclusive, further adjustments were made for each of the other activities.

### TABLE 2. Prevalence of Symptoms by Physical Activity Levels and Changes in Physical Activity From Q1 to Q92

<table>
<thead>
<tr>
<th>Physical activity</th>
<th>Breathlessness</th>
<th>Leg Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Any</td>
<td>Severe</td>
</tr>
<tr>
<td>Inactive/occasional</td>
<td>64.4</td>
<td>35.6</td>
</tr>
<tr>
<td>Light</td>
<td>53.6</td>
<td>17.7</td>
</tr>
<tr>
<td>Moderate</td>
<td>49.0</td>
<td>12.0</td>
</tr>
<tr>
<td>Moderate to vigorous/vigorous</td>
<td>39.9</td>
<td>13.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Changes in physical activity</th>
<th>Breathlessness</th>
<th>Leg Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A (inactive/occasional)</td>
<td>64.1</td>
<td>34.4</td>
</tr>
<tr>
<td>Group B (at least lightly active)</td>
<td>65.1</td>
<td>36.5</td>
</tr>
<tr>
<td>Group C (inactive/occasionally)</td>
<td>52.7</td>
<td>21.2</td>
</tr>
<tr>
<td>Group D (at least lightly active)</td>
<td>44.1</td>
<td>11.5</td>
</tr>
</tbody>
</table>

Group A, inactive/occasionally active at Q1 and Q92.
Group B, at least lightly active at Q1, inactive/occasionally active at Q92.
Group C, inactive/occasionally active at Q1, at least lightly active at Q92.
Group D, at least lightly active at Q1 and Q92.

### TABLE 3. Type of Recreational Activity and Adjusted Relative Risk of Mortality in Men With Diagnosed CHD, Excluding Men Reporting “Poor Health”

<table>
<thead>
<tr>
<th>Recreational activity</th>
<th>No. of Men</th>
<th>Total Mortality</th>
<th>CVD Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>n</td>
<td>Adjusted RR*</td>
</tr>
<tr>
<td>Inactive/fairly inactive, ( &lt;4 \text{ h/weekend} )</td>
<td>148</td>
<td>48</td>
<td>1.00</td>
</tr>
<tr>
<td>Average, 4 h/weekend</td>
<td>312</td>
<td>47</td>
<td>0.45 (0.30, 0.68)</td>
</tr>
<tr>
<td>Fairly/very active, ( &gt;4 \text{ h/weekend} )</td>
<td>312</td>
<td>36</td>
<td>0.41 (0.26, 0.65)</td>
</tr>
<tr>
<td>Regular walking, min/d</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>269</td>
<td>65</td>
<td>1.00</td>
</tr>
<tr>
<td>1–40</td>
<td>276</td>
<td>41</td>
<td>0.73 (0.49, 1.09)</td>
</tr>
<tr>
<td>( &gt;40 )</td>
<td>227</td>
<td>25</td>
<td>0.48 (0.30, 0.77)</td>
</tr>
<tr>
<td>Gardening</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>180</td>
<td>41</td>
<td>1.00</td>
</tr>
<tr>
<td>Light</td>
<td>276</td>
<td>52</td>
<td>0.89 (0.58, 1.34)</td>
</tr>
<tr>
<td>Moderate/heavy</td>
<td>316</td>
<td>37</td>
<td>0.59 (0.37, 0.93)</td>
</tr>
<tr>
<td>Sporting activity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None or ( &lt;1/\text{mo} )</td>
<td>572</td>
<td>104</td>
<td>1.00</td>
</tr>
<tr>
<td>( \geq 1 \text{ mo} )</td>
<td>200</td>
<td>27</td>
<td>0.82 (0.53, 1.29)</td>
</tr>
</tbody>
</table>

*Adjusted for age, smoking, social class, obesity, self-rated health, history of myocardial infarction, stroke, and diabetes.
This made only minor differences to the relations seen in Table 3. The benefits of recreational activity, regular walking >40 minutes, and moderate or heavy gardening were seen in those with and without chest pain or severe breathlessness on exertion. Sporting activity was beneficial in those with no chest pain or severe breathlessness but not in those with chest pain or severe breathlessness.

**Changes in Physical Activity**

To assess the effects of changes in physical activity over the 12 to 14 years between Q1 and Q92 on mortality rates during 5 years of follow-up, the men were grouped into 4 groups on the basis of their physical activity patterns at Q1 and Q92: (A) inactive/occasionally active at Q1 and Q92, (B) at least lightly active at Q1 but inactive/occasionally active at Q92, (C) inactive/occasionally active at Q1 but at least lightly active at Q92, and (D) at least lightly active at Q1 and Q92. Men who became inactive/occasionally active (group B) had the highest mortality rates (Table 4). Compared with those who remained inactive (A), those who became at least lightly active (C) and those who remained lightly active (D) showed a significantly lower mortality risk, and this was of marginal significance after adjustment ($P=0.06$ and $P=0.09$, respectively). The same pattern of mortality risk were seen for cardiovascular mortality, although the differences from group A were not statistically significant. Men who remained inactive (A) and men who became inactive (B) showed similar prevalence of symptoms, for example, exertion-related breathlessness, calf pain and chest pain, and reporting of disability and fair health status, and both groups showed higher prevalence rates of symptoms than those who became or remained active (Table 2). However, the benefit of taking up physical activity was seen even when men with chest pain or severe breathlessness were excluded.

**Discussion**

Cardiac rehabilitation programs have provided evidence for the wide acceptance of physical activity as an important factor in the treatment of subjects with established CHD. Physical training usually is part of a comprehensive cardiac rehabilitation program, including risk factor management and counseling, and it is difficult to identify the relative importance of each preventive measure. The physical training usually involves supervision in a hospital or other specialized center. Few studies have examined the effects of leisure-time physical activity and the type of activity on mortality in subjects with established CHD in a general population.

**Benefits of Light or Moderate Physical Activity**

In this study of older men with established CHD, light and moderate levels of physical activity, even when taken up later in life, were associated with a significant reduction in risk of all-cause and cardiovascular mortality rates. The benefit was seen in men <65 and in men ≥65 years of age. Benefit was achieved by light forms of physical activity (eg, walking, gardening, and recreational activity). Even those with chest pain or severe breathlessness achieved significant benefit from these lighter activities. Although sporting activity was beneficial in those with no reported chest pain, it conferred little benefit in those with chest pain in whom lighter nonsporting activity was more beneficial.

**Potential Bias**

Some of the benefit seen may be due to severity of disease in those who are inactive, but we have excluded all men who reported “poor health.” Statistical adjustment for symptoms and disability status made minor differences to the relations. The benefit was most clearly seen in those with no chest pain or breathlessness on exertion, and optimal benefit was seen in those undertaking light or moderate activity. More vigorous levels...
conferred no additional benefit, and these men were less likely to have chest pain or severe breathlessness than the lighter activity group. In men with chest pain or severe breathlessness, more vigorous activity appeared to confer little benefit. It is unlikely that the benefit seen with light or moderate activity is simply due to severity of disease in the inactive subjects.

Previous Studies
Most trials on the effectiveness of physical training and risk factor management in myocardial infarction survivors have not shown a significant effect on mortality and morbidity, although many have shown an improvement in exercise tolerance,20 risk factor profile,21 and psychosocial status.22 Meta-analyses have indicated a trend toward a significant reduction in overall mortality and in cardiac mortality rates in patients undergoing physical training.6,9 However, the relatively small number of exercise-only trials and the fact that rehabilitation programs include other interventions do not allow a definitive conclusion to be reached about the independent effects of the physical exercise component.

Few population-based prospective studies have examined the effects of physical activity in men with established CHD, but most suggest a beneficial effect. In a small Japanese study of 80 male myocardial infarction survivors who had been treated in a hospital coronary care unit but not educated about their lifestyle, higher daily physical activity was associated with a significantly lower risk of cardiac death.23 In a study of 782 Harvard alumni 35 to 74 years of age with reported history of CHD, those who exercised <2000 kcal/wk were at greater risk of CHD death than those more active.24

Conclusions
There is a need for every hospital to have facilities and staff for cardiac rehabilitation after discharge, but it is unlikely that such facilities will ever be able to deal with the ongoing needs of all those with established CHD. The level and type of physical activity carried out as part of everyday activities can be of considerable benefit to patients with established CHD. Vigorous or “sporting” activity is not required, and regular leisure activities such as walking and gardening appear to be sufficient to achieve significant benefit. In formal, medically supervised exercise programs, the risk of untoward events taking place is remarkably small, and this risk is likely to be even smaller in home-based leisure physical activity.25,26 Regular light or moderate physical activity should be actively encouraged in all those with established CHD without pressure to achieve the vigorous exercise previously regarded as necessary for benefit.

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References
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