Physical Activity, Physical Fitness, and All-Cause Mortality in Women: Do Women Need to be Active?

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Physical inactivity is associated with higher mortality rates in most studies in men, but studies in women are more equivocal. The purpose of this study was to evaluate the relationship of sedentary living habits to all-cause mortality in women. A group of 3,120 adult women completed a preventive medical examination, and were followed for approximately 8 years for mortality. There were 43 deaths and a total of 25,433 person-years observed during follow-up. Physical fitness was assessed at baseline by a maximal exercise test on a treadmill, and physical activity was estimated by a self-administered questionnaire. Age-adjusted all-cause mortality rates were significantly inversely associated with physical fitness. Death rates were 40, 16, and 7 per 10,000 person-years of follow-up across low, moderate, and high categories of physical fitness, respectively. However, death rates did not differ across low, moderate, and high categories of physical activity. These findings are different than for men in the same study, where both physical activity and physical fitness were inversely associated with mortality risk. We attribute the lack of association between physical activity and mortality in women to be due to inadequate assessment of activity, and that this also is the likely explanation for the difference in results between women and men in published studies of physical activity and mortality.

Abbreviations: CHD = coronary heart disease

INTRODUCTION

Sedentary lifestyle is established as a risk factor for cardiovascular disease and all-cause mortality in men [1,2], but the relation in women is less certain. Powell et al [1] report that in 10 of 14 comparisons there was no relationship between inactivity and coronary heart disease (CHD) in women. For example, there was a significant inverse gradient for CHD risk across levels of reported physical activity in women in the Framingham study in univariate analyses, but this association disappeared with adjustment for age and other established risk factors [3]. It may be that sedentary habits increase the risk of disease in men but not in women, although that seems unlikely when one considers the similar pathophysiology of atherosclerosis in the two sexes. In the only published study on physical fitness and mortality in women, we reported an increased relative risk of 4.65 for all-cause mortality when women in the least physically fit quintile were compared with those in the most fit quintile [4]. This finding was comparable to data in men in the same study (relative risk = 3.44) in a similar analysis.

Thus, there is an apparent divergence in existing data: low fitness and low activity are associated with higher risk in men. In women, low fitness is strongly associated with risk, but low activity appears to be unrelated. The purpose of this report is to evaluate the relationship of sedentary lifestyle to mortality in men and women, and to contrast these results with earlier findings on physical fitness and mortality in the same population.

METHODS

We followed a population of 10,224 men and 3,120 women who were given a preventive medical examination at least once during 1970 to 1981. Study participants were from middle to upper socioeconomic strata, most were employed in professional or executive positions, and approximately 70% were college graduates. They were fol-
lowed until date of death or until December 31, 1985, with an average length of follow-up of slightly more than 8 years, and a total follow-up of 85,049 person-years in men and 25,433 person-years in women. This cohort of patients was apparently healthy at baseline, because patients with a history or evidence of diabetes, myocardial infarction, hypertension, stroke, or abnormal resting or exercise electrocardiograms were excluded. Details of the examination and follow-up procedures have been published [4–6], and only a brief description of key methods will be presented here.

Physical fitness was assessed by a maximal exercise test on a treadmill [7]. The treadmill test began at 0% elevation and with a speed of 88 M/minute. Grade was increased to 2% for the second minute, and 1% per minute until 25 minutes. After 25 minutes, grade was held constant and the speed was increased 5.4 M/minute until the test was terminated when patients reached exhaustion. Total time on the treadmill was used to assign patients to fitness quintiles within age groups for both men and women. In this report, the first quintile is labeled low fitness, the second and third quintiles are grouped into a moderate fitness category, and the fourth and fifth quintiles are combined for a high fitness group.

Physical activity was assessed by questions on exercise participation included on the medical history questionnaire completed by patients at the clinical examination. Patients were presented a list of 18 common leisure-time or recreational activities, and were asked if they had participated in any of the activities over the past month. Three categories of physical activity were created: Patients who did not indicate any participation were categorized as inactive, patients who indicated that they walked, ran, or jogged were classified as highly active, and all others were categorized as moderately active. Mortality surveillance was accomplished by a variety of methods including follow-up via Social Security Administration files, state departments of motor vehicles, and the National Death Index. There were 240 deaths in men and 43 deaths in women in the cohort through 1985.

Mortality rates per 10,000 person-years of follow-up were computed for each of the activity and fitness categories for men and women. These rates were age-adjusted by the direct method, using the entire population as the standard. Relative risks for age-adjusted all-cause mortality (and associated 95% confidence intervals) were computed for low and moderate activity and fitness categories using the high activity and fitness categories respectively as the referent group.

RESULTS

Baseline characteristics of selected variables are shown in Table 1. Decedents were older, more unfit, and had less favorable risk profiles than did survivors. Age-adjusted all-cause death rates per 10,000 person-years of follow-up are presented in Table 2 for low, moderate, and high levels of physical activity and physical fitness for men and women. The total number of person-years and deaths differ slightly between activity and fitness analyses. This is primarily due to missing data on activity in the first 3 years of the study. There was a strong inverse gradient of death rates across physical fitness categories in both men and women, with the gradient being slightly steeper in women. The test for linear trend was significant (p < 0.001) in both men and women. The relation between physical activity and mortality was different in women than in men. In men, the inverse gradient of rates across activity strata was apparent (p < 0.001), but was totally absent in women.

DISCUSSION

Identical analyses were performed in a cohort of men and women with age-adjusted all-cause mortality as the dependent variable and either physical fitness or physical activity as the exposure variable. Similar results were seen for the two analyses in men: Death rates were lower in the more active and more fit men. Direction and magnitude of the gradient in men were similar to previous reports for both activity [8] and fitness [9] analyses. The slope of the gradient is steeper, however, in the fitness analysis in men than in the activity analysis. The difference in the strength of these two relationships may be explained by the relative accuracy and validity of assessment of the two exposure variables. Physical activity assessment is relatively crude, and undoubtedly leads to considerable misclassification. Physical fitness, as assessed by the maximal exercise test, is more objective and reliable in comparison to activity assessment. There was likely much more misclassification on the activity variable than for the fitness variable, which would bias the activity analyses toward the null hypothesis. The classification scheme used in this study is crude, but limitations of the way data were entered into the computer file preclude a more detailed classification. Although this method does result in misclassification, it should be primarily confined to misclassification between the moderate- and high-activity categories. Some individuals in the moderately active group, for example, might be regular swimmers or cyclists. It seems reasonable to assume that patients in the low-activity group, with no participation in any of the 18 activities in the past month, were relatively sedentary.

Stronger associations between physical fitness and mortality than for activity and mortality also are seen in other studies in men, with relative risks in the fitness studies being considerably higher than those reported in the activity studies. For example, Ekelund et al [9] report a relative
Physical Activity and Mortality in Women

Table 1. Baseline Characteristics of Men and Women Participants in the Aerobics Center Longitudinal Study [4]

<table>
<thead>
<tr>
<th></th>
<th>Women Survivors</th>
<th>Women Decedents</th>
<th>Men Survivors</th>
<th>Men Decedents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Follow-up (years)</td>
<td>(n = 3,077)</td>
<td>(n = 43)</td>
<td>(n = 9,984)</td>
<td>(n = 240)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>8.2 ± 2.9*</td>
<td>6.5 ± 3.8</td>
<td>8.4 ± 2.9</td>
<td>6.5 ± 4.0</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>40.8 ± 9.9</td>
<td>51.7 ± 14.5</td>
<td>41.5 ± 9.3</td>
<td>49.8 ± 11.6</td>
</tr>
<tr>
<td>Treadmill time (minutes)</td>
<td>22.2 ± 3.5</td>
<td>23.2 ± 3.7</td>
<td>25.6 ± 3.3</td>
<td>25.8 ± 3.4</td>
</tr>
<tr>
<td>Total cholesterol (mmol/L)</td>
<td>11.5 ± 4.0</td>
<td>8.2 ± 4.2</td>
<td>17.0 ± 4.7</td>
<td>13.5 ± 5.9</td>
</tr>
<tr>
<td>Systolic BP (mmHg)</td>
<td>5.20 ± 0.95</td>
<td>6.05 ± 1.0</td>
<td>5.45 ± 1.0</td>
<td>6.05 ± 1.2</td>
</tr>
<tr>
<td>Current smokers (%)</td>
<td>112.2 ± 14.0</td>
<td>124.1 ± 19.5</td>
<td>120.4 ± 13.1</td>
<td>126.1 ± 17.1</td>
</tr>
</tbody>
</table>

* Mean ± standard deviation.

risk for CHD of 6.5 for the least fit quartile compared with the most fit quartile in their population of men. Morris et al [10] report a relative risk of 2.8 for CHD when comparing men who get no vigorous exercise with those who are frequently vigorously active. A similar comparison by Leon et al [8] for the least active tertile compared with the most active tertile yielded a relative risk of 1.6, the same as reported here for men (Table 2).

It may be that studies on physical activity and mortality underestimate the true impact of sedentary living, due to crude assessment techniques and subsequent misclassification, and this may help explain the difference in results between men and women in the literature and in the analyses reported here. The relation between fitness and mortality in women is similar, although slightly stronger, than the comparable finding in men. However, we also noted an inverse association between physical activity in men, but found no relation between physical activity and mortality in women, a finding that is consistent with the

review of Powell et al [1], which showed that 71% of the published studies in women found no relationship between activity and CHD. These data could indicate that both low levels of activity and fitness are risk factors for all-cause mortality in men, but that only low fitness, and not low activity, is a risk factor in women. We believe that the more likely explanation is that the physical activity assessment technique used in our study (and others) was less accurate for women than for men. The focus on traditional sport and leisure-time activities in the questionnaire misses potentially significant sources of energy expenditure that may be more common for women such as those associated with child care and household tasks. Thus, substantial errors in physical activity assessment could occur. Furthermore, this rationale may explain the lack of association between physical activity and disease reported in many published studies. Most of the physical activity assessment methods used were developed for studies in men, and have been applied to studies in women.

Table 2. Age-Adjusted All-Cause Death Rates for Men and Women in the Aerobics Center Longitudinal Study by Low, Moderate, and High Levels of Physical Activity and Physical Fitness

<table>
<thead>
<tr>
<th>Physical fitness</th>
<th>Women # of deaths</th>
<th>Person-years of follow-up</th>
<th>Age-adjusted all-cause death rate/10,000 person-years</th>
<th>RR*</th>
<th>95% CI</th>
<th>Men # of deaths</th>
<th>Person-years of follow-up</th>
<th>Age-adjusted all-cause death rate/10,000 person-years</th>
<th>RR*</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>18</td>
<td>4,916</td>
<td>39.5</td>
<td>5.35</td>
<td>2.44-11.73</td>
<td>75</td>
<td>14,515</td>
<td>64.0</td>
<td>3.16</td>
<td>1.92-5.20</td>
</tr>
<tr>
<td>Moderate</td>
<td>17</td>
<td>10,382</td>
<td>16.4</td>
<td>2.22</td>
<td>0.93-5.30</td>
<td>87</td>
<td>34,185</td>
<td>26.3</td>
<td>1.30</td>
<td>0.73-2.32</td>
</tr>
<tr>
<td>High</td>
<td>8</td>
<td>10,135</td>
<td>7.4</td>
<td>1.00</td>
<td></td>
<td>78</td>
<td>36,349</td>
<td>20.3</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>p (trend) &lt;0.001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p (trend) &lt;0.001</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Physical activity

| Low | 22  | 8,876 | 22.6   | 0.95 | 0.54-1.70 | 138            | 29,551                   | 46.3                                                  | 1.70| 1.06-2.74 |
| Moderate | 4  | 2,493 | 17.9   | 0.75 | 0.41-1.39 | 30             | 7,097                    | 40.3                                                  | 1.48| 0.9-2.42 |
| High | 16  | 7,669 | 23.7   | 1.00 |           | 74             | 27,535                   | 27.1                                                  | 1.00|          |

p (trend) = 0.305

* Relative risk.
Physical fitness is an objective marker for the overall level of physical activity or total energy expenditure in individuals. A sedentary lifestyle is established as a risk factor for mortality in men, and the fitness data presented here suggest that sedentary living is also hazardous for women, the data on activity and mortality notwithstanding. A first step to further explore this issue would be to conduct additional research to develop and validate physical activity assessment techniques for women. This can then be followed by additional studies on activity and health in women.

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REFERENCES


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