Physical Activity and Cardiovascular Disease Risk in Middle-aged and Older Women

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The authors investigated the relation between physical activity and cardiovascular disease (CVD) in women by following 1,564 University of Pennsylvania alumnae (mean age, 45.5 years), initially free of CVD, from 1962 until 1993. Energy expenditure was estimated from the daily number of flights of stairs climbed and blocks walked as well as the sports played and was categorized into approximate thirds (<500, 500–999, ≥1,000 kcal/week). During 35,021 person-years, 181 CVD cases were identified. After adjustment for coronary risk factors, the relative risks of CVD were 0.99 (95% confidence interval (CI): 0.69, 1.41) and 0.88 (95% CI: 0.62, 1.25) for women who expended 500–999 and ≥1,000, respectively, compared with <500 kcal/week (p for trend = 0.45). Only walking was found to be inversely related to CVD risk (p for trend = 0.054). Compared with women who walked <4 blocks/day, the relative risks of CVD were 0.84 (95% CI: 0.59, 1.19) and 0.67 (95% CI: 0.45, 1.01) for women who walked 4–9 and ≥10 blocks/day, respectively. Finally, an interaction (p = 0.023) between body mass index and physical activity on CVD risk was observed, with an inverse association only for leaner (<23 kg/m²) women. These data showed no overall association of physical activity with CVD risk in women. However, walking ≥10 blocks/day (approximately 6 miles (9.7 km)/week) was associated with a 33% decreased risk. One explanation for this finding may be that walking was reported more precisely than other kinds of activities. Am J Epidemiol 1999; 150:408–16.

The leading cause of death among women in the United States is cardiovascular disease (CVD) (1). Numerous studies have suggested an inverse association between physical activity and CVD risk among men (2, 3). The relation between physical activity and CVD risk among women remains unclear, with an assumed benefit extrapolated from the findings for men (4). In fact, studies that involved women have yielded inconsistent results (5–19). For example, the Framingham Study found no association between physical activity and CVD among women (5). In contrast, on the basis of findings from the Iowa Women’s Health Study (6), postmenopausal women who participated in regular physical activity regimens had a significantly lower risk of dying from CVD compared with physically inactive subjects.

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Abbreviations: BMI, body mass index; CVD, cardiovascular disease.

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The variability among findings may reflect a weaker association between physical activity and CVD among women than among men (9, 11, 13). Although studies of women and of men demonstrate similar correlations between higher physical activity levels and coronary risk factors, there may be gender-related differences in how they affect the subsequent development of CVD. Alternatively, many previous studies may have lacked a detailed measurement of physical activity, possibly introducing measurement error and attenuating the results. Finally, because of small numbers of CVD outcomes, most studies have lacked power to detect modest inverse associations.

Therefore, to investigate whether physical activity during middle and late years alters the risk of CVD, we studied 1,564 University of Pennsylvania alumnae who were initially free of CVD and who provided a detailed report of their physical activity. We also assessed the associations of each component of physical activity, including stairs climbed, blocks walked, and sports played, with CVD risk and examined potential effect modification by coronary risk factors.

MATERIALS AND METHODS

Subjects

Female subjects in the College Alumni Health Study, an ongoing prospective cohort study, matricu-
Assessment of physical activity

To assess physical activity in 1962, we asked alumnae on the 1962 questionnaire to report the daily number of flights of stairs they climbed and city blocks they walked and the sports in which they currently participated, as well as the number of hours per week spent on each sport. While we did not directly assess occupational-related physical activity among these older women, we expect that most of this activity comprised climbing stairs and walking only. From these data, we estimated an index of weekly energy expenditure. Women who climbed up and down a flight of stairs daily expended 28 kilocalories per week (kcal/week), and those who walked a city block daily expended 56 kcal/week. Each sport was assigned a classification of energy cost, a metabolic equivalent score (1 metabolic equivalent = the energy expenditure while sitting quietly, which for an average adult is approximately 3.5 ml of oxygen per kilogram of body weight per minute) (21). This score was multiplied by body weight in kilograms and hours per week spent on that sport to provide a weekly energy expenditure for that particular sport, since the resting metabolic rate is approximately 1 kcal/kg of body weight/hour.

We then summed the calculated energy expenditures for flights climbed, blocks walked, and all sports reported to estimate a composite physical activity index in kilocalories per week. We did not expect any confounding by body weight in our definition of physical activity because we adjusted for body mass index (BMI) in our analyses. Furthermore, a strong correlation (r = 0.95) between physical activity indexes calculated with (as detailed above) or without regard to body weight (i.e., assuming that light activities require 5 kcal/minute, vigorous activities require 10 kcal/minute, and combinations require 7.5 kcal/minute (22)) provided strong evidence for no confounding. Alumnae were then categorized into approximate thirds of physical activity in 1962: <500, 500-999, and ≥1,000 kcal/week. We further grouped each component of physical activity into approximate thirds: flights climbed—<4, 4-11, and ≥12 flights/day; blocks walked—<4, 4-9, ≥10 blocks/day; and sports played—0, 1-999, and ≥1,000 kcal/week.

This technique of assessing physical activity has been demonstrated to be reliable and valid (23-29). For example, when reliability was evaluated, correlations for estimates of energy expenditure among women were 0.76 over 4 weeks and 0.73 over 1 year (28). For validity, estimates of energy expenditure obtained from our questionnaire yielded age-adjusted correlation coefficients for women of 0.54 compared with activity records and 0.53 compared with VO$_2$ peak measurements, a measure of physical fitness (29).

Ascertainment of CVD

We ascertained 181 cases of CVD (including angina pectoris, coronary artery bypass graft surgery, myocardial infarction, and stroke) through self-reports on follow-up questionnaires sent in 1976, 1980, and 1993. The date of diagnosis was taken as the earliest reported year of diagnosis from the three questionnaires. Deaths were compiled continuously by the University of Pennsylvania alumni office, which maintains a weekly list of deceased alumnae. For each death reported by the alumni office, we requested and obtained a death certificate from the appropriate state. Mortality data were collected through 1992. Therefore, our distinction between "nonfatal" (131 cases) and "fatal" (50 cases) CVD reflects the manner in which cases were ascertained.

Of the initially eligible population of 2,363, 1,564 women (67 percent) returned at least one of the follow-up questionnaires (1976, 1980, or 1993) or were known to have died. Although the proportion followed was low, loss to follow-up was likely to be random with respect to CVD since age-specific rates among the 1,564 women were similar to rates among women from the 1988 National Health Interview Survey (30).

Data analysis

BMI was calculated by dividing weight in kilograms by height in meters squared. We also collected information on coronary risk factors, including hypertension (classified in analyses as no or yes), diabetes mellitus (no or yes), smoking status (never, former, or current (<20 or >20 cigarettes/day)), and family history of coronary heart disease (no or yes). We expect that self-reported data on coronary risk factors among this cohort of women were valid and reliable, as demonstrated in several studies of women (31-34). We computed Spearman's correlation coefficients compar-
ing energy (in kcal/week) expended on each component of physical activity, including flights climbed, blocks walked, and sports played.

We calculated person-years of follow-up from 1962 to the year in which CVD was first reported, the year of death, or the year in which the latest questionnaire was returned, whichever occurred first. Relative risks and 95 percent confidence intervals for CVD were calculated for each physical activity level by using Cox proportional hazards analysis, always with the lowest level of physical activity (<500 kcal/week) as the referent. The assumption of proportional hazards was satisfied by testing for the interaction between follow-up time and physical activity category \((p = 0.73)\). All \(p\) values reflected the results of two-tailed tests \((\alpha = 0.05)\).

Crude models adjusted only for age; multivariate models further adjusted for BMI, hypertension, diabetes mellitus, smoking status, and family history of coronary heart disease. Tests for trend were calculated by treating physical activity as an ordinal variable, using the median value of physical activity from each category. In secondary analyses, relative risks were compared for the associations between physical activity and either nonfatal or fatal CVD. We also performed analyses by excluding women who had CVD during the first 5 years of follow-up to minimize any bias due to illnesses that might have affected baseline physical activity. Sensitivity analyses assessed whether increasing the cutpoint for the highest level of physical activity appreciably altered the relative risk estimates. We also examined whether additional adjustment by alcohol intake and postmenopausal hormone use ascertained from the 1980 and 1993 follow-up questionnaires, respectively, affected the overall relative risks for a subset of women.

We examined the associations of each component of physical activity with CVD risk by using the lowest level as the referent. Multivariate models adjusted for the coronary risk factors described above and for total physical activity. We then examined whether any coronary risk factors modified the association between physical activity and CVD by using stratum-specific models. Age \((<45 and \geq 45)\) years and BMI \((<23 and \geq 23 \text{ kg/m}^2)\) were dichotomized at the approximate median of the distribution of the study population. We also assessed follow-up at age \(<55\) years and at age \(\geq 55\) years by using this age as a proxy for menopausal status. Follow-up at age \(<55\) years was assumed to reflect the premenopausal state and follow-up at age \(\geq 55\) years the postmenopausal state. Age 55 years was chosen as the age for defining menopause since 95 percent of US women reach menopause after age 55 years (Dr. Kathryn M. Rexrode, Brigham and Women’s Hospital, Boston, Massachusetts, personal communication, 1998). Only women free of CVD by age 55 years were included in the latter analysis. Finally, we examined whether physical activity expressed as a time-varying covariate was associated with CVD risk in a subset of women who, on both the baseline and 1980 questionnaires, reported physical activity.

### RESULTS

Women in each category of physical activity were compared according to coronary risk factors at baseline in 1962 (table 1), and no remarkable differences were observed. The mean (standard deviation) age at entry of all 1,564 alumnae was 45.5 (4.6) years, with a BMI of 22.4 (3.0) kg/m\(^2\) and a mean physical activity level of 1,082.9 (1,222.7) kcal/week. The median values in the three categories of physical activity were

<table>
<thead>
<tr>
<th>TABLE 1. Characteristics of University of Pennsylvania alumnae from the College Alumni Health Study, by levels of physical activity, 1962</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristic</td>
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<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
</tr>
<tr>
<td>45.7 (4.9)</td>
</tr>
<tr>
<td>45.5 (4.4)</td>
</tr>
<tr>
<td>45.3 (4.5)</td>
</tr>
<tr>
<td>22.2 (7.8)</td>
</tr>
<tr>
<td>Body mass index (kg/m(^2))</td>
</tr>
<tr>
<td>Smoking status</td>
</tr>
<tr>
<td>Current</td>
</tr>
<tr>
<td>(\geq 20) cigarettes/day</td>
</tr>
<tr>
<td>(&lt; 20) cigarettes/day</td>
</tr>
<tr>
<td>Former</td>
</tr>
<tr>
<td>Never</td>
</tr>
<tr>
<td>Hypertension</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
</tr>
<tr>
<td>Family history of CHD†</td>
</tr>
</tbody>
</table>

* Estimated from flights of stairs climbed, blocks walked, and sports played.
† SD, standard deviation; CHD, coronary heart disease.

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We then compared women in our study population (n = 1,564) with women who were eligible but were excluded because they were lost to follow-up (i.e., they had not responded to any follow-up questionnaires or were not known to have died; n = 799). Women who were excluded tended to be not only older, less active, and more hypertensive but also to have a lower prevalence of diabetes, smoking, and family history of coronary heart disease (data not shown).

Only 26.4 percent of subjects reported any sports play in 1962 (figure 1). However, the relative contributions of energy expended from flights climbed and blocks walked to total physical activity were comparable among women who reported no or any sports play. On average, the energy expended from flights climbed contributed 1.5–2 times the energy expended per week compared with the energy expended from blocks walked. We found strong correlations (all \( p = 0.0001 \)) between the physical activity index and the energy expended from all three types of physical activity (table 2). However, the correlations among specific types of physical activity were weaker.

During a total of 35,021 person-years of follow-up (median length of follow-up, 20 years), 181 CVD cases (131 nonfatal and 50 fatal) occurred. As shown in table 3, we found no overall association between higher levels of physical activity and CVD risk. Adjustment for additional coronary risk factors yielded findings similar to those obtained from the crude, age-adjusted models. Compared with subjects who expended <500 kcal/week, women who expended 500–999 and ≥1,000 kcal/week had nonsignificant relative risks of 0.99 and 0.86, respectively (\( p \) for trend = 0.37).

We found no appreciable difference in relative risks when we considered the effect of physical activity separately on the risk of nonfatal or fatal CVD. We then conducted analyses that excluded women with incident CVD during the first 5 years of follow-up to minimize any bias due to illnesses that might have changed their level of physical activity at baseline. These results were also virtually identical to the overall results. In sensitivity analyses, no matter how high we set the uppermost level of physical activity, we

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**FIGURE 1.** Relative contributions of kcal/week to total physical activity in 1962 among University of Pennsylvania alumnae from the College Alumni Health Study.

**TABLE 2.** Spearman’s correlation coefficients comparing energy expended (in kcal/week) by University of Pennsylvania alumnae from the College Alumni Health Study on different types of physical activity, 1962

<table>
<thead>
<tr>
<th>Activity Type</th>
<th>Physical Activity Index</th>
<th>Flights of stairs climbed</th>
<th>Blocks walked</th>
<th>Sports played</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.46***</td>
<td>0.62***</td>
<td>0.65***</td>
<td></td>
</tr>
</tbody>
</table>

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**TABLE 3.** Relative risks (RR) and 95% confidence intervals (CI) of cardiovascular disease among University of Pennsylvania alumnae from the College Alumni Health Study, by levels of physical activity, 1962–1993

<table>
<thead>
<tr>
<th>Physical activity level* (kcal/week)</th>
<th>No. of cases</th>
<th>Person-years</th>
<th>Age-adjusted model RR</th>
<th>95% CI</th>
<th>Multivariate model† RR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;500</td>
<td>69</td>
<td>12,417</td>
<td>1.00</td>
<td>1.00</td>
<td>Reference</td>
<td>1.00</td>
</tr>
<tr>
<td>500–999</td>
<td>53</td>
<td>9,831</td>
<td>0.99</td>
<td>0.69</td>
<td>1.41</td>
<td>0.99</td>
</tr>
<tr>
<td>≥1,000</td>
<td>59</td>
<td>12,773</td>
<td>0.86</td>
<td>0.61</td>
<td>1.22</td>
<td>0.88</td>
</tr>
</tbody>
</table>

\( p \) for trend = 0.37 \( p \) for trend = 0.45

* Estimated from flights of stairs climbed, blocks walked, and sports played.

† Adjusted for age (in years), body mass index (in kg/m²), hypertension (no or yes), diabetes mellitus (no or yes), smoking status (never, former, current ≤20 cigarettes/day, >20 cigarettes/day), and family history of coronary heart disease (no or yes).
found no significant reduction in CVD risk among women in the highest category compared with women who expended <500 kcal/week. We also examined the relation between physical activity and CVD in a subset of 573 women who returned both the 1980 and 1993 questionnaires that inquired about alcohol intake and postmenopausal hormone use (79 nonfatal cases of CVD). Additional adjustment for these variables did not substantially change any of the overall relative risk estimates.

We also examined whether the relation between physical activity and CVD risk differed according to the type of physical activity performed (table 4). In addition to adjusting for coronary risk factors, we controlled for total physical activity (in kcal/week) in multivariate models. Therefore, the findings from multivariate models assume that the level of total physical activity is held constant and that the relative risk reflects the effect of, for example, substituting other types of activity for climbing 4–11 flights/day. We found no association between greater numbers of flights climbed and CVD risk in either crude (p for trend = 0.91) or multivariate (p for trend = 0.89) models. In contrast, we found an inverse association between the number of blocks walked and CVD risk. Compared with subjects who walked <4 blocks/day, those who walked 4–9 and ≥10 blocks/day had multivariate relative risks of 0.84 (95 percent confidence interval: 0.59, 1.19) and 0.67 (95 percent confidence interval: 0.45, 1.01), respectively (p for trend = 0.054). Higher levels of sports play were not associated with CVD risk according to either crude or multivariate models. Because so few women reported any sports play, we lacked sufficient power to address the intensity of sports played.

We then examined whether the relation between physical activity and CVD risk differed according to various coronary risk factors (table 5). We found a significant interaction between only physical activity level and BMI (p for interaction = 0.023) dichotomized at <23 and ≥23 kg/m². An inverse association between physical activity and CVD risk appeared to be restricted to lean women with a BMI of <23 kg/m² (p for trend = 0.043). After multivariate adjustment, lean women who expended ≥1,000 versus <500 kcal/week had a 37 percent decreased CVD risk. The association between physical activity and CVD did not differ according to menopausal status, whether defined at a cutoff of age 55 years or at other ages.

Finally, because physical activity levels may change over time, we examined a subset of 962 women who provided information regarding physical activity on both the 1962 and 1980 questionnaires. No association was found between baseline (1962) total physical activity, considered as a continuous variable, and CVD risk (p = 0.58) after control for coronary risk factors in this subset. However, when we analyzed total physical activity as a continuous, time-varying covariate assessed initially in 1962 and updated in 1980, we found a marginally significant inverse association with

<table>
<thead>
<tr>
<th>Physical activity type</th>
<th>No. of cases</th>
<th>Person-years</th>
<th>Age-adjusted model</th>
<th>Multivariate model*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>RR 95% CI</td>
<td>RR 95% CI</td>
</tr>
<tr>
<td>Flights of stairs climbed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;4/day</td>
<td>63</td>
<td>11,122</td>
<td>1.00 Reference</td>
<td>1.00 Reference</td>
</tr>
<tr>
<td>4–11/day</td>
<td>62</td>
<td>13,579</td>
<td>0.83 0.59, 1.19</td>
<td>0.86 0.60, 1.31</td>
</tr>
<tr>
<td>≥12/day</td>
<td>56</td>
<td>10,320</td>
<td>0.95 0.67, 1.37</td>
<td>1.01 0.69, 1.47</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>p for trend = 0.91</td>
<td>p for trend = 0.89</td>
</tr>
<tr>
<td>Blocks walked</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;4/day</td>
<td>75</td>
<td>13,113</td>
<td>1.00 Reference</td>
<td>1.00 Reference</td>
</tr>
<tr>
<td>4–9/day</td>
<td>56</td>
<td>11,106</td>
<td>0.89 0.53, 1.32</td>
<td>0.84 0.59, 1.19</td>
</tr>
<tr>
<td>≥10/day</td>
<td>48</td>
<td>10,802</td>
<td>0.73 0.51, 1.06</td>
<td>0.87 0.54, 1.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>p for trend = 0.09</td>
<td>p for trend = 0.054</td>
</tr>
<tr>
<td>Total sports played†</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>133</td>
<td>25,597</td>
<td>1.00 Reference</td>
<td>1.00 Reference</td>
</tr>
<tr>
<td>1–999 kcal/week</td>
<td>19</td>
<td>3,736</td>
<td>1.10 0.68, 1.79</td>
<td>1.23 0.74, 2.03</td>
</tr>
<tr>
<td>≥1,000 kcal/week</td>
<td>29</td>
<td>5,688</td>
<td>1.14 0.76, 1.72</td>
<td>1.32 0.74, 2.37</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>p for trend = 0.50</td>
<td>p for trend = 0.33</td>
</tr>
</tbody>
</table>

* Adjusted for age (in years), body mass index (in kg/m²), hypertension (no or yes), diabetes mellitus (no or yes), smoking status (never, former, current (≤20 cigarettes/day, >20 cigarettes/day)), family history of coronary heart disease (no or yes), and total physical activity (in kcal/week).
† Energy expended from all sports played.

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CVD risk in a multivariate model ($p = 0.076$), with a relative risk of 0.94 (95 percent confidence interval: 0.87, 1.01) for each 500 kcal/week increase in physical activity.

**DISCUSSION**

We found no overall association between physical activity and CVD risk in this cohort of middle-aged and older women. However, these data indicate that walking ≥10 blocks/day, or approximately 6 miles (9.7 km)/week, may be associated with a 33 percent decreased risk of CVD. Neither an increased energy expenditure from climbing stairs nor sports play was associated with CVD risk. Finally, in this population of women, we found that the benefit of physical activity was limited to leaner women with a body mass index of <23 kg/m$^2$. No other coronary risk factors appeared to modify the association between physical activity and CVD.

Although physical inactivity is an established, independent risk factor for CVD in men, Powell et al. (35) reported in 1987 that 10 of 14 studies had found no significant inverse association among women. More recent studies have continued to report equivocal results. It remains unclear whether the lack of association among women is a result of measurement error in the assessment of physical activity (36), of insufficient outcomes and compromised power, or of a genuine lack of effect. For middle-aged women in the Atherosclerosis Risk in Communities Study, Folsom et al. (8) used separate models for both sports play and leisure-time activity and found nonsignificant inverse associations with the risk of coronary heart disease. Haapanen et al. (9) observed no significant association between leisure-time activity and the risk of coronary heart disease in 1,500 middle-aged women, with a relative risk of 1.25 comparing low versus high levels of activity. Vigorous physical activity also was unassociated with coronary heart disease. The Adventist Health Study reported an inverse association between physical activity and fatal coronary heart disease but not
myocardial infarction (10). Finally, strong inverse associations between leisure-time physical activity and CVD mortality (6) or nonfatal myocardial infarction (11) among postmenopausal women were found in the Iowa Women's Health Study and Group Health Cooperative enrollees.

Our finding of a modest but nonsignificant inverse association for total physical activity is consistent with the range of relative risk estimates obtained for women. In contrast, studies of men have demonstrated considerably more strength and consistency for an inverse association. There are several potential reasons why physical activity has not been observed to be as protective for women as for men. First, even after menopause, women tend to have higher levels of high density lipoprotein cholesterol than men do. Increased physical activity in women may produce changes only within the upper distribution of high density lipoprotein cholesterol levels, at which the impact on their risk of CVD would be less beneficial.

Second, the relatively low overall levels of physical activity among our study population underscore the gender differences in physical activity during the 1960s. In fact, women's average physical activity levels increased modestly between 1962 and 1980. More recent measurements among women have shown higher levels of physical activity, as evident in the studies by Kushi et al. (6) and Lemaitre et al. (11). The greater variability and range of physical activity levels found in these studies and others may have increased the power to detect differences in CVD risk. Third, even a measurement error regarding physical activity in our study, if random with respect to CVD risk, would have biased our results toward the null value, especially if the true magnitude of effect for physical activity on CVD risk were modest at best. Post hoc power calculations suggest that our study had insufficient power to detect a small, significant difference of, for example, 14 percent between the highest and lowest categories of physical activity.

We found one component of physical activity, walking, to be associated with a 33 percent decreased CVD risk. Walking was also weakly correlated with other types of physical activity (Spearman's r = 0.07-0.16), suggesting that climbing stairs, walking blocks, and playing sports are independent of one another. The reduction in risk associated with walking was independent of coronary risk factors and total physical activity. If valid, this finding suggests that a greater proportion of a woman's energy expenditure should include walking. This is particularly relevant to middle-aged and older women, approximately 58 percent of whom engage in little or no physical activity, according to the Behavioral Risk Factor Surveillance System (37).

Walking for exercise can be easily incorporated into the current Surgeon General's recommendation for 30 minutes of moderate-intensity physical activity most days of the week (38). In fact, walking was the most popular recreational activity among women who completed our 1993 questionnaire. However, it is unclear whether this finding merely reflects women's more precise reporting of walking compared with stair climbing or sports play.

Intervention studies have established beneficial effects of physical activity on body weight (39), insulin sensitivity (40), lipoprotein profiles (41), and other coronary risk factors in women. We have no a priori explanation for the significant interaction between physical activity level and BMI. This finding may be a function of chance. Because we controlled for BMI within each stratum, residual confounding by BMI is unlikely to explain this result. Leaner women may experience greater improvements in coronary risk factors from higher levels of physical activity, thereby reducing their subsequent risk of CVD. Alternatively, heavier women may be more likely than lean women to misreport their level of physical activity, resulting in greater misclassification (42).

Some limitations should be considered in light of our results. First, only 66 percent of eligible women were followed successfully. Women who were not followed up tended to have both favorable and unfavorable levels of coronary risk factors, suggesting that our study cohort and those women lost to follow-up should have had comparable incidence rates of CVD. We found the age-specific incidence rates of CVD among women comprising our study population to be similar to incidence rates in the 1988 National Health Interview Survey (30), suggesting that loss to follow-up was random with respect to CVD occurrence. Second, our study population was inactive; only 26 percent of the women reported any sports play. Their low activity levels appear representative of the predominantly sedentary lifestyles of the early 1960s. Still, this finding limited our ability to examine how activity intensity may differentially affect CVD risk. Additionally, our assessment of only sports but not other recreational activities further contributed to the low levels of physical activity observed.

Another potential limitation is that we followed women over a long period of time, during which physical activity levels likely changed, which also would have contributed to misclassification of physical activity. When we updated our information on physical activity, we found that total physical activity had an inverse association of borderline significance with CVD risk. This finding confirms the importance of including multiple longitudinal measurements of phys-
Physical activity in future prospective studies of women, as noted by Lissner et al. (43). Finally, the lack of control for dietary factors, lipids, and other biochemical factors may have introduced residual confounding. However, we expect that the magnitude of residual confounding was modest regarding physical activity level.

In conclusion, our study does not support an overall inverse association between total physical activity and CVD risk in middle-aged and older women. However, we found that walking ≥10 blocks/day (approximately 6 miles (9.7 km)/week) was related to a decreased CVD risk. Future studies of women need to better assess physical activity, taking into account changes over time.

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

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