Relationship Between Physical Activity and Heart Failure Risk in Women

Iffat Rahman, PhD; Andrea Bellavia, MSc; Alicja Wolk, DrMedSci

Background—Physical activity is a modifiable health-related behavior shown to be associated with reduced risk of coronary heart disease and stroke. There is some evidence that this could also be the case for heart failure. We investigated whether total physical activity, as well as different domains of physical activity, was associated with heart failure risk.

Methods and Results—The Swedish Mammography Cohort was used in which 27,895 women were followed up from 1997 to 2011. First event of heart failure was ascertained through the Swedish National Patient Register and Cause of Death Register. Cox proportional hazards regression analyses were conducted to estimate multivariable-adjusted hazard ratios and 95% confidence intervals. We also analyzed survival percentiles by applying Laplace regression. During an average follow-up time of 13 years (369,207 person-years), we ascertained 2,402 first events of heart failure hospitalizations and deaths. We found that moderate to high levels of total physical activity were associated with a reduced risk of future heart failure. When looking into different domains of physical activity, walking/bicycling ≥20 minutes/d was associated with 29% lower risk of heart failure (95% confidence interval, −36% to −21%), when investigating survival percentiles this could be translated into 18 months longer heart failure–free survival.

Conclusions—Our study shows that physical activity could protect against heart failure in women. When looking closer into different domains of physical activity, walking or biking ≥20 minutes every day was associated with the largest risk reduction of heart failure. (Circ Heart Fail. 2014;7:877-881.)

Key Words: epidemiology • heart failure
in the second questionnaire, hence 1997 served as baseline for the current study. In total, 38,984 women completed the questionnaires.

We excluded individuals with prevalent HF, myocardial infarction, or cancer (except nonmelanoma skin cancer; n=2672) from the baseline population, based on linkage of the cohort to the Swedish National Patient Register and the Swedish Cancer Register. This effort was made because the above-mentioned diseases might affect both traditional HF risk factors and HF development. Individuals with missing information on total PA (n=5179) were also excluded from the study sample. The final study population consisted of 27,895 women.

The questionnaire also included information on participant’s educational attainment, diagnosis of diabetes mellitus (which was complemented with information from the diabetes register and the Swedish National Patient Register), weight, height, and waist circumference. Information on history of stroke and angina was obtained from the Swedish National Patient Register.

Assessment of PA
Participants reported their level of activity at work, home/household work, walking/bicycling, and exercise in the year before study enrollment. Questions on inactivity (watching television or reading) and hours per day of sleeping and sitting or lying down were also asked for.

Each type of PA was assigned an intensity score defined as metabolic equivalents (MET) hours/d, the intensity score was based on the compendium of physical activities. The mean MET values assigned for the different types of physical activities were as follows: walking/bicycling ≈ 3.6 MET; exercise ≈ 5.0 MET; work occupation ≈ 1.3 MET for mostly sitting down to 3.9 for heavy manual work; home/household work ≈ 2.5 MET; watching television/reading = 1.2 MET; sleep ≈ 0.9 MET. Total daily PA score (TPA) was then estimated by multiplying the intensity score of each type of PA for its reported duration and then adding all specific activities together. Work occupation contributed to the intensity score of each type of PA for its reported duration and then adding all specific activities together. Work occupation contributed to the intensity score of each type of PA for its reported duration and then adding all specific activities together. Work occupation contributed to the intensity score of each type of PA for its reported duration and then adding all specific activities together. Work occupation contributed to the intensity score of each type of PA for its reported duration and then adding all specific activities together.

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BMI indicates body mass index; HF, heart failure; MET, metabolic equivalents; and MI, myocardial infarction.

Table 1. Age-Standardized Descriptive Statistics of 27895 Women From the Swedish Mammography Cohort

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Quartiles of Total Physical Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total physical activity, MET h/d</td>
<td>&lt;39 39–42 43–46 &gt;46</td>
</tr>
<tr>
<td>No. of participants</td>
<td>7171 6439 7519 6766</td>
</tr>
<tr>
<td>Age at baseline, y</td>
<td>61.0 61.1 61.5 61.5</td>
</tr>
<tr>
<td>University education, %</td>
<td>23.9 25.2 20.5 10.5</td>
</tr>
<tr>
<td>Ever smokers, %</td>
<td>50.3 45.7 43.6 43.7</td>
</tr>
<tr>
<td>Current drinkers, %</td>
<td>86.4 85.7 84.2 81.5</td>
</tr>
<tr>
<td>History of stroke, %</td>
<td>1.8 1.0 1.0 0.5</td>
</tr>
<tr>
<td>History of angina, %</td>
<td>2.5 1.6 1.7 1.4</td>
</tr>
<tr>
<td>Family history of MI, %</td>
<td>30.6 30.0 30.6 33.3</td>
</tr>
<tr>
<td>Hypertension, %</td>
<td>22.1 20.4 19.4 19.2</td>
</tr>
<tr>
<td>Diabetes mellitus, %</td>
<td>3.9 3.2 3.0 3.1</td>
</tr>
<tr>
<td>BMI &gt;30 kg/m², %</td>
<td>34.1 31.6 32.4 32.9</td>
</tr>
<tr>
<td>HF cases, %</td>
<td>10.3 8.9 7.5 7.2</td>
</tr>
</tbody>
</table>

The descriptive statistics are expressed as means unless otherwise stated. BMI indicates body mass index; HF, heart failure; MET, metabolic equivalents; and MI, myocardial infarction.

Table 2. Association Between Quartiles of Total Daily Physical Activity Score and Risk of Heart Failure

<table>
<thead>
<tr>
<th>Model</th>
<th>Quartiles of Total Physical Activity (MET h/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;39 39–42 43–46 &gt;46</td>
</tr>
<tr>
<td>Age-adjusted</td>
<td>1.0 (ref) 0.80 (0.71–0.89) 0.67 (0.61–0.75) 0.64 (0.58–0.72)</td>
</tr>
<tr>
<td>HR (95% CI)</td>
<td></td>
</tr>
<tr>
<td>Multivariable-adjusted</td>
<td>1.0 (ref) 0.88 (0.79–0.98) 0.76 (0.68–0.85) 0.73 (0.65–0.82)</td>
</tr>
<tr>
<td>HR (95% CI)*</td>
<td></td>
</tr>
</tbody>
</table>

CI indicates confidence interval; HR, hazard ratio; and MET, metabolic equivalents.

Table 3. Association Between Different Types of Physical Activity and Risk of Heart Failure

<table>
<thead>
<tr>
<th>Type of Physical Activity</th>
<th>Hazard Ratio (95% CI)*</th>
<th>Hazard Ratio (95% CI)†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking/bicycling ≥20</td>
<td>0.65 (0.59–0.73)</td>
<td>0.71 (0.64–0.80)</td>
</tr>
<tr>
<td>vs &lt;20 min/d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exercise ≥1 vs &lt;1 h/wk</td>
<td>0.73 (0.67–0.80)</td>
<td>0.83 (0.75–0.92)</td>
</tr>
<tr>
<td>Work occupation active</td>
<td>0.82 (0.74–0.90)</td>
<td>0.93 (0.83–1.03)</td>
</tr>
<tr>
<td>vs mostly sitting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home/household work</td>
<td>0.73 (0.62–0.85)</td>
<td>0.82 (0.70–0.97)</td>
</tr>
<tr>
<td>≥1 vs &lt;1 h/d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inactivity (watching TV/</td>
<td>1.00 (0.83–1.19)</td>
<td>0.99 (0.83–1.18)</td>
</tr>
<tr>
<td>reading) &lt;3 vs ≥3 h/d</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CI indicates confidence interval; and TV, television.

*Adjusted for educational attainment (primary school, high school, and university), smoking (never, past, and current [<10 and >10 cigarettes/d], alcohol consumption (never/past/current [<5 and ≥5 g/d]), family history of myocardial infarction, history of stroke, history of angina, hypertension, diabetes mellitus, body mass index (<18.5, 18.5–24.9, 25–29.9, and ≥30 kg/m²), and waist circumference (<80, 80–88, >88 cm).

†Additionally adjusted for all types of physical activity.
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PA are poorly understood. Nevertheless, some explanations of the PA domain of leisure-time activity in that study. are to some extent similar because walking and bicycling was part of bicycling, followed by exercise and household work. Our findings mutually adjusted for. The sensitivity analysis in which we measured the association at fifth PD showed negligible differences when compared with the main Laplace analysis, with walking/bicycling showing the biggest PD followed by exercise (data not shown).

The largest difference was detected for walking/bicycling. On the basis of the first 8% of participants who developed HF, women who engaged in walking or bicycling for <20 minutes/d had HF event 18 months earlier than women who walked or biked for ≥20 minutes/d (PD=547 days; 95% CI, 288–805). The sensitivity analysis in which we measured the association at fifth PD showed negligible differences when compared with the main Laplace analysis, with walking/bicycling showing the biggest PD followed by exercise (data not shown).

### Discussion

We found that moderate to high levels of TPA were associated with a reduced risk of future HF. When examining which domains of PA were associated with a reduced risk of HF, we found walking/bicycling for >20 minutes a day, exercising for >1 hour/wk, and engaging in >1 hour household work per day to be inversely associated with HF development. Each of these types of activity reduced HF risk statistically significantly and independently of each other. Active daily walking or bicycling had the largest effect, reducing the risk of HF with 29%. Furthermore, women with a low score on certain domains of PA, particularly on walking/bicycling, developed HF 18 months earlier than women who were more active.

Our findings on the association between TPA and HF risk are in line with previous studies. However, we noticed a nonlinear trend; after moderate levels of TPA, there was no further association with a reduced risk of HF. None of the above-mentioned studies evaluated the dose–response association with flexible models, such as splines. Our study is in line with a previous meta-analysis investigating the dose–response relationship between TPA and coronary heart disease, which detected a risk reduction with moderate levels of TPA but only a modest further risk reduction at higher levels of TPA.

A former study investigating the effect of different types of PA on HF risk found occupational activity and leisure-time PA to be associated with HF. We observed the largest effect from walking/bicycling for ≥20 minutes a day, exercising for >1 hour/wk, and engaging in >1 hour household work per day to be inversely associated with HF development. Each of these types of activity reduced HF risk statistically significantly and independently of each other. Active daily walking or bicycling had the largest effect, reducing the risk of HF with 29%. Furthermore, women with a low score on certain domains of PA, particularly on walking/bicycling, developed HF 18 months earlier than women who were more active.

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The cardioprotective biological mechanisms exerted by PA are poorly understood. Nevertheless, some explanations have been proposed. For instance, it has been suggested that the beneficial effects of PA on cardiovascular disease risk are mediated by reductions in mainly inflammatory and homostatic biomarkers, and to some extent blood pressure, lipids, and body mass index. Moreover, in a study by deFilippi et al., it was shown that moderate levels of PA were associated with lower levels of the cardiovascular disease biomarker–sensitive troponin T and N-terminal pro–B-type natriuretic peptide and subsequently also lower risk of HF.

Strengths of our study include the large size of the population-based cohort. The study had a long follow-up time, and we were able to identify a large number of incident HF events. The outcome definition was based on clinical diagnoses and not self-reports. A validation study on primary HF diagnoses in the Swedish National Patient Register has shown that the validity for a primary HF diagnosis is high (95%). To avoid misclassification of HF outcome, we also included HF diagnoses at the second position where the validity has been shown to be 76%. The validity for HF diagnosis in positions 3 to 6 has been reported to be 63%. Therefore, we limited our HF definition to include diagnoses only at the first and second positions. Furthermore, we could not capture outpatient cases who were admitted to a private specialized healthcare setting. Misclassification of HF outcome could have afflicted this study possibly contributing to attenuation of the associations with HF risk.

PA was examined according to MET hours per day of TPA, considering various domains of PA. It is a well-validated construct of PA intensity, which takes into account the multidimensional nature of PA. In addition, we also modeled the different domains of TPA separately (eg, walking, occupational activity, and leisure-time inactivity). These estimates are more accessible and can easily be conveyed to society for public health improvements.

In addition to presenting the results in HRs, we complemented our analyses using Laplace regression to provide an absolute estimate of differences in HF-free survival according to levels of PA. Laplace regression models the percentiles of survival expressing results directly in terms of time differences across levels of the exposure (ie, years, months, and days). The estimates of Laplace regression are not dependent on the baseline risk and on the length of follow-up. Moreover, by using this method, we were able to present the results in an intuitive way that is easily accessible to the general public.

A potential limitation to this study is that the measurements of PA were based on self-reports of the study participants’ habitual PA level in the past year, hence a certain degree of misclassification of PA cannot be ruled out. This could particularly have been a problem for TPA because a previous validation study on a subsample of SMC showed that the correlation between self-reported TPA and PA measured with accelerometers was 0.38. Moreover, TPA was self-reported for a 1-year period before baseline; therefore, it is possible that TPA changed during the follow-up time. Because of the prospective design of the SMC, we do not expect that a potential misclassification is dependent on the outcome, hence a potential misclassification of TPA could have led to an underestimation of the association with HF risk.

It should be emphasized that we cannot infer on causality based on our study results. The association between PA and risk of future HF could be, for instance, because of unmeasured confounders or residual confounding both at baseline
and during follow-up time. For example, we could not identify study participants with subclinical diabetes mellitus at baseline because we did not administer an oral glucose tolerance test; therefore, subclinical diabetes mellitus could potentially have confounded the associations between PA and HF risk.

There may also be some concerns on the generalizability of this study. We investigated the association between PA and HF in a population consisting of middle-aged and elderly white women, thus we might not be able to extrapolate our findings to other ethnicities, younger age groups, or men.

Conclusions

Our study shows that moderate to high levels of PA could protect against HF in women. When looking closer into different domains of PA, walking or biking for ≥20 minutes every day was associated with the largest risk reduction of HF. Public awareness of the beneficial effect of PA could potentially contribute to reducing the HF burden in society. Additional investigations are, therefore, warranted.

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Disclosures

None.

References

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