Coffee Consumption and Incidence of Heart Failure in Women

Levitan et al: Coffee and Incident Heart Failure

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Abstract

**Background**—Previous studies of the relationship between coffee consumption and incidence of heart failure (HF) have not been consistent, with both potential benefit and potential harm reported. We therefore examined the association between coffee consumption and HF hospitalization or mortality in women.

**Methods and Results**—We conducted a prospective, observational study of 34,551 participants of the Swedish Mammography Cohort who were 48-83 years old and did not have HF, diabetes, or myocardial infarction at baseline. Diet was measured using food-frequency questionnaires. Cox models were used to calculate hazard ratios of HF hospitalization or death from HF as the primary cause, as determined through the Swedish inpatient and cause-of-death registers between January 1, 1998 and December 31, 2006. Over 9 years of follow-up, 602 HF events occurred. Women who consumed ≥5 cups of coffee per day did not have higher rates of HF events than those who consumed <5 cups per day (multivariable-adjusted hazard ratio = 0.93, 95% confidence interval: 0.72-1.20). Compared to women who consumed ≤1 cup of coffee per day, hazard ratios were 1.01, 0.82, 0.94, and 0.87 for women who consumed 2, 3, 4, and ≥5 cups per day, respectively (p for trend = 0.23). Further adjustment for self-reported hypertension did not change the results.

**Conclusions**—In this population of middle-aged and older women, we did not find an association between coffee consumption and incidence of HF events.

**Key Words:** epidemiology, heart failure, diet, nutrition
The relationship between coffee consumption and incidence of heart failure (HF) has been examined in several studies with conflicting results. In a study of multiple potential risk factors for HF, men who drank 5 or more cups of coffee per day had a higher risk of developing HF. However, in subsequent studies of initially healthy men and of men and women recruited after myocardial infarction coffee consumption and incidence of HF were unrelated. In a recent large study which examined the association of coffee with HF in men and women separately, coffee drinking was not associated with HF in men, but women who drank 1-6 cups of coffee per day had a lower rate of HF than abstainers or very heavy consumers.

The associations between coffee consumption and risk factors for HF, such as hypertension, elevated cholesterol, coronary heart disease, and diabetes, are complex. Coffee consumption transiently increases blood pressure in people who are not habitual coffee consumers, but this effect is blunted in regular drinkers. A meta-analysis of longer trials (>7 days) found a slight increase in blood pressure associated with coffee intake that was smaller than the increase associated with a similar dose of caffeine in pill form. Studies of the association of habitual coffee consumption with hypertension have produced mixed results including no association, inverse associations, positive associations, and inverse U-shaped associations. Coffee beans contain lipids which can increase cholesterol concentrations, but filtered coffee, which is commonly consumed, contains little of the lipid component. There have been a large number of studies which examined the association between coffee consumption and incidence of coronary heart disease. Case-control studies tended to find an increased risk associated with coffee consumption, but cohort studies have suggested that there is a weaker association, no association, or even that coffee drinking may protect against
coronary heart disease.\textsuperscript{15, 16} In contrast, coffee drinking has been fairly consistently associated with a lower risk of type 2 diabetes.\textsuperscript{17, 18}

Because of the evidence for associations between coffee drinking and risk factors for HF and the inconsistent results of previous studies of coffee and incident HF, we decided to study the relationship between coffee drinking and rates of HF hospitalization and mortality among a large cohort of initially healthy middle-aged and older women.

**Methods**

Subjects in this study were drawn from the Swedish Mammography Cohort. The Swedish Mammography Cohort has been previously described.\textsuperscript{19} Briefly, the study includes women born between 1914 and 1948 living in Västmanland and Uppsala counties in central Sweden. In 1996, 39,227 women completed questionnaires with items on demographic, behavioral, and anthropometric factors and consumption of foods and beverages. Participants who had a history of cancer (other than nonmelanoma skin cancer), who did not provide correct national identification numbers, or who reported implausible energy intakes ($>3$ standard deviations from the natural logarithm transformed mean) were excluded ($n = 792$). As this was a study examining incident HF, those women with a previous diagnosis of HF were excluded ($n = 334$). In addition, we excluded women with a history of diabetes or myocardial infarction ($n = 1,867$), since these diagnoses might result in a change in dietary habits. Finally, women with missing data on coffee consumption ($n = 1,683$) were excluded leaving 34,551 Swedish Mammography Cohort participants. The study was approved by the Regional Ethical Review Board at Karolinska Institute, Stockholm, Sweden. Completion and return of the self-administered questionnaire was taken to imply consent.
Participants were asked to report average intake of coffee over the last year in cups/day or cups/week. The Spearman correlation coefficient between questionnaire-based coffee intake and an average of 4 1-week diet records was 0.63 (Alicja Wolk, DrMedSci, unpublished data, 2009). We classified coffee consumption as \( \leq 1 \) cup/day, 2 cups/day, 3 cups/day, 4 cups/day and \( \geq 5 \) cups/day. Assessment of risk factors such as history of hypertension, elevated cholesterol, and family history of heart disease at less than 60 years of age was based on self-report, as this study did not have in-person visits or blood draws.

The primary endpoint was defined as hospitalization for HF as a primary diagnosis, as determined by the Swedish Inpatient Registry records, or mortality from HF as the primary cause, as determined by the Swedish National Death Register records (International Classification of Diseases-9 code 428 or International Classification of Diseases-10 codes I50 or I11.0). A prior study reported that 95% of patients discharged with these codes as the primary diagnosis had confirmed HF on medical record review. Study participants were followed from January 1, 1998 to the date of first admission for HF, death from HF or other causes, or the end of the study follow-up period (December 31, 2006), whichever came first. Participants who died of causes other than HF were censored.

Cox proportional hazards models were used to estimate hazard ratios and 95% confidence intervals. Age was accounted for by allowing the baseline hazard to vary. We adjusted for body mass index, total activity score, smoking, history of high cholesterol, family history of myocardial infarction before age 60, education level, living alone, current use of post-menopausal hormones, aspirin use, and alcohol, tea, fat (saturated, monounsaturated and polyunsaturated) and sodium intake. We initially examined the incidence rate ratio comparing women who drank 5 or more cups of coffee per day to those who drank < 5 cups per day. We
then examined the association of coffee as a 5-level exposure (≤1 cup/day, 2 cups/day, 3 cups/day, 4 cups/day and ≥ 5 cups/day) with ≤1 cup/day as the reference group. A test for linear trend across categories of coffee consumption was performed by entering the value for the median intake in each category and modeling coffee consumption as a continuous variable.

We did not adjust for hypertension in the primary models because a potential mechanism for coffee consumption to cause HF is through elevated blood pressure. We further adjusted the models for self-reported hypertension in sensitivity analyses. Further sensitivity analyses excluded participants who developed HF during the first two years of follow-up because of the possibility that symptoms of unrecognized HF at baseline may affect coffee consumption and excluded women who did not consume any coffee (n = 449) from the lowest exposure group because these individuals may represent a sicker subgroup of the population. We tested for violation of the proportional hazards assumption by entering the product of coffee consumption and the natural logarithm of time into the model; we did not find evidence for deviation from proportionality. All analyses were conducted using SAS 9.1 (Cary, NC). We considered 2-sided p-values < 0.05 to be statistically significant.

Results

Over 9 years of follow-up of 34,551 women without known HF, diabetes, or myocardial infarction at baseline, 48 women died of HF and 554 were hospitalized for HF, corresponding to a rate of 19.2 cases per 10,000 person-years. Compared to women who drank ≤ 1 cup of coffee per day, women who drank the most coffee were, on average, younger and less likely to have completed high school, to be living alone, and to take postmenopausal hormones (Table). They consumed less tea on average and were more likely to be current smokers.
Compared to women who consumed less than 5 cups of coffee per day, women who consumed 5 or more cups did not have increased rates of HF events in age-adjusted models (hazard ratio = 0.96, 95% confidence interval 0.75-1.24) or multivariable-adjusted models (hazard ratio = 0.93, 95% confidence interval 0.72-1.20). We did not find evidence for an association with HF events when coffee consumption was considered as a multiple level exposure (Figure). Compared to women who consumed ≤1 cup of coffee per day, hazard ratios from multivariable-adjusted models were 1.01 (95% CI 0.79-1.30), 0.82 (95% CI 0.62-1.07), 0.94 (95% CI 0.70-1.25), and 0.87 (95% CI 0.63-1.20) for women who consumed 2, 3, 4, and ≥5 cups per day, respectively (p for trend = 0.23). After further adjusting for self-reported hypertension, the hazard ratio comparing women who drank more than 5 cups of coffee per day to those who consumed less than 5 was 0.94 (95% CI 0.73-1.22). Compared to women who consumed ≤1 cup of coffee per day, hazard ratios from multivariable-adjusted models including hypertension were 1.02 (95% CI 0.79-1.30), 0.82 (95% CI 0.63-1.07), 0.94 (95% CI 0.70-1.25), and 0.88 (95% CI 0.64-1.21) for women who consumed 2, 3, 4, and ≥5 cups per day, respectively (p for trend = 0.26). Excluding the first 2 years of follow-up did not materially change the results. The associations were not altered when women who did not drink any coffee were excluded from the analysis.

Discussion

There was no statistically significant association between coffee drinking and HF in this population of middle-aged and older women. These results are in keeping with our previous study among men from the same region,² with a study of post-myocardial infarction patients,³ and with the men included in a large cohort study.⁴ However, other studies have found an
increased risk among men\(^1\) and a decreased risk among women\(^4\) who drank coffee. This variation between studies is similar to that seen for other cardiovascular effects of coffee.

The strengths of this study include the prospective design, the large sample size, and follow-up using nearly complete registries of hospital discharges and vital statistics. However, coffee consumption was assessed using food-frequency questionnaires, which is expected to lead to some misclassification of exposure. This misclassification could bias the results toward no association and prevent us from detecting a true association. Coffee consumption was measured at a single time point which does not allow for examination of the effect of changing consumption. Previous research in the population demonstrated that coffee consumption was relatively stable across time \((r = 0.50\) for measurements made 10 years apart, Wolk, unpublished data).

The rate of hospitalization for HF in this study population \((19.2\) cases per 10,000 person-years\) was similar to the rates in the general population of Swedish women \((24.4\) cases per 10,000 person-years in 1993 and 17.1 cases per 10,000 person-years in 2000\).\(^{21}\) This is lower than rates reported in studies from US. For example, in Olmsted County, Minnesota the rate of HF was 28.9 per 10,000 person-years in women,\(^{22}\) in the Cardiovascular Health Study the rate was 146 per 10,000 person-years in women,\(^{23}\) and in the Framingham Heart Study (1990-1999) the rate was 32.7 per 10,000 person-years in women.\(^{24}\) These US studies differed from the current study in location, age distribution, the inclusion participants with a history diabetes, myocardial infarction, and, in the Cardiovascular Health study, HF, and the assessment of cases of HF which did not result in hospitalization.

A previous study from Sweden found that 95\% patients with a primary discharge diagnosis of HF had HF on medical record review,\(^{20}\) though even clinical diagnosis of HF can be
difficult leading to potential misclassification of events. The assessment of HF deaths using vital statistics has not been validated in Sweden. We do not expect deaths incorrectly attributed to HF to influence our results, as 92% of the HF events in the population were hospitalizations rather than mortality. This study could not detect HF managed on an outpatient basis, but we expect many of the cases of HF in this population to result in hospitalization. In a recent report from the Swedish HF registry, the majority of participants were enrolled after hospitalization (64%), and smaller numbers were enrolled after treatment at a hospital-based clinic (26%) or a primary care clinic (10%).

This study population was drawn from Sweden where decaffeinated coffee is uncommon. These results may not be generalizable to other patterns of coffee consumption. We did not include women with established heart disease in this study which could also limit generalizability; however, results were similar in a study of people from the same region with a history of myocardial infarction. Because of the design of the study, we do not have objective baseline measures of risk factors such as blood pressure or measures of subclinical disease such as left ventricular ejection fraction. We did explore the possibility of subclinical disease causing changes in coffee intake by performing an analysis which excluded the first several years of follow-up, and found that the results did not change appreciably. Future studies with information on events such as development of diabetes which often proceed HF could help definitively settled the question of whether coffee consumption contributes to HF. More than 600 women experience HF events in this population. With the large number of cases it is not likely that a strong association would be missed, but a more subtle association could be.

In conclusion, we did not find a statistically significant association between coffee drinking and HF events in this population of middle-aged and older women.
Sources of Funding

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Disclosures

None.
References


Table. Baseline characteristics* of 34,551 participants in the Swedish Mammography Cohort by coffee consumption

<table>
<thead>
<tr>
<th>Coffee consumption, cups/day</th>
<th>≤1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>≥5</th>
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<tbody>
<tr>
<td>N</td>
<td>4,378</td>
<td>9,057</td>
<td>8,885</td>
<td>6,102</td>
<td>6,129</td>
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<tr>
<td>Age (year)</td>
<td>62.5 (9.4)</td>
<td>62.6 (9.3)</td>
<td>61.6 (9.1)</td>
<td>61.5 (9.0)</td>
<td>59.3 (8.3)</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>24.9 (4.0)</td>
<td>24.9 (3.8)</td>
<td>25.0 (3.8)</td>
<td>24.9 (3.7)</td>
<td>25.1 (4.0)</td>
</tr>
<tr>
<td>Physical activity (metabolic equivalent-hour/day)</td>
<td>42.2 (4.2)</td>
<td>42.3 (4.1)</td>
<td>42.6 (4.2)</td>
<td>42.8 (4.1)</td>
<td>43.0 (4.4)</td>
</tr>
<tr>
<td>Education (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than high school</td>
<td>68.1</td>
<td>72.6</td>
<td>74.3</td>
<td>77.0</td>
<td>75.5</td>
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<tr>
<td>High School</td>
<td>8.6</td>
<td>8.1</td>
<td>7.4</td>
<td>7.3</td>
<td>8.5</td>
</tr>
<tr>
<td>University</td>
<td>23.3</td>
<td>19.3</td>
<td>18.3</td>
<td>15.7</td>
<td>16.0</td>
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<td>Living alone (%)</td>
<td>29.0</td>
<td>25.9</td>
<td>22.3</td>
<td>23.0</td>
<td>20.9</td>
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<td>Postmenopausal hormone</td>
<td>55.9</td>
<td>52.8</td>
<td>51.9</td>
<td>49.3</td>
<td>47.9</td>
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<tr>
<td>Cigarette smoking (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td>14.4</td>
<td>17.4</td>
<td>21.2</td>
<td>26.9</td>
<td>39.3</td>
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<tr>
<td>Past</td>
<td>24.8</td>
<td>24.2</td>
<td>22.8</td>
<td>22.8</td>
<td>21.3</td>
</tr>
<tr>
<td>Never</td>
<td>60.8</td>
<td>58.4</td>
<td>56.0</td>
<td>50.3</td>
<td>39.4</td>
</tr>
<tr>
<td>High cholesterol (%)</td>
<td>8.0</td>
<td>7.9</td>
<td>8.1</td>
<td>7.7</td>
<td>8.1</td>
</tr>
<tr>
<td>Hypertension (%)</td>
<td>22.4</td>
<td>22.3</td>
<td>19.4</td>
<td>18.7</td>
<td>16.7</td>
</tr>
<tr>
<td>Family history of myocardial infarction at &lt; 60 years (%)</td>
<td>17.1</td>
<td>16.8</td>
<td>16.8</td>
<td>16.8</td>
<td>18.0</td>
</tr>
<tr>
<td></td>
<td>44.3</td>
<td>42.6</td>
<td>43.0</td>
<td>42.9</td>
<td>45.3</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Aspirin use (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcohol, g/day</td>
<td>4.2 (5.5)</td>
<td>4.4 (5.3)</td>
<td>4.3 (5.1)</td>
<td>4.1 (5.0)</td>
<td>4.1 (5.3)</td>
</tr>
<tr>
<td>Tea, servings/day</td>
<td>1.3 (1.4)</td>
<td>0.7 (1.0)</td>
<td>0.5 (0.9)</td>
<td>0.4 (0.8)</td>
<td>0.3 (0.9)</td>
</tr>
<tr>
<td>Saturated fat, g/day</td>
<td>26.8 (6.4)</td>
<td>27.1 (6.2)</td>
<td>27.2 (6.1)</td>
<td>27.6 (6.4)</td>
<td>28.0 (6.7)</td>
</tr>
<tr>
<td>Monounsaturated fat, g/day</td>
<td>19.7 (3.6)</td>
<td>19.9 (3.4)</td>
<td>20.0 (3.3)</td>
<td>20.1 (3.4)</td>
<td>20.3 (3.5)</td>
</tr>
<tr>
<td>Polyunsaturated fat, g/day</td>
<td>8.1 (2.0)</td>
<td>8.0 (1.8)</td>
<td>8.0 (1.8)</td>
<td>7.9 (1.8)</td>
<td>8.0 (1.8)</td>
</tr>
<tr>
<td>Sodium, mg/day</td>
<td>2,544 (430)</td>
<td>2,525 (385)</td>
<td>2,526 (380)</td>
<td>2,509 (365)</td>
<td>2,511 (374)</td>
</tr>
</tbody>
</table>

* Mean (standard deviation) or percent

† Adjusted for energy using the residuals method
Figure Legend

Coffee consumption and hazard ratios of heart failure hospitalization or mortality. Cox proportional hazards model accounting for age and adjusted for body mass index (kg/m²), total activity score (metabolic equivalent-hour/day), smoking (current, past, or never), history of high cholesterol (yes or no), family history of myocardial infarction before age 60 (yes or no), education level (less than high school, high school, or university), living alone (yes or no), postmenopausal hormones (yes or no), aspirin use (yes or no), alcohol (g/day), tea (serving/day), energy-adjusted fat intake (saturated, monounsaturated and polyunsaturated), and energy-adjusted daily sodium intake.
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