Coffee Consumption and Incidence of Heart Failure in Women

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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 to 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 to 1.20). Compared with 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. (Circ Heart Fail. 2011;4:414-418.)

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 development of HF.1 However, in subsequent studies of initially healthy men2 and of men and women recruited after myocardial infarction,3 coffee consumption and incidence of HF were unrelated. In a recent large study that 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 to 6 cups of coffee per day had a lower rate of HF than abstainers or very heavy consumers.4

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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.5 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.6 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.7–10 Coffee beans contain lipids, which can increase cholesterol concentrations,11 but filtered coffee, which is commonly consumed, contains little of the lipid component.12 There have been a large number of studies that 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,13 but cohort studies have suggested that there is a weaker association,13 no association,14 or even that coffee drinking may protect against coronary heart disease.15,16 In contrast,
coffee drinking has been fairly consistently associated with a lower risk of type 2 diabetes.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.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). Because 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=1867) because these diagnoses might result in a change in dietary habits. Finally, women with missing data on coffee consumption (n=1683) 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 per day or cups per 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 ≤1 cup/d, 2 cups/d, 3 cups/d, 4 cups/d, and ≥5 cups/d. Assessment of risk factors such as history of hypertension, elevated cholesterol, and family history of heart disease were collected 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 years, education level, living alone, current use of postmenopausal 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 cups of coffee per day with those who drank <5 cups per day. We then examined the association of coffee as a 5-level exposure (≤1 cup/d, 2 cups/d, 3 cups/d, 4 cups/d, and ≥5 cups/d) with ≤1 cup/d 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 had development of HF during the first 2 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 probability 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 with 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 with women who consumed <5 cups of coffee per day, women who consumed ≥5 cups did not have increased rates of HF events in age-adjusted models (hazard ratio, 0.96; 95% CI, 0.75 to 1.24) or multivariable-adjusted models (hazard ratio, 0.93; 95% CI, 0.72 to 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 with women who consumed ≤1 cup of coffee per day, hazard ratios from multivariable-adjusted models were 1.01 (95% CI, 0.79 to 1.30), 0.82 (95% CI, 0.62 to 1.07), 0.94 (95% CI, 0.70 to 1.25), and 0.87 (95% CI, 0.63 to 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 ≥5 cups of coffee per day with those who consumed <5 was 0.94 (95% CI, 0.73 to 1.22). Compared with women who consumed ≤1 cup of coffee per day, hazard ratios from multivariable-adjusted models including hypertension were 1.02 (95% CI, 0.79 to 1.30), 0.82 (95% CI, 0.63 to 1.07), 0.94 (95% CI, 0.70 to 1.25), and 0.88 (95% CI, 0.64 to 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, with a study of postmyocardial infarction patients, and with the men included in a large cohort study. However, other studies have found an increased risk among men and a decreased risk among women 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). This is lower than rates reported in studies from the United States. For example, in Olmsted County, Minnesota, the rate of HF was 28.9 per 10 000 person-years in women, in the Cardiovascular Health Study the rate was 146 per 10 000 person-years in women, and in the Framingham Heart Study (1990 to 1999) the rate was 32.7 per 10 000 person-years in women. 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 that 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, 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 because 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

| Table. Baseline Characteristics of 34 551 Participants in the Swedish Mammography Cohort by Coffee Consumption |
|---------------------------------------------------|-------------------|-------------------|-------------------|-------------------|
| Coffee Consumption, Cups per Day                  |
| n                                                  | 4378              | 9057              | 8885              | 6102              | 6129              |
| Age, y                                             | 62.5 (9.4)        | 62.6 (9.3)        | 61.6 (9.1)        | 61.5 (9.0)        | 59.3 (8.3)        |
| Body mass index, kg/m²                             | 24.9 (4.0)        | 24.9 (3.8)        | 25.0 (3.8)        | 24.9 (3.7)        | 25.1 (4.0)        |
| Physical activity, metabolic equivalent-h/d        | 42.2 (4.2)        | 42.3 (4.1)        | 42.6 (4.2)        | 42.8 (4.1)        | 43.0 (4.4)        |
| Education, %                                       |                   |                   |                   |                   |                   |
| Less than high school                              | 68.1              | 72.6              | 74.3              | 77.0              | 75.5              |
| High school                                        | 8.6               | 8.1               | 7.4               | 7.3               | 8.5               |
| University                                         | 23.3              | 19.3              | 18.3              | 15.7              | 16.0              |
| Living alone, %                                    | 29.0              | 25.9              | 22.3              | 23.0              | 20.9              |
| Postmenopausal hormone therapy, %                  | 55.9              | 52.8              | 51.9              | 49.3              | 47.9              |
| Cigarette smoking, %                               |                   |                   |                   |                   |                   |
| Current                                            | 14.4              | 17.4              | 21.2              | 26.9              | 39.3              |
| Past                                               | 24.8              | 24.2              | 22.8              | 22.8              | 21.3              |
| Never                                              | 60.8              | 58.4              | 56.0              | 50.3              | 39.4              |
| High cholesterol, %                                | 8.0               | 7.9               | 8.1               | 7.7               | 8.1               |
| Hypertension, %                                     | 22.4              | 22.3              | 19.4              | 18.7              | 16.7              |
| Family history of myocardial infarction at <60 y, % | 17.1              | 16.8              | 16.8              | 16.8              | 18.0              |
| Aspirin use, %                                      | 44.3              | 42.6              | 43.0              | 42.9              | 45.3              |
| Alcohol, g/d                                       | 4.2 (5.5)         | 4.4 (5.3)         | 4.3 (5.1)         | 4.1 (5.0)         | 4.1 (5.3)         |
| Tea, servings per day                              | 1.3 (1.4)         | 0.7 (1.0)         | 0.5 (0.9)         | 0.4 (0.8)         | 0.3 (0.9)         |
| Saturated fat, g/d*                                | 26.8 (6.4)        | 27.1 (6.2)        | 27.2 (6.1)        | 27.6 (6.4)        | 28.0 (6.7)        |
| Monounsaturated fat, g/d*                          | 19.7 (3.6)        | 19.9 (3.4)        | 20.0 (3.3)        | 20.1 (3.4)        | 20.3 (3.5)        |
| Polyunsaturated fat, g/d*                          | 8.1 (2.0)         | 8.0 (1.8)         | 8.0 (1.8)         | 7.9 (1.8)         | 8.0 (1.8)         |
| Sodium, mg/d*                                      | 2544 (430)        | 2525 (385)        | 2526 (380)        | 2509 (365)        | 2511 (374)        |

Values are mean (standard deviation) or percent.
*Adjusted for energy, using the residuals method.
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%).25

This study population was drawn from Sweden, where decaffeinated coffee is uncommon.26 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.3

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 that excluded the first several years of follow-up and found that the results did not change appreciably. To definitively determine whether coffee increases risk of HF, studies are needed that assess risk factors for HF that develop during follow-up, such as diabetes and myocardial infarction. More than 600 women have 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 missed.

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.

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**CLINICAL PERSPECTIVE**

A previous study raised the concern that heavy coffee consumption (>5 cups per day) may increase risk of heart failure. Subsequent investigations have not replicated the results. This study reports on the relationship between coffee consumption and incidence of heart failure hospitalization or mortality among more than 34,000 women ages 48 to 83 years, living in central Sweden. Coffee consumption was high; >6000 of the women consumed ≥5 cups of coffee per day. The women were followed through administrative records. Over 9 years of follow-up, 602 of the women were hospitalized for or died of heart failure. There was no evidence that coffee consumption was associated with heart failure in this population. Taken together, the studies suggest that intake of coffee is not an important risk factor for development of heart failure.
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