Review

The Effects of Coffee Consumption on the Risk of Heart Failure

Yujie Wang, MSc;[1] Gang Hu, MD, PhD[2]*

[1] School of Human Ecology, Louisiana State University AgCenter, Baton Rouge, LA
[2] Chronic Disease Epidemiology Laboratory, Pennington Biomedical Research Center, Baton Rouge, LA

Heart Failure (HF) has become a major public health problem in both developed and developing countries of the world. Although medical and surgical management has been improved, morbidity and mortality after onset of HF remain substantial; consequently, increasing attention has been drawn to preventing HF by management of lifestyle factors of HF. Coffee consumption is one of the lifestyle factors which has been linked to HF risk. Five prospective studies investigated the association between coffee consumption and the HF risk. However, the results of these studies were inconsistent. The authors conducted a review on the association between coffee consumption and HF risk in order to explore the possible reasons for the discordance and provide future research direction on this topic.
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Key Words: *heart failure, coffee consumption*

INTRODUCTION

The individual and joint associations of modifiable lifestyle factors such as physical activity, obesity, smoking, dietary intake on the risk of heart failure (HF) have been studied extensively in recent years. Now, it is well accepted that people who engage in a healthy lifestyle have a low risk of HF. Since morbidity and mortality after onset of HF remain substantial despite of medical and surgical management, preventing HF by management of lifestyle factors of HF has been attached greater importance that ever before.

Coffee is one of the most frequently and widely consumed beverages in the world.[1] It has been suggested that coffee consumption may be associated with the risk of coronary heart disease (CHD),[2] hypertension,[3] stroke,[4] and type 2 diabetes.[5] However, the association of coffee consumption and HF risk is less extensively studied. Till now, there are five studies which investigated this association. However, Results from these studies have not yet been summarized. What is more? The possible reasons for the inconsistency and what is needed to be done in order to make the association between coffee consumption and HF clear have not been explored.

METHODS

A systematic literature search for studies on coffee consumption and HF risk published from January 1980 to September 2011 was conducted in PubMed, EMBASE, Agricola, and the Cochrane Library digital database. The keywords used included “coffee”, “caffeine”, “heart failure”, and “cardiovascular diseases”. In addition, hand searching of the references cited in review articles was performed. The full text was reviewed if studies reported the association between coffee consumption and HF in humans.

RESULTS

The first prospective study on the relation between coffee consumption and the risk of HF was conducted among 7,495 participants of the Multifactor Primary Prevention Study, in which the association of coffee consumption with HF were first studied in bivariate analysis and further studied in multiple logistic regression.[6] Coffee consumption was classified into three categories: 0, 1-4, ≥5cups/day in the bivariate analysis. Result of this analysis indicated that coffee consumption is marginally associated with HF risk. When entered the multiple logistic regression model, coffee consumption was analyzed as a variable of two category (<5 cups/day and ≥5cups/day). Results of this analysis suggested that coffee consumption ≥5cups/day (relative risk = 1.17; 95% confidence interval [CI], 1.05-1.30, compared with coffee consumption <5 cups/day) was an independent predictor of HF.[6] This is the only study which provided evidence showing that coffee consumption increased the risk of HF, while there are four other studies yielded opposite results. In a cohort of Swedish men, a prospective cohort of 37,315 men aged 45-79 years old, Ahmed et al.[7] classified coffee consumption into five categories: <1 cup/day, 2 cups/day, 3 cups/day, 4 cups/day and ≥ 5 cups/day. They did not find a significant association between coffee consumption and HF hospitalization and HF mortality. Furthermore, the authors conducted a 4 degree of freedom likelihood ratio test to exam whether including coffee consumption added information to the model. Result of this likelihood ratio test confirmed that coffee consumption was not a significant predictor of HF events.[7] The National Finrisk Study followed

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***Corresponding Author:** Chronic Disease Epidemiology Laboratory, Pennington Biomedical Research Center, 6400 Perkins Road, Baton Rouge, LA 70808. (Email: gang.hu@pbrc.edu)

Table 1. Selected findings on the association between coffee consumption and the risk of heart failure.

Author, year	No. of heart failure cases /No. of participants*	Age range (years)	Follow-up	Major findings, coffee consumption HR /OR/RR (95% CI)	Adjustment factors
Wilhelmsen et al, 2001[6]	937M/7,495M	55-79	up to 27-year	Coffee consumption<5 cups/day, OR 1.00 (reference) Coffee consumption≥5 cups/day, OR 1.53 (1.29-1.81)	age, MI in brothers or sisters, MI in parents, stroke in parents, DM, chest pain, dyspnoea, intermittent claudication, smoking, alcohol abuse, physical activity, body height, body weight, weight change from age 20, heart rate, SBP or antihypertensive treatment, and BMI
Mukamal et al, 2009[10]	372/1,369	45-70	up to 9-year	Coffee consumption 0-1 cup/day, HR 1.00 (reference) Coffee consumption1-3 cups/day, HR 1.01 (0.70-1.47) Coffee consumption 3-5 cups/day, HR 1.04 (0.71-1.52) Coffee consumption 5-7 cups/day, HR 0.91 (0.60-1.38) Coffee consumption ≥7 cups/day, HR 0.71(0.42-1.18)	Age, sex, DM, smoking, obesity, physical inactivity, alcohol consumption, tea consumption, and education
Ahmed et al, 2009[7]	784M/37,315M	45-79	9-year	Coffee consumption ≤1 cup/day, RR 1.00 (reference) Coffee consumption 2 cups/day, RR 0.87 (0.69-1.11) Coffee consumption 3 cups/day, RR 0.89 (0.70-1.14) Coffee consumption 4 cups/day, RR 0.89 (0.69-1.15) Coffee consumption ≥5 cups/day, RR 0.89 (0.69-1.15)	Age, BMI, total activity score, smoking, history of high cholesterol, family history of MI before age 60, education level, marital status, aspirin use, alcohol, tea, energy-adjusted fat intake, and energy-adjusted daily sodium intake
Wang et al, 2011[8]	3,827 (2,020M/1,807F) /59, 490 (28,837M/30,653F)	25-74	19.2-year	Men Coffee consumption 0 cup/day, HR 1.00 (reference) Coffee consumption1-2 cups/day, HR 0.91 (0.71-1.16) Coffee consumption 3-4 cups/day, HR 0.88 (0.70-1.10) Coffee consumption 5-6 cups/day, HR 0.91 (0.73-1.13) Coffee consumption 7-9 cups/day, HR 0.96 (0.76-1.22) Coffee consumption ≥10 cups/day, HR 1.02 (0.80-1.30) Women Coffee consumption 0 cup/day, HR 1.00 (reference) Coffee consumption1-2 cups/day, HR 0.73 (0.56-0.97) Coffee consumption 3-4 cups/day, HR 0.77 (0.60-0.98) Coffee consumption 5-6 cups/day, HR 0.68 (0.53-0.88) Coffee consumption 7-9 cups/day, HR 0.80 (0.61-1.04) Coffee consumption ≥10 cups/day, HR 0.88 (0.65-1.19)	Age, study year, education, cigarette smoking, alcohol consumption, physical activity, BMI, SBP, total cholesterol, history of MI, DM, valvular heart disease, and tea consumption
Levitan et al, 2011[9]	602F/34,551F	48-83	9-year	Coffee consumption ≤1 cup/day, HR 1.00 (reference) Coffee consumption 2 cups/day, HR 1.01 (0.79-1.30) Coffee consumption 3 cups/day, HR 0.82 (0.62-1.07) Coffee consumption 4 cups/day, HR 0.94 (0.70-1.25) Coffee consumption ≥5 cups/day, HR 0.87 (0.63-1.20)	Age, BMI, total activity score, smoking, history of high cholesterol, family history of MI before age 60 years, education ,level, living alone, postmenopausal hormones, aspirin use, alcohol, tea, energy-adjusted fat intake, and energy-adjusted daily sodium intake

* The participants of the study conducted by Mukamal et al were nonfatal acute MI patients. The participants of the other four studies were healthy people.
Abbreviations: BMI=body mass index, DM=diabetes mellitus, MI=myocardial infarction, SBP=systolic blood pressure, HR=heard ratio, OR=odds ratio, RR=relative risk.

groups: 0 cup/day, 1-2 cups/day, 3-4 coups/day, 5-6 cups/day, 7-9 cups/day, and ≥ 10 cups/day. The association of coffee consumption with the risk of HF was analyzed using Cox proportional hazards regression mode. The authors did not find any detrimental effect of coffee consumption on the risk of HF in either men or women. In women, a low to moderate amount of coffee drinking was associated with a reduced risk of HF.[8] Levitan et al.[9] conducted a study among 34,551on Swedish Mammography Cohort participants to assess the role of coffee consumption in the development of HF.[9] Baseline measurement of different amount of coffee consumption (≤1cup/day, 2 cups/day, 3 coups/day, 4 cups/day, and ≥ 5 cups/day) was used to predict incident HF. No statistically significant association between coffee consumption and HF events (HF hospitalization and HF mortality) was found in this population of middle-aged and older women.[9] Results from the study conducted on 1,369 people aged 45-70 years, who had nonfatal acute myocardial infarction, from Stockholm Heart Epidemiology Program showed that hazard ratio (with 95% confidence interval) of HF associated with the amount of coffee consumption (0-1 cup/day, 1-3 cups/day, 3-5 cups/day, 5-7 cups/day, ≥ 7 cups/day) were 1.00, 1.01 (0.70-1.47), 1.04 (0.71-1.52), 0.91 (0.60-1.38), and 0.71 (0.42-1.18), which indicated that coffee consumption was not associated with hospitalization for congestive HF in this study cohort.

DISCUSSION

Till now, there are five prospective studies dealt with the association between coffee consumption and the risk of HF.[6-10] One out of the five studies found detrimental effect of coffee consumption on the risk of HF, three out of the five studies found no statistically significant association, while one study found no statistically significant association among men, but an inverse association between low to moderate coffee consumption and the risk of HF among women.[6-10] The inconsistency among the five studies may be partly explained by the difference in the characteristics in the study samples, difference in the follow-up length, difference in the types of coffee consumed, and difference in how coffee consumption was defined / categorized.

The characteristics of the study samples in the five studies differ a lot.[6-10] For example, one from the fives studies was conducted on nonfatal acute myocardial infarction patients,[10] while the other four were conducted on healthy people.[6-9] Also, the participants of the five studies were from different age range (Four studies were conducted on middle-aged and old people, while only on study also included young adults.) and different countries (Finland or Sweden). Furthermore, three out of the five studies were only conducted on one gender,[6,7,9] while the other two included participants from both genders.[8,10] One out of the two studies conducted on both gender observed gender difference in the association between coffee consumption and the risk of HF.[8] The author of this study explored the possible reasons of the observed gender difference. They pointed out that their finding was keeping in line with the finding of the observation regarding CHD mortality based on these same data: inverse association in women while no association in men.[11] Many epidemiologic studies have demonstrated that it is more likely for smokers than non-smokers to have more unhealthy lifestyle habits (e.g., physical inactivity, alcohol abuse).[12] In their study, coffee consumption was directly associated with smoking, and the prevalence of smoking was much higher among men than women.[8] They stated that although smoking was adjusted in their study, not all smoking-related unhealthy lifestyle habits were controlled. Therefore, they thought one possible explanation for the observed gender difference in the association between coffee consumption and the risk of HF is the difference in the prevalence of smoking between men and women and smoking related unhealthy lifestyle habits.[2] It has been suggested by several studies that intake of certain food is not only often associated with intake of other foods, but also associated with non-dietary behaviors.[13-15] Therefore, it might be more reasonable to consider the effect of coffee consumption on the risk of HF in the context of dietary pattern. This approach may provide additional information than just looked at the association between coffee consumption and the risk of HF separately.

There are mainly three categories of functional compounds in coffee: caffeine, antioxidants, and trace elements. These functional compounds may have either beneficial or detrimental effects on the cardiovascular system. Caffeine, a major component of coffee, prevents adenosine's negative inotropic effect as an adenosine-receptor antagonist[16] and increases the sensitivity of the myofilaments to calcium.[17] Also, caffeine decreases insulin sensitivity[18] and increases serum homocysteine levels[19] and blood pressure.[20] In addition, caffeine stimulates free fatty acid release from peripheral tissues.[21] On the other hand, antioxidants, obtained from coffee, like chlorogenic acid, phenolic compounds, flavonoids, melanoidins, and various lipid-soluble compounds such as furans, pyrroles, and maltol have beneficial antioxidant effects and might improve insulin sensitivity.[22] Trace elements in coffee such as potassium, niacin, and magnesium have beneficial effects on glucose and insulin metabolism,[23] improve insulin sensitivity,[22] decrease low-grade inflammation,[24] and lower diabetes risk.[25] In all of the five studies, coffee consumption was measured by cup.[6-10] None of the five studies reported the types of coffee, or the amount of the three major functional compounds. Therefore, it can only be speculated that the observed difference in the association between coffee consumption and the risk of HF might be partly caused by the difference in types of coffee and the amount of the functional compounds in coffee.

Although the mechanism behind the association between coffee consumption and the risk of HF is incompletely understood as Wang et al. was stated,[8] several putative mechanisms have been proposed to explain the inverse association between coffee consumption and HF risk among women reported in Wang et al.'s paper.[8] Because HF and CHD share risk factors such as: hypertension, diabetes, obesity, and smoking, CHD is regarded as a more common etiology in HF than ever before.[6,26] Wu et al.[2] reported that their meta-analysis of 21 prospective cohort studies on the association between coffee consumption and the risk of CHD did not support the hypothesis that coffee consumption increases the long-term risk of CHD, and habitual moderate coffee drinking was associated with a lower risk of CHD in women.[2] Their findings on the relationship between coffee consumption and the risk of CHD are similar with Wang et al.'s findings about the association between coffee consumption and the risk of HF.[8] Similarly, high intake of coffee was also associated with reduced risk of diabetes, one established risk factor for HF, suggested by a recent meta-analysis on 18 cohort studies.[5] In addition, result of another met-analysis on 6 perspective cohort studies suggested that habitual coffee consumption > 3 cups/day was not associated with an increased risk of hypertension, another established risk factor of HF, while 1-3 cups/day's coffee consumption was associated with slightly evaluated risk of hypertension when compared with coffee consumption<1 cup/day.[3] Therefore, the effect of coffee consumption on HF reported in Wang et al.'s paper[8] may be partly mediated by its effect on HF risk factors such as CHD, diabetes and hypertension.

CONCLUSION

HF has become a major economic, social and personal burden worldwide. Our review based on the scientific evidence concludes that the association between coffee consumption and the risk of HF has not been properly established. Since the five studies on the association between coffee consumption and HF risk were conducted in populations with European (especially Northern European) and little is known whether coffee consumption would affect other ethnics. To close this gap, continuous research on the causality between coffee and HF risk is needed. The development in this field presents an exciting opportunity to address whether the lifestyle interventions can reduce or delay the incidence of HF. In addition, it will provide the basis for decisions that physicians and policy makers have to make in their everyday work.

CONFLICT OF INTEREST

None.

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