Coffee Consumption and Incident Kidney Disease: Results From the Atherosclerosis Risk in Communities (ARIC) Study

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Background: Moderate coffee consumption has been suggested to be associated with lower risk for chronic conditions such as diabetes, a major precursor to chronic kidney disease (CKD). However, the association between coffee and CKD has not been fully established.

Study Design: Prospective cohort study.

Setting & Participants: 14,209 participants aged 45 to 64 years from the Atherosclerosis Risk in Communities (ARIC) Study.

Predictors: Coffee consumption (cups per day) was assessed at visits 1 (1987-1989) and 3 (1993-1995) using food frequency questionnaires.

Outcomes: Incident CKD defined as estimated glomerular filtration rate < 60 mL/min/1.73 m^2 accompanied by ≥25% estimated glomerular filtration rate decline, CKD-related hospitalization or death, or end-stage renal disease.

Results: There were 3,845 cases of incident CKD over a median of 24 years of follow-up. Men, whites, current smokers, and participants without comorbid conditions were more likely to consume higher amounts of coffee per day. After adjustment for demographic, clinical, and dietary factors, higher categories of coffee consumption were associated with lower risk for incident CKD compared with those who never consumed coffee (HR for <1 cup per day, 0.90 [95% CI, 0.82-0.99]; 1-<2 cups per day, 0.90 [95% CI, 0.82-0.99]; 2-<3 cups per day, 0.87 [95% CI, 0.77-0.97]; and ≥3 cups per day, 0.84 [95% CI, 0.75-0.94]). In continuous analysis, for each additional cup of coffee consumed per day, risk for incident CKD was lower by 3% (HR, 0.97; 95% CI, 0.95-0.99; $P < 0.001$).

Limitations: Self-reported coffee consumption and observational design.

Conclusions: Participants who drank higher amounts of coffee had lower risk for incident CKD after adjusting for covariates. Coffee consumers may not be at adverse risk for kidney disease.

Complete author and article information provided before references.

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Am J Kidney Dis. XX(XX): 1-9. Published online Month X, 2018.

doi: 10.1053/j.ajkd.2018.01.030

Coffee is one of the most frequently consumed beverages in the United States, with ~75% of the US population 20 years and older reported to be coffee drinkers.[1] According to the 2015 to 2020 Dietary Guidelines for Americans, moderate coffee consumption (3-5 cups per day or 400 mg/d of caffeine) is not associated with long-term health risks such as cancer or cardiovascular disease and therefore can be incorporated into healthy eating styles.[2] Coffee consumption has been shown to be protective against multiple chronic conditions such as diabetes,[3,4] coronary heart disease,[5] cancer,[6,7] and all-cause mortality.[8-11]

Sparse literature exists as to whether coffee consumption is associated with chronic kidney disease (CKD), a disease with growing prevalence and costs.[12] A recent meta-analysis identified 4 cohort studies that found no significant association between coffee and CKD, but the pooled results suggested a potential inverse association among women.[13] These 4 prior studies were conducted in Italy, Japan, and Korea. Few prior studies have examined a longitudinal association between coffee and CKD in the United States.

Our study seeks to examine the risk for incident CKD across different levels of coffee consumption in the United States, using data from the community-based Atherosclerosis Risk in Communities (ARIC) Study.

Methods

Study Population

The ARIC Study is a community-based cohort of 15,792 middle-aged (45-64 years) predominantly black and white men and women.[14] Study participants were recruited and enrolled in 1987 to 1989 from 4 US communities: Forsyth County, NC; Jackson, MS; suburbs of Minneapolis, MN; and Washington County, MD. Participants attended follow-up visits in 1990 to 1992 (visit 2), 1993 to 1995 (visit 3), 1996 to 1998 (visit 4), and 2011 to 2013 (visit 5). An ethics committee at each site approved the study protocol, and study participants provided informed consent.

Due to small numbers, we excluded participants who were not black or white (n = 48), blacks from Washington County, MD (n = 33), and blacks from Minneapolis, MN (n = 22). We additionally excluded those who had prevalent CKD (estimated glomerular filtration rate [eGFR] < 60 mL/min/1.73 m^2) or missing serum creatinine values (n = 353), were not fasting or were missing glucose measurement (n = 527), or were missing body mass index values (n = 10). We further excluded those who were missing data needed to calculate a DASH (Dietary Approaches to Stop Hypertension) diet score (n = 435), missing coffee consumption data (n = 28), missing

alcohol status (n = 34), or had implausible levels of total energy intake (<500 or >3,500 kcal/d for women; <700 or >4,500 kcal/d for men; n = 93). A total of 14,209 ARIC Study participants were included in our analysis.

Assessment of Coffee Consumption

Coffee consumption was assessed using a 66-item semiquantitative food frequency questionnaire (FFQ), which was administered in person by a trained interviewer at visits 1 (1987-1989) and 3 (1993-1995). Participants were asked to report how frequently they consumed an 8-ounce cup of regular (nondecaffeinated) coffee on average during the past year. Frequency options included almost never, 1 to 3 cups per month, 1 cup per week, 2 to 4 cups per week, 5 to 6 cups per week, 1 cup per day, 2 to 3 cups per day, 4 to 6 cups per day, and more than 6 cups per day. From visit 1 to visit 3, a total of 44% of participants did not change their response in the FFQ about coffee consumption and 25% changed their response by 1 category. These categorical responses were converted into cups per week as a continuous variable (eg, for category 2-4 cups per week: 3 cups per week). We used a cumulative approach to incorporate data from both visits 1 and 3.[15] For participants who remained event free at visit 3, we used the mean coffee consumption of visits 1 and 3 for a more precise estimate. For participants who developed incident CKD between visits 1 and 3 or did not have visit 3 coffee data, we used their coffee consumption from visit 1 to capture the amount of coffee they drank before their CKD event. After taking into account cumulative consumption from visits 1 and 3 coffee intake, the continuous variable was converted into cups per week and recategorized into 5 new groups: never, fewer than 1 cup per day, 1 or more to fewer than 2 cups per day, 2 or more to fewer than 3 cups per day, and 3 or more cups per day. Participants who responded "almost never" for both FFQs were categorized into the group labeled "never."

Outcome Assessment

Incident CKD was defined as at least 1 of the following criteria: (1) eGFR < 60 mL/min/1.73 m^2 accompanied by ≥25% eGFR decline at any subsequent study visit relative to baseline, (2) *International Classification of Diseases, Ninth/Tenth Revision* (ICD-9/10) code for a hospitalization related to CKD stage ≥ 3, (3) ICD-9/10 code for a death related to CKD stage ≥ 3 identified through linkage to the National Death Index, or (4) end-stage renal disease (ESRD) identified by linkage to the US Renal Data System (USRDS) registry.[16] For ICD-9/10 codes, any diagnosis (primary, secondary, etc) was included. eGFR was calculated using the 2009 CKD-EPI (CKD Epidemiology Collaboration) equation using serum creatinine measured using the modified kinetic Jaffé method.[17-19] Competing events for this outcome included death due to malignant neoplasms in the lung, chronic obstructive pulmonary disease, acute myocardial infarction, and atherosclerotic heart disease.

As a sensitivity analysis for this composite definition of incident CKD, we defined incident CKD using visit-based measures only (eGFR < 60 mL/min/1.73 m^2 and ≥30% eGFR decline). Competing events were the same as for the composite definition of incident CKD.

We also assessed the development of advanced kidney disease using a secondary outcome of ESRD. Cases were identified using the USRDS registry, representing cases of kidney transplantation and dialysis. Kidney failure was used as a sensitivity analysis for the ESRD definition,[20] defined as: (1) ESRD; (2) *ICD-9 Clinical Modification* (*ICD-9-CM*) and *ICD-10-CM* codes from hospitalizations and deaths that represented kidney failure, transplantation, and dialysis; and (3) a study visit eGFR < 15 mL/min/1.73 m^2.[19] Any mention of the *ICD-9/10* codes anywhere on the forms was included.

Assessment of Covariates

In our analysis, we adjusted for demographic, study design, lifestyle, and clinical factors that might influence coffee consumption and kidney outcomes. Information for age, sex, race, study center, education level, smoking status, physical activity, and alcohol status were assessed at baseline using an interviewer-administered questionnaire.[14] Race and study center were combined into one variable given the nonuniform distribution of racial groups across study centers. Physical activity index score was calculated based on intensity and time dedicated to sport and nonsport exercise during leisure time. Possible values for this score ranged from 1 (lowest physical activity) to 5 (highest physical activity).[14] Alcohol status was categorized into never, former, current (moderate), and current (heavy). Moderate alcohol drinkers consisted of women who drank fewer than 1 drink per day and men who drank fewer than 2 drinks per day. Heavy alcohol drinkers consisted of women who drank 1 or more drinks per day and men who drank 2 or more drinks per day. To capture diet quality, we used a DASH diet score based on low intake of red and processed meat, sweetened beverages, and sodium and high intake of fruits, vegetables, whole grains, nuts and legumes, and low-fat dairy.[21] Each component was scored from 1 to 5 based on ranked distribution in quintiles.

Clinical factors included systolic and diastolic blood pressures, fasting glucose concentration, eGFR, diabetes, hypertension, and use of antihypertensive medication. Diabetes was defined at baseline as fasting blood glucose concentration ≥ 126 mg/dL, nonfasting glucose concentration ≥ 200 mg/dL, self-reported history of physician-diagnosed diabetes, or use of diabetes medication in the preceding 2 weeks. Hypertension was defined as systolic blood pressure ≥ 140 mm Hg, diastolic blood pressure ≥ 90 mm Hg, or use of antihypertensive medication in the past 2 weeks.

Cumulative energy intake was determined by calculating the mean energy intake of visits 1 and 3 for participants