Coffee, Decaffeinated Coffee, Caffeine, and Tea Consumption in Young Adulthood and Atherosclerosis Later in Life

The CARDIA Study

Jared P. Reis, Catherine M. Loria, Lyn M. Steffen, Xia Zhou, Linda van Horn, David S. Siscovick, David R. Jacobs, Jr, J. Jeffrey Carr

Objective—To determine the association of coffee, decaffeinated coffee, caffeine, and tea consumption in young adulthood with the presence and progression of coronary artery calcified (CAC) plaques and carotid intima-media thickness later in life.

Methods and Results—The Coronary Artery Risk Development in Young Adults (CARDIA) Study is a cohort of 5115 white and black adults who were aged 18 to 30 years when they completed a baseline clinic examination from 1985 to 1986. Subsequent examinations were conducted 2, 5, 7, 10, 15, and 20 years later. After multivariable adjustment, no association was observed between average coffee, decaffeinated coffee, or caffeine consumption (years 0 and 7) and presence of CAC (score, >0 Agatston units at year 15 or 20), CAC progression (incident CAC at year 20 or increase in CAC score by ≥20 Agatston units), or high carotid intima-media thickness (>80th percentile, year 20). However, tea consumption displayed a nonsignificant trend for an inverse association with CAC (P=0.08 for trend) and an inverse association with CAC progression (P=0.04 for trend) but no association with high carotid intima-media thickness (P>0.20 for trend). Stratification of the coffee analyses by sex, race, or smoking yielded similar nonsignificant patterns.

Conclusion—We observed no substantial association between coffee or caffeine intake and coronary and carotid atherosclerosis. However, our results suggested an inverse association between tea and CAC but not carotid atherosclerosis. (Arterioscler Thromb Vasc Biol. 2010;30:00-00.)

Key Words: antioxidants ■ atherosclerosis ■ calcification ■ carotid arteries ■ diet ■ epidemiology ■ nutrition

Coffee is one of the most widely consumed beverages in the world. More than half of all Americans drink coffee, with an average per capita intake of approximately 2 cups per day.1 Coffee is the primary source of caffeine in many populations; it also contains several other biologically active components that may have either harmful or beneficial cardiovascular effects. For instance, caffeine may immediately lead to an increase in blood pressure, although there is little evidence of an elevation in long-term studies.2 Coffee contains the diterpene cafestol, which increases serum low-density lipoprotein cholesterol concentrations.3 However, a higher coffee intake has also been associated with a substantially lower risk for type 2 diabetes mellitus as the result, at least in part, of a favorable influence on postload glucose metabolism.4,5

Despite the documented metabolic effects of coffee consumption from short-term intervention trials, results from studies of habitual coffee intake over long periods and coronary heart disease events have been equivocal. In the most recent meta-analysis6 conducted, summary measures of association from case-control studies suggest a direct association between coffee intake and coronary heart disease, compared with no consumption. However, meta-analyses of cohort studies suggest no substantial association.5–3 More recent analyses of US cohort studies suggest that light-to-moderate consumption of coffee may modestly reduce risk of stroke,7 all-cause mortality, and cardiovascular disease–related mortality.10,11

Tea is another widely consumed beverage purported to have beneficial cardiovascular effects. In carefully conducted meta-analyses of cohort and case-control studies of tea consumption, Peters et al12 estimated a summary 11% decrease in risk of myocardial infarction and Arab et al13 showed a 21% lower risk of fatal and nonfatal stroke, with increases in tea consumption of 3 cups per day. Recent cohort studies have shown that regular tea consumption may lower the risk of hypertension14 and death from cardiovascular
Similar to coffee, the protective effects of tea on cardiovascular disease are believed to be largely attributed to the presence of high levels of polyphenols, primarily flavonoids.18–21 Although the relation of coffee consumption with metabolic risk factors for coronary heart disease and incident events has been a topic of frequent interest, few studies have determined whether coffee, caffeine, or tea may be associated with atherosclerosis.22,23 Even fewer studies have evaluated whether these factors may influence atherosclerotic disease progression. The Coronary Artery Risk Development in Young Adults (CARDIA) Study offered a unique opportunity to examine the shape of the dose-response association of habitual coffee, decaffeinated coffee, caffeine, and tea consumption during young adulthood with the subsequent development and progression of coronary and carotid atherosclerosis later in life.

Methods

Study Population

CARDIA is a multicenter longitudinal study of the development and determinants of cardiovascular disease over time in 5115 young adults initially aged 18 to 30 years from 1985 to 1986. Black and white adults were recruited from 4 US cities (Birmingham, Ala; Chicago, Ill; Minneapolis, Minn; and Oakland, Calif) with population-based samples approximately balanced within center by sex, age (18 to 24 or 25 to 30 years), race (white or black), and education (high school graduate or less or greater than high school graduate). Participants have been reexamined 2, 5, 7, 10, 15, and 20 years after baseline; and retention rates across examinations were 91%, 86%, 81%, 79%, 74%, and 72%, respectively. Further details of study recruitment and design are available.24 All participants provided written informed consent at each examination, and institutional review boards from each field center and the coordinating center approved the study annually.

Clinical Measurements

Participants were asked to fast for 12 hours and to avoid smoking and heavy physical activity 2 hours before their examination. Body weight was measured to the nearest 0.2 kg with a calibrated balance beam scale. Height was measured with a vertical ruler to the nearest 0.5 cm. Body mass index was calculated as weight in kilograms divided by height in meters squared. Waist was measured with a tape in duplicate to the nearest 0.5 cm around the narrowest part of the waist. Blood pressure was measured on the right arm with a Hawksley random zero sphygmomanometer (WA Baum Company, Copaque, NY) in seated participants after a 5-minute rest. Three measurements were obtained at 1-minute intervals. Systolic and diastolic blood pressure measurements were recorded as the phase 1 and phase 5 Korotkoff sounds, respectively. The average of the second and third measurements was used in analyses.

Blood was drawn by venipuncture according to a standard protocol.25 Plasma high-density lipoprotein cholesterol and triglyceride concentrations were measured with an enzymatic assay by Northwest Lipids Research Laboratory (Seattle, Wash). Low-density lipoprotein cholesterol was derived by the Friedewald equation.26 Serum glucose and insulin measurements were obtained at Linco Research (St Louis, Mo). The insulin measurements were performed by using a radioimmunoassay with an overnight equilibrium-incubation format.

Coffee, Caffeine, Tea, and Other Dietary Information

The validated, interviewer-administered, quantitative CARDIA dietary history was previously described.27,28 Briefly, the CARDIA dietary history asked individuals to report foods eaten, including beverages, during the previous month using about 100 header questions (eg, “Do you eat meat?”) followed by open-ended responses. The CARDIA dietary history was administered at years 0, 7, and 20. Participants were asked to report their usual coffee consumption, including cappuccino and flavored coffee, in fluid ounces or cups. Participants were also asked about usual tea consumption, either iced or hot. One cup of coffee or tea was considered approximately equal to 8 oz (237 mL). We created categories of coffee and tea consumption (in cups per day) based on the overall distribution of intake before examining associations with atherosclerosis. Total daily caffeine intake (in milligrams per day) was calculated from all caffeine-containing beverages and foods reported. Nutrients were derived from the food and nutrient content databases developed by the Minnesota Nutrition Coordinating Center. We used the distribution of all participants to define quintiles of caffeine intake.

20 dietary measures from the CARDIA dietary history used in the current study included total energy (kilojoules per day), fruit and vegetable consumption (servings per day), and whole and refined grain consumption (servings per day). The average of dietary information collected at years 0 and 7 was used in analyses because the cumulative average consumption at 2 or more points has been shown to more accurately reflect habitual intake than only a single assessment29 and to reduce the possibility that the measurement of coronary calcified atherosclerosis at year 15 may have influenced coffee, caffeine, or tea consumption measured at year 20.

Computed Tomography

Coronary artery calcified (CAC) plaque was measured at years 15 and 20 by computed tomography of the chest.30 Electron beam computed tomography (Chicago and Oakland centers) and multidetector computed tomography (Minneapolis and Birmingham centers) scanners were used to obtain 40 contiguous 2.5- to 3.0-mm-thick transverse images from the root of the aorta to the apex of the heart in 2 sequential scans. Participants underwent scanning over a hydroxyapatite phantom to allow monitoring of image brightness and noise and to adjust for scanner differences. Data from both scans were transmitted electronically to the CARDIA CT Reading Center at Harbor-UCLA Medical Center, Calif (year 15) and Wake Forest University School of Medicine, Winston-Salem, NC (year 20). A calcium score in Agatston units (AU)11 was calculated for each calcified lesion, and the scores were summed across all lesions within a given artery and across all arteries (left anterior descending, left main, circumflex, and right coronary) to obtain the total calcium score. The presence of CAC was defined as a total calcified plaque score of greater than 0 AU, measured at year 15 or 20. For those with measures of CAC at both follow-up examinations (years 15 and 20), we also examined the association of coffee, caffeine, and tea consumption with 5-year progression of CAC, defined as incident CAC at year 20 or an increase in CAC score of 20 AU or greater.32

Carotid Ultrasonography

High-resolution B-mode ultrasonography was used to capture images of the bilateral common carotid (CC) and carotid bulb/intimal carotid (IC) arteries using an ultrasound machine (Logiq 700; General Electric Medical Systems) at the year 20 examination. Four images (1 longitudinal image of the CC and 3 longitudinal images of the IC) were acquired. Measurements of the maximal carotid intima-media thickness (CIMT) were made at a central reading center by readers blinded to all clinical information. The maximum CIMT of the CC and IC was defined as the mean of the CIMT of the near and far wall on both the left and right sides. The number of measurements that were available for averaging ranged from 1 to 4 for the CC and from 1 to 16 for the IC.33 A normalized composite CIMT measure was derived from combining the maximal CIMT of the CC and the IC (consisting of the arithmetic mean of the maximal CIMT of the right and left CC and IC). The internal carotid artery was not included in the composite CIMT measure because we found that the internal carotid artery was not consistently measurable in our population of young adults.
average of all IC and bulb measurements) by averaging these 2 measurements after standardization (subtraction of the mean and division by the SD for the measurement). We used the distribution of all CARDIA participants examined (>80th percentile) to define high CIMT because a threshold to define a clinically significant CIMT has not yet been established.

Other Measures
Standard questionnaires were used to maintain consistency in the assessment of demographic (age, sex, race, and education) and behavioral (physical activity, cigarette smoking, and alcohol use) information across CARDIA examination visits. The CARDIA Physical Activity History questionnaire queries the amount of time per week spent in 13 categories of leisure, occupational, and household physical activities during the past 12 months.34 Physical activity level was summarized as units of total activity, incorporating moderate- and high-intensity activities. A score of 100 exercise units is roughly equivalent to participation in vigorous activity 2 to 3 h/wk for 6 months of the year. Education was represented as years of schooling achieved by examination year 7. Cigarette smoking status at year 7 was classified as current, former, or never and was based on information collected at baseline and years 2, 5, and 7. Total daily alcohol consumption was calculated from an interviewer-administered questionnaire.35

Sample for Analysis
Of those who completed the year 15 (n=3672) or year 20 (n=3549) examination, 3042 and 3138, respectively, had data on CAC from at least 1 examination. A total of 3257 participants had data on CIMT at year 20. After excluding participants who were deemed unreliable because they reported an extreme energy intake (<800 or >8000 kcal/d for men and <600 or >6000 kcal/d for women) at years 0 or 7, 3574 had data on CAC and 3175 had information on CIMT. In general, persons who were excluded, had missing data, or were lost to follow-up were more likely to be black, younger, less educated, and smokers at baseline than were those included in the study sample; however, there was little difference in their baseline coffee, caffeine, or tea consumption.

Statistical Analysis
Participant characteristics were described according to average caffeinated coffee consumption using means and proportions. We used linear and logistic regression models to assess the significance level for linear trend across the categories of coffee for continuous and categorical characteristics, respectively, with adjustment for age, sex, and race. All continuous characteristics reflect the average of years 0 and 7, except age (year 0). Multivariable logistic regression models were used to estimate odds ratios and 95% CIs for the presence of CAC, CAC progression, and high CIMT associated with each level of caffeinated and decaffeinated coffee, caffeine, and tea consumption compared with the lowest level. Initial models minimally adjusted for age (in years), sex, race (white or black), smoking (current, former, or never), and center (Birmingham, Chicago, Minneapolis, or Oakland). Because coffee, caffeine, and tea intake may also be associated with other demographic, behavioral, clinical, and dietary measures, fully adjusted models also accounted for educational attainment (less than high school, high school graduate, bachelor’s degree, or master’s degree or higher), physical activity (exercise units), alcohol intake (milliliters per day), body mass index, total energy (kilocalories per day), fruit and vegetable intake (servings per day), and whole and refined grain intake (servings per day). Tests for a linear trend were performed by entering the categorical coffee, caffeine, and tea variables separately into the multivariable models as ordinal terms.

We also determined the association of coffee, caffeine, and tea consumption with the normalized composite CIMT expressed as a continuous variable in multivariable linear regression models. In addition, we examined associations with CIMT of the CC and IC separately as dichotomous outcome variables, defined by the 80th percentile; and as continuous natural logarithm–transformed variables.

Because coronary atherosclerosis is greater among men than women and among white than black adults,36 and because coffee consumption varies across these subpopulations,37 we also explored the association between coffee and atherosclerosis within models stratified by sex and race. In addition, we examined whether the coffee-atherosclerosis relation was present among current, former, or never smokers because smoking is strongly associated with coffee intake and has been previously shown to modify this association.25 We formally tested for the presence of effect modification by introducing a multiplicative interaction term into each multivariable model. Like most reports of observational studies, our study did not apply multiplicity adjustments for the number of statistical tests conducted. However, the primary analyses were based on a priori hypotheses. Tests of statistical significance were 2-tailed, with an α level of .05. Computer software (SAS version 9.1; SAS Institute, Cary, NC) was used to perform all analyses.

Results
The proportions of participants consuming 0, less than 1, 1 to 2, 3 to 4, and greater than 4 cups per day of caffeinated coffee were 37.2%, 31.0%, 15.7%, 10.7%, and 5.4%, respectively. Decaffeinated coffee consumption was low: 82.4% reported no consumption, 13.6% reported less than 1 cup per day, and 4.0% reported 1 cup per day or more. Approximately 31.1% reported no tea consumption, whereas 53.8%, 8.9%, and 6.2% reported less than 1, 1 to 2, and greater than 2 cups per day, respectively. Table 1 displays the demographic, lifestyle, dietary, and clinical characteristics of the 3574 participants with information on CAC according to average caffeinated coffee consumption at years 0 and 7. Caffeinated coffee consumption was positively associated with decaffeinated coffee but not with tea. Higher coffee consumption, but not decaffeinated coffee consumption, was strongly associated with smoking and a higher alcohol intake, whereas higher tea consumption was associated with a lower prevalence of smoking and lower alcohol use (data not shown). Higher coffee consumption was also associated with older age, male sex, and white race (Table 1). Coffee was also associated with a higher total energy and caffeine intake and was inversely related to resting diastolic blood pressure and fasting insulin levels, although the variability across categories of coffee was small. Approximately 18.6% had CAC present defined as a score of greater than 0 AU at year 15 (prevalence, 11.3%); or at year 20 (prevalence, 18.4%); for those with measures of CAC at both examinations (n=2415), 16.1% had CAC progression. Table 2 shows the adjusted associations of average caffeinated and decaffeinated coffee, caffeine, and tea consumption at years 0 and 7 with the presence of CAC at year 15 or 20 and CAC progression from year 15 to 20. Caffeinated and decaffeinated coffee and caffeine intake greater than the lowest category of consumption did not increase or decrease the odds for CAC or its progression. However, tea consumption displayed a nonsignificant trend for a lower presence of CAC (P=0.08 for trend in the fully adjusted model) and an inverse association with its progression (P=0.04 for trend). Those who drank more than 2 cups per day of tea, compared with those who reported no tea consumption, had a 46% lower adjusted odds of CAC progression (odds ratio, 0.54; 95% CI, 0.30 to 0.97). The adjusted odds ratios and 95% CIs for high CIMT at year 20, according to average coffee, caffeine, and tea consumption at years 0 and 7, are displayed in Table 3. No
evidence for an association was observed between caffeinated or decaffeinated coffee, caffeine, or tea intake and CIMT. Similar nonsignificant results were observed when the standardized average maximum CIMT was treated as a continuous outcome variable and when the CIMTs of the CC and IC were considered separately as dichotomous and continuous outcome variables (data not shown).

The mean consumption of caffeinated coffee at years 0 and 7 was not significantly associated with the presence of CAC at year 15 or 20, progression of CAC from year 15 to 20, or CIMT at year 20 within multivariable models stratified by sex, race, and smoking status ($P>0.10$ for trend for all and $P>0.20$ for interaction for all) (data not shown).

We also repeated all analyses combining information on caffeinated and decaffeinated coffee consumption (total coffee) at years 0 and 7; nonsignificant results were observed, including when analyses were stratified by sex, race, and smoking status (data not shown). In addition, a similar pattern of results was observed when we used an alternate definition of CAC progression, defined as incident CAC at year 20 or an increase in CAC score of 1 AU or greater between year 15 and 20 (data not shown).

### Discussion

In this population-based cohort, we observed no evidence for a substantial association between the habitual consumption of coffee or caffeine during young adulthood and CAC measured 15 to 20 years later. On the other hand, tea consumption displayed an inverse association with 5-year progression of
Atherosclerosis has been accumulating. Data from a sub-

verse association between tea consumption and the presence

versus association between tea consumption and the presence

population-based Rotterdam Study showed a significant in-

sample of 3454 Dutch adults, 55 years and older, from the

CAC. No association was observed between coffee, caffeine,

a comprehensive meta-analysis of epidemiological data

on tea and the primary prevention of cardiovascular disease

published through 2000, participants who increased their tea

consumption by 3 cups per day had an 11% decrease in the

risk of myocardial infarction.12 Several cohort studies and

meta-analyses,13,16,38 but not all,39 published since then have

identified protective associations between habitual tea intake

and cardiovascular disease. Evidence for an association with

atherosclerosis has been accumulating. Data from a sub-

sample of 3454 Dutch adults, 55 years and older, from the

population-based Rotterdam Study showed a significant in-

verse association between tea consumption and the presence

of severe abdominal aortic calcified plaques, reflected by the

length of the calcified area.40 In addition, a higher intake of

green tea was associated with lower odds for significant

stenosis of 1 or more coronary arteries among 117 Japanese41

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Table 2. Adjusted Data for the Presence of CAC Plaques at Year 15 or 20 and Progression of CAC From Year 15 to 20 According to

Average Coffee, Caffeine, and Tea Consumption at Years 0 and 7

<table>
<thead>
<tr>
<th>Beverage Consumption</th>
<th>Presence of CAC (n=3574)*</th>
<th>Progression of CAC (n=2415)†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of Cases/ Noncases Unadjusted %</td>
<td>OR (95% CI)</td>
</tr>
<tr>
<td>Caffeinated coffee, cups/d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>220/1108</td>
<td>16.6</td>
</tr>
<tr>
<td>&lt;1</td>
<td>187/921</td>
<td>16.9</td>
</tr>
<tr>
<td>1–2</td>
<td>107/455</td>
<td>19.0</td>
</tr>
<tr>
<td>3–4</td>
<td>92/291</td>
<td>24.0</td>
</tr>
<tr>
<td>&gt;4</td>
<td>57/136</td>
<td>29.5</td>
</tr>
<tr>
<td>P value for trend</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

Decaffeinated coffee, cups/d | | | | |
| 0 | 547/2397 | 18.6 | 1.00 (referent) | 1.00 (referent) | 316/1659 | 16.0 | 1.00 (referent) | 1.00 (referent) |
| <1 | 85/396 | 21.3 | 1.00 (referent) | 1.00 (referent) | 53/286 | 15.6 | 1.04 (0.74–1.45) | 1.10 (0.78–1.54) |
| >1 | 31/118 | 20.8 | 0.99 (0.64–1.55) | 1.07 (0.68–1.68) | 20/81 | 19.8 | 1.29 (0.74–2.23) | 1.39 (0.79–2.43) |
| P value for trend | NA | NA | >0.20 | >0.20 | NA | NA | >0.20 | >0.20 |

Total caffeine, mg/d | | | | |
| <26.6 | 117/596 | 16.4 | 1.00 (referent) | 1.00 (referent) | 58/387 | 13.0 | 1.00 (referent) | 1.00 (referent) |
| 26.6–75.9 | 107/604 | 15.1 | 0.82 (0.61–1.12) | 0.78 (0.57–1.07) | 58/399 | 12.7 | 0.94 (0.62–1.42) | 0.89 (0.58–1.35) |
| 76.0–169.0 | 131/574 | 18.6 | 0.89 (0.66–1.20) | 0.85 (0.63–1.16) | 77/401 | 16.1 | 1.10 (0.74–1.63) | 1.03 (0.68–1.54) |
| 169.1–342.7 | 133/589 | 18.4 | 0.80 (0.59–1.09) | 0.77 (0.56–1.06) | 80/432 | 15.6 | 0.94 (0.63–1.41) | 0.92 (0.61–1.39) |
| >342.7 | 175/548 | 24.2 | 0.85 (0.62–1.16) | 0.80 (0.58–1.10) | 116/407 | 22.2 | 1.13 (0.76–1.69) | 1.06 (0.70–1.60) |
| P value for trend | NA | NA | >0.20 | >0.20 | NA | NA | >0.20 | >0.20 |

Tea, cups/d | | | | |
| 0 | 237/875 | 21.3 | 1.00 (referent) | 1.00 (referent) | 128/658 | 18.4 | 1.00 (referent) | 1.00 (referent) |
| <1 | 333/1588 | 17.3 | 0.81 (0.66–1.00) | 0.85 (0.69–1.04) | 209/1131 | 15.6 | 0.85 (0.65–1.10) | 0.86 (0.66–1.12) |
| 1–2 | 57/261 | 17.9 | 0.83 (0.58–1.18) | 0.84 (0.59–1.21) | 35/196 | 15.2 | 0.81 (0.52–1.26) | 0.79 (0.50–1.25) |
| >2 | 36/186 | 16.2 | 0.74 (0.48–1.13) | 0.72 (0.47–1.11) | 17/131 | 11.5 | 0.59 (0.33–1.06) | 0.54 (0.30–0.97) |
| P value for trend | NA | NA | 0.07 | 0.08 | NA | NA | 0.06 | 0.04 |

NA indicates not applicable; OR, odds ratio.

*Presence is defined as a CAC score of greater than 0 Agatston units at year 15 or 20.

†Progression is defined as incident CAC at year 20 or an increase in CAC score by greater than 20 Agatston units between years 15 and 20.

‡Model 1 adjusts for baseline age (in years), sex, race (white or black), smoking (smoker, former, or never), and center (Birmingham, Ala; Chicago, Ill; Minneapolis, Minn; or Oakland, Calif).

§Model 2 adjusts for all of the variables in model 1 and for educational attainment (less than high school, high school graduate, bachelor’s degree, or master’s degree or higher), physical activity (exercise units), body mass index (calculated as weight in kilograms divided by height in meters squared), alcohol intake (in milliliters per day), total energy (in kilocalories per day), fruit and vegetable intake (servings per day), and whole and refined grain intake (servings per day).
cially influence the progression of CAC. Future studies are needed to confirm these findings.

All tea is derived from the same plant (*Camellia sinensis*), which is grown in more than 30 countries. Black tea is primarily consumed in the United States and Europe, whereas green tea is the main tea beverage consumed in East Asian countries, such as China and Japan. In the United States, it has been estimated that approximately 21% of adults older than 20 years drink tea daily, generally similar to that observed in the current study (15%).43 Black teas are produced by promoting the enzymatic oxidation of catechins, whereas green teas are generated by inactivating these enzymes. Although we did not collect information on the type of tea consumed by participants, it was likely to be predominantly black tea. Both green and black teas contain comparable total amounts of flavonoids, although their individual quantities may differ.44

The most widely mentioned mechanism linking regular tea consumption with reduced atherosclerosis includes the protective effects of flavonoids on the oxidation of low-density lipoproteins18 and the development of fatty streaks in animal models.45 Key events in early atherogenesis. Studies20,46 of apolipoprotein E–deficient mice fed an atherogenic diet supplemented with tea catechins have shown reduced accumulation of remal and aortic atherosclerosis compared with mice fed only an atherogenic diet. A second mechanism includes potential effects of flavonoids present in tea on the vascular endothelium, widely regarded to be involved in all stages of atherosclerotic plaque formation.47–50 For example, Duffy et al48 showed that tea consumption improved endothelium-dependent flow-mediated dilation 2 hours after the ingestion of tea; this effect was maintained after 4 weeks of daily tea consumption among patients with clinical cardiovascular disease. Additional mechanisms that may explain, at least in part, the association of tea with atherosclerosis include antithrombotic and anti-inflammatory effects of flavonoids present in tea.51,52

We observed a nonsignificant trend for an inverse association between tea and the presence of CAC and a significant inverse association with CAC progression but no evidence for an association with CIMT. In a cross-sectional population-based study of 6597 French adults, aged 65 to 85 years,
Debette et al\textsuperscript{22} noted that regular tea consumption was associated with a lower presence of carotid plaques in women; however, similar to our findings, there was no evidence of a relation with CIMT of the CC artery in either sex. These researchers speculated that tea consumption may be more strongly associated with advanced atherosclerosis, as reflected by the presence of calcified carotid plaque versus CIMT. Another explanation is that CIMT may not be a good indicator of the inflammatory process that is consistent with atherosclerotic disease because age-related thickening has been shown to occur in the absence of overt atherosclerosis.\textsuperscript{53}

We found no evidence to suggest that habitual coffee consumption may be associated with CAC or CIMT. Furthermore, there was no association among subgroups of men, women, whites, blacks, smokers, and nonsmokers. To our knowledge, only a single report has been published examining whether coffee may be associated with atherosclerosis. In a subsequent analysis of 1570 older Dutch adults from the Rotterdam Study, van Woudenberg et al\textsuperscript{33} showed a complex pattern of associations between coffee and CAC. A significant inverse association was observed among women, whereas among men, smoking appeared to modify this relation because a positive association was found among nonsmoking men but not among men who were current smokers. These investigators were unable to explain why coffee appeared protective among women and subsequently harmful among nonsmoking men. Our null results suggest that the modest inverse association between coffee consumption, stroke, and cardiovascular mortality observed in recent studies\textsuperscript{6-11} may not be mediated by a beneficial influence of coffee on coronary or carotid atherosclerosis.

The strengths of our study include a population-based sampling method; a biracial cohort; extensive data on potential confounders; a large sample size, well balanced with respect to age, sex, race, and education, that increased precision and permitted simultaneous adjustment for multiple variables; repeat assessments of coffee, caffeine, tea, and other potential confounding factors; the comprehensive CARDIA dietary history; and the standardized data collection protocols and rigorous quality control of the CARDIA study. Nevertheless, several limitations deserve mention. First, participants in the current study were observed from young adulthood into early middle age, when the prevalence of atherosclerotic plaques is still relatively low. In addition, although nearly two-thirds of participants reported drinking coffee, only approximately 16% reported consuming 3 cups per day or more. Thus, we cannot rule out a possible beneficial or hazardous association between habitual coffee consumption and CAC or CIMT among older adults and/or those with higher levels of intake. Second, although we have controlled for a number of potential confounders, the study is observational, and we could not exclude the possibility of residual confounding from unmeasured or inadequately measured confounders. Third, similar to most longitudinal studies, our results may be susceptible to nonresponse; however, retention of the cohort after 15 to 20 years was high and we noted no differences in baseline coffee, caffeine, or tea consumption between those who were included versus those who were not included in the current study. Fourth, we could not differentiate the type of tea consumed by participants. Finally, as previously discussed, the probability of committing a type I error may have increased with the number of statistical tests performed; however, our primary analyses were based on predetermined hypotheses.

In conclusion, the present long-term population-based study showed no substantial association between habitual coffee, decaffeinated coffee, or caffeine consumption assessed during young adulthood and well-documented markers of coronary and carotid atherosclerosis measured 15 to 20 years later. However, tea consumption displayed evidence for a protective association with coronary calcification. Our findings suggest that tea consumption may prevent the development and progression of coronary calcification, whereas coffee and caffeine intake at the levels reported in the current study do not appear to be beneficial or harmful.

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Disclosures
None.

References


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