Caffeine and Cholesterol: Interactions With Hostility

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The consumption of caffeinated beverages has been linked to elevated serum cholesterol and an increased risk of coronary disease, although the relationships are inconsistent across studies and remain controversial. The effect of caffeine on cholesterol and coronary disease risk may be modulated by other factors. Using cohort data from a subsample of the University of North Carolina Alumni Heart Study, we investigated whether the relationships between caffeinated beverage consumption and serum lipid and lipoprotein levels in middle-aged men and women were modulated by levels of trait hostility. After adjustment for other risk factors, higher caffeinated beverage intake was associated with higher low-density lipoprotein cholesterol levels and a higher ratio of total to high-density lipoprotein cholesterol, both indicative of greater coronary disease risk. The interactive effects of hostility and caffeine intake were ambiguous, although there were trends for caffeine intake to have stronger effects on low-density lipoprotein and on total cholesterol in people with less hostility. Additional studies of personality characteristics and other factors that can modulate the cholesterol-raising effects of coffee drinking may be warranted because they might clarify the health consequences associated with coffee drinking and lead to the identification of individuals who would benefit most from changes in their coffee drinking.
Key words: Caffeine, coffee, cholesterol, lipoproteins, hostility.

INTRODUCTION

Despite more than two decades of research, there is still no conclusive answer to the question of whether coffee drinking increases the risk of coronary heart disease (CHD). Initial studies from the Boston Collaborative Drug Surveillance Program in the early 1970's reported that people who drank more than 5 cups of coffee daily had twice the risk of acute myocardial infarction as did people who drank no coffee at all (1, 2). However, recent reviews of this work and more than 20 subsequent epidemiological studies describe a literature full of contradictory evidence that can only tentatively reach the conclusion that coffee drinking may be a CHD risk factor (3, 4). Related studies of the relationship between coffee and elevated serum cholesterol were stimulated by a report from the Tromsø Heart Study that linked the two (5). Here too, however, reviews describe a pattern of inconsistent and contradictory relationships between coffee drinking and cholesterol that suggests a possible relationship, but provides no conclusive answer (4, 6).

The failure, thus far, to reach a conclusion regarding the effects of coffee drinking or caffeine consumption on risk for CHD does not diminish the importance of these questions. Given the large number of people who drink moderate to large amounts of coffee daily, or consume caffeine in other beverages and foods, the identification of even a small increase in CHD risk attributable to coffee or caffeine would have significant public health implications. Therefore, it is important to continue investigating the effects of caffeine and coffee drinking.

The discrepancies of the studies are commonly attributed to the presence of methodological shortcomings in some investigations or to the difficulties inherent in quantifying coffee or caffeine intake in epidemiological studies (3, 4, 6). However, an alternative explanation is that the relationship between coffee drinking or caffeine intake and CHD depends on a third factor that has not been considered in studies to date. Research suggests that caffeine's health risks could depend on factors related to psychophysiological stress reactivity. Caffeine has been shown to intensify the harmful effects of chronic social stress in animals (7). Studies in humans have shown that caffeine can potentiate cardiovascular and neuroendocrine stress responses in the laboratory (8–12) and perhaps in the natural environment as well (13–15). These demonstrations of caffeine-stress interactions suggest that caffeine or coffee drinking might have greater effects on CHD risk in situations or for individuals who can be characterized by exaggerated stress reactivity.

The present study, conducted with data collected in the University of North Carolina Alumni Heart

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Received for publication January 4, 1993; revision received September 1, 1993

0033-3174/94/5603-0260$03 00/0

Study (UNCAHS, 16, 17) investigated the role that the personality characteristic of cynical hostility might play in the relationship between caffeine intake and levels of serum cholesterol and lipoproteins. The trait of hostility appears to be a significant risk factor for coronary artery disease and CHD (18–20). Furthermore, it is generally believed that hostile people are characterized by exaggerated cardiovascular and neuroendocrine stress reactivity, and that this exaggerated reactivity is the mechanism that stimulates atherogenesis and increases CHD risk. Given evidence that caffeine potentiates stress reactivity, we hypothesized that the relationship between caffeine intake and cholesterol might vary depending on the individual's level of hostility and specifically that the caffeine-cholesterol relationship would be stronger in more hostile individuals.

MATERIALS AND METHODS

Study Sample

The 763 subjects in this study (166 women, 597 men) were a subset of the participants in the University of North Carolina Alumni Heart Study (UNCAHS), a prospective epidemiological study that focuses on the role of hostility as a risk factor for coronary heart disease in 3,855 male and 855 female college graduates (16, 17). The UNCAHS initiated enrollment in 1986–87 with a target cohort that had originally completed the Minnesota Multiphasic Personality Inventory (MMPI) during the period from 1964–1966, when the participants were students at the University of North Carolina at Chapel Hill (16). The UNCAHS sample is largely composed of white, well-educated white-collar professionals, most of whom reside in the Southeastern United States. Greater detail on the UNCAHS sample is available elsewhere (16, 17).

Assessment of Cardiovascular Disease Risk Factors

The overall UNCAHS design includes a series of annual questionnaires that focus on changes in health behaviors and health status. The initial questionnaire was completed by 4710 individuals in 1987 to 1990, and it provided data on each participant's weight, height, current exercise habits, current and past smoking history, current alcohol consumption, and current consumption of caffeinated beverages. The following health behavior measures were derived from these questionnaire data.

Weight and height were used to calculate the body mass index for estimation of obesity, using the standard formula (body mass index = weight (kg)/height $(m)^2$). Current exercise level was quantified as the reported average number of hours each week that the respondent exercised or played sports. Alcohol consumption was quantified as the reported total number of servings of beer, wine, and liquor consumed in the past week. Smoking status was defined categorically as either current cigarette smoker or nonsmoker. For present purposes, ex-smokers were combined with nonsmokers on the assumption that neither group was currently exposed to the potential effects of cigarette smoking on serum lipids. The few subjects who only smoked pipes or cigars were also collated with nonsmokers.

The initial questionnaire included one item regarding consumption of caffeinated beverages. Participants were asked to report the average number of daily servings of caffeinated beverages (including coffee, tea, and caffeinated soft drinks) they consumed, where a "serving" was defined as an average-sized cup, glass, or bottle. This response did not distinguish among the different potential sources of caffeine. Furthermore, it included only servings of caffeinated coffee and did not include consumption of decaffeinated coffee. The number reported for this item was used to quantify daily caffeinated beverage intake.

A follow-up questionnaire was mailed to participants one year after the initial questionnaire, in the interval from 1988 to 1991. Completed by 3841 participants, it included the 50-item Cook-Medley hostility scale (Ho) (21) derived from items on the Minnesota Multiphasic Personality Inventory (MMPI). Scores on the Cook-Medley Ho Scale have been related to coronary artery disease, coronary heart disease, and all-cause mortality (20, 22–24). The present investigation used a Composite Hostility score, based on a subset of 27 of the items reflecting cynicism (13 items), aggressive responding (9 items), and hostile affect (5 items) in their content, that was found by Barefoot et al. (24) to be a better predictor of survival than the total Ho score from all 50 items.

The UNCAHS offered participants a lipid panel assessment, which was completed by 833 (18%) of the participants in the study. All lipid panels were performed at offices of Roche Biomedical Laboratories near each participant's home. Blood samples for the lipid panel were drawn after a 12-hour fast. Total cholesterol, the HDL-C fraction, and triglycerides were measured directly with automated enzymatic methods (25). The LDL-C fraction was estimated using standard equations (LDL-C = Total Cholesterol - HDL Cholesterol - Triglycerides/5) (26). In addition, the ratio of total cholesterol to HDL-C was also calculated as a cholesterol risk factor (27).

The 763 individuals who were included in the analyses of the present study were those who had complete data on all of the variables of interest (lipid panels, hostility, caffeinated beverage consumption, exercise, alcohol consumption, cigarette smoking, and body mass index). They constituted 91.6% of the 833 who had lipid data and 16% of the UNCAHS sample described in the earlier report (17).

Data Analysis Strategy

The potential associations of caffeinated beverage intake and hostility with levels of serum lipids and lipoproteins were tested using multiple regression models (28). In order to reduce the overall Type I error rate for the study, total serum cholesterol (TOT-C), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C) were initially combined in multivariate multiple regression models (29). If multivariate effects were significant, then follow-up univariate tests were conducted. Because lipid ratio (TOT-C/HDL-C) is a linear combination of other measures, it had to be analyzed separately.

Age, body mass index, cigarette smoking, alcohol consumption, and weekly exercise were included as covariates in the models to control for their known effects on cholesterol. In order to accommodate possible non-linear relationships between these covariates and the dependent measures, restricted cubic splines (30) were initially fit for each of the covariates. If significant non-linear covariate relationships were observed, they were kept in

the regression models that tested the effects of caffeine intake and hostility. If non-linear effects were not significant, only the linear effect of the covariate was included. Gender was included as a covariate, because data from men and women were combined, and initial multivariate models also included interactions of gender with the other covariates as well as with caffeine intake and hostility. However, multivariate tests did not detect significant gender interactions and these terms were dropped from the regression models reported here. Testing of the effects of caffeine intake and hostility in the regression models included initial fitting of restricted cubic splines to test for possible nonlinear relationships between these factors and the cholesterol measures. Results are reported in terms of the partial regression coefficients that relate predictor and dependent variables, after adjustment for the effects of covariates and other predictors in the regression model.

RESULTS

Descriptive statistics for the sample are presented in Table 1. Values for risk factors are roughly those that would be expected for a well-educated, middle-aged (44–46 yrs) group of men and women. The subsample used in this study is also a reasonable cross-section of the original UNCAHS sample (17) although compared to the remainder of the UNCAHS sample, this subsample had a lower daily caffeinated beverage intake (3.2 vs. 3.6 daily servings, $p < .0001$), and lower body mass index (24.3 vs. 24.9 kg/m^2, $p < .0001$). Participants in this subsample were less likely to be male (78% vs. 82%, $p < .001$) and the subsample had a smaller proportion of cigarette smokers (12.5% vs. 18.0%, $p < .01$). The subsample and remainder did not differ in Cook-Medley Ho score (14.3 vs. 14.0), in the Composite Hostility score (8.8 vs. 8.7), in alcohol use (6.5 vs. 6.6 weekly servings) or in weekly hours of exercise (3.4 vs. 3.5).

TABLE 1. Descriptive Statistics for Study Sample (N = 763)

	Mean	SD
Covariate risk factors		
Sex (% Male)	78%	—
% Cigarette smokers	12%	—
Age (yrs)	41.8	2.3
Body mass index (kg/m^2)	24.3	3.4
Alcohol (weekly servings)	6.5	8.5
Exercise (hours per week)	3.4	2.9
Predictor variables		
Daily caffeine servings	3.2	2.5
Cook-Medley hostility	14.3	6.5
Composite hostility	8.8	4.3
Measures of serum cholesterol		
Total cholesterol (mg/dl)	203.8	37.5
LDL-cholesterol (mg/dl)	132.3	34.6
HDL-cholesterol (mg/dl)	48.5	12.3
Total-C/HDL-C Ratio	4.46	1.36

Relationships among the independent, covariate, and dependent measures were examined using bivariate correlations, as reported in Table 2. Daily caffeine intake was correlated positively with serum levels of TOT-C and LDL-C and negatively related to serum levels of HDL-C. Higher caffeine intake was also associated with higher lipid ratios. Hostility scores were correlated negatively with HDL-C levels and positively with lipid ratio. The covariate risk factors were related to serum cholesterol levels as expected, with male gender, higher body mass index, and current smoking all associated with higher TOT-C and LDL-C levels, lower HDL-C levels and a higher lipid ratio, indicative of a poorer lipid profile associated with these known coronary disease risk factors.

Correlations also revealed relationships between caffeine intake, hostility, and the other risk factors. Daily caffeine intake was significantly correlated with hostility, gender, body mass index, and smoking. As expected, the Composite Hostility score was highly correlated with the score on the Cook-Medley Ho scale from which its items were selected. Composite Hostility was correlated only with body mass index in this subsample, and not with gender or the other CHD risk factors. The correlations in Table 2 suggest that higher daily caffeine intake may cluster with other CHD risk factors, although the relationships are relatively weak (accounting for 2–6% of variance). Furthermore, the pattern of complex interrelationships between caffeine intake and the other risk factor variables confirms the necessity of statistical controls for the other risk factor variables in the multiple regression analysis investigating caffeine intake and hostility interactions.

Effects of Caffeine and Hostility on Serum Cholesterol

The primary objective of the present study was to investigate if hostility altered the relationship between caffeine intake and serum cholesterol levels, which would be indicated by a significant interaction between these two factors in the regression models predicting cholesterol variables. The interaction between caffeine intake and Composite Hostility was evaluated by multivariate multiple regression, including TOT-C, LDL-C, and HDL-C as dependent measures and controlling for the effects of caffeine intake, hostility, age, gender, body mass index, current smoking status, alcohol consumption,

and weekly exercise. Analysis of this regression model revealed a significant interaction of caffeine intake and hostility in the multivariate test (Wilks' lambda $F(3, 739) = 2.69$, $p = 0.047$). However, none of the subsequent univariate tests of the caffeine intake-hostility interaction was significant. There were trends for LDL-C ($t(739) = -1.91$, $p = 0.06$) and for TOT-C ($t(739) = -1.51$, $p = 0.13$). Interactions were clearly not significant for HDL-C and for the TOT-C/HDL-C lipid ratio that was tested separately (both $p > 0.3$). Predicted values, adjusted for the six covariates, are shown in Figure 1, for three levels of caffeine intake and three levels of hostility. The graphs show that the trends in TOT-C and LDL-C measures contradict our hypothesis that the effect of caffeine intake would be greatest in high hostile individuals. Indeed, the graphs suggest that caffeine's effect on TOT-C and LDL-C diminish as hostility score increases in the sample.

In the absence of a significant univariate caffeine-hostility interaction, the relationships between daily caffeine intake and serum cholesterol and lipoproteins were evaluated by multivariate multiple regression, including TOT-C, LDL-C, and HDL-C as dependent measures and controlling for the effects of the same set of covariates plus Composite Hostility. The tests for non-linearity in caffeine intake effects were not significant, and thus only the linear effect of caffeine was included. The multivariate test was significant (Wilks' lambda $F(3, 740) = 3.20$, $p = 0.02$) and subsequent univariate tests ($df = 740$) revealed a linear effect of caffeine intake on LDL-C ($t = 2.50$, $p = 0.013$), and trends for TOT-C ($t = 1.72$, $p = 0.087$) and HDL-C ($t = -1.89$, $p = 0.06$). Caffeine intake was also significantly related to the TOT-C/HDL-C Lipid Ratio, which was analyzed separately ($t = 2.85$, $p = 0.005$). Regression coefficients are presented in Table 3. Each additional daily serving of caffeinated beverage was associated with a 1.29 mg/dl increase in LDL-C, after controlling for the effects of the other cholesterol risk factors, and a 0.053 increase in the lipid ratio.

The related analysis of Composite Hostility scores, adjusting for the same covariates plus caffeine intake, revealed a trend for non-linear effects of hostility in the multivariate test (Wilks' lambda $F(3, 740) = 1.72$, $p = 0.078$). However, only the linear effect of hostility was retained and the linear relationship between hostility and cholesterol was significant (Wilks' lambda $F(3, 740) = 3.67$, $p = 0.012$).

TABLE 2. Correlations between Independent Variables, Covariate Risk Factors, and Serum Lipid Dependent Variables ($N = 763$)

	Caffeine	Composite hostility	Sex	Total-C	LDL-C	HDL-C	Tot/HDL ratio
Caffeine intake (daily servings)	1.0	0.15****	0.16****	0.13***	0.15****	−0.18****	0.23****
Composite hostility	0.15****	1 0	0.03	0.06	0.06	−0.12***	0.15****
Cook-Medley hostility	0.15****	0.92****	0.01	0.04	0.03	−0.10**	0.12***
Sex (M = 1/F = 0)	0.16****	0.03	1.0	0.14****	0.20****	−0.37****	0.35****
Age (yrs)	0.04	−0.04	−0.12***	0.03	−0.00	0.12***	−0.06
Body mass index (kg/m^2)	0.24****	0.10**	0.29****	0.15****	0.13***	−0.31****	0.33****
Smokes (Y = 1/N = 0)	0.15****	0.06	0.03	0.10**	0.10**	−0.11**	0.16****
Alcohol (weekly servings)	0.07	0.03	0.20****	0.18****	0.11**	0.12***	−0.00
Exercise (weekly hours)	−0.05	0.03	0.11***	−0.02	−0.01	0.07*	−0.07*

* $p < .05$; ** $p < .01$; *** $p < .001$; **** $p < .0001$.

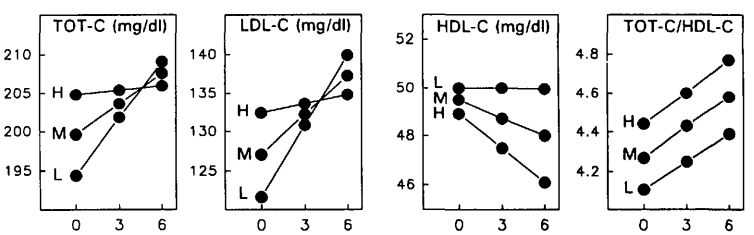

Fig. 1. Predicted values of serum cholesterol and lipoprotein variables by daily caffeine intake for high (H; 90th percentile), medium (M; 50th percentile), and low (L; 10th percentile) levels of Composite Hostility score. Predicted values have been adjusted for the effects of age, gender, body mass index, smoking status, alcohol consumption, and exercise.

TABLE 3. Partial Regression Coefficients Predicting Lipid and Lipoprotein Variables, Controlling for Age, Sex, Smoking Status, Alcohol Consumption, Exercise, and Body Mass Index

	TOT-C (mg/dl)	LDL-C (mg/dl)	HDL-C (mg/dl)	Lipid ratio
Daily caffeine intake (# of servings)	0.97	1.29*	−0.31	0.053**
Composite hostility (27-item scale)	0.26	0.19	−0.22*	0.028**

* $p \leq .05$; ** $p \leq .005$.

Follow-up univariate tests (df = 740) revealed a significant effect of hostility on HDL-C (t = -2.38, p = 0.02), but not on LDL-C or TOT-C (both $p > 0.30$). The relationship between hostility and the TOT-C/HDL-C ratio was significant as well (t = 2.85, p = .005). Regression coefficients (Table 3) for these relationships indicate that higher hostility scores are associated with lower HDL-C levels and a higher TOT-C/HDL-C lipid ratio. A similar relationship between hostility and lipid ratio was reported in an earlier study using UNCAHS data that measured hostility with the 50-item Cook-Medley Ho score (17).

A significant effect of gender was observed for each of the multivariate models described above. However, no significant interactions were observed between gender and any of the covariate risk factors or between gender and daily caffeine intake or hostility in multivariate tests. Because they are unrelated to the effects and interactions of caffeine intake and hostility, these results are not presented here.

DISCUSSION

The significant interaction between caffeine intake and hostility, which would indicate that hostility modulated the effects of caffeine intake on cholesterol, was not observed in any of the four cholesterol measures. Although the multivariate test of TOT-C, LDL-C, and HDL-C did reveal a significant caffeine-hostility interaction, we could not locate this effect in any of the variables when follow-up univariate tests were performed. The caffeine-hostility interactions approached significance for LDL-C and TOT-C, but effects did not reach statistical significance when adjustments were made for other risk factors. This outcome suggests that some interaction may be occurring, but that the effect was too weak to be detected in these data.

The form of the caffeine-hostility interaction for LDL-C and TOT-C, suggested by the trends, contradicts our hypothesis that caffeine would have a stronger effect on cholesterol in hostile individuals. In Figure 1, it is clear that the interactions for LDL-C and TOT-C indicate a diminishing of the positive relationship between caffeine intake and cholesterol as hostility score increased in the sample. Rather than exaggerating the effects of hostility on cholesterol, caffeine appears to have no effect on TOT-C and LDL-C in hostile individuals. One interpretation of this pattern of interaction is that high hostility and caffeine intake share a common mechanism to elevate cholesterol. The sympathetic adrenal-medullary (SAM) system could provide a common mechanism, given that caffeine is known to activate SAM activity and intensify stress reactivity and given that hostility is associated with exaggerated SAM activity. Further experimental investigations may explore this hypothesis. However, present results do suggest that our hypothesis that hostility and caffeine intake would synergistically increase cholesterol and CHD risk is probably wrong.

Caffeine intake itself was found to be significantly related to LDL-C and the TOT-C/HDL-C ratio, with trends that approached statistical significance for TOT-C and HDL-C. Furthermore, results suggest a linear relationship, given that significant non-linear relationships were not observed. This finding supports a dose-response relationship for the effect of caffeine intake on cholesterol and argues against the presence of some threshold of intake below which caffeine has no effect. All of the observed effects were in the direction of higher CHD risk associated with higher levels of caffeine intake. Caffeine intake was positively related to LDL-C, one of the lipoproteins thought to be more directly involved in the atherosclerotic process (31) and to the TOT-C/HDL-C ratio, which is another important indicator of CHD risk (27). The trend for lower HDL-C with higher caffeine intake also suggests an increased risk for CHD, since HDL-C is the component of cholesterol that is thought to be beneficial in reducing risk (31). The apparent reduction in HDL-C may have also influenced the relationship between caffeine intake and TOT-C, with the negative relationship partially offsetting the positive relationship between caffeine intake and the LDL-C component of TOT-C. These

results add to the literature that demonstrates that caffeine intake (or coffee drinking) is associated with higher cholesterol levels (4, 6) and supports the hypothesis that caffeine intake or coffee drinking may be a risk factor for CHD.

A relationship between hostility and lipid ratio was reported earlier (17), although the earlier study used the total score from the Cook-Medley Ho scale rather than the score from the 27-item Composite Hostility scale used here. Given that Composite Hostility is a subset of the Cook-Medley Ho scale, the effect seen here, higher lipid ratios in hostile individuals, is not surprising. However, the additional analyses of TOT-C, LDL-C, and HDL-C in the present study reveal that hostility results in higher lipid ratio scores because it is associated with lower HDL-C values, and not with higher TOT-C or LDL-C values. This suggests that hostility might increase CHD risk by reducing levels of the beneficial, protective component of cholesterol, rather than by increasing the atherogenic component.

The regression coefficients relating caffeine intake to cholesterol (Table 3) are small in size and do not indicate large changes in cholesterol level with each increasing daily serving. The LDL-C coefficient for caffeine intake suggests only a 6% difference in LDL-C between 0 and 6 servings of caffeinated beverages per day. Although small, these changes are within the range of observed differences between the minimum and maximum limits of coffee drinking in other studies that have found significant effects on cholesterol (4, 6). Certainly, the multiple regression models used here tend to underestimate the size of the effects of caffeine intake, because the adjustment for other risk factors means that only effects uniquely attributable to caffeine intake, and not to any other risk factor correlated with caffeine intake, are represented in the regression coefficients. Bivariate regressions without covariate adjustment, like the correlations in Table 2, yield coefficients for caffeine intake that are two to three times larger than those in Table 3 (i.e., 1.91 mg/dl/serving for TOT-C, 2.14 mg/dl/serving for LDL-C, and -0.89 mg/dl/serving for HDL-C). These larger values represent the upper limit of the effect of caffeine intake, and the true direct effects probably lie somewhere in between.

There is no doubt that the relationships between caffeine intake and cholesterol were negatively affected by the crude estimation of caffeine or coffee intake. Accurate estimation of caffeine intake and coffee consumption has been a major methodological problem throughout research on the health risks of caffeine and coffee (4). However, the single item score, which combined daily consumption of coffee, tea, and caffeinated soft drinks, made estimates of caffeine intake less precise. Coffee contains more than twice the caffeine per serving than the other beverages included in the total and the proportions of each source are unknown. Surveys have demonstrated that coffee drinking is the most predominant source of caffeine for adults (32), and this preference may have been demonstrated in our middle-aged sample, but we do not know. This combined score also differs from most of the earlier studies, which either focused on coffee-drinking or examined coffee and tea separately. The importance of quantifying coffee intake separately is also emphasized by the fact that attention has focused on the possible role of coffee constituents other than caffeine in the relationship between coffee and cholesterol (4, 6). The imprecision in measurement of caffeine intake probably weakened relationships in the present study, working both to reduce the statistical significance of the caffeine-cholesterol relationships and to attenuate the regression coefficients indicating how big the effects might be. Despite the limitations of our investigation, we did obtain results that were similar to those of other studies that quantified coffee intake directly.

The UNCAHS sample, and the specific subsample studied here, are not representative of the general middle-aged population in race, education, occupation or residence, and they have risk factor patterns that reflect their status (17). Furthermore, Siegler et al. report that the subsample who had lipid assessments consumed less caffeine, had lower mean body mass index, and were less likely to smoke. In general, these individuals are probably more health-conscious than the average person. The relative homogeneity of the sample studied here and the greater health-consciousness and lower-than-average levels of risk factors seen in the present sample would lead to more conservative estimates of the effects of potential risk factors such as caffeine intake. A more heterogeneous sample may provide a better opportunity to detect caffeine-hostility interactions in cholesterol level and CHD risk factors.

Because this is a cross-sectional study, it cannot determine that higher caffeine intake causes higher levels of cholesterol or that changes in caffeine intake would change cholesterol level or CHD risk. Clinical trials are necessary to determine whether reductions in caffeine intake or coffee consumption will reduce cholesterol levels and decrease CHD risk. Some trials have been conducted, but as with the cross-sectional studies the results thus far are mixed (4, 6). We hope that the results of the present

investigation might encourage the further investigation of individual differences such as hostility in future cross-sectional studies and clinical studies of the effects of coffee drinking. Exploration of individual differences may help to clarify the effects of caffeine and coffee drinking on CHD and health in general. Such investigations may help to identify those individuals who will benefit from reductions in their coffee drinking and those who will not.

This research was supported by the following grants: National Institute on Drug Abuse, R01 DA 06857; National Heart, Lung, and Blood Institute, P01 36587; National Institute of Mental Health, K05 MH 70482; and by the John D. and Catherine T. MacArthur Foundation Research Network on Determinants and Consequences of Health Promoting and Health Damaging Behaviors.

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