The Combined Effect of Smoking and Coffee Drinking on LDL and HDL Cholesterol

SIEGFRIED HEYDEN, M.D., PH.D., GERARDO HEISS, M.D., PH.D., CHRISTIAN MANEGOLD, M.D., HERMAN A. TYROLER, M.D., CURTIS G. HAMES, M.D., ALAN G. BARTEL, M.D., and GERALD COOPER, M.D.

SUMMARY Conflicting reports on the effect of smoking and coffee drinking on lipoproteins prompted us to study the combined effect of these two associated, widely prevalent habits in 361 persons randomly sampled from the Evans County cohort. Low-density lipoprotein (LDL) cholesterol levels were significantly higher among persons who smoked cigarettes and consumed five or more cups of coffee per day than among non-smokers who abstained from coffee. Conversely, high-density lipoprotein (HDL) cholesterol was higher in persons who did not smoke or drink coffee than in coffee-consuming smokers. However, this trend was not statistically significant. Triglycerides and very low-density lipoprotein (VLDL) cholesterol were highest among smokers who drank five or more cups of coffee per day, but these differences did not reach statistical significance. Lipoprotein cholesterol levels were adjusted for age, sex and body mass. Smoking and coffee drinking interact in affecting LDL and total cholesterol, but coffee drinking alone did not appear to affect blood lipids.

MANY EPIDEMIOLOGICAL STUDIES have been concerned with the effects of caffeine and nicotine use on risk factors for ischemic heart disease (IHD).

Some investigators, including Bellet et al.,1, 2 and Little et al.,3 have suggested that caffeine affects lipid metabolism. The Framingham Study4 showed no associations between coffee consumption and total cholesterol concentration, based on a stratification of eight coffee-consuming groups. Cholesterol levels did not vary with increasing daily consumption of coffee or cigarettes. Sacks et al.5 reported higher levels of total cholesterol and low-density lipoprotein (LDL) among coffee-drinking vegetarians than in vegetarians who did not drink coffee. The authors stated: "Specifically, these increased levels of low-density lipoprotein and total cholesterol could not be accounted for by the declared addition of milk or cream to the coffee." In 1976, Nichols, from the Tecumseh Study,6 concluded: "Correlation coefficients between frequency of coffee consumption and serum cholesterol levels for men and women were positive at a low level, and were statistically significant for women," but not for men. To our knowledge, the first systematic analysis of lipoproteins among coffee drinkers and abstainers was made in the Honolulu Heart Study.7 LDL levels among coffee-consuming Japanese men living in Hawaii were higher compared with those who did not drink coffee. The difference was slight, but statistically significant.

Drinking a cup of strong coffee temporarily increases free fatty acids and triglycerides in the serum, which is related to catecholamine release, as recently shown experimentally in nine young noncoffee-drinking volunteers.8 Smoking a cigarette produces the same metabolic effects. Cigarette smoking was reported to be associated with increased total cholesterol levels in the Oslo Study,9 and with increased LDL and decreased high-density lipoprotein (HDL) levels among 10,000 men in Israel.10 Neither of these two studies examined the combined effect of both cigarette smoking and coffee drinking on cholesterol metabolism.

Methods

We examined the association of cigarette smoking and coffee drinking with serum lipid and lipoprotein levels in two surveys of the Evans County population sample 5 years apart.

The 1971-72 examination of the Evans County cohort was conducted as a collaborative, lipoprotein-phenotyping study of a random sample of a presumably healthy, biracial population (n = 361). The lipid and lipoprotein determinations were performed at the Center for Disease Control (CDC) in Atlanta, Georgia. In 1977, lipids and lipoproteins were measured, again by CDC, in 320 survivors of the
original population sample who still lived in Evans County.

Most studies have classified coffee drinkers using a cutoff point of five or six cups per day to examine high vs low or no coffee consumption. We used coffee consumption ascertained during the first survey of the Evans County cohort in the study reported here, with a cutoff point of five cups per day to ensure comparability. Smoking habits were recorded as daily cigarette consumption, and subjects were classified as either current smokers or nonsmokers. The pertinent sections of the original questionnaire were re-administered during the 1977 examination.

A noticeable reduction in both smoking and coffee consumption had taken place over the 5 years between the two surveys, perhaps the result of the aging of the cohort, as well as the sharp increase in coffee prices. Because of the general decrease in both cigarette and coffee consumption, we restricted the examination of the 1977 data to comparisons between smokers and nonsmokers, and drinkers of one or more cups of coffee per day vs abstainers from coffee.

The well-known associations between lipids and lipoproteins, and age, sex and body mass were confirmed by these data. Smoking and coffee drinking habits were also differentially distributed by these covariates. Consequently, we adjusted all results for sex, age and Quetelet's index (W/H²) of body mass by analysis of covariance after examination of the underlying statistical assumptions. Tests of statistical significance are based on the pertinent F ratios.

Results

The following findings are from the survey conducted in 1972. Figure 1 shows comparisons of LDL cholesterol levels by cigarette smoking and coffee drinking habits. Among nonsmokers, those who drank less than five cups of coffee and those who drank more than that amount had similar adjusted LDL levels, 132 and 134 mg/dl, respectively. However, there were differences among smokers: In smokers who drank less than five cups of coffee per day, the mean LDL level was 127 mg/dl (n = 104), as opposed to 149 mg/dl in those who drank more than five cups of coffee per day (n = 21). The difference was statistically significant (p < 0.01). Among consumers of less than five cups of coffee per day, LDL levels were similar among smokers and nonsmokers (132 vs 127 mg/dl). In contrast, among consumers of five or more cups of coffee per day, smoking was associated with higher LDL cholesterol (149 mg/dl) when compared with nonsmokers (134 mg/dl). The statistical significance for interactive effects between smoking and coffee consumption was p = 0.02.

Similar comparisons of levels of HDL cholesterol are shown in figure 2. Among nonsmokers, adjusted HDL levels varied from 57–64 mg/dl between the two categories of coffee consumption. These differences were not statistically significant. Among the 104 smokers who drank less than five cups of coffee per day, the adjusted mean HDL level was 56 mg/dl. The mean HDL concentration was lower (47 mg/dl) among the 21 smokers who consumed five or more cups of coffee per day. The difference between the smokers who drank five or more cups of coffee per day and those who drank less than that amount was of borderline statistical significance (p = 0.06). Despite the fact that the association of both habits, i.e., drinking five or more cups of coffee per day and smoking cigarettes was accompanied by the lowest adjusted HDL cholesterol levels, the statistical test for interaction was not significant.

These findings prompted us to reexamine the surviving study population and test our results by replication. We restricted the 1977 analysis to whites (n = 166). Most Evans County blacks smoked less than 10 cigarettes per day, and only a minority of blacks drank coffee at all, which precluded a powerful test of possible effects.

**Figure 1.** Evans County population random sample. Mean low-density lipoprotein (LDL) by smoking and coffee drinking. LDL concentrations are mg/dl.

**Figure 2.** Evans County population random sample. Mean high-density lipoprotein (HDL) by smoking and coffee drinking. HDL concentrations are mg/dl.
The bivariate analysis of coffee consumption and smoking habits in 1977 again showed the highest adjusted mean LDL levels (158 mg/dl) in coffee drinkers who smoked (fig. 3; table 1). We restricted the 1977 data to comparison between drinkers of one or more cups of coffee per day and abstainers. Nonsmokers who drank any amount of coffee showed the same LDL concentrations as smokers who abstained from coffee drinking (135 and 136 mg/dl, respectively). The lowest LDL was encountered among nonsmokers who did not drink coffee: 130 mg/dl. The combined effect of coffee consumption and smoking is expressed by a statistically significant interaction effect ($p = 0.003$).

The association of total cholesterol levels with smoking and coffee drinking was the same as that just described for LDL cholesterol (fig. 4). Mean HDL cholesterol concentration varied only slightly, from 48 to 54 mg/dl among the four smoking and coffee consumption subgroups. These differences were not statistically significant, nor was there any significant interaction effect (fig. 5). Triglycerides were subject to the same synergistic effect of coffee drinking and cigarette smoking. However, because of the large variability of triglyceride levels, the results were not statistically significant (fig. 6). Likewise, very low-density lipoprotein was also highest among persons who both drank coffee and smoked, but again, the variance of this lipoprotein fraction reduced the significance of the finding (fig. 7).

**Discussion**

In the 1972 examination, each demographic subgroup — blacks and whites, males and females — showed the same trend, i.e., higher LDL and lower HDL levels among cigarette smokers. The relationship between the lipoproteins and cigarette smoking was maximal in persons who drank five or more cups of coffee per day, with lower LDL and higher HDL concentrations in nonsmokers than in smokers. Among drinkers of little or no coffee, there was no statistically significant relationship between cigarette smoking and any of the lipid parameters mentioned. Neither cigarette smoking nor high coffee usage per se were associated with high LDL or low HDL cholesterol levels. Conversely, there were lipid and lipoprotein differences among Evans County residents who both smoked and consumed five or more cups of coffee per day. We therefore concluded that there might be an interactive effect of smoking and coffee consumption on lipids and lipoproteins. On replication of the lipoprotein findings of 1972, an interactive effect of smoking and coffee drinking on HDL levels was not present in the 1977 observations. (In 1972, we found a marginal level of significance.) However, there was evidence of an interactive effect between smoking and coffee drinking on LDL cholesterol levels among whites in 1977. The discrepancy between the results obtained in 1972 and those obtained in 1977 may be explained by the fact that both coffee consumption and the frequency of heavy smoking were sharply reduced in 1977. Consequently, the 1977 analysis was limited to moderate coffee usage, i.e.,

**Table 1. Distribution of Smokers and Nonsmokers According to Coffee Drinking Among 166 Whites in Evans County, Georgia**

<table>
<thead>
<tr>
<th></th>
<th>Non-coffee drinkers</th>
<th>Coffee drinkers</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonsmokers</td>
<td>60</td>
<td>31</td>
<td>91</td>
</tr>
<tr>
<td>Smokers</td>
<td>61</td>
<td>14</td>
<td>75</td>
</tr>
</tbody>
</table>

**Figure 5. Mean high-density lipoprotein cholesterol (mg/dl), adjusted for age, sex and body mass. Evans County whites (n = 166).**
with most study participants drinking one to five cups of coffee per day and with non- and ex-smokers contrasted with moderate smokers. As a corollary, even moderate coffee consumption combined with the smoking habit is associated with an elevation of LDL and total cholesterol levels in the white population of Evans County. Coffee drinking in the absence of smoking was not found to be associated with statistically significant differences in lipid or lipoprotein levels.

These findings derived from a community-based study offer insight into the potentially hazardous effects of two widely prevalent habits. The high degree to which cigarette smoking and coffee drinking are associated in the general population indicates that the interactive effect of coffee drinking and smoking in the elevation of total cholesterol and LDL found in Evans County deserves replication. These analyses were performed on survivors of the Evans County Heart Research cohort, under surveillance since 1960. If the results presented here are corroborated by other investigators, persons who both smoke cigarettes and drink coffee are at risk for the elevation of an atherogenic component of blood lipids. The observed and statistically tested interactive effect suggests synergism between coffee consumption and cigarette smoking on serum lipids. Neither the pharmacologically active agents in cigarette smoke or coffee, nor their physiologic mechanism, can be elucidated from these epidemiological observations. Metabolic studies now appear to be indicated.

References

The combined effect of smoking and coffee drinking on LDL and HDL cholesterol.
S Heyden, G Heiss, C Manegold, H A Tyroler, C G Hames, A G Bartel and G Cooper

_Circulation._ 1979;60:22-25
doi: 10.1161/01.CIR.60.1.22

_Circulation_ is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 1979 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/60/1/22