Alcoholic beverage preference, diet, and health habits in the UNC Alumni Heart Study[1–3]

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ABSTRACT

Background: Moderate alcohol intake is related to better health, and additional benefits may be associated with wine. However, beverage preference may be confounded by lifestyle factors related to health.

Objective: The goal was to describe the associations between alcoholic-beverage preferences and indicators of a healthy diet and other health habits.

Design: This cross-sectional study included data from 2864 men and 1571 women enrolled in the UNC Alumni Heart Study. Self-reports of drinking habits were used as predictors of health behaviors and of intakes of nutrients and food groups.

Results: Subjects who preferred wine had healthier diets than did those who preferred beer or spirits or had no preference. Wine drinkers reported eating more servings of fruit and vegetables and fewer servings of red or fried meats. The diets of wine drinkers contained less cholesterol, saturated fat, and alcohol and more fiber. Wine drinkers were less likely to smoke. Compared with all drinkers, those who drank no alcohol consumed fewer vegetables but more fiber. Nondrinkers were less likely to exercise regularly and had a higher mean body mass index. Controlling for income and education had little effect on these associations.

Conclusions: The apparent health benefits of wine compared with other alcoholic beverages, as described by others, may be a result of confounding by dietary habits and other lifestyle factors. Confounding by lifestyle variables could also be a factor in the previously observed health differences between drinkers and nondrinkers, although the evidence for this association is not as strong. *Am J Clin Nutr* 2002;76:466–72.

KEY WORDS Wine, beer, spirits, alcohol, liquor, smoking, exercise, body mass index, lifestyle, diet, dietary habits, nutrition, UNC Alumni Heart Study

INTRODUCTION

The J-shaped relation between alcohol consumption and mortality is well established (1). It has been suggested that the association between alcohol intake and mortality may be modified by the type of alcoholic beverage consumed, but the evidence supporting this proposition is controversial (2). The most prominent hypothesis is that wine conveys health benefits that other alcoholic beverages do not. Several studies found that wine drinkers have lower overall mortality rates and lower rates of heart disease, cancer, and other health problems (3–7). Biological mechanisms that might explain these findings have been identified (8–11). However, a review article concluded that the literature does not provide adequate support for the wine hypothesis (2).

The interpretation of this literature is complicated by a number of factors, the foremost being the associations between beverage preference and a variety of lifestyle characteristics that could also influence health. Socioeconomic status (SES) is most often mentioned as a potential confounder. Education and income have been included as covariates in most studies, but it is not clear that these controls have been adequate, especially in light of the wide range of SES in those samples. Aside from SES, a number of other lifestyle factors could be associated with beverage preference and could account in part for the apparent beneficial effects of wine. For example, it has been noted that people who differ regarding beverage preferences also differ on health habits, drinking patterns, smoking, intellectual performance, and personality characteristics (12–15). Diet is another health-related domain that is a potential correlate of beverage preference. In a Danish study, it was observed that wine drinkers had healthier diets than those who preferred beer or spirits, a difference that remained after controlling for education, smoking, and body mass index (BMI; in kg/m^2) (16). However, other studies generally have not investigated this potential association between diet and alcoholic-beverage preference in detail.

The same line of reasoning could be applied to the comparison between persons who drink alcohol and those who do not. Nondrinkers have higher morbidity and mortality than moderate drinkers (1), a finding often attributed to the positive effects of alcohol consumption on HDL cholesterol concentrations (17). The association between drinking status (drinker or nondrinker) and

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health could also be confounded by lifestyle factors. This has been the subject of relatively few studies, although studies have often controlled for health factors such as smoking, exercise, BMI, and aspects of diet (eg, 18–21).

The present investigation examined the associations of drinking status and alcoholic-beverage preference with diet, measured in terms of consumption of specific foods and nutrients that are indicative of a healthy diet. We also examined the associations of drinking status and alcoholic-beverage preference with non-dietary indicators of a healthy lifestyle. The sample differs from that of the previous Danish study (16) in 2 important respects. It is from the United States, where there has been little investigation of this issue in large samples. It is also composed of highly educated individuals who are relatively similar to each other with respect to SES compared with samples in many previous studies. This homogeneity should reduce the problems of confounding by SES that occur in most studies of alcohol and health.

TABLE 1
Food-group indexes

Food-group index	Component foods
Fruit	Oranges or tangerines, apples or pears, applesauce, bananas, cantaloupe, watermelon, grapes, peaches or nectarines, strawberries, grapefruit, mixed fruit salad, prunes, raisins, and fruit juice
Red or fried meats	Hamburgers, cheeseburgers, meat sandwiches (with or without cheese), fried fish, hot dogs, corn dogs or kosher franks, bacon, beef or pork sausage, main dish (beef, pork, or lamb), and fried chicken
Vegetables	Raw tomatoes, broccoli, carrots, cauliflower, cabbage or coleslaw, corn, green beans, kale or other greens, spinach (raw or cooked), sweet potatoes, yams, pumpkin, acorn or butternut squash, summer squash, vegetable combination, lettuce or lettuce salad, beans or lentils, refried beans, sweet red peppers, sweet green or yellow peppers, and green hot chili peppers

SUBJECTS AND METHODS

Sample

The UNC Alumni Heart Study (UNCAHS) is a longitudinal study of cardiovascular disease risk factors, with special emphasis on psychosocial variables. The sample is composed of individuals who were students at the University of North Carolina in the years 1964–1966 and their spouses. The sample is overwhelmingly European American (99%) and highly educated (*see* Results).

The primary data used in the present investigation were obtained from the sixth wave of data collection; this questionnaire was mailed to 6111 persons in 1994. The questionnaire contained a health update, items about general well being, and a 153-item food-frequency questionnaire (FFQ). It was returned by 4662 participants (76.3% of potential participants), and a total of 1571 women and 2864 men provided usable data on beverage intake and food consumption. The procedures were approved by the Duke University Medical Center Institutional Review Board. The participants gave their written, informed consent when they enrolled in the UNCAHS.

Beverage preference

As part of the FFQ, participants were asked to indicate the number of servings of beer, red wine, other wine, and liquor or mixed drinks that they had consumed in the past month. On the basis of their responses, participants were divided into 5 categories: nondrinkers, drinkers who preferred wine, beer, or spirits, and drinkers with no preference. Those classified as preferring beer, wine, or spirits reported that >50% of their alcohol intake was from that particular beverage. Those who did not obtain 50% of their alcohol consumption from one type of beverage were classified as having no preference. Nondrinkers reported no consumption of alcoholic beverages.

Food-group indexes

We used the strategy of Tjønneland et al (16) to select 3 groups of foods that are commonly thought to indicate how healthy the diet is. The 3 food groups we chose were fruit, vegetables, and red or fried meats. The index for each food group was the total number of daily servings of the component foods, as reported by the participant. The component foods of each food-group index are listed in **Table 1**.

Nutrient intakes

The participants' responses on the FFQ were used to estimate their intakes of saturated fat, cholesterol, and fiber. These were used as indicators of how healthy the diet is. We also analyzed the amount of alcohol in the diet from all sources, including foods. Foods reported on the FFQ were coded for nutrient content by using the FOOD INTAKE ANALYSIS SYSTEM (22), which uses the US Department of Agriculture Survey Nutrient Database (23). Each food on the FFQ was assigned a weighted average of the nutrient amounts in similar foods. For example, the nutrient values for corn were obtained by averaging across several types of common corn preparations. Portion sizes (including those for beverage consumption) were estimated from food diaries kept by 259 UNCAHS participants in a pilot test and from standard servings recorded in the FOOD INTAKE ANALYSIS SYSTEM. A more detailed description of these calculations was published previously (24).

Health-behavior indicators

We measured 4 health-behavior indicators: dietary supplement use, smoking, exercise, and BMI. Dietary supplement use was a dichotomous variable reflecting the participant's response to a question asking whether he or she was currently taking vitamins, minerals, fish oil, antacids, or fiber to supplement the diet. Smoking was coded as a dichotomous variable reflecting the participant's report that he or she did or did not currently smoke cigarettes. The exercise measure was obtained from the fifth wave of UNCAHS data collection, which occurred in 1993, 1 y before administration of the FFQ. Exercise was categorized into 3 levels: no activity or irregular participation in light activity, regular (at least weekly) participation in light activity such as walking or bowling, and regular participation in aerobic activity. BMI was calculated as self-reported weight (in kg) divided by height^2 (in m).

Socioeconomic status

Education was measured as an ordinal variable with 6 possible values: high school or less (n = 39), some college or technical training ($n = 434$), college degree ($n = 818$), some postgraduate work ($n = 1129$), master's degree ($n = 1065$), and doctoral or professional degree ($n = 910$).

Income was not ascertained at the time the FFQ was administered, but was obtained from responses to the questionnaire administered at the third wave in 1990. Participant income was analyzed as 11 ordinal categories. The categories started with < \$10 000 and increased in \$10 000 increments up to \$70 000. Higher incomes were divided into 4 categories: \$70 000 to \$99 999, \$100 000 to \$149 999, \$150 000 to \$299 999, and ≥ \$300 000.

The third SES measure, occupational prestige, was derived from a census-based classification system that was constructed on the basis of rankings initially computed for the 1980 labor force (25, 26). Scores can range from 14 to 91, with higher scores indicating greater occupational prestige. Occupations were coded from responses to questionnaires at both the first wave (1987) and the third wave (1990).

Heterogeneity of nondrinkers

It has been suggested that comparisons between persons who consume alcohol and those who do not can be contaminated by the presence of former drinkers in the nondrinker category. Former drinkers tend to have more illnesses and poorer health habits than persons who never drank alcohol, inflating the estimates of health problems among nondrinkers (27, 28). The potential effect of this phenomenon was evaluated in the present study by comparing categories of nondrinkers on the basis of drinking history. Information on past drinking habits was available for 805 of those participants classified as nondrinkers. In 1990, 4 y before the collection of dietary data, 234 nondrinkers said they had never been drinkers, 243 said that they used to drink but quit, and 328 said that they were consuming alcohol at that time. Those in the last category may have quit drinking in the interim or may be occasional drinkers who did not consume any alcohol during the period covered by the FFQ.

Statistical analysis

For analyses of food-group indexes and nutrients that involved similar continuous variables, multivariate analysis of variance was used. We tested for main effects of sex and beverage preference and the sex × beverage-preference interaction. If the multivariate test was significant and the interaction with sex was not, multiple regression models of each variable were examined for main effects of sex and beverage preference. In addition to the tests for an overall effect of drinking choice (4 df), 2 planned contrasts of theoretical interest were evaluated in each model. The first compared the nondrinkers with all alcohol drinkers. The second compared those who preferred wine with all other drinkers. These analyses were then repeated, controlling for those SES indicators that were potential confounders. Health-habit indicators were examined individually with multiple regression analyses for continuous variables and logistic regression analyses for dichotomous or ordinal variables. Statistical analyses were performed with SAS, version 6.12 (SAS Institute Inc, Cary, NC).

RESULTS

Demographic characteristics

The demographic characteristics of the participants by beverage-preference category are shown in **Table 2**. The data show that participants who preferred wine were more likely to be women, a finding consistent with several other studies (12, 13, 15, 16). Men who drank alcohol tended to prefer beer.

The average household income of the sample was quite high, as would be expected given the origin of the sample. Nearly 90% of participants had incomes that exceeded the national median family income for 1993, which was \$31 241 (29), and 12% reported annual incomes > \$150 000. An ordinal logistic model showed that there were no sex differences in household income, but there were substantial differences across beverage-preference categories ($P < 0.0001$). Incomes of nondrinkers were considerably lower than incomes of drinkers ($P < 0.0001$). The differences among categories of drinkers were not as striking, but those who preferred wine had significantly higher incomes than those in the other 3 beverage-preference categories ($P < 0.0001$).

Not surprisingly, the educational achievements of the participants were also quite high compared with samples of the general population. Only 11% had not attained a college degree and 71% had some further education beyond college. In an ordinal logistic model, there were educational differences associated with both sex ($P < 0.001$) and beverage preference ($P < 0.001$). The trends can be seen in the percentages of those who attained advanced

TABLE 2
Sample characteristics

Characteristic	Nondrinkers	Drinkers			
		Prefer spirits	Prefer beer	No preference	Prefer wine
Sample size (*n* [%])					
Women	368 [23]	193 [12]	227 [14]	65 [4]	718 [46]
Men	492 [17]	415 [14]	1035 [36]	259 [9]	663 [23]
Household income ≥\$70 K (%)					
Women	39.9	44.9	59.6	63.3	63.7
Men	36.5	56.1	51.4	67.1	60.6
Advanced degree (%)[1]					
Women	29.9	31.1	39.4	32.8	37.3
Men	43.8	47.1	48.2	55.8	59.1
Mean occupational prestige score[2]					
Women	56.1	56.7	57.5	57.6	58.4
Men	61.6	60.8	61.9	60.8	63.1

[1] A degree attained after a college degree.
[2] Derived from a census-based classification system in which scores range from 14 to 91 (higher scores indicate greater prestige).

TABLE 3
Reported servings from food-group indexes by sex and beverage preference[1]

Food-group indexes	Nondrinkers	Drinkers: Prefer beer	Drinkers: Prefer spirits	Drinkers: No preference	Drinkers: Prefer wine	Sex main effect (df = 1, 4429)	Beverage-preference main effect (df = 4, 4429)	Nondrinkers vs drinkers	Wine drinkers vs other drinkers
	servings/d	*servings/d*							
Fruit									
Women	2.61 ± 1.8[2]	2.36 ± 1.7	2.37 ± 2.7	2.37 ± 1.7	2.64 ± 1.8	$P < 0.0001$	$P < 0.0001$	NS	$P < 0.0001$
Men	2.28 ± 2.1	2.16 ± 1.5	1.89 ± 1.4	2.40 ± 1.9	2.58 ± 2.0				
Vegetables									
Women	3.02 ± 1.6	3.13 ± 1.6	2.92 ± 1.6	3.37 ± 1.5	3.49 ± 1.7	$P < 0.0001$	$P < 0.0001$	$P < 0.0001$	$P < 0.0001$
Men	2.77 ± 1.6	2.92 ± 1.5	2.78 ± 1.4	3.21 ± 1.7	3.22 ± 1.7				
Red or fried meats									
Women	0.64 ± 0.5	0.64 ± 0.4	0.74 ± 0.5	0.63 ± 0.4	0.59 ± 0.4	$P < 0.0001$	$P < 0.0001$	NS	$P < 0.0001$
Men	0.92 ± 0.7	0.94 ± 0.7	1.00 ± 0.7	0.94 ± 0.6	0.76 ± 0.6				

[1] There were no significant sex × beverage-preference interactions.
[2] $\bar{x}$ ± SD.

degrees (a degree obtained after a college degree). Educational attainment was lowest among nondrinkers ($P = 0.001$). Among drinkers, those who preferred wine and those with no preference were especially likely to have received advanced degrees. Wine drinkers had higher attainment across all educational categories than did other drinkers ($P < 0.0001$).

The occupational prestige measure showed a difference by sex ($P < 0.0001$) but showed smaller differences across beverage-preference categories than did the other SES measures. Although there was a tendency for those who preferred wine to have higher occupational prestige scores, the overall test of differences between beverage-preference categories was not significant ($P = 0.13$). Because of this result and the relatively large number of missing scores (817), the occupational prestige variable was not used in subsequent models as a control for SES.

Food-group indexes

The multivariate analysis of food-group indexes yielded highly significant main effects of sex and beverage preference ($P < 0.0001$), but the interaction of sex and beverage preference was not significant (**Table 3**). For all 3 food-group indexes, women reported healthier dietary habits. The overall beverage-preference effect was also significant for all 3 food-group indexes. Nondrinkers and drinkers reported significantly different intakes on only one of the food-group indexes, vegetables, with lower intakes by nondrinkers. There were significant differences between wine drinkers and other drinkers in intakes from all 3 food-group indexes.

Nutrient intakes

A multivariate analysis of variance with saturated fat, cholesterol, and fiber intakes as the dependent variables showed that the overall effects of sex and beverage-preference category on nutrient intake were significant ($P < 0.0001$; **Table 4**). The sex × beverage-preference interaction was not significant. Women reported healthier diets than did men as reflected by intakes of all 3 nutrients. There were also significant differences by beverage preference for intakes of all 3 nutrients. The data for total alcohol intake are also reported in Table 4.

Differences between drinkers and nondrinkers were observed for saturated fat and fiber intakes, although the comparison on the

TABLE 4
Reported nutrient intakes by sex and beverage preference[1]

Nutrient intakes	Nondrinkers	Drinkers: Prefer beer	Drinkers: Prefer spirits	Drinkers: No preference	Drinkers: Prefer wine	Sex main effect (df = 1, 4429)	Beverage-preference main effect (df = 4, 4429)	Nondrinkers vs drinkers	Wine drinkers vs other drinkers
Saturated fat (% of energy intake)									
Women	10.6 ± 2.5[2]	10.9 ± 2.4	10.8 ± 2.0	10.4 ± 2.0	10.3 ± 2.0	$P = 0.0002$	$P = 0.0005$	$P = 0.05$	$P = 0.001$
Men	11.1 ± 2.4	10.8 ± 2.1	11.0 ± 2.4	10.8 ± 2.1	10.7 ± 2.3				
Fiber (g/1000 mJ)									
Women	2.6 ± 0.7	2.4 ± 0.5	2.3 ± 0.5	2.4 ± 0.5	2.6 ± 0.6	$P < 0.0001$	$P < 0.0001$	$P < 0.0001$	$P < 0.0001$
Men	2.4 ± 0.6	2.3 ± 0.5	2.1 ± 0.5	2.3 ± 0.5	2.5 ± 0.6				
Cholesterol (mg/1000 mJ)									
Women	24.2 ± 8.8	23.4 ± 6.7	24.7 ± 7.7	23.6 ± 6.2	23.3 ± 7.1	$P < 0.005$	$P < 0.0005$	NS	$P < 0.002$
Men	24.7 ± 7.6	24.1 ± 6.8	25.2 ± 7.3	25.1 ± 6.3	23.9 ± 6.8				
Alcohol (g)									
Women	0 ± 0	18.6 ± 21.4	18.7 ± 21.2	21.8 ± 24.4	17.5 ± 17.4	$P < 0.0001$	$P < 0.0001$	$P < 0.0001$	$P < 0.0001$
Men	0 ± 0	29.4 ± 34.7	32.8 ± 22.9	28.5 ± 22.9	22.2 ± 19.9				

[1] There were no significant sex × beverage-preference interactions.
[2] $\bar{x}$ ± SD.

TABLE 5
Health behaviors by sex and beverage preference[1]

Behavior	Nondrinkers	Drinkers: Prefer beer	Drinkers: Prefer spirits	Drinkers: No preference	Drinkers: Prefer wine	Sex main effect	Beverage-preference main effect	Nondrinkers vs drinkers	Wine drinkers vs other drinkers
Dietary supplement use (%)									
Women	60.8	64.0	57.9	54.7	59.8	$P < 0.0001$	NS	—	—
Men	52.3	47.2	52.3	51.9	52.3				
Smokers (%)									
Women	7.0	12.8	15.8	8.2	6.6	NS	$P < 0.0001$	NS	$P < 0.0001$
Men	9.8	9.6	22.0	9.8	6.1				
Aerobic exercise (%)[2]									
Women	31.3	39.5	34.9	42.6	43.4	$P < 0.0001$	$P < 0.0001$	$P < 0.0001$	$P < 0.05$
Men	39.8	53.3	47.3	54.1	54.0				
BMI (kg/m^2)									
Women	25.1 ± 5.5[3]	22.9 ± 3.9	23.8 ± 4.4	24.7 ± 5.6	23.6 ± 4.0	$P < 0.0001$	$P < 0.0001$	$P < 0.0001$	NS
Men	26.6 ± 4.6	25.8 ± 3.4	26.2 ± 3.5	26.0 ± 3.6	25.8 ± 3.6				

[1] There were no significant sex × beverage-preference interactions except for BMI ($P = 0.01$).
[2] Regular (at least weekly) participation in aerobic activity.
[3] $\bar{x}$ ± SD.

saturated fat variable would not be significant if it were adjusted for multiple tests. Nondrinkers reported higher fiber intake than did drinkers. Compared with other drinkers, wine drinkers reported significantly higher fiber intake and lower consumption of saturated fat, cholesterol, and alcohol.

Health behaviors

Data on dietary supplement use, smoking, exercise, and BMI are shown in **Table 5**. A higher percentage of women than of men consumed dietary supplements. Women had lower BMI values but fewer women than men engaged in exercise. Smoking rates were low in this sample and did not differ significantly by sex. Only one of the sex × beverage-preference interactions, the interaction for BMI, was significant ($P = 0.01$). This interaction was mainly a result of sex differences in BMI patterns among drinkers, but had little effect on the contrasts of primary interest (nondrinkers versus drinkers and wine drinkers versus other drinkers). The results of the contrasts were unchanged when the data were analyzed separately for men and women.

All health-behavior indicators except for dietary supplement use were associated with beverage preference. For smoking, the effect was primarily a result of lower rates of smoking among wine drinkers than among those who preferred other beverages. The contrast between wine drinkers and other drinkers was not significant for BMI and would not be significant for exercise if adjusted for multiple tests. For these variables, the most significant differences were between drinkers and nondrinkers; fewer nondrinkers engaged in regular exercise, and nondrinkers had higher BMI values.

Effect of controlling for SES

All of the significant comparisons reported above were repeated in models that controlled for education and income. With 2 exceptions, the introduction of these covariates had little influence on the effect sizes. The comparison between wine drinkers and other drinkers on the exercise variable, which was marginally significant in the initial analysis, was no longer significant when controlled for SES. The only other model in which SES controls had a sizable effect was the contrast between drinkers and nondrinkers on the variable representing saturated fat intake. In that case, the effect size was reduced by 49%. All other contrasts remained significant and the mean reduction in effect size was only 10%.

Heterogeneity of nondrinkers

Participants who never drank, who had quit drinking, who reported drinking in 1990 but not in 1994 were compared on all 10 dependent variables (excluding alcohol consumption). Only 4 of the models showed significant effects associated with drinking history. Participants who used to drink but quit reported more servings of vegetables than those in the other categories ($P = 0.01$), and they also consumed more saturated fat than did those who never drank ($P = 0.05$). Participants who never drank had lower rates of smoking and taking dietary supplements than did participants in the other categories ($P < 0.001$ for both). Thus, heterogeneity among nondrinkers may have contributed to the failure to find significant differences between drinkers and nondrinkers for the smoking and dietary supplement variables. Otherwise, there is little evidence that the drinking history of nondrinkers played a substantial role in the main study findings.

DISCUSSION

These analyses of data from a large American cohort have identified several potential confounders that could account for a portion of the beneficial health effects of alcohol, especially wine. Alcohol intake and alcoholic-beverage preference were found to be associated with a variety of dietary indicators and with smoking, exercise, and BMI. The evidence of lifestyle differences was strongest for the comparisons between participants who preferred wine and those who preferred other alcoholic beverages. There was evidence that wine drinkers had potentially healthier diets, as indicated by all except one of the dietary measures. In addition, they were less likely to smoke than participants who preferred other beverages. These findings confirm previous observations, but also extend them in several ways.

One of the potential explanations for the better health of wine drinkers has been confounding with SES, even though previous studies often included statistical controls for income, education, or both.

The data from the present study further weaken that explanation, at least in its most basic form. Large differences in dietary practices and health behavior were observed, even though the sample was relatively homogeneous with regard to SES compared with previous studies. Certainly it would be difficult to argue that these behaviors differed across groups because of superior knowledge or resources among those who preferred wine. Even within the restricted range of SES in the sample, there was evidence suggesting confounding with beverage preference, but the addition of SES controls in the form of covariates did little to alter the associations. Clearly, we must look to concepts other than SES that encompass a broader range of lifestyle differences to explain the findings of the present study. SES differences may still have played an additional role in other studies.

The associations of beverage preference with a broad range of dietary and health practices would lead one to expect that moderate wine consumption may be associated with a variety of health outcomes. Much of the attention paid to the health effects of alcohol has focused on coronary heart disease and the beneficial role of elevated HDL concentrations (17). Our data suggest that persons who consume wine have health habits that could influence other health outcomes as well. For example, those who preferred wine consumed more fruit and vegetables, had higher fiber intakes, and had a lower prevalence of smoking. These behaviors might translate into lower incidence of cancer. Indeed, studies have shown that wine drinkers have lower rates of a variety of health problems, including cancers, stroke, hip fracture, and all-cause mortality (3–7). The observed associations of wine preference with dietary and health habits illustrate potential pathways that might make a plausible connection between wine drinking and a broad range of health benefits.

This study also examined lifestyle differences between those who consume alcohol and those who abstain. Previous studies have examined the potential confounding of lifestyle factors with wine drinking, but less emphasis has been placed on confounding as an alternative explanation for the health differences between those who drink alcohol and those who do not. Our findings showed that nondrinkers reported lower vegetable intakes, higher fat consumption, higher BMI values, and less exercise than did drinkers. However, the associations of lifestyle differences with alcohol consumption were not as pervasive across measures as those observed between wine drinkers and other drinkers. For one measure, fiber consumption, nondrinkers consumed a healthier average amount than did drinkers. Thus, those who abstain from alcohol may have other habits that could partially explain their relatively higher rates of morbidity and mortality, but the evidence of confounding is not as strong as it is for the associations between preference for wine and lifestyle.

Another way in which this study extends previous research is that the sample differs considerably from those in previous studies. Interpretation of the epidemiologic literature on alcohol and health is complicated by the significant differences in beverage-preference patterns across cultures and across time within a particular culture. For example, wine drinkers are in the minority in a country such as the Czech Republic (30), but they are the majority in a country such as Italy (31). Likewise, wine drinking is much more popular in Denmark today than it was 25 y ago (15). Such differences in beverage popularity influence the demographic makeup of the various beverage-preference groups and potentially affect the generality of findings across studies conducted in different countries and time periods. One way to address these issues and evaluate the robustness of the phenomena is to examine the characteristics of beverage-preference groups in diverse samples. The most informative samples should be those that are relatively homogeneous demographically but heterogeneous with regard to beverage preference so that adequate comparisons can be made between beverage-preference categories. The UNCAHS participants were relatively homogeneous with regard to education and income and varied substantially in beverage preference. They were primarily from the southeastern United States and most were born in the mid-1940s. These sample characteristics are advantageous for clearly showing the correlates of beverage preference and for extending the observations in the literature to this culture and cohort. However, they also limit the generality of the findings.

One limitation of the present study is its reliance on self-reports. A tendency for participants to describe their lifestyles as healthier than they actually were may have affected the results. Although this may have introduced some error, it is unlikely to account for the main findings unless this bias was substantial and was differentially distributed among those with various beverage preferences. In addition, measures of alcohol intake derived from questionnaires such as the one used in this study were found to agree closely with estimates derived from extensive interview procedures (32).

These data further highlight the myriad of lifestyle and cultural factors associated with beverage preference that could help explain the relation between alcohol intake and mortality and the previously reported additional benefits of wine. It would be very difficult to conduct appropriate randomized trials that would eliminate this confounding, so researchers must continue to consider lifestyle factors when interpreting the literature.

REFERENCES

1. Fagrell B, DeFaire U, Bondy S, et al. The effects of light to moderate drinking on cardiovascular diseases. J Intern Med 1999;246:331–40.
2. Rimm EB, Klatsky A, Grobbee D, Stampfer MJ. Review of moderate alcohol consumption and reduced risk of coronary heart disease: is the effect due to beer, wine, or spirits? BMJ 1996;312:731–6.
3. Grønbæk M, Becker U, Johansen D, et al. Type of alcohol consumed and mortality from all causes, coronary heart disease, and cancer. Ann Intern Med 2000;133:411–9.
4. Prescott E, Grønbæk M, Becker U, Sørensen TIA. Alcohol intake and the risk of lung cancer: influence of type of alcoholic beverage. Am J Epidemiol 1999;149:463–70.
5. Truelsen T, Grønbæk M, Schnohr P, Boysen G. Intake of beer, wine, and spirits and risk of stroke. Stroke 1998;29:2467–72.
6. Høidrup S, Grønbæk M, Lauritzen JB, Schroll M. Alcohol intake, beverage preference, and risk of hip fracture in men and women. Am J Epidemiol 1999;149:993–1001.
7. Grønbæk M, Deis A, Sørensen TI, Becker U, Schnohr P, Jensen G. Mortality associated with moderate intake of wine, beer, or spirits. BMJ 1995;310:1165–9.
8. Fitzpatrick DF, Hirschfield SL, Coffey RG. Endothelium-dependent vasorelaxing activity of wine and other grape products. Am J Physiol 1993;265:H774–8.
9. Maxwell S, Cruickshank A, Thorpe G. Red wine and antioxidant activity in serum. Lancet 1994;344:193–4.
10. Hertog MG, Feskens EJ, Hollman PC, Katan MB, Kromhout D. Dietary antioxidant flavonoids and risk of coronary heart disease: the Zutphen Elderly Study. Lancet 1993;342:1007–11.
11. Jang M, Cai L, Udeani GO, et al. Cancer chemopreventive therapy activity of reservatrol, a natural product derived from grapes. Science 1997;275:218–20.

12. Klatsky AL, Armstrong MA, Kipp H. Correlates of alcoholic beverage preference: traits of persons who choose wine, liquor, or beer. Br J Addict 1990;85:1279–89.
13. Klein H, Pittman DJ. Drinker prototypes in American society. J Subst Abuse 1990;2:299–316.
14. Grønbæk M, Tjønneland A, Johansen D, Stripp C, Overvad K. Type of alcohol and drinking pattern in 56,970 Danish men and women. Eur J Clin Nutr 2000;54:174–6.
15. Mortensen EL, Jensen HH, Sanders SA, Reinisch JM. Better psychological functioning and higher social status may largely explain the apparent health benefits of wine: a study of wine- and beer-drinking in young Danish adults. Arch Intern Med 2001;161:1844–8.
16. Tjønneland A, Grønbæk M, Stripp C, Overvad K. Wine intake and diet in a random sample of 48,763 Danish men and women. Am J Clin Nutr 1999;69:49–54.
17. Gaziano JM, Hennekens CH, Godfried SL, et al. Type of alcoholic beverage and risk of myocardial infarction. Am J Cardiol 1999;83:52–7.
18. Camergo CA Jr, Hennekens CH, Gaziano JM, Glynn RJ, Manson JE, Stampher MJ. Prospective study of moderate alcohol consumption and mortality in US male physicians. Arch Intern Med 1997;157:79–85.
19. Grønbæk M, Deis A, Sørensen TIA, et al. Influence of sex, age, body mass index, and smoking on alcohol intake and mortality. BMJ 1994; 308:302–6.
20. Solomon CG, Hu FB, Frank B, et al. Moderate alcohol consumption and risk of coronary heart disease among women with type 2 diabetes mellitus. Circulation 2000;102:494–9.
21. Kearney J, Giovannucci E, Rimm EB, et al. Diet, alcohol, and smoking and the occurrence of hyperplastic polyps of the colon and rectum (United States). Cancer Causes Control 1995;6:45–56.
22. The University of Texas. FOOD INTAKE ANALYSIS SYSTEM, version 2.3. Houston: The University of Texas Houston, School of Public Health, 1993.
23. US Department of Agriculture, Human Nutrition Information Service. USDA nutrient database for individual intake surveys, release 7.0. Springfield, VA: National Technical Information Service, 1993.
24. McPherson RS, Feaganes JR, Siegler IC. Measurement of dietary intake in the UNC Alumni Heart Study. Prev Med 2000;31:56–67.
25. Stevens G, Featherman DL. A revised socioeconomic index of occupational status. Soc Sci Res 1981;10:364–95.
26. Stevens G, Cho JH. Socioeconomic indexes and the new 1980 Census Occupational Classification scheme. Soc Sci Res 1985;14: 142–68.
27. Fillmore KM, Golding JM, Graves KL, et al. Alcohol consumption and mortality. I. Characteristics of drinking groups. Addiction 1998; 93:183–203.
28. Shaper AG, Wannamethee G, Walker M. Alcohol and mortality in British men: explaining the U-shaped curve. Lancet 1988;2:1267–73.
29. Statistical Abstract of the United States, The National Data Book. 119th ed. Washington, DC: US Census Bureau, 1999.
30. Bobak M, Skodova Z, Marmot M. Effect of beer drinking on risk of myocardial infarction: population based case-control study. BMJ 2000;320:1378–9.
31. Farchi G, Fidanza F, Giampaoli S, Mariotti S, Menotti A. Alcohol and survival in the Italian rural cohorts of the Seven Countries Study. Int J Epidemiol 2000;29:667–71.
32. Grønbæk M, Heitmann B. Validity of self-reported intakes of wine, beer and spirits in population studies. Eur J Clin Nutr 1996;50: 487–90.