The Prevalence of Coffee Drinking Among Hospitalized and Population-Based Control Groups

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• **Data on coffee-drinking habits obtained from a case-control study conducted in Detroit were used to compare the proportions of coffee drinkers in a hospital and a population control series. The comparison was based on interviews with 262 hospitalized controls and 427 population controls. The overall proportion of coffee drinkers in the total hospital control group was similar to that in the population control group. However, the proportion of moderate-to-heavy coffee drinkers among controls hospitalized for conditions that may have caused them to alter their diet (eg, gastrointestinal disorders and cardiovascular disease) was lower than that among population controls. In contrast, the proportion of moderate-to-heavy coffee drinkers among controls hospitalized for conditions that probably did not cause a change in diet (eg, fractures) was almost identical to that among population controls. These results suggest that, in hospital-based case-control studies of the effects of coffee consumption, it would be prudent to restrict the referent group to those patients hospitalized for conditions that probably did not cause a change in diet. The magnitude of bias resulting from failure to exclude controls hospitalized for diet-altering conditions will depend on two factors that may vary between studies: (1) the distribution of diet-altering conditions among the hospital controls, and (2) the relationship of these diseases to coffee consumption.**

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THE RELATIONSHIP between coffee drinking and pancreatic cancer risk has been examined in four hospital-based case-control studies, yielding conflicting results.[1-4] The positive study conducted by MacMahon and co-workers[2] has been criticized because of the procedure used to select the control group.[5-8] MacMahon et al[2] chose hospitalized controls from patients under the care of the same physicians as the pancreatic cancer cases. As a result, a large proportion of the control group consisted of patients hospitalized for gastrointestinal (GI) disorders.[2,9] Gastrointestinal disorders, as well as several other chronic conditions, may cause individuals to alter their coffee-drinking habits. Since these conditions are more highly prevalent among hospital patients than in the general population, the estimate of the effect of coffee drinking obtained from hospital-based case-control studies in general may be biased.

In the present study, we compared the proportions of coffee drinkers among hospitalized controls in different diagnostic categories and among population controls to determine the extent of this bias and the possible ways to eliminate it. One approach for eliminating such bias from hospital-based studies is to exclude controls hospitalized for conditions known or suspected of being related to the exposure under study.[10-15] We have examined the potential result of such exclusion in hospital-based studies of the effects of coffee drinking.

METHODS

Data included in this analysis were collected in Detroit as part of the National Bladder Cancer Study.[16] Although this report does not pertain to bladder cancer per se, the information on coffee-drinking habits obtained from this case-control study of bladder cancer can be used to address the present methodological issue.

In Detroit, we selected a hospital control series in addition to the population control series selected for the national study. To be eligible for study, a subject had to be between the ages of 21 and 84 years and a resident of metropolitan Detroit, which includes Wayne, Oakland, and Macomb counties. The population control series was drawn from the general population of the tricounty Detroit area in such a way that population controls would be similar to the cases with respect to age and sex. Approximately as many population controls as cases were selected. The procedure followed for the selection of the population controls depended on age. Population controls aged 21 to 64 years were chosen from 2,368 households selected by random-digit dialing.[17] Population controls aged 65 to 84 years were selected by random sampling from the Health Care Financing Administration's lists of the Detroit population older than age 64.

The hospital control series was chosen, irrespective of diagnosis, from discharge lists. Hospital controls were matched to cases for age (within five years), race, sex, hospital, and approximate date of discharge. For each hospital control identified for study, all discharge diagnoses listed on the discharge summary were recorded. In the present analysis, we used only the primary diagnosis, which was taken to be the reason for hospitalization. The reason for hospitalization of all hospital controls was reviewed by a physician, and controls hospitalized for conditions that may have caused them to alter their diet were identified. This review was conducted without knowledge of the subject's coffee-drinking habits.

A total of 538 population controls and 347 hospital controls were interviewed (84% of the total population controls identified and 71% of the total hospital controls identified). Interviews were conducted in person by a trained interviewer. The questionnaire was designed to elicit information on artificial sweetener use, coffee consumption, smoking, occupation, residence, source of drinking water, fluid intake, use of hair dyes, and medical history. All subjects were asked the following questions to obtain detailed information on coffee-drinking habits: whether they had drunk more than 100 cups of coffee in their entire lifetime; the total number of years they drank coffee; and, for each type of coffee consumed, the amount they drank in a typical week in the

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winter one year before the interview. The coffee consumption data included in this analysis were based on responses to this last question. "Coffee consumption" denoted exposure to one or more types of coffee (ie, caffeinated, decaffeinated, instant, or ground).

The primary measures of exposure in this study were the proportion of coffee drinkers and the proportion of moderate-to-heavy drinkers (ie, drinkers of two or more cups of coffee per day). Adjusted proportions of coffee drinkers were computed by the direct method. Initially, proportions were adjusted for age, smoking, and sex. Age was the only factor for which adjustment had an impact on the proportions of coffee drinkers; thus, only age-adjusted proportions were given. Adjustment for smoking had virtually no effect on the proportions of coffee drinkers, since there was little difference in smoking habits between hospital and population control groups. Hospital controls had a slightly lower proportion of nonsmokers and a slightly higher proportion of smokers of more than one pack per day than population controls (35% *v* 40%; 27% *v* 20%, respectively). The proportions of coffee drinkers were also unaffected by adjustment for sex. Significance tests of the difference in proportions of coffee drinkers between control groups were computed using a standard normal deviate.

The present analysis was confined to white subjects because there were too few nonwhite subjects (92 population controls and 37 hospital controls) for satisfactory analysis. In addition, 19 population controls and 48 hospital controls were considered ineligible for analysis because either the subject provided insufficient information to determine an accurate history of coffee consumption or the interview was judged by the interviewer to be unreliable. A total of 427 white population controls and 262 white hospital controls were included in this presentation. Additional details regarding the methods used to conduct this study have been described elsewhere.[18]

RESULTS

Table 1 indicates that the overall proportion of coffee drinkers in the total hospital control group was similar to that in the population control group. For men, 87% of hospital controls drank some type of coffee, compared with 89% of population controls. This finding was also observed when caffeinated, decaffeinated, instant, or ground coffee was considered individually. For women, 88% of hospital controls and 85% of population controls were coffee drinkers. Female hospital and population controls were also similar with regard to proportions of caffeinated coffee drinkers and ground coffee drinkers. This pattern was not consistent, however, for exposure to decaffeinated coffee or instant coffee. For decaffeinated coffee, the proportion of drinkers among female hospital controls was slightly higher than that among female population controls (38% *v* 32%, respectively). For instant coffee, in contrast, the proportion of drinkers among female hospital controls was slightly lower than that among population controls (48% *v* 54%, respectively). The number of female controls was small, however, and neither of these differences was significant ($P>.40$).

We also compared the amount of coffee consumed by all hospital and population controls (Table 2). The quantity consumed by male hospital controls was almost identical to that consumed by male population controls. Female hospital controls, in contrast, drank less coffee than female population controls. Hospital controls had a higher proportion of light drinkers (ie, drinkers of less than two cups per day) and a lower proportion of moderate drinkers (ie, drinkers of two or more cups but less than four cups per day) than population controls ($P=.008$ and $P=.032$, respectively). The proportion of heavy drinkers (ie, drinkers of four or more cups per day) in each of the female control groups was similar. For men and women combined, a slight difference in the proportion of moderate-to-heavy drinkers between the hospital and population control groups was apparent (68% *v* 73%, respectively).

Hospital controls were categorized into two groups according to the reason for hospitalization: (1) those hospitalized for conditions that may have caused them to alter their dietary habits, and (2) those hospitalized for conditions that probably did not cause them to alter their diet. (Diagnoses *incidental* to hospitalization were ignored.) The specific diagnoses included in each of these categories are shown in Table 3. The category of "diet-altering" conditions consisted of digestive disorders and other specified chronic conditions. The category of "non-diet-altering" conditions consisted of acute conditions and other conditions that appeared to be unlikely to affect diet. Twenty-nine controls were not classified because it was unclear if the conditions for which they were hospitalized would have caused a change in diet. For example, although diet modification is not routinely recommended to patients hos-

Table 1.—Number of Controls and Percentage of Controls Who Were Coffee Drinkers, by Sex and Type of Control Group

	Men		Women	
	Total Population Controls	Total Hospital Controls	Total Population Controls	Total Hospital Controls
Total No.	291	199	136	63
Controls who were coffee drinkers, %*	89	87	85	88
Caffeinated coffee drinkers, %	80	78	73	70
Decaffeinated coffee drinkers, %	33	31	32	38
Instant coffee drinkers, %	54	57	54	48
Ground coffee drinkers, %	66	62	58	59

*Adjusted for age. Subjects included in each category may have drunk other types of coffee.

Table 2.—Distribution of Controls by Coffee-Drinking Habits, Sex, and Type of Control Group*

	No. (%)†			
	Men		Women	
Coffee-Drinking Habits (Cups/Day)	Total Population Controls	Total Hospital Controls	Total Population Controls	Total Hospital Controls
0‡	32(11)	25(13)	21(15)	8(13)
1-<2	47(16)	30(16)	19(14)	19(30)
2-<4	106(36)	70(35)	61(45)	18(29)
≥4	106(37)	73(36)	35(26)	18(28)
Total	**291(100)**	**198(100)**	**136(100)**	**63(100)**

*One control who consumed an unknown amount of coffee was excluded.
†Adjusted for age.
‡Included occasional coffee drinkers.

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pitalized for arthritis and rheumatism, chronic disability resulting from these illnesses may cause such patients to alter their diets.

Table 4 compares the proportions of moderate-to-heavy coffee drinkers among population controls and among hospital controls in different diagnostic categories. As noted, the proportion of moderate-to-heavy drinkers in the total hospital control group was slightly lower than that in the population control group. Of all hospital controls, those hospitalized for digestive disorders had the lowest proportion of moderate-to-heavy drinkers. Only 55% of controls hospitalized for digestive disorders drank two or more cups per day, compared with 73% of population controls (P=.025). Controls hospitalized for other chronic conditions that may have caused a change in diet (eg, cardiovascular disease) had a slightly lower proportion of moderate-to-heavy drinkers than population controls. In contrast, the proportion of moderate-to-heavy drinkers among controls hospitalized for conditions that probably did not cause a change in diet (eg, fractures) was almost identical to that among population controls. Overall, 74% of controls hospitalized for non-diet-altering conditions drank two or more cups per day, compared with 73% of population controls. Similar patterns were observed when these comparisons were based on the overall proportion of coffee drinkers, regardless of the amount consumed. Patterns noted for women were also similar to those noted for men, although the number of female hospital controls was small.

Among coffee drinkers, the types of coffee consumed by population controls, all hospital controls, and hospital controls with diet-altering conditions are compared in Table 5. Coffee drinkers in the total hospital control group were similar to drinkers in the population control group with regard to type of coffee consumed. In contrast, drinkers in the hospital control group with diet-altering conditions included a lower proportion of caffeinated coffee drinkers and a higher proportion of decaffeinated coffee drinkers than drinkers in the population control group. These differences, however, were not statistically significant (P=.082).

Table 3.—Distribution of Hospital Controls by Primary Diagnosis

Diagnostic Category	No. (%) of Hospital Controls
Conditions that may cause a change in diet	
Digestive disorders	34 (13)
Gastroenteritis and colitis	4
Malignant neoplasm of the stomach, large intestine, and rectosigmoid junction	3
Diseases of esophagus	1
Ulcer of stomach	3
Gastritis and duodenitis	3
Intestinal obstruction	1
Diverticula of intestine	1
Chronic enteritis and ulcerative colitis	1
Other diseases of the intestine and peritoneum	8
Cholelithiasis (not specified as acute)	4
Cholecystitis and cholangitis	3
Gastrointestinal tract symptoms	2
Other chronic conditions	90 (34)
Diabetes mellitus	4
Chronic rheumatic heart disease	1
Hypertensive disease	3
Ischemic heart disease	39
Other forms of heart disease	9
Cerebrovascular disease	10
Disease of arteries, arterioles, and capillaries	6
Vascular and cardiac surgery	2
Malignant neoplasms of the lung and bronchus	3
Chronic bronchitis	3
Emphysema	3
Asthma	1
Other diseases of the lung	4
Chronic nephritis	1
Cystic kidney disease	1
Conditions that probably did not cause a change in diet	
Acute conditions	19 (7)
Acute respiratory disorders	3
Acute appendicitis	2
Trauma	12
Acute glaucoma	1
Acute otitis media with mastoiditis	1
Other conditions	89 (34)
Infective and parasitic diseases, NEC* (nonintestinal)	3
Benign neoplasms and neoplasms of unspecified nature	5
Diseases of the nervous system and sense organs, NEC	11
Diseases of the circulatory system, NEC	4
Nasal polyp	1
Inguinal hernia	18
Diseases of the genitourinary system, NEC	23
Complications of pregnancy, childbirth, and the puerperium	1
Diseases of the skin and subcutaneous tissue, NEC	2
Diseases of the musculoskeletal system and connective tissue, NEC	13
Symptoms and ill-defined conditions, NEC	4
Adverse effects, NEC	4
Conditions NEC	29 (12)
All conditions	262 (100)

*NEC indicates not elsewhere classified.

Table 4.—Number of Controls and Percentage of Controls Who Were Drinkers of Two or More Cups of Coffee per Day, by Type of Control Group*

Control Group	No.	Percentage of Controls Who Were Drinkers of ≥2 Cups/Day†
Total population controls	427	73
Total hospital controls	261	68
Controls with conditions that may have caused a change in diet	124	64
Digestive disorders	34	55
Other chronic conditions	90	68
Controls with conditions that probably did not cause a change in diet	108	74
Acute conditions	19	70
Other conditions	89	75
Controls with conditions not elsewhere classified	29	63

*One control who consumed an unknown amount of coffee was excluded.
†Adjusted for age.

Table 5.—Distribution of Coffee Drinkers by Type of Coffee Consumed and Type of Control Group*

Type of Coffee	No.(%)† Total Population Controls	Total Hospital Controls	Hospital Controls With Diet-Altering Conditions
Caffeinated	314(84)	187(81)	83(77)
Decaffeinated only	60(16)	41(19)	25(23)
Total	374(100)	228(100)	108(100)

*Two controls who consumed unknown types of coffee were excluded.
†Adjusted for age.

COMMENT

The results of this study indicate that the prevalence of moderate-to-heavy coffee consumption among controls hospitalized for conditions identified a priori because they were thought to cause a change in diet was lower than that among controls selected from the general population. Among controls hospitalized for such diet-altering conditions, those hospitalized for digestive disorders had the lowest proportion of moderate-to-heavy coffee drinkers. In contrast, the proportion of moderate-to-heavy coffee drinkers among controls hospitalized for conditions thought not to cause a change in diet was almost identical to that among population controls. Among coffee drinkers, we observed that controls hospitalized for diet-altering conditions included a lower proportion of caffeinated coffee drinkers and a higher proportion of decaffeinated coffee drinkers than either hospital controls with non-diet-altering conditions or population controls. This last finding pertaining to type of coffee consumed by hospital controls with GI or cardiovascular diseases as compared with other hospital patients is similar to that observed in a study of young women conducted by Rosenberg et al.[19]

Our results suggest that, in hospital-based case-control studies of the effects of coffee consumption, it would be prudent to restrict the referent group to those patients hospitalized for conditions that probably did not cause a change in diet. Failure to exclude controls hospitalized for diet-altering conditions may result in biased estimation of the relative risks associated with coffee consumption. In the extreme case, assuming the exposure rates observed in this study, the relative risk for moderate-to-heavy coffee drinkers estimated from a case-control study in which the referent group consisted only of controls hospitalized for digestive disorders would be approximately twice the relative risk estimated from a population-based case-control study. This inflation of the relative risk estimate would simply reflect differences in the proportion of moderate-to-heavy coffee drinkers between control groups, regardless of the underlying association between coffee consumption and the disease under study. If the referent group consisted only of controls hospitalized for non-diet-altering conditions, the relative risk for moderate-to-heavy coffee drinkers would be identical to the relative risk estimated from a population-based case-control study.

In the hospital-based study conducted by MacMahon and co-workers,[2] patients with GI disorders were overrepresented in relation to a typical hospital patient series. In a subsequent analysis, MacMahon et al[9] observed that the relative risks estimated with controls hospitalized for GI disorders were indeed higher than those estimated with controls hospitalized for other conditions, since controls with GI disorders reported lower coffee consumption than did controls with other conditions. Although exclusion of controls hospitalized for GI disorders did not change the overall findings reported by MacMahon et al,[2,9] it did result in decreased estimates of relative risk. In our study, by contrast, exclusion of patients hospitalized for GI disorders would have had a negligible effect on estimates of relative risk because such patients constituted a small proportion of the total hospital control group. Thus, the magnitude of bias resulting from failure to restrict the referent group to controls hospitalized for non-diet-altering conditions may vary between studies. In any given study, the magnitude of this bias will depend on two factors: (1) the distribution of diet-altering conditions among the hospital controls and (2) the relationship of these conditions to coffee consumption.

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