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## Are Racial Differences in Squamous Cell Esophageal Cancer Explained by Alcohol and Tobacco Use?

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**Background:** In the United States, incidence rates of squamous cell esophageal cancer are more than five times higher among black men than among white men. Reasons that might explain this large racial disparity are being sought. **Purpose:** We evaluated whether differential use of alcohol and tobacco can fully account for the excess of squamous cell esophageal cancer among U.S. blacks. **Methods:** We conducted a population-based, case-control study with in-person interviews with 373 squamous cell esophageal cancer case patients (124 white males and 249 black males) and 1364 control subjects (750 white males and 614 black males) from three U.S. geographic areas. Histologically confirmed cases of squamous cell esophageal cancer newly diagnosed from August 1, 1986, through April 30, 1989, among white and black men aged 30-79 years were included. **Results:** Alcohol use of more than one drink per day and/or current cigarette use of at least one pack per day accounted for 92.7% (95% confidence interval [CI] = 86.8%-98.5%) of the squamous cell esophageal cancers in blacks, versus 86.3% (95% CI = 75.5%-97.1%) in whites, and for 94% of the difference between the black and white annual incidence rates. The interaction between race and the continuous drinking/smoking variable in a logistic regression analysis was statistically significant (two-sided,  $P = .02$ ). Exposure rates among controls at all levels of combined alcohol and tobacco

use examined were slightly higher among blacks and accounted for a small portion of the racial differences in incidence rates. **Conclusion:** Although the vast majority of esophageal cancers in both blacks and whites in our data can be explained by use of alcohol and tobacco, it is not clear why heavy consumption of alcohol and/or tobacco is responsible for 14.9 per 100 000 per year more cases of squamous cell esophageal cancer among blacks than among whites. The differences in the odds ratios appear to account for more of the racial differences in incidence rates than do the prevalences of exposure to alcohol and tobacco alone. The reasons for this apparent racial difference in carcinogenic risk from the same level of alcohol and tobacco use are unknown, but they may include qualitative differences in alcohol consumption, differences in other environmental exposures that interact with alcohol and/or tobacco to modify risks, or differences in susceptibility to these factors. [J Natl Cancer Inst 86:1340-1345, 1994]

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In the United States, the incidence rates of esophageal cancer are more than three times higher among black men than among white men (1). The higher incidence rates in black men are due to the excess of squamous cell esophageal carcinomas, which occur at a rate more than five times higher in blacks than in whites (16.8 in blacks versus 3.0 in whites per 100 000 population) (2).

To ascertain the reasons for this large racial disparity, we conducted a population-based, case-control study of esophageal cancer among white and black men in three geographic areas of the United States. Because alcohol consumption and tobacco use are the major determinants of esophageal cancer in the United States (3,4), we evaluate in this study whether differential use of alcohol and tobacco can account for the excess of squamous cell esophageal cancer among U.S. blacks.

## Subjects and Methods

### Subjects

Concurrent population-based, case-control studies of four cancers (i.e., cancers of the esophagus, prostate, and pancreas and multiple myeloma) that

occur in excess among U.S. blacks were conducted during 1986-1989 in three geographic areas of the United States. For efficiency, one large control group was chosen for all four cancer types. We decided to include only male esophageal cancer patients because the number of female esophageal cancer patients available would have been too small to adequately address race-sex-specific differences in risk. (For each race, the number of affected females is about one-third the number of affected males.)

Included in the study were all histologically confirmed cases of esophageal cancer [International Classification of Diseases for Oncology (ICD-O) (5) site code 150] or cancer of the esophageal-gastric junction (ICD-O site code 151.0) newly diagnosed from August 1, 1986, through April 30, 1989, among white and black men aged 30-79 years. Case patients were residents of geographic areas covered by three population-based cancer registries: the Georgia Center for Cancer Statistics (DeKalb or Fulton counties), the Metropolitan Detroit Cancer Surveillance System (Macomb, Oakland, or Wayne counties), and the New Jersey State Cancer Registry (10 counties). Because survival from this disease is poor, a rapid reporting system was set up to ascertain and interview esophageal cancer patients within 6 weeks of diagnosis. Cases were identified from pathology and outpatient records at hospitals in the catchment areas. Pathology records were used to categorize the esophageal cancer cases (ICD-O code 150) into one of the following three histologic groups: squamous cell carcinoma (ICD-O codes 8050-8082), adenocarcinoma (ICD-O codes 8140-8573), and all other histologic types including carcinoma not otherwise specified.

For each geographic area, registry data from prior years were used to estimate the race- and age-specific (5-year age groups) numbers of cases anticipated in order to construct a sampling frame for controls. Control selection utilized two sources: 1) random-digit-dialing (RDD) techniques (6) for control subjects aged 30-64 years and 2) random sampling from computerized listings of Medicare recipients provided by the Health Care Financing Administration (HCFA), Baltimore, Md., for control subjects aged 65-79 years.

Trained interviewers conducted in-person interviews with the case patients and control subjects.

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See "Notes" section following "References."

They obtained detailed information on the use of alcohol and tobacco, usual adult diet, usual occupation, medical and dental histories, and sociodemographic factors.

Interviews were completed for 317 whites (68.5%) and for 270 blacks (67.7%) with esophageal cancer. The most common reason for no response was that the subjects were deceased (17% whites and 21% blacks). Other reasons included too ill to respond (8% whites and 8% blacks) and refusal to be interviewed (5% whites and 2% blacks). The response rates were 72.2% and 75.7%, respectively, for the white and black HCFA control subjects and 76.2% and 78.6%, respectively, for the white and black RDD control subjects at the interview phase and 86% at the household screening phase. Among all control subjects, refusal to be interviewed was the most common reason for no response (18% whites and 12% blacks), followed by too ill or deceased (4% whites and 6% blacks).

Of the 317 white male patients interviewed, 124 had squamous cell cancers, 174 had adenocarcinomas, and 19 had other or unspecified types. Among the 270 black male patients interviewed, 249 had squamous cell cancers, 10 had adenocarcinomas, and 11 had other or unspecified types. Since squamous cell carcinoma and adenocarcinoma have distinctly different demographic patterns (squamous cell carcinoma is in excess in blacks, whereas whites have higher rates of adenocarcinoma), we decided to restrict our investigation of reasons for the excess rates of esophageal cancer among blacks compared with whites to the cell type that showed this excess, squamous cell carcinoma. In this report, we limit our analyses to the 373 case patients with squamous cell esophageal cancer (124 whites and 249 blacks) and 1364 control subjects (750 whites and 614 blacks).

## Statistical Analysis

Data were analyzed using unconditional logistic regression (7). Race-specific adjusted odds ratios (ORs) and 95% confidence intervals (CIs) were obtained using the EPICURE programs for personal computers (8). Alcohol drinkers were defined as those who reported consuming at least one drink of beer, wine, or hard liquor per month for at least 6 months. For drinkers, usual weekly consumption of each type of beverage was ascertained. Total alcohol consumption was estimated by summing the contribution from each type of alcohol, where one drink was equivalent to 12 ounces of beer, 4 ounces of wine, and 1½ ounces of hard liquor.

Tobacco smokers were defined as subjects who reported smoking at least one cigarette per day or one cigar or pipe per week for 6 months or longer. For each type of tobacco, questions were asked on the age at first and last use, as well as the number of years and usual amount smoked. Subjects were considered to be ex-smokers if they had stopped smoking for 2 or more years.

All models included the selection factors age and geographic area. Other variables also included, where indicated, were recent annual family income, number of years smoked cigarettes (when assessing alcohol effects), and number of drinks of alcohol per week (when assessing smoking effects). Adjustment for other social class variables, such as education and marital status, and dietary variables, such as

fruit and vegetable consumption, did not substantially alter the risk estimates; thus, these variables were not included in the final models.

Categorical variables were entered as continuous variables in the race-specific logistic models to test for linear trend. To evaluate whether risks for alcohol and tobacco use were significantly different for blacks and whites, we added interaction terms combining race and the continuous-exposure variables of interest to logistic models containing data for blacks and whites combined. The combined effects of drinking and smoking were examined by fitting several alternative models containing an interaction parameter that represented additive and multiplicative risk models as special cases (8-10). Population-attributable risk (PAR) estimates of the proportion of squamous cell esophageal cancers due to smoking and/or drinking were calculated separately for whites and blacks by use of the method of Whittemore (11,12). PAR estimates were adjusted for smoking status, number of drinks consumed per week, and age where indicated.

Although 7% of the white case patients aged 30-64 years and 12% of the black case patients aged 30-64 years did not have a telephone (a selection criterion for controls younger than 65 years), when the analysis was restricted to younger case patients with a telephone, the results were similar. Therefore, the analyses presented include all study participants.

## Results

The distribution of the squamous cell case patients and control subjects by the selection factors race, age, and geographic area is presented in Table 1. The median age was 61 years for black case patients and 63 years for white case patients.

Only five white case patients (4%) and 10 black case patients (4%) reported being nonsmokers of tobacco compared with 160 white control subjects (21%) and 135 black control subjects (22%) (Table 2). For both whites and blacks, the adjusted risks of squamous cell esopha-

geal cancer were significantly elevated for cigarette smokers compared with nonsmokers, and the proportions of cigarette smokers were similar (69% whites and 70% blacks). The drinking-adjusted PARs for cigarette smoking were 71.6% (95% CI = 41.1%-90.1%) for whites and 63.6% (95% CI = 36.9%-83.9%) for blacks. The risks for smokers of pipes or cigars also were elevated for blacks and whites, although only the CI for whites did not include 1.0. Significant positive trends in esophageal cancer risk were seen by duration of cigarette smoking for both races ( $P < .001$  for each). Generally positive, although less consistent, trends were seen for intensity of smoking. Although ex-smokers had elevated risks, they had about half the risks of current smokers. The percentage of cigarette smokers who had quit smoking was significantly greater among whites (61%) than among blacks (45%) ( $P < .001$ ). ORs for smoking variables were higher for whites than for blacks; however, none of these differences were statistically significant. Alcohol consumption was a powerful confounder of smoking, with adjusted estimates of ORs being approximately half of the crude estimate. For example, ORs for duration of smoking adjusted for age, geographic area, and income, but not for drinking, were 2.6, 5.7, and 10.9, respectively, for smoking for 1-29, 30-39, and 40 or more years for whites and 2.7, 6.0, and 11.1, respectively, for blacks.

Almost every case patient reported drinking alcohol. Only 2% of white case patients and 1% of black case patients

**Table 1.** Numbers of interviewed male case patients with squamous cell esophageal cancer and control subjects according to age, geographic area, and race

Factor	White				Black			
	Case		Control		Case		Control	
	No.	%	No.	%	No.	%	No.	%
Age, y								
<50	8	6.5	125	16.7	37	14.9	87	14.2
50-59	35	28.2	218	29.1	77	30.9	154	25.1
60-69	55	44.3	224	29.9	106	42.6	185	30.1
≥70	26	21.0	183	24.4	29	11.6	188	30.6
Geographic area								
Atlanta	9	7.3	167	22.3	53	21.3	128	20.8
Detroit	56	45.2	277	36.9	94	37.8	254	41.4
New Jersey	59	47.6	306	40.8	102	41.0	232	37.8
Total	124		750		249		614	

**Table 2.** ORs for squamous cell esophageal cancer in men according to smoking characteristics and race\*

Smoking characteristic	White				Black			
	No. of cases†	No. of controls‡	OR‡	95% CI	No. of cases†	No. of controls‡	OR‡	95% CI
Nonsmoker	5	160	1.0		10	135	1.0	
Pipe/cigar smoker only	12	65	5.2	1.6-17.0	10	44	2.0	0.6-6.1
Cigarette smoker	107	517	3.7	1.4-9.7	228	427	3.2	1.5-7.0
Intensity, cigarettes/d								
1-19	16	125	2.9	0.9-8.8	61	189	2.2	0.9-4.9
20-39	57	271	3.8	1.4-10.4	130	195	4.0	1.8-8.9
≥40	34	119	3.9	1.4-11.2	35	42	3.4	1.3-8.5
		(Trend test $P = .078$ )				(Trend test $P < .001$ )		
Duration, years smoked cigarettes								
1-29	18	223	2.0	0.7-6.0	35	137	1.7	0.7-4.1
30-39	24	122	3.6	1.3-10.6	55	94	3.0	1.3-6.9
≥40	64	156	5.9	2.1-16.3	135	182	5.1	2.3-11.6
		(Trend test $P < .001$ )				(Trend test $P < .001$ )		
Cigarette smoking status								
Ex-smoker	38	316	2.4	0.9-6.5	39	191	1.5	0.7-3.6
Current smoker	69	201	5.5	2.0-14.9	188	236	4.2	1.9-9.2
		(Trend test $P < .001$ )				(Trend test $P < .001$ )		

\*Numbers do not add up because of missing values.

†Excludes subjects with unknown intensity, duration, or cigarette smoking status.

‡Adjusted for age, geographic area, alcohol consumption, and income. All risks relative to a risk of 1.0 for nonsmokers of tobacco.

were considered to be nondrinkers compared with 21% of white control subjects and 23% of black control subjects (Table 3). The smoking-adjusted PARs for drinking were 91.8% (95% CI = 80.5%-100%) for whites and 94.0% (95% CI = 87.0%-100%) for blacks. Adjusted ORs were strongly associated with the number of drinks consumed per week, reaching 16.1 (whites) and 26.9 (blacks) for consumption of 85 or more drinks per week compared with seven or fewer drinks per week. The ORs at each level of consumption were greater for blacks than for whites, and there was a statistically significant interaction between race and the number of drinks of alcoholic beverage consumed ( $P = .04$ ). Smoking did confound the ORs associated with drinking,

but not as profoundly as the confounding effect of drinking on smoking. The ORs for number of drinks per week without adjustment for smoking were 3.8, 10.2, 23.0, and 32.9, respectively, for 8-14, 15-35, 36-84, and 85 or more drinks per week among blacks and 2.0, 5.3, 13.8, and 18.3, respectively, among whites. The proportion of heavy drinkers (≥36 drinks per week) was higher among blacks (14.2%) than among whites (11.5%), but this difference was not statistically significant ( $P = .13$ ).

Since so few case patients abstained from smoking and drinking, it was not possible to assess the role of smoking in the absence of drinking or the role of drinking in the absence of smoking. This situation also precluded the use of non-

drinkers and nonsmokers as the referent group to investigate the combined effects of drinking and smoking and to calculate the PARs due to combined habits. Therefore, the referent group for these analyses was expanded to include subjects (six white case patients and 262 white control subjects and six black case patients and 199 black control subjects) with no exposure or light exposure to alcohol and tobacco (nonsmokers, ex-smokers of cigarettes, current smokers of <20 cigarettes per day, nondrinkers, and drinkers of fewer than eight drinks per week). With the use of this combined referent group, the drinking-, age-, and income-adjusted ORs for current smokers of more than one pack of cigarettes per day were 2.6 (95% CI = 1.6-4.0) for whites and 2.1

**Table 3.** ORs for squamous cell esophageal cancer in men according to drinking characteristics and race

Drinking characteristic	White				Black			
	No. of cases*	No. of controls*	OR†	95% CI	No. of cases*	No. of controls*	OR†	95% CI
Never drank	2	155	1.0		3	139	1.0	
Drank	122	595	13.2	3.2-55.4	246	475	15.5	4.7-50.6
Intensity, drinks/wk								
0-7	15	377	1.0		14	271	1.0	
8-14	12	139	1.9	1.2-5.6	24	106	3.2	1.5-6.8
15-35	33	148	4.8	2.4-13.4	77	149	7.9	4.1-15.2
36-84	45	66	11.5	5.8-22.8	85	66	16.7	8.4-33.2
≥85	19	20	16.1	6.7-38.9	46	21	26.9	11.9-60.9
		(Trend test $P < .001$ )				(Trend test $P < .001$ )		

\*Excludes subjects with unknown drinking intensity.

†Adjusted for age, geographic area, smoking, and income.

(95% CI = 1.5-3.1) for blacks, and the corresponding PARs were slightly greater for whites (33.1%; 95% CI = 19.1%-50.9%) than for blacks (27.5%; 95% CI = 14.6%-45.7%). The smoking-, age-, and income-adjusted ORs for drinkers of more than one drink per day were 11.0 (95% CI = 6.1-20.0) for blacks and 6.3 (95% CI = 3.5-11.4) for whites, and the corresponding PARs were slightly greater for blacks (84.9%; 95% CI = 76.8%-93.0%) than for whites (76.4%; 95% CI = 62.5%-86.2%).

Table 4 shows the adjusted ORs for each drinking/smoking level and the percentages of exposed control subjects. The separate effects of drinking and smoking were apparent by the positive dose gradients associated with alcohol use within each cigarette smoking category and vice versa. For every level of drinking/smoking, the ORs were higher for blacks than for whites, reaching 35.4 (95% CI = 10.0-125.5) among whites and 149.2 (95% CI = 39.2-567.4) among blacks. The interaction between race and the continuous-drinking/smoking variable was statistically significant ( $P = .02$ ). For both races, combined exposure to alcohol and cigarettes was intermediate between an additive and a multiplicative model and was not statistically significantly different from either model for whites but was statistically different from an additive model for blacks. Adjustment for social class variables, such as education and marital status, and dietary variables, such as fruit and vegetable consumption, did not substantially alter the risk estimates for any of the smoking and/or drinking variables.

The age-adjusted PARs for drinkers of more than one drink per day and/or smokers of at least one pack of cigarettes per day were 86.3% (95% CI = 75.5%-97.1%) for whites and 92.7% (95% CI = 86.8%-98.5%) for blacks. A somewhat higher percentage of white (39.0%) than black (35.5%) control subjects reported light use of alcohol and cigarettes, but this difference was not statistically significant ( $P = .22$ ). The proportion of exposed control subjects was significantly greater ( $P = .019$ ) for blacks in only one of the nine other drinking/smoking categories: heavy smoking status (36-84 drinks per week).

To estimate what the race-specific annual incidence rates of squamous cell esophageal cancer would be if people refrained from heavy drinking and smoking (i.e., consumed one drink or less of alcoholic beverage and smoked less than one pack of cigarettes per day), we applied the complement of the race-specific PARs from this study to the annual age-adjusted squamous cell incidence rates for the three geographic areas combined (19.4 per 100 000 for blacks and 3.6 per 100 000 for whites, an excess among blacks of 15.8 cases per 100 000 per year). We estimated that the annual incidence rates would be  $19.4 \times (1 - 0.927) = 1.4$  per 100 000 person-years for blacks and  $3.6 \times (1 - 0.863) = 0.5$  per 100 000 person-years for whites in the absence of heavy smoking and drinking (Table 4). Conversely, the annual incidence rates due to heavy drinking and/or smoking would be 18.0 per 100 000 per year for blacks and 3.1 per 100 000 per year for

whites, an excess among blacks of 14.9 cases per 100 000 per year. Thus, heavy drinking and/or smoking would account for 94% of the excess in incidence rates among blacks (14.9 cases per 100 000 individuals per year of the 15.8 cases per 100 000 per year overall difference between the black and the white rates).

For each race, we estimated the annual incidence rate within each level of drinking and smoking by multiplying the estimates of the rate of squamous cell esophageal cancer in those with no exposure or light exposure by the adjusted ORs for each drinking/smoking category (Table 4). As one would expect, with a higher base-line rate among blacks and a higher OR for each level of drinking and smoking, blacks had substantially higher incidence rates than whites at each level. In fact, the rates were three to nine times higher for each level except for the heaviest drinking/smoking category, where the rate in blacks was 12 times higher. This unusually high rate, however, was based on only five black control subjects. These higher incidence rates in blacks versus whites at each level of exposure were the main contributors to the black-white difference in the overall incidence rates attributable to heavier drinking and smoking (94%), rather than the slight differences in the exposure rates of the control subjects. For example, if the exposure rates among white control subjects were applied to the strata-specific incidence rates among black control subjects, the overall rate in blacks was lowered only slightly. Indeed, this elimination of the slight difference in exposure rates be-

**Table 4.** ORs, percentage of exposed control subjects, and estimated incidence rates for exposure to alcohol and cigarettes by race

Smoking status*	Drinks per week	White				Black			
		OR†	95% CI	Control, %	Rate‡	OR†	95% CI	Control, %	Rate‡
Light	0-7	1.0	—	39.0	0.5	1.0	—	35.5	1.4
	8-14	1.8	0.5-6.1	15.5	0.9	5.7	2.0-15.8	13.8	8.0
	15-35	4.6	1.7-12.8	14.8	2.3	10.6	4.1-27.2	18.0	14.8
	36-84	19.7	7.2-53.4	5.9	9.8	39.5	14.5-107.8	5.2	55.3
	≥85	29.0	7.2-116.5	1.2	14.5	31.0	9.8-98.5	2.7	43.4
Heavy	0-7	3.3	1.0-10.8	9.9	1.6	4.5	1.4-14.6	8.0	6.3
	8-14	8.7	2.4-32.4	3.2	4.4	14.2	4.1-49.1	2.7	19.9
	15-35	22.1	7.8-62.3	5.5	11.0	36.8	13.9-97.2	7.0	51.5
	36-84	28.5	10.1-80.2	3.4	14.2	42.1	15.8-112.6	6.2	58.9
	≥85	35.4	10.0-125.5	1.6	17.7	149.2	39.2-567.4	0.9	208.9

\*Light = nonsmoker, ex-smoker, or current smoker of <1 pack/d. Heavy = current smoker of one pack or more per day.

†All ORs adjusted for age, geographic area, and income. Excludes six black case patients and 18 control subjects (eight whites and 10 blacks) with unknown drinking or smoking status and 22 case patients (12 whites and 10 blacks) and 109 control subjects (65 whites and 44 blacks) who smoked only pipes or cigars.

‡Estimated annual incidence rate per 100 000 person-years.

tween the races would reduce the black-white difference by less than 10%.

## Discussion

In Western Europe and North America, 80%-90% of the risk of esophageal cancer has been attributed to the use of alcohol and tobacco (3,4). Similarly, our population-based study found that alcohol consumption of more than one drink per day and/or current cigarette consumption of at least one pack per day accounted for 93% of the disease in blacks and 86% in whites.

Although several other U.S. studies obtained smoking and drinking histories for both white and black case patients, data were not presented separately for blacks and whites (13-15). Our study is the first to look specifically at the reasons for the higher incidence rates among blacks. Because our study was designed to examine risk factors separately by race, we had large enough numbers of case patients of each race to estimate risks for blacks and whites separately. Other advantages of our study over previous studies include the following: Our study was population based; the participation rate in our study was relatively high, considering the poor survival rates for esophageal cancer; all patients in our study were interviewed directly; and we were able to conduct cell type-specific analyses.

The vast majority of esophageal cancers in both blacks and whites in our data can be explained by use of alcohol and tobacco, with alcohol consumption of more than one drink per day and/or current cigarette consumption of at least one pack per day accounting for 94% of the excess in incidence rates among blacks. However, it is not clear why heavier consumption of alcohol and/or tobacco is responsible for 14.9/100 000 per year more cases of squamous cell esophageal cancer among blacks than among whites. Some of the remaining excess is also almost assuredly due to lower levels of drinking and smoking, but it is difficult to quantify this because of the scarcity of nonsmoking and nondrinking case patients.

The higher ORs for blacks at each level of combined drinking and smoking appear to account for more of the difference in incidence rates between blacks and

whites than do the slightly higher exposure rates among black control subjects. A detailed examination of drinking within each drinking/smoking category revealed similar mean levels of alcohol consumption for black and white case patients; therefore, the higher ORs among blacks do not appear to be due to residual confounding from alcohol. Even in the lightest smoking and drinking category, the incidence rate among blacks was almost three times higher than among whites. Since black case patients in this lightly exposed group were not heavier users than white case patients, the risks appear to be qualitatively different rather than the result of differences in exposure rates. Both the difference in base-line rate and the higher OR among blacks for each level of smoking and drinking resulted in an estimated incidence rate among blacks for heavier levels of drinking and/or smoking that ranged from three to nine times higher than the corresponding rate for whites. A similar finding of higher ORs for the same level of alcohol consumption among blacks compared with whites was recently described in a study of oral cancer (16), lending credibility to the suspicion that exposure to the same level of carcinogens from alcohol puts blacks at greater risk of developing certain squamous cell tumors than whites.

The reasons for this apparent racial difference in susceptibility to the carcinogenic effects of alcohol and tobacco are unknown. Indeed, the mechanism of action of esophageal carcinogenesis due to these exposures is not known. While various initiators, promoters, and complete carcinogens have been identified in tobacco smoke condensate (17), the specific agents responsible for esophageal cancer and their mechanisms of action have not. Even less is known about alcohol carcinogenesis. While alcoholic beverages are known human carcinogens (18), the mechanism(s) or component(s) responsible for their carcinogenicity have not been identified. Some types of alcoholic beverages, including beer and whiskey, may contain compounds that are carcinogenic. In addition, alcohol may enhance susceptibility to carcinogens found in other substances, such as cigarette smoke, through a variety of mechanisms (e.g., interfering with DNA repair mechanisms, altering the immune

system, changing metabolism, increasing absorption, and enhancing activation of procarcinogens) (19,20).

Perhaps the apparent difference in susceptibility between blacks and whites could be used to clarify our understanding of the carcinogens in alcohol and tobacco and their mechanisms of action with respect to esophageal cancer. The risk related to alcohol use could be due to qualitative differences in alcohol use, with blacks drinking more hazardous types of alcoholic beverages at each level. Alternatively, there could be other environmental determinants, such as nutritional factors, that are different between blacks and whites and that interact with alcohol and/or tobacco to modify risks. Finally, blacks could have an increased genetic susceptibility either to squamous cell esophageal cancer itself or to the alcohol- and/or tobacco-induced disease. Various racial differences in polymorphic forms of proto-oncogenes and tumor suppressor genes that affect metabolism of carcinogens or procarcinogens are being increasingly described (21-24). Investigation of some of these differences in the context of esophageal cancer not only may resolve the racial disparity, but also may provide insight into basic carcinogenic mechanisms.

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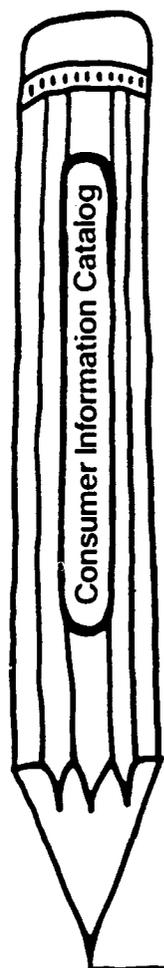
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