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Racial differences in the relationship between tobacco, alcohol and squamous cell carcinoma of the head and neck

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Abstract

Purpose—Tobacco and alcohol use are well-known risk factors for squamous cell carcinoma of the head and neck (SCCHN), but there has been little examination of disparities in SCCHN and racial patterns of tobacco and alcohol use, especially for African-Americans. The Carolina Head and Neck Cancer Study, a population-based case-control study, was utilized to determine if relationships between tobacco and alcohol use and SCCHN differed by race.

Methods—Using a rapid case ascertainment system, cases were recruited from 46 contiguous counties in North Carolina from 2002–2006. Controls, selected from motor vehicle records, were frequency-matched to cases on age, sex, and race. This analysis was based on 989 white and 351 African-American cases and 1114 white and 264 African-American controls. Analyses were performed using unconditional logistic regression, adjusting for age, sex, race, education and fruit and vegetable consumption.

Results—The association between SCCHN and ever tobacco use among African-Americans (odds ratio (OR) 9.68 95% confidence interval (CI) 4.70, 19.9) was much greater than that observed in whites (OR:1.94 95% CI 1.51, 2.50). Smaller differences were observed when examining ever alcohol use (African-Americans OR: 3.71 CI 1.65, 8.30 Whites OR: 1.31 CI 0.96, 1.78). African-Americans consistently had greater effect measure estimates when examining common levels of duration and intensity metrics of tobacco and alcohol use, both independently and jointly. No racial differences in the effects of environmental (passive) tobacco smoke were observed.

Conclusions—These findings suggest racial differences in SCCHN are not solely explained by differences in consumption patterns, and tobacco and alcohol may have greater impact in African-Americans.

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Conflict of Interest

The authors declare that they have no conflict of interest.

Keywords

head and neck neoplasms; tobacco; cigarettes; alcohol; etiology

Squamous cell carcinoma of the head and neck (SCCHN) is one of the ten most frequently diagnosed cancers globally and consists of cancers found in the oral cavity, pharynx and larynx [1]. Within the United States, the American Cancer Society estimates that there will be 52,140 new cases and 11,460 deaths attributable to these cancers in 2011 [2]. Data from the National Cancer Institute's Surveillance Epidemiology and End Results database (SEER) suggest racial disparities in incidence and mortality related to these cancers, with African-American males bearing the largest burden of disease [3]. These disparities are especially pronounced for laryngeal cancer. From 1975–2008, the age-adjusted incidence rate for laryngeal cancer among African-American males was 12.8 per 100,000, compared to 8.0 in White males, 2.5 in Black females, and 1.6 in White females [4]. African-American males also have the greatest rate of oropharyngeal cancer, 21.8 per 100,000 compared to 17.9 for White males, 7.1 for White females and 7.0 for African-American females, although in recent years the rate among White males has been increasing [4]. In North Carolina, the 2005–2009 age-adjusted incidence rate for SCCHN was 10.2 per 100,000 among whites and 12.4 per 100,000 among African-Americans. There are also disparity in mortality in North Carolina with an age-adjusted mortality rate per 100,000 people of 3.0 among whites and 5.6 among African-Americans [5].

Tobacco use and alcohol consumption have been consistently demonstrated to be risk factors for SCCHN in U.S. and international epidemiologic studies [6]. Findings document clear dose-response relationships and evidence of interaction between tobacco and alcohol use in contributing to SCCHN risk [7, 8]. Previous research estimated that use of tobacco and/or alcohol may account for three-fourths of all oral and pharyngeal cancers in the United States. [7] Since then, research suggests that infection with human papillomavirus (HPV) may also contribute to certain subtypes of SCCHN, particularly among non-smokers and non-drinkers [9, 10].

Despite the evidence that SCCHN incidence varies by race and, overall, may be largely attributable to tobacco and alcohol use, there has been little focus on differences in consumption patterns between ethnic and racial groups, especially for African-Americans. Using data from a case-control study conducted between 1984 and1985, Day et al conducted one of the few comparisons of risk factors between African-Americans and whites and found slightly different consumption patterns by race [11]. Their findings, based on 194 African-American cases, showed similar odds of oral and pharyngeal cancer associated with tobacco use between the groups but noted some differences in the relationship between alcohol consumption and oral cancer, with African-Americans having greater odds of disease. Laryngeal cancer was not included in their study case group.

The objective of the present analysis was to utilize a large population-based case-control study of oral, pharyngeal and laryngeal cancers, in order to determine if the relationships between tobacco and alcohol use and risk of SCCHN were different for African-Americans and whites. This analysis included examination of the interaction between tobacco and alcohol use and stratification by different sites of SCCHN.

Materials and Methods

The Carolina Head and Neck Cancer Study (CHANCE) included cases, aged 20–80, who were residents of a 46-county region in North Carolina with newly diagnosed first primary

invasive SCCHN between January 1, 2002 and February 28, 2006 [12]. We included ICD-O-3 topography codes C01.9 to C14.8 and C32.0 to C32.9. We excluded tumors of the lip (C0.00–C00.9), salivary glands (C07.9, C08.0–C08.9), nasopharynx (C11.0–C11.9), nasal cavity (C30.0), and nasal sinuses (C31.0–C31.9). Subjects with carcinomas of other histologies, carcinomas at other head and neck sites, or a history of recurrent or second primary tumors were not eligible. Using rapid case ascertainment conducted through the North Carolina Central Cancer Registry, cancer registrars at the 54 hospitals in the study were contacted monthly to identify and provide eligible, newly diagnosed cases. Pathology reports and corresponding slides of tumor specimens from the patient's diagnostic surgery were obtained, usually within 4–8 weeks of diagnosis, and histologic confirmation was verified by our study pathologist (WF).

Controls, aged 20 to 80 years, were residents of the same 46 North Carolina counties and had never been diagnosed with SCCHN. Identified through North Carolina Department of Motor Vehicle records, controls were frequency matched with cases using random sampling with stratification on age (20–49,50–54,55–59,60–64,65–69,70–74,75–80), race (white, black, other), and sex (male, female).

Potentially eligible controls and cases (after physician notification) were first contacted by mail and then by nurse-interviewers to verify eligibility and schedule an interview. Written informed consent was obtained prior to the interview, and participants received compensation for time spent completing the study interview and donating a biologic sample. For subjects who were deceased, an attempt was made to locate a family member or proxy with knowledge of the subject's exposures who was willing to complete an abridged version of the survey. All study protocols were reviewed and approved by the University of North Carolina's Institutional Review Board.

Demographics and exposure to potential SCCHN risk factors and covariates were assessed during the in-person interview using standardized survey questions. Each potential risk factor was assessed in a separate section including a gateway question with ever-use defined as: smoking 100 cigarettes over a lifetime; smoking 20 cigars; use of a pipe at least 20 times; use of chewing tobacco at least 20 times; use of snuff at least 20 times; drinking 50 beers over a lifetime; drinking wine 20 times; and drinking hard liquor 20 times. A positive response to the gateway question triggered additional questions on age started, age stopped use if quit, years of use, type of cigarette or size of typical alcoholic drink and typical amount used/consumed. Cases were asked about use the year prior to diagnosis while controls were asked about current use. Environmental (second hand, passive, involuntary) tobacco smoke (ETS) exposure was determined by asking if participants had been exposed to tobacco smoke at work or home and the number of cigarettes, cigars, or pipefulls that each person in the household smoked inside the home.

Using responses to these questions and based on the distribution, cigarette and alcohol use were classified by intensity, duration, and cumulative use. The number of cigarettes smoked per day was categorized into the following: never-smoker, less than 19 cigarettes per day, and 20 or more cigarettes per day. Duration was defined in years using the categories of never smoker, 1–19, 20–39, 40–49 and 50 or more. Cumulative use was defined by pack-years, calculated by multiplying the number of cigarette packs (20 cigarettes per pack) smoked per day by the total number of years smoked and then categorized into never-smokers, less than 20 pack-years, and 20 or more.

Beer, liquor and wine consumption were each coded as six-level variables with the following categories: 0, <1, 1–4, 5–14, 15–29, and 30 or more drinks per week. Duration of consumption of each of these beverages was coded as: never, 1–9 years, 10–19 years, and 20

or more years. Cumulative alcohol use was calculated by converting the number of each type of drink consumed per week to total ethanol grams then multiplying by years that type of alcohol was consumed, and then summing across the three types of alcohol. Subsequently, the cumulative, or total, alcohol variable was categorized into a 5-level variable, with a never drinker category and four categories defined by quartiles of consumption among all participants to prevent the undue influence of extreme values.

The odds ratio (OR) estimate for the effect of each exposure on SCCHN was obtained using unconditional logistic regression, with the matching factors and their interactions included within each model. Based on review of the literature, all models were a priori adjusted for education, classified as high school or less, some college, and college degree or more, and quintiles of fruit and vegetable consumption [13]. Fruit and vegetable consumption were separately calculated based on reported dietary intake [13]. Proxy respondents were excluded from multivariable analysis because they lacked data on fruit and vegetable consumption. Models with cigarette exposure variables as the main exposure also adjusted for alcohol consumption, using the categorical variable of total ethanol consumed, and use of other tobacco products. Models examining other tobacco use variables adjusted for alcohol consumption and duration of cigarette smoking. Models focusing on alcohol use variables also adjusted for duration of cigarette smoking and use of other tobacco products.

To examine differences in risk factors for SCCHN between African-Americans and whites, we included an interaction term between the exposure and race and conducted likelihood ratio tests, specifying an alpha level of 0.10. Models were also stratified by cancer site, using the following definitions: oral cavity (ICD-O-3 C01.9–C02.3, C03.0–C03.1, C03.9, C04.0–C04.4, C04.8–C05.0, C06.0–C06.2, C06.8–C06.9), oropharynx (C02.4, C05.1–C05.2, C09.0–C09.1, C09.8–C10.4, C10.8–C10.9), hypopharynx (C12.9–C13.2, C13.8–C13.9), oral cavity-oropharynx-hypopharynx not otherwise specified (C02.8–C02.9, C05.8–C05.9, C014.0), or larynx (C32.0–C32.9). Additional analyses were stratified by cancer sites that are known to be related to HPV infection (C01.9-base of tongue, NOS, C02.4-lingual tonsil, C09.0–C09.9-tonsil, C10.0–C10.9-oropharynx) [10], as it is hypothesized that tobacco and alcohol would play less of a role in the etiology of these cancers. When examining the data by site, some exposure categories were collapsed due to smaller sample size.

In order to examine joint effects of tobacco and alcohol exposure, we constructed an unconditional logistic regression model which included interaction terms between duration of cigarette smoking and weekly alcohol consumption, defined as total number of drinks per week. We chose these two measures of tobacco and alcohol consumption in order to explore the combination of the most definitive metrics representing the highest risk behaviors identified in earlier analyses. Due to small sample size, we combined the never drinkers and very light drinkers (< 1 drink per week) into a single category. To explore interaction on the additive scale, interaction contrast ratios (ICRs) and 95% confidence intervals were calculated comparing those who used the greatest amounts of both tobacco and alcohol to those with no tobacco and alcohol use [14]. All analyses were performed using SASv9.2.

Results

Case response proportions were similar between African-Americans and whites, 74.9% and 77.0%. Control response rates were 35.8% among African-Americans and 51.4% for whites. This difference is driven in part by the lower contact rate for African-American controls (62.7% versus 82.8% for whites). Overall, the questionnaire was completed for 1,389 eligible cases and 1,396 eligible controls. Twenty-one cases of lip cancer were excluded, as were 28 cases and 18 controls who specified ‘other race’. The final sample consisted of

1340 cases (989 white, 351 African-American) and 1378 controls (1114 white, 264 African-American). Only 51 cases (3.8%) and 17 controls (1.2%) required proxy interviews.

Table 1 presents case and control distributions for demographic factors, stratified by race. Both races had greater educational attainment among controls. Although there were univariate differences between cases and controls for the matching factors age, race and sex, comparison of the joint distribution of these variables between cases and controls showed less than a 2.0% difference for all combinations (data not shown).

The association between SCCHN and ever tobacco use among African-Americans (OR: 9.68 95% confidence interval (CI) 4.70, 19.9) was much greater than that observed in whites (OR:1.94 95% CI 1.51, 2.50). As shown in Table 2, the odds ratios for measures of cigarette smoking intensity and duration are larger in magnitude for African-Americans than whites, although the estimates for African-Americans are less precise. Among those at the higher levels of duration and cigarettes per day of cigarette use, African-Americans had a 6–9-fold greater odds of SCCHN than among whites. Likelihood ratio tests indicated these differences are statistically significant, and suggest that race modifies the relationship between various measures of cigarette use and the effect on SCCHN incidence. We examined finer categorizations of cigarettes per day and found the racial differences in odds of cancer remained. Among African Americans, odds ratios for 1–19, 20–39, 40–59, and 60+ cigarettes per day, compared to referent never smokers were 6.42 (3.01, 13.7), 12.6 (5.81,27.1), 59.6 (15.0, 237), and 14.8 (3.01, 72.9), respectively. Among whites, these odds ratios were 1.15 (0.83, 1.59), 2.38 (1.80, 3.15), 3.06 (2.14, 4.38), and 2.23 (1.16, 4.27), respectively. Because the effect estimates for categories over 20 cigarettes per day were very imprecise with wide confidence intervals among African-Americans, we decided to collapse them into a single 20+ category. We also examined pack-years smoked and found similar results, with African-Americans consistently having higher odds ratios than whites (data not shown).

SCCHN risk decreased as the number of years since quitting increased for both races, but the odds ratios remained greater, but more imprecise, among African-Americans. There was also a stronger relationship between initiating cigarette use at a younger age and SCCHN among African-Americans than whites. When examining type of cigarette smoked, there was a greater variability in odds of disease among African-Americans. However, these estimates were imprecise.

Subsequently, we restricted our analyses to only smokers and further examined the effects of smoking frequency and duration using continuous measures of the smoking metrics. For every 10 year increase in smoking duration, the odds of SCCHN doubled among African-American smokers (OR: 2.03 95% CI 1.61., 2.55), compared to an increase of 1.46 times the odds among white smokers (95%CI 1.33, 1.60). For every 10 pack-year increase in cigarette smoking, the odds of SCCHN were 1.43 (95% CI 1.26, 1.61) times greater when examining African-American smokers and 1.20 (1.14, 1.25) times greater among white smokers. Similar results were observed when examining the effect of an increase of 10 cigarettes smoked per day [(African-Americans OR: 1.56 (95% CI 1.26, 1.93) vs whites OR: 1.25 (95% CI 1.14, 1.37)].

When we examined the individual effects of other types of tobacco, simultaneously controlling for the others as well as cigarette use, we did not observe any strong relationships with the odds of SCCHN (Table 2). After stratifying by race, we observed elevated, though imprecise, ORs among African-Americans when examining the relationship between use of either snuff or chew and SCCHN, and the likelihood ratio test examining the interaction between race and snuff use was statistically significant using our

criteria of 0.10. In order to differentiate the effects of other types of tobacco from each other as well as from cigarette use, we created a variable which separates use of a single form of tobacco from using multiple types. As seen in Table 2, those who smoked cigars and/or pipes only also have elevated odds of SCCHN. The odds of SCCHN associated with the use of multiple types of smokeable tobacco was not greater than using cigarettes alone. The small number of cases who used smokeless tobacco alone made interpretation difficult due to poor precision, but African-Americans who used only smokeless tobacco had a slightly elevated odds of SCCHN.

In order to detangle the effects of active tobacco use from ETS, we stratified the ETS models by ever use of tobacco products (Table 3). Among never users of tobacco, odds ratio estimates for different measures of ETS exposure were less than 1. Among self-tobacco users, exposure to ETS was associated with SCCHN, and the odds ratios trended higher as the amount of ETS exposure increased. This relationship is seen in both African-Americans and whites.

For alcohol consumption, there were racial differences in the magnitude of associations with SCCHN, although these differences were smaller than those observed for cigarette use. The odds ratio corresponding to any lifetime alcohol use among African-Americans (OR 3.71 95% CI 1.65, 8.30) was almost triple that observed among whites (OR 1.31 95% CI 0.96, 1.78). Both races showed greater odds of disease as either amount or duration of alcohol consumption increased, with African-Americans consistently having slightly larger odds ratio estimates (Table 4). Using the total alcohol variable, among both racial groups, we observed that the lowest levels of consumption were associated with decreased odds of SCCHN, while the highest levels of consumption were associated with greater odds of SCCHN. Odds ratios related to wine consumption were lower than beer or liquor consumption, particularly among whites, where ever wine consumption was associated with reduced odds of SCCHN compared to non-drinkers and only the highest level of wine consumption (more than 30 drinks per week) was associated with greater odds of SCCHN.

Compared to non-drinkers/very light drinkers and non-smokers, the joint effect of alcohol and tobacco increased as amount increased, especially for African-Americans (Table 5). Some of these estimates were very imprecise due to the small numbers within cells. For the assessment of the additive interaction of consuming the greatest amounts of alcohol and tobacco compared to non-users, the overall ICR was 10.3 (95% CI 3.81,16.8), suggesting excess risk due to the interaction between tobacco and alcohol. When stratifying by race, the ICR for whites was 5.98 (95% CI −0.08, 12.0) and 138 (95% CI −141, 418) for African-Americans. Among Whites, the odds ratio comparing the highest alcohol users to non/very light drinkers among non-smokers is similar to the odds ratio comparing the highest users of tobacco to non-smokers among non/very light drinkers (Table 5). Among African-Americans, however, the odds ratios suggest that alcohol consumption has less of an effect on non-smokers than smoking has among non/very light drinkers.

Stratifying by site of primary tumor showed that the relationship between tobacco use and cancer was consistently greatest for laryngeal tumors and wine consumption was associated with reduced odds of SCCHN among oral cavity and laryngeal cases (Online Resource 1, Supplementary Table 1). African-Americans and whites had similar tumor site distributions, although hypopharynx tumors made up approximately 8% of African-American cases, compared to only 4% among white cases. When stratifying by both race and site, African-Americans continued to have greater effect measure estimates related to smoking and alcohol use than whites for all tumor sites except hypopharynx tumors. However, these stratified results are based on very small numbers and are highly imprecise. (Online Resource 1, Supplementary Tables 2 and 3) Whites were slightly more likely to have a

tumor site with presumed HPV-infection than African-Americans (26.5% vs. 21.6%). The association between tobacco use and SCCHN was consistently greater among those whose tumor site was not associated with presumed HPV-infection (Online Resource 1, Supplementary Table 4). The same was true for beer consumption, but not for wine and liquor consumption. When examining these results stratified by race, African-Americans with HPV-related tumor sites have greater odds of SCCHN corresponding to tobacco and alcohol use compared to those with non-HPV-related sites, although these estimates were highly imprecise. Wine-consumption was again associated with reduced odds of SCCHN among whites with non-HPV related tumor sites (Online Resource 1, Supplementary Tables 5 and 6).

We ran additional models which adjusted for each type of alcohol separately, as opposed to the total consumption variable, as well as models which adjusted for tobacco using pack-years and found no material difference in the estimates obtained (data not shown). We also ran joint models using pack-years instead of year of smoking and found similar results (data not shown). To determine if the racial disparities observed were due to residual confounding related to education, we reran our analyses using a finer adjustment variable that included 7 levels of education (less than 8 years, 8–11 years, completed high school, vocational work, some college, college graduate and postgraduate). This finder educational adjustment did not have a material effect on our results and the racial disparities in the effects of tobacco and alcohol use remained. No difference in results were found when using conditional logistic regression models to account for matching. Appropriate model fit was explored and verified by examining model residuals and delta-betas.

Discussion

This study found the effects of tobacco use and alcohol consumption on odds of SCCHN were consistently greater among African-Americans, whether measuring exposure by intensity, duration, or cumulative use. Additionally, the joint effect of tobacco and alcohol use, as well as the impact of smoking among non-drinkers and the impact of greater smoking frequency and duration among smokers was greater among African-Americans. These findings suggest that previously observed racial differences in SCCHN incidence are not solely explained by differences in consumption patterns between African-Americans and whites, and the impact of tobacco and alcohol may be stronger in African-Americans.

Our estimates of SCCHN related to tobacco and alcohol use among whites are consistent with reports from the International Head and Neck Cancer Epidemiology Consortium (INHANCE), a pooled analysis of 15 case-control studies [8, 15–17]. For example, their odds ratio comparing those who consumed more than 30 drinks of beer per week to non-drinkers of 3.2 (2.2, 4.7) was just slightly higher than our result of 2.85 (1.96, 4.16) [15]. Both studies found the relationship between tobacco and SCCHN strongest among laryngeal cases, with increasing odds of cancer as metrics of smoking duration increased [17]. Our findings of strong interaction between tobacco and alcohol in contributing to the odds of SCCHN and a lack of an association when examining ever ETS exposure among never tobacco users are also consistent with INHANCE analyses. [8, 16]. The reduced risk of SCCHN with wine consumption, among whites observed in our study was not seen in the INHANCE analysis but has been observed in other case-control studies of SCCHN [11].

Our results were not entirely consistent with the previous study of differences between whites and blacks in risk factors for oropharyngeal carcinoma [11]. Although we found similar racial differences in the relationship between alcohol use and SCCHN, Day et al did not find any difference in the race-stratified odds ratios corresponding to any cigarette use. Day et al did not include laryngeal cases in their analysis, and our results showed that the

relationship between tobacco use and SCCHN was strongest in laryngeal cases [11]. However, we continued to observe racial differences in odds ratios when we restricted to only oral or oropharyngeal tumor sites, although the estimates were imprecise due to small numbers. It is possible that, because the previous study was conducted in the mid-1980s, changing tobacco consumption patterns may explain the differences in our results.

It has been suggested that racial disparities in tobacco-related cancers may be due to the greater use of mentholated cigarettes among African-Americans [18]. Previous research in both oropharyngeal and lung cancers have found no excess cancer risk among smokers of mentholated cigarettes compared to nonmentholated cigarette smokers [18–20]. In our study, we found that smokers of both unfiltered and filtered menthol cigarettes had the greatest odds of cancer, although these effect estimates were imprecise. When we focused on those who smoke filtered cigarettes only, our results among whites show there is little difference in the odds of SCCHN when comparing those who smoked menthol cigarettes with those who smoked non-menthol cigarettes. Among African-Americans, smokers of filtered menthol cigarettes have lower odds than those who smoked filtered non-menthol cigarettes, similar to a recent study of lung cancer by Blot et al, which also observed lower odds of cancer among menthol cigarette smokers, among both African-Americans and whites [20]. It is unclear if mentholation itself or smoking behaviors and other characteristics of smokers who choose mentholated cigarettes contribute to these findings.

Day et al did not examine other forms of tobacco use, but we observed racial differences in the relationship between smokeless tobacco and SCCHN. A review by Boffetta et al. examined 11 studies in the US and Europe and found an increased risk of oral cancer associated with smokeless tobacco among US-based studies (summary relative risk (RR), 95% CI: 2.6 1.3, 5.2) but not among those conducted in Europe (summary RR, 95% CI 1.0 0.7, 1.3) [21]. Among the US studies, there was evidence of heterogeneity, with two studies observing null results and larger effect estimates observed in studies of women only. We did not find strong associations between smokeless tobacco and SCCHN overall, but we did observe a greater association for snuff use when we restricted to only oral cavity sites (OR, 95% CI: 0.99 (0.61, 1.60) to 1.31 (0.48, 3.61), all sites vs. oral cavity only). Only one of the previous studies stratified by race and found greater odds of disease among white women who reported using dry snuff [22]. It was noted that the snuff used by these women had very high nitrosamine concentrations. It is possible that racial differences in the type of snuff used, as well as usage patterns, may contribute to the differences observed in our study.

Our findings that African-Americans had a greater odds of SCCHN associated with total alcohol consumption were consistent with the previous study of racial disparities in oropharyngeal cancer, but we obtained slightly different results when examining the effects of consumption frequency for the different types of alcohol. In Day et al, whites had greater odds ratios related to frequency of beer consumption than African-Americans, while African-Americans had greater odds ratios related to wine and hard liquor consumption. In our study, African-Americans had greater effects across all three types of alcohol. In general, the odds ratios related to alcohol consumption for African-Americans tended to be higher in our study. The odds ratios amongst whites tended to be higher in the previous study, especially at the higher levels of consumption. For example, in our study whites who consumed 30 or more servings of beer per week had an odds ratio of 2.5 (95%CI 1.64, 3.81) while Day et al observed an odds ratio of 6.2 (95% CI 3.9, 9.9) [11]. These differences could be partly due to the use of a different referent group in the two studies (combination of light and non-drinkers vs non-drinkers in the Day study) or the inclusion of laryngeal cases in our study. Additionally, changes in the ethanol content of the average beer consumed over the last two decades could also contribute to the differences observed in our study. For example, light beers, with lower ethanol contents, have increased their market share steadily since the

late 80s [23]. Because neither study incorporated type of beer or specific alcohol contents into the analysis, it is possible that a 12oz serving of beer, the metric of beer consumption used, represents slightly different ethanol amounts, causing differences in the observed odds of SCCHN.

Although we explored finer adjustments of education in our analysis, residual confounding related to unmeasured socioeconomic factors is one potential explanation for our findings, as previous research suggests associations between cancer incidence and socioeconomic status can vary by race [24, 25]. Recent research suggests that African-Americans and Whites may smoke cigarettes differently, with African-Americans smoking lower numbers of cigarettes per day more intensely, leading to higher values of biomarkers of exposure to nicotine and potential differences in carcinogen exposure given the same reported consumption of cigarettes [26].

Similarly, previous research has shown that African-Americans and whites consume different types of alcohol, which could explain some of the differences observed in their odds of SCCHN. Rothman et al reported that the risk of hypopharyngeal cancer was higher in those who consumed dark liquors when compared to light liquors, while the risk of laryngeal cancer was relatively similar [27]. Dark liquors, like cognacs, whiskeys, and dark rums, contain higher levels of non-alcoholic chemicals that could be potential carcinogens [27]. While Day et al observed that African-Americans were more likely to drink dark liquor, they did not see any difference in the odds of SCCHN related to different types of liquor [11]. There has been research which observed differences in cancer risk when examining consumption of red versus white wine [28, 29], although other studies have observed no difference [30]. It is plausible that differences in the specific types of alcoholic beverages consumed could contribute to the differences observed in our study.

It is also possible that racial differences in tobacco and alcohol metabolism could explain our results. Previous work among healthy smokers found that African-Americans had a lower ratio of urinary detoxification by-products to metabolites of the tobacco-related carcinogen 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK), compared to whites. This ratio is thought to be a measure of tobacco detoxification capacity. [31]. Additionally, a number of studies, with mixed results, have examined the relationship between SCCHN and polymorphisms in genes which code for the metabolic enzymes which are involved in either the activation or detoxification of chemicals found in tobacco and/or alcohol, although there has been limited research in African-American populations [32, 33]. A meta-analysis by Varela-Lema et al found an association between one of these polymorphisms, GSTM1-deletion, and oral cancer only among African-Americans and other populations of African descent, suggesting the potential for gene-gene or gene-environment interactions to explain racial disparities in cancer incidence [34].

Previous research suggests that although men are more likely to have SCCHN, than women, the relationship between tobacco and SCCHN is stronger in women [35]. It is possible that gender differences between the racial groups being compared could cause differences in the observed odds ratios. However, there were similar percentages of women in both the African-American and White groups, and we matched on and adjusted for sex in our study. Additionally, we conducted a sex- and race-stratified analysis and found that racial differences persisted although effect measure estimates were higher, but highly imprecise due to small numbers of women, consistent with previous research. For example, odds ratios for smoking more than 20 cigarettes per day were 2.05 (1.49, 2.82) and 4.63 (3.00, 7.15) in white and African-American men respectively, but 10.7 (4.99, 22.7) and 24.0 (10.6, 54.6) in white and African-American women respectively.

Our study is among the largest individual population-based studies of head and neck cancer conducted in the United States. We were able to collect and examine detailed information about intensity and duration of tobacco and alcohol use in both African-Americans and whites, enabling us to determine how the independent and joint effects of these factors may differentially impact racial groups. We had a large enough sample size to examine the relationship between tobacco and alcohol with different tumor sites, and the population-based design gives us confidence that our results are generalizable to the underlying population.

Although we have a larger number of African-Americans in our sample than previous studies, the still relatively small number led to imprecise estimates when examining certain exposures. We did not have molecular confirmation of HPV-related cases. Our classification relied on previous research which identified sites shown to be associated with HPV infection [10]. Despite this potential for misclassification, our tobacco-related findings among whites were relatively consistent with previous studies which utilized serology to identify HPV-related cases, although we did not observe differences in SCCHN and alcohol use associations by HPV-status similar to previous studies [36, 37]. Our response among controls was low at 48%, and varied by race with African-American controls having a lower response. While we do not have data on persons who refused participation, our overall findings regarding tobacco and alcohol as risk factors for SCCHN are consistent with the literature, supporting the validity of our study. Comparing our controls to results from the 2002–2005 Behavioral Risk Factor Surveillance System (BRFSS) surveys in North Carolina suggests that the controls were more likely to ever smoke than the general adult population of North Carolina within the relevant age range, although our controls were more likely to be male which could explain part of this discrepancy [38]. This control selection could have caused our estimates to be lower in magnitude, but would not likely explain the large differences observed between African-Americans and Whites as both races had greater prevalence of smoking than their BRFSS counterparts. While recall bias is a limitation inherent to the case-control design, there is no evidence to suggest that recall of tobacco and alcohol use varies by race.

In summary, our study found that the relationships between tobacco, alcohol and SCCHN vary by race, with these risk factors having a greater impact on African-Americans. These differences may be explained by differences in metabolism, use and cessation patterns and/or socioeconomic factors that are not fully accounted for in our study. Future studies should continue to examine racial differences in patterns and metabolism of tobacco and alcohol in order to understand the racial disparities in SCCHN observed in the United States.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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ABBREVIATIONS

CHANCE	Carolina Head and Neck Cancer Study
CI	confidence interval

ETS	Environmental tobacco smoke
HPV	Human pappillomavirus
ICR	Interaction Contrast Ratio
INHANCE	International Head and Neck Cancer Epidemiology Consortium
OR	odds ratio
RR	relative risk
SCCHN	squamous cell carcinoma of the head and neck
SEER	Surveillance Epidemiology and End Results

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Table 1

Demographic Profile of SCCHN Cases and Controls in the Carolina Head and Neck Cancer Study (CHANCE), 2002–2006, Stratified by Race

	Overall (n=2718)				African-Americans (n=615)				Whites (n=2103)			
	Cases	n=1340	Controls	n=1378	Cases	n=351	Controls	n=264	Cases	n=989	Controls	n=1114
	n	%	n	%	n	%	n	%	n	%	n	%
Age												
20–49	254	19	156	11.3	84	23.9	36	13.6	170	17.2	120	10.8
50–54	210	15.7	161	11.7	71	20.2	47	17.8	139	14.1	114	10.2
55–59	222	16.6	207	15	66	18.8	49	18.6	156	15.8	158	14.2
60–64	229	17.1	205	14.9	57	16.2	46	17.4	172	17.4	159	14.3
65–69	178	13.3	247	17.9	36	10.3	43	16.3	142	14.4	204	18.3
70–74	152	11.3	231	16.8	26	7.4	24	9.1	126	12.7	207	18.6
75–80	95	7.1	171	12.4	11	3.1	19	7.2	84	8.5	152	13.6
Sex												
Male	1021	76.2	960	69.7	279	79.5	185	70.1	742	75	775	69.6
Female	319	23.8	418	30.3	72	20.5	79	29.9	247	25	339	30.4
Education High school or less	837	62.5	549	39.8	311	88.6	137	51.9	526	53.2	412	37
Some college	313	23.4	410	29.8	34	9.7	68	25.8	279	28.2	342	30.7
College or more	190	14.2	419	30.4	6	1.7	59	22.4	184	18.6	360	32.3
Proxy Status												
Self	1289	96.2	1361	98.8	330	94	261	98.9	959	97	1100	98.7
Proxy	51	3.8	17	1.2	21	6	3	1.1	30	3	14	1.3
Fruit Consumption, mean (sd)	2.15 (1.69)		2.56 (1.72)		2.24 (2.01)		2.50 (1.66)		2.12 (1.58)		2.57 (1.73)	
Vegetable Consumption, mean (sd)	2.41 (1.29)		2.14 (0.97)		2.45 (1.77)		2.09 (1.15)		2.40 (1.10)		2.15 (0.92)	

sd: standard deviation

[a]Fruit/vegetable consumption data was unavailable for proxy respondents.

Table 2

Relationship Between Tobacco Use and SCCHN Within the Carolina Head and Neck Cancer Study (CHANCE) 2002–2006, Stratified by Race

	Overall							African-Americans							Whites						
	Cases		Controls		Crude		Adjusted	Cases		Controls		Crude		Adjusted	Cases		Controls		Crude		Adjusted
	n	%	n	%	OR	OR	95% CI	n	%	n	%	OR	OR	95% CI	n	%	n	%	OR	OR	95% CI
Current Cigarette Use																					
Never smoked	173	12.9	525	38.1	1	1		16	4.6	103	39	1	1		157	15.9	422	37.9	1	1	
Ex-smoker	394	29.5	583	42.3	2.16	1.63	1.26, 2.11	80	22.9	97	36.7	5.68	5.73	2.66, 12.4	314	31.8	486	43.7	1.83	1.37	1.04, 1.81
Current Smoker	770	40.3	269	19.5	8.26	3.92	3.00, 5.13	253	72.5	64	24.2	25.8	15.1	7.11, 32.0	517	52.3	205	18.4	6.53	3.14	2.36, 4.20
																					Likelihood Ratio Test: $\chi^2 = 19.0$ df=2, $P<0.001$
Cigarettes Per Day																					
Never Smokers	173	13	525	38.2	1	1		16	4.6	103	39	1	1		157	15.9	422	37.9	1	1	
1–19	231	17.3	338	24.6	1.95	1.48	1.12, 1.97	107	30.6	95	36	7.38	6.39	3.00, 13.6	124	12.6	243	21.9	1.43	1.14	0.83, 1.58
20+	931	69.7	512	37.2	5.87	3.14	2.44, 4.05	227	64.9	66	25	22.6	15.1	7.09, 32.3	704	71.5	446	40.1	4.57	2.51	1.92, 3.27
																					Likelihood Ratio Test: $\chi^2 = 26.3$ df=2, $P<0.001$
Years Smoked																					
Never Smokers	173	13	525	38.2	1	1		16	4.7	103	39	1	1		157	15.9	422	38.1	1	1	
1–19	119	9	294	21.4	1.08	1.03	0.75, 1.41	19	5.5	55	20.8	2.05	2.75	1.10, 6.90	100	10.1	239	21.6	0.99	0.92	0.65, 1.28
20–39	499	37.6	334	24.3	3.95	2.47	1.87, 3.25	179	52.2	69	26.1	13.7	11.1	5.16, 23.9	320	32.4	265	23.9	3	1.89	1.41, 2.55
40–49	344	25.9	142	10.3	9.83	5.18	3.74, 7.19	90	26.2	31	11.7	30.6	21.4	8.87, 51.4	254	25.8	111	10	8.01	4.24	2.98, 6.05
50+	194	14.6	78	5.68	14.5	6.36	4.28, 9.43	39	11.4	6	2.27	95.5	47.3	13.3, 167	155	15.7	72	6.49	10.7	4.91	3.25, 7.42
																					Likelihood Ratio Test: $\chi^2 = 26.5$ df=4, $P<0.001$
Years Since Quitting																					
Never Smoked	173	12.9	525	38.1	1	1		16	4.6	103	39	1	1		157	15.9	422	37.9	1	1	
Current Smokers	770	57.6	269	19.5	8.31	4.05	3.09, 5.30	253	72.5	64	24.2	26.2	15.4	7.26, 32.8	517	52.3	205	18.4	6.55	3.2	2.41, 4.31
1–9	167	12.5	111	8.1	4.63	2.98	2.11, 4.20	40	11.5	20	7.6	14.2	13	5.15, 32.7	127	12.9	91	8.2	3.77	2.36	1.62, 3.44
10–19	93	7	138	10	2.07	1.45	1.01, 2.09	22	6.3	27	10.2	5.28	4.46	1.70, 11.7	71	7.2	111	10	1.76	1.25	0.84, 1.87
20+	134	10	334	24.3	1.28	1.16	0.85, 1.58	18	5.2	50	18.9	2.16	2.75	1.06, 7.13	116	11.7	284	25.5	1.17	1.04	0.75, 1.44
																					Likelihood Ratio Test: $\chi^2 = 20.4$ df=4, $P<0.001$
Age Started Smoking																					
Never Smokers	173	13	525	38.2	1	1		16	4.6	103	39	1	1		157	15.9	422	38	1	1	

	Overall							African-Americans							Whites						
	Cases		Controls		Crude		Adjusted	Cases		Controls		Crude		Adjusted	Cases		Controls		Crude		Adjusted
	n	%	n	%	OR	OR	95% CI	n	%	n	%	OR	OR	95% CI	n	%	n	%	OR	OR	95% CI
<17	706	53	405	29.5	5.37	2.7	2.07, 3.52	201	58.3	65	24.6	21.9	14.9	6.83, 32.4	505	51.2	340	30.6	4.1	2.05	1.55, 2.73
17–24	403	30.3	389	28.3	3.22	2.22	1.71, 2.89	114	33	84	31.8	8.71	6.91	3.24, 14.7	289	29.3	305	27.5	2.73	1.95	1.47, 2.59
25+	50	3.8	55	4	2.89	2.01	1.22, 3.29	14	4.1	12	4.6	8.48	9.26	2.81, 30.5	36	3.7	43	3.9	2.37	1.56	0.90, 2.73
																					Likelihood Ratio Test: χ^2 = 29.0 df=3, P<0.001
Type of Cigarette																					
Never Smokers	173	13	525	38.3	1	1		16	4.6	103	39.2	1	1		157	15.9	422	38.1	1	1	
Filtered Menthols	277	20.8	180	13.1	3.98	2.37	1.74, 3.25	147	42.1	78	29.7	14	7.18	3.36, 15.3	130	13.2	102	9.21	3.45	2.15	1.49, 3.10
Filtered Non-menthols	581	43.5	377	27.5	4.6	2.55	1.98, 3.31	108	31	44	16.7	28	15.3	6.67, 35.1	473	48	333	30.1	3.42	2.04	1.55, 2.67
Filtered Menthols and Non-menthols	70	5.24	63	4.6	3.19	1.91	1.20, 3.02	20	5.73	11	4.2	19.4	8.29	2.54, 27.0	50	5.1	52	4.69	2.22	1.56	0.94, 2.59
Unfiltered	75	5.62	101	7.37	2.95	1.58	1.03, 2.42	18	5.16	13	4.9	19.9	9.12	2.95, 28.3	57	5.8	88	7.94	2.06	1.23	0.77, 1.96
Both filtered and unfiltered menthols and/or non-menthols	159	11.9	125	9.2	4.81	2.61	1.81, 3.77	40	11.5	14	5.3	38.1	15.8	5.48, 45.7	119	12.1	111	10	3.14	2.05	1.39, 3.04
																					Likelihood Ratio Test: χ^2 = 28.4 df=5, P<0.001
Ever Cigar																					
No	1010	75.5	1060	77	1	1		276	79.1	214	81.1	1	1		734	74.3	846	76	1	1	
Yes	327	24.5	317	23	1.05	0.87	0.68, 1.13	73	20.9	50	18.9	0.98	1.03	0.61, 1.74	254	25.7	267	24	1.07	0.84	0.63, 1.12
																					Likelihood Ratio Test: χ^2 = 0.47 df=1, P=0.49
Ever Pipe																					
No	1122	83.9	1099	79.9	1	1		315	90	232	87.9	1	1		734	74.3	846	76	1	1	
Yes	215	16.1	276	20.1	0.8	0.75	0.56, 1.00	35	10	32	12.1	0.79	0.76	0.39, 1.50	180	18.3	244	22	0.8	0.75	0.55, 1.01
																					Likelihood Ratio Test: χ^2 = 0.006 df=1, P=0.94
Ever Chew																					
No	1128	84.2	1218	88.5	1	1		298	84.9	241	91.3	1	1		734	74.3	846	76	1	1	
Yes	211	15.8	159	11.6	1.46	1.18	0.87, 1.61	53	15	23	8.7	1.96	1.72	0.84, 3.51	158	16	136	12.2	1.36	1.1	0.80, 1.53
																					Likelihood Ratio Test: χ^2 = 1.31 df=1, P=0.25
Ever Snuff																					
No	1268	94.6	1325	96.3	1	1		318	90.6	252	95.5	1	1		734	74.3	846	76	1	1	
Yes	72	5.4	51	3.7	1.41	0.99	0.61, 1.60	33	9.4	12	4.6	2.98	2.35	0.93, 5.95	39	3.9	39	3.51	0.99	0.72	0.42, 1.26

	Overall							African-Americans							Whites						
	Cases		Controls		Crude		Adjusted	Cases		Controls		Crude		Adjusted	Cases		Controls		Crude		Adjusted
	n	%	n	%	OR	OR	95% CI	n	%	n	%	OR	OR	95% CI	n	%	n	%	OR	OR	95% CI
																					Likelihood Ratio Test: χ^2 = 4.92 df=1, *P*=0.027
Tobacco Type																					
None	127	9.5	442	32.1	1	1		8	2.3	88	33.3	1	1		119	12.1	354	31.8	1	1	
Cigarettes Only	801	60	490	35.6	5.62	2.87	2.19, 3.75	250	71.6	104	39.4	26.9	14.4	5.88, 35.5	551	55.9	386	34.9	4.30	2.29	1.72, 3.04
Cigars and/or Pipes	33	2.5	58	4.2	2.08	1.64	0.94, 2.83	3	0.9	6	2.3	4.52	5.57	0.82, 37.9	30	3.0	52	4.7	1.79	1.38	0.78, 2.46
Cigarettes and Cigars and/or Pipes	361	27	362	26.3	3.48	1.75	1.27, 2.39	83	23.8	57	21.6	15.5	9.87	3.73, 26.0	278	28.2	305	27.4	2.75	1.37	0.98, 1.92
Smokeless Tobacco	13	1.0	25	1.8	1.73	0.9	0.38, 2.07	5	1.4	9	3.4	8.59	2.52	0.41, 15.7	8	0.8	16	1.4	1.23	0.86	0.33, 2.28
																					Likelihood Ratio Test: χ^2 = 22.3 df=4, *P*<0.001

CI: Confidence Interval df: degrees of freedom; OR: odds ratio

[a]All models exclude missing data. Crude models adjusted for matching factors and their interactions. Adjusted models include matching factors, their interactions, and education, fruit and vegetable consumption and total alcohol consumption; Cigarette models also adjusted for other tobacco use; Other tobacco ever models adjusted for duration of cigarette smoking and use of other forms of tobacco.

Table 3

Relationship Between Exposure to Environmental Tobacco Smoke and SCCHN Within the Carolina Head and Neck Cancer Study (CHANCE) 2002–2006, Stratified by Race and Self Use of Tobacco

	Overall							African-Americans							Whites						
	Cases		Controls		Crude		Adjusted	Cases		Controls		Crude		Adjusted	Cases		Controls		Crude		Adjusted
	n	%	n	%	OR	OR	95% CI	n	%	n	%	OR	OR	95% CI	n	%	n	%	OR	OR	95% CI
3a. Never Used Tobacco Products																					
Exposed to Cigarettes at Home																					
Yes	53	42.4	188	42.9	1	1		2	25	37	43	1	1		51	43.6	151	42.9	1	1	
No	72	57.6	250	57.1	1.12	0.82	0.53, 1.27	6	75	49	57	1.1	0.81	0.45, 1.45	66	56.4	201	57	1.12	0.82	0.52, 1.28
Amount of Cigarettes Exposed to Daily																					
None	72	57.6	250	58.3	1	1		6	75	49	58.3	1	1		66	56.4	201	58.3	1	1	
1–19	33	26.4	113	26.3	1.17	0.86	0.51, 1.43	1	12.5	29	34.5	0.95	0.74	0.38, 1.43	32	27.4	84	24.4	1.25	0.9	0.53, 1.52
20 or more	20	16	66	15.4	1.25	0.86	0.47, 1.57	1	12.5	6	7.14	1.66	1.12	0.51, 2.48	19	16.2	60	17.4	1.21	0.84	0.46, 1.54
3b. Ever Used Tobacco Products																					
Exposed to Cigarettes at Home																					
Yes	800	69	539	58.5	1	1		209	65.5	98	56	1	1		591	70	441	59	1	1	
No	359	31	383	41.5	1.62	1.31	1.06, 1.61	110	34.5	77	44	1.6	1.29	0.86, 1.96	249	29.6	306	41	1.63	1.31	1.04, 1.66
Amount of Cigarettes Exposed to Daily																					
None	359	32	383	41.8	1	1		110	36.2	77	44.8	1	1		249	30.4	306	41.1	1	1	
1–19	269	24	278	30.4	1.06	1.01	0.78, 1.29	76	25	60	34.9	0.86	0.86	0.54, 1.39	193	23.6	218	29.3	1.14	1.06	0.80, 1.41
20 or more	494	44	255	27.8	2.06	1.58	1.24, 2.02	118	38.8	35	20.4	2.65	2	1.18, 3.40	396	46	220	29.6	1.96	1.5	1.15, 1.97

CI: confidence interval; df: degrees of freedom; OR: odds ratio

[a] All models exclude missing data. Crude models adjusted for matching factors and their interactions. Adjusted models include matching factors, their interactions, and education, fruit and vegetable consumption and total alcohol consumption

[b] Likelihood ratio test for effect measure modification by race: Any exposure in the home: χ^2=0.003, df=1, *P*=0.96; Amount of cigarettes exposed to daily: χ^2=2.64, df=3, *P*=0.45

Table 4

Relationship Between Alcohol Consumption and SCCHN within the Carolina Head and Neck Cancer Study (CHANCE) 2002–2006, Stratified by Race

	Overall							African-Americans							Whites						
	Cases		Controls		Crude		Adjusted	Cases		Controls		Crude		Adjusted	Cases		Controls		Crude		Adjusted
Alcohol Use	**n**	**%**	**n**	**%**	**OR**	**OR**	**95% CI**	**n**	**%**	**n**	**%**	**OR**	**OR**	**95% CI**	**n**	**%**	**n**	**%**	**OR**	**OR**	**95% CI**
Total Alcohol Consumption (ml of ethanol)																					
Never	124	10.1	296	22.3	1	1		10	3.14	56	22	1	1		115	12.6	240	22.6	1	1	
Up to 11,232	59	4.79	161	12.1	0.78	0.73	0.48, 1.11	3	0.94	29	11.4	0.62	0.47	0.09, 2.42	56	6.12	132	12.3	0.77	0.74	0.48, 1.14
11,232–204,469	234	19	406	30.6	1.32	1.19	0.86, 1.64	37	11.6	68	26.7	3.41	2.32	0.96, 5.61	197	21.5	338	31.5	1.13	1.08	0.76, 1.51
204–469–927,946	319	25.9	321	24.2	2.52	1.88	1.35, 2.61	78	24.5	62	24.3	8.49	4.71	1.97, 11.3	241	26.3	259	24.1	2.01	1.6	1.13, 2.29
927,946 and greater	496	40.2	144	10.8	9.03	4.01	2.80, 5.76	190	59.8	40	15.7	33.2	11.6	4.75, 28.4	306	33.4	104	9.69	6.71	3.17	2.13, 4.71
																					Likelihood Ratio Test: χ^2 =12.2 df=4, P=0.02
Beers Per Week																					
None	243	18.4	499	36.4	1	1		38	11.1	88	33.6	1	1		205	20.9	411	37.1	1	1	
<1	111	8.4	189	13.8	1.26	0.94	0.66, 1.34	12	3.5	31	11.8	0.81	0.67	0.28, 1.61	99	10.1	158	14.3	1.32	0.98	0.67, 1.43
1–4	193	14.6	295	21.5	1.42	1.13	0.83, 1.55	45	12.1	43	16.4	2.41	1.78	0.90, 3.51	148	15.1	252	22.7	1.24	1.02	0.72, 1.44
5–14	282	21.3	239	17.4	2.44	1.37	1.00, 1.89	97	28.3	62	23.7	3.29	1.66	0.91, 3.04	185	18.9	177	16	2.2	1.32	0.92, 1.88
15–29	163	12.3	72	5.3	4.68	2.16	1.46, 3.19	52	15.2	22	8.4	5.12	2.69	1.29, 5.62	111	11.3	50	4.5	4.61	2.02	1.29, 3.18
30+	331	25	77	5.6	8.77	2.85	1.96, 4.16	99	28.9	16	6.11	12.3	4.42	2.08, 9.40	232	23.7	61	5.5	7.89	2.5	1.64, 3.81
																					Likelihood Ratio Test: χ^2 = 5.8 df=5, P=0.33
Years Drank Beer																					
None	243	18.6	499	36.7	1	1		38	11.2	88	33.7	1	1		205	21.2	411	37.4	1	1	
<10	67	5.1	92	6.8	1.31	0.78	0.51, 1.19	14	4.1	23	8.8	1.16	0.81	0.34, 1.96	53	5.5	69	6.3	1.39	0.79	0.48, 1.28
10–19	115	8.8	134	9.9	1.44	0.97	0.57, 1.40	33	9.7	35	13.4	1.98	1.51	0.73, 3.15	82	8.5	99	9	1.33	0.85	0.56, 1.30
20+	885	67.6	636	46.7	2.79	1.67	1.27, 2.21	255	75	115	44.1	4.63	2.26	1.30, 3.95	630	65	521	47.4	2.42	1.55	1.15, 2.10
																					Likelihood Ra tio Test: χ^2 = 2.65 df=3, P=0.45
Wines Per Week																					
None	634	48.2	597	43.5	1	1		110	32.5	128	48.7	1	1		524	53.7	469	42.3	1	1	
<1	203	15.4	327	23.9	0.55	0.63	0.48, 0.81	15	4.42	47	17.9	0.35	0.36	0.18, 0.74	188	19.3	280	25.3	0.57	0.65	0.49, 0.86
1–4	206	15.7	284	20.7	0.59	0.62	0.47, 0.82	58	17.1	49	18.6	1.22	1.06	0.61, 1.84	148	15.2	235	21.2	0.49	0.53	0.39, 0.72
5–14	131	10	124	9	0.97	1.02	0.72, 1.43	51	15	22	8.4	2.63	1.57	0.79, 3.10	80	8.2	102	9.2	0.71	0.88	0.59, 1.29

	Overall							African-Americans							Whites						
	Cases		Controls		Crude		Adjusted	Cases		Controls		Crude		Adjusted	Cases		Controls		Crude		Adjusted
Alcohol Use	**n**	**%**	**n**	**%**	**OR**	**OR**	**95% CI**	**n**	**%**	**n**	**%**	**OR**	**OR**	**95% CI**	**n**	**%**	**n**	**%**	**OR**	**OR**	**95% CI**
15–29	50	3.8	28	2	1.46	0.89	0.49, 1.60	31	9.1	10	3.8	3.21	1.31	0.55, 3.15	19	2	18	1.6	0.92	0.67	0.30, 1.52
30+	91	6.9	11	8	6.08	3.42	1.71, 6.89	74	21.8	7	2.7	10.5	4.58	1.92, 11.0	17	1.7	4	0.4	3.36	2.36	0.67, 8.24
																					Likelihood Ratio Test: χ^2 = 12.7 df=5, P=0.027
Years Drank Wine																					
None	634	48.9	597	44	1	1		110	32.7	128	49	1	1		524	54.6	469	42.8	1	1	
<10	121	9.3	159	11.7	0.6	0.53	0.38, 0.73	40	11.9	29	11.1	1.4	1.1	0.56, 2.13	81	8.4	130	11.9	0.49	0.43	0.30, 0.62
10–19	143	11	120	8.8	0.94	1	0.72, 1.40	42	12.5	25	9.6	1.65	1.45	0.75, 2,80	101	10.5	95	8.7	0.83	0.9	0.62, 1.32
20+	398	30.7	482	35.5	0.71	0.76	0.60, 0.96	144	42.9	79	30.3	1.91	1.12	0.70, 1.78	254	26.5	403	36.7	0.55	0.68	0.42, 0.89
																					Likelih ood Ratio Test: χ^2 = 7.35 df=3, P=0.061
Liquor Per Week																					
None	276	20.9	491	35.9	1	1		40	11.6	87	33.2	1	1		236	24.2	404	36.5	1	1	
<1	190	14.4	276	20.2	1.09	1.24	0.91, 1.68	13	3.8	35	13.4	0.76	0.67	0.28, 1.60	177	18.2	241	21.8	1.1	1.3	0.94, 1.80
1–4	228	17.3	299	21.8	1.3	1.29	0.95, 1.75	40	11.6	51	19.5	1.84	1.57	0.78, 3.15	188	19.3	248	22.4	1.22	1.25	0.90, 1.74
5–14	205	15.5	168	12.3	2.22	1.58	1.13, 2.21	73	21.2	41	15.7	4.37	3.22	1.64, 6.34	132	13.5	127	11.5	1.82	1.26	0.87, 1.84
15–29	163	12.4	72	5.3	4.09	2.31	1.56, 3.44	50	14.5	24	9.2	5.39	3.42	1.60, 7.34	113	11.6	48	4.3	3.96	2.13	1.35, 3.34
30+	257	19.5	63	4.6	7.12	3.53	2.37, 5.26	128	37.2	24	9.2	12.6	5.75	2.83, 11.7	129	13.2	39	3.5	5.61	2.93	1.82, 4.71
																					Likelihood Ratio Test: χ^2 = 14.1 df=5, P=0.015
Years Drank Liquor																					
None	276	21.1	491	36.1	1	1		87	33.2	40	11.7	1	1		236	24.5	404	36.8	1	1	
<10	106	8.1	126	9.3	1.11	0.97	0.66, 1.40	26	9.9	20	5.9	1.28	1.35	0.58, 3.17	86	8.9	100	9.1	1.1	0.91	0.60, 1.37
10–19	157	12	148	10.9	1.49	1.47	1.04, 2.08	39	14.9	39	11.4	1.98	2.18	1.08, 4.42	118	12.2	109	9.9	1.47	1.36	0.93, 2.00
20+	767	58.7	594	43.7	2.22	1.83	1.39, 2.41	110	42	242	71	5.14	2.88	1.61, 5.14	525	54.4	484	44.1	1.83	1.67	1.25, 2.24
																					Likelihood Ratio Test: χ^2 = 3.16 df=3, P=0.37

CI: confidence interval; df: degrees of freedom; OR: odds ratio

[a]All models exclude missing data. Crude models adjusted for matching factors and their interactions. Adjusted models include matching factors, their interactions, and education, fruit and vegetable consumption, duration of cigarette smoking, ever use of other tobacco products and use of other alcohol types.

Table 5

Joint Effects of Cigarette Use and Alcohol Consumption on SCCHN Within the Carolina Head and Neck Cancer Study (CHANCE), 2002–2006, Stratified by Race

Years of Smoking	Alcohol Drinks/Week									
	Never or Less than 1		1–4		5–14		15–29		30+	
	OR (N)	95% CI	OR (N)	95% CI	OR (N)	95% CI	OR (N)	95% CI	OR (N)	95% CI
					5a. Overall					
Never Smoker	1 (297)		1.16 (185)	0.71, 1.89	2.35 (127)	1.41, 3.92	1.28 (45)	0.58, 2.86	3.76 (41)	1.78, 7.97
<20 years	1.27 (66)	0.66, 2.47	1.18 (103)	0.66, 2.12	1.88 (133)	1.12, 3.14	1.69 (60)	0.86, 3.35	4.21 (46)	2.08, 8.53
>20 years	3.93 (156)	2.49, 6.22	4.03 (211)	2.64, 6.17	4.71 (279)	3.15, 7.08	8.24 (253)	5.38, 12.6	16.0 (637)	10.8, 23.7
					5b. African-Americans					
Never Smoker	1 (60)		1.15 (24)	0.39, 3.42	1.81 (13)	0.62, 5.29	1.89 (9)	0.56, 6.43	5.97 (12)	1.93, 18.5
<20 years	2.69 (5)	0.84, 8.60	2.71 (21)	0.74, 9.97	3.37 (14)	0.95, 11.9	5.35 (16)	1.49, 19.1	13.1 (16)	3.82, 45.2
>20 years	15.9 (15)	6.49, 38.7	16.5 (28)	5.09, 53.2	15.6 (54)	5.43, 44.8	43.5 (67)	14.9, 127	78.5 (233)	28.8, 214
					5c. Whites					
Never Smoker	1 (237)		1.10 (161)	0.67, 1.82	2.21 (114)	1.31, 3.74	1.26 (36)	0.55, 2.86	4.13 (29)	1.87, 9.10
<20 years	1.10 (61)	0.56, 2.14	1.07 (82)	0.58,1.97	1.68 (119)	0.99, 2.86	1.45 (44)	0.71, 2.98	3.71 (30)	1.73, 7.96
>20 years	3.27 (141)	2.05, 5.22	3.27 (183)	2.10, 5.10	3.94 (225)	2.56, 6.08	5.97 (186)	3.77, 9.45	11.2 (404)	7.34, 17.2