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Smoking Behavior and Lung Cancer in a Biracial Cohort:

The Atherosclerosis Risk in Communities Study

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Abstract

Background—In the U.S., the incidence of lung cancer varies by race, with rates being highest among black men. There are marked differences in smoking behavior between blacks and whites, but little is known regarding how these differences contribute to the racial disparities in lung cancer.

Purpose—To compare the lung cancer risk associated with smoking in 14,610 blacks and whites in the prospective cohort Atherosclerosis Risk in Communities study.

Methods—Smoking characteristics were ascertained at baseline and three follow-up visits in 1990–1992, 1993–1995, and 1996–1998 (response rates were 93%, 86%, and 80%, respectively),

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as well as from annual telephone interviews. Data were analyzed in the fall of 2012. Multivariable-adjusted proportional hazards models were used to calculate hazard ratios and 95% CIs for lung cancer.

Results—Over 20 years of follow-up (1987–2006), 470 incident cases of lung cancer occurred. Lung cancer incident rates were highest in black men and lowest in black women. However, there was no evidence to support racial differences in the associations of smoking status, intensity, or age at initiation with lung cancer risk (all $p_{\text{interaction}} > 0.25$). The hazard ratio for those who started smoking at age ≤ 12 versus >22 years was 3.03 (95% CI=1.62, 5.67). Prolonged smoking cessation (≥ 10 years) was associated with a decrease in lung cancer risk, with equivalent benefits in whites and blacks, 84% and 74%, respectively ($p_{\text{interaction}}=0.25$).

Conclusions—Smoking confers similar lung cancer risk in blacks and whites.

Introduction

In the U.S., despite the falling prevalence of cigarette smoking over the past three decades, lung cancer remains the leading cause of neoplastic mortality, responsible for more than 160,000 deaths each year and an annual incidence of more than 226,000 cases.¹ These estimates belie the marked racial disparity in both incidence and mortality from lung cancer between black and white men: in the U.S. (2004–2008), the age-adjusted incidence rates (per 100,000 person-years) were 102.7 in black men, 83.7 in white men, 51.4 in black women, and 57.2 in white women.¹

Tobacco exposure has been estimated to explain 90% of all lung cancer cases.² However, differences in smoking behavior are unlikely to explain all racial difference in lung cancer incidence and mortality. Compared with whites, black men tend to start smoking later and smoke fewer cigarettes but are less likely to quit.³ Higher lung cancer incidence and mortality and lower smoking quit rates in black compared to white smokers may be due to the fact that, on average, blacks consume 30% more nicotine per cigarette than white smokers⁴ and have higher serum cotinine levels even after controlling for the number of cigarettes per day (cpd), nicotine content, and frequency of inhalation.^{5,6} Additionally, blacks become nicotine dependent at lower numbers of cpd than whites.⁷

The few epidemiologic studies that have examined race-specific lung cancer hazards associated with smoking reported contradictory results.^{8–13} Two case-control studies did not find any differences in lung cancer risk between blacks and whites in relation to smoking and smoking cessation,^{8,9} whereas the Multiethnic Cohort Study¹³—the only cohort study among these studies—reported that, in those who smoked 10–20 cpd, white smokers of both genders had approximately half the risk of lung cancer compared with black smokers, but the associations were comparable among heavy smokers.¹³ Given this ongoing uncertainty and lack of prospective studies, we used prospective data from the biracial Atherosclerosis Risk in Communities (ARIC) study to explore whether racial differences exist in the association between smoking-related behavior and risk of lung cancer.

Methods

Study Design, Population, and Data Collection

In 1987–1989 (Visit 1), 15,792 people aged 45–64 years from the four following communities were recruited: Forsyth County NC, Jackson MS, suburban Minneapolis MN, and Washington County MD (overall response rate=60%).^{14,15} Participants from Washington County and Minneapolis were almost exclusively white (99.4%), whereas the Forsyth sample included 12% blacks and 88% whites. The Jackson sample consisted solely of blacks. For this analysis, 1,187 participants were excluded if they were not black or white ($n=48$), were blacks from Minneapolis and Washington County ($n=55$), did not consent to participate in studies of non-cardiovascular diseases ($n=187$), self-reported history of cancer at baseline ($n=882$), or had missing values on smoking at baseline ($n=12$) (some individuals were excluded for more than one reason), leaving 14,610 for the present analysis.

Three follow-up visits (1990–1992, 1993–1995, and 1996–1998) occurred and the response rates at each visit (93%, 86%, and 80%, respectively) were calculated as the number of participants at the current visit divided by the number at baseline minus the number of those who died between baseline and that visit. Additionally, participants were contacted annually by telephone to ascertain hospitalizations and deaths through December 2006, so that approximately 94% of the enrolled cohort still living was participating in follow-up calls. The ARIC study protocol was approved by the IRB of each participating university and informed consent was obtained from each study participant.

Exposure Ascertainment

Questionnaires were used to assess education, household income, alcohol intake, physical activity, and history of cancer. Physical activity was assessed by the Baecke questionnaire.¹⁶ Anthropometric characteristics were measured by certified technicians.

Ascertainment of smoking behavior was obtained by interview at each follow-up visit. Additional information about smoking status was recorded annually via a telephone interview from the 11th year after baseline through 2006. For the analysis of smoking status at baseline, participants were grouped into current, former, and never smokers. Additional data on smoking habits among current and former smokers was also recorded: average number of cpd at baseline and during follow-up, age at smoking initiation and age at smoking cessation. Pack-years of smoking at baseline were calculated as the average number of cpd multiplied by the years of smoking divided by 20. When specific questions about smoking behavior were not answered (e.g., for time of quitting, 33 responses were missing), these people were excluded from the corresponding analysis but kept in other analyses.

Outcome Ascertainment

Incident lung cancers were ascertained in 1987–2006 by linkage to cancer registries and supplemented by hospital records.^{17,18} Primary site, date of cancer diagnosis, and source of diagnostic information were recorded. Information about lung cancer stage or histology was not collected.

Statistical Analysis

Participants' characteristics were examined across smoking status separately for black and white men and women using a general linear model or chi-square test. Age-adjusted incidence rates for lung cancer were calculated using Poisson regression. The participants were followed from baseline until date of lung cancer diagnosis, death, loss to follow-up, or the end of follow-up in December 31, 2006, whichever occurred first. Cox proportional hazards regression models were used to estimate hazard ratios (HR) and 95% CIs of lung cancer in relation to smoking characteristics. The assumption of proportional hazards was tested by adding to the model an interaction term between follow-up time and exposure of interest, as well as by inspection of the log (–log(survival function)) curves. There was no evidence that these assumptions were violated for smoking status or pack-years. Two models were used in the analysis of smoking behavior and outcome: Model 1 was adjusted for baseline age, gender, race, and study center; and Model 2 was additionally adjusted for smoking characteristics depending on the analysis. Further adjustment for education, BMI, sport index, or alcohol intake did not markedly change the associations and these variables were not included in the final model.

The analyses of lung cancer and smoking status at baseline were additionally adjusted for pack-years of smoking. To assess whether age at smoking initiation was an independent risk factor for lung cancer in current smokers, we categorized it into five groups (12, 13–15, 16–18, 19–21, and ≥22 years) using ≥22 years as the reference group. The models were adjusted for the number of cpd at baseline and the total number of smoking years (as a time-dependent variable), which incorporated information from the baseline and follow-up questionnaires and was updated until the end of follow-up. For the analysis of smoking cessation, the lung cancer risk was estimated for former smokers with the time of smoking cessation of 1–3, 4–9, or ≥10 years versus current smokers at baseline. Former smokers with smoking cessation time ≥1 year were considered current smokers. This model was also adjusted for the number of cpd and number of smoking years. The cut-off points for all smoking characteristics were selected based on the distribution of the entire cohort.¹⁹

Multiplicative interactions of race and gender with smoking characteristics were assessed by including cross-product terms in Model 1. There was 80% and 90% power to detect an interaction between race and the number of cigarettes of 2.5 and 3, respectively, in relation to lung cancer risk. In addition, additive interaction by race was assessed using relative excess risks due to interactions (RERIs).^{20,21} Unless otherwise stated, all results of the tests for interaction were on the multiplicative scale.

Population-attributable fractions for lung cancer due to smoking were calculated based on smoking prevalence (p_c) among lung cancer cases in the ARIC cohort: p_c multiplied by $(HR_{\text{for ever smoking}} - 1) / (HR_{\text{for ever smoking}})$ in a multivariable model.²² All analyses were performed using SAS, version 9.1 (SAS Institute, Cary NC) in the fall of 2012.

Results

The analytic cohort included 14,610 participants (27.6% black) with no prior self-reported cancer diagnosis (except non-melanoma skin cancer). Mean ages at baseline were

comparable in whites (54.2 years) and blacks (53.6 years), whereas the percentage of women was slightly higher among blacks than whites: 61.3% versus 51.9%. Compared with whites, blacks had higher BMI, lower education status and household income, were less physically active, and consumed less alcohol (Table 1).

Smoking Characteristics

Smoking prevalence differed between blacks and whites at baseline (Table 2): current smoking was higher among black than white men (39% versus 25%) but comparable in black and white women (approximately 25%). Compared with whites, blacks smoked fewer cpd over their smoking years before baseline (23% and 22% less in men and women, respectively), and the percentage of heavy smokers (>24 cpd) was substantially lower in blacks (in men, 17% versus 49%; in women, 5% versus 28%, respectively). The percentage of smokers who had quit smoking was lower for blacks than whites (46% versus 66% in men, and 41% versus 50% in women, respectively) at baseline (Table 2). The difference in the proportion of smokers between whites and blacks remained until the end of follow-up, which was driven by the lower percentage of quitters in black men (38% versus 49%), whereas this percentage was 52% among both black and white women.

Smoking and Lung Cancer Incidence

Over 20 years of follow-up, 470 lung cancers (111 in blacks) occurred. The gender- and race-specific age adjusted incidence rates for lung cancer by smoking status are shown in Table 3 and Supplementary Table 1. The lung cancer incidence rate in men was non-significantly higher in blacks than in whites ($p=0.09$). In contrast, black women had a lower incidence rate than white women ($p=0.04$) and the lowest incidence rate among all race and gender groups. In the analysis of smoking status and lung cancer risk, there was no evidence of an interaction (either multiplicative [$p=0.43$] or additive [$p=0.53$]) with race; however there was evidence of an interaction with gender ($p_{\text{interaction}}=0.05$), with higher lung cancer risk for men than women (Table 3). Overall, the population fractions attributable to ever smoking were 95%, 92%, 78%, and 65% in black men, white men, white women, and black women, respectively.

An analysis of prolonged smoking cessation with lung cancer risk showed reduced risk with increased duration of cessation: compared with current smokers, individuals (blacks and whites analyzed together) who quit smoking for 10 years had 83% (95% CI=78%, 89%) lower risk of lung cancer ($p_{\text{trend}}<0.0001$; Table 4). The associations were similar in both races and although the effect appeared to be slightly weaker in blacks than whites, there was no evidence of a significant interaction with race ($p_{\text{interaction}}=0.25$) or gender ($p_{\text{interaction}}=0.81$; Supplementary Table 2).

Smoking Intensity, Age at Smoking Initiation, and Lung Cancer Risk

In current compared to never smokers, there was a monotonic trend between the number of cpd and lung cancer risk in both blacks and whites ($p_{\text{interaction}}=0.88$; Figure 1) that also did not differ by gender ($p_{\text{interaction}}=0.08$). Compared with never smokers, current smokers consuming 1–14, 15–24 and >24 cpd had an approximate 7-, 11-, and 16-fold increased risk of lung cancer, respectively. Early age of initiation among current smokers was also

independently associated with increased lung cancer risk after adjusting for the number of cpd and total smoking duration: in the overall cohort, compared with those who started smoking at age 22 years, the multivariable-adjusted HR for those who started at age 12 years was 3.03 (95% CI=1.62, 5.67), with higher estimates observed for blacks than whites (Table 5). However, the interaction of age at smoking initiation with race ($p_{\text{interaction}}=0.73$) or gender ($p_{\text{interaction}}=0.63$; Supplementary Table 3) was not statistically significant.

Discussion

In agreement with recent reports from nationally representative datasets,^{1,12} the age-adjusted incidence rates of lung cancer in the ARIC study population varied by race and gender: the highest overall incidence rates of lung cancer were observed in black men, and the lowest incidence rate, in black women. These racial differences may be driven by a higher proportion of current smokers among black than white men and the interplay between cumulative exposure to smoking and susceptibility to carcinogenic agents.⁴⁻⁶ Among current smokers, the incidence rates were actually slightly higher in white than in black men, which likely reflects a greater cumulative exposure to cigarettes in whites than in blacks. In women, both the lower prevalence and intensity of smoking among black compared with white women likely explains the lower incidence of lung cancer among black women, a finding that is consistent with published reports.^{1,12} Of note, lung cancer incidence rates in the ARIC were higher than those in the general population,¹ most likely due to the higher percentage of ever smokers in the ARIC study.²³ Ever smoking (current and former) explained more than 90% of lung cancer cases in black and white men, 78% in white women, and 65% in black women.

There was no evidence from this large biracial cohort that the impact of smoking intensity, age at smoking initiation, or time since smoking cessation on incident lung cancer differed between blacks and whites. Of particular importance from a public health perspective was that the long-term benefits of cessation were similar in blacks and whites, which is in agreement with the only other published study that reported race-specific effects of smoking cessation on lung cancer risk.⁹

The lack of any significant racial interaction in the associations between measures of smoking and lung cancer risk concurs with most^{8,24} but not all studies. For example, greater risk of smoking-related lung cancer among blacks compared to whites was reported at both lower¹³ and higher levels of cigarette consumption,⁹ although in the latter study, there was no overall interaction between race and cigarette consumption. In the ARIC study, there was no evidence to suggest any difference in the dose-response relation between blacks and whites, although it should be noted that the study lacked power to reliably preclude the possibility of a small race-interaction with dose. This limitation is not unique to the current study and it may account for the inconsistencies between earlier studies regarding a racial difference in the dose-response relation between smoking and lung cancer. Alternatively, different adjustment for smoking duration and intensity between studies as well as different populations under study may account for some of the discrepancies in the reported risk estimates.²⁴

The observed inverse association between age at smoking initiation and incident lung cancer is in agreement with other published reports,^{25–28} although, to our knowledge, no other study has reported race-specific associations. In the current study, individuals who began smoking before age 12 years had three times the risk of lung cancer compared with those who started a decade later, even after consideration of cumulative cigarette exposure. It has been speculated that exposure to tobacco carcinogens during adolescence may cause DNA damage in epithelial cells in the airway that will evolve into lung cancer in later life, as adolescence is a time of rapid physiologic growth.^{29,30} It is plausible that the inverse relationship between age of smoking onset and incident lung cancer is primarily due to the longer duration of smoking among those who started smoking early in life. Since age of smoking initiation is strongly associated with duration of smoking, we adjusted our analysis for the total number of smoking-years as a time-dependent covariate instead of adjusting for pack-years at baseline. We believe that this analysis is able to differentiate between the effects of early smoking initiation and cumulative tobacco exposure on lung cancer risk. The strong inverse association between age at smoking initiation and lung cancer risk is especially important because of international studies reporting an early onset of smoking in many countries.²⁸

Although the primary focus of the current study was to examine racial differences in smoking-related risk of lung cancer, there was a noticeable gender difference in smoking-related risk of lung cancer to the detriment of men, which is consistent with several previous studies.^{31–33} This gender difference was most likely due to gender differences in the percentage of smokers, the intensity of smoking, and other smoking behaviors.

The strengths of our study are that it is a large, population-based prospective cohort with practically complete follow-up and detailed information about smoking characteristics that were ascertained from follow-up visits and annual telephone interviews. Therefore, we were able to accurately determine the number of smoking-years for all but 113 participants. Moreover, blacks and whites received the same questionnaire, allowing direct comparison within the same study. The greatest limitation of the current study was that most of the black ARIC participants were recruited from a single center whereas the whites were recruited from the other three field centers. Therefore, geographically based confounding of racial differences cannot be excluded as an explanation for the results. Other important limitations are a limited power for subgroup analyses in blacks and absence of histologic information. Another limitation is the lack of information on types of cigarettes smoked and inhalation behavior. Blacks smoke more menthol cigarettes; however, the association between mentholated cigarette consumption and the risk of lung cancer is controversial,³⁴ with studies reporting positive,^{5,35} null,^{9,36} or inverse associations.³⁷ Another potential limitation is the self-report of smoking characteristics. However, it is unlikely that this bias would have affected blacks or whites in different ways. A study of self-reported smoking frequency among blacks and whites by Clark et al. calculated the number of collected cigarette butts and found no significant differences in the validity of self-reports between races.⁵ Finally, the response rate at baseline was moderate. The responders in ARIC were less likely to be smokers than in the source communities.³⁸ This could lead to lower incidence rates in ARIC, as smoking explains a large proportion of lung cancer. However, given the prospective study design, it seems unlikely that responders and non-responders at baseline

would have different smoking–lung cancer associations. Thus, the moderate response rate at baseline could limit generalizability but should not affect internal validity.

In summary, lung cancer risk associated with various measures of cigarette consumption in middle-aged blacks mirror those observed in whites. Our study underscores the benefits of prolonged smoking cessation in both blacks and whites.^{39,40} However, given that former smokers continue to have substantially greater lung cancer risk even after more than a decade of smoking abstinence,^{39,41,42} particular attention should be given to smoking prevention, especially in youth.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Hazard ratios and 95% CIs for lung cancer according to the baseline number of cigarettes smoked per day in current smokers versus never smokers in the Atherosclerosis Risk in Communities Study, 1987–2006.

Note: Adjusted for age, study center, and gender. $p_{\text{interaction by race}} = 0.88$ and

$p_{\text{interaction by gender}} = 0.08$.

Table 1

Sociodemographic characteristics at baseline of ARIC study participants by race and gender, 1987–1989

Baseline characteristics M (SD) or prevalence (%)	White men <i>n</i> =5,090 (34.8%)	White women <i>n</i> =5,487 (37.6%)	Black men <i>n</i> =1,560 (23.5%)	Black women <i>n</i> =2,473 (31.1%)
Age, years	54.7 (5.7)	53.9 (5.7)	53.8 (6.0)	53.4 (5.7)
% Education—more than high school	52.3	40.7	36.0	36.7
% Total annual household \$15,999	8.9	16.0	44.0	59.1
BMI, kg/m ²	27.4 (4.0)	26.7 (5.5)	27.6 (4.9)	30.8 (6.5)
Sport index	2.7 (0.8)	2.4 (0.8)	2.2 (0.7)	2.2 (0.7)
% Current smokers	24.6	24.5	38.7	24.7
% Ever smokers	72.1	48.8	72.2	41.9
Alcohol grams/day	10.0 (17.1)	3.6 (7.6)	9.9 (21.7)	1.5 (5.5)

Note: Values represent the M (SD) unless otherwise stated.

ARIC, Atherosclerosis Risk in Communities

Table 2
Smoking characteristics among current and former smokers by race and gender, ARIC study, 1987–1989

Baseline characteristics	White men		White women		Black men		Black women	
	Former n=2,416 (47.5%)	Current n=1,252 (24.6%)	Former n=1,332 (24.3%)	Current n=1,344 (24.5%)	Former n=522 (33.5%)	Current n=603 (38.7%)	Former n=A21 (17.3%)	Current n=610 (24.7%)
Cigarettes per day		26.1 (13.2)		20.5 (11.0)		17.4 (10.4)		12.0 (8.3)
% Heavy smokers ^a		49.2		28.1		17.2		4.9
Cigarettes per day over smoking years	23.8 (13.1)	24.1 (9.9)	15.7 (11.3)	18.3 (9.0)	18.0 (13.7)	18.6 (11.7)	13.2 (11.6)	13.3 (9.4)
Years of smoking	21.7 (11.2)	35.4 (7.9)	18.8 (11.3)	31.7 (8.5)	22.7 (11.7)	34.6 (8.5)	20.7 (11.1)	30.3 (9.1)
Pack-years	27.7 (22.5)	43.4 (21.4)	17.1 (17.4)	29.7 (17.5)	22.4 (24.7)	32.8 (23.0)	14.8 (16.1)	21.1 (19.1)
Age at smoking initiation, years	17.5 (3.5)	17.3 (4.5)	19.6 (5.0)	20.6 (6.7)	17.9 (4.4)	18.1 (5.2)	20.3 (6.5)	21.5 (7.5)
% Started smoking before 12 years	5.1	8.5	1.0	1.6	8.6	10.0	4.5	5.3
Time since quitting, years	15.3 (10.6)		14.1 (10.6)		13.6 (10.2)		11.8 (9.8)	

Note: Values represent the M (SD) unless otherwise stated.

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^a Heavy smoking in current smokers at baseline was defined as >24 cigarettes per day.

Table 3

Incidence rates and HRs for lung cancer by smoking status, ARIC study, 1987–2006

Baseline smoking status	Incident cases	Person-years	Incidence rate ^a (95% CI)	HR ^{*b} (95% CI)	HR ^c (95% CI)
White					
Overall	359	177,420	1.77 (1.58, 1.98)		
Never	21	73,644	0.24 (0.16, 0.37)	1	1
Former	101	63,037	1.29 (1.05, 1.59)	4.66 (2.90, 7.50)	2.66 (1.62, 4.37)
Current	237	40,739	5.34 (4.67, 6.12)	21.87 (13.97, 34.25)	9.12 (5.62, 14.80)
<i>p</i> trend ^d				<0.0001	<0.0001
Black					
Overall	111	64,197	1.64 (1.35, 1.98)		
Never	9	31,102	0.26 (0.14, 0.51)	1	1
Former	23	15,199	1.25 (0.82, 1.92)	3.65 (1.66, 7.99)	2.80 (1.24, 6.29)
Current	79	17,896	4.28 (3.40, 5.39)	13.24 (6.56, 26.72)	8.72 (4.17, 18.25)
<i>p</i> trend ^d				<0.0001	<0.0001
Men					
Overall	297	107,116	2.42 (2.14, 2.74)		
Never	6	31,636	0.17 (0.07, 0.37)	1	1
Former	95	48,090	1.51 (1.21, 1.88)	9.23 (4.04, 21.08)	5.40 (2.33, 12.50)
Current	196	27,389	6.55 (5.64, 7.60)	41.41 (18.36, 93.42)	18.79 (8.13, 43.44)
<i>p</i> trend ^d				<0.0001	<0.0001
Women					
Overall	173	134,501	1.19 (1.02, 1.38)		
Never	24	73,110	0.29 (0.19, 0.43)	1	1
Former	29	30,146	0.87 (0.60, 1.26)	2.91 (1.69, 5.01)	1.91 (1.09, 3.36)
Current	120	31,246	3.69 (3.06, 4.45)	13.13 (8.46, 20.41)	6.61 (4.05, 10.78)
<i>p</i> trend ^d				<0.0001	<0.0001

Note: Boldface indicates statistical significance.

ARIC, Atherosclerosis Risk in Communities; HR, hazard ratio

^a Adjusted for age, per 1,000 person-years.

^b Adjusted for age and ARIC center, and for gender or race, as appropriate.

^c Additionally adjusted for pack-years of smoking reported at baseline.

^d Tests for trend were conducted by including smoking status as an ordinal continuous variable in the model.

*
 $p_{\text{interaction by race}}=0.43$ and $p_{\text{interaction by gender}}=0.05$.

Table 4

Lung cancer risk by quitting time for former versus current smoking among whites and blacks

Time since quitting, years	Incident cases	Person-years	HR ^{a,b} (95% CI)	HR ^c (95% CI)
Overall ^d				
Current smokers	333	65,386	1	1
2-3	19	7,217	0.44 (0.27, 0.69)	0.43 (0.27, 0.68)
4-9	33	15,549	0.36 (0.25, 0.51)	0.36 (0.25, 0.52)
10	53	48,181	0.16 (0.12, 0.21)	0.17 (0.13, 0.23)
<i>p</i> trend ^e			<0.0001	<0.0001
Whites				
Current smokers	251	45,923	1	1
2-3	17	5,481	0.48 (0.30, 0.79)	0.46 (0.28, 0.75)
4-9	27	12,431	0.34 (0.23, 0.51)	0.34 (0.23, 0.51)
10	41	39,655	0.14 (0.10, 0.20)	0.16 (0.11, 0.22)
<i>p</i> trend ^e			<0.0001	<0.0001
Blacks				
Current smokers	82	19,463	1	1
2-3	2	1,735	0.24 (0.06, 0.99)	0.25 (0.06, 1.01)
4-9	6	3,118	0.43 (0.19, 0.98)	0.46 (0.20, 1.06)
10	12	8,526	0.25 (0.14, 0.46)	0.26 (0.14, 0.50)
<i>p</i> trend ^e			<0.0001	<0.0001

Note: Boldface indicates statistical significance.

^a Smoking status and time since quitting were reported at baseline.

^b Adjusted for age, ARIC center, and gender, and, in the total cohort, for race.

^c Additionally adjusted for the number of cigarettes smoked per day over smoking years (reported at baseline) and number of years of smoking.

^d The number of former smokers in this table is less than that in Table 3 because 33 participants (with two lung cancer cases) did not report time since quitting. Former smokers who were quitters for <1 year were considered current smokers. Therefore, the numbers of current smokers are also different here and in Table 3.

^e Tests for trend were conducted by including the categories for time since quitting as an ordinal continuous variable in the model.

* *p*interaction by race=0.25 and *p*interaction by gender=0.81 among current and former smokers at baseline (*n*=8,473).

Table 5

Lung cancer risk by age at smoking initiation among white and black current smokers

Age at smoking initiation among current smokers, years	Incident cases	Person-years	HR ^a (95% CI)	HR ^b (95% CI)
Overall ^c				
22	31	12,483	1	1
19–21	63	12,580	2.07 (1.34, 3.19)	2.01 (1.26, 3.20)
16–18	111	20,198	2.14 (1.43, 3.21)	1.94 (1.22, 3.09)
13–15	75	8,765	3.12 (2.02, 4.80)	2.58 (1.54, 4.31)
12	30	2,725	3.55 (2.11, 5.95)	3.03 (1.62, 5.67)
<i>P</i> trend			<0.0001	0.0008
Whites				
22	23	7,553	1	1
19–21	45	8,818	1.81 (1.09, 3.00)	1.59 (0.93, 2.72)
16–18	87	14,941	1.98 (1.24, 3.16)	1.60 (0.95, 2.71)
13–15	60	6,596	2.97 (1.80, 4.88)	2.15 (1.19, 3.85)
12	18	1,678	2.92 (1.54, 5.55)	2.19 (1.03, 4.65)
<i>P</i> trend ^d			<0.0001	0.02
Blacks				
22	8	4,930	1	1
19–21	18	3,761	2.83 (1.22, 6.54)	3.65 (1.43, 9.32)
16–18	24	5,257	2.54 (1.12, 5.73)	3.19 (1.20, 8.49)
13–15	15	2,169	3.41 (1.42, 8.16)	4.19 (1.44, 12.24)
12	12	1,048	5.28 (2.12, 13.13)	6.47 (1.97, 21.30)
<i>P</i> trend ^d			0.0006	0.01

Note: Boldface indicates statistical significance.

ARIC, Atherosclerosis Risk in Communities; HR, hazard ratio

^a Adjusted for age, ARIC center, and gender, and, in the total cohort, for race.

^b Additionally adjusted for the number of cigarettes smoked per day at baseline and total number of years of smoking as a time-dependent covariate.

^c 119 current smokers (with three lung cancer cases) had missing information on age at smoking initiation.

^d Tests for trend were conducted by including the categories for age at smoking initiation as an ordinal continuous variable in the model.

* *P*interaction by race=0.73 and *P*interaction by gender= 0.63 among current smokers at baseline (*n*=3,690).