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Original Article

Alcohol Consumption and Incident Stroke Among Older Adults

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Abstract

Objectives: This study examines the relationship between alcohol consumption and incident stroke among older adults and tests whether alcohol consumption contributes to observed race and sex differences in stroke.

Method: Data are from a U.S. national cohort of black and white adults aged 45 and older, the REasons for Geographic And Racial Differences in Stroke (REGARDS) study. Current and past drinking levels were reported at baseline (2003–2007). Participants who had never had a stroke were followed for adjudicated stroke events through September 2015 (n = 27,265). We calculated Cox proportional hazard models for stroke, adjusting for demographic, socioeconomic, behavioral, and health characteristics.

Results: Participants, mean age 64.7 years, consumed on average 2.2 drinks/week and experienced 1,140 first-time stroke events over median 9.1 years follow-up. Nondrinkers had a 12% higher risk of stroke than current drinkers; the risk of stroke among nondrinkers largely reflected high risks among past drinkers; these differences were explained by socioeconomic characteristics. Among current drinkers, light drinkers had significantly lower stroke risks than moderate drinkers after accounting for demographic, socioeconomic, behavioral, and health characteristics. Implications of alcohol did not differ between blacks and whites but did differ by sex: Especially among women, nondrinkers, and specifically past drinkers, had higher risks; these differences were largely explained by health characteristics and behaviors. Alcohol did not explain race and sex differences in stroke incidence.

Discussion: Among older adults, those who used to, but no longer, drink had higher risks of stroke, especially among women; current light drinkers had the lowest risk of stroke.

Keywords: Alcohol use—Cohort studies—Epidemiology—Gender—Race—Stroke

Writing during the prohibition era, Raymond Pearl concluded that moderate consumption of alcohol was not harmful to one's health (Pearl, 1926). Since then, several studies have indicated that moderate consumption of alcohol is associated with better health and lower mortality risks. The relationship between alcohol consumption and mortality has been described as U shaped, with higher mortality for abstainers and heavy drinkers and lower mortality for moderate drinkers (Marmot, Rose, Shipley, & Thomas, 1981). Moderate alcohol consumption has been found to be inversely associated with coronary heart disease morbidity and mortality across several populations (Marmot, 1984).

Some scholars have argued that the robustness of these associations across methods and populations indicates protective effects of alcohol consumption against heart disease and mortality (Bovet & Paccaud, 2001; Marmot, 2001).

Few studies have examined the health implications of alcohol consumption for older adults, but there is some evidence that moderate alcohol consumption is also linked with lower mortality at older ages (Goldberg, Burchfiel, Reed, Wergowske, & Chiu, 1994; Thun et al., 1997). For adults, especially at older ages, stroke is a major cause of morbidity and mortality (Howard & Goff, 2012; Mozaffarian et al., 2015). This study examines the relationships between alcohol consumption among older adults and their risk of stroke.

Alcohol Consumption Patterns

In the United States in 2012, 71% of adults aged 18 years and older reported drinking in the past year, and 51.3% of adults were current regular drinkers, defined as 12 or more drinks in the past year (Schiller, Lucas, Ward, & Peregoy, 2012). Older adults tend to decrease their total alcohol intake after retirement (Ferreira & Weems, 2008); in a 2008 national survey, approximately 40% of adults aged 65 years and older reported that they drank alcohol (Jardim-Botelho et al., 2014).

Alcohol consumption patterns differ by sex and race (Petrea et al., 2009; Rosamond et al., 1999). Men tend to drink more frequently and in larger amounts than women, and women are more often lifetime abstainers (Wilsnack, Vogeltanz, Wilsnack, & Harris, 2000); these patterns are similar for adults aged 65 years and older (Ferreira & Weems, 2008). Whites are more likely to drink alcohol, but blacks who drink have higher volume of intake and frequency of heavy drinking (Chartier & Caetano, 2010; Fesahazion, Thorpe, Bell, & LaVeist, 2012; Kerr, Patterson, & Greenfield, 2009). Fewer black than white men are heavy drinkers; however, those black men who are heavy drinkers tend to maintain heavy drinking practices to older ages (Chartier & Caetano, 2010).

Alcohol Consumption and Health

Several studies have shown links between alcohol consumption, morbidity, and mortality. Even after controlling for numerous possible confounders, such as age, employment, race, smoking, blood pressure, body mass index (BMI), fat consumption, and cholesterol, the relationship between alcohol consumption and mortality is U shaped (Fuller, 2011; Liao, McGee, Cao, & Cooper, 2000; Marmot et al., 1981; Paganini-Hill, Kawas, & Corrada, 2007; Thun et al., 1997; Wannamethee & Shaper, 1997). Studies have found U-shaped relationships between alcohol consumption and cardiovascular disease (CVD) mortality in several populations (Fuller, 2011; Marmot, 1984; Thun et al., 1997). Data from the Cancer Prevention II study of adults aged 30 years and older showed that risk of death from coronary heart disease and other circulatory diseases was lower for men and women who drank one to three drinks per day compared with those who did not drink (Thun et al., 1997). Nationally representative U.S. data indicated that moderate drinkers had lower all-cause and coronary heart disease mortality than nondrinkers, even when adjusting for age, race, education, marital status, employment, smoking, income, self-reported health, and previous diagnosis of heart problems (Fuller, 2011). In the Whitehall Study of male civil servants aged 40–64 years in England, CVD mortality was higher among nondrinkers than among drinkers (Marmot et al., 1981).

Biological mechanisms could underlie cardioprotective effects of moderate drinking. Specifically, moderate drinking increases levels of high-density lipoprotein cholesterol, which can prevent clots and reduce platelet aggregation and so can protect against CVD and stroke (Agarwal, 2002).

At the same time, inverse associations between alcohol intake and morbidity and mortality could be spurious (Fillmore, Stockwell, Chikritzhs, Bostrom, & Kerr, 2007; Thun et al., 1997). For example, in the United States, nondrinkers often are from poorer socioeconomic circumstances and have lower levels of education than drinkers, and socioeconomic status and education are positively associated with health; thus, the poorer health outcomes of nondrinkers may be due to their socioeconomic disadvantage rather than their avoidance of alcohol (Fekjaer, 2013; Fillmore et al., 2007; Naimi et al., 2005; Naimi, Xuan, Brown, & Saitz, 2013). Therefore, it is important to examine associations using adequate controls for socioeconomic status and to not rely on cross-sectional associations. Another concern is that people may stop drinking precisely because they are experiencing health problems, entailing possible reverse causation. Thus, former drinkers may be at higher risk for adverse health outcomes; occasional drinkers (less than 12 drinks/year) may also include individuals who reduced their alcohol intake due to health problems. Therefore, former drinkers, occasional drinkers, and lifetime abstainers should be separated in analyses, as combining them may show artificially high risks for nondrinkers. Some of the documented protective effects of alcohol may disappear when former drinkers and occasional drinkers are separated from lifetime abstainers (Fillmore et al., 2007). In addition, consequences may differ for those drinking seven drinks over the course of a week or over the course of one day, so patterns of drinking should be considered (Marmot, 2001; Thun et al., 1997). Nonetheless, several studies showed that moderate alcohol consumption was associated with better outcomes, even after controlling for socioeconomic status and distinguishing former and occasional drinkers from lifetime abstainers. They have shown a U-shaped relationship between alcohol consumption and all-cause mortality, coronary heart disease mortality, and intracerebral hemorrhage (Thrift, Donnan, & McNeil, 1999).

Patterns of Stroke and Associatons With Alcohol

There are two major types of stroke: (a) ischemic stroke accounts for the majority of strokes in the United States and occurs as a result of an obstruction in a blood vessel supplying blood to the brain; (b) hemorrhagic stroke occurs when a weakened blood vessel ruptures. The association between alcohol consumption and stroke may vary with type of stroke (Klatsky, 2015).

Across case–control and cohort studies, ischemic stroke morbidity and mortality had J-shaped relationships with alcohol consumption (Camargo, 1996; Patra et al., 2010). A meta-analysis of 35 studies found lower risks of stroke for drinkers who consumed ≤12 g of alcohol per day compared with abstainers (Reynolds et al., 2003): light drinkers had a 17% lower risk of total stroke and 20% lower risk of ischemic stroke compared with abstainers; moderate drinkers (12–23 g/day) also had a 25% lower risk of ischemic stroke compared with abstainers.

Hemorrhagic stroke morbidity and mortality increased with alcohol use (Camargo, 1996; Patra et al., 2010), with a positive linear relationship between alcohol consumption and hemorrhagic stroke (Reynolds et al., 2003). Although heavy drinking is associated with hemorrhagic stroke, the relationships between light-to-moderate alcohol consumption and hemorrhagic stroke have been conflicting, likely because of small numbers of hemorrhagic strokes in most studies (Owolabi & Agunloye, 2013; Patra et al., 2010; Thrift et al., 1999).

Another meta-analysis of 27 prospective studies found that light drinkers had a lower risk of total stroke, ischemic stroke, and stroke mortality but not hemorrhagic stroke; heavy drinkers had higher risk of total stroke but not of hemorrhagic stroke, ischemic stroke, or stroke mortality (Zhang et al., 2014). In the ARIC study of older adults across four U.S. communities, light and moderate drinkers did not have a lower incidence of ischemic stroke than abstainers, whereas heavy drinkers had higher incidence (Jones et al., 2015).

In a prospective cohort of Swedish older adults, those who had been very light drinkers (<0.5 drink/day) in middle age had significantly lower risks of stroke during the following four decades than did heavy drinkers (>2 drinks/day) and nondrinkers; the risk of stroke among nondrinkers increased with age, whereas the risks associated with heavy drinking decreased (Kadlecová, Andel, Mikulík, Handing, & Pedersen, 2015).

Stroke incidence and mortality differ between blacks and whites in the United States (Gillum, 1999; Go et al., 2014; Howard et al., 2011; Kleindorfer et al., 2010; Sacco et al., 1998): black men have the highest age-adjusted rate of incident stroke (4.4/1,000 person-years), black women the second highest (3.1/1,000 person-years), and white men (1.8/1,000 person-years) and women the lowest (1.2/1,000 person-years; Rosamond et al., 1999). Stroke mortality rates follow similar patterns (Gillum, 1999).

Whether the relationship between alcohol consumption and stroke outcomes differs for men and women remains uncertain. Some studies have reported lower risks of incident stroke among drinkers for both men and women, but different patterns with respect to stroke mortality (Ikehara et al., 2008; Zheng et al., 2015). Others have reported protective effects only for women (Hansagi, Romelsjo, Gerhardsson de Verdier, Andreasson, & Leifman, 1995); still others have reported that women experience a J-shaped relationship rather than linear relationship for hemorrhagic stroke (Jimenez et al., 2012).

This study examined the relationships between alcohol consumption among older adults and their risk of experiencing a stroke. As previous research identified higher risk of stroke among blacks compared with whites and among men compared with women, as well as differences in alcohol consumption patterns across these groups (Fesahazion et al., 2012; Go et al., 2014; Howard et al., 2011; Kleindorfer et al., 2010; Petrea et al., 2009; Sacco et al., 1998), we explore whether differences in alcohol consumption explain some of the observed differences in stroke risks between blacks and whites and between men and women.

Method

Data

We used data from the REasons for Geographic and Racial Differences in Stroke (REGARDS) study, a national longitudinal study of black and white adults aged 45 years and older (n = 30,239). Stroke risks differ across regions of the United States (Borhani, 1965; Howard et al., 2011), and the REGARDS study was designed to measure and understand these differences (Howard et al., 2005). Therefore, a stratified random sample was conducted with oversampling in the region dubbed the "stroke belt" (Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee; Lanska & Kuller, 1995). Twenty-one percent of the sample was randomly selected from the "buckle" of the stroke belt (coastal plain region of North Carolina, South Carolina, and Georgia), 35% from the rest of the stroke belt states (remainder of North Carolina, South Carolina, and Georgia plus Alabama, Mississippi, Tennessee, Arkansas, and Louisiana), and the remaining 44% from the other 40 contiguous U.S. states. Blacks were oversampled to characterize racial differences in stroke.

Participants were recruited between January 2003 and October 2007. Each participant was first mailed a letter and brochure explaining the study and then telephoned to recruit and obtain verbal consent. Written consent was obtained during the subsequent in-person evaluation. Using a computer-assisted telephone interview (CATI), trained interviewers obtained information on demographic and socioeconomic characteristics, medical history, and lifestyle risk factors. A brief physical exam, including blood pressure measurements, blood samples, and anthropometry, was

conducted in-person 3–4 weeks after the CATI. Participants were contacted every 6 months by telephone to document self- or proxy-reported suspected stroke. The institutional review boards of participating institutions approved the study. Additional details on REGARDS are provided elsewhere (Howard et al., 2005).

REGARDS cooperation and response rates at baseline were 49% and 33%, respectively, comparable with other cardiovascular cohort studies (Morton, Cahill, & Hartge, 2006). During follow-up, more than 80% of participants completed at least 75% of follow-up. The REGARDS study is still ongoing, but, for this analysis, we used follow-up data through September 2015.

Respondents who had reported having ever experienced a stroke at baseline were excluded from this analysis (n = 1,930), as were those missing in-person data (n = 56), those who only participated in the baseline questionnaire (n = 447), and those who did not respond to questions about alcohol (n = 541), resulting in an analytic sample of 27,265.

Alcohol Determination

Data on alcohol use were collected through questions at baseline. The first was "Do you presently drink alcoholic beverages, including beer, wine, and other drinks made with hard liquor, even occasionally?" If answered affirmatively, the following question was asked: "How many alcoholic beverages do you presently drink? For example, one per day, three per week, and so on. Please include beer, wine and hard liquor." If participants answered "no" to the first alcohol question, the follow-up question was "Have you ever drunk alcoholic beverages, including beer, wine, and other drinks made with hard liquor on a regular basis? By regular, we mean at least 1 drink per month for 1 year."

We created three measures of alcohol consumption. The simplest was current drinking status: drinker or not drinker. A second measure was drinking history: current drinker, lifetime abstainer, or past regular drinker. The third measure was consumption level, which additionally categorized current drinkers, in line with National Institute on Alcohol Abuse and Alcoholism definitions, as occasional drinkers (current drinkers who did not drink in an average week), light drinkers (up to 1 drinks/week on average for both men and women), moderate drinkers (1–7.5 drinks/week for women and 1–15 drinks/week for men), and heavy drinkers (≥7.5 drinks/week for women and ≥15 drinks/week for men; National Institute on Alcohol Abuse and Alcoholism, 2016).

Stroke Events Determination

The outcome of interest was the occurrence of any adjudicated stroke event in a person who reported never having had a stroke at baseline. During telephone interviews at each follow-up contact, a report of possible stroke, transient ischemic attack, death, hospitalization or emergency department visit for brain aneurysm, brain hemorrhage, stroke symptoms, or unknown reason generated a request for retrieval of medical records. A stroke nurse conducted an initial review to exclude events that were obviously not strokes. Then, medical records of suspected strokes were centrally adjudicated by physicians. For deaths with no medical records, death certificates and/or proxy interviews were used. Stroke was defined using the World Health Organization (WHO) definition of focal neurologic symptoms lasting more than 24 hr or those with neuroimaging data consistent with stroke. Details of this method are described elsewhere (Howard et al., 2011). The outcome variable combined clinical and WHO stroke definitions. Strokes were classified as ischemic or hemorrhagic whenever the type could be determined.

Covariates

Self-reported characteristics at baseline were used as covariates in models. Demographic characteristics were: age, race (black, white), and sex (female, male). Social and economic variables were urbanicity of residence (urban, rural, or mixed—county-level category from the 2000 U.S. Census), annual household income (<$20,000, $20,000–$34,000, $35,000–$74,000, >$75,000), education level (less than high school, high school graduate, some college, college graduate and above), and marital status (married, divorced, widowed, single, other). Stroke belt residence is a socioeconomic indicator as well as a sampling criterion (stroke belt, stroke buckle, non-belt). Health and health behaviors measures were smoking (yes, no), physical activity (≥4 times/week, 1–3 times/week, 0 times/week—in response to a question about frequency of engaging in intense physical activity sufficient to work up a sweat), BMI category (underweight, normal, overweight, obese—based on measured height and weight compared with standard CDC cut points), diabetes (yes, no—based on fasting glucose ≥ 126 mg/dL, nonfasting ≥ 200 mg/dL, or self-report of glucose control medication), and hypertension (yes, no—based on systolic blood pressure ≥ 140 mmHg, diastolic blood pressure ≥ 90 mmHg, or self-reported current hypertension medication use).

Statistical Analysis

The follow-up period for analysis was from recruitment until September 30, 2015. Follow-up time for each participant was calculated from date of in-home visit to date of first stroke, death, or last telephone contact. Similarly, attained age was calculated from date of birth to date of first stroke, death, or last telephone contact. Demographic, social, economic, health, and behavior characteristics at baseline were examined for the entire cohort and then compared across current drinkers and nondrinkers. Continuous variables were summarized as means and standard deviations,

and statistical differences were detected using *t* tests. Categorical variables were summarized as proportions and tested for significant differences using chi-square tests.

Cox proportional hazard models were used to estimate the associations between incident stroke and the three measures of alcohol exposure (Table 2), first unadjusted (Model 0) and then sequentially adding demographic characteristics (Model 1), social and economic characteristics (Model 2), and health characteristics and behaviors (Model 3). Attained age was used as the time variable in models.

To determine whether the implications of alcohol consumption were different for blacks compared with whites and for men compared with women, we tested two-way and three-way interaction terms between race and sex and the three measures of alcohol use. Significance of interaction terms was examined using an a priori level of $\alpha < .10$, which indicates heterogeneity in risk justifying stratified models. Stratified results are presented in Table 3.

As previous research has identified higher risk of stroke among blacks compared with whites and among men compared with women, as well as differences in alcohol consumption patterns across these groups, we examined whether patterns of alcohol consumption explained these differences in risks of stroke (Table 4).

Finally, because the relationships between alcohol and stroke type may differ, we also present stratified models examining relationships between alcohol consumption and ischemic and hemorrhagic stroke (Table 5).

Analyses were conducted using SAS 9.3. The proportional hazards assumption was tested by including the cross-product of log-transformed age and each of the covariates in the final Cox models.

Results

Drinking patterns are shown in Table 1. Nearly half (48.2%) of the participants were not current drinkers; most nondrinkers (63.3%) were lifetime abstainers. Among current drinkers, more than a third were moderate drinkers, 28.6% were light drinkers, 26.5% were occasional drinkers, and less than 8% were heavy drinkers.

Other characteristics of the study population at baseline are shown in Table 2. Average age was 64.7 years; 55.6% were women, 59.9% were white, and 59.5% were married; the income category with the highest proportion of participants was $35,000–74,000; 35.9% of participants were college graduates, and 70.4% lived in urban areas. Fourteen percent were current smokers, 33% did not exercise, 38% were obese, 20.1% had diabetes, and 57.6% had hypertension. Participants experienced 926 observed first-time strokes (775 ischemic, 91 hemorrhagic, and 60 undetermined) during an average follow-up time of 7 years (median 9.1 years).

Current drinkers and nondrinkers differed significantly in terms of stroke events as well as on demographic, socioeconomic, and health and behavioral measures: 4.7% of nondrinkers and 3.7% of drinkers experienced a stroke event within 7 years. Nondrinkers were older than current drinkers and were more often women, black, and widowed; they more often had a household income of <$35,000; had high school education or less; lived in the stroke belt or stroke belt buckle; and lived in a nonurban area than current drinkers. Current drinkers were more often smokers, whereas nondrinkers were more often obese, did not exercise, and had diabetes.

In unadjusted models (Table 3, Panel A), nondrinkers had a 12% higher hazard of stroke than current drinkers. This association was attenuated and became nonsignificant when we accounted for demographic and socioeconomic characteristics.

When nondrinkers are distinguished into lifetime abstainers and past regular drinkers (Table 3, Panel B), unadjusted hazards of stroke were more than a third higher among past drinkers compared with current drinkers, whereas the hazard of lifetime abstainers was similar to that of current drinkers. The differences in hazard of stroke between current drinkers and past drinkers were robust to

Table 1. Drinking Patterns of Older Adults

	All (*n* = 27,265)	Current drinker (*n* = 14,116)	Nondrinker (*n* = 13,149)	
Drinking patterns	Mean (*SD*) or %	Mean (*SD*) or %	Mean (*SD*) or %	*p* Value
Mean number of drinks per week	2.18 (6.38)	4.21 (8.37)	0	<.0001*
Median number of drinks per week (75%)	0 (1)	1 (6)	0	
Drinking history and level				
Lifetime abstainer	30.50	0	63.25	<.0001**
Past drinker	17.72	0	36.75	
Occasional drinker	13.70	26.46	0	
Light drinker	14.81	28.61	0	
Moderate drinker	19.18	37.05	0	
Heavy drinker	4.08	7.88	0	

Note: Significant at .05 alpha level: **t* test, ***chi-square test.
Source: REGARDS.

Table 2. Baseline Characteristics of Older Adults by Drinking Status

	All (n = 27,265)	Current drinker (n = 14,116)	Nondrinker (n = 13,149)	
Characteristics	Mean (*SD*) or %	Mean (*SD*) or %	Mean (*SD*) or %	p Value
Had stroke	4.18	3.69	4.71	<.0001**
Age at baseline (mean)	64.67 (9.40)	63.76 (9.36)	65.65 (9.42)	<.0001*
Sex, %				
Men	44.40	50.28	38.09	<.0001**
Race (ref.: white), %				
Black	40.16	32.15	48.76	<.0001**
Marital status				
Single	5.23	5.27	5.18	<.0001**
Married	59.54	63.16	55.65	
Divorced	14.51	15.00	13.99	
Widowed	18.47	14.40	22.84	
Other	2.25	2.17	2.33	
Household income				
<$20,000	17.09	10.82	23.81	<.0001**
$20,000–34,000	23.93	21.11	26.95	
$35,000–74,000	30.34	33.81	26.63	
>$75,000	16.54	23.54	9.02	
Refused	12.10	10.72	13.59	
Education				
Less than high school	11.67	6.33	17.42	<.0001**
High school	25.64	21.47	30.12	
Some college	26.78	27.08	26.46	
College graduation	35.86	45.10	25.93	
Geographic region				
Stroke belt	34.71	31.33	38.34	<.0001**
Stroke belt buckle	21.12	19.38	23.00	
Non-belt	44.17	49.30	38.66	
Urbanicity				
Urban	70.42	71.37	69.40	0.0003**
Rural	9.92	9.23	10.67	
Mixed	9.98	9.87	10.11	
Missing	9.67	9.53	9.82	
Current smoker	14.00	16.05	11.80	<.0001**
Weight status				
Underweight	1.03	1.03	1.03	<.0001**
Normal	23.58	25.89	21.09	
Overweight	36.69	39.21	33.99	
Obese	38.00	33.25	43.11	
Exercise				
None	32.96	29.63	36.54	<.0001**
1–3/week	36.07	38.16	33.83	
≥4/week	29.54	30.92	28.06	
Had diabetes	20.07	14.36	26.19	<.0001**
Had hypertension	57.55	52.87	62.58	<.0001**

Note: Significant at .05 alpha level: **chi-square test.
Source: REGARDS.

demographic characteristics (Model 1), but became small and nonsignificant after accounting for socioeconomic characteristics (Model 2). These patterns indicate that current drinkers had lower stroke risk than past drinkers but that these differences may be explained by social and economic differences between current drinkers and past drinkers.

We distinguished alcohol consumption levels in Panel C. In unadjusted models, compared with moderate drinkers, light drinkers had 19% lower hazards of stroke than

Table 3. Incident Stroke and Alcohol Consumption Among Older Adults

	Model 0	Model 1	Model 2	Model 3
	Univariate	Models 0 + demographic[a]	Model 1 + socioeconomic[b]	Model 2 + health and behaviors[c]
Variables	Hazard ratio (95% CI)	Hazard ratio (95% CI)	Hazard ratio (95% CI)	Hazard ratio (95% CI)
(A) Drinking status (ref.: current drinker)				
Nondrinker	1.12 (1.00–1.26)**	1.11 (0.98–1.25)	1.02 (0.89–1.16)	1.05 (0.91–1.20)
(B) Drinking history (ref.: current drinker)				
Lifetime abstainer	1.02 (0.89–1.17)	1.02 (0.90–1.18)	0.97 (0.83–1.12)	1.01 (0.87–1.18)
Past drinker	1.32 (1.14–1.54)***	1.24 (1.06–1.45)***	1.11 (0.93–1.32)	1.10 (0.92–1.30)
(C) Consumption level (ref.: moderate drinker)				
Occasional drinker	0.90 (0.72–1.11)	0.91 (0.74–1.13)	0.83 (0.66–1.06)	0.85 (0.67–1.08)
Light drinker	0.81 (0.65–1.01)+	0.80 (0.64–1.00)+	0.80 (0.63–1.01)	0.78 (0.61–0.98)*
Heavy drinker	1.03 (0.74–1.43)	1.05 (0.75–1.46)	0.91 (0.63–1.31)	0.83 (0.57–1.21)
Lifetime abstainer	0.94 (0.80–1.11)	0.95 (0.79–1.13)	0.85 (0.70–1.04)	0.89 (0.73–1.08)
Past drinker	1.22 (1.02–1.47)*	1.15 (0.95–1.39)	0.98 (0.80–1.21)	0.96 (0.78–1.19)

Note: BMI = body mass index; CI = confidence interval. n = 27,265.
[a]Sex, race. [b]Marital status, income, education, U.S. geographical region, and urbanicity. [c]Smoking, BMI category, physical activity level, diabetes, and hypertension.
+p < .1, *p < .05, **p < .01, ***p < .001.
Source: REGARDS.

moderate drinkers. After accounting for demographic, socioeconomic, behavioral, and health characteristics, the lower hazard of stroke among light drinkers remained significant (hazard ratio [HR] = 0.78, 95% confidence interval: 0.61–0.98).

At the same time, past drinkers had 22% higher hazards of stroke than moderate drinkers, consistent with the previous models; this higher risk was explained by the sex and race composition of past drinkers compared with moderate drinkers.

To determine whether the implications of alcohol consumption were different for blacks compared with whites and for women compared with men, we tested race and sex interaction terms. Only the interaction between alcohol and sex were significant (drinking status and sex: p = .013; drinking history and sex: p = .015; consumption level and sex: p = .0638); two-way interactions between race and measures of alcohol were not significant, nor were three-way interactions between race, sex, and alcohol measures. These patterns indicate that current drinking status and drinking history have different implications for women compared with men but not for blacks compared with whites. Sex-stratified results are presented in Table 4. In Panel A, we see that it was only among women that nondrinkers had higher hazards of stroke than current drinkers. Women who reported that they did not currently drink had more than a third higher hazard of stroke compared with those who did drink (HR = 1.32); these differences were explained in part by differences in race, marital status, income, education, and place of residence of drinkers and nondrinkers, but remained marginally significant at the 10% level even after accounting for these, behaviors and health characteristics. When examining drinking history (Panel B), among women, both lifetime abstainers and past drinkers had higher hazards of stroke than current drinkers. Differences in stroke incidence between lifetime abstainers and current drinkers were explained by differences in stroke risks across race (Model 1). Even after accounting for race, socioeconomic, and health and behavioral differences between past drinkers and current drinkers, women who stopped drinking had 43% higher hazards of stroke compared with current drinkers. When compared with moderate drinkers (Panel C), women who were past drinkers again had significantly higher hazards of stroke, but these differences were explained by health and behavior characteristics.

In Table 5, we explored the role of alcohol consumption in race and sex differences in incident stroke. Compared with white men, black men had 28% higher hazard of incident stroke, whereas white women had 20% lower hazard of stroke; black women had similar hazard of stroke to white men. Whether we considered alcohol consumption in terms of current drinking status (Panel A), drinking history (Panel B), or consumption level (Panel C), alcohol habits explained little or no component of these race and sex differences in stroke (Model 1 across panels). In fact, sex and race differences in stroke were explained by health and behavior differences across race and sex groups: smoking, physical activity level, BMI, diabetes, and hypertension (Model 3 across panels). Thus, alcohol consumption patterns do not explain observed differences in stroke between black and white men and women.

We also analyzed hemorrhagic and ischemic stroke separately (Table 6). No measures of drinking patterns were significantly associated with hemorrhagic stroke, perhaps due to the small number of these strokes, even in our large sample. Current nondrinkers, especially past drinkers, were more likely to experience ischemic strokes and light

Table 4. Stroke and Alcohol Consumption for Older Adults, by Sex

	Model 0	Model 1	Model 2	Model 3
	Univariate	Model 0 + demographic[a]	Model 1 + socioeconomic[b]	Model 2 + health and behaviors[c]
Variables	Hazard ratio (95% CI)	Hazard ratio (95% CI)	Hazard ratio (95% CI)	Hazard ratio (95% CI)
(A) Drinking status: female (15,160/558; ref.: current drinker)				
Nondrinker	1.32 (1.11–1.58)**	1.26 (1.05–1.50)*	1.18 (0.97–1.44)+	1.19 (0.98–1.46)+
Drinking status: male (12,105/582; ref.: current drinker)				
Nondrinker	1.02 (0.87–1.20)	0.99 (0.84–1.17)	0.89 (0.73–1.07)	0.92 (0.76–1.12)
(B) Drinking history: female (15,160/558; ref.: current drinker)				
Lifetime abstainer	1.20 (1.00–1.45)+	1.16 (0.96–1.40)	1.09 (0.88–1.35)	1.12 (0.90–1.38)
Past drinker	1.74 (1.38–2.20)***	1.62 (1.28–2.07)***	1.51 (1.15–1.97)**	1.43 (1.10–1.87)**
Drinking history: male (12,105/582; ref.: current drinker)				
Lifetime abstainer	0.95 (0.77–1.17)	0.93 (0.76–1.15)	0.86 (0.68–1.08)	0.92 (0.73–1.17)
Past drinker	1.09 (0.89–1.33)	1.04 (0.85–1.28)	0.91 (0.73–1.15)	0.93 (0.74–1.17)
(C) Consumption level: female (15,160/558; ref.: moderate drinker)				
Occasional drinker	1.18 (0.83–1.70)	1.14 (0.79–1.63)	0.99 (0.67–1.46)	0.97 (0.66–1.44)
Light drinker	0.92 (0.62–1.37)	0.88 (0.59–1.32)	0.85 (0.56–1.29)	0.78 (0.51–1.19)
Heavy drinker	1.55 (0.92–2.62)	1.57 (0.93–2.65)+	1.37 (0.77–2.44)	1.29 (0.72–2.29)
Lifetime abstainer	1.30 (0.95–1.78)+	1.22 (0.89–1.67)	1.06 (0.75–1.49)	1.04 (0.74–1.47)
Past drinker	1.89 (1.34–2.66)***	1.71 (1.21–2.43)**	1.46 (1.00–2.14)+	1.34 (0.91–1.96)
Consumption level: male (12,105/582; ref.: moderate drinker)				
Occasional drinker	0.88 (0.66–1.19)	0.87 (0.65–1.17)	0.84 (0.61–1.16)	0.83 (0.64–1.08)
Light drinker	0.86 (0.66–1.14)	0.83 (0.63–1.10)	0.85 (0.64–1.14)	0.65 (0.39–1.07)
Heavy drinker	0.85 (0.55–1.33)	0.85 (0.54–1.32)	0.72 (0.43–1.18)	0.84 (0.63–1.13)
Lifetime abstainer	0.89 (0.70–1.12)	0.86 (0.68–1.09)	0.78 (0.60–1.01)	0.87 (0.63–1.21)
Past drinker	1.02 (0.81–1.28)	0.96 (0.76–1.21)	0.83 (0.64–1.07)	0.84 (0.65–1.09)

Note: BMI = body mass index; CI = confidence interval. n = 27,265.
[a]Race. [b]Marital status, income, education, U.S. geographical region, and urbanicity. [c]Smoking, BMI category, physical activity level, diabetes, and hypertension.
+$p < .1$, *$p < .05$, **$p < .01$, ***$p < .001$.
Source: REGARDS.

drinkers were less likely to experience ischemic strokes than moderate drinkers.

Interaction terms indicated different associations between alcohol and ischemic (but not hemorrhagic) stroke by sex but not race. Hazard of ischemic stroke was significantly higher in nondrinkers compared with drinkers among women (see Supplementary Appendix). Among women only, both lifetime abstainers and past drinkers had higher hazards of stroke than current drinkers. The higher hazard among lifetime abstaining women was largely explained by their race, as was the higher risk experienced by heavy drinkers.

Discussion

This study examined the relationships between alcohol consumption and risk of stroke among older adults and explored whether differences in alcohol consumption explain some of the observed differences in stroke risks between black and white older adults and between men and women. In this large prospective cohort study of white and black adults aged 45 years and older in the United States, alcohol consumption was negatively associated with incident stroke: compared with current drinkers, nondrinkers had 12% higher hazard of incident stroke. Risks were specifically high among past drinkers; perhaps some of them stopped drinking because they had developed health problems. Most differences in stroke risk were explained by the sex and race composition of drinkers and nondrinkers. Among all groups, current light drinkers, who consumed up to 1 drink/week, had the lowest hazard of stroke; they had 22% lower hazards compared with moderate drinkers (1–7.5 drinks/week for women, 1–15 for men).

Although many studies reported lower risks of mortality among moderate drinkers, this study of stroke risks among older adults found lowest risks of stroke among light drinkers. It is noteworthy that this association remains significant after accounting for the many other differences between drinkers and nondrinkers. For example, the fact that more current drinkers than nondrinkers were smokers may obscure associations between alcohol and stroke, as smoking itself is associated with stroke incidence. On the other hand, nondrinkers were heavier and more often obese than current drinkers, a difference that may be worth

Table 5. Role of Alcohol, With Multiple Measures, in Differences in Stroke Between Black and White Men and Women

	Models 0	Model 1	Model 2	Model 3
	Univariate[a]	Model 0 + alcohol consumption	Model 1 + demographic and socioeconomic[b]	Model 2 + health and behaviors[c]
Variables	Hazard ratio (95% CI)	Hazard ratio (95% CI)	Hazard ratio (95% CI)	Hazard ratio (95% CI)
(A) Drinking status: current/not current (ref.: white male; 8,062/385)				
Black female (6,907/277)	1.08 (0.92–1.26)	1.05 (0.89–1.23)	1.11 (0.91–1.34)	0.99 (0.81–1.24)
Black male (4,043/197)	1.28 (1.08–1.52)**	1.26 (1.06–1.50)**	1.31 (1.08–1.59)**	1.17 (0.96–1.42)
White female (8,253/281)	0.80 (0.68–0.93)**	0.79 (0.68–0.92)**	0.80 (0.67–0.96)*	0.86 (0.72–1.03)
(B) Drinking history: current, past, never (ref.: white male; 8,062/385)				
Black female (6,907/277)	1.08 (0.92–1.26)	1.07 (0.91–1.25)	1.13 (0.93–1.37)	1.00 (0.82–1.23)
Black male (4,043/197)	1.28 (1.08–1.52)**	1.24 (1.04–1.48)*	1.30 (1.07–1.58)**	1.16 (0.95–1.41)
White female (8,253/281)	0.80 (0.68–0.93)**	0.81 (0.69–0.95)**	0.82 (0.69–0.98)**	0.87 (0.72–1.05)
(C) Consumption level: lifetime abstainer, past, occasional, light, moderate, heavy drinker (ref.: white male; 8,062/385)				
Black female (6,907/277)	1.08 (0.92–1.26)	1.09 (0.93–1.29)	1.17 (0.96–1.42)	1.03 (0.84–1.27)
Black male (4,043/197)	1.28 (1.08–1.52)**	1.26 (1.06–1.50)**	1.32 (1.09–1.61)**	1.18 (0.97–1.43)
White female (8,253/281)	0.80 (0.68–0.93)**	0.82 (0.70–0.96)*	0.84 (0.70–1.01)+	0.89 (0.74–1.07)

Note: BMI = body mass index; CI = confidence interval. n = 27,265.
[a]Race, sex. [b]Marital status, income, education, U.S. geographical region, and urbanicity. [c]Smoking, BMI category, physical activity level, diabetes, and hypertension.
+$p < .1$, *$p < .05$, **$p < .01$, ***$p < .001$.
Source: REGARDS.

exploring given the complex relationships between body weight and mortality at older ages (Winter, MacInnis, Wattanapenpaiboon, & Nowson, 2014). Our categorizations of drinking status may not be sufficiently detailed. Systematic characterization of older adults' health-related behaviors could provide useful information for understanding stroke and other health outcomes. This could include characterizing the prevalence of health-related behaviors, for example detailed drinking patterns; associations between behaviors, for example between drinking, smoking, and eating patterns; and patterns of reporting about behaviors that may be stigmatized, such as alcohol, in terms of validity, reliability, and willingness to respond.

Consistent with previous studies, older white women had the lowest hazard of stroke, whereas older black men had the highest (Gillum, 1999; Rosamond et al., 1999). In spite of these divergent patterns of stroke outcomes, both women and blacks were less often current drinkers than were white men, highlighting the complexity of the relationship between alcohol and stroke.

The relationship between patterns of drinking alcohol and stroke incidence did not differ by race, but did differ by sex. It was especially among women that nondrinkers, and specifically past regular drinkers, had higher risks of stroke than current drinkers. This pattern is consistent with previous studies that reported protective effects of alcohol for women only (Hansagi et al., 1995). It could be that older women are more likely than older men to stop drinking after a negative health event. Associations between alcohol consumption levels and stroke were suggestive of a J-shaped relationship reported in other populations (Jimenez et al., 2012).

This study also explored whether the higher risk of stroke among black compared with white older adults and among men compared with women is in part a result of differences in alcohol consumption. Alcohol consumption in fact did not explain the differences in stroke experienced by black and white men and women. These sex and race differences did however seem to be explained by other behaviors and behavioral-related health characteristics, such as smoking, physical activity, and body weight.

REGARDS is a geographically diverse study with near-national coverage and one of the largest cohorts of blacks and whites evaluating stroke outcomes; still, it is not nationally representative of older adults. We explored patterns of hemorrhagic and ischemic stroke separately, but, due to the small number of hemorrhagic stroke events, which is typical across studies, we may not have detected all pertinent associations. Indeed, the finding that light drinkers may have an advantage in stroke incidence relative to moderate drinkers may be linked with risks of hemorrhagic strokes among moderate to heavy drinkers, but we were not able to quantify these relationships.

Different types of alcohol may have different implications for stroke risk, but we did not have information on types of alcohol consumed. Still, studies have indicated that the amount rather than the type of beverage matters for CVD risks (Baglietto, English, Hoper, Powles, & Giles, 2006).

Table 6. Hemorrhagic and Ischemic Stroke and Alcohol Among Older Adults

	Model 0	Model 1	Model 2	Model 3
	Univariate	Model 0 + demographic[a]	Model 1 + socioeconomic[b]	Model 2 + health and behaviors[c]
Variables	Hazard ratio (95% CI)	Hazard ratio (95% CI)	Hazard ratio (95% CI)	Hazard ratio (95% CI)
(A) Drinking status: hemorrhagic stroke (ref.: current drinker; 13,647/52)				
Nondrinker (12,590/60)	1.11 (0.76–1.61)	1.08 (0.74–1.57)	0.95 (0.62–1.45)	0.96 (0.63–1.49)
Drinking status: ischemic stroke (ref.: current drinker; 14,032/437)				
Nondrinker (13,051/521)	1.13 (0.99–1.28)+	1.09 (0.95–1.24)	1.07 (0.92–1.23)	1.06 (0.92–1.23)
(B) Drinking history: hemorrhagic stroke (ref.: current drinker; 13,647/52)				
Lifetime abstainer (7,980/39)	1.09 (0.72–1.65)	1.06 (0.70–1.62)	0.99 (0.62–1.59)	1.05 (0.65–1.68)
Past drinker (4,610/21)	1.15 (0.69–1.91)	1.11 (0.66–1.86)	0.77 (0.42–1.43)	0.77 (0.42–1.43)
Drinking history: ischemic stroke (ref.: current drinker; 14,032/437)				
Lifetime abstainer (8,261/320)	1.04 (0.90–1.20)	1.00 (0.87–1.16)	0.97 (0.82–1.14)	1.01 (0.86–1.19)
Past drinker (4,790/201)	1.31 (1.11–1.55)**	1.25 (1.06–1.48)**	1.15 (0.95–1.39)	1.12 (0.93–1.36)
(C) Consumption level: hemorrhagic stroke (ref.: moderate drinker; 5,038/25)				
Occasional drinker (3,605/10)	0.57 (0.27–1.18)	0.55 (0.27–1.16)	0.62 (0.28–1.36)	0.63 (0.29–1.39)
Light drinker (3,932/16)	0.91 (0.48–1.70)	0.89 (0.47–1.66)	1.04 (0.54–2.02)	1.04 (0.54–2.00)
Heavy drinker (1,072/1)	0.21 (0.03–1.53)	0.21 (0.03–1.53)	0.25 (0.03–1.85)	0.24 (0.03–1.80)
Lifetime abstainer (7,980/39)	0.87 (0.53–1.44)	0.84 (0.50–1.40)	0.85 (0.47–1.52)	0.89 (0.50–1.61)
Past drinker (4,610/21)	0.92 (0.51–1.64)	0.87 (0.48–1.58)	0.66 (0.33–1.33)	0.66 (0.33–1.34)
Consumption level: ischemic stroke (ref.: moderate drinker; 5,194/181)				
Occasional drinker (3,714/119)	0.92 (0.73–1.15)	0.89 (0.71–1.12)	0.83 (0.64–1.07)	0.85 (0.66–1.09)
Light drinker (4,014/98)	0.78 (0.61–1.00)*	0.76 (0.59–0.97)*	0.75 (0.58–0.98)*	0.73 (0.56–0.94)*
Heavy drinker (1,110/39)	1.14 (0.81–1.61)	1.14 (0.81–1.61)	0.97 (0.66–1.44)	0.90 (0.61–1.33)
Lifetime abstainer (8,261/320)	0.96 (0.80–1.16)	0.91 (0.76–1.10)	0.85 (0.69–1.04)	0.88 (0.71–1.08)
Past drinker (4,790/201)	1.22 (0.99–1.49)+	1.24 (1.09–1.42)	1.01 (0.80–1.26)	0.97 (0.77–1.22)

Note: BMI = body mass index; CI = confidence interval.
[a]Race. [b]Marital status, income, education, U.S. geographical region, and urbanicity. [c]Smoking, BMI category, physical activity level, diabetes, and hypertension.
$^{+}p < .1$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.
Source: REGARDS.

Self-reported information on drinking and other behaviors, especially those that may be stigmatizing, may be inaccurate or imprecise. If people with and without subsequent stroke had different levels of accuracy in reporting alcohol consumption at baseline, our results could be biased.

Nonresponse and loss to follow-up could result in biased results if the relationship between alcohol consumption and stroke were different for nonresponders compared with responders. A related consideration is that older adults in the United States may be reluctant to reveal their alcohol intake; this would be of concern if those in poor health underreported more frequently than those in good health.

REGARDS only collected information on alcohol intake as part of its baseline questionnaire. Ideally, we would have had a more detailed drinking history to better measure exposure to alcohol, including drinking habits at younger ages and during the study follow-up. As such, we cannot assess the consequences of changes in alcohol intake or the ages at which drinking patterns may be most pertinent for stroke. Still, we respect temporal ordering, examining incident stroke during years subsequent to recording drinking patterns.

Information about the implications of alcohol consumption among older men and women is limited, even though older adults are at high risk of morbidity and mortality, including from stroke. This study used information on adjudicated stroke events, together with multiple approaches to categorizing drinking patterns in a large national cohort of older adults. We found low levels of alcohol consumption among older adults in the United States, with average consumption at 2.2 drinks/week and more than half of drinkers having less than 1 drink in a typical week. There were differences in incident stroke both between drinkers and nondrinkers and among drinkers, with risks being consistently

higher among past drinkers, especially for women. After adjusting for demographic, socioeconomic, behavioral, and health characteristics, light drinkers had lower hazard of stroke compared with moderate drinkers and to a lesser extent compared with nondrinkers. Though patterns of stroke and of alcohol consumption differed among blacks and whites and among men and women, drinking patterns did not contribute to explaining race and sex differences in incident stroke.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences* online.

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Conflict of Interest

The authors have no conflicts of interest to declare.

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