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Association between alcohol consumption and stroke in Nigeria and Ghana: A case–control study

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Abstract

Background: The aim of the study was to examine the association between alcohol consumption and stroke in Nigeria and Ghana.

Methods: The study is a multicentre, case–control study. Cases included consenting adults 18 years of age and older with acute stroke and controls were age-and -gender -matched stroke –free adults. Alcohol consumption was self-reported. The participants were classified into three alcohol-drinking status, which included abstainers, former drinkers, and current drinkers. The current drinkers were further classified into different alcohol drinking levels, including infrequent, light, moderate, heavy, and binge drinkers. Conditional logistic regression was used to determine associations between the drinking status and stroke, and the association between the different levels of current alcohol consumption and stroke. Five models were evaluated. Model 1 was unadjusted. Model 2 was adjusted for demographic characteristics. Model 3 included Model 2, lifestyle and psychosocial characteristics. Model 4 included Model 3 and dietary characteristics. Model 5 included Model 4 and metabolic characteristics.

Results: A total of 7368 participants took part in the study. Half were stroke participants, and half were control participants. On the associations between drinking status and stroke, respectively, former drinkers showed no significant association with stroke. However, a significant association was observed between current drinkers and stroke in Models 1 and 2, with an odds ratio of 1.19 (95% CI: 1.04–1.38; $p < 0.05$) and 1.17 (95% CI: 1.01–1.36; $p < 0.05$), respectively. Regarding the various levels of current alcohol drinking and their association with stroke, no significant association was observed between light drinking and stroke in Model 5. In contrast, moderate drinkers, binge drinkers, and heavy drinkers showed a persistent and significant association with stroke respectively.

Conclusion: There is a significant association between stroke and current alcohol consumption, especially among heavy, binge, and moderate drinkers.

Keywords

Stroke, lifetime alcohol abstainers, former alcohol drinkers, current alcohol drinkers

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Introduction

Stroke is the second leading cause of death in the world, with around 5.5 million deaths each year.[1] The prevalence of stroke is on the rise in Nigeria and most sub-Saharan African (SSA) countries. It is also a leading cause of neurological admission in most tertiary hospitals in Nigeria.[2,3] According to data from the 2016 Global Burden of Disease Study, Nigeria had one of the highest prevalence of current alcohol use among persons 15 years of age and older in SSA, with a population-level range of 40%–59.9% for both genders.[4] Alcohol consumption is one of the behavioural risk factors for stroke.[5] It was first implicated as a possible risk factor in 1725.[6] However, some later epidemiological studies have shown that alcohol consumption has an inconsistent association with stroke.[7,8] Light-to-moderate alcohol consumption has been associated with a lower risk of stroke, according to certain studies.[8] However, some other studies contradict these findings.[9]

There are studies from other regions of the world on the association between alcohol consumption and stroke.[10,11] However, there is a dearth of data emanating from the SSA region on the association between alcohol consumption and stroke. Furthermore, a variety of research populations are required to examine the association between alcohol consumption and stroke since distinct genetic, environmental, and lifestyle differences may have varied effects on the outcome of the association between alcohol consumption and stroke.

We present the findings of a multicentre case–control study in Nigeria and Ghana that used validated measures of alcohol consumption to examine the association between alcohol consumption and stroke in the West African region.

Methods

Study design

The Stroke Investigative Research and Educational Network (SIREN) study is a multicentre, case–control study involving 16 sites in Nigeria and Ghana that started in August 2014. Details of the study design and methods have been extensively documented elsewhere.[12,13] Ethical approval was obtained from the primary site, the University of Ibadan/University College Hospital Ethics Committee, with approval number UI/EC/13/0105, and additional approval from the participating hospital sites in Nigeria and Ghana. Informed consent was obtained from all participants.

Bilingual research assistants assisted in the index evaluation of cases and controls, which was done using a comprehensive, standardized process that was based on the WHO-STEPS Stroke Surveillance, INTERSTROKE, and REGARD protocols with the necessary modifications.[13] The study included consenting adults 18 years of age and older, who had their first clinical stroke within 8 days of the current symptom onset or who were last seen "without deficit" with a cranial computed tomography or magnetic resonance imaging performed within 10 days of the current symptom onset. A close relative gave consent when the stroke participant was unconscious. Consenting stroke-free adults from neighbouring communities around the hospital sites served as controls.

The eight-item questionnaire for verifying stroke-free status was used to ascertain stroke-free status among the controls. Stroke was defined as rapidly developing clinical signs of focal or global disturbance of brain function, lasting for more than 24 hours or resulting in death, with no

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apparent cause other than vascular.[12] Those with subarachnoid haemorrhage, subdural hematoma, or epidural haemorrhage were not eligible for the study. Recurrent or repeated stroke cases were also excluded.

Data collection

Data collection and description of covariates had been elaborated in earlier publications.[12,13] The questionnaire section on lifestyle assessment was used to obtain information regarding current and previous alcohol consumption. Each alcoholic drink type provided on the questionnaire was converted to the equivalent number of grams of alcohol to harmonize the various forms of alcohol consumed in this study. These were then standardized by converting the grams of alcohol into the equivalent number of alcoholic drinks. The quantity of pure alcohol in a typical drink is not universally agreed upon; estimates vary from 8 to 20 g, depending on the country.[14] However, 10 g is the unit of measurement used in the sample questionnaire form for the Alcohol Use Disorders Identification Test (AUDIT), developed by the World Health Organization.[15] More countries than any other have accepted this standard[16], with 10 g serving as this study's standard drink equivalent.

Alcohol consumption: Binge drinking is defined as a pattern of drinking alcohol that brings the blood alcohol concentration to 0.08%, or 0.08 g of alcohol per deciliter, or higher. For a typical adult, this pattern corresponds to consuming five or more drinks (male) or four or more drinks (female) in about 2 h.[17] Lifetime abstinence from alcohol is defined as consuming fewer than 12 drinks in a lifetime.[18] A former regular alcohol drinker is defined as consuming at least 12 drinks in any 1 year of a lifetime, but no drinks in the past year.[18] A current infrequent (occasional) drinker is defined as a person who has consumed 1–11 drinks in the past year.[19] A current light drinker is defined as a person who has consumed at least 12 drinks in the past year but 3 drinks or less per week, on average, over the past year.[18] A current moderate drinker is defined as more than 3 drinks but no more than 7 drinks per week for women and more than 3 drinks but no more than 14 drinks per week for men, on average over the past year.[18] A current heavy alcohol drinker among men is defined as consuming more than 4 drinks on any day or more than 14 drinks per week and, for women, consuming more than 3 drinks on any day or more than 7 drinks per week.[18]

Statistical analysis

The demographic, behavioural, psychological, and vascular characteristics of lifetime abstainers, former drinkers, and current drinkers were compared. Chi-square test was conducted to determine whether any categorical factors produced substantially different findings. Continuous variables' mean and standard deviation were calculated, and statistical differences were examined using the analysis of variance (ANOVA) test. Conditional logistic regression at a 95% confidence interval (CI) was used to determine the associations between the different status of alcohol consumption and stroke occurrence, and the different current alcohol consumption levels and stroke occurrence (Table 2 and Table 3). Five models were evaluated: Model 1 was unadjusted, and Model 2 was adjusted for demographic characteristics (age, domicile, marital status, income, and education). Model 3 included Model 2, lifestyle and psychosocial characteristics (tobacco use, depression, stress). Model 4 included Model 3 and dietary characteristics (low vegetable consumption, regular meat intake). Model 5 included Model 4 and metabolic characteristics (waist-to-hip ratio, diabetes, hypertension, dyslipidemia, family history of cardiovascular disease (CVD)). The missingness in the data was imputed using the multivariate imputation by chained equation package in R. All statistical analyses were carried out using SPSS (version 25) and the R statistical package (version 4.1.1), at a two-sided $p < 0.05$.

Results

Characteristics of the study population based on alcohol consumption status

Among the participants, there were 5197 (70.54%) lifetime alcohol abstainers, 1067 (14.48%) former alcohol drinkers, and 1104 (14.98%) current alcohol drinkers. The proportion of lifetime abstainers, former drinkers, and current drinkers was 50.8%, 48.6%, and 47.4%, respectively, among the stroke cases. Among the control group, the prevalence of lifetime abstainers, former drinkers, and current drinkers was 49.2%, 51.4%, and 52.6%, respectively.

In addition, 75.4% of the participants were above 50 years of age, 75.1% were married, and 55.5% lived in urban areas. The prevalence of tobacco use was 5.9%. The prevalence of physical inactivity was 3.5%, depression was 7.0%, general obesity was 21.1%, hypertension was 77.5%, diabetes was 24.4%, and dyslipidemia was 62.3%. Low vegetable consumption was reported at 22.8%, and the meat consumption rate was 72.1% among all the participants (Table 1).

Furthermore, with regard to gender, women were in the majority among lifetime abstainers (55.4%). In addition, the prevalence of diabetes, dyslipidemia, and raised waist/hip ratio was significantly higher among women.

Table 1. Characteristics of the study population based on alcohol consumption status.

Characteristics	All N = 7368 n (%)	Lifetime abstainer N = 5197 n (%)	Former drinker N = 1067 n (%)	Current drinker N = 1104 n (%)	p
Stroke					
Control	3684 (50.0)	2642 (50.8)	519 (48.6)	523 (47.4)	0.071
Cases	3684 (50.0)	2555 (49.2)	548 (51.4)	581 (52.6)	
Gender					
Female	3376 (45.8)	2881 (55.4)	299 (28.0)	196 (17.8)	
Male	3992 (54.2)	2316 (44.6)	768 (72.0)	908 (82.2)	
Age in years (mean ± SD)	59.0 ± 13.9	59.1 ± 13.3	60.5 ± 13.0	56.8 ± 12.5	<0.0001
<50	1809 (24.6)	1280 (24.6)	206 (19.3)	323 (29.3)	<0.0001
⩾50	5559 (75.4)	3917 (75.4)	861 (80.7)	781 (70.7)	
Domicile					
Rural	1018 (13.8)	799 (15.4)	98 (9.2)	121 (11.0)	<0.0001
Semi-Urban	2080 (28.2)	1541 (29.6)	286 (26.8)	253 (22.9)	
Urban	4270 (58.0)	2857 (55.0)	683 (64.0)	730 (66.1)	
Marital status					
Never married	300 (4.1)	205 (4.0)	34 (3.2)	61 (5.5)	<0.0001
Currently married /cohabiting	5533 (75.1)	3843 (73.9)	812 (76.1)	878 (79.5)	
Formally married	1535 (20.8)	1149 (22.1)	221 (20.7)	165 (15.0)	
Income					
⩽US$100	3953 (53.7)	3021 (58.1)	472 (44.2)	460 (41.7)	<0.0001
>US$100	3415 (46.3)	2176 (41.9)	595 (55.8)	644 (58.3)	
Education					
No education	1537 (20.9)	1330 (25.6)	123 (11.5)	84 (7.6)	<0.0001
Some education	5831 (79.1)	3867 (74.4)	944 (88.5)	1020 (92.4)	
Lifestyle and psychosocial function					
Tobacco use					
Never used	6769 (91.9)	5071 (97.6)	842 (78.9)	856 (77.5)	<0.0001
Former user	166 (2.2)	43 (0.8)	25 (2.4)	98 (8.9)	
Current user	433 (5.9)	83 (1.6)	200 (18.7)	150 (13.6)	
Physical inactivity (yes)	258 (3.5)	176 (3.4)	47 (4.4)	35 (3.2)	0.208

(Continued)

Table 1. (Continued)

Characteristics	All N = 7368 n (%)	Lifetime abstainer N = 5197 n (%)	Former drinker N = 1067 n (%)	Current drinker N = 1104 n (%)	p
Depression (Yes)	515 (7.0)	292 (5.6)	111 (10.4)	112 (10.1)	<0.0001
Stress (Yes)	1203 (16.3)	697 (13.4)	253 (23.7)	253 (22.9)	<0.0001
Metabolic factors					
BMI in kg/m^2 (mean ± SD)	26.4 ± 5.5	26.4 ± 5.3	26.6 ± 5.3	26.1 ± 5.1	0.203
<30	5812 (78.9)	4088 (78.7)	839 (78.6)	885 (80.2)	0.527
⩾30	1556 (21.1)	1109 (21.3)	228 (21.4)	219 (19.8)	
Waist-to-hip ratio (mean ± SD)	0.93 ± 0.08	0.92 ± 0.08	0.93 ± 0.09	0.93 ± 0.08	0.622
Waist-to-hip ratio (Raised)	5637 (76.5)	4038 (77.7)	785 (73.6)	814 (73.7)	0.001
Fasting blood glucose in mg/dl (mean ± SD)	104.2 ± 40.4	103.8 ± 40.6	105.6 ± 44.4	104.2 ± 35.0	0.582
Diabetic (Yes)	1800 (24.4)	1241 (23.9)	312 (29.2)	247 (22.4)	<0.0001
SBP in mmHg (mean ± SD)	148.0 ± 28.4	147.9 ± 30.3	148 .6 ± 29.0	148.0 ± 28.4	0.782
DBP in mmHg (mean ± SD)	89.2 ± 19.6	89.0 ± 17.5	89.2 ± 17.9	89.8 ± 18.0	0.378
Hypertensive (Yes)	5712 (77.5)	3966 (76.3)	884 (82.8)	862 (78.1)	<0.0001
Total cholesterol in mg/dl (mean ± SD)	198.8 ± 53.9	190.7 ± 53.1	196.3 ± 57.3	198.8 ± 53.4	<0.0001
Triglyceride in mg/dl (mean ± SD)	116.7 ± 70.6	118 .8 ± 73.2	110 ± 62.9	113.6 ± 65.0	0.002
Dyslipidemia (Yes)	4593 (62.3)	3168 (61.0)	744 (69.7)	681 (61.7)	<0.0001
Family history of CVD (Yes)	2288 (31.1)	1346 (25.9)	484 (45.4)	458 (41.5)	<0.0001
Low vegetable consumption	1683 (22.8)	215 (19.5)	177 (16.6)	1291 (24.8)	<0.0001
Fruit consumption	6357 (86.3)	4474 (86.1)	924 (86.6)	959 (86.9)	0.751
Regular meat consumption (yes)	5311 (72.1)	3784 (72.8)	704 (66.0)	823 (74.5)	<0.0001

However, men make up the majority of current drinkers (88.2%). The current drinkers were younger, more likely to be urban residents, and had more formal education when compared to lifetime abstainers. In addition, there was a higher prevalence of depression, stress, a history of current smoking, and a family history of CVD, among current alcohol drinkers (Table 1).

Association between alcohol drinking status and stroke

There was no significant association between former alcohol drinkers and stroke ($p > 0.05$). Among current alcohol drinkers, there was a significant odds of stroke in Models 1 and 2 ($p < 0.05$). In Models 3–5, no association was

Table 2. The association between alcohol drinking status and stroke.

Variables	Model 1	Model 2	Model 3	Model 4	Full model
	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Drinking status					
Lifetime abstainer (Ref)	1	1	1	1	1
Former drinkers	1.12 (0.98–1.30)	1.03 (0.89–1.20)	0.97 (0.83–1.13)	1.01 (0.86–1.18)	0.78 (0.64–0.96)
Current drinkers	1.19 (1.04–1.38)*	1.17 (1.01–1.36)*	1.11 (0.95–1.29)	1.10 (0.94–1.29)	0.98 (0.79–1.21)

*$p < 0.05$; significant variable, Model 1: Unadjusted; Model 2: Model 1 with demographic characteristics (age: "< 50 vs ⩾ 50 years," domicile: "rural vs urban," marital status: "never married vs currently married/cohabiting and formally married," income: "⩽ US$100 vs > US$100," and education: "no education vs some education"); Model 3: Model 2 with lifestyle and psychosocial function (Tobacco use: "never vs ever," depression: "not depressed vs depressed," stress: "stressed vs not stressed"); Model 4: Model 3 with dietary factors (low vegetable consumption: "no vs yes," regular meat intake: "no vs yes"); Model 5: Model 4 with metabolic factors (waist-to-hip ratio: "not raised vs raised," diabetes: "no vs yes," hypertension: "normotensive vs hypertensive," dyslipidemia: "no vs yes," family history of CVD: "no vs yes").

observed in any of the these three models ($p > 0.05$) (Table 2 and Figure 1).

Association between current alcohol drinking levels and stroke

The association between current alcohol drinking levels versus stroke, with "infrequent (occasional) alcohol drinker" used as a reference, showed that light alcohol drinking had significant associations with stroke in Models 1–4 ($p < 0.05$). The ORs of stroke were higher in Models 1 and 2, with a progressive decrease from Models 3–5. The association in Model 5 was not significant ($p > 0.05$). There was a significant association between binge alcohol drinking and stroke in all five models ($p < 0.05$). However, the ORs of stroke were higher in Models 1–3, with a progressive decrease in Models 4–5. Furthermore, all five models showed a strong correlation ($p < 0.05$) between heavy drinking and stroke, with high probabilities of stroke in each model. This trend was consistent with what was shown in people who consumed moderate amounts of alcohol (Table 3 and Figure 2).

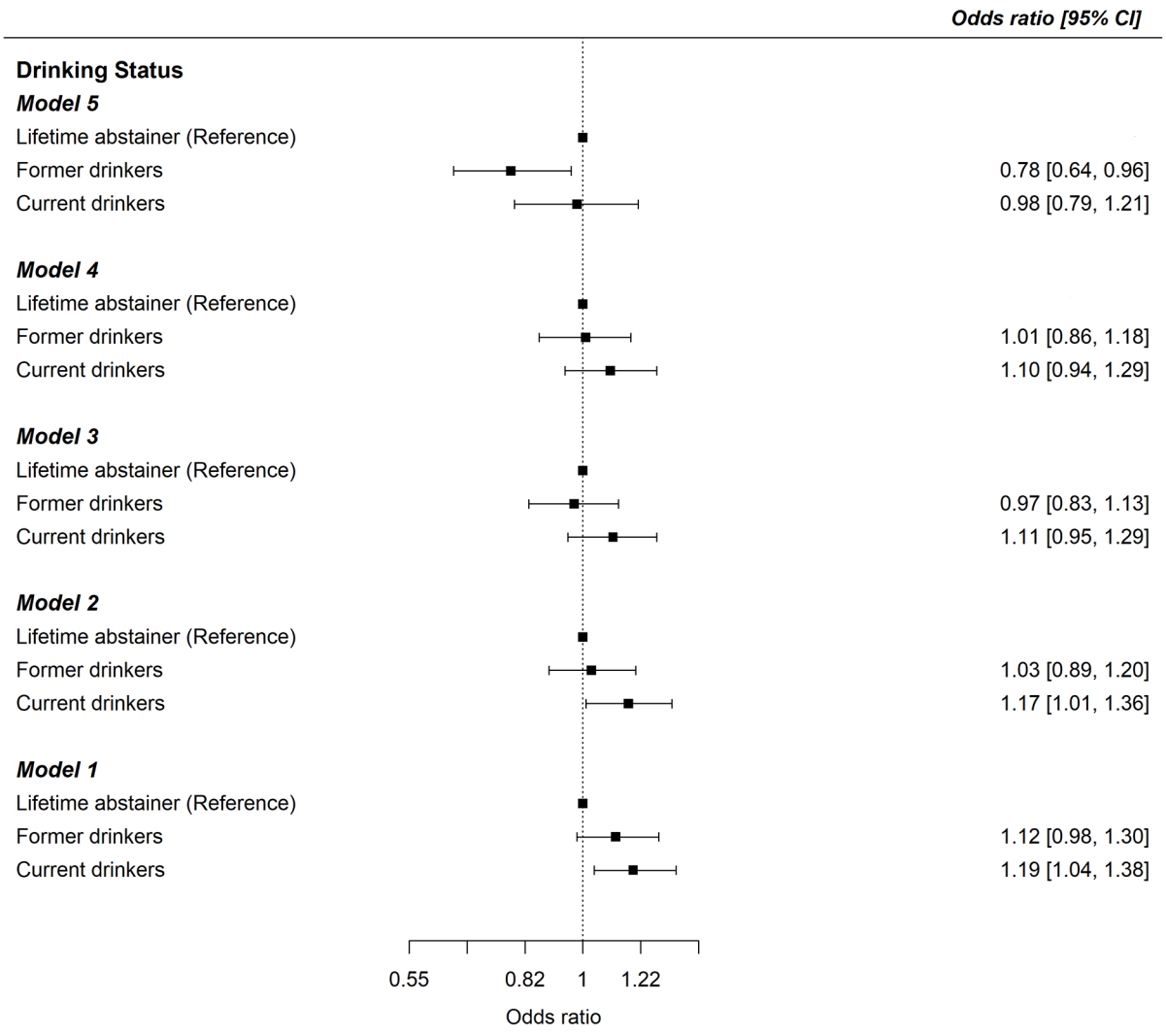
Discussion

This study examined the association between alcohol consumption and stroke in Nigeria and Ghana. The study included consenting participants, half of whom were stroke participants (including the unconcious whose relatives gave consent), and half of whom were control participants (consenting stroke-free adults) recruited mostly from the communities in the catchment areas of the SIREN hospitals. In this study current drinkers were found to be younger, male, cigarette smokers, and in higher-paying occupations. The INTERSTROKE study and the PURE study reported similar findings.[19,20] However, the prevalence of current alcohol drinkers in this study (14.98%) was substantially lower than the prevalence reported in the INTERSTROKE (25.0%).[19] and the PURE study (31%).[20]

There were 5197 (70.13%) lifetime abstainers among the study participants. In the majority of African countries, including Nigeria and Ghana, alcohol plays an important role in several social events and cultural activities[21,22] and one would have expected a lower prevalence of lifetime abstainers. However, religion could be one of the reasons for the finding. Drinking alcohol is forbidden in Islam, and in Nigeria and Ghana, where Muslims constitute about 53% and 19% of the population, respectively.[23,24] Furthermore, some Christians abstain from alcohol because it is forbidden by some factions of the Pentecostal and Evangelical churches in the SSA region. There may also be some people who do not drink alcohol due to poverty, bearing in mind that the income of the lifetime abstainers was significantly lower than that of former and current alcohol drinkers (Table 1).

It was also observed that a majority of the lifetime abstainers in this study were women. This is not surprising because it is a known fact that alcohol consumption among women in Africa is low.[25] However, some research is needed to determine the reasons for the high prevalence of lifetime abstainers among women in the SSA region. Although there are a variety of contributing factors to this result, our study has shown that a very significant percentage of the population in the West African region are lifetime abstainers.

Figure 1. Forest plot of odds ratio (OR) and 95% confidence intervals (CI) for the association between drinking status (including former and current alcohol users) and Stroke. Conditional logistic regression models were used to estimate OR (95% CI) using lifetime abstainers as a reference. Model 1 was unadjusted or crude odds. Model 2 was adjusted for demographic factors, including age, domicile, marital status, income, and education. Model 3 was adjusted for lifestyle and psychosocial factors, including tobacco use, depression, and stress, in addition to covariates in Model 2. Model 4 was adjusted for dietary factors, including low vegetable and regular meat consumption, in addition to covariates in Model 3. Model 5 is the final model and was adjusted for metabolic factors, including waist-to-hip ratio, diabetes, hypertension, dyslipidemia, and family history of CVD, in addition to covariates in Model 4. All statistical analyses were carried out at a two-sided $p < 0.05$.



The prevalence of former drinkers in this study was 14.48%, similar to that observed in the INTERSTROKE study.[19] The reason for the former drinker's status may be due to a decision to change their lifestyle, usually due to pressure from relatives and friends or a chronic illness that is attributed to alcohol consumption by a medical doctor.

The association between alcohol drinking status and stroke was explored, with lifetime abstainers as a reference. Among former alcohol drinkers, there was no significant risk of stroke in the five models. This was in contrast with the odds of stroke in the current alcohol drinkers category. The associations between current drinkers and stroke were significant ($p < 0.5$) in Models 1 and 2 only. These results implied that the likelihood of stroke occurring among current drinkers in the two models was about 19% and 17%, respectively, higher than it was in lifetime abstainers. In the

Table 3. The association between current alcohol drinking levels and stroke.

Variables	Model 1	Model 2	Model 3	Model 4	Full model
	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Current drinkers only (alcohol consumption categories)					
Infrequent (occasional) drinkers	1	1	1	1	1
Light drinkers	4.03 (1.46–11.10)*	4.24 (1.50–11.99)*	3.85 (1.30–11.41)*	3.45 (1.12–10.61)*	2.85 (0.56–14.59)
Moderate drinkers	7.34 (1.52–35.33)*	6.49 (1.23–34.09)*	5.57 (1.03–30.26)*	5.40 (0.95–30.84)*	11.17 (1.25–99.5)*
Binge drinkers	6.82 (3.01–15.47)*	7.30 (3.17–16.90)*	6.81 (2.91–15.94)*	5.80 (2.45–13.70)*	3.37 (1.06–10.66)*
Heavy drinkers	6.59 (2.43–17.85)*	6.21 (2.28–16.91)*	5.62 (2.06–15.34)*	5.42 (1.95–15.08)*	7.28 (1.72–30.83)*

*$p < 0.05$: significant variable. Model 1: Unadjusted; Model 2: Model 1 with demographic characteristics (age: "< 50 vs. ≥ 50 years," domicile: "rural vs. urban," marital status: "never married vs. currently married/cohabiting and formally married," income: "≤ US$100 vs. >US$100," and education: "no education vs. some education"); Model 3: Model 2 with lifestyle and psychosocial function (Tobacco use: "never vs. ever," depression: "not depressed vs depressed," stress: "stressed vs not stressed"); Model 4: Model 3 with dietary factors (low vegetable consumption: "no vs yes," regular meat intake: "no vs yes"); Model 5: Model 4 with metabolic factors (waist-to-hip ratio: "not raised vs. raised," diabetes: "no vs. yes," hypertension: "normotensive vs hypertensive," dyslipidemia: "no vs yes," family history of CVD: "no vs yes".

INTERSTROKE study, current drinking was not associated with stroke in the African region.[19] A previous study reported that lifetime abstinence from alcohol consumption is a risk factor for stroke and that the likelihood of stroke occurring in lifetime abstainers is significantly higher than in former and current drinkers. The differences observed may be due to the study's small sample size (309 participants). In addition, the study was conducted in a different geographical region.[26] There was no significant association between former drinkers and stroke, and the same observation was made in the INTERSTROKE study.[19]

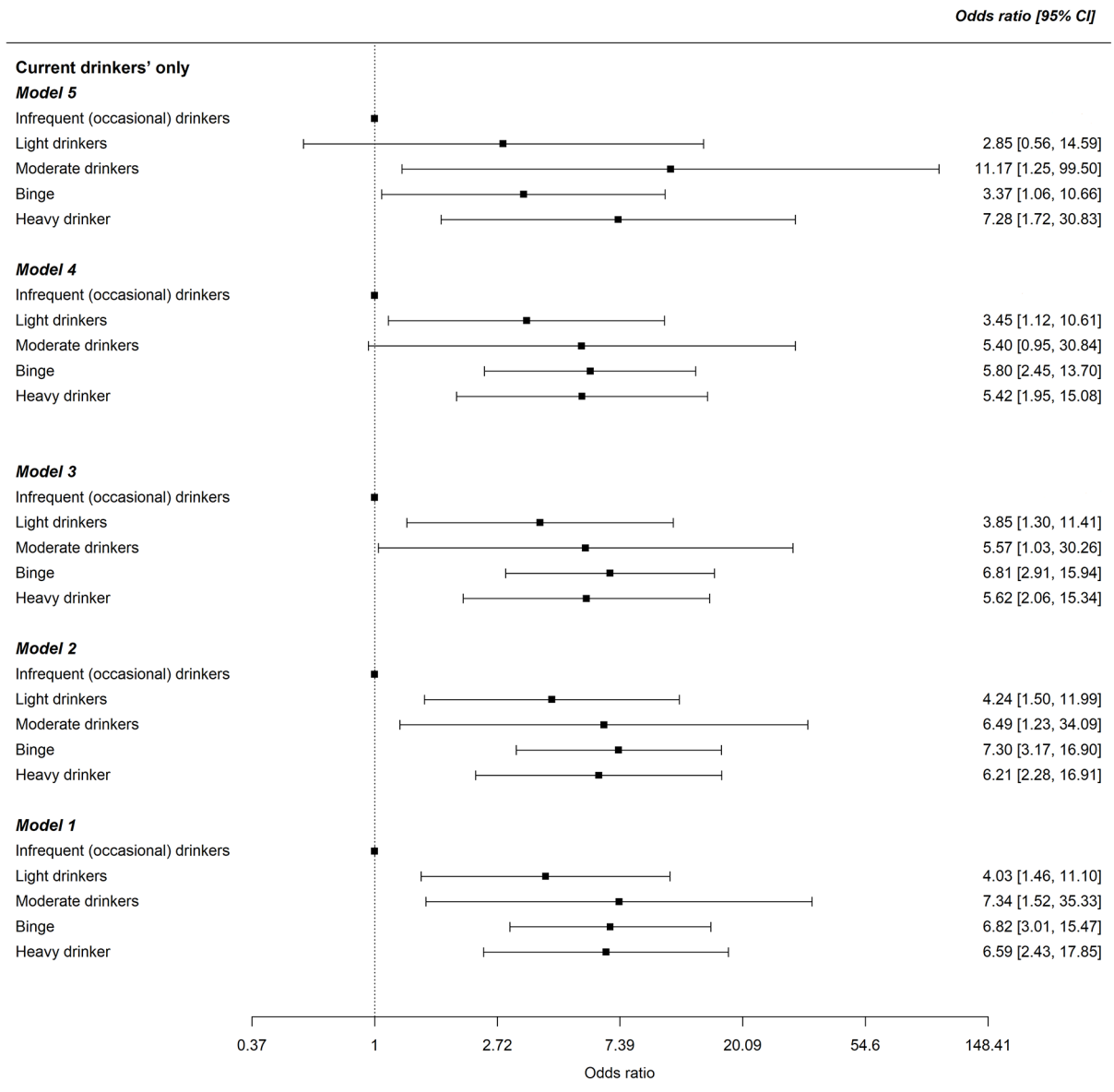
The associations between light, binge, moderate, and heavy drinkers and stroke, with occasional drinkers used as the reference, were to some extent influenced by confounding variables. However, the influences observed varied at the different current drinking levels and were more profound at the light level. The odds of stroke were significant in all models, among binge, moderate, and heavy drinker levels. Like a coin, there were two sides to the observations made in the light drinkers' category: the ORs observed in Models 1–4 were significant ($p < 0.05$), but the OR of stroke was not significant in Model 5 (OR: 2.85; 95% CI: 0.56–14.59; $p > 0.05$).

Our findings are similar to those made in the INTERSTROKE study.[19] In the study, high, moderate, and binge alcohol consumption levels were associated with increased odds of all strokes. However, low drinking (light drinkers) levels were associated with reduced odds of stroke in the African region and some other regions.

Our study provides insight into the association between alcohol consumption and stroke in the West African region. We observed that heavy, moderate, and binge alcohol drinking levels were associated with increased odds of stroke even after adjusting for known covariates. The same applies to the light drinking level, except in Model 5. These findings suggest that none of the current alcohol consumption levels is safe or protective against stroke in the West African region and that light (except when fully adjusted for confounders), moderate, binge, and heavy alcohol drinking levels are all risk factors for stroke in the region. Our findings are similar to those of larger studies which reported that high alcohol intake was associated with harm and that low alcohol intake was associated with little or no protection against stroke.[19,27] Our findings are also in keeping with the statement by the World Health Organization that there is no safe level of alcohol consumption that is not harmful to one's health and that "the potential protective effects of alcohol consumption, as suggested by some studies, are tightly connected with the comparison groups chosen and the statistical methods used and may not consider other relevant factors."[9]

However, to be categorically certain that these current alcohol drinking levels are all risk factors for stroke, the relative risk will have to be estimated, and this is not an option in case–control studies.[28]

Figure 2. Forest plot of ORs and 95% CIs for the association between current drinking levels (including light, moderate, binge, and heavy alcohol drinking and Stroke. Conditional logistic regression models were used to estimate OR (95% CI) using infrequent/occasional drinkers as a reference. Model 1 was unadjusted or crude odds. Model 2 was adjusted for demographic factors, including age, domicile, marital status, income, and education. Model 3 was adjusted for lifestyle and psychosocial factors, including tobacco use, depression and stress, in addition to covariates in Model 2. Model 4 was adjusted for dietary factors, including low vegetable and regular meat consumption, in addition to covariates in Model 3. Model 5 is the final model and was adjusted for metabolic factors, including waist-to-hip ratio, diabetes, hypertension, dyslipidemia, and family history of CVD, in addition to covariates in Model 4. All statistical analyses were carried out at a two-sided $p < 0.05$.



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