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Ho Yan Janet Li

Yale University, hoyan.li@yale.edu

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Alcohol Consumption in Relation to Stroke in a Multi-Ethnic Study Population

by

Ho Yan Janet Li

A thesis submitted to Yale School of Public Health
In partial fulfillment for the degree of

Master of Public Health

in

Chronic Disease Epidemiology

A cross-sectional study derived from the Kohala Health Research Project examining the association between alcohol consumption and stroke risk in Hawaiʻi.

Primary Reader: Dr. Xiaomei Ma
Second Reader: Dr. Joseph Keaweʻaimoku Kaholokula

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Abstract

Background: Stroke accounts for a much larger percentage of deaths in Hawai'i than in the rest of the United States, and Native Hawaiians experience stroke ten years younger than their Caucasian counterparts. Although the exact reason for this disparity is unclear, the high prevalence of alcohol consumption, along with other factors, has raised concerns.

Methods: The objective of this thesis is to assess the relationship between alcohol consumption and stroke in the Kohala Health Research Project, a multi-ethnic cross-sectional study of Hawai'I residents conducted during 1995-2000. Alcohol consumption was defined as binary (yes vs. no) and categorical (nondrinkers, moderate drinkers, and heavy drinkers), and stroke risk was classified using adaptations of the National Stroke Association's scorecard. Multivariate logistic regression models were used to adjust for a variety of demographic, behavioral, psychosocial, and medical factors, and a backwards function was used to arrive at a final model.

Results: Alcohol consumption was associated with a lower risk of stroke among the 910 subjects [adjusted odds ratio (OR) = 0.6, 95% confidence interval (CI): 0.4-0.8]. Compared with non-drinkers, moderate drinkers had a significantly lower risk of stroke (adjusted OR = 0.5, 95% CI: 0.3-0.7), while heavy drinkers did not appear to have a significantly different risk of stroke (adjusted OR = 0.8, 95% CI: 0.5-1.4). A higher level of education was also associated with a lower risk of stroke, whereas older individuals and ethnic minorities (Native Hawaiians and Japanese) had high risks of stroke.

Conclusion: Alcohol consumption, especially moderate amounts of alcohol consumption, was associated with a lower risk of stroke in this multi-ethnic population. Given the cross-sectional design of the study, a temporal relationship could not be established. Prospective cohort studies are needed to further examine the relationship between alcohol consumption and stroke risk.

Table of Contents

Introduction

In the United States, 795,000 people experience a new or recurrent stroke annually.[1] Stroke, a disturbance of an artery occluding the blood supply to the brain, account for the 18.4% of deaths in the entire United States and 43.2% of deaths in the state of Hawaiʻi.[1] In addition, Native Hawaiians are at a greater risk for developing hemorrhagic strokes and on average, are 10 years younger at the time of their first stroke, compared to their Caucasian counterparts.[2] Filipinos have the highest risk for coronary artery disease and stroke, compared to Asian Indian, Chinese, Japanese, Korean, and non-Hispanic Whites.[3]

The unique demographical and acculturation in Hawaiʻi may contribute to poorer health in Native Hawaiians compared to others in the United States. For instance, prevalence of obesity and overweight among Native Hawaiians are Pacific Peoples (e.g. Samoans, Microneasans) is as high as 74.7%. Native Hawaiians have a high prevalence of alcohol, smoking, and obesity, which may lead to chronic diseases including type II diabetes mellitus, cancer, and cardiovascular diseases.[4] Native Hawaiians are at a greater risk for developing hemorrhagic strokes and on average, are 10 years younger at the time of their first stroke, compared to their Caucasian counterparts.[2] The incidence of obesity, diabetes, high cholesterol, hypertension, and cardiovascular diseases continues to rise, causing a significant healthcare and economic burden to the population of Hawaiʻi.[5]

However, there is a dearth of studies aimed at explaining the high stroke risk among residents in Hawaiʻi. The Honolulu Heart Program observed a three to fourfold increased risk of stroke among moderate and heavy alcohol drinkers and hypothesized that alcohol consumption might cause stroke by altering platelet metabolism and weakening cerebral arteries.[6] Additionally, the overall high prevalence of alcohol consumption among Hawaiʻi residents varies

by ethnicity.[7] Given the unique demographics of Hawaiʻi with different ethnic groups and acculturation, it is important to assess the relationship between alcohol consumption and stroke risk in a multi-ethnic study population of Hawaiʻi, which is the objective of this thesis.

Methods

Study Population

The Kohala Health Research Project (KHRP) was a community-based, cross-sectional study conducted from 1995 to 2000.[8] The original study population, known as the Native Hawaiian Health Research Project, comprised 574 Native Hawaiians who were non-pregnant adults over 30 years of age living in the North Kohala district of Hawaiʻi. In 1996, the Native Hawaiian Health Research Project was expanded to include all ethnic groups greater than 18 years of age who lived in North Kohala, Hawaiʻi and Waimea/Kehaka, Kauaʻi (predominant groups were Native Hawaiians, Filipinos, Japanese, and Caucasians). The expansion, now known as the KHRP recruited participants via public flyers, television announcements, and presentations to local community organizations. A total of 1,197 participants completed the study. All participants signed a consent form after reviewing the description of the study, expected length of involvement in study, purpose, procedures, risks, benefits, and confidentiality with an investigator. The aim of the overall study was to examine diabetes and cardiovascular risk factors in a multi-ethnic study population.

Data Collection

All subjects underwent a clinical exam comprising of fasting laboratory measures, vital signs, and anthropometric measurement, and completed questionnaires to assess a range of demographic, behavioral, psychosocial, and medical factors. For this study, data on sex, age, marital status, education level, work history, annual household income, ethnic ancestry, medical

history, diet, depression, and social support were used.[9] Both ethnic admixture and percentage of Hawaiian ancestry (blood quantum) were determined by self-report, and later confirmed with a genealogical interview.

An alcohol consumption survey, adopted from the Honolulu Heart Study's alcohol questionnaire, assessed the frequency and type of alcohol consumed within the past month. The first question asked, "Have you ever consumed alcohol (i.e., beer, wine, liquor, etc.) within the last month?" If the participant answered yes, he or she was prompted to answer the following questions: "How many weeks within the last month did you consume alcohol?" (frequency); "How many days in a typical week did you drink alcohol?"(frequency); "On the average day when you drank any alcohol, how many drinks did you have on average?" (frequency); and "Please check the type of alcoholic drink(s) you consumed in the last month?" (type).

Categorization of Alcohol Consumption and Stroke Risk

In this study, alcohol consumption was first defined as a binary variable (yes vs. no), and then as a three-level categorical variable: non-drinkers, moderate drinkers (1 drink per day), and heavy drinkers (2 or more drinks per day).[10]

The National Stroke Association defines stroke risk based on several individual characteristics, including blood pressure >140/90 mm Hg or unknown, atrial fibrillation (irregular heartbeat), smoker, cholesterol >240 mg/dL or unknown, diabetic, lack of exercise, overweight, and family history of stroke. High risk individuals have at least three of the above risk factors, and low risk individuals have less than three risk factors.[11] The KHRP defined hypertension as a history of systolic blood pressure ≥140 mm Hg or diastolic blood pressure ≥90 mm Hg. Individuals with a history of hypertension but not on medications at the time of the study were considered normotensive if their recorded blood pressure was <140/90 mm Hg.

6

Therefore, hypertension in this study was defined as: 1) a blood pressure >140/90 mm Hg or 2) if participants had a history of hypertension and were taking hypertensive medications. The KHRP did not collect specific information on atrial fibrillation. The following heart condition questions were asked: "Heart condition? If yes"; "Have you ever been told that you had a heart attack?"; "Have you ever had heart surgery or balloon angioplasty?"; "Has a medical personnel ever told you that you have heart failure?" As these heart conditions are complications of atrial fibrillation, we considered anyone who answered "yes" to any of those conditions to have a "circulatory condition" and used the circulatory condition variable as a surrogate measure for atrial fibrillation.[12] The KHRP collected data on physical activity in a modified activity questionnaire assessing frequency and duration of 30 different activities, but this data was not available for analysis. As the KHRP did not on family history of stroke, we developed a modified risk classification by excluding physical exercise and family history of stroke. This study classified high risk individuals if they have two or more risk factors out of a total of six (i.e., hypertension, circulatory condition, smoker, cholesterol >240 mg/dL, diabetes, and overweight) and those who had stroke in the past regardless of risk factors. The remaining participants remained classified as low risk.

Statistical Analysis

Participants with missing information on variables of interest were excluded from the study. The final analysis included 910 subjects. This study utilized chi-square (χ^2) analysis for categorical variables to analyze the distributions of age sex, ethnicity, educational level, income, marital status, alcohol consumption, drinking status, smoking history, Center for Epidemiological Studies-Depression (CES-D) scores, and Lubben Social Network Scale (LSNS) scores. Bivariate associations between the above covariates and alcohol consumption (yes vs. no;

heavy, moderate vs. non-drinkers) were also evaluated. A logistic regression model used binary stroke risk as the dependent variable and alcohol consumption as the independent variable while adjusting for multiple covariates (age, sex, ethnicity, educational level, marital status, smoking history, CES-D scores, and LSNS scores). A backwards function was utilized to arrive at a final multivariate model. An alpha level of 0.05 was used for statistical significance, and all tests were two-sided. A sensitivity analysis was performed to exclude participants who had a stroke in the past from the group of high stroke risk. Due to the exclusion of two variables used by the National Stroke Association for categorization of stroke risk (i.e., exercise and family history of stroke), another sensitivity analysis was performed by re-categorizing high-risk as three out of the six risk factors and the rest of the participants as low-risk. All statistical analyses were conducted using SAS 9.3 for Windows (SAS Institute, Cary, North Carolina).

Results

Of the 910 subjects, most were 40 years or older (73%), and female (54%) (Table 1). The racial/ethnic composition was rather diverse, with 25%, 43%, 15%, and 17% of the subjects being White, Native Hawaiian, Filipino, and Japanese, respectively. The majority of the subjects (66%) had at least a high school diploma, had a low income (56%), and were currently married (64%). Many were former/current smokers (51%), did not suffer from depression (92%), and had low social support (62%). Most of the study population was not obese (71%), did not have a circulatory condition (87%), was not hypertensive (66%), did not have high cholesterol (68%), and were not diabetic (89%).

When the distributions of different factors were examined by stroke risk (high vs. low), sex, income, smoking history, CES-D scores, and LSNS scores did not appear to differ by stroke risk status. Factors that were significantly associated with stroke-risk included age, ethnicity,

education level, marital status, drinking status, obesity, circulatory condition, hypertension, high cholesterol, and diabetes. Compared with subjects in the low-risk group, high-risk individuals were more likely to be older than 40 years, be non-Caucasian (i.e., Native Hawaiian, Filipino or Japanese), have received less education, have low income, be currently married, be non-drinker, be obese, have a circulatory condition, have hypertension, have high cholesterol, and be non-diabetic.

As shown in Table 1, a larger proportion of subjects with a high stroke risk were non-drinkers, compared with individuals who were classified as having a low risk of stroke (70% vs. 47%). When alcohol consumption was further categorized as a three-level variable, subjects with high stroke risk were less likely to be moderate drinkers comparewi those with lowtrok risk (19.2% vs. 40.4%).

Without controlling for other factors, the odds of having a high risk for stroke were significantly increased in those older than 40 years of age than those younger than 40 [odds ratio (OR)=3.5, 95% confidence interval (CI): 2.4-5.1], Japanese than Whites (OR=4.8, 95% CI: 3.0-7.7), and those currently married than never married (OR=1.8, 95% CI: 1.2-2.6).

The odds of having a high risk for stroke were significantly lower among those with more than 12 years of education (OR=0.5, 95% CI: 0.4-0.7), and moderate drinkers than non-drinkers (OR=0.4, 95% CI: 0.2-0.6).

After all variables in Table 2 were included simultaneously in a multivariate logistic regression model, a backward approach was used to derive a final model to identify factors predictive of stroke risk. This final model included alcohol consumption, age, ethnicity, and educational level.

In the final multivariate model, alcohol consumption, age, higher education, and ethnicity were significantly associated with stroke risk (Table 3). Individuals who consumed alcohol were 40% less likely to have a high risk of stroke (OR = 0.6, 95% CI: 0.4-0.8) than non-drinkers. Subjects 40 years or older were 4.1 times (95% CI: 2.7-6.0) more likely to be at a high risk of stroke than those younger than 40 years of age. Native Hawaiians were 3.6 times (95% CI: 2.3-5.6) more likely to be at a high stroke risk than their Caucasian counterparts. Japanese were also at a greater stroke risk (OR = 3.6, 95% CI: 2.2-5.9) than Caucasians. Filipinos also appeared to have a higher stroke risk than Caucasians, but the association did not reach statistical significance. In addition, those with more than 12 years of education were 40% less likely to have a high risk of stroke than those with less education (OR = 0.6, 95% CI: 0.5-0.9).

Table 4 shows the results from the final multivariate model when alcohol consumption was categorized into three levels: non-drinkers, moderate drinkers, and heavy drinkers. Compared with non-drinkers, moderate drinkers had a significantly lower risk of stroke (OR = 0.5, 95% CI: 0.3-0.7), while heavy drinkers did not appear to have a significantly different risk of stroke (adjusted OR = 0.8, 95% CI: 0.5-1.4). A higher level of education was also associated with a lower risk of stroke, whereas older individuals and ethnic minorities (Native Hawaiians and Japanese) had higher risks of stroke.

Sensitivity Analyses

A sensitivity analysis was performed with strict high-risk criteria to make it more comparable to the National Stroke Association scale (e.g. participants needed to meet three of the following six criteria to be considered having a high risk for stroke: blood pressure >140/90 mm Hg or unknown, smoker, cholesterol >240 mg/dL or unknown, diabetic, overweight, and

circulatory condition). There were no systemic differences in the results (detailed data not shown).

Another set of sensitivity analysis was performed to exclude people who had a stroke. There were no differences observed between the results of the sensitivity analysis and the results of the original analysis. All primary findings were essentially the same.

Discussion

This is the first study using the KHRP database to evaluate the relationship between alcohol consumption and stroke risk in a diverse, multi-ethnic population of Hawai'i. Alcohol consumption, especially in moderate amounts, was associated with a significantly lower risk of stroke, even after adjusting for a number of covariates.

Previous studies focusing on the relationship between alcohol consumption and stroke have been inconsistent. A meta-analysis showed that low alcohol intake has a protective effect against stroke, whereas heavy alcohol consumption increases total stroke risk.[13] Moderate alcohol consumption was associated with a reduced risk of ischemic stroke, although there were exceptions depending on age and other cardiovascular risk factors.[14] The Nurses' Health Study showed that light-to-moderate alcohol use was protective in women, but there was no association between high alcohol use and stroke risk.[15] Among male health professionals, there was no correlation between drinking and ischemic stroke risk.[16]

The results from this study suggest an independent association between alcohol consumption and stroke risk. Studies have shown the effect of alcohol may depend on ethnicity with no association among Asians, the majority of the population in Hawai'i.[17] The prevalence of alcohol consumption varies across different ethnicities (e.g. Native Hawaiians, Japanese, Caucasians, and Filipinos). Cultural differences across these groups may account for drinking

variations as the majority of the sample population are Filipino, and heavy alcohol use is a male predominant behavior among this ethnicity.[18]

Higher education, classified as beyond high school, was also protective against stroke risk. Furthermore, those who were older, of Native Hawaiian and Japanese descent were more likely to be at high stroke risk in this study population.

The KHRP is a large study focusing on the factors contributing to chronic disease in Hawai'i and included a diverse group of Native Hawaiians, Japanese, Caucasians, and Filipinos. It has provided valuable information on the burden of diabetes and cardiovascular diseases. The two primary strengths of this thesis include: (1) the availability of rich data from a unique study population with racial and ethnic diversity, and (2) the ability to adjust for many demographic, behavioral, psychosocial, and medical factors when analyzing the relationship between alcohol consumption and stroke risk.

This study also some limitations. First, the cross-sectional nature of this study made it difficult to establish a temporal relationship, so the results need to be interpreted with caution. Second, due to the lack of data on selected variables such as family history of stroke, adaptations had to be made to classify stroke risk. However, the available information was used to its full potential with sensitivity analysis strengthening the findings of this study. Third, there was a possibility of measurement errors, including "non-drinkers" underreporting their alcohol intake due to social desirability bias. The non-drinker group may have included past. Lastly, the most recent year of data collection was 2000, although there is no reason to believe that patterns of alcohol consumptions have changed substantially in Hawai'i over the last 15 years.

In conclusion, this cross-sectional study found that alcohol consumption, especially in moderate amounts, was associated with a significantly lower risk of stroke in a multi-ethnic

population of Hawai'i. Prospective cohort studies are needed to further classify the association

between alcohol consumption and stroke risk by additionally assessing the type of alcohol

consumed, stroke type, and inclusion of a large number of participants with racial and ethnic

diversity.

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Table 1. Characteristics of the Study Population

Characteristic	N (%)	Stroke Risk High (N = 323)[a]	Stroke Risk Low (N = 587)[b]	P[e]
Age (years)				<.001
<40	239 (26.3)	41 (12.7)	198 (33.7)	
≥40	671 (74.7)	282 (87.3)	389 (66.3)	
Sex				0.46
Male	419 (46.0)	154 (47.7)	265 (45.1)	
Female	491 (54.0)	169 (52.3)	322 (54.9)	
Ethnicity				<.001
White	229 (25.2)	36 (11.2)	193 (32.9)	
Native Hawaiian	388 (42.6)	153 (47.4)	235 (40.0)	
Filipino	138 (15.2)	61 (18.9)	77 (13.1)	
Japanese	155 (17.0)	73 (22.6)	82 (14.0)	
Educational level (years)				<.001
≤12	603 (66.3)	244 (75.5)	359 (61.2)	
>12	307 (33.7)	79 (24.5)	228 (38.8)	
Income[c]				0.09
Low	509 (55.9)	193 (59.8)	316 (53.8)	
High	401 (44.1)	130 (40.3)	271 (46.2)	
Marital status				0.01
Never married	158 (17.4)	40 (12.4)	118 (20.1)	
Currently married	581 (63.9)	217 (67.2)	364 (62.0)	
Disrupted marriage[d]	171 (18.8)	66 (20.4)	105 (17.9)	
Alcohol consumption				<.001
No	501 (55.1)	225 (70.0)	276 (47.0)	
Yes	409 (45.0)	98 (30.3)	311 (53.0)	
Drinking status				<.001
Non-drinker	501 (55.1)	225 (70.0)	276 (47.0)	
Moderate drinker	299 (32.9)	62 (19.2)	237 (40.4)	
Heavy drinker	110 (12.1)	36 (11.2)	74 (12.6)	
Smoking history				0.22
Never smoker	446 (49.0)	149 (46.1)	297 (50.6)	
Current smoker	313 (34.4)	123 (38.1)	190 (32.4)	
Former smoker	151 (16.6)	51 (15.8)	100 (17.0)	
CES-D scores				0.56
<16 (no depression)	833 (91.5)	298 (92.3)	535 (91.1)	
≥16 (depression)	77 (8.5)	25 (7.7)	52 (8.9)	
LSNS scores				0.60
≥9 (low social support)	560 (61.5)	195 (60.4)	365 (62.2)	
<9 (high social support)	350 (38.5)	128 (39.6)	222 (37.8)	
Obesity (BMI≥30)				<.001
No	647 (71.1)	149 (46.1)	489 (84.8)	

Yes	263 (28.9)	174 (53.9)	89 (15.2)	
Circulatory condition				<.001
No	791 (86.9)	231 (71.5)	560 (95.4)	
Yes	119 (13.1)	92 (28.5)	27 (4.6)	
Hypertension				<.001
No	596 (65.5)	74 (22.9)	522 (88.9)	
Yes	314 (34.5)	249 (77.1)	65 (11.1)	
High cholesterol				<.001
No	614 (67.5)	121 (37.5)	493 (84.0)	
Yes	296 (32.5)	202 (62.5)	94 (16.0)	
Diabetes				<.001
No	813 (89.3)	233 (72.1)	580 (98.8)	
Yes	97 (10.7)	90 (27.9)	7 (1.2)	

[a] All displayed results are frequencies and column %

[b] Percentages may not sum to 100% due to rounding.

[c] Low income defines as <$50,000; High income defined as ≥$50,000

[d] Disrupted marital status includes people who are separated, divorced, or widowed.

[e] P-values are from χ^2 test.

Abbreviations. BMI, body mass index, CES-D, Center for Epidemiological Studies-Depression; LSNS, Lubben Social Network Scale.

Table 2. Unadjusted Associations between Study Variables and Risk of Stroke

Characteristic	High Stroke Risk	Low Stroke Risk	Unadjusted OR (95% CI)
Age (years)			
<40	41	198	1.0
≥40	282	389	3.5 (2.4-5.1)
Sex			
Male	154	265	1.0
Female	169	322	0.9 (0.7-1.2)
Ethnicity			
White	36	193	1.0
Native Hawaiian	153	235	3.5 (2.3-5.3)
Filipino	61	77	4.3 (2.6-7.0)
Japanese	73	82	4.8 (3.0-7.7)
Educational level (years)			
≤12	244	359	1.0
>12	79	228	0.5 (0.4-0.7)
Income			
Low	193	316	1.0
High	130	271	0.8 (0.6-1.1)
Marital status			
Never married	40	118	1.0
Currently married	217	364	1.8 (1.2-2.6)

Disrupted marriage[d]	66	105	1.9 (1.2-3.0)
Alcohol Consumption			
No	225	276	1.0
Yes	98	311	0.5 (0.4-0.8)
Drinking status			
Non-drinker	225	276	1.0
Moderate drinker	62	237	0.4 (0.2-0.6)
Heavy drinker	36	74	0.8 (0.5-1.4)
Smoking history			
Never smoker	149	297	1.0
Current smoker	123	190	1.3 (1.0-1.7)
Former smoker	51	100	1.0 (0.7-1.5)
CES-D scores			
<16 (no depression)	298	535	1.0
≥16 (depression)	25	52	0.9 (0.5-1.4)
LSNS scores			
≥9 (low social support)	195	365	1.0
<9 (high social support)	128	222	1.1 (0.8-1.4)

[a]OR: odds ratio; CI: 95% confidence interval. Derived from logistic regression models.
Abbreviations. BMI, body mass index, CES-D, Center for Epidemiological Studies-Depression; LSNS, Lubben Social Network Scale.

Table 3. Multivariate Logistic Regression Analysis of Factors Associated with Risk of Stroke and Binary Alcohol Consumption

Characteristic	Adjusted OR (95% CI)[a]	p
Alcohol consumption		
No	1.0	
Yes	0.6 (0.4-0.8)	<.001
Age (years)		
<40	1.0	
≥40	4.1 (2.7-6.0)	<.001
Ethnicity		
White	1.0	
Native Hawaiian	3.6 (2.3-5.6)	0.01
Filipino	3.4 (2.0-5.8)	0.07
Japanese	3.6 (2.2-5.9)	0.02
Educational level (years)		<.001
≤12	1.0	
>12	0.6 (0.5-0.9)	0.01

[a]Variables in the table were mutually adjusted

Table 4. Multivariate Logistic Regression Analysis of Factors Associated with Risk of Stroke and Categorical Alcohol Consumption

Characteristic	Adjusted OR (95% CI)[a]	p
Drinking status		
Non-drinker	1.0	
Moderate drinker	0.5 (0.3-0.7)	<.001
Heavy drinker	0.8 (0.5-1.4)	0.44
Age (years)		
<40	1.0	
≥40	4.3 (2.9-6.3)	<.001
Ethnicity		
White	1.0	
Native Hawaiian	3.2 (2.1-5.1)	0.02
Filipino	3.2 (1.9-5.5)	0.07
Japanese	3.4 (2.1-5.6)	0.02
Educational level (years)		
≤12	1.0	
>12	0.7 (0.5-0.9)	0.01

[a]Variables in the table were mutually adjusted