The Association Between Heart Disease and Heavy Alcohol Drinking Among Adults in the United States

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THE ASSOCIATION BETWEEN HEART DISEASE AND HEAVY ALCOHOL DRINKING AMONG ADULTS IN THE UNITED STATES

Objective

Heart disease (also called cardiovascular disease) refers to the various types of problems of the heart - the disease of heart and blood vessels. It is the leading cause of death in the United States, affecting most racial groups and genders (CDC, 2023). The objective of this study is to explore the association between heart disease and heavy alcohol drinking, while controlling for one's age, sex, exercise, race, smoking and general health.

Introduction

According to the Centers for Disease Control and Prevention (CDC), one person dies in the United States every 33 seconds from heart disease. In 2021, heart disease accounted for 695,000 recorded deaths – 1 in every 5 deaths. Coronary heart disease (CHD), the most common type of heart disease, was responsible for 54% of heart disease deaths (375, 476). 1 in every 20 adults aged 20 and older in the United States have CHD (National Center for Health Statistics, 2023). Every 40 seconds, someone has a heart attack (also called myocardial infarction). 805,000 cases are being reported every year, with 75% of those being first heart attack occurrences, and 20% of heart attacks being silent.

Studies have shown that the key risk factors for heart disease include high blood pressure, high blood cholesterol and smoking. Additionally, lifestyle choices and medical conditions can put people at a higher risk for heart disease and these include diabetes, overweight and obesity, unhealthy diet, physical inactivity, and excessive alcohol use. Excessive alcohol use includes binge drinking, heavy drinking, and drinking by pregnant women or people younger than age 21. Heart diseases arising from long term excessive alcohol use include myocardial

infarctions, alcoholic cardiomyopathy, arrhythmias, and coronary heart disease (John Hopkins Medicine, 2023).

Studies about the association between alcohol intake and heart disease have had controversial outcomes. Observational studies have demonstrated a lower risk of heart disease with light to moderate alcohol intake compared with either abstinence or heavy consumption, suggesting J- or U-shaped epidemiologic associations (Biddinger et al., 2022). Heavy alcohol consumption (4 or more standard drinks per day) and binge drinking (5 standard drinks on a single occasion for men and more than 4 for women) is associated with detrimental effects (Piano, 2017). This study is interested in finding out just how much risk of heart disease is associated with heavy alcohol consumption while factoring demographic, general health, and lifestyle differences.

Methods: Data

This study explores the relationship between heart disease and heavy alcohol drinking among the adult population in the United States. Specifically, the population of interest is comprised of adults aged 18 and older, who reside in the 50 states, U.S. territories, and the District of Columbia. A sample of this population is drawn from the Behavior Risk Factor Surveillance System (BRFSS) 2021 survey.

The BRFSS, conducted by the CDC, is a system of health-related telephone surveys that collect state data about U.S. residents regarding their health-related risk behaviors, chronic health conditions, and use of preventive services. The state of Florida was unable to collect BRFSS data over enough months to meet the minimum requirements for inclusion in the

2021 annual aggregate data set, hence the BRFSS 2021 survey data contains data from 49 states, the District of Columbia, Guam, Puerto Rico, and the US Virgin Islands. Of the 438,693 participants in the BRFSS 2021 survey, 387,171 (88.3%) satisfied the requirements for this study: aged 18 years or older, lived in one of the 50 states or US territories, and had complete data for all variables.

Methods: Model

The research objective for this study is to investigate the association between heart disease and heavy alcohol drinking, and the model can be summarized as follows:

HEARTDISEASE = f (H_DRINK, AGECAT, SEX, EXERCISE, RACE, GENERALHEALTH, SMOKE)

HEARTDISEASE represents whether a BRFSS respondent has ever reported having coronary heart disease (CHD) or myocardial infarction (MI) (1 = yes; 0 = no); H_DRINK represents heavy drinkers, and states whether respondent has had more than 14 drinks per week if male, or more than 7 drinks per week, if female (1 = yes; 0 = no). AGECAT represents the age category of the respondent (1 = 18 – 34 years old; 2 = 35 – 54 years old; 3 = 55 years and older). SEX is the reported biological sex of the respondent (1 = female; 0 = male). EXERCISE represents whether respondent participated in any physical activities or exercises in the past month other than in their regular job (1 = no; 0 = yes). RACE represents respondent's race or ethnicity (4 = White, Non-Hispanic; 3 = Black, Non-Hispanic; 2 = Other/Multiracial, Non-Hispanic; 1 = Hispanic). GENERALHEALTH represents respondent's health status (1 = Excellent or Very Good; 2 = Good; 3 = Fair or Poor).

SMOKE represents the respondent's smoking status (4 = Everyday; 3 = Some days; 2 = Former; 1 = Never).

Methods: Statistical Analysis

The statistical analysis performed in this study consists of both tests of association and logistic regression. Pearson Chi-Squared tests of association will be performed between the control variables and the exposure variable and are presented in Table 1 along with univariate statistics. Similar tests will be performed between the control, exposure, and outcome variables, and are presented in Table 2 along with univariate statistics. Logistic regression is used to estimate adjusted odds ratios (and their 95% confidence intervals) for the outcome variable (HEARTDISEASE) with respect to the exposure variable (H_DRINK) and control variables (AGECAT, SEX, EXERCISE, RACE, GENERALHEALTH, and SMOKE), presented in Table 3.

With respect to the regression analysis, tests for confounding between the exposure and control variables are performed, goodness of fit statistics are reported, and interactions between exposure and control variables are investigated. All statistical analysis is conducted using SAS.

Results

Of the 438,693 BRFSS 2021 participants, 387,171 (88.3%) had complete data for this study. The demographic characteristics of this population are compared in Table 1 with respect to the exposure variable, heavy alcohol drinking (H_DRINK).

Table 1. Characteristics of 387,171 BRFSS 2021 participants by Heavy Drinking category

	Population		No		Yes		
Variable	N	%	n	%	n	%	p value *
	387,171	100.0%	364,085	94.0%	23,086	6.0%	
Age							
18-34	65,339	16.9%	60,710	16.7%	4,629	20.1%	
35-54	110,385	28.5%	102,465	28.1%	7,920	34.3%	
55+	211,447	54.6%	200,910	55.2%	10,537	45.6%	<.0001
Sex							
Male	177,903	45.9%	166,932	45.8%	10,971	47.5%	
Female	209,268	54.1%	197,153	54.2%	12,115	52.5%	<.0001
Exercise							
Yes	293,920	75.9%	275,695	75.7%	18,225	78.9%	
No	93,251	24.1%	88,390	24.3%	4,861	21.1%	<.0001
Race							
Hispanic	34,044	8.8%	32,471	8.9%	1,573	6.8%	
Other	29,933	7.7%	28,386	7.8%	1,547	6.7%	
Black	28,374	7.3%	27,222	7.5%	1,152	5.0%	
White	294,820	76.1%	276,006	75.8%	18,814	81.5%	<.0001
General Health							
Excellent/Very Good	202,259	52.2%	189,164	52.0%	13,095	56.7%	
Good	121,541	31.4%	114,509	31.5%	7,032	30.5%	
Fair/Poor	63,371	16.4%	60,412	16.6%	2,959	12.8%	<.0001
Smoke							
Never	231,883	59.9%	222,816	61.2%	9,067	39.3%	
Former	105,799	27.3%	97,770	26.9%	8,029	34.8%	
Somedays	13,602	3.5%	12,174	3.3%	1,428	6.2%	
Everyday	35,887	9.3%	31,325	8.6%	4,562	19.8%	<.0001

* p values based on Pearson chi-square test of association

Of the entire population, 28.5% were between 35 and 54 years old, 54.6% were aged 55 and older, 54.1% were female, 24.1% were non-exercisers, 7.7% were multiracial or from other

races, 7.3% were non-Hispanic Black, 76.1% were non-Hispanic White, 31.4% had good health, 16.4% had fair or poor health, 27.3% were former smokers, 3.5% smoked on some days, and 9.3% smoked every day. There were proportionately more participants aged 35-54 than expected who reported heavy drinking (34.3% vs. 28.5%; $p<0.0001$) but proportionately fewer aged 55 and older than expected who reported heavy drinking (45.6% vs. 54.6%; $p<0.0001$). There were proportionately fewer females than expected who reported heavy drinking (52.5% vs. 54.1%; $p<0.0001$). There were proportionately fewer non-exercisers than expected who reported heavy drinking (21.1% vs. 24.1%; $p<0.0001$).

With respect to race, there were proportionately fewer Multiracial/Other race than expected who reported heavy drinking (6.7% vs. 7.7%; $p<0.0001$), proportionately fewer non-Hispanic Blacks who reported heavy drinking (5.0% vs. 7.3%; $p<0.001$) but proportionately more non-Hispanic Whites than expected who reported heavy drinking (81.5% vs. 76.1%; $p<0.0001$). With respect to general health, there were proportionately fewer participants with good health than expected who reported heavy drinking (30.5% vs. 31.4%; $p<0.0001$) and proportionately fewer participants with fair or poor health than expected who reported heavy drinking (12.8% vs. 16.4%; $p<0.0001$). With respect to smoking, there were proportionately more former smokers than expected who reported heavy drinking (34.8% vs. 27.3%; $p<0.0001$), proportionately more 'some-days' smokers who reported heavy drinking (6.2% vs. 3.5%; $p<0.001$), and proportionately more everyday smokers than expected who reported heavy drinking (19.8% vs. 9.3%; $p<0.0001$).

The demographic characteristics of this population are compared in Table 2 with respect to the outcome variable, presence of heart disease (HEARTDISEASE).

Table 2. Characteristics of 387,171 BRFSS 2021 participants by presence of heart disease.

	Population		Heart Disease - No		Heart Disease - Yes		
Variable	N	%	n	%	n	%	p value *
	387,171	100.0%	355,446	91.8%	31,725	8.2%	
Heavy Drinking							
No	364,085	94.0%	333,564	93.8%	30,521	96.2%	
Yes	23,086	6.0%	21,882	6.2%	1,204	3.8%	<.0001
Age							
18-34	65,339	16.9%	64,819	18.2%	520	1.6%	
35-54	110,385	28.5%	106,998	30.1%	3,387	10.7%	
55+	211,447	54.6%	183,629	51.7%	27,818	87.7%	<.0001
Sex							
Male	177,903	45.9%	159,509	44.9%	18,394	58.0%	
Female	209,268	54.1%	195,937	55.1%	13,331	42.0%	<.0001
Exercise							
Yes	293,920	75.9%	274,164	77.1%	19,756	62.3%	
No	93,251	24.1%	81,282	22.9%	11,969	37.7%	<.0001
Race							
Hispanic	34,044	8.8%	32,334	9.1%	1,710	5.4%	
Other	29,933	7.7%	27,832	7.8%	2,101	6.6%	
Black	28,374	7.3%	26,276	7.4%	2,098	6.6%	
White	294,820	76.1%	269,004	75.7%	25,816	81.4%	<.0001
General Health							
Excellent/Very Good	202,259	52.2%	195,092	54.9%	7,167	22.6%	
Good	121,541	31.4%	110,784	31.2%	10,757	33.9%	
Fair/Poor	63,371	16.4%	49,570	13.9%	13,801	43.5%	<.0001
Smoke							
Never	231,883	59.9%	218,547	61.5%	13,336	42.0%	
Former	105,799	27.3%	92,517	26.0%	13,282	41.9%	
Somedays	13,602	3.5%	12,341	3.5%	1,261	4.0%	
Everyday	35,887	9.3%	32,041	9.0%	3,846	12.1%	<.0001

* p values based on Pearson chi-square test of association

Overall, 8.2% of the entire population had heart disease. There were proportionately fewer aged 35 to 54 than expected who had heart disease (10.7% vs 28.5%; p<0.0001) but proportionately more aged 55 and older than expected who had heart disease (87.7% vs 54.6%; p<0.0001). There were proportionately fewer females than expected who had heart disease (42.0% vs 54.1%; p<0.0001) and proportionately more non-exercisers than expected who had heart disease (37.7% vs 24.1%; p<0.0001). With respect to race, there were

proportionately fewer Multiracial/Other race than expected who had heart disease (6.6% vs. 7.7%; $p<0.0001$), proportionately fewer non-Hispanic Blacks than expected who had heart disease (6.6% vs. 7.3%; $p<0.0001$), but proportionately more non-Hispanic Whites than expected who had heart disease (81.4% vs. 76.1%; $p<0.0001$).

There were proportionately more participants with good health than expected who had heart disease (33.9% vs 31.4%; $p<0.0001$) and proportionately more participants with fair or poor health than expected who had heart disease (43.5% vs 16.4%; $p<0.0001$). There were proportionately more former smokers than expected who had heart disease (41.9% vs. 27.3%; $p<0.0001$), proportionately more 'some-days' smokers than expected who had heart disease (4.0% vs. 3.5%; $p<0.0001$), and proportionately more everyday smokers than expected who had heart disease (12.1% vs. 9.3%; $p<0.0001$). With respect to the exposure variable heavy drinking, there were proportionately fewer than expected who had heart disease (3.8% vs 6.0%; $p<0.0001$).

Adjusted odds ratios for heart disease with respect to the exposure and control variables obtained from the logistic regression are presented in Table 3.

Table 3. Logistic regression analysis comparing the adjusted odds ratio of heart disease in 387,171 BRFSS 2021 participants.

Variable	Heart Disease - No		Heart Disease - Yes		OR*	95% CI
	n	%	n	%		
	355,446	91.8%	31,725	8.2%	-----	-----
Heavy Drinking						
No	333,564	93.8%	30,521	96.2%	-----	-----
Yes	21,882	6.2%	1,204	3.8%	0.662	0.622 - 0.705
Age						
18-34	64,819	18.2%	520	1.6%	-----	-----
35-54	106,998	30.1%	3,387	10.7%	3.376	3.075 - 3.706
55+	183,629	51.7%	27,818	87.7%	13.817	12.651 - 15.090
Sex						
Male	159,509	44.9%	18,394	58.0%	-----	-----
Female	195,937	55.1%	13,331	42.0%	0.529	0.516 - 0.542
Exercise						
Yes	274,164	77.1%	19,756	62.3%	-----	-----
No	81,282	22.9%	11,969	37.7%	1.174	1.142 - 1.205
Race						
Hispanic	32,334	9.1%	1,710	5.4%	-----	-----
Other	27,832	7.8%	2,101	6.6%	1.328	1.238 - 1.425
Black	26,276	7.4%	2,098	6.6%	1.098	1.024 - 1.178
White	269,004	75.7%	25,816	81.4%	1.378	1.306 - 1.454
General Health						
Excellent/Very Good	195,092	54.9%	7,167	22.6%	-----	-----
Good	110,784	31.2%	10,757	33.9%	2.318	2.246 - 2.393
Fair/Poor	49,570	13.9%	13,801	43.5%	5.802	5.614 - 5.996
Smoke						
Never	218,547	61.5%	13,336	42.0%	-----	-----
Former	92,517	26.0%	13,282	41.9%	1.527	1.486 - 1.568
Somedays	12,341	3.5%	1,261	4.0%	1.410	1.321 - 1.504
Everyday	32,041	9.0%	3,846	12.1%	1.386	1.330 - 1.444

* 95% confidence intervals are for reported odds ratios.

Those aged 35 to 54 had higher odds (3.4 times or 240%) of heart disease than those aged 18 to 34, after controlling for sex, exercise, race, general health, smoking, and heavy drinking (OR= 3.376; 95% CI = 3.075 – 3.706). Those aged 55 and older had substantially greater odds (13.8 times or 1280%) of heart disease than those aged 18 to 34 after controlling for sex, exercise, race, general health, smoking, and heavy drinking (OR= 13.817; 95% CI = 12.651 –

15.090). Females had roughly half the odds of having heart disease compared to males, after controlling for age, exercise, race, general health, smoking, and heavy drinking (OR= 0.529; 95% CI = 0.516 – 0.542). Non-exercisers had slightly higher odds (1.2 times or 20%) of heart disease than exercisers after controlling for age, sex, race, general health, smoking, and heavy drinking (OR= 1.174; 95% CI = 1.142 – 1.205).

With respect to race, Multiracial/Other race had higher odds (1.3 times) of heart disease than Hispanics after controlling for age, sex, exercise, general health, smoking, and heavy drinking (OR= 1,328; 95% CI = 1.238 – 1.425). Non-Hispanic Blacks had slightly higher odds (1.1 times or 10% more) of heart disease than Hispanics after controlling for age, sex, exercise, general health, smoking, and heavy drinking (OR= 1.098; 95% CI = 1.024 – 1.178). Non-Hispanic Whites had higher odds (1.4 times) of having heart disease than Hispanics after controlling for age, sex, exercise, general health, smoking, and heavy drinking (OR= 1.378; 95% CI = 1.306 – 1.454). Those with good health had twice the odds of heart disease compared to those with excellent or very good heath after controlling for age, sex, exercise, race, smoking, and heavy drinking (OR= 2.318; 95% CI = 2.246 – 2.393). Those with fair or poor health had substantially greater odds (5.8 times or 480% more) of heart disease compared to those with excellent or very good heath after controlling for age, sex, exercise, race, smoking, and heavy drinking (OR= 5.802; 95% CI = 5.614 – 5.996).

Former smokers had one and half times the odds (50% more) of having heart disease compared to those who have never smoked after controlling for age, sex, exercise, race, general health, and heavy drinking (OR= 1.527; 95% CI = 1.486 – 1.568). Those who

smoked on some days had higher odds (1.4 times or 40% more) of having heart disease compared to those who have never smoked after controlling for age, sex, exercise, race, general health, and heavy drinking (OR= 1.410; 95% CI = 1.321 – 1.504). Those who smoked every day had higher odds (1.4 times or 40% more) of having heart disease compared to those who have never smoked after controlling for age, sex, exercise, race, general health, and heavy drinking (OR= 1.386; 95% CI = 1.330 – 1.444). With respect to the exposure variable heavy drinking, those who are heavy drinkers had two-thirds the odds (0.66 times) of heart disease compared to non-heavy drinkers after controlling for age, sex, exercise, race, general health, and smoking (OR= 0.662; 95% CI = 0.622 – 0.705).

The AUC statistic for the logistic regression was 0.806 and the max rescaled R-squared was 0.2129 indicating excellent discrimination according to Hosmer and Lemeshow's general rule. A goodness of fit deviance test yielded a p-value of <0.0001 indicating that the current model does not fit the data well, compared to a model with interactions. Statistically significant two-way interactions were added, yielding the following model:

$$\text{HEARTDISEASE} = \alpha + \beta_1 \text{H\_DRINK} + \beta_2 \text{AGECAT} + \beta_3 \text{SEX} + \beta_4 \text{EXERCISE} + \beta_5 \text{RACE} + \beta_6 \text{GENERALHEALTH} + \beta_7 \text{SMOKE} + \beta_8 \text{H\_DRINK*AGECAT} + \beta_9 \text{H\_DRINK*RACECAT} + \beta_{10} \text{H\_DRINK*SMOKE}$$

Estimation of this model used backward hierarchical elimination. The Deviance statistic p-value for this interacted model is statistically significant (<0.0001), suggesting that a better model is warranted. The AUC of this interacted model, however, improves to 0.807 as well

as the max rescaled R-squared which improved to 0.2132 maintaining excellent discrimination according to Hosmer and Lemeshow's general rule. In the interaction of H_DRINK and RACECAT, RACECAT = 3 (non-Hispanic Black) was not statistically significant even though both RACECAT = 2 and 4 were statistically significant, so it was left in the model. Similarly, in the interaction of H_DRINK and SMOKE, SMOKE = 2 and 3 were not statistically significant, only SMOKE = 4 (every day smoker) was statistically significant, and so it was left in the model.

Since the exposure variable H_DRINK interacts with AGECAT, RACECAT, and SMOKE, and some elements of these interactions are statistically significant while some are not, the relationship between HEARTDISEASE and H_DRINK is modified by these control variables. For simplicity, these are reported as ranges in Table 4.

Table 4 OR for heart disease with respect to H_DRINK accounting for effect modification with AGECAT, RACECAT and SMOKE

H_DRINK	OR Range
No	----
Yes	0.444 – 2.491

Thus, compared with non-heavy alcohol drinkers, heavy alcohol drinkers had between 0.4 times and 2.5 times the odds of having heart disease, depending on their age, race, and smoking status (the average effect is 0.662 times greater or 33.8% less). Adjustment for effect modification thus increases the odds (reduces it too, depending on level of interaction) of a heavy alcohol drinker having heart disease.

Finally, we tested for confounding between the exposure variable H_DRINK and control variables SEX, EXERCISE, GENERALHEALTH, AGECAT, RACECAT and SMOKE. Employing the 10% rule for whether the base H_DRINK adjusted odds ratios are changed by more than 10% with the removal of either one of SEX, EXERCISE, GENERALHEALTH, AGECAT, RACECAT or SMOKE, we find that AGECAT is a confounder. However, since the coefficients of all control variables are statistically significant, they are retained in the model.

Strength and Limitations

Strengths

This study was based on a large, well-established, and widely used survey system to analyze the association between heavy alcohol drinking and heart disease while controlling for age, sex, race, exercise, general health, and smoking. The data used was taken from a recent survey conducted in 2021 and includes a substantial number of participants (387,171). This provides confidence that we have leveraged a significant sample that may well represent the entire population of interest.

Limitations

As with any survey, data validity is questionable as it is based on the participants' self-reported responses. The criteria for this study reduced the number of participants from 438,693 to 387,171 (loss of 11.7%). The exposure variable H_DRINK states whether participants have had more than 14 drinks per week if male, or more than 7 drinks per week if female. It does not distinguish if this drinking habit is habitual (weekly for many weeks consecutively), a few times or one-off. Thus, with more complete data on heavy drinking

patterns, these findings and relationships could be altered. Similarly, the outcome variable HEARTDISEASE is defined as whether a BRFSS respondent has ever reported having coronary heart disease (CHD) or myocardial infarction (MI). Heart disease spans beyond CHD and myocardial infarctions (heart attacks). It also includes symptoms such as stroke, heart failure, arrhythmias, blood pressure changes and hypertension. This study did not factor these into the definition of heart disease because of availability of data.

Conclusion

The objective of this study is to quantify the relationship between the presence of heart disease and heavy alcohol consumption, while controlling for age, sex, race, exercise, general health, and smoking. The population of interest for this study was adults aged 18 years and older, resident in the United States. The study employs data for a sample of this population from the 2021 BRFSS survey of over 400,000 Americans on health-related questions including the use of health care, the presence of chronic health conditions and health-related risk behaviors.

The study finds that the odds of heart disease was between 0.444 and 2.491 times higher for heavy alcohol drinkers vs non-heavy alcohol drinkers, depending on their age, race, and smoking status. This suggests a J- or somewhat U-like shape relationship.

It is important to note that this study found that aging increases the odds of heart disease, with those over age 55 facing 13.8 times greater odds of having heart disease as compared to those aged 18 to 34. Additionally, females were half as likely as males to have heart disease (47% fewer odds); and those with fair or poor health have 480% increased odds of having heart disease compared to those who have excellent or very good health.

The study increases our knowledge of the relationship between heart disease and heavy alcohol consumption by using a large and representative sample of the U.S. population. The results indicate some association between heavy alcohol drinking and heart disease. Additional research into the underlying cause of this relationship is warranted. Despite the current study's findings, there is plenty of room for future research. Additional variables in the BRFSS should be considered to control for other known risk factors for heart disease and may include mental health, and other cardiovascular outcomes such as previous heart attack, stroke, or hypertension.

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