Alcohol Consumption and Mortality Risk in the United States

Introduction

There is contradictory evidence on the impact of alcohol consumption on health, even though it is well established that heavy alcohol consumption is a major risk factor for mortality. Previous research provides substantial evidence that the alcohol consumption – mortality relationship follows a J-shaped curve, where moderate drinkers are at a reduced risk of death compared with nondrinkers, while heavier drinkers are at increased risk (Kerr and Ye 2010). Past literature concludes that occasional moderate alcohol consumption has a protective role in health such as for cardiovascular health and that the association is somewhat causal. Contrary to that, moderate alcohol consumption induces breast cancer risk among women (Brooks and Zakhari 2013; Fuller 2011). Moderate steady drinkers exhibit lower rates of mortality in general and greater life expectancy than did abstainers and heavy drinkers (Costanzo et al. 2010; Dawson 2000; Kerr et al. 2011; Plunk et al. 2014; Rehm et al. 2010, 2017; Rehm and Imtiaz 2016).

According to the 2015 National Survey on Drug Use and Health (NSDUH 2018), around 85 percent people aged 18 or older drank alcohol at some point in their life, around 70 percent drank in the past year, and around 55 percent drank in the past month. Prevalence of drinking is higher among college aged students (18-22 years), who are exposed to binge drinking and heavy alcohol use. Excessive alcohol use at any age comes with an economic burden, family consequences, physiological damages, unintentional injuries and motor-vehicle accidents and deaths, and increased risk of cancer and cardiovascular diseases (NIAAA 2018).

An estimated 88,000 people (approximately 62,000 men and 26,000 women) die from alcohol-related causes annually. However, this number is not sufficient to address the impact of alcohol consumption and policies to regulate drinking behavior on mortality risk in the United

States. The National Legal Minimum Drinking Age Act (MLDA) was introduced in 1984 which required that States prohibit persons under 21 years of age from purchasing or publicly possessing alcoholic beverages; also, states would no longer receive federal funds for highway and road maintenance if they did not comply with this policy. After a brief period of resistance, by 1989 all states complied with the policy (NIAAA 2018; Voas, Tippetts, and Fell 2003). From a policy perspective, how might an increase in the federal drinking age impact the number of alcohol-related deaths pre- and post-policy implementation? The purpose of this paper is to determine the association between alcohol consumption and mortality risk and whether the minimum drinking age act had any impact on the mortality rate for the cohorts pre-1963 and post-1963.

Previous Research

The impact of alcohol consumption on health and mortality vary by the social and physical environment and by sociodemographic variables such as education, race and ethnicity, age, sex, marital status and health behaviors. However, racial/ethnic differences in mortality associated with alcohol consumption patterns and related deaths have garnered little attention to date in the United State and the bulk of the previous research has been done on non-Hispanic whites in the US or European populations (Jackson et al. 2015; Trias-Llimo´s et al. 2018). Recent investigations point out that mortality risks of alcohol consumption are dependent on race and gender-specific drinking patterns. Men in older cohorts report frequent and heavy drinking compared to women. Blacks are more likely to have chronic health conditions such as kidney disease, type 2 diabetes, and hypertension which can be exacerbated by heavy alcohol drinking (Delker, Brown, and Hasin 2016; Jackson et al. 2015).

Volume of alcohol consumption varies by race/ethnicity. High-risk drinking is prevalent among ethnic minorities such as Native Americans and Hispanics. Non-Hispanic whites drink more than other race/ethnic groups and tend to be frequent heavy drinkers (Fuller 2011). Differential effects by race and ethnicity are visible on coronary heart disease-related mortality when volume of alcohol intake is considered. Black men show a positive association of alcohol consumption and risk, whereas white men show an inverse relationship. The underlying reasons for blacks to show a positive association can be due to fewer years of formal education, lower income, higher prevalence of obesity (BMI $\geq$ 30), higher blood pressure, and a higher prevalence of diabetes (Fuchs et al. 2004; Kerr et al. 2011). Interestingly though, the J-shaped relationship between alcohol consumption and mortality is often missing when African American males and females were investigated. The burden of mortality is similarly high for Native Americans in relation to alcohol consumption (Chartier and Caetano 2010; Mukamal et al. 2010; Mukamal, Ding, and Djoussé 2006; Sempos et al. 2003; Shield et al. 2013).

It has been more than three decades since the minimum legal drinking age act was introduced in the United States. In 1994 Wagenaar and Wolfson reported that rate of MLDA enforcement is low and varies widely by states. However, DeJong and Blanchette (2014) conclude that MLDA has been effective so far in the United States and reduced the proportion of alcohol-related motor vehicle deaths and alcohol consumption among youths. Many states coupled the MLDA with zero-tolerance legislation which makes it illegal for young drivers under age 21 years to drink alcohol and drive (Voas et al. 2003). Alcohol and mortality association are well studied and have been focused around trend, patterns of consumption, effects on health, and sociodemographic determinants across race/ethnicity. However, a gap exists with respect to how the MLDA affected the alcohol consumption behavior and whether

there is any variation in mortality outcome across cohorts. This paper aims to examine the sociodemographic characteristics and health behaviors in alcohol consumption and the subsequent mortality risk in the United States for two different cohorts.

Data and Methods

Data

To investigate mortality risk due to drinking habits, nationally representative data from the public-use National Health Interview Survey-Linked Mortality Files (NHIS-LMF), 2001 to 2009, linked to prospective mortality follow-up through December 2009 were used. The NHIS asked about the current alcohol drinking status first in 1988 and then in 1990. A decade later, in 2001, the current drinking status question was brought back into the survey and has been part of the survey since then. Hence, in this paper, the dataset is restricted from 2001-2009. To address the mortality follow-up and fluctuations in mortality rates over time, each year of NHIS data from 2001-2009 is treated as a wave. After addressing the missing data by multiple imputations, the final analytic sample is 505,662.

Measurement

Outcome Variable: Mortality

Mortality status is treated as a binary outcome variable for this examination, where outcome ‘1’ means assumed deceased and ‘0’ means assumed alive. NHIS reports the final vital status (assumed alive or assumed deceased) for persons age 18+ who are eligible for mortality follow-up. This eligibility status is determined by NCHS based on probabilistic matches of survey participants’ NHIS records to the National Death Index (NDI) records.

Predictor Variable: Alcohol Consumption

The main predictor variable for this study was 'current' alcohol drinking status which was recoded to five categories, including: 1) lifetime abstainer; 2) former drinker; 3) light drinker; 4) moderate drinker; and 5) heavy drinker. Drinking status is determined by asking the respondents, in any one year, have you had at least 12 drinks of any type of alcoholic beverage? Alcoholic beverages include liquor, such as whiskey or gin, beer, wine, wine coolers, or any other type of alcoholic beverage. Lifetime abstainer is individuals who have never had any drinks in life. Former drinkers are a combination of the former drinker, former infrequent drinker, and former regular drinker. Light drinkers include current drinkers, current infrequent drinkers, and current drinker (level unknown, which means the individuals are unknown about their level of alcohol consumption). Moderate drinkers are current moderate drinkers. Heavy drinkers are current heavy drinkers. Alcohol drinking status (not current) is also categorized to: 1) lifetime abstainer, 2) former drinker, and 3) current drinker to address variation across cohorts.

Covariates

Covariates include sociodemographic variables and behavioral status, including age, sex, educational status, race and ethnicity, marital status, and smoking status. The data contains observations aged 15 and over to include the cohort whose year of birth goes back to the 1940s and who had the chance to start drinking earlier than the federal standard of 21 years that was enacted in 1984. Hence, I am interested in comparing these two cohorts: early cohort includes adults born up to 1963; late cohort includes adults with births starting in 1963 because by 1984 these individuals would be 21 years old and eligible to drink legally. The cohort before 1963 is termed as the *early* cohort and the cohort after 1963 is termed as *late* cohort.

Age is categorized as: 15-18, 18-24, 24-35, 35-45, 45-65, and 65+. The reason behind this age categorization is that young adults are exposed to drinking at around age 18, even though the legal drinking age is 21 in the United States. The 18-24 age group captures college students when alcohol consumption is expected to be higher. The 24-35 age category captures various transitions into adulthood, such as getting a job, getting married, and having children. The intention was to look at whether this age group diverge in their drinking status and related mortality risk. The 35-45 age category captures the early middle age population; whereas, the 45-65 age category captures the height of working age adults and potential mid-life crises. The final age category is limited to age 65-85 because people experience increased risks of mortality, and the scope of the paper limits the differentiation of mortality caused by different types of diseases.

In this study, education is categorized into: 1) less than high school that included kindergarten to grade 11; 2) high school that requires the completion of grade 12; 3) some college is equivalent of 3 to 4 years of college or less; and 4) college+ is 4 years of college/Bachelor's degree or more. To construct the Race and Ethnicity variable, two variables, self-reported race and the Hispanic ethnicity, were combined and categorized to: non-Hispanic White, non-Hispanic Black and Hispanic.

As an individual level predictor for this study, marital status is categorized to married, separated and never married. To determine the smoking status, respondents were asked, have you smoked at least 100 cigarettes in your entire life? Smoking is included among the predictor variables as a major proximate behavior to examine mortality risk and is categorized as: 1) current smoker; 2) former smoker; or 3) never smoked.

Statistical Method

Chi-square tests of each variable by drinking category was done to conduct bivariate analysis to see if the distribution across these categories is significantly different or not. Additionally, since the response variable was categorical with two possible outcomes (i.e. binary outcomes, dead or alive), logistic regression was performed to examine the relationship between mortality and sociodemographic characteristics and health behaviors. The structural form of the model describes the patterns of interactions and associations. Binary variables can be represented using an indicator variable Y_i, taking on values 0 or 1, and modeled using a binomial distribution with probability $P(Y_i=1) = \pi_i$. Logistic regression models this probability as a function of one or more explanatory variables. To perform logistic regression in R, use the command:

> glm (response ~ explanantory_variables, family=binomial)

The family = binomial instructs R to perform logistic regression. The advantage of GLMs over traditional OLS regression is that we do not need to transform the response Y to have a normal distribution. Also, the models are fitted via Maximum Likelihood estimation, thus optimal properties of the estimators. However, the limitation is, responses must be independent. The data analysis was done in R, version 3.5.1 as it provides flexibility in handling the dataset. Packages such as ‘car’, ‘dplyr’, ‘lm’, ‘Hmic’, ‘questionr’, ‘stargazer’, ‘survey’, ‘tidyr’, ‘foreign’, ‘mice, were used to conduct the multiple imputations, and descriptive and regression analysis.

Results

Descriptive Results

Of the 505,662 respondents with a final mortality status, there were 10,915 respondents assumed deceased and 494,747 respondents assumed alive. From the selected sample, 232,429 respondents fall under the early cohort, while 273,233 individuals fall under the late cohort. Out

of the total complete observations, 262,085 were females and 243,577 were males. The bulk of the observations fall within the age range of 24-65 years. Table 1 shows the bivariate distribution (weighted percentage based on survey design) of individuals across the five categories of drinking status by various background characteristics. Bivariate analysis shows significant association among the variables and across their categories.

Table 1: Current drinking status by background characteristics (weighted percentages, n=505,662)

		Alcohol Consumption Behavior				
Variables		**Lifetime Abstainer**	**Former Drinker**	**Light Drinker**	**Moderate Drinker**	**Heavy Drinker**
Mortality Status***						
	Alive	17.5	12.4	45.7	17.9	6.5
	Dead	20.1	27.9	29.3	14.2	8.5
Education***						
	Less than High School	29.1	18.4	33.6	12.6	6.2
	High School	20.0	14.7	42.1	16.3	6.9
	Some College	15.1	12.2	47.8	17.7	7.2
	College+	12.3	8.7	51.5	22.1	5.4
Race/Ethnicity***						
	Non-Hispanic White	13.1	12.7	46.8	19.8	7.5
	Non-Hispanic Black	29.3	14.6	40.6	11.6	3.9
	Hispanic	30.3	11.3	42.0	12.8	3.7
Age***						
	18-24	24.1	4.3	42.2	19.4	10.0
	24-35	17.2	8.6	49.7	18.5	6.0
	35-45	15.7	12.4	48.0	17.9	6.0
	45-65	16.4	18.4	42.3	16.9	6.0
	65-85	20.6	27.9	34.6	13.8	3.1
Sex***						
	Male	12.0	12.4	41.2	26.7	7.6
	Female	22.8	13.1	49.3	9.3	5.4
Marital Status***						
	Never Married	19.8	7.6	43.1	20.4	9.1
	Married	16.9	14.0	46.6	17.3	5.2
	Separated	16.2	17.0	44.1	15.3	7.3
Smoking Status***						
	Current Smoker	7.4	13.3	43.3	22.7	13.3
	Former Smoker	5.6	19.5	45.7	22.2	6.9
	Never Smoke	26.4	10.1	46.1	14.1	3.4
Wave***						
	2001	18.0	12.2	46.4	17.2	6.1

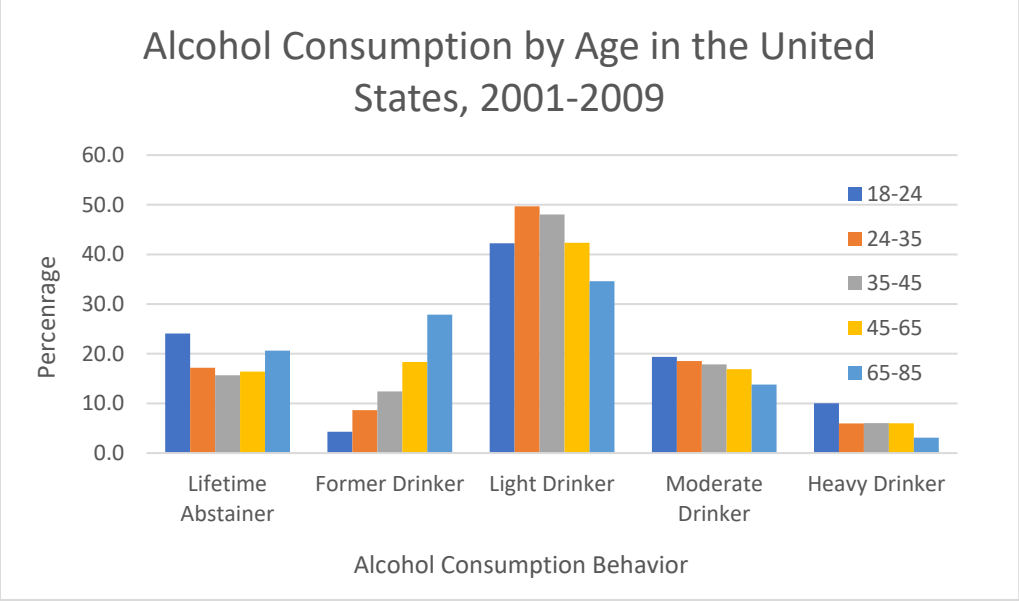
	2002	17.8	12.4	46.5	17.2	6.2
	2003	19.0	12.2	45.4	17.2	6.2
	2004	18.9	12.5	45.2	17.3	6.1
	2005	18.6	12.4	45.4	17.4	6.3
	2006	18.3	12.7	44.3	18.0	6.8
	2007	17.0	13.2	44.6	18.2	7.0
	2008	15.5	13.3	45.2	18.7	7.2
	2009	15.1	14.0	45.2	18.9	6.8
Cohort***						
	Early	16.4	17.6	42.9	17.1	6.0
	Late	18.6	8.3	47.6	18.5	7.0

Weight: mortwt; ***$P \leq 0.05$

Adjusted Wald chi-square Statistic

From Chart 1, light drinking is noted as the most preferred mode of drinking in all age groups, with the bulk of the individuals falling under the 18-65 age range. After age 45, the preference for light drinking diminishes, and the percentage of former drinkers increases. Moderate drinking habits remain stable with a slight decrease after the middle ages. Heavy drinking is gradually seen to be decreasing as individuals get older.

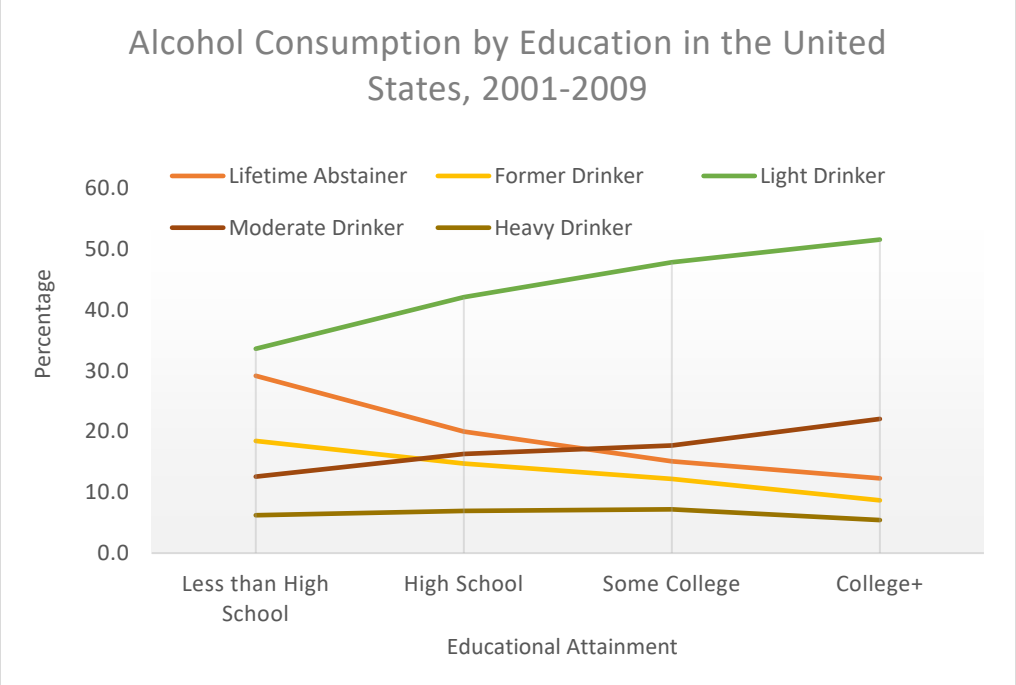
Chart 1: Current alcohol consumption status by age in the United States, 2001-2009



Source: NHIS-LMF 2001-2009

Increasing educational attainment (Chart 2) shows a noticeable increase in the percentage of light drinkers as well as a mild increase in the percentage of moderate drinker category. It is seen that, with each level of degree accomplishment, the percentage of lifetime abstainers decreases.

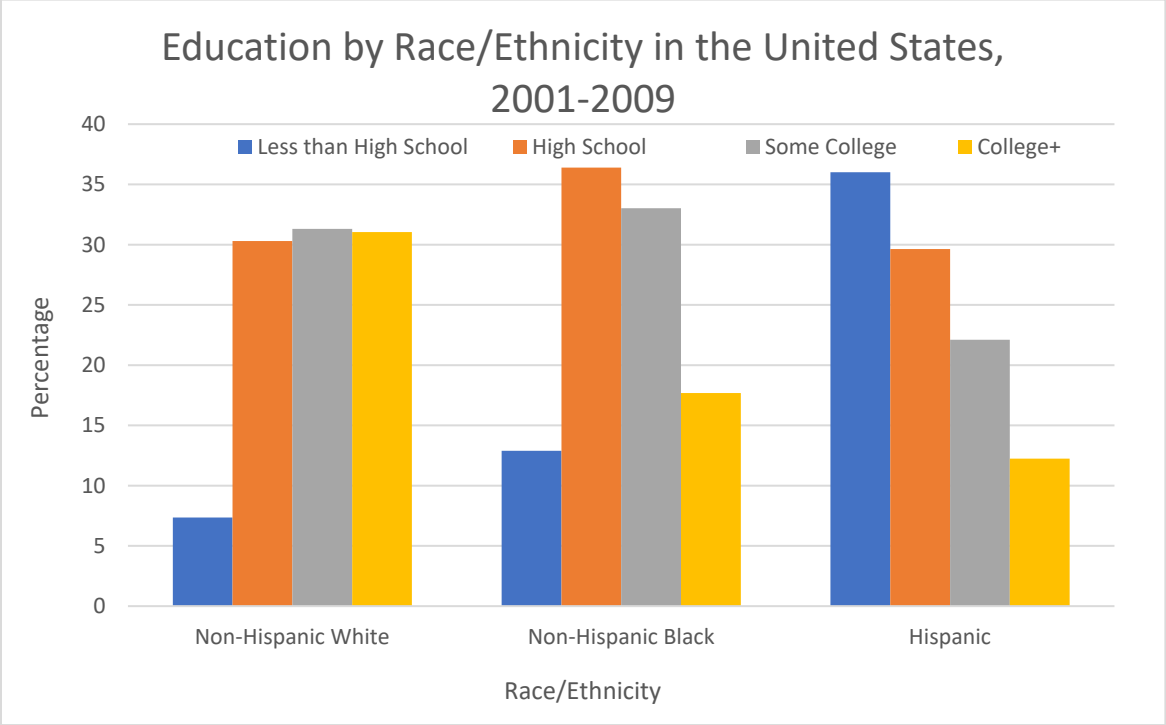
Chart 2: Current alcohol consumption status by education in the United States, 2001-2009



Source: NHIS-LMF 2001-2009

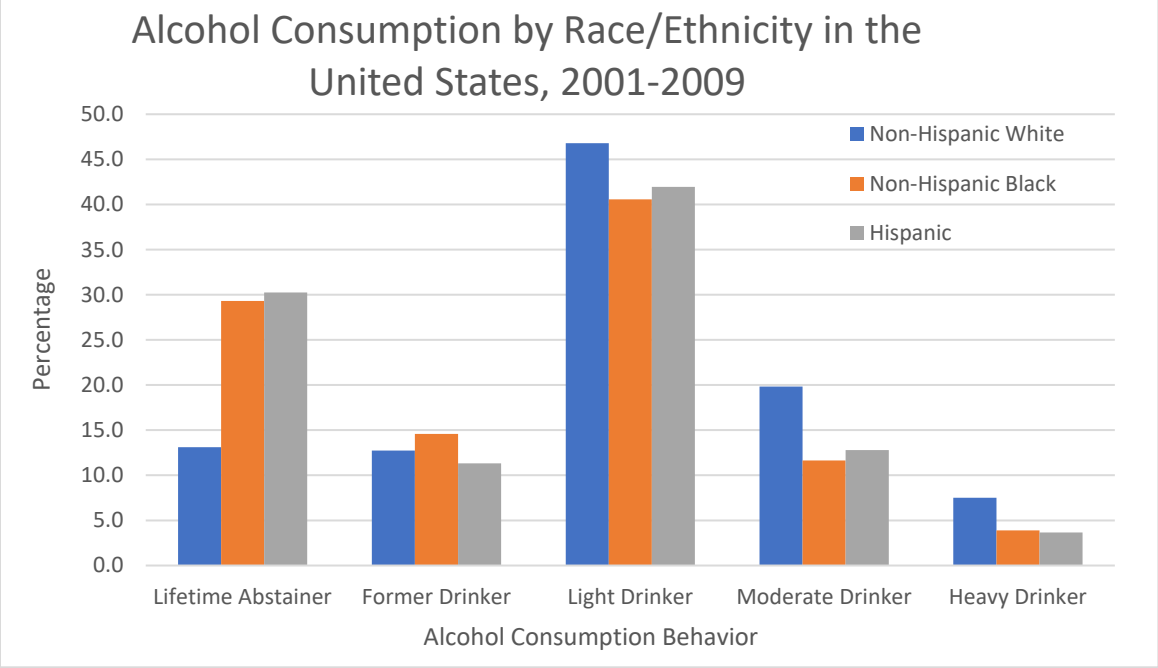
In terms of education among the different racial and ethnic groups, Hispanics show a decrease in the percentage of adults with increasing levels of educational attainment (Chart 3). Non-Hispanic blacks are in a better position than the Hispanics with respect to educational attainment. Non-Hispanic whites maintain a consistent level of educational attainment. Light drinking is preferred by individuals of all races and ethnicities, with non-Hispanic whites showing the highest percentage, whereas Hispanics and non-Hispanic blacks are at similar levels (Chart 4).

Chart 3: Educational attainment by race/ethnicity in the United States, 2001-2009



Source: NHIS-LMF 2001-2009

Chart 4: Current alcohol consumption status by race/ethnicity in the United States, 2001-2009

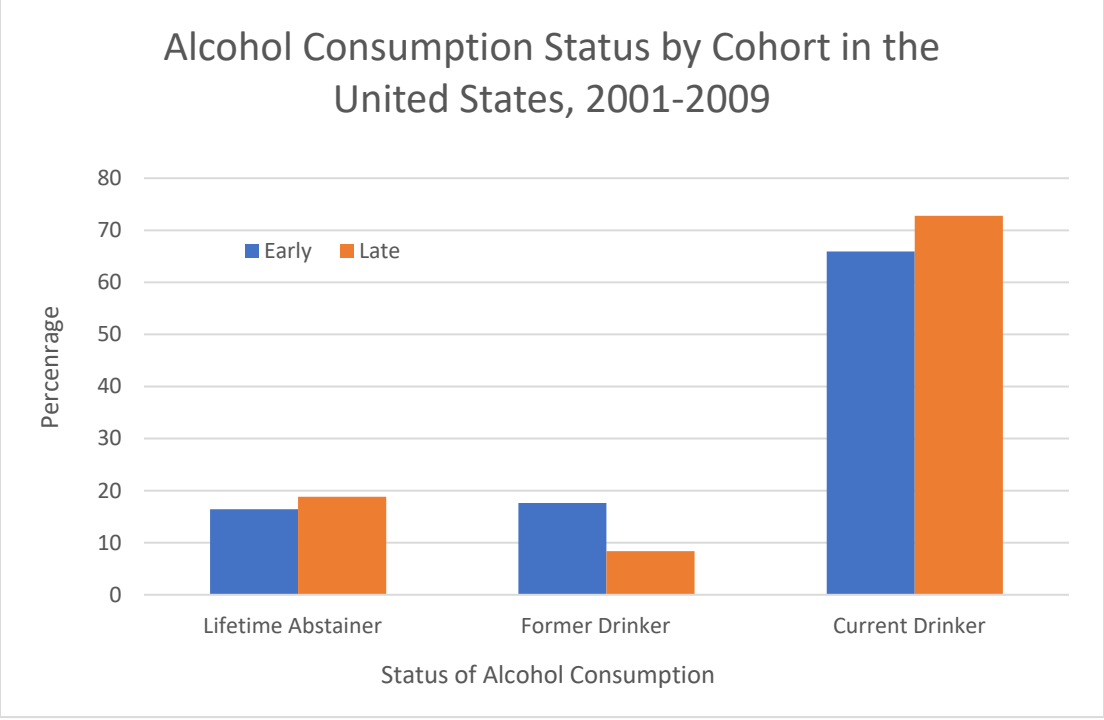


Source: NHIS-LMF 2001-2009

Compared to married or separated, never married individuals are more likely to be heavy drinkers (Table 1). However, married individuals tend to prefer light drinking more compared to other categories. Considering health behaviors, current smokers are twice more likely to be heavy drinkers than other smoking status categories. Current smokers are also higher in number in the light and moderate drinking categories.

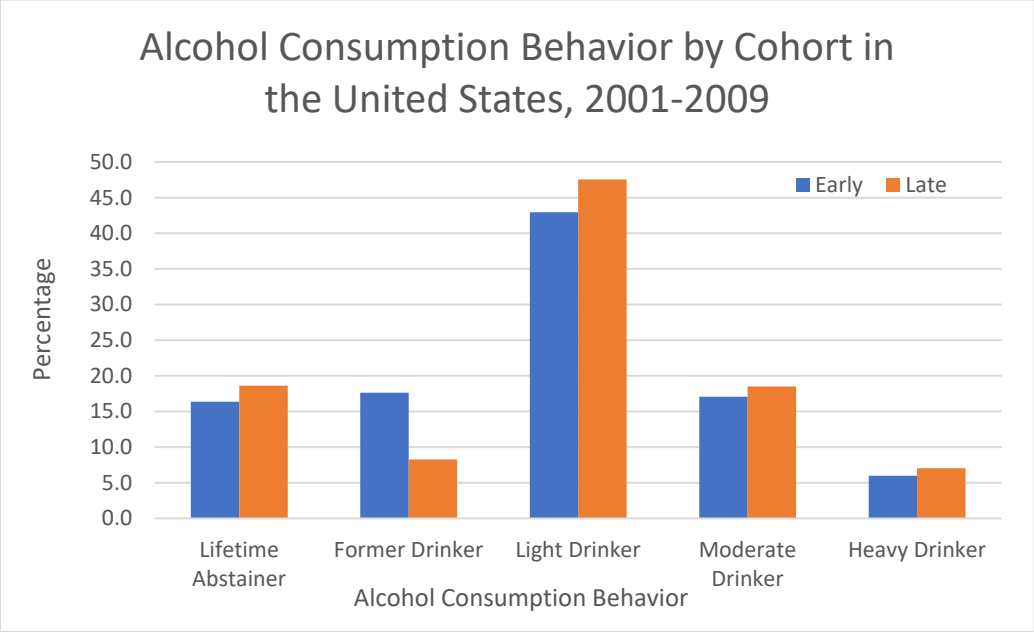
Among the two cohorts, individuals of later cohort are more likely to be current drinkers as well as light or moderate drinkers (Charts 5 and 6). Noticeably, the number of former drinkers is more than double among the early cohort. This may be due to the fact that with age those individuals have refrained from alcoholic beverage intake.

Chart 5: Alcohol consumption status by cohort in the United States, 2001-2009



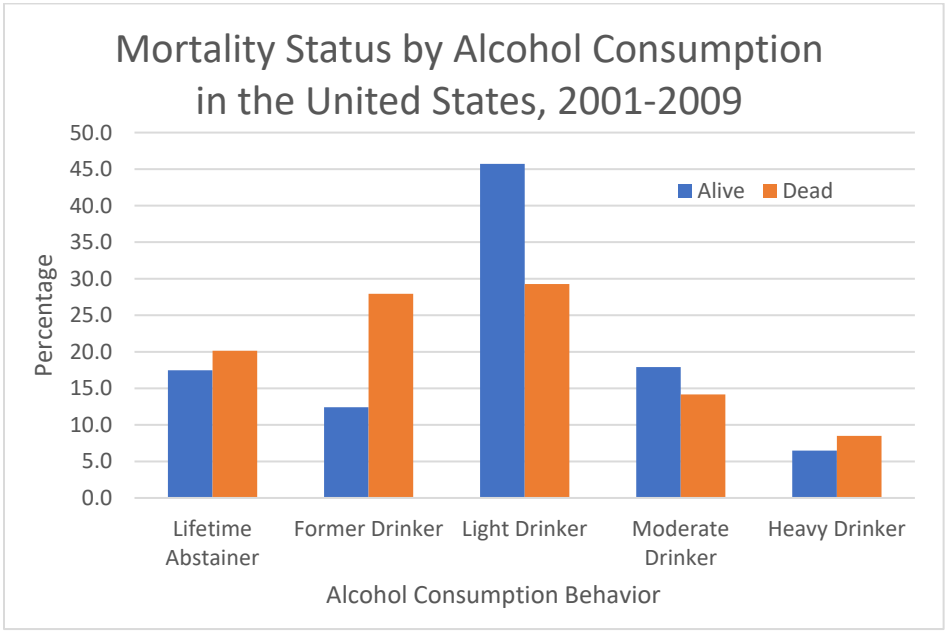
Source: NHIS-LMF 2001-2009

Chart 6: Current alcohol consumption status by cohort in the United States, 2001-2009



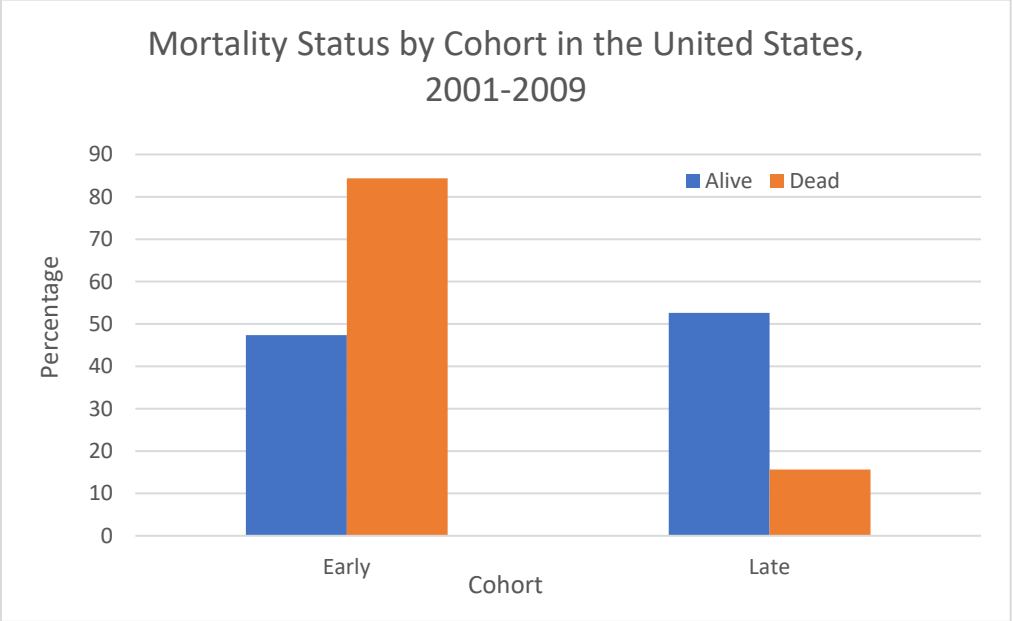
Source: NHIS-LMF 2001-2009

Chart 7: Final mortality status by alcohol consumption in the United States, 2001-2009



Source: NHIS-LMF 2001-2009

Chart 8: Final mortality status by cohort in the United States, 2001-2009



Source: NHIS-LMF 2001-2009

As noted in Chart 7, individuals who are light drinkers tend to be alive at follow-up period compared to being deceased, which refers back to the idea that light drinking tends to have a protective effect on human health (Fuller 2011). The mortality status is also visibly different among the two cohorts, with the later cohort showing a lower percentage of deaths compared to the early cohort (Chart 8).

Logistic Regression Results

Table 2 presents the regression results of the mortality risk with respect to the predictors included in the analysis. There are 4 models included in the analysis. Model 1 only looks at the association between mortality and alcohol consumption. Model 2 includes the waves (years) to model 1 to see if the mortality risk varies over the time period of data collection. Model 3 includes sociodemographic and health behavior variables such as age, sex, education, race and ethnicity and marital status, and smoking status to model 2. The final model includes the cohort variable to see if variation in mortality risks exist between the two cohorts.

Table 2: Logistic Regression coefficients for the effects of independent variables on mortality

Regression Results

	Model 1	**Model 2**	**Model 3**	**Model 4**
Former Drinker (ref=Heavy Drinker)	1.713***	1.711***	1.370***	1.369***
	(1.625, 1.802)	(1.624, 1.799)	(1.280, 1.461)	(1.279, 1.460)
Lifetime Abstainer	0.877**	0.841***	1.226***	1.227***
	(0.787, 0.968)	(0.751, 0.931)	(1.130, 1.322)	(1.130, 1.323)
Light Drinker	0.487***	0.475***	0.620***	0.621***
	(0.398, 0.577)	(0.386, 0.565)	(0.529, 0.711)	(0.530, 0.712)
Moderate Drinker	0.602***	0.597***	0.651***	0.651***
	(0.507, 0.698)	(0.502, 0.692)	(0.551, 0.750)	(0.552, 0.751)
2002 (ref=2001)		0.952	0.929*	0.937
		(0.883, 1.022)	(0.858, 1.000)	(0.866, 1.007)
2003		0.871***	0.831***	0.844***
		(0.796, 0.946)	(0.756, 0.906)	(0.769, 0.919)
2004		0.711***	0.661***	0.676***
		(0.632, 0.789)	(0.581, 0.741)	(0.596, 0.756)
2005		0.690***	0.634***	0.651***
		(0.612, 0.769)	(0.555, 0.713)	(0.572, 0.731)
2006		0.575***	0.498***	0.515***
		(0.490, 0.661)	(0.412, 0.585)	(0.428, 0.603)
2007		0.454***	0.369***	0.384***
		(0.364, 0.544)	(0.278, 0.460)	(0.292, 0.476)
2008		0.399***	0.302***	0.316***
		(0.294, 0.503)	(0.197, 0.408)	(0.210, 0.422)
2009		0.274***	0.196***	0.206***
		(0.156, 0.392)	(0.075, 0.317)	(0.084, 0.328)
College+ (ref=LHS)			0.420***	0.420***
			(0.339, 0.501)	(0.339, 0.501)
High School			0.680***	0.679***
			(0.616, 0.743)	(0.616, 0.743)
Some College			0.597***	0.596***
			(0.526, 0.667)	(0.526, 0.667)
Hispanic (ref=NH White)			0.873***	0.878***
			(0.808, 0.938)	(0.813, 0.943)
NH Black			1.280***	1.280***
			(1.221, 1.339)	(1.221, 1.339)
Male			1.646***	1.646***
			(1.599, 1.692)	(1.600, 1.692)
Age 24-35 (ref=18-24)			1.528***	1.529***
			(1.380, 1.675)	(1.381, 1.676)
Age 35-45			3.626***	2.873***
			(3.484, 3.768)	(2.715, 3.030)
Age 45-65			11.572***	7.749***

			(11.435, 11.710)	(7.575, 7.923)
Age 65+			25.805***	16.945***
			(25.615, 25.995)	(16.726, 17.165)
Never Married (ref=Married)			1.568***	1.575***
			(1.496, 1.639)	(1.503, 1.647)
Separated			1.544***	1.541***
			(1.488, 1.599)	(1.485, 1.597)
Former Smoker (ref=Current Smoker)			0.664***	0.664***
			(0.606, 0.721)	(0.606, 0.721)
Never Smoked			0.466***	0.468***
			(0.410, 0.522)	(0.412, 0.523)
Late				0.669***
				(0.557, 0.781)
Constant	0.032***	0.051***	0.013***	0.019***
	(-0.046, 0.111)	(-0.039, 0.141)	(-0.158, 0.185)	(-0.179, 0.218)
N	432,175	432,175	432,175	432,175
AIC	96,450.500	94,927.180	85,169.900	85,117.760

*p < .05; **p < .01; ***p < .001

Model 1 indicates that former drinkers have a lower chance of survival compared to light, moderate drinkers and lifetime abstainers. Similar to the findings of previous studies, the moderate drinkers show a positive impact on the health and chances of survival compared to the heavy drinkers (Fuller 2011). The odds ratios display that moderate drinkers are 35 percent less like to die than heavy drinkers. Former drinkers are 70 percent more like to die than heavy drinkers. Light drinkers have the highest chance of surviving among other alcohol drinking individuals. However, this comparison might be difficult as one can die due to diseases of aging and these are people who already gave up alcoholic beverages at some point in their life. Accounting for the waves of the mortality follow-up (Model 2), the mortality risk does not seem to change much for the levels of alcohol consumptions. However, with each consecutive wave, the chances of people dying decreases. In the 2009 wave, individuals are around 73 percent less likely to die than someone from 2001, whereas, someone from 2003 is around 13 percent less likely to die than someone from 2001.

Model 3 indicates that college-educated individuals are 60 percent more likely to survive than individuals with less than high school education and high school educated individuals are 32 percent less likely to die over the follow-up period. It shows that education does have a moderating effect on the mortality outcome. As for the Hispanics, they are 13 percent less likely to die than the non-Hispanic whites. However, non-Hispanic blacks are 30 percent less likely to survive in the follow-up period than the non-Hispanic whites.

Males are sixty-four percent more likely to die over the follow-up period compared to females. Marital status also shows a stark difference in mortality outcomes where the never married and separated individuals are 57 percent and 54 percent more likely to die, respectively, than the individuals who are married in the follow-up period. Smoking as a health behavior also shows that former smokers and non-smokers survive at higher rates than current smokers in the follow-up period.

Age has an interesting effect on the mortality outcome, which reflects a J-shape relationship. Individuals aged 24-35 shows a higher likelihood (53 percent) to die in the follow-up period than the individuals from the 18-24 age group. The chances of survival decrease with the following age groups of 35-45 and 45-65, the latter of which shows almost twelve times more chances of dying than the reference age group 18-24 during the mortality follow-up.

Model 4 includes the final independent variable, cohort, in the regression model. With respect to the cohorts (pre-1963 and post-1963), the later cohort is 33 percent less likely to die over the follow-up period than the earlier cohort. The inclusion of the sociodemographic factors and health behaviors slightly decrease the strength of model 4 which is expected as similar conclusions can be found in the literature. The more independent predictors are included in the

model, the more they will moderate the association between the variables and impact the outcome.

Discussion and Conclusion

The study looks at the mortality risks due to alcohol consumption behavior considering the sociodemographic and health behaviors of individuals in the United States. Consistent with previous findings, moderate or light alcohol consumption showed a protective effect on the mortality outcome (Fuchs et al. 2004; Fuller 2011). However, heavy alcohol consumption (binge drinking on 5 or more days in the past month) does have its toll on the health and mortality outcome which is aligned to more recent findings where it is seen alcohol is linked to risk factors of global disease burden and premature death (Collaborators 2018; Zaridze et al. 2014). Racial and ethnic differences do not diverge from the past findings either as we see that Hispanics enjoy better survival chances in the mortality follow-up period compared to non-Hispanic whites and non-Hispanic blacks.

The Hispanic paradox persists, even with the inclusion of alcoholic beverage consumption in the model. It reinforces the fact that social conditions and racial disparities are still persistent in the United States with respect to mortality risk as the non-Hispanic blacks are still showing higher mortality risk than the other two population (Caetano et al. 2010; Jackson et al. 2015). Lower SES does not impact Hispanics in the same way as it does non-Hispanic blacks possibly due to their strong social networks, familial ties and values. Joblessness, fewer opportunities, exposure to risky health behaviors, living in close proximity to environmental hazards are just some of the few obstacles that hold non-Hispanic black individuals back (Fenelon, Chinn, and Anderson 2017). It is time such racial segregation and disparities are addressed at the policy level. Structural adjustment policy can be introduced, and affirmative

action can be taken to give non-Hispanic blacks the advantage they need to be on the same page as non-Hispanic whites or Hispanics.

Heavy alcohol use might be more disadvantageous to male educational attainment than females, however, we find that increasing educational attainment does not seem to lower the preference for alcoholic beverages (Staff et al. 2008). Education is found to moderate alcoholic beverage consumption, which may lead to the protective effect on health as well as the lower risk of dying in the follow-up period. Less than a high school education is strongly associated with death risks in the follow-up period compared to other educational categories. It points out a policy concern that ensuring education up to high school graduation and reducing the number of dropouts should be a primary concern at the state and local level. Irrespective of the generational effects, education can help situate an individual, from any racial and ethnic background, for the life chances that may not be otherwise available. Education can lead to better employment, higher income, social and professional networks, and a better understanding of health and health care needs (Olshansky et al. 2012; Zimmerman and Woolf 2014).

An overarching effort in this paper was the look at the two cohorts, pre-1963, who did not have any minimum restrictions on drinking, and post-1963, who would be 21 years old when then minimum drinking age act was introduced in 1984. Individuals who had drinking habits in the earlier cohort had increased risk of death in the follow-up period compared to the later cohort. According to the MLDA, the Federal government can withhold ten percent of Federal funding for highways from States that do not prohibit people under age 21 from buying or publicly possessing any alcoholic beverage. After the enactment of the MLDA in 1984, states that had initiated sobriety checkpoints effectively reduced drinking and driving and alcohol-related fatal crashes (Fell et al. 2003). The MLDA perhaps lowered the mortality risk of the later

cohort and calls for stricter enforcement and other evidence-based prevention efforts that have been demonstrated to reduce underage drinking and alcohol-related problems to avoid alcohol consumption related mortality risks (DeJong and Blanchette 2014; Yörük and Yörük 2011).

The national law specifically prohibits the purchase and public possession of alcoholic beverages. However, it does not prohibit persons under 21 (also called youth or minors) from drinking. While every State abides by the MLDA standard, State law varies on specifics about possession and exceptions to the law, such as allowing people under 21 to drink with their parents. Advertisements of alcoholic beverages often attract young adult to try alcoholic beverages and have subsequent alcohol abuse problems. Efforts should be directed towards how to prohibit alcohol drinking before the legal age of 21 (Franke and Wilcox 1987; NIAAA 2018; Voas et al. 2003).

This study is not the first effort to look at the effect of the MLDA on mortality. However, the cohort perspective is something unique that has not been looked upon previously. This study contributes to the understanding of how a policy can make a social impact in the years to come by addressing the appropriate use of alcoholic beverage. The findings generally demonstrate that specifying the minimum drinking age to 21 and forcing states to abide by the rule lowered the mortality risk in the later cohort. Comparing two cohorts from two different era this study fills up a gap in the literature by providing an analysis of the variation in alcohol consumption related mortality by cohorts. Furthermore, in the future, areas such as women's labor market participation and alcohol consumption behavior as well as risk-taking behavior among young adults and alcoholic beverage intake early in life should be studied thoroughly. Future research should also consider the age-period-cohort analysis of the effect of the national minimum legal drinking age act on alcohol-related adult mortality in the United States.

Limitation

A major limitation of this study was not being able to deal with missing data. In the logistic regression, only complete cases were included as predictors. Furthermore, hazard analysis might be able to explain the association between mortality risk and alcohol consumption better. Linked datasets in combination with hazard modeling procedures allow researchers broader analyses of demographic, social, and behavioral influences on adult mortality.

Additional health behaviors could be added to the analysis to examine their association with alcohol consumption and mortality risks. Mortality is a cumulative outcome of health behaviors, life choices, and sociodemographic backgrounds. It would have been better if more health behaviors, such as food habits, sleeping patterns, income, employment, social capital, and networks could be controlled for.

Data from NHIS was used from 2001-2009, with mortality follow-up period up to 2009. Even though this study benefits from a nationally representative sample, the follow-up period is rather short. A longer follow-up period would include more deaths which could provide us with more precise estimates.

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