



# Problem drinking as intentional risky behavior: Examining the association between state health insurance coverage and excessive alcohol consumption

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## ABSTRACT

The moral hazard theory asserts that having health insurance may increase individual risk-taking behaviors. We examined the association between state health insurance coverage and excessive alcohol use among U.S. adults. We used 2001–2017 Behavioral Risk Factor Surveillance System data to estimate annual binge and heavy drinking rates for each state. In a multivariable regression analysis, we used difference-in-difference (DID) models to assess the association between state-level insurance coverage and binge and heavy drinking. Additionally, we assess the potential asymmetric effect and whether economic recessions (2001, 2008–09) had a moderation effect. In the multivariable DID analysis, aggregate state insurance coverage was not significantly associated with binge drinking rates in baseline analysis with state-fixed effects (Model 1), and in the analysis that extends the baseline model to include state unique time trend (Model 2). A similar result was found for heavy drinking in Model 1. In contrast, the result showed a significant association between health insurance coverage and heavy drinking rates in Model 2. However, we found no significant association for binge and heavy drinking rates in both models in the analyses restricting data to periods before the methodological change in the BRFSS sampling frame. The results did not show asymmetric effects, and the association between health insurance and excessive alcohol use did not differ during economic recessions. These findings largely do not support assertions that health insurance may lead to moral hazards (risk-taking behaviors), especially binge drinking

## 1. Introduction

Alcohol consumption remains a significant public health problem, and is the leading risk factor for premature death and disability among people aged 15–49, accounting for 2.8 million deaths in 2016 (Griswold et al., 2018). Annually in the United States, approximately 88,000 deaths and \$250 billion in economic costs are attributed to excessive alcohol use, including binge drinking, heavy drinking, and drinking by pregnant women or those younger than the age of 21 (CDC, n.d.a). Excessive alcohol use contributes to more than 40 diseases or injury categories, including some cancers, diabetes mellitus, stroke and other cardiovascular diseases, and gastrointestinal disease (Rehm et al., 2017). Alcohol use is highly prevalent in the U.S., with approximately

70% of adults reporting that they drank alcohol in the past year, and 56% reporting that they drank in the past month, according to the 2015 National Survey on Drug Use and Health (NSDUH) (Substance Abuse and Mental Health Services Administration (SAMHSA, n.d.)).

Although the health risks of excessive alcohol consumption are well established, public attitudes toward addiction, including alcohol dependence, are mixed. Though accumulating evidence over the past two decades has validated the significant role of neurobiology (Agrawal and Lynskey, 2008; Ross and Peselow, 2009; Stanbrook, 2012), many still perceive addiction as a social problem (Holden, 2012; Levy, 2013; Room, 2005; Schomerus et al., 2011a; Schomerus et al., 2011b), suggesting that it is a moral failure or a lack of personal responsibility. Partly due to the stigmatization of substance use, including alcohol,

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there are also concerns about “moral hazard” behavior. Ex-ante moral hazard refers to the phenomenon that health insurance may decrease an individual’s effort to maintain his or her health, by discouraging lifestyle improvement and preventive action. In this context, there is a plausible concern that having insurance that will treat substance abuse disorders might increase the likelihood of substance abuse behavior (Dave and Kaestner, 2009). Empirical work on ex-ante moral hazard is limited relating to substance abuse, including alcohol consumption (Einav and Finkelstein, 2017; Spenkuch, 2012).

Assessing health insurance coverage is complex. The few studies that have examined the effects of health insurance coverage on risky health behaviors have produced mixed findings. A study conducted in the 1980s found that health insurance had no significant impact on smoking behaviors and weight (Brook et al., 1983). In contrast, Dave and Kaestner (Dave and Kaestner, 2009) found that obtaining Medicare was associated with increases in smoking and drinking behavior, lower probability of smoking cessation, and decreases in physical activity among those above the age of 65. Brown et al. found that health insurance was inversely associated with alcohol use among pregnant women (Brown et al., 2016). In contrast, a positive association was found between health insurance and alcohol use among non-pregnant women. A study by Barbaresco et al., 2015 found that the ACA young adult insurance expansion significantly increased binge drinking behaviors among those aged 23–25, but not healthcare service utilization. Overall, evidence of ex-ante moral hazard is mixed and context-specific. Most recent studies on moral hazard have focused on ACA expansion-eligible populations. In this study, we used the 2001–2017 Behavioral Risk Factor Surveillance System (BRFSS) to examine the association between insurance coverage and drinking behaviors among U.S. adults. Our study focuses on moral hazard at the population level by examining the association between state-level health insurance coverage rates and excessive drinking rates (binge drinking and heavy drinking). The use of aggregate state-level insurance data is less prone to self-selection concerns resulting from adverse selection in individual health insurance, i. e., people with substance abuse issues being more likely to purchase substance abuse coverage. The aggregate state insurance measure is more exogenous than the individual insurance variable, given that the state-level aggregate are less likely to be influenced by individual self-selection. Additionally, we assessed the asymmetric effects of economic conditions and the moderating effects of the economic recession on the relationship between health insurance and excessive drinking behaviors. Previous studies have shown that alcohol consumption varies with the macroeconomy, and the association was influenced by the Great Recession (Bor et al., 2013; Cotti et al., 2015; Pacula, 2011; Ruhm and Black, 2002).

## 2. Methods

### 2.1. Data

We used data from the 2001–2017 Behavioral Risk Factor Surveillance System. The BRFSS was designed in the early 1980s by the Centers for Disease Control and Prevention (CDC) to collect state resident data about health-related risk behaviors and events, chronic health conditions, and the use of preventive services for all noninstitutionalized U.S. adult population (age  $\geq 18$ ) (Wolfson et al., 2020). Established in 1984 and has been administered, BRFSS became a nationwide survey in 1993. More than 400,000 adult interviews are completed each year. The BRFSS survey contains a core component, optional modules, and state-added questions. Facing the rapid rise in the proportion of U.S. households that contain only cellular telephones and no landline telephones, BRFSS adopted a new weighting methodology in 2011 to incorporate cellular telephone survey data (CDC, n.d.b). The study was based on publicly available anonymized databases and thus exempt from ethical compliance.

### 2.2. Dependent variables

We estimated annual binge and heavy drinking rates for each state using BRFSS data. Binge drinking and heavy drinking were defined differently for males and females, as is standard in the literature (CDC, n.d.c). Heavy drinking was defined as having more than 14 drinks per week for males and having more than 7 drinks per week for females. Binge drinking was defined as having 5 or more drinks on one occasion for males and having 4 or more drinks on one occasion for females; although, before 2006, binge drinking was defined as having 5 or more drinks on one occasion for both males and females (CDC, n.d.d).

### 2.3. Independent variables

Our primary variable of interest is the state insurance coverage rate. The insurance coverage rate is operationalized as the proportion of the population covered by any insurance for each state, which was obtained from the U.S. Census Bureau. We followed the U.S. Census Bureau’s recommendation and used the Current Population Survey Annual Social and Economic Supplement (CPS ASEC) data to estimate 2001–2007 insurance coverage and the American Community Survey (ACS) to estimate the insurance coverage rate after 2007. These two estimates differ slightly, but the trend is parallel between 2009 and 2012 (US Census Bureau, n.d.).

Additionally, we obtained state unemployment rates (Bureau of Labor statistics, n.d.a) and median household income (Bureau of Labor statistics, n.d.b) (in thousand dollars) for each state from the Bureau of Labor Statistics, state laws on medical marijuana laws from ProCon.org (ProCon.org, 2019), and state alcohol taxes from the tax policy center (Tax policy Center, n.d.). Additional state-level characteristics, including the log of the population, mean age, percentage of the state population that is male, and percentage of the state population that is white were calculated using U.S. Population Data obtained through the National Cancer Institute (National Cancer Institute, n.d.). The inflation-adjusted beer excise tax was measured in each state at the 2018 price level. An additional dichotomous indicator of BRFSS methodological change was created to capture the new weighting method since 2011.

### 2.4. Statistical analysis

We generated annual prevalence estimates of heavy and binge drinking for each state. Sampling weights were included in the heavy and binge drinking prevalence estimates to account for the complex survey design. We used difference-in-difference (DID) models to estimate whether changes in insurance coverage are associated with binge and heavy drinking rates. The outcome variables, the state-level aggregate binge, and heavy drinking rates, were log-transformed to address potential skewness.

We used multivariable DID linear regression to assess the association between insurance coverage and heavy drinking. The heavy drinking rate was modeled as a function of insurance coverage adjusting for state-level characteristics, including the log of the population, the mean age, the percentage of the state population that is male, the percentage of the state population that is white, state beer taxes, state unemployment rate, state median household income (in thousand), medical marijuana laws, survey year, and methodological change indicator. Model 1 additionally adjusted for state-fixed effects to control for unobserved confounding influences that are time-invariant within a state. To allow a state-specific time trend and control for unobserved state-level factors that evolve at a constant smooth function, Model 2 added an interaction between state and year to the baseline Model 1. To assess the potential impact of BRFSS methodology change, sensitivity analyses were performed by restricting the analyses to 2001 to 2010, comparing to the results obtained when using the full sample (2001–2017).

We tested whether the association between health insurance and heaving-drinking rates differed between economic downturns and

upturns. Following previous studies, we replaced health insurance variables in Model 1 with two decomposed variables – insurance coverage during economic downturns and insurance coverage during economic upturns – in order to capture potential asymmetric effects (Azagba et al., 2021; Carpenter et al., 2017; Mocan and Bali, 2010). We define downturns and upturns as periods when the unemployment rate is higher or lower, respectively, than the prior period and zero otherwise.

We tested whether economic recessions in 2001 and 2008–2009 moderated the effect of health insurance on the heavy drinking rate (National Bureau of Economic Research, n.d.). In the analysis, we modified Model 1 by adding a control for whether a recession occurred as well as the interaction between health insurance coverage and recession indicator. We repeated the models in testing the association between insurance coverage and binge drinking rates. All tests were two-sided and used a 5% significance level, and analyses were performed using SAS 9.4 (SAS Institute, Inc., Cary, NC) and R 4.0.2.

### 3. Results

The median state-drinking rates and insurance coverage rate during the study period are presented in Fig. 1. The median binge and heavy drinking rates increased from 14.8% and 5.1% in 2001 to 17.4% and 6.5% in 2017, respectively. During the same period, the state median insurance coverage rate increased by approximately 4 percentage points, from 88.4% in 2001 to 92.1% in 2017.

Table 1 reports the multivariable DID regression results from examining the association between insurance coverage and binge drinking rates. The analysis with state-fixed-effect (Model 1) found no statistically significant association between health insurance coverage and binge drinking rates ( $\beta = 0.035, p = 0.84$ ). A similar result was found in Model 2, which allowed states to have a unique time trend. Specifically, health insurance coverage was again not significantly associated with binge drinking rates ( $\beta = 0.17, p = 0.34$ ). The sensitivity

analyses restricting to 2001 to 2010 yielded similar findings; health insurance coverage was not associated with binge drinking rates (Supplemental Table 1). In terms of other covariates, significant statistical associations were found between higher binge-drinking rates and state unemployment rate, median household income, beer tax, and percentage of the state population that is white. However, the mean age, the percentage of the state population who is male, legalization of medical marijuana, and log of the population were associated with lower binge-drinking rates (Table 1).

The association between insurance coverage and heavy drinking is presented in Table 2. Results showed no significant association between insurance coverage and heavy drink rates after adjusting for state fixed effects and other covariates ( $\beta = 0.32, p = 0.20$ , Model 1). In contrast, a statistically significant association was found in Model 2, adjusting for state unique time trend ( $\beta = 0.62, p = 0.02$ , Model 2). In the sensitivity analyses (Supplemental Table 2), restricting data to periods before the methodological change in the BRFSS sampling frame (2001 to 2010), no significant association was found for Model 1 and Model 2. Other covariates significantly associated with the prevalence of heavy drinking were median household income, mean age, beer tax, legalization of medical marijuana, and percentage of the state population that is white (Table 2).

#### 3.1. Economic symmetric effects and economic recession

Table 3 presents the association between insurance coverage and alcohol use in economic downward and upward trends. Compared to Model 1, the association between insurance coverage and excessive drinking had the same direction during economic downturns and upturns. Therefore, we concluded that the effects of insurance coverage were symmetric during economic downturn and upturn, given that the decomposed coefficients were not statistically significantly different. The association between insurance coverage and excessive drinking

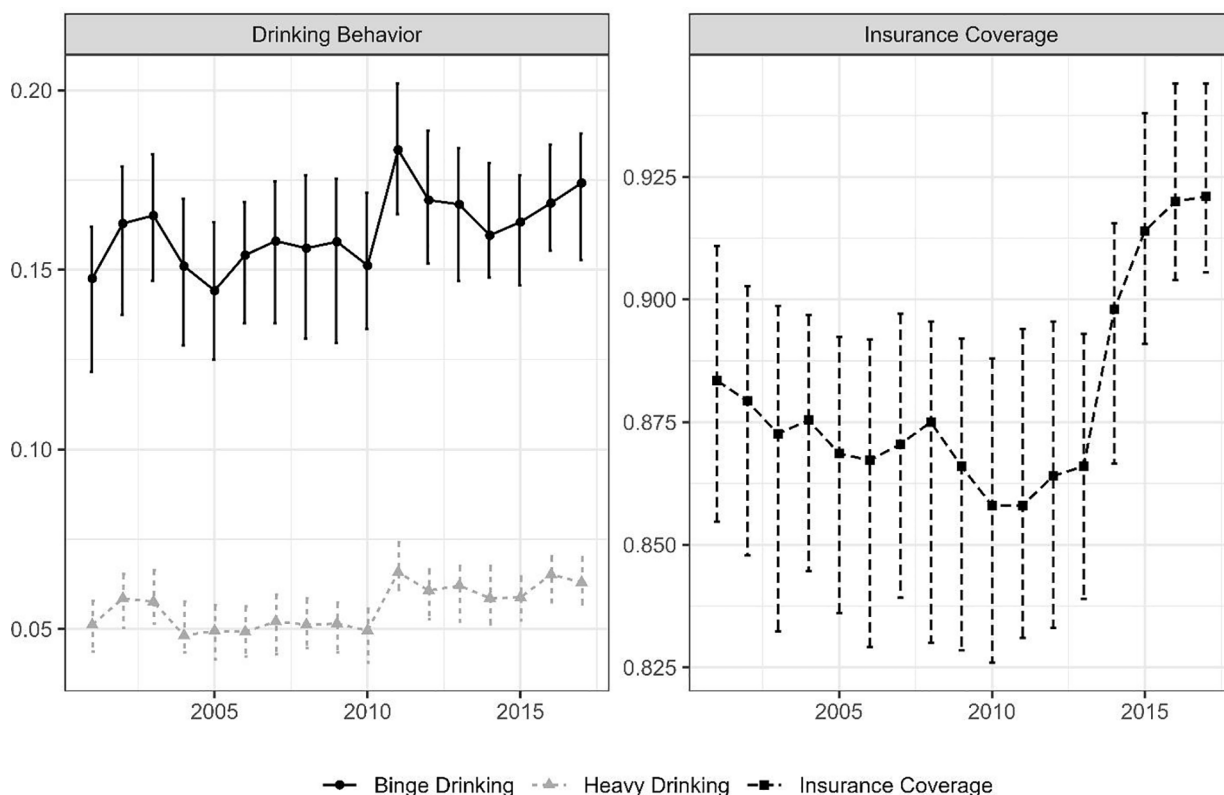


Fig. 1. Median state-drinking rates and insurance coverage rate, 2001–2017. For each rate, the point represents the median rate at that year, and the error bar represents the interquartile range (from lower 1st quartile to upper 3rd quartile).

**Table 1**  
Association between Insurance coverage and binge drinking.

	Model 1			Model 2		
	B	SE (β)	p-value	B	SE (β)	p-value
Insurance coverage	0.035	0.168	0.840	0.170	0.179	0.340
Unemployment rate	0.007	0.002	<0.001	0.008	0.002	<0.001
Median household income/\$1000	0.004	0.001	<0.001	0.004	0.001	<0.001
Mean age	-0.051	0.013	<0.001	-0.027	0.042	0.520
Male%	-12.070	2.691	<0.001	-15.582	4.830	<0.001
Beer tax	0.117	0.032	<0.001	0.049	0.039	0.210
Marijuana law	-0.027	0.013	0.030	-0.010	0.015	0.520
Year	0.015	0.004	<0.001	-0.017	0.012	0.180
Methodological change indicator	0.157	0.012	<0.001	0.157	0.011	<0.001
Log of population	-0.359	0.132	0.010	0.172	0.428	0.690
White%	2.736	0.387	<0.001	-3.855	2.472	0.120

Model 1 additionally adjusted for state-fixed effects. Model 2 added the interaction between state and year to Model 1. P < 0.05 is presented in bold.

**Table 2**  
Association between insurance coverage and heavy drinking.

	Model 1			Model 2		
	β	SE (β)	p-value	B	SE (β)	p-value
Insurance coverage	0.318	0.247	0.20	0.622	0.260	0.02
Unemployment rate	0.002	0.003	0.53	0.009	0.003	0.01
Median household income/\$1000	0.004	0.002	0.02	0.007	0.002	<0.001
Mean age	-0.041	0.019	0.03	-0.113	0.061	0.06
Male%	-1.412	3.942	0.72	-10.310	7.036	0.14
Beer tax	0.200	0.047	<0.001	0.180	0.057	<0.001
Marijuana law	-0.061	0.018	<0.001	0.010	0.022	0.64
Year	0.003	0.006	0.63	-0.004	0.018	0.82
Methodological change indicator	0.266	0.017	<0.001	0.270	0.016	<0.001
Log of population	-0.125	0.193	0.52	-0.999	0.623	0.11
White%	2.559	0.567	<0.001	-6.485	3.602	0.07

Model 1 additionally adjusted for state-fixed effects. Model 2 added the interaction between state and year to Model 2. P < 0.05 is presented in bold.

adjusting for economic recession is presented in Table 4. We found that economic recession did not have a significant impact on excessive drinking (β = -0.07, p = 0.68 for binge drinking; β = -0.14, p = 0.55 for heavy drinking) and did not moderate the effect of health insurance coverage (β = 0.05, p = 0.79 for binge drinking; β = 0.17, p = 0.55 for heavy drinking).

**4. Discussion**

This study examined the population-level association between state

**Table 3**  
Association between insurance coverage and alcohol substance use in economic downward and upward trends.

	Baseline Model 1: insurance coverage		insurance coverage in periods when the unemployment rate is higher than the prior period	insurance coverage in periods when the unemployment rate is lower than the prior period
	β	SE (β)		
Binge drinking	β	0.035	-0.005	0.003
	SE (β)	0.168	0.174	0.172
	p-value	0.84	0.98	0.99
Heavy drinking	β	0.318	0.107	0.147
	SE (β)	0.247	0.253	0.250
	p-value	0.20	0.67	0.55

P < 0.05 is presented in bold.

health insurance coverage and excessive drinking behaviors. Additionally, we assessed the potential asymmetric effect and whether economic recessions (2001, 2008–09) had a moderation effect in the relationship between health insurance and problem drinking. We consistently found no significant association between state insurance coverage and binge drinking rates in analyses with state fixed-effects as well as a model that accounted for state unique time trends. Mixed findings were found for rates of heavy drinking. In particular, no significant association was obtained in analyses with state fixed-effects, while the model with state unique time trends yielded significant associations between state insurance coverage and binge and heavy drinking. However, this added component may have reduced the variation in insurance coverage change across states and may lead to identification concerns. To assess whether the methodological change in the BRFSS sampling frame (2011) may have affected our findings, we restricted the analyses to periods before 2011 (i.e., 2001–2010). The results consistently showed no significant associations between binge and heavy drinking and state insurance coverage rates. We also found that excessive drinking behaviors were associated with other sociodemographic characteristics (e.g., percentage of the state population that is white), which provides practical importance for developing programs, interventions, and policies to prevent excessive drinking (Bingham et al., 2007). A negative association of medical marijuana law and drinking behaviors might suggest the substitution effects of marijuana on alcohol consumptions (Guttmanova et al., 2016).

This study provides new insights into an ex-ante moral hazard for drinking behaviors, on which there has been highly limited prior research. Though not directly comparable, previous findings showed that the ACA insurance expansion for young adults significantly increased binge drinking behaviors among the covered population (age 23–25) (Barbaresco et al., 2015). A simulation study among the elderly eligible for Medicare also showed Medicare coverage is positively associated with alcohol consumption and smoking (Dave and Kaestner, 2009; Khwaja, 2006). However, prior research using data from the U.S.

**Table 4**  
Association between insurance coverage and drinking adjusting for economic recession.

	Binge drinking			Heavy drinking		
	$\beta$	SE ( $\beta$ )	p-value	$\beta$	SE ( $\beta$ )	p-value
Insurance coverage	0.140	0.177	0.43	0.287	0.260	0.27
Economic recession period (2001, 2008, 2009)	-0.067	0.162	0.68	-0.144	0.238	0.55
Insurance coverage * Economic recession	0.048	0.186	0.79	0.165	0.274	0.55
Unemployment rate	0.009	0.002	<b>&lt;0.001</b>	0.002	0.004	0.56
Median household income/\$1000	0.004	0.001	<b>&lt;0.001</b>	0.004	0.002	<b>0.02</b>
Mean age	-0.050	0.013	<b>&lt;0.001</b>	-0.042	0.019	<b>0.03</b>
Male%	-12.080	2.682	<b>&lt;0.001</b>	-1.420	3.946	0.72
Beer tax	0.116	0.032	<b>&lt;0.001</b>	0.200	0.047	<b>&lt;0.001</b>
Marijuana law	-0.028	0.013	<b>0.03</b>	-0.060	0.019	<b>&lt;0.001</b>
Year	0.014	0.004	<b>&lt;0.001</b>	0.003	0.006	0.61
Methodological change indicator	0.149	0.012	<b>&lt;0.001</b>	0.266	0.018	<b>&lt;0.001</b>
Log of population	-0.368	0.132	<b>0.01</b>	-0.134	0.194	0.49
White %	2.702	0.386	<b>&lt;0.001</b>	2.552	0.568	<b>&lt;0.001</b>

P < 0.05 is presented in bold. Model adjusted economic trend index, the interaction between economic trend index and insurance coverage in addition to covariates in the baseline model 1.

Health and Retirement Study found that health insurance of male non-retirees was associated with a decrease in the probability of unhealthy drinking (Dong, 2013). Cotti et al. used the Nielsen Consumer Panel and found that ACA Medicaid expansion was not associated with ex-ante moral hazard in alcohol consumption (Cotti et al., 2019). Similar null findings were found in other studies evaluating the effects of ACA Medicaid expansion (Courtemanche et al., 2018; He et al., 2020; Simon et al., 2017).

Several possible factors may help explain the inconclusive association between health insurance coverage and drinking behaviors. According to ex-ante moral hazard theory, health insurance might increase the propensity for risk-taking behaviors. Another component that may complicate the relationship between health insurance coverage and drinking behaviors is adverse selection (i.e., individuals' self-select into having insurance that covers their unhealthy behaviors) (Wilson, 1989). Adverse selection poses more concerns in analysis using individual data; however, this study used aggregate state insurance data potentially less prone to individual self-selection. At the same time, socioeconomic characteristics, such as income, education, and employment, are likely associated with drinking behaviors and insurance status (Doiron et al., 2008). Future empirical studies should examine the intersection of insurance policies with moral hazard theory within the context of unintended consequences (Rivara et al., 2000; Schermer et al., 2003).

We found that the economic recession did not significantly moderate the relationship or lack of relationship between health insurance coverage and excessive drinking behaviors. One systematic review notes that economic crises can increase and decrease alcohol consumption, with the net impact unclear (de Goeij et al., 2015). The self-medication model of drinking suggests that alcohol is used to cope with psychological distress (de Goeij et al., 2015). In this model, the elevated stress, anxiety, and depression caused by economic recession would increase excessive alcohol consumption (de Goeij et al., 2015; Harhay et al., 2014). Theoretically, unemployment and reduced working load would also expand time availability for drinking and other activities, ultimately

increasing the risk of excessive drinking. Alternatively, tighter budget constraints might also contribute to reduced alcohol consumption during economic crises. A previous study estimated that around 880,000 U. S. adults stopped drinking because of the Great Recession (Bor et al., 2013). These effects can be offsetting, possibly explaining our no-effect finding.

This study had some limitations. The data source is a survey that relies on information reported by the participant and may, therefore, be subject to response error due to inaccurate recall or intentionally inaccurate reporting of events or experiences. While the study accounted for state fixed-effects, other time-variant state-level confounders may not be captured. However, we extended the baseline state fixed-effects model to capture state-specific time trends in Model 2. Lastly, while the analysis controlled for the BRFSS methodological change in 2011, it remains unclear to what extent it may have affected our main findings. Additionally, we obtained consistent findings in the restricted analyses that used data from 2001 to 2010.

## 5. Conclusion

This study used nationally representative survey data to assess the association between state insurance coverage and drinking behaviors among U.S. adults. Results show that aggregate state health insurance coverage appears unrelated to binge drinking and the lack of association during the economic recession. We obtained mixed findings for heavy drink rates, with no significant association found in analyses with state fixed-effects. In contrast, the model with state unique time trends yielded a significant association. Additional sensitivity analyses provided consistent findings. Overall, these findings, for the most part, do not support assertions that health insurance may lead to more problematic drinking.

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## CRedit authorship contribution statement

**Sunday Azagba:** Conceptualization, Methodology, Formal Writing, Formal analysis, Supervision, Funding acquisition. **Lingpeng Shan:** Formal analysis; Writing - review & editing. **Mark Wolfson:** Writing - review & editing. **Mark Hall:** Writing - review & editing. **Frank Chaloupka:** Writing - review & editing.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.pmedr.2021.101556>.

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