Published in final edited form as:

Drug Alcohol Rev. 2020 March ; 39(3): 255–266. doi:10.1111/dar.13041.

Association between state-level alcohol availability and taxation policies on the prevalence of alcohol-related harms to persons other than the drinker in the USA, 2000–2015

PAMELA J. TRANGENSTEIN [Associate Scientist], MEENAKSHI S. SUBBARAMAN [Biostatistician], THOMAS K. GREENFIELD [Scientific Director], NINA MULIA [Scientist], WILLIAM C. KERR [Senior Scientist], KATHERINE J. KARRIKER-JAFFE [Scientist]

Alcohol Research Group, Public Health Institute, Emeryville, USA

Abstract

Introduction and Aims.—Alcohol-related harms to others (AHTO) are consequences of alcohol use borne by persons other than the drinker. This study assessed whether the odds of experiencing AHTO are associated with alcohol availability and taxation policies.

Design and Methods.—This study pooled data from four waves of the National Alcohol Survey ($n = 20656$ adults). We measured past-year AHTO exposure using three binary variables: physical (pushed/hit/assaulted or property damage by someone who had been drinking), family or financial (family/marital problems or financial harms by someone who had been drinking) and driving AHTO (riding in a vehicle with a drink-driver or being in a drink-driving crash). Policies included bar and off-premise alcohol outlet density (separately), alcohol retail hours, beer and spirits taxes (separately) and monopoly on retail/wholesale alcohol purchases.

Results.—Monopolies were associated with 41.2% lower odds of physical harms [adjusted odds ratio (aOR) = 0.59, 95% confidence interval (CI) 0.45, 0.77, $q < 0.001$ correcting for multiple analyses], and a 10% increase in bar density was associated with a 1.2% increase in odds of driving-related harms ($e^{\ln(1.1) * \beta} = 1.01$, 95% CI 1.00, 1.02, $q = 0.03$). Among men, beer taxes were associated with lower odds of physical harms ($e^{\ln(1.1) * \beta} = 0.93$, 95% CI 0.88, 0.98 $q = 0.03$) and monopolies were associated with lower odds of physical (aOR = 0.45, 95% CI 0.35, 0.59, $q < 0.001$) and driving harms (aOR = 0.66, 95% CI 1.00, 1.02, $q = 0.03$).

Discussion and Conclusions.—Monopolies, taxes and outlet density are associated with odds of some AHTO. Future longitudinal research should test whether physical availability and taxation policies may be protective for bystanders as well as drinkers. [Trangenstein PJ, Subbaraman MS, Greenfield TK, Mulia N, Kerr WC, Karriker-Jaffe KJ. Association between state-level alcohol availability and taxation policies on the prevalence of alcohol-related harms to persons other than the drinker in the USA, 2000–2015.

Keywords

alcohol; alcohol policy; alcohol-related harms to others; alcohol tax; state monopoly

Introduction

Over the past decade, there has been an effort to expand the emphasis on the harms drinkers may inflict on persons around them. This focus on ‘secondhand’ harms will likely increase traditional estimates of the burden of alcohol on drinkers by adding a new dimension of harms. These harms borne by ‘others’ may be substantial because these harms are common [1–3] and have meaningful health-related consequences [4].

Alcohol-related harms to others (AHTO) are harms attributable to alcohol that occur in social behaviour, interactions or settings [5,6], and are caused by someone other than the victim. AHTO are diverse and include incidents such as being pushed, hit or assaulted; suffering a traffic crash; having one’s house, car or property vandalised; experiencing family problems; and experiencing financial trouble [7]. To date, the AHTO research establishes the prevalence, individual risk factors and mental health consequences for AHTO. Roughly 10% of the US population report AHTO in the past year [8,9], and persons harmed by drinkers in the past year also tend to report higher levels of depression [10,11] and distress [3] as well as lower personal wellbeing [12]. Women [2,12–17], young adults [8,14,16–20] and persons who belong to minority racial/ethnic groups [21,22] are more likely to report AHTO. These findings are all essential to understanding the role of AHTO in society.

However, problem definitions imply the types of solutions that are appropriate. From the perspective of an ecological model of health [23], in isolation, descriptions of the types of persons who experience AHTO will point primarily to individual-level interventions or targeting prevention strategies to high-risk populations. Even though the highest-risk drinkers cause the most harms per person, the majority of alcohol-related problems at the population level result from lower risk drinkers [24]. Consequently, effective solutions require population-wide strategies, and multi-level research designs are best able to inform multi-level strategies [25].

Given their ability to alter drinking patterns [25,26], alcohol policies are perhaps some of the most critical environmental determinants of AHTO [27,28]. There are three potential reasons why alcohol policies may influence the prevalence of AHTO: (i) reducing binge drinking prevalence would prevent intoxication-related AHTO; (ii) altering the types of alcohol consumed by drinkers may reduce AHTO associated with stronger alcohol; and (iii) changing the location of drinking and the ways that drinkers interact with others may impact the transmission of AHTO. A recent US analysis found that restrictiveness of the overall state-level alcohol policy environment was associated with the prevalence rate of some AHTO [28]. However, much remains unknown about the association between alcohol control policies and AHTO, including the specific policies that are most effective in reducing and preventing AHTO. Our study addresses this gap by examining associations between AHTO prevalence and physical availability and taxation policies. We use data from multiple cross-sectional waves of the National Alcohol Survey (NAS) to determine whether state physical availability (i.e. government monopolies, after 10 pm alcohol sales), state beer and spirits taxes, and ZIP code-level alcohol outlet density are associated with odds of self-reported AHTO in the USA.

Methods

Data sources

We combined NAS survey data with policy data from the National Institute on Alcohol Abuse and Alcoholism's Alcohol Policy Information System (APIS), the Prevention Research Center's Statewide Availability Data System [29], US Census Bureau Business Register, the National Alcoholic Beverage Control Association (NABCA) survey book and the Tax Foundation. Each of these data sources is described below.

National Alcohol Surveys.—We pooled data from the four administrations of the NAS: 2000 (N10, $n = 7612$), 2005 (N11, $n = 6919$), 2010 (N12, $n = 7969$) and 2015 (N13, $n = 7071$). The 2000 and 2005 NAS used a landline telephone-based sampling strategy, and the 2010 and 2015 versions used a dual-landline and cell phone sampling strategy. In each administration, the NAS over-sampled persons who are African American, Hispanic/Latino or from US states with low populations (the latter in all years except 2015). Weights were calculated to adjust for unequal selection probabilities, non-response and demographics (using respective epochs' Census data). Detailed information about the NAS methods is available elsewhere [30,31]. The analytic sample ($n = 20\,656$) included respondents with complete data on demographics, AHTO and policy measures. Table 1 summarises the demographics of the analytic sample.

Alcohol policy information system.—APIS is a federally maintained website that contains information about state- and federal-level alcohol policies in five domains, including alcohol beverage control and taxation and pricing. We obtained information about state monopoly of retail and wholesale alcohol sales and hours of alcohol retail sales for all years and state beer and spirits taxes from 2003 to 2015 from APIS.

NABCA survey book.—The NABCA survey book compiles operational and regulatory survey data from counties and states in control and license jurisdictions across the USA. It provides pricing data for control states that is unavailable in APIS. We derived tax estimate equivalents from control states using previously established methods [32].

Statewide Availability Data System.—Because APIS data does not contain tax information prior to 2003, we obtained information about alcohol taxes from 2000 to 2002 from the Prevention Research Center's Statewide Availability Data System [29]. This system is an archive of state-level data about alcohol availability, sales, use and consequences from 1933 to 2003.

US Census Bureau Business Register.—The US Census Bureau Business Register is an administrative data source on employer establishments reported in the ZIP Code Business Patterns datasets. We used data from 2000, 2005, 2010 and 2015. Previous research demonstrated these data were strongly correlated with official state licensing records [33].

Ethics

The institutional review board at the Public Health Institute approved the NAS, and all participants provided informed consent.

Measures

This analysis uses measures that are operationalised at several levels (i.e. individual, ZIP code, county, state and regional) (Figure 1), as described below.

Alcohol-related harms to others.—All AHTO items on the NAS used a 12-month recall period and were derived from earlier work [34,35]. We used six items to create three pairwise constructs following Karriker-Jaffe and Greenfield [36] and Greenfield *et al.* [28]: (i) *family or financial harms* (family/marriage problems and financial trouble from others' drinking); (ii) *physical harms* (being pushed, hit or assaulted and having one's house, car or property vandalised by someone who had been drinking); and (iii) *driving-related harms* (being in a motor vehicle crash due to another drinker and riding in a car with someone who had been drinking).

Alcohol policies.—Policies included ZIP code-level alcohol outlet density and state-level restrictions on late-night alcohol sales, alcohol taxes and monopolies on wholesale and retail alcohol sales.

Taxes—Tax data were from APIS and the Statewide Availability Data System, although we also incorporated data about spirits mark-ups in states with a monopoly using data from the NABCA survey book [32]. We calculated beer and spirits taxes by combining excise taxes and ad valorem excise taxes, which are a percentage of the beverages' retail price. We verified tax data against information from the Federation of Tax Administration. The final tax variables included total taxes by beverage type (separately for beer and spirits), and we transformed these using the natural log to adjust for skewness. We excluded wine taxes because beer and wine taxes tend to be collinear, and wine comprises less than 20% of the alcohol consumed in the USA [37]. We also considered restrictions on drink specials and wholesale pricing regulations but determined that these policies were unlikely to yield population-wide changes in consumption.

Monopoly on alcohol retail sales and wholesale—We obtained data from APIS on whether the state exercises monopoly control over retail or wholesale alcohol sales to create one binary (yes/no) variable based on the year of the survey. There were 18 control states in 2000 and 17 control states in 2015.

Alcohol retail hours—We used one binary variable for whether the state allows off-premise alcohol retail sales after 10 pm (yes/no) using data from APIS. There were 34 states that allowed alcohol sales after 10 pm in 2000 and 36 states that allowed these sales in 2015.

Alcohol outlet density—As a proxy for restrictions on alcohol outlet density, we included the number of businesses with a liquor license (i.e. alcohol outlets) in each participant's residential ZIP code. We focused on the types of alcohol outlets that have

the strongest associations with harms: bars and off-premise outlets [38–41]. Specifically, we calculated *off-premise alcohol outlet density* as the number of liquor and convenience stores that sell beer, wine and/or spirits per square mile. Convenience stores were only included in states that permit the sale of alcohol in this type of store. We calculated *on-premise outlet density* as the number of bars per square mile. We performed a natural log transformation on the alcohol outlet variables to adjust for skewness.

We considered whether state monopolies may modify or confound the association between alcohol outlet density and AHTO. We tested for and did not find any statistical interactions, and none of the inferences changed based on the combination of outlet density and/or monopoly variables included in the models. Therefore, we present models with all three availability policies simultaneously to examine associations with each specific policy.

Covariates.—Self-reported, individual-level covariates included *age* [categorical, 18–29 years (reference), 30–39 years, 40–49 years, 50–59 years and 60+ years], *gender* [male vs. female (reference)], *race/ethnicity* [White (reference) vs. African American, Hispanic/Latino and other racial/ethnic groups], *marital status* [not married (reference) vs. married or living with a partner] and *poverty status* [below federal poverty line (reference) vs. income 1–2 times the federal poverty line, and income >2 times the federal poverty line]. The AHTO literature finds that people who are younger, are not married or have low incomes tend to have higher odds of being harmed by drinkers [16,42–44], and the odds of AHTO differ by race/ethnicity [2,42,44]. In addition, women are more likely to be harmed by family or friends and to suffer family/financial harms or relationship harms than men [42]. Conversely, men are more likely to be harmed by strangers and to experience physical/aggression- or driving-related harms [42]. We included a binary (yes/no) indicator of whether respondents have a biological relative who is/was an alcoholic or lived with someone they classified as a ‘problem drinker’ when growing up, which is associated with higher odds of AHTO later in life [42,45].

We also adjusted for two environmental covariates: *county-level poverty* and *regional drinking*. We obtained the average proportion of persons below the federal poverty line in the county from the American Community Survey. The findings linking area-level economic disadvantage to AHTO are mixed [46–49], and suggest that the associations may differ by type of AHTO [46] or respondent demographics [49]. Area-level economic disadvantage also is related with alcohol availability [50,51] and abstinence [52]. *Regional drinking* is a covariate that classifies each state’s drinking culture as wet, moderate or dry based on national survey data on the prevalence of abstinence and 5+ drinking in the past month, as well as apparent per capita ethanol consumption (based on alcohol sales and tax data) [53]. North Central and New England were classified as wet, the Middle Atlantic, Pacific and South Coast were classified as moderate, and the South was classified as dry [53]. We adjusted for regional drinking because it is related to both policy implementation and drinking culture. We also considered using the state per capita alcohol consumption instead of regional drinking pattern, and the results did not change substantially.

Analysis

Approximately two-thirds (68.7%) of respondents provided their residential address. Study staff geocoded these addresses, and the ZIP code geometric centroid was used for the remaining participants. We then used these coordinates to link participants' data to area-level policies and covariates.

Our goal was to model the variability in three pairwise AHTO constructs across states using mixed models. We nested individuals within states; there was not sufficient clustering to warrant additional levels in the analyses. We fit models using random intercepts and fixed effects for all policies and covariates. These models predicted the odds of reporting the three types of AHTO associated with each policy after adjusting for individual-, county- and region-level covariates. After running the models for the entire analytic sample, we stratified by gender, because previous research demonstrates that men and women experience different types of AHTO [14,17]. We compared models that included and excluded the respondent's own alcohol consumption. The results were similar, so we presented models without the consumption variables because we hypothesised that drinking patterns could be a mediator based on extant literature [6].

We used a row-standardised adjacency matrix and Moran's Index to test for spatial dependence in the AHTO outcomes. We determined that when there was dependence, it was almost always negative. This typically results in slightly wider confidence intervals and, therefore, a bias toward the null hypothesis.

Finally, we applied a Benjamini-Hochberg-Simes multiple testing correction to minimise the odds of false positives associated with multiple comparisons [54]. This correction suppresses the type I error rate by ordering P -values from smallest to largest and ranking them. The method then calculates a critical value as $\left(\frac{i}{m}\right) * Q$ where i is the P -value rank, m is the total number of tests and Q is the false discovery rate (i.e. the expected proportion of all incorrectly rejected null hypotheses) [55]. The output of this correction is a corrected q -value in which all q -values that are equal to or smaller than the critical value are significant (in this instance, less than or equal to 0.05) [55].

Results

Sample description

The sample contained 20 656 adults (see Table 1). Roughly half (53.1%) were female and most (71.3%) were White, non-Hispanic/Latino. Approximately 1 in 20 participants reported experiencing each type of AHTO (5.0% physical harms, 4.6% family/marital harms and 5.0% driving-related harms). Men were more likely than women to report physical (6.2% vs. 3.9%, $\chi^2 = 80.54$, $P < 0.001$) and driving-related harms (5.9% vs. 4.2%, $\chi^2 = 43.86$, $P < 0.001$). Women were more likely than men to report family/financial harms (3.1% vs. 5.9%, $\chi^2 = 126.50$, $P < 0.001$).

Alcohol availability and policy trends

Across all years, the average taxes per drink of spirits (20.5¢) was roughly twice the average taxes per beer (9.4¢, see Table 2). From 2000 to 2015, the taxes paid per drink fell for both spirits (22.9¢ to 18.4¢, $F = 1358.8$, $P < 0.001$) and beer (10.8¢ to 8.0¢, $F = 882.0$, $P < 0.001$). The average ZIP code had 0.62 bars and 1.18 liquor/convenience stores per square mile. About two out of every three participants were from a state that allowed off-premise alcohol sales after 10 pm (63.2%), and one in every three participants (30.7%) resided in a state with a monopoly on alcohol wholesale or retail sales.

Association between alcohol availability/policy and AHTO

The results of the regressions are summarised in Table 3. Participants from ZIP codes with a 10% higher bar density had 1.2% higher odds of driving-related harms [$e^{\ln(1.1)} * \beta = 1.012$, 95% confidence interval (CI) 1.000, 1.021, $q = 0.01$] after adjusting for the other policies and covariates. As compared to persons who lived in a license state, persons who lived in a state with a monopoly over alcohol wholesale or retail sales had 41.2% lower odds of physical harms (adjusted odds ratio 0.59, 95% CI 0.45, 0.77, $q < 0.001$). There was no association between family/financial AHTO and alcohol availability policies.

Association between alcohol availability/policy and AHTO by gender

Table 4 summarises the regression results for past-year AHTO stratified by gender. As compared to men who lived in states with privatised alcohol, men who lived in a state with a retail or wholesale monopoly had 55.5% lower odds of being harmed physically (adjusted odds ratio 0.45, 95% CI 0.35, 0.59, $q < 0.001$) and 34.3% lower odds of driving-related harms (adjusted odds ratio 0.66, 95% CI 0.49, 0.88, $q < 0.01$) by someone who had been drinking. In addition, a 10% increase in the state beer tax was associated with a 7.4% lower odds of experiencing physical harms for men ($e^{\ln(1.1)} * \beta = 0.93$, 95% CI 0.88, 0.98, $q = 0.03$). There were no associations for women.

Discussion

This study found that ZIP code and state-level alcohol control policies were related to the odds of being harmed by others' drinking for some harms and particularly among men. Among the policy variables, state monopolies had the strongest cross-sectional association with AHTO prevalence; they were associated with lower odds of physical AHTO in the full sample and physical and driving-related AHTO among men. Higher beer taxes were also associated with lower odds of physical AHTO among men.

In isolation, our results cannot comment on whether alcohol policies shape the odds of AHTO or whether states with lower odds of AHTO enact stricter policies (or whether both processes occur), because it used a cross-sectional design. However, our results are largely consistent with a recent longitudinal analysis conducted by Greenfield *et al.* [28]. Their analysis used alcohol policy scores (APS) to test associations between summary scores describing a state's different alcohol policies and the same three pairwise AHTO constructs in a sample that pooled data from both the NAS and the National Alcohol's Harms to Others Survey [28]. They found that more restrictive impaired driving APSs (i.e. a measure of 10

drink-driving policies) were associated with lower odds of driving-related harms in the full sample [28]. In addition, more restrictive binge drinking APSs (i.e. a measure of 29 alcohol control policies) and impaired driving APSs were associated with lower odds of physical and driving-related harms for persons under age 40 [28].

When compared to our analysis, the APSs are more statistically efficient estimators and measure the simultaneous, synergistic effects of up to five types of alcohol policies (i.e. physical availability, underage drinking drink-driving, social host or dram shop and price). However, these composite measures are unable to identify the specific policy(ies) that drove any associations. Our findings are complementary to and extend the prior results by investigating whether physical availability and/or taxes could be important policies driving these associations.

State monopolies and beer taxes emerged as having the strongest associations with AHTO among the six policies we considered. The extant literature confirms that government monopolies are effective strategies to reduce population-level consumption [25]. Assuming that beverages with higher alcohol content carry greater risk, US monopolies often restrict physical and economic availability of spirits through government-operated retail stores and/or mark-ups. As the recent privatisation in Washington state demonstrated, these two types of policies can interact to shape how people drink; when Washington state increased the price of spirits, drinkers substituted with lower price or lower quality products [56]. This may be why beer, but not spirits, taxes emerged in our analysis; after raising the price of beer, there were no lower-cost alternatives to which drinkers could switch [57].

When considering these findings in the context of the extant literature, our results suggest that the association between state monopolies and physical and drink-driving AHTO may be mediated by patterns of spirits consumption. Conversely, there could also be an unmeasured confounder that is associated with population characteristics that lead states to have lower prevalence rates of AHTO and adopt more restrictive policies like a control state framework and higher beer taxes. Future longitudinal research is needed to test these hypotheses.

A large literature consistently shows that outlet density is associated with physical AHTO, such as violent crime [41,58] and child abuse [59], as well as alcohol-involved motor vehicle crashes [60–62]. Our analysis detected associations between bar density and driving-related harms. When viewed in concert with findings from the alcohol outlet density literature, it suggests that these policies may influence odds of AHTO by altering how drinkers interact [17]. For example, bars may lure drinking drivers to social locations away from their homes, and they may harm others along the way. However, we measured outlet density using counts of alcohol outlets in an area, which can introduce measurement error [63]. These results should be interpreted with caution, and we encourage future research with more robust designs in this area.

This analysis has several additional limitations. Participants made their own attribution as to whether experienced harms were attributable with others' drinking. It is possible that the harms were reported that were not attributable to alcohol, but also that some alcohol-attributable harms were not reported. The types of AHTO included in our analysis tend to be

more commonly reported among males, and we did not include types of AHTO that females are more likely to report such as psychological [64] and sexual harms [2]. Therefore, the lack of reported associations among women may be an artefact of the harms that we assessed. In addition, even after pooling four waves of data, our sample only included an average of roughly 400 participants per state and there was slight residual negative spatial dependence in the AHTO variables. This means we could have been underpowered to detect differences and our confidence intervals could have been too wide; both of these bias our analyses toward the null. We also note that beer tax evaluations are sensitive to the inclusion of state fixed effects [65–67], and we did not have sufficient sample sizes to include such effects. We did, however, adjust for other regional and county-level variables to account for place-based variation.

Conclusions

There is a large literature that establishes that specific policies are associated with certain AHTO (such as child abuse and drink-driving), and this analysis extended those efforts using the more generalised approach of the revived AHTO field to assess associations between a variety of population-level AHTO and alcohol control policies. Despite the limitations, many findings are consistent with the larger literature and these analyses generated a range of potential directions for future research. We encourage future inquiry along these lines because history demonstrates that weaving AHTO into narratives that define public health problems has a unique power to justify a need for policy change. A prime example is the way Mothers against Drunk Driving framed the *National Minimum Drinking Age Act* as protecting potential future victims from alcohol-impaired drivers [68] and help to pass over 400 policies from 1984–1986 [69].

Acknowledgements

The authors would like to thank Deidre Patterson and Edwina Williams for their work on alcohol taxes, geo-coding and data linkages. This work was supported by the National Institutes of Health's National Institute on Alcohol Abuse and Alcoholism (grants R01AA00 22791, TKG and KJK-J, multiple PIs and P50AA00 5595, WCK, PI). PJT was also supported by Award Number T32AA007240, Graduate Research Training in Alcohol Problems: Alcohol-related Disparities (S. Zemore, PI) funded by the National Institute on Alcohol Abuse and Alcoholism. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institute on Alcohol Abuse and Alcoholism or the National Institutes of Health, which played no role in data collection, data analysis, writing the manuscript or the decision to submit the manuscript for publication.

Conflict of Interest

This work was supported by NIAAA (grants R01AA0022791, P50AA005595 and T32AA007240). PJT, MSS, WCK and TKG have received support for contracts and/or travel from the National Alcohol Beverage Control Association.

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Figure 1. Summary of the measures used in the analysis and their respective levels and data source(s). ACS, American Community Survey; AHTO, alcohol-related harms to others; APIS, Alcohol Policy Information System; NAS, National Alcohol Survey. ^aKerr [53]. ^bTax data are from the Alcohol Policy Information System, Statewide Availability Data System, and the NABCA Survey Book. ^cUS Census Bureau Business Register.

Description of the National Alcohol Survey analytic sample, overall and by those affirming 12-month alcohol-related harms to others: USA 2000–2015

Table 1.

	Total (n = 20 656)	Physical harms ^a		Family or financial problems ^b		Driving-related harms ^c	
		Yes (n = 933)	P-value	Yes (n = 849)	P-value	Yes (n = 920)	P-value
<i>Sex</i>							
Women	12 091 (53.1%)	420 (3.9%)	<0.001	591 (5.9%)	<0.001	441 (4.2%)	<0.001
Men	8555 (46.9%)	513 (6.2%)		258 (3.1%)		479 (5.9%)	
<i>Age, years</i>							
18–29	3123 (19.0%)	371 (11.4%)	<0.001	199 (6.5%)	<0.001	378 (11.8%)	<0.001
30–39	3473 (19.1%)	193 (5.7%)		192 (5.8%)		187 (5.7%)	
40–49	3832 (19.6%)	172 (4.6%)		186 (5.2%)		164 (4.5%)	
50–59	3790 (17.7%)	125 (3.1%)		170 (4.6%)		112 (2.7%)	
60+	6428 (24.7%)	72 (1.2%)		102 (1.8%)		79 (1.1%)	
<i>Race/ethnicity</i>							
White	11 787 (71.3%)	461 (4.3%)	<0.001	502 (4.7%)	0.67	479 (4.4%)	<0.01
Black	4304 (11.5%)	207 (6.4%)		143 (3.9%)		198 (6.8%)	
Hispanic/Latino	4117 (13.6%)	243 (7.3%)		188 (4.8%)		223 (6.2%)	
Others/missing	438 (3.5%)	22 (5.7%)		16 (4.4%)		20 (5.5%)	
<i>Marital status</i>							
Single or never married	9783 (38.9%)	515 (6.9%)	<0.001	352 (4.7%)	0.58	528 (7.0%)	<0.001
Married/cohabitating	10 863 (61.1%)	418 (3.7%)		497 (4.5%)		392 (3.7%)	
<i>Poverty status</i>							
Below federal poverty line	2998 (12.0%)	232 (9.0%)	<0.001	193 (7.9%)	<0.001	178 (6.9%)	<0.001
1–2x federal poverty line	3341 (15.7%)	178 (6.1%)		145 (4.8%)		164 (5.1%)	
>2x federal poverty line	10 833 (56.7%)	413 (4.2%)		419 (4.3%)		481 (5.0%)	
Missing	3474 (15.6%)	110 (3.7%)		92 (2.9%)		97 (3.4%)	
<i>Family history of alcohol problems</i>							
No	10 002 (47.5%)	303 (3.3%)	<0.001	205 (2.2%)	<0.001	295 (3.4%)	<0.001
Yes	10 644 (52.5%)	630 (6.5%)		644 (6.8%)		625 (6.4%)	
<i>Regional drinking</i>							
Wet	5087 (26.8%)	234 (5.1%)	0.50	213 (4.6%)	0.78	245 (5.2%)	0.63

	Physical harms ^a		Family or financial problems ^b		Driving-related harms ^c	
	Total (n = 20 656)	Yes (n = 933)	P-value	Yes (n = 849)	P-value	Yes (n = 920)
Moderate	11 352 (51.1%)	527 (5.1%)		455 (4.5%)		508 (5.0%)
Dry	4207 (22.2%)	172 (4.5%)		181 (4.9%)		167 (4.6%)
<i>High-poverty county^d</i>						
No	19 348 (96.2%)	873 (6.0%)	0.67	802 (4.6%)	0.27	871 (5.0%)
Yes	1298 (3.8%)	60 (5.4%)		47 (3.7%)		49 (4.6%)

^aPhysical harms include being pushed, hit or shoved and/or property damage by someone else who had been drinking in the past 12 months.

^bFamily or financial harms include suffering family/marital problems or financial harms from someone else's drinking in the past 12 months.

^cDriving-related harms include riding with a drink-driver or being in a traffic crash caused by someone else's drinking in the past 12 months.

^dHigh-poverty county defined as a county with more than 15% of households living below the federal poverty line.

Table 2.

Alcohol availability and policies by year

	Year			
	2000	2005	2010	2015
<i>ZIP-code level availability, mean (SD)</i>				
Bar density ^a	0.66 (0.03)	0.69 (0.12)	0.52 (0.04)	0.63 (0.06)
Off-premise density ^b	1.07 (0.03)	1.37 (0.07)	1.05 (0.04)	1.35 (0.05)
<i>State-level availability policy, percent</i>				
After 10 pm off-premise sales ^c	60.8%	66.8%	63.8%	64.5%
<i>State-level policies, mean (SD)</i>				
Spirits taxes ^d	22.9¢ (<0.1¢)	20.8¢ (0.1¢)	19.3¢ (0.1¢)	18.4¢ (0.1¢)
Beer taxes ^e	10.8¢ (<0.1¢)	9.7¢ (0.1¢)	8.7¢ (0.1¢)	8.0¢ (0.1¢)
Monopoly on retail or wholesales ^f	34.3%	31.2%	28.0%	28.4%

^aThe number of bars per square mile.^bThe number of liquor and convenience stores that sell beer, wine and/or spirits per square mile. Convenience stores were only included in states where alcohol could be sold in convenience stores.^cBinary indicator for whether the state allows off-premise alcohol retail sales after 10 pm.^dTotal state taxes on beer, which includes specific excise taxes and ad valorem excise taxes (taxes based on the price of alcoholic beverages).^eTotal state taxes on spirits, which includes specific excise taxes, ad valorem excise taxes (taxes based on the price of alcoholic beverages), and mark-ups in states with a monopoly control on retail alcohol sales.^fWhether the state exercises monopoly control over retail or wholesale alcohol sales within its borders.

Table 3.

Overall logistic regression results for association between alcohol availability/policies and alcohol-related harms to others, $n = 20\,656$ (bold font indicates q -value < 0.05)

	Physical harms			Family or financial harms			Driving-related harms		
	aOR	95% CI	q -Value ^d	aOR	95% CI	q -Value ^d	aOR	95% CI	q -Value ^d
Policies									
<i>ZIP code level</i>									
Bar density ^b	1.00	0.99, 1.02	0.566	1.00	0.99, 1.01	0.791	1.01	1.00, 1.02	0.029
Off-premise density ^c	0.99	0.97, 1.00	0.175	0.99	0.98, 1.01	0.696	0.99	0.98, 1.00	0.329
<i>State level</i>									
After 10 pm off-premise sales ^d	0.76	0.60, 0.97	0.054	1.02	0.85, 1.23	0.825	0.89	0.72, 1.11	0.457
Spirits taxes ^e	0.99	0.94, 1.04	0.803	1.04	0.98, 1.10	0.533	0.98	0.94, 1.04	0.685
Beer taxes ^f	0.94	0.89, 0.99	0.054	0.99	0.95, 1.04	0.805	1.00	0.93, 1.07	0.974
State monopoly ^g	0.59	0.45, 0.77	<0.001	0.95	0.72, 1.26	0.805	0.83	0.64, 1.06	0.329
Covariates									
<i>Individual level</i>									
Gender									
Female	(ref)			(ref)			(ref)		
Male	1.30	1.00, 1.30	<0.001	0.44	1.00, 0.44	<0.001	1.19	1.00, 1.19	0.001
Age									
<30 years	(ref)			(ref)			(ref)		
30–39 years	0.58	0.45, 0.76	<0.001	0.84	0.62, 1.15	0.533	0.51	0.38, 0.68	<0.001
40–49 years	0.49	0.35, 0.68	<0.001	0.67	0.49, 0.92	0.050	0.38	0.27, 0.53	<0.001
50–59 years	0.30	0.23, 0.40	<0.001	0.64	0.46, 0.88	0.029	0.24	0.18, 0.34	<0.001
60+ years	0.13	0.09, 0.18	<0.001	0.25	0.17, 0.38	<0.001	0.09	0.06, 0.15	<0.001
Race/ethnicity									
White	(ref)			(ref)			(ref)		
Black	1.23	0.92, 1.62	0.231	0.72	0.52, 0.99	0.129	1.12	0.87, 1.45	0.517
Hispanic	1.24	0.90, 1.72	0.249	0.87	0.67, 1.12	0.533	0.93	0.71, 1.21	0.685

	Physical harms			Family or financial harms			Driving-related harms		
	aOR	95% CI	q-Value ^a	aOR	95% CI	q-Value ^a	aOR	95% CI	q-Value ^a
Other/missing	1.23	0.64, 2.34	0.624	0.78	0.28, 2.14	0.791	1.10	0.52, 2.32	0.899
Marital status									
Single/never married	(ref)			(ref)			(ref)		
Married/cohabitating	0.62	0.53, 0.73	<0.001	0.94	0.70, 1.26	0.791	0.68	0.52, 0.89	0.015
Family history of alcohol problems									
No	(ref)			(ref)			(ref)		
Yes	1.91	1.52, 2.39	<0.001	3.11	2.29, 4.22	<0.001	2.04	1.68, 2.48	<0.001
Census tract level									
Poverty status									
Below poverty level	(ref)			(ref)			(ref)		
1–2x above poverty	0.82	0.61, 1.09	0.249	0.74	0.50, 1.09	0.339	0.82	0.59, 1.15	0.408
>2x above poverty	0.59	0.42, 0.81	0.003	0.67	0.50, 0.90	0.032	0.84	0.63, 1.14	0.408
Missing	0.55	0.38, 0.78	0.003	0.52	0.37, 0.74	0.002	0.62	0.43, 0.90	0.030
County level									
High-poverty county	(ref)			(ref)			(ref)		
No	1.04	0.62, 1.73	0.950	0.81	0.52, 1.27	0.571	0.81	0.42, 1.55	0.685
Yes									
Regional level									
Regional drinking									
Dry	(ref)			(ref)			(ref)		
Moderate	1.01	0.77, 1.34	0.950	1.11	0.90, 1.36	0.533	0.99	0.78, 1.25	0.952
Wet	1.23	0.84, 1.80	0.367	1.17	0.86, 1.58	0.533	1.02	0.76, 1.35	0.952

^a Adjusted probability score using a Benjamini-Hochberg-Simes false discovery rate correction.

^b The number of bars per square mile. Variable transformed using the natural logarithm; aORs provided assume a 10% increase in outlet density and are calculated as $e^{\ln(1.1) * \beta}$.

^c The number of liquor and convenience stores that sell beer, wine and/or spirits per square mile. Convenience stores were only included in states where alcohol could be sold in convenience stores. Variable transformed using the natural logarithm; aORs provided assume a 10% increase in outlet density and are calculated as $e^{\ln(1.1) * \beta}$.

^d Binary indicator for whether the state allows off-premise alcohol retail sales after 10 pm.

^e Total state taxes on beer, which includes specific excise taxes and ad valorem excise taxes (taxes based on the price of alcoholic beverages). Variable transformed using the natural logarithm; aORs provided assume a 10% increase in taxes and are calculated as $e^{\ln(1.1) * \beta}$.

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Total state taxes on spirits, which includes specific excise taxes, ad valorem excise taxes (taxes based on the price of alcoholic beverages) and mark-ups in states with a monopoly control on retail alcohol sales. Variable transformed using the natural logarithm; aORs provided assume a 10% increase in taxes and are calculated as $e^{\ln(1.1) * \beta}$.
Whether the state exercises monopoly control over retail or wholesale alcohol sales within its borders. aOR, adjusted odds ratio; CI, confidence interval; ref., reference group.

Logistic regression results for association between alcohol availability/policies and past-year alcohol-related harms to others stratified by gender (bold font indicates q -value<0.05)

Table 4.

	Physical harms			Family or financial harms			Driving-related harms		
	aOR	95% CI	q -Value ^a	aOR	95% CI	q -Value ^a	aOR	95% CI	q -Value ^a
Men (n = 8555)^b									
<i>ZIP code level</i>									
Bar density ^c	1.00	0.99, 1.02	0.686	0.99	0.98, 1.02	0.960	1.01	0.99, 1.02	0.160
Off-premise density ^d	0.99	0.97, 1.01	0.408	0.99	0.98, 1.02	0.960	0.99	0.98, 1.01	0.294
<i>State level</i>									
After 10 pm off-premise sales ^e	0.84	0.66, 1.05	0.244	1.18	0.73, 1.88	0.809	0.81	0.61, 1.07	0.145
Spirits taxes ^f	0.99	0.93, 1.07	0.979	1.08	1.00, 1.16	0.160	0.98	0.92, 1.04	0.534
Beer taxes ^g	0.93	0.88, 0.98	0.029	0.93	0.84, 1.03	0.327	1.05	0.95, 1.16	0.376
State monopoly on retail or wholesales ^h	0.45	0.35, 0.59	<0.001	1.07	0.64, 1.79	0.935	0.66	0.49, 0.88	0.005
Women (n = 12 091)^b									
<i>ZIP code level</i>									
Bar density ^c	1.01	0.99, 1.02	0.572	1.00	0.99, 1.01	0.849	1.01	1.00, 1.03	0.070
Off-premise density ^d	0.98	0.97, 1.00	0.190	0.99	0.98, 1.01	0.806	0.99	0.98, 1.01	0.654
<i>State level</i>									
After 10 pm off-premise sales ^e	0.65	-0.39, 1.02	0.197	0.94	0.73, 1.23	0.891	0.96	0.67, 1.38	0.869
Spirits taxes ^f	0.97	0.88, 1.08	0.703	1.00	0.94, 1.07	0.957	0.99	0.94, 1.04	0.778
Beer taxes ^g	0.96	0.87, 1.06	0.572	1.02	0.97, 1.07	0.806	0.94	0.87, 1.02	0.334
State monopoly on retail or wholesales ^h	0.85	0.48, 1.48	0.703	0.88	0.61, 1.26	0.806	1.08	0.74, 1.57	0.778

Note: Adjusted for individual-level demographics, including age, race/ethnicity (White, Black, Hispanic and other/missing), marital status (single/never married, married/cohabitating) and family history of alcohol problems. Also adjusted for census tract-level (below poverty level, 1–2x above poverty, >2x above poverty, missing) and county-level poverty status. At the regional level, adjusted for drinking pattern (wet, dry and moderate).

^a Adjusted probability score using a Benjamini-Hochberg-Simes false discovery rate correction.

b Unadjusted percentage of men and women in the sample. Note this value differs from Table 1, which reports adjusted percentages.

c The number of bars per square mile. Variable transformed using the natural logarithm; aORs provided assume a 10% increase in outlet density and are calculated as $e^{\ln(1.1) * \beta}$.

d The number of liquor and convenience stores that sell beer, wine, and/or spirits per square mile. Convenience stores were only included in states where alcohol could be sold in convenience stores. Variable transformed using the natural logarithm; aORs provided assume a 10% increase in outlet density and are calculated as $e^{\ln(1.1) * \beta}$.

e Binary indicator for whether the state allows off-premise alcohol retail sales after 10 pm.

f Total state taxes on beer, which include specific excise taxes and ad valorem excise taxes (taxes based on the price of alcoholic beverages). Variable transformed using the natural logarithm; aORs provided assume a 10% increase in taxes and are calculated as $e^{\ln(1.1) * \beta}$.

g Total state taxes on spirits, which include specific excise taxes, ad valorem excise taxes (taxes based on the price of alcoholic beverages), and mark-ups in states with a monopoly control on retail alcohol sales. Variable transformed using the natural logarithm; aORs provided assume a 10% increase in taxes and are calculated as $e^{\ln(1.1) * \beta}$.

h Whether the state exercises monopoly control over retail or wholesale alcohol sales within its borders. aOR, adjusted odds ratio; CI, confidence interval; ref., reference group.