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Estimating mental health impacts of alcohol's harms from other drinkers: Using propensity scoring methods with national cross-sectional data from the U.S

Katherine J. Karriker-Jaffe, PhD, Libo Li, PhD, and Thomas K. Greenfield, PhD

Alcohol Research Group, Public Health Institute, Emeryville, CA, USA

Abstract

Background & Aims—Alcohol's harms to others (AHTO) may cause substantial distress, particularly when harms are perpetrated by close others. One challenge to identifying causal impacts is that people harmed by drinkers differ in many ways from those not so harmed, so our aim was to assess mental health in relation to two serious types of AHTO, financial harm and assault by someone who had been drinking, using propensity score (PS) weighting to adjust for potentially confounding differences.

Design—Cross-sectional, nationally-representative, random sample of adults.

Setting—United States (U.S.).

Participants—76 respondents reporting financial harm compared to 4,625 with no past-year AHTO; 192 respondents reporting assault compared with 4,623 with no past-year AHTO.

Measurements—Predictors were reported exposure to financial problems due to someone's drinking and assault by someone who had been drinking. Mental health outcomes were quality of life, distress and positive affect. Confounders included family history of alcohol problems, child physical/sexual abuse, substance use/dependence, impacts of recent economic recession, racial/ethnic discrimination, poverty, and other demographics.

Results—In double-robust PS weighted models, for financial harm, there were associations with reduced quality of life ($B=-0.28$, $p=.02$) and increased distress ($aOR=4.69$, $p<.001$), and for assault by a partner or family member, there were associations with increased distress ($aOR=2.23$, $p=.09$). For assault by a friend or stranger, none of the associations were statistically significant after PS weighting (all $p>.10$).

Conclusions—Financial troubles due to someone else's drinking and assaults perpetrated by drinking intimates (spouses, other partners or family members) were associated with poor mental health.

Corresponding Author: Katherine Karriker-Jaffe, Alcohol Research Group, Public Health Institute, 6001 Shellmound Street, Suite 450, Emeryville, CA 94608-1010 USA, kkarrikerjaffe@arg.org, Phone: +1 (510) 898-5846, Fax: +1 (510) 985-6459.

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Keywords

alcohol's harms to others; mental health; propensity scoring; surveys; cross-sectional

There is a growing interest in the myriad ways heavy drinkers can harm other people, including partners, friends and members of society at large [1]. Collectively, these effects of heavy drinking are referred to as alcohol's harm to others (hereafter, AHTO) or second-hand effects of alcohol [2]. In the United States (U.S.), prevalence of lifetime harms ranges from approximately 7% for financial harms to 28% for assault by someone who had been drinking [3], with past-year prevalence markedly lower (1–2% and 3–4%, respectively) [3] but quite stable over time [4]. Quantifying mental health and quality of life of those affected by others' drinking has garnered recent attention in the U.S. [4–6], Australia [7, 8] and New Zealand [9, 10]. One important limitation of prior work in this area is that many possible confounders have been ignored when assessing mental health impacts of AHTO. To address this limitation, we utilize propensity scoring (PS) methods to examine mental health in relation to two types of alcohol-related harms—financial harm and assault—reported by a population-representative sample of U.S. adults.

Background

Both clinical experience and cross-sectional general population data suggest experiencing severe harms from other drinkers may be associated with worse mental health [7–15]. One recent study using the 2010 U.S. National Alcohol Survey (NAS) [6] showed four harms from other drinkers—family/marriage difficulties; financial troubles; being pushed, hit or assaulted; having property vandalized—each showed a strong, independent association with depression and distress. A later analysis of the 2015 NAS [5] found harms incurred due to the drinking of known others—that is, a partner/spouse, family member or friend—were associated with recent depression or anxiety, but harms due to a stranger's drinking were not.

Those harmed by other drinkers may differ in many ways from those not so harmed. For example, people who are heavy drinkers [6] and those with parents or other relatives with alcohol use disorders [5] are more likely to report AHTO as adults. To date, most analyses of mental health impacts of AHTO have accounted for only a few possible confounders. For example, Ferris et al. [8] only included key demographic covariates (sex, age, partnership status, employment status, education) and the respondent's own drinking, and Livingston et al. [15] and Casswell et al. [9] included similar covariates. Our own work, while including more possible confounders, is no exception to this critique: Greenfield et al. [6] included key demographics (sex, race/ethnicity, age, marital status, poverty, employment status, education), the respondent's own drinking (12-month volume, past-year maximum), and family history of alcohol problems; Karriker-Jaffe et al. [5] included a similar set of covariates. In addition to these important constructs, the most recent NAS contains detailed information about many possible confounders that may be related to both AHTO and mental health, including whether someone has a history of child and/or adult physical and/or sexual abuse [13, 16], the respondent's own substance use and dependence, impacts of the recent

economic recession (which may be particularly relevant to occurrence [4] and effects of financial troubles due to someone else's drinking), and experiences of racial/ethnic discrimination (which could be relevant to assault by someone who has been drinking, although no known studies have addressed this issue).

To begin to address this limitation of the extant literature, in the current study, we use data from the 2015 NAS to re-examine two serious AHTO previously shown to be associated with mental health. As this is one of the first studies to apply PS methods to this research question, we focused on financial troubles and assault given the severity of these types of harms and our prior work showing associations of each with recent distress [6]. The present analyses included preliminary regression models adjusting for a broad range of possible confounders, as well as a set of models applying PS weights estimated using generalized boosted models (GBM) to balance a wider range of possible confounders across groups, thereby creating a situation in which those harmed by others' drinking are statistically similar to a weighted sample of those who are not so harmed in order to isolate the association between reported exposure to AHTO and potential mental health outcomes [17–19]. Thus, study aims were to extend prior research by using the GBM-based PS approach to:

1. Estimate associations between financial troubles due to someone else's drinking with mental health (respondents' self-reported quality of life, distress, and positive affect), and
2. Estimate associations between assault and/or physical harm caused by someone who had been drinking with respondents' mental health.

Based on prior research, we expected financial troubles caused by known heavy drinkers to have a stronger relationship with mental health than assault. We disaggregated the cases of assault to analyze separately those perpetrated by drinking intimates (partner/spouse or family member; 40% of those reporting assault/physical harm) and by drinking others (friend/coworker or stranger; 60%). Based on prior studies [5, 8], we expected the former would be more distressing than the latter.

Methods

Dataset

We used data from the 2014–15 National Alcohol Survey, which utilized computer-assisted telephone interviews conducted with a representative sample of U.S. residents ages 18 years and older who were either English- or Spanish-speaking. The sampling design included random-digit-dialed samples of adults reached by landline and cellular telephones, as well as geographically-targeted oversamples of Black/African American and Hispanic/Latino (hereafter, Black and Hispanic, respectively) adults. Further survey details are provided elsewhere [5]. The Institutional Review Boards of the Public Health Institute, Oakland, CA and the fieldwork agency, ICF, Inc., Fairfax, VA approved study protocols. Cooperation rates for respondents confirmed to be eligible (COOP4) were 52.0% for the cell phone and 38.7% for the landline subsamples, with response rates (RR4) of 27.3% and 16.1%, respectively [20]. Data from groups of randomly-selected phone numbers, including complete interviews

as well as refusals and other non-participants, showed no association between groups' survey completion rates and prevalence of past-year drinking [5]. Among those who started the interview, respondents who completed the interview (n=5,632) were less likely to be Black and more likely to be college-educated, high-income and/or from a family with a history of alcohol problems than respondents who did not complete it (n=991). There were no differences in completion by gender, age, past-year drinking or past-year AHTO (any vs. none). The current analysis includes all respondents with data on AHTO and mental health (N=5,619).

Measures

Predictor group classification—The key predictors were (a) having “financial trouble due to someone else’s drinking” in the past year and (b) being “pushed, hit or assaulted by someone who had been drinking” and/or being “physically harmed by someone who had been drinking” (asked separately) in the past year. We assessed the perpetrator of each type of harm, including (a) intimate perpetrators (spouses, boyfriends/girlfriends and family members including parents, siblings, children, other relatives) and (b) friends, coworkers and strangers. Almost all respondents who reported financial harms indicated these were caused by a drinking partner/spouse (62%) and/or family member (32%). Assaults were most commonly attributed to strangers, and physical harm was most commonly attributed to drinking spouses and/or strangers. Under half (42.7%) of the respondents reporting assault reported physical harm, and most (77.6%) respondents reporting physical harm also reported assault.

Analyses involved comparisons of 76 respondents reporting financial troubles due to someone else’s drinking in the past year or of 192 respondents reporting assault/physical harm by someone who had been drinking with those respondents reporting no harm due to someone else’s drinking in the past year (n=4,625 for financial harm; 4,623 for assault). We excluded cases who reported experiencing some other type of AHTO in the past year (n=918 for financial harm; 804 for assault); this heterogeneous group included people reporting harms such as property damage/vandalism, traffic accidents or feeling threatened/afraid of someone who had been drinking [5].

Outcomes—Quality of life was a single-item measure (“how would you rate your quality of life?”) summarizing respondents’ subjective wellness and life satisfaction in general [21]. This item showed good construct validity in a sample of people affected by substance abuse disorders [21]. Response options were excellent, very good, good, fair, and poor. The most frequent response (32.9%) was “very good”, with 14.2% of respondents reporting either fair or poor quality of life. High scores (range 1–5) indicated better quality of life.

Distress was measured using a 4-item screener [PHQ-4; 22] including two questions assessing core diagnostic criteria for depressive disorders, and two questions assessing core criteria for generalized anxiety disorder [23]. We classified respondents as positive for depression and/or anxiety (vs. negative for both). A small group (4.8%) screened above clinical guidelines for distress (2.5% with depression, 3.3% with anxiety) in the past two weeks. Distress is negatively associated with, but distinct from, quality of life [21].

Positive affect was based on two items from the CES-D scale [24]. The questions assess how often respondents “felt happy” and “enjoyed life” in the past two weeks. Response options ranged from not at all to nearly every day. Scores were averaged (range 1–4); higher scores indicated greater positive affect ($M=3.54$; $SD=0.8$). Positive affect is associated with resilience and use of adaptive coping strategies in response to stress [25, 26].

Possible confounders—See Tables 1 and 2 for a list of all possible confounders, including response categories for each. Demographic variables included age, sex, race/ethnicity, marital status, employment status, education, annual household income, people living in household, number of minor children, poverty status, housing situation, how severely household was affected by 2008–10 recession, and sexual orientation.

Substance use variables were past-year drinking maximum; frequency of drunkenness in past year; past-year count of DSM-5 symptoms of alcohol use disorder (AUD; range 0–11) [27]; whether respondent has been to alcohol/drug treatment or is in recovery; frequency of marijuana, other drug and tobacco use in the past year; and past-year count of drug problems (range 0–3) [28].

Early-life living situation and adverse experiences included family history of alcohol problems, family structure during childhood, mother’s highest level of education, physical and sexual abuse during childhood [29], and physical and sexual abuse since age 18 [29, 30].

Other possible confounders were frequency of racial/ethnic discrimination [31] (never, once, 2–3 times, 4+ times); average score on 3-item scale of racial stigma consciousness (range 1–4; higher scores indicate greater perceived stigma) [32]; score on 4-item impulsivity/sensation-seeking scale (range 1–4; higher scores indicate greater impulsivity) [33]; body mass index (categorical); level of exercise; religious characteristics [34] (affiliation, importance and whether religion is unfavorable toward alcohol); and region of the country, classified according to Kerr [35] with state groupings based on alcohol consumption.

Analysis

We compared mental health of those reporting AHTO with a comparison group that did not report any AHTO in the past year, with the latter group weighted to be statistically similar to the group reporting AHTO. We used the average treatment effect among the treated (ATT) [18, 36]. To estimate ATT, each group reporting a given type of AHTO was compared with the group without any harm [36]; we conducted separate analyses (i.e., one for financial harms, another for assault/physical harm) with each using a single PS calculated specifically for the target comparison. Given the long list of potential confounders, generalized boosted models (GBM) [36, 37] implemented in the TWANG package in R [38] were used to estimate the PS model of harm (vs. no harm) and obtain weights for an inverse probability of treatment weighted (IPTW) estimation. PS weighting using GBM uses iterative procedures based on regression and classification trees and thereby avoids the more subjective model selection process common in traditional parametric logistic regression analysis. Using GBM as an automated data-adaptive algorithm has more desirable properties [37] over traditional PS model estimation based on parametric linear logistic regression, especially when using higher-order interactions and polynomials, and in terms of prediction error [39, 40]. GBM

also automatically creates indicator variables for missing values on confounders, includes them in the regression tree estimation and evaluates the balance of those indicator variables after PS weighting [36, 38].

We began the GBM algorithm with a single simple regression tree [36, 37] for an initial PS model of harm (such as financial harm) compared with no harm, adding a new regression tree at each iteration to best fit the residuals of the model from the previous iteration. During the iteration process, we included up to quartic polynomials and four-way interactions [41], and we specified a maximum of 50,000 iterations. In general, as more regression trees are added, a stopping rule must be used to avoid overfitting and to determine the optimal number of iterations for the final PS model. We used the absolute standardized mean difference (also called standardized bias or effect size) between the PS weighted distributions of the covariates in each treatment condition as our balance metric for each covariate at each iteration, with the mean of those covariate balance metrics calculated across covariates as the summary statistic for measuring model fit. Given a sufficient number of iterations, the mean of the balance metrics will generally decrease to an optimal number of iterations before increasing again; thus, the final model can be determined by the iteration associated with the lowest mean.

In the final model, we considered a standardized mean difference with absolute value greater than .20 after PS weighting (i.e. a small effect size [42]) to be evidence of imbalance. Covariates that remained unbalanced after PS weighting were added into the model to estimate the causal effects of harms. This is called double-robust estimation [43, 44]. Double-robust estimation has advantages over traditional PS weighting alone, including yielding consistent estimates of the treatment effect if either the model for the outcome or the propensity score model is correct [43]. An additional strength of PS approaches is that they are well-suited to situations in which effects of an exposure (reports of AHTO) may be both confounded and moderated by substantive covariates [45]; these could include early-life and adult adverse experiences such as physical or sexual abuse, in particular.

For comparison with the PS weighted estimates of ATT, and to show the strength of associations between confounders and the mental health outcomes, we also present unadjusted bivariate and adjusted multivariable regression results. For model parsimony, the final adjusted regression models only contain covariates associated with the outcome at $p < .10$.

Results

Tables 1 and 2 show distributions of confounders that were unbalanced between the two groups before and after applying the PS weights. As evident in the tables, a great many of the possible confounders were not balanced when comparing those reporting AHTO with the unweighted comparison group who had not reported any type of harm due to someone else's drinking in the past year. After PS weighting, this imbalance was reduced, although several possible confounders remained unbalanced. For financial harm, after PS weighting, in addition to some key demographics such as age and socioeconomic status, the respondent's own heavy drinking and AUD symptoms, other substance use and drug problems, treatment

and recovery status, whether they grew up in a two-parent household, experiences of physical abuse and childhood sexual abuse, experiences of racial/ethnic stigma, and impact of the recent recession remained unbalanced. For assault, after PS weighting, the respondent's age, heavy drinking (maximum number of drinks/day and frequency of drunkenness) and AUD symptoms, other substance use and drug problems, experiences of physical abuse since age 18, and impulsivity/sensation seeking remained unbalanced.

For financial harm, both bivariate and adjusted multivariable regression models showed significant associations of AHTO with all three mental health outcomes (see Table 3). Results from the adjusted multivariable regression models (including coefficients for covariates) are presented in Supplemental Tables S1–S3. Significant associations of financial harm with reduced quality of life, increased distress and less positive affect remained after PS weighting, with these relationships also seen for reduced quality of life and increased distress in the double-robust models containing the unbalanced confounders. In the double-robust PS weighted models, the following confounders were associated with mental health (all $p < .10$; confounders varied slightly by outcome): age, marital status, income below poverty, impact of the recession, respondent's maximum number of drinks/day or frequency of drunkenness, AUD symptoms, drug problems, whether they grew up in a two-parent household and sexual abuse in childhood.

For assault, unadjusted bivariate regression models showed significant associations of AHTO with all three mental health outcomes; significant associations only remained for assault with increased distress in adjusted regression models (Table 3). Results from the adjusted regression model for distress are in Supplemental Table S4. After PS weighting, the associations with assault were significant for reduced quality of life and increased distress, but these were not significant in the double-robust PS models.

Findings varied substantially when looking at the different perpetrators of assault (Table 3). For partner/family-perpetrated assaults, unadjusted bivariate regression models showed significant associations of AHTO with all three mental health outcomes; significant associations remained for partner/family assault with increased distress in adjusted regression models. Results from the adjusted regression model for distress are in Supplemental Table S5. Significant associations of partner/family assault remained after PS weighting, but these were not significant in the double-robust models.

For stranger/friend-perpetrated assaults, unadjusted bivariate regression models showed a significant association of AHTO with reduced quality of life, greater odds of distress and reduced positive affect. However, none of the mental health outcomes were significantly associated with stranger/friend assault in adjusted regression models or in models using PS weights.

Discussion

In this U.S. sample, there were stronger relationships of poor mental health with financial troubles due to someone else's drinking and with assaults perpetrated by intimates (spouses, other partners or family members) than with those perpetrated by friends or strangers. These

relationships were evident in analyses using PS weighting to account for a large group of possible confounders, including early-life and more recent hardship and abuse, respondents' own substance use, and many other important covariates.

Our results extend findings from recent Australian studies [8, 15] focused on negative impacts of respondents' relationships with heavy drinkers on personal well-being and health-related quality of life. Our findings also advance beyond our prior work in this area [5, 6] in several ways: (1) We compared the associations of exposure to distinct harms caused by someone who had been drinking using rigorous analytic methods to adjust for possible confounders; (2) we examined several indicators of mental health; and (3) we included the source of the harm. In these GBM-based PS models, findings suggest there are greater impacts from assault and physical harm attributed to drinking intimates than to drinking strangers or friends. This counterfactual comparison provides stronger evidence of detrimental effects of harm from these intimate perpetrators than has been found in prior studies, such as one from Australia that noted slightly elevated, but not significantly different, rates of distress (depression or anxiety) among people harmed by a partner (42%) or close family member (35%) than a co-worker (25%) [8].

Current mental health status and AHTO also may be related in part to persistent and ongoing life stressors. Because several confounders could not be balanced across the two groups (those reporting AHTO and those who did not report such harms in the prior year), more research is needed to describe the ways early life circumstances affect adults' mental health later in the lifecourse. As others have argued [46], we need more mental health screening and treatment. This issue may be particularly acute for women, as they made up the majority of the sample reporting financial harms due to someone else's drinking (71%), and this was the type of harm most strongly associated with worse quality of life and mental health. We also note that more than a quarter (28%) of those who reported financial harm also reported being assaulted or physically harmed by a spouse or family member, and another 51% reported some other harm perpetrated by a spouse or family member, which suggests these harms do not occur in isolation. Women often are unable to leave relationships where they are financially dependent upon their spouse or partner [47]. The additional burden on women posed by a partner's alcohol problems deserves further attention in treatment interventions, as well as in policies to prevent such alcohol-related harm, as mental health status is worse for victims living with a heavy drinker than for people less exposed to such drinkers [9]. Future work also should employ PS analyses comparing mental health outcomes for multiple types of AHTO within a family system (such as financial harm, assault, other marital/family problems, property damage, and other types of harm), as this type of comparison was beyond the scope of our study.

Because our study is cross-sectional, causality cannot be determined. However, the AHTO items referenced the previous 12 months, while the distress and positive affect items referenced the prior two weeks; quality of life, however, was assessed in general terms (that is, without a specified timeframe and not specifically in reference to mental health) and is assumed to reflect respondents' current situations. It is likely that most of these outcomes were assessed following, rather than before, the experience of alcohol-related harm. However, it also is possible that people experiencing mental health problems may be

targeted as victims by heavy drinkers. Another important note is that there is limited statistical power for evaluating certain types of rarely-occurring harms, even with the large sample. Due to limitations of survey research, our findings may not be representative of certain population subgroups at elevated risk of AHTO, such as young adults or people with severe substance use problems. It is possible that some harms, particularly those involving assault or injury perpetrated by intimate partners, may be under-reported due to social desirability and/or legal concerns [48]. There also may be limitations to survey-elicited reports of confounding variables, such as illicit drug use or childhood victimization. Other possible confounders, such as physical health conditions, are important to examine in future studies. Despite these limitations, the use of the GBM-based PS weighting method provides a stronger counterfactual comparison for AHTO exposure than in prior research, addressing a much wider range of potential confounders than heretofore. Future surveys should collect detailed information about factors associated with both AHTO and mental health, including early life adverse experiences and family structure, as well as adult experiences of hardship, discrimination, and alcohol and drug problems, in order to better estimate the population burden of AHTO.

Conclusion

Using PS weights to account for the broad range of possible confounders, findings suggest there are significant mental health impacts of serious AHTO such as financial troubles because of someone else's drinking. Interventions to reduce alcohol-related harms should emphasize minimizing financial problems caused by others' drinking in order to benefit the public's mental health.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1
 Financial troubles due to someone else's drinking: Covariates before and after PS weighting

	Financially Harmed (N=76) Mean (SD) or %	Unweighted Comparison Group (N=4,625) Mean (SD) or %	PS Weighted Comparison Group Mean (SD) or %	std. mean diff	std. mean diff
Age (years)	44.553 (15.031)	54.22 (17.635)	47.960 (16.135)	-0.643	-0.227
Male	28.9%	39.6%	36.8%	-0.236	-0.172
Race/ethnicity:					
American Indian/Alaska Native	3.9%	1.0%	2.7%	0.151	0.066
Black/African American	17.1%	25.1%	21.9%	-0.212	-0.126
Non-Black Hispanic	19.7%	20.7%	20.2%	-0.025	-0.011
Non-Hispanic White	56.6%	49.6%	52.5%	0.14	0.082
Marital status:					
Married/live with someone	47.4%	53.5%	51.9%	-0.123	-0.092
Never married	31.6%	20.0%	21.5%	0.25	0.217
Separated/divorced/widowed	21.1%	26.5%	26.6%	-0.134	-0.135
Employment status:					
Employed	57.9%	49.6%	56.5%	0.169	0.029
Homemaker	1.3%	4.3%	3.0%	-0.258	-0.149
Other	17.1%	12.1%	17.7%	0.133	-0.016
Retired	6.6%	28.2%	13.9%	-0.871	-0.293
Unemployed	17.1%	5.9%	9.0%	0.297	0.216
Education:					
Less than high school	14.5%	12.3%	12.9%	0.063	0.045
High school diploma	22.4%	26.8%	20.7%	-0.106	0.039
Some college	23.7%	25.1%	27.0%	-0.032	-0.078
4-year college degree (or more)	39.5%	35.9%	39.3%	0.073	0.003
Annual income:					
<= US\$10K	21.1%	9.7%	12.5%	0.278	0.210
US\$10-20K	18.4%	14.7%	20.1%	0.095	-0.044
US\$20-40K	21.1%	20.8%	19.8%	0.007	0.032
US\$40-60K	14.5%	14.3%	13.6%	0.005	0.024

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	Financially Harmed (N=76) Mean (SD) or %	Unweighted Comparison Group (N=4,625) Mean (SD) or %	PS Weighted Comparison Group Mean (SD) or %	std. mean diff	std. mean diff
US\$60-80K	7.9%	12.6%	9.9%	-0.174	-0.073
US\$80-100K	3.9%	6.9%	6.5%	-0.149	-0.129
US\$100K+	9.2%	12.6%	13.0%	-0.118	-0.132
Household size:					
1 person	32.9%	41.8%	35.9%	-0.189	-0.065
2	30.3%	33.4%	26.9%	-0.068	0.074
3	13.2%	10.9%	18.0%	0.066	-0.143
4	14.5%	8%	11.8%	0.183	0.075
5	3.9%	4%	4.6%	-0.002	-0.036
6+	5.3%	1.9%	2.7%	0.152	0.113
Number of children under 17: None	43.4%	69.5%	53.5%	-0.526	-0.204
1	23.7%	12.5%	18.4%	0.264	0.124
2	15.8%	10.8%	17.6%	0.136	-0.050
3	10.5%	4.5%	6.4%	0.198	0.134
4	5.3%	1.9%	2.8%	0.151	0.111
5+	1.3%	0.9%	1.3%	0.038	0.003
Poverty status: /					
Not poor	48.7%	59.8%	55.8%	-0.222	-0.143
Near poor	10.5%	12.3%	13.3%	-0.057	-0.090
Below poverty	35.5%	15.2%	23.6%	0.424	0.250
Current housing situation:					
House owner	40.8%	61.2%	49.5%	-0.415	-0.177
Live in someone else's house	11.8%	6.4%	8.2%	0.168	0.113
Rent apartment	17.1%	17.7%	20.1%	-0.015	-0.080
Rent house	23.7%	12.2%	18.8%	0.27	0.114
Other living situation	6.6%	2.6%	3.4%	0.162	0.130
Affected by recession:					
Not at all	7.9%	27.2%	15.3%	-0.715	-0.275
A little affected	13.2%	24.5%	18.7%	-0.337	-0.163
Moderately affected	25.0%	29.6%	27.5%	-0.107	-0.058

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	Financially Harmed (N=76) Mean (SD) or %	Unweighted Comparison Group (N=4,625) Mean (SD) or %	std. mean diff	PS Weighted Comparison Group Mean (SD) or %	std. mean diff
Severely affected	50.0%	15.8%	0.683	36.5%	0.270
Heterosexual ²	84.2%	88.2%	-0.108	86.1%	-0.051
Maximum drinking in past year:					
0 drinks	31.6%	41.9%	-0.221	34.3%	-0.058
1 drink	10.5%	17.5%	-0.228	16.5%	-0.196
2 drinks	11.8%	12.6%	-0.024	13.5%	-0.051
3 drinks	11.8%	8.5%	0.103	9.6%	0.068
4 drinks	10.5%	6.1%	0.145	7.0%	0.114
5-7 drinks	10.5%	7.0%	0.115	10.5%	0.000
8-11 drinks	3.9%	3.6%	0.016	4.1%	-0.007
12-23 drinks	1.3%	1.6%	-0.021	1.4%	-0.007
24 or more drinks	7.9%	0.5%	0.274	2.4%	0.205
Frequency of drunkenness (past yr):					
Every day or nearly every day	5.3%	0.3%	0.224	0.9%	0.195
Once or twice a week	2.6%	1.1%	0.096	1.7%	0.059
Once to 3 times a month	5.3%	4.0%	0.057	4.5%	0.036
Less than once a month	10.5%	6.8%	0.122	8.4%	0.068
Once in those 12 months	14.5%	7.6%	0.195	11.3%	0.090
Never in those 12 months	56.6%	74.3%	-0.357	67.1%	-0.212
Alcohol use disorder symptoms	1.355 (2.832)	0.22 (0.855)	0.401	0.565 (1.701)	0.279
Went to treatment/in recovery	38.2%	9.6%	0.584	24.0%	0.290
Marijuana use in past year:					
Frequent	26.3%	4.6%	0.493	13.1%	0.299
Occasional	6.6%	2.8%	0.153	3.8%	0.114
Never	67.1%	92.6%	-0.543	83.1%	-0.341
Other drug use in past year:					
Frequent	7.9%	2.0%	0.218	5.7%	0.080
Occasional	6.6%	1.4%	0.209	2.0%	0.185
Never	85.5%	96.6%	-0.314	92.3%	-0.192
Tobacco use in past year:					

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	Financially Harmed (N=76) Mean (SD) or %	Unweighted Comparison Group (N=4,625) Mean (SD) or %	std. mean diff	PS Weighted Comparison Group Mean (SD) or %	std. mean diff
Frequent	34.2%	13.5%	0.437	23.3%	0.229
Occasional	10.5%	2.7%	0.254	3.5%	0.230
Never	55.3%	83.8%	-0.574	73.2%	-0.360
Drug problems in past year	0.145 (0.354)	0.005 (0.073)	0.393	0.045 (0.207)	0.282
Family history of alcohol problems	82.9%	49.8%	0.88	72.5%	0.275
Family structure in childhood:					
Two parents (biological, step or adoptive)	53.9%	75.1%	-0.425	67.6%	-0.274
One parent	35.5%	18.5%	0.356	23.5%	0.251
Another family member (grandparent, aunt or uncle)	5.3%	5.0%	0.014	6.1%	-0.040
Lived with someone else	5.3%	1.4%	0.171	2.7%	0.113
Mother's highest level of education:					
Less than high school	25%	27.4%	-0.054	23.9%	0.026
High school diploma	23.7%	31.1%	-0.174	29.2%	-0.129
Some college	19.7%	14%	0.144	18.1%	0.040
College degree or more	19.7%	14.7%	0.126	18.4%	0.034
Physical abuse in childhood	53.9%	16.5%	0.75	40.9%	0.262
Sexual abuse in childhood	36.8%	9.2%	0.573	26.0%	0.226
Physical abuse since 18	72.4%	23.4%	1.094	59.0%	0.298
Sexual abuse since 18	17.1%	4.8%	0.327	13.5%	0.096
Experience of racial discrimination:					
Never	46.1%	66.3%	-0.407	52.9%	-0.137
Once	10.5%	8.2%	0.077	10.1%	0.012
2-3 times	19.7%	12.3%	0.186	17.0%	0.068
4 or more times	23.7%	13.1%	0.248	19.9%	0.088
Racial/ethnic stigma scale	2.454 (0.702)	2.122 (0.708)	0.473	2.298 (0.708)	0.223
Impulsivity/sensation-seeking	2.059 (0.913)	1.671 (0.719)	0.425	1.915 (0.834)	0.158
BMI:					
Underweight	1.3%	1.4%	-0.006	1.0%	0.027
Normal	32.9%	29.4%	0.074	29.1%	0.082
Overweight	32.9%	32.6%	0.007	33.2%	-0.006

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	Financially Harmed (N=76) Mean (SD) or %	Unweighted Comparison Group (N=4,625) Mean (SD) or %	std. mean diff	PS Weighted Comparison Group Mean (SD) or %	std. mean diff
Obese	30.3%	30.1%	0.003	30.7%	-0.009
Level of exercise:					
Vigorous or heavy	10.5%	8.5%	0.066	8.1%	0.079
Moderate	22.4%	33.2%	-0.259	29.5%	-0.172
Light	50.0%	44.9%	0.102	46.7%	0.065
No exercise	6.6%	6.6%	0.001	6.5%	0.003
Other	1.3%	0.8%	0.045	1.1%	0.021
Disabled	9.2%	6.1%	0.108	8.1%	0.039
Religion:					
Protestant (miscellaneous)	27.6%	36.2%	-0.192	30.7%	-0.070
Catholic	21.1%	23.1%	-0.049	20.1%	0.024
Other	28.9%	21.3%	0.168	23.7%	0.116
None	22.4%	16.7%	0.136	23.1%	-0.017
Religion not at all important	48.7%	39.9%	0.175	45.2%	0.071
Religion favorable to alcohol	71.1%	63.3%	0.172	68.6%	0.053
Region:					
Dry south	28.9%	21.2%	0.171	24.0%	0.11
Middle Atlantic	19.7%	18.9%	0.021	17.3%	0.061
New England	2.6%	2.7%	-0.004	2.3%	0.021
North central	15.8%	16.2%	-0.011	16.7%	-0.026
Pacific	11.8%	16.4%	-0.142	17.0%	-0.159
South coast	21.1%	24.5%	-0.086	22.7%	-0.041

¹ Poverty status coded as “near poor” if income below 150% of US federal poverty level and “in poverty” if income below 100% of poverty level.

² “Only heterosexual” compared to all others, including “mostly heterosexual”, bisexual, “mostly homosexual”, “only homosexual”.

Standardized mean differences (std. mean diff) larger than |.20| are shown in **bold text**.

Table 2
 Assault or physical harm by someone who had been drinking: Covariates before and after PS weighting

	Assaulted/Physically Harmed (N=192) Mean (SD) or %	Unweighted Comparison Group (N=4,623) Mean (SD) or %	PS Weighted Comparison Group Mean (SD) or %	std. mean diff	std. mean diff
Age (years)	40.266 (15.289)	54.224 (17.638)	44.069 (16.208)	-0.913	-0.249
Male	52.6%	39.6%	49.1%	0.26	0.069
Race/ethnicity:					
American Indian/Alaska Native	4.2%	1.0%	2.8%	0.158	0.067
Asian/Pacific Islander	1.6%	1.8%	1.6%	-0.015	-0.002
Black/African American	28.6%	25.1%	29.5%	0.079	-0.019
Non-Black Hispanic	29.7%	20.7%	27.7%	0.197	0.044
Non-Hispanic White	34.9%	49.7%	37.3%	-0.31	-0.050
Marital status:					
Married/live with someone	41.1%	53.5%	45.1%	-0.251	-0.081
Never married	41.7%	20.0%	34.5%	0.44	0.145
Separated/divorced/widowed	17.2%	26.5%	20.3%	-0.247	-0.083
Employment status:					
Employed	57.3%	49.5%	57.7%	0.157	-0.008
Homemaker	2.6%	4.3%	2.8%	-0.104	-0.013
Other	19.8%	12.1%	18.5%	0.193	0.032
Retired	6.8%	28.2%	10.6%	-0.853	-0.151
Unemployed	13.5%	5.9%	10.4%	0.223	0.092
Education:					
Less than high school	15.6%	12.3%	13.0%	0.093	0.071
High school diploma	27.1%	26.8%	26.2%	0.007	0.020
Some college	31.8%	25.1%	30.1%	0.144	0.036
4-year college degree (or more)	25.5%	35.9%	30.7%	-0.238	-0.118
Annual income:					
<= US\$10K	22.4%	9.7%	14.8%	0.304	0.182
US\$10-20K	18.8%	14.7%	18.1%	0.104	0.016
US\$20-40K	17.2%	20.8%	21.5%	-0.095	-0.113

	Assaulted/Physically Harmed (N=192) Mean (SD) or %	Unweighted Comparison Group (N=4,623) Mean (SD) or %	std. mean diff	PS Weighted Comparison Group Mean (SD) or %	std. mean diff
US\$40-60K	13.5%	14.3%	-0.022	13.0%	0.016
US\$60-80K	7.3%	12.6%	-0.203	9.5%	-0.084
US\$80-100K	3.1%	6.9%	-0.214	5.1%	-0.111
US\$100K+	9.4%	12.6%	-0.111	10.6%	-0.041
Household size:					
1 person	50.5%	41.8%	0.174	47.9%	0.053
2	22.9%	33.4%	-0.249	24.0%	-0.026
3	11.5%	10.9%	0.017	13.8%	-0.073
4	8.9%	8.0%	0.028	8.5%	0.014
5	4.7%	4.0%	0.033	4.2%	0.021
6+	1.6%	1.8%	-0.022	1.6%	-0.006
Number of children under 17:					
None	60.9%	69.5%	-0.176	63.1%	-0.044
1	14.6%	12.4%	0.061	15.7%	-0.032
2	14.6%	10.8%	0.106	13.0%	0.045
3	6.2%	4.5%	0.074	5.4%	0.035
4 children in household	2.6%	1.9%	0.045	2.0%	0.035
5+ children in household	1%	0.9%	0.017	0.8%	0.028
Poverty status: /					
Not poor	44.3%	59.8%	-0.312	52.7%	-0.170
Near poor	15.1%	12.3%	0.079	14.0%	0.030
Below poverty	29.7%	15.2%	0.316	22.4%	0.160
Current housing situation:					
House owner	27.6%	61.2%	-0.75	37.1%	-0.212
Live in someone else's house	16.7%	6.4%	0.275	13.3%	0.091
Rent apartment	29.7%	17.7%	0.263	26.9%	0.062
Rent house	20.3%	12.2%	0.201	18.4%	0.049
Other living situation	5.7%	2.6%	0.137	4.4%	0.056
Affected by recession:					
Not at all	20.8%	27.2%	-0.156	22.7%	-0.046

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	Assaulted/Physically Harmed (N=192) Mean (SD) or %	Unweighted Comparison Group (N=4,623) Mean (SD) or %	PS Weighted Comparison Group Mean (SD) or %	std. mean diff	std. mean diff
A little affected	22.9%	24.5%	21.8%	-0.038	0.027
Moderately affected	23.4%	29.7%	28.1%	-0.147	-0.110
Severely affected	31.2%	15.8%	25.6%	0.333	0.122
Heterosexual ²	82.3%	88.1%	85.9%	-0.153	-0.094
Maximum drinking in past year:					
0 drinks	30.7%	41.9%	33.8%	-0.241	-0.067
1 drink	12.0%	17.5%	13.6%	-0.17	-0.049
2 drinks	5.2%	12.6%	10.4%	-0.334	-0.234
3 drinks	5.7%	8.5%	8.2%	-0.12	-0.107
4 drinks	5.7%	6.1%	6.5%	-0.015	-0.032
5-7 drinks	13.0%	7.0%	12.4%	0.179	0.020
8-11 drinks	10.9%	3.6%	7.1%	0.234	0.124
12-23 drinks	8.9%	1.6%	3.5%	0.257	0.188
24 or more drinks	7.3%	0.5%	4.1%	0.261	0.124
Frequency of drunkenness past yr:					
Every day or nearly every day	5.7%	0.3%	3.1%	0.235	0.113
Three to 4 times a week	3.1%	0.4%	1.3%	0.158	0.106
Once or twice a week	7.8%	1.1%	4.0%	0.25	0.141
Once to 3 times a month	12.5%	4.0%	7.1%	0.257	0.163
Less than once a month	10.9%	6.8%	11.5%	0.134	-0.017
Once in those 12 months	6.2%	7.6%	8.5%	-0.056	-0.095
Never in those 12 months	50.0%	74.3%	60.3%	-0.486	-0.206
Alcohol use disorder symptoms	1.661 (2.745)	0.22 (0.856)	0.866 (1.954)	0.525	0.290
Went to treatment/in recovery	31.2%	9.6%	22.9%	0.465	0.179
Marijuana use in past year:					
Frequent	22.9%	4.6%	14.6%	0.436	0.199
Occasional	5.7%	2.8%	6.0%	0.126	-0.011
Never	71.4%	92.6%	79.4%	-0.47	-0.179
Other drug use in past year:					
Frequent	12.5%	2.0%	5.5%	0.317	0.213

	Assaulted/Physically Harmed (N=192) Mean (SD) or %	Unweighted Comparison Group (N=4,623) Mean (SD) or %	PS Weighted Comparison Group Mean (SD) or %	std. mean diff	std. mean diff
Occasional	5.7%	1.4%	3.2%	0.186	0.110
Never	81.8%	96.6%	91.4%	-0.384	-0.248
Tobacco use in past year:					
Frequent	33.3%	13.5%	24.0%	0.421	0.198
Occasional	8.9%	2.7%	5.5%	0.216	0.119
Never	57.8%	83.8%	70.5%	-0.526	-0.257
Drug problems in past year	0.104 (0.306)	0.005 (0.073)	0.030 (0.171)	0.322	0.242
Family history of alcohol problems	68.2%	49.8%	61.8%	0.397	0.138
Family structure in childhood:					
Two parents (biological, step or adoptive)	58.9%	75.1%	66.7%	-0.331	-0.160
One parent	30.2%	18.5%	24.6%	0.256	0.123
Another family member (grandparent, aunt or uncle)	7.3%	5.0%	6.5%	0.09	0.029
Lived with someone else	3.6%	1.4%	2.2%	0.117	0.079
Mother's highest level of education:					
Less than high school	0.245	0.273	0.240	-0.067	0.011
High school diploma	0.271	0.311	0.281	-0.09	-0.023
Some college	0.172	0.14	0.181	0.085	-0.023
College degree or more	0.208	0.147	0.182	0.15	0.065
Physical abuse in childhood	46.9%	16.5%	37.0%	0.608	0.198
Sexual abuse in childhood	24.5%	9.2%	17.5%	0.356	0.162
Physical abuse since 18	64.6%	23.4%	52.5%	0.861	0.252
Sexual abuse since 18	16.1%	4.8%	10.5%	0.308	0.154
Experience of racial discrimination:					
Never	43.8%	66.4%	45.0%	-0.456	-0.026
Once	4.7%	8.2%	7.6%	-0.165	-0.137
2-3 times	20.3%	12.4%	19.4%	0.198	0.022
4 or more times	31.2%	13.1%	28.0%	0.392	0.071
Racial/ethnic stigma scale	2.48 (0.811)	2.121 (0.708)	2.366 (0.792)	0.442	0.141
Impulsivity/sensation-seeking	2.242 (0.899)	1.671 (0.719)	2.041 (0.864)	0.635	0.224
BMI:					

	Assaulted/Physically Harmed (N=192) Mean (SD) or %	Unweighted Comparison Group (N=4,623) Mean (SD) or %	std. mean diff	PS Weighted Comparison Group Mean (SD) or %	std. mean diff
Underweight	1%	1.4%	-0.034	1.2%	-0.012
Normal	31.8%	29.4%	0.051	30.6%	0.024
Overweight	37.5%	32.6%	0.102	35.3%	0.045
Obese	26.6%	30.1%	-0.081	28.2%	-0.037
Level of exercise:					
Vigorous or heavy	11.5%	8.5%	0.094	11.6%	-0.005
Moderate	33.3%	33.2%	0.003	32.3%	0.023
Light	43.2%	44.9%	-0.033	42.7%	0.010
No exercise	5.2%	6.6%	-0.061	6.0%	-0.035
Other	0.5%	0.8%	-0.039	1.1%	-0.085
Disabled	6.2%	6.1%	0.006	6.3%	-0.002
Religion:					
Protestant (miscellaneous)	22.9%	36.2%	-0.316	27.2%	-0.103
Catholic	27.1%	23.1%	0.091	24.3%	0.063
Jewish	1.0%	2.1%	-0.102	1.7%	-0.062
Muslim	2.1%	0.6%	0.103	0.6%	0.106
Other	27.6%	21.3%	0.14	26.1%	0.034
None	19.3%	16.7%	0.065	20.2%	-0.023
Importance of religion:					
Not at all	49.0%	40.0%	0.18	44.4%	0.091
Religious attitude to alcohol:					
Favorable	58.9%	63.3%	-0.091	63.8%	-0.100
Region:					
Dry south	16.7%	21.2%	-0.122	19.0%	-0.062
Middle Atlantic	22.9%	18.9%	0.096	21.0%	0.047
New England	2.1%	2.7%	-0.043	2.3%	-0.012
North central	17.7%	16.2%	0.04	17.4%	0.007
Pacific	17.2%	16.5%	0.019	17.8%	-0.017
South coast	23.4%	24.6%	-0.026	22.6%	0.020

/ Poverty status coded as "near poor" if income below 150% of US federal poverty level and "in poverty" if income below 100% of poverty level.

²“Only heterosexual” compared to all others, including “mostly heterosexual”, bisexual, “mostly homosexual”, “only homosexual”.

Standardized mean differences (std. mean diff) larger than |.20| are shown in **bold text**.

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Table 3

Estimated treatment effects of exposure to AHTO on mental health outcomes

	<u>Financial harm</u>					
	Quality of Life		Distress		Positive Affect	
	Estimate (SE)	P-value	OR (95% CI)	P-value	Estimate (SE)	P-value
Bivariate Regression	-0.72 (.1)	< .001	8.31 (4.84, 14.27)	< .001	-0.56 (.1)	< .001
Adjusted / Multivariable Regression	-0.26 (.1)	0.02	5.77 (3.10, 10.75)	< .001	-0.26 (.1)	0.03
Bivariate PS Weighted Model	-0.51 (.1)	< .001	4.46 (2.45, 8.12)	0.001	-0.36 (.1)	0.004
Double-Robust / PS Weighted Model	-0.28 (.1)	.02	4.69 (1.96, 11.20)	< .001	-0.15 (.1)	0.18
<u>Any assault/physical harm</u>						
	Estimate (SE)	P-value	OR (95% CI)	P-value	Estimate (SE)	P-value
Bivariate Regression	-0.37 (.1)	0.001	3.93 (2.53, 6.10)	< .001	-0.33 (.1)	< .001
Adjusted / Multivariable Regression	-0.06 (.1)	0.47	2.40 (1.44, 4.01)	< .001	-0.11 (.1)	0.13
Bivariate PS Weighted Model	-0.19 (.1)	0.034	2.02 (1.17, 3.49)	0.012	-0.15 (.1)	0.06
Double-Robust / PS Weighted Model	-0.11 (.1)	0.22	1.32 (0.69, 2.55)	0.40	-0.04 (.1)	0.59
<u>Partner/Family Assault/physical harm</u>						
	Estimate (SE)	P-value	OR (95% CI)	P-value	Estimate (SE)	P-value
Bivariate Regression	-0.51 (.1)	0.001	5.72 (3.14, 10.42)	< .001	-0.41 (.1)	< .001
Adjusted / Multivariable Regression	-0.03 (.1)	0.81	3.77 (1.90, 7.48)	< .001	-0.17 (.1)	0.17
Bivariate PS Weighted Model	-0.22 (.1)	0.07	2.79 (1.41, 5.53)	0.003	-0.25 (.1)	0.04
Double-Robust / PS Weighted Model	-0.06 (.1)	0.6	2.23 (0.88, 5.61)	0.09	-0.11 (.1)	0.30
<u>Friend/Stranger Assault/physical harm</u>						
	Estimate (SE)	P-value	OR (95% CI)	P-value	Estimate (SE)	P-value
Bivariate Regression	-0.28 (.1)	0.01	2.87 (1.55, 5.32)	< .001	-0.29 (.1)	< .001
Adjusted / Multivariable Regression	-0.03 (.1)	0.74	1.63 (0.83, 3.21)	0.16	-0.02 (.1)	0.80
Bivariate PS Weighted Model	-0.18 (.1)	0.13	1.76 (0.88, 3.53)	0.112	-0.11 (.1)	0.28
Double-Robust / PS Weighted Model	-0.06 (.1)	0.61	1.17 (0.53, 2.57)	0.70	-0.001 (.1)	0.99

Covariates included in the adjusted models varied across exposures and outcomes; see Supplemental Tables S1–S2 for adjusted regression models for financial harm and partner/family assault/physical harm. Covariates retained in the regression models met $p < .10$ threshold; those retained in the PS weighted model had a standardized mean difference $> |.20|$ after weighting.

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