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Alcohol brief intervention, specialty treatment and drinking outcomes at 12 months: Results from a systematic alcohol screening and brief intervention initiative in adult primary care

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Abstract

Background: Alcohol screening, brief intervention and referral to treatment (SBIRT) in adult primary care is an evidence-based, public health strategy to address unhealthy alcohol use, but evidence of effectiveness of alcohol brief intervention (ABI) in real-world implementation is lacking.

Methods: We fit marginal structural models with inverse probability weighting to estimate the causal effects of ABI on 12-month drinking outcomes using longitudinal electronic health records data for 312,056 adults with a positive screening result for unhealthy drinking between 2014 and 2017 in a large healthcare system that implemented systematic primary care-based SBIRT. We examined effects of ABI with and without adjusting for receipt of specialty alcohol use disorder (AUD) treatment, and whether effects varied by patient demographic characteristics and alcohol use patterns.

Results: Receiving ABI resulted in significantly greater reductions in heavy drinking days (mean difference [95% CI] = ₋0.26 [−0.45, −0.08]), drinking days per week (−0.04 [−0.07, −0.01]), drinks per drinking day (−0.05 [−0.08, −0.02]) and drinks per week (−0.16 [−0.27, −0.04]). Effects of ABI on 12-month drinking outcomes varied by baseline consumption level, age group and whether patients already had an AUD, with better improvement in those who were drinking at levels exceeding only daily limits, younger, and without an AUD.

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All authors have contributed to the work and approved the final version.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.drugalcdep.2022.109458.

Conclusions: Systematic ABI in adult primary care has the potential to reduce drinking among people with unhealthy drinking considerably on both an individual and population level. More research is needed to help optimize ABI, in particular tailoring it to diverse sub-populations, and studying its long-term public health impact.

Keywords

Unhealthy alcohol use; Alcohol brief intervention; Systematic primary care-based SBIRT; Electronic health records; Causal inference; Effect heterogeneity

1. Introduction

Harmful use of alcohol is a serious public health problem with significant health, social and economic impacts (Centers for Disease Control and Prevention, 2021; Esser et al., 2020; Spillane et al., 2020). Epidemiological research has shown that hazardous drinking without alcohol use disorder (AUD) comprises the majority of alcohol problems in the general population (Beyer et al., 2018; U.S. Department of Health and Human Services and Office of the Surgeon General, 2016). Moreover, many people are unaware that their alcohol consumption level puts them at risk for adverse health consequences and AUDs (Bates et al., 2018). Thus, a large impact on public health could be achieved by reducing alcohol consumption among individuals whose drinking exceeds recommended limits, including those not meeting AUD criteria.

For over 20 years, public health leaders have recommended alcohol screening, brief intervention and referral to treatment (SBIRT) in adult primary care as an evidence-based strategy to address unhealthy drinking (Babor et al., 2017; U. S. Preventive Services Task Force et al., 2018). Core components of SBIRT include both “BI” or brief intervention, and referral to specialty treatment as needed. Following identification of unhealthy alcohol consumption, clinicians provide alcohol brief interventions (ABI) that typically include providing information regarding risks (e.g., linking alcohol use to specific health problems), offering normative feedback indicating that patients are drinking more than peers, exploring motivation to change, and advising patients to cut back or stop (Moyer and Finney, 2004). Patients with more serious drinking problems are often referred to specialty care for further assessment and/or treatment, including AUD pharmacotherapy.

Evidence from clinical trials on the efficacy of primary care ABIs has been mixed (Beich et al., 2003; Kaner et al., 2009; Whitlock et al., 2004), and effectiveness has not been extensively examined in the context of real-world implementation. While some systematic reviews and meta-analyses support the effectiveness of ABIs in reducing alcohol-related problems (Kaner et al., 2018), findings from the limited evaluations of large-scale alcohol SBIRT implementation studies have not found significant effects of ABI on drinking outcomes (Kaner et al., 2013; Williams et al., 2014). In addition, those with higher alcohol problem severity often need more extensive treatment and may be less likely to benefit from ABI alone. Conversely, extensive research supports effectiveness of specialty AUD treatment, but it has not been well studied in the context of systematic SBIRT implementation.

One major challenge related to this lack of real-world evidence of ABI effectiveness is the need for methods that enable causal inference using observational data generated in routine clinical practice. Observational data are subject to biases from confounding and selection, which can lead to biased estimates of treatment effects. For example, there may be imbalance in baseline patient characteristics between groups with and without receipt of ABI, non-censoring and subsequent screening and outcome measures. All of these need to be properly accounted for in models evaluating ABI effectiveness using observational data, yet traditional covariate-adjusted regression may be inadequate to eliminate all such biases. Marginal structural models (MSM) are a class of statistical methods that aim to fully adjust for measured confounders to enhance treatment group comparability in observational studies, thus estimating causal effects in a way approximating randomized controlled trials (Hernan and Robins, 2016; Robins et al., ´ 2000). There have been rapid and ongoing advances and adoptions of MSM in epidemiologic studies (Cain et al., 2016; Danaei et al., 2018; Gilsanz et al., 2021; Lin et al., 2021; Pazzagli et al., 2018; Ross et al., 2021); however, applications of MSM in addiction research has been limited.

Using longitudinal electronic health record (EHR) data from an integrated healthcare system, this study examined 12-month causal effects of receiving ABI on drinking outcomes in a large cohort of adult primary care patients who screened positive for unhealthy drinking. Because we studied alcohol use outcomes in the context of an SBIRT initiative which includes both BIs and specialty treatment referrals, we examined effects of ABIs with and without adjusting for receipt of specialty AUD treatment, and examined associations between receipt of specialty AUD treatment – including outpatient visits to Addiction Medicine and pharmacotherapy for AUD – and follow-up drinking outcomes. We also examined whether ABI effects varied by patient demographic characteristics and alcohol use patterns. Findings may yield insight into factors that influence SBIRT effectiveness and will allow providers to take those into consideration when implementing SBIRT.

2. Methods

2.1. Study setting

Kaiser Permanente Northern California (KPNC) is a non-profit integrated healthcare system of over four million members, representing about one third of all Northern Californians, with a socio-economically diverse membership similar to the local and state-wide insured population, excluding those with very low income (Gordon, 2015). KPNC provides care to a population insured through employer-based plans, Medicare, Medicaid and health insurance exchanges (Satre et al., 2020). KPNC has 21 medical centers, 266 medical offices, and 2147 adult primary care physicians and providers, and provides specialty Psychiatry and Addiction Medicine treatment as a covered benefit. Treatment for AUD is provided in specialty clinics, which patients can access without referral. The group-based alcohol treatment model (with individual counseling and medications as needed) is similar to outpatient treatment programs nationwide. AUD pharmacotherapy is available in primary care, Addiction Medicine and Psychiatry. This study was approved by the Institutional Review Board at KPNC.

2.2. Systematic alcohol screening and brief intervention in adult primary care

The Alcohol as a Vital Sign (AVS) initiative is an SBIRT workflow in adult primary care (Internal Medicine or Family Practice) at KPNC. Using National Institute on Alcohol Abuse and Alcoholism (NIAAA) screening instruments embedded in the EHR, medical assistants conduct screening by asking a modified single-item screening question [“How many times in the past three months have you had 5 or more drinks in a day” (for men aged 18–65), or “4 or more drinks” for men aged ≥ 66 and women of all ages], followed by two questions on typical drinking days per week and typical number of drinks per drinking day (National Institute on Alcohol Abuse and Alcoholism, 2005). Medical assistants ask these questions as they collect vital sign information, and record responses in the EHR.

Drinking that exceeds the NIAAA recommended daily limits (>3 drinks/day for women and men aged ≥66, or >4 drinks/day for men aged 18–65) and/or weekly limits (>7 drinks/week for women and men aged ≥66, or >14 drinks/week for men aged 18–65), is considered positive for unhealthy drinking. Per protocol, physicians conduct an ABI with patients who screen positive, based on Motivational Interviewing principles (Miller and Rollnick, 2013) and provide a referral to Addiction Medicine if needed. The EHR alerts medical assistants with a best-practice reminder to screen patients annually, except for those with a prior positive screen for unhealthy drinking, in which case the reminder “fires” automatically every six months until a negative screen.

2.3. Sample

We identified 440,882 patients who screened positive for unhealthy drinking in KPNC adult primary care between January 1, 2014 and December 31, 2017; index date was defined as the date of the first positive screen for unhealthy drinking during this period. We excluded patients who: (1) did not have continuous membership in the prior year (n = 106,750, 24.2%), (2) were over 85 years old (2272, 0.5%), or (3) did not have complete alcohol screening results on the index date (i.e., one or more of the three responses was missing) (n = 19,804, 4.5%). The final analytical sample consisted of 312,056 patients among 3180 providers (Fig. 1).

2.4. Measures

2.4.1. Alcohol brief intervention (ABI) at index screening—ABI was determined using ICD-9 (V65.42 and V65.49) or ICD-10 codes (Z71.41 and Z71.89), Current Procedural Terminology codes (96160, 99420, 99408, and 99409) and Healthcare Common Procedure Coding System codes (G0396, G0397, G0443, and H0050).

2.4.2. Alcohol consumption at index screening—We classified patients into mutually exclusive groups: “exceeding only daily limit,” “exceeding only weekly limit,” or “exceeding both daily and weekly limits” per NIAAA drinking limits.

2.4.3. Other index screening measures—We defined index year of screening, facility and department, based on the index positive screening.

2.4.4. 12-month drinking outcomes—Using follow-up screening data, we examined effects of ABI on four alcohol-related outcomes as *changes between the index date and the 12-month follow-up* in heavy drinking days/past 3 months ("heavy drinking"), drinking days/week ("drinking frequency"), drinks/drinking day ("drinking intensity") and drinks/week ("total consumption"). Because patients may not have had a follow-up screening exactly 12 months post-index, we identified all follow-up screenings between 7 and 12 months later; if a patient had more than one screening during this period, the visit closest to 12-month follow-up was chosen.

2.4.5. Specialty AUD treatment in months 1–6 after the index screening—An indicator for receiving specialty AUD treatment in the 6 months post-index was defined as either having ≥ 1 outpatient KPNC Addiction Medicine visit or receiving AUD pharmacotherapy (i.e., acamprosate, disulfiram, naltrexone, gabapentin, or topiramate) (Joshi et al., 2021; Knox et al., 2019; Kranzler and Soyka, 2018; Soyka and Muller, 2017) from an outpatient KPNC pharmacy.

2.4.6. Patient characteristics—From the EHR, we extracted patients' sex, age, race/ethnicity and insurance type at the index date. Smoking status was determined based on the most recent tobacco screening in the prior year. We used the most recent record of self-reported physical activity in the prior year, classified into three groups: inactive (0 min/week), insufficient activity (>0 but <149 min/week), and sufficient activity (≥150 min/week) (Golightly et al., 2017). Similarly, we used the most recent record of body mass index (BMI) in the prior year and created four groups: underweight (<18.5), normal weight (18.5–24.9), overweight (25.0–29.9), and obese (≥30.0) (Centers for Disease Control and Prevention, 2021). To adjust for medical comorbidities, we used the Charlson comorbidity index (Charlson et al., 2008). We also identified whether individuals had any AUDs, drug use disorders, mental health conditions (Palzes et al., 2020a, 2020b) (including depression, bipolar disorder, schizophrenia, schizoaffective disorder, anxiety disorder, obsessive–compulsive disorder, pervasive developmental disorder, anorexia nervosa, and bulimia nervosa), or substance abuse-related medical conditions (SAMCs) (Bistre et al., 2021; Short et al., 2020) in the prior year, based on ICD-9 and ICD-10 codes. As a proxy for socioeconomic status (SES), we used the neighborhood deprivation index (NDI) from geocoded census data (Messer et al., 2006). We extracted service utilization (emergency department, inpatient and primary care) in the prior year and summarized them into categories of 0, 1, 2, or ≥ 3.

2.4.7. Provider characteristics—We extracted providers' age, sex, race/ethnicity, specialty (Internal Medicine, Family Practice, Other) and years of service for the primary care providers of the index visit from administrative databases.

2.5. Statistical analysis

Preliminary bivariate analyses examined how alcohol consumption level at index screening, patient characteristics and proportions having AUD treatment within the first 6 months after index screening differed between those who did and did not receive an ABI. We then used MSM with inverse probability weighting (Hernán et al., 2000; Mansournia and Altman,

2016; Mohammad et al., 2015; Robins et al., 2000) to estimate causal effects of receiving ABI on 12-month drinking outcomes:

First, for each patient, we generated an inverse probability of treatment weight (IPTW) for receiving ABI by fitting logistic regression models on a set of patient and provider characteristics hypothesized to be associated with receiving ABI and/or drinking outcomes, based on preliminary analyses and the literature (Bachhuber et al., 2017; Chen et al., 2020; Lu et al., 2021; McKnight-Eily et al., 2020; Mertens et al., 2015; Williams et al., 2012): patient's age, sex, race/ethnicity, insurance type, NDI, Charlson index, drug use disorder, mental health conditions, SAMCs, BMI, physical activity, smoking status, alcohol consumption level at index screening, index year, index department, index facility, and prior healthcare utilization; provider's age, sex, race/ethnicity, specialty, and years of service. We also generated an inverse probability weight for being censored (IPCW) at 12 months by fitting logistic regression models on the same set of covariates as above, plus receipt of ABI for the index screening and receipt of specialty AUD treatment in the 6 months post-index. A stabilized weight was generated as the product of IPTW and IPCW.

Second, for each 12-month drinking outcome, we estimated the average treatment effect of receiving an ABI by fitting weighted regression models using stabilized weights, with estimates and robust standard errors acquired using SAS SURVEYREG procedure. We first fitted the weighted models including only the main effect of ABI as the predictor, then refitted the models including both the main effects of ABI and specialty AUD treatment as predictors.

Third, we examined possible ABI effect heterogeneity by index alcohol consumption level, sex, age group, AUD status and race/ ethnicity. For each of these, we re-estimated the weights within each variable level, then estimated BI effects on each drinking outcome using a single weighted model including the interaction term between ABI and the variable. We also examined whether associations between specialty AUD treatment and drinking outcomes differed across these patient subgroups by including the corresponding interactions.

Significance was defined at $p < 0.05$ and all tests were two-tailed. Analyses were performed using SAS 9.4 (SAS Institute Inc.).

3. Results

3.1. Receipt of ABI and AUD treatment

Among the 312,056 eligible patients screening positive for unhealthy drinking, 48% received an ABI (Table 1). All the patient demographic and clinical characteristics examined were significantly associated with receipt of ABI, consistent with our prior findings (Lu et al., 2021). We calculated the standardized differences of means (for continuous variables) and proportions (for categorical variables) (Yang and Dalton, 2012) with and without applying the inverse probability weighting; results indicated that weighting improved the balance in patient characteristics between ABI and no-ABI groups (supplementary tables 1–4).

There were no differences between those who did and did not receive an ABI in outpatient visits to Addiction Medicine (1.2% in both groups). However, fewer patients who had an ABI received an AUD medication (2.5% vs. 2.8%, $p < .001$) or had any specialty AUD treatment during the 6 months post-index date (3.4% vs. 3.7%, $p < .001$).

3.2. Overall ABI effect on drinking outcomes at 12 months

Comparisons of results from weighted models with and without adjusting for receipt of specialty AUD treatment found identical estimated treatment effects of ABI, therefore, we present results of ABI effects adjusting for receipt of specialty AUD treatment (Table 2). We found significant average causal effects of ABI on greater reductions in all four drinking outcomes: heavy drinking days/past 3 months (estimated mean difference [95% confidence interval, CI]= −0.26 [−0.45, −0.08], p = 0.005), drinking days/week (−0.04 [−0.07, −0.01], p = 0.006), drinks/drinking day (−0.05 [−0.08, −0.02], p = 0.001) and drinks/week (−0.16 [−0.27, −0.04], p = 0.009).

3.3. Heterogeneity of ABI effect by patient subgroups

We found significant differences in ABI effects on change in heavy drinking days/past 3 months and change in drinks/drinking day at follow-up by baseline alcohol consumption level (Table 3). Receipt of ABI resulted in greater reduction of heavy drinking days/past 3 months among patients who exceeded only daily drinking limits (estimated mean difference [95% CI] = −0.48 [−0.63, −0.34], $p < .001$) and those who exceeded both daily and weekly limits (−1.30 [−2.35, −0.24], p = 0.016) at the index screening, but a greater increase among patients who exceeded only weekly limits (0.38 [0.11, 0.64], p = 0.005). Additionally, receipt of ABI resulted in a slightly greater reduction in drinks/ drinking day among patients exceeding only daily drinking limits (−0.10 [−0.14, −0.06], $p < .001$), but no significant changes among patients who exceeded only weekly limits or those who exceeded both daily and weekly limits.

We did not find significant variation in ABI effects by sex or race/ethnicity on any of the four drinking outcomes. However, we found variation in ABI effects on change in drinks/ drinking day across age groups. ABI was associated with an additional −0.18 and −0.07 drinks/drinking day reduction at 12 months for those aged 18–24 and 25–34, respectively, but an additional 0.04 drinks/drinking day increase among those 65 and older. We also found that receiving ABI resulted in significantly greater reduction in all four drinking outcomes at 12 months among those without an AUD, but not among those with an AUD diagnosis in the year before the index screening, with p value for the interaction between ABI and AUD significant for change in drinking days/week.

3.4. Associations between specialty AUD treatment and drinking outcomes at the 12-month follow-up and heterogeneity by patient subgroups

Receipt of any specialty AUD treatment in the 6 months post-index was associated with greater reductions in all four drinking outcomes at 12 months: heavy drinking days/past 3 months (estimated mean difference [95% CI]= ₋3.20 [−3.98, −2.43]), drinking day/week (−0.83 [−0.92, −0.74]), drinks/drinking day (−0.59 [−0.70, −0.48]) and drinks/week (−4.21 [−4.84, −3.57]) (all $p < .001$) (Table 4).

We also found significant interactions between specialty treatment and baseline alcohol consumption. Specialty AUD treatment was associated with the greatest reductions in drinking outcomes among those exceeding both daily and weekly limits at baseline (Table 4). Among those exceeding both daily and weekly limits at baseline, receiving specialty treatment was associated with 10 less heavy drinking days (estimated mean difference [95% CI]= −10.76 [−13.69, −7.82], $p < .001$) and 9 drinks less per week compared to those who did not receive specialty treatment (−9.13 [−11.29, −7.00], $p < .001$). Associations between specialty treatment and change in heavy drinking days/past 3 months, change in drinks/drinking day and change in drinks/week also significantly varied by sex, where specialty AUD treatment was associated with greater reductions among men. In addition, we found that associations between specialty treatment and drinking outcomes differed by age group, with specialty treatment associated with greater reductions in all four drinking outcomes among middle aged patients. Receiving specialty AUD treatment was associated with significantly greater reductions in heavy drinking days, change in drinks/drinking day and change in drinks/week for those with an AUD diagnosis 1 year before the index date: among them, receiving specialty treatment in the 6 months after index was associated with 6.5 less heavy drinking days and 6.9 drinks less per week compared to those who did not receive specialty treatment (estimated mean difference [95% CI]= −6.54 [−9.31, −3.76], $p < .001$ and −6.90 [−9.14, −4.66], $p < .001$, respectively). For all four drinking outcomes, receiving specialty treatment was associated with greater reduction across racial/ethnic groups, but differences between racial/ethnic groups were not statistically significant.

4. Discussion

In this study, we examined effects of receiving an ABI on four drinking outcomes in a large, socio-demographically diverse sample of adult primary care patients screening positive for unhealthy alcohol use during routine screening within an integrated healthcare system. In the overall sample, there were modest but significant effects of receiving ABI on reduction in heavy drinking (heavy drinking days/past 3 months), drinking frequency (drinking days/ week), intensity (drinks/ drinking day) and total consumption (drinks/week) at the 12-month follow-up, independent of receipt of AUD treatment.

Effect sizes were averaged across the sample and were consistent with the literature to date which suggests that while effect sizes of ABI vary by outcome measures, populations and settings, overall they are small to moderate (Beyer et al., 2018; Kaner et al., 2018; Platt et al., 2016). However, these results are meaningful given the intervention brevity, low cost and potential to improve patient health (Grant et al., 2016). Further, impacts may be substantial on a population level, considering the potential reach of ABI when routinely delivered. For example, as of September 2021, there have been over 14 million screenings among over 4 million unique patients (current average regional screening rate of 89%), and 1.3 million ABIs delivered within KPNC, with a cumulative ABI rate of 67% (Sterling et al., 2021). Taking into account these high screening rates, cumulative ABI delivery rates and the absolute numbers of patients reached, results may translate into clinically significant population-level changes, especially longitudinally. Consistent with the original intent of the SBIRT model (Babor et al., 2017), our findings support the potential for systematic SBIRT

to have a substantial public health impact and lay the groundwork for further examination of the role and impact of its specific components.

We also found that effects of ABI on follow-up drinking outcomes varied by baseline consumption level, age group and whether patients already had an AUD, with better improvement in those drinking at lower levels, who were younger, and those without an AUD. While we were unable to explore the underlying mechanisms of these ABI effect heterogeneities, results are consistent with recommendations that those with AUDs may need higher-intensity interventions to reduce unhealthy drinking (and are supported by our findings here on the role of subsequent specialty care) (Knox et al., 2019; Kranzler and Soyka, 2018; National Institute on Alcohol Abuse and Alcoholism, 2005). ABIs likely can benefit individuals across the lifespan (Schonfeld et al., 2015), but studies have found ABI particularly well suited for young adults (Becker et al., 2021), and guidelines have been proposed to address potential stigma and enhance intervention efficacy among older patients (Satre and Leibowitz, 2015; Substance Abuse and Mental Health Services Administration, 2020). Our findings underscore the importance of future research to better understand the variability in outcomes following receipt of ABI. Findings could help inform intervention development and delivery of ABI, concerning strategies for intervention tailoring (National Institute on Alcohol Abuse and Alcoholism, 2013).

We also found significant associations between receipt of specialty AUD treatment – either outpatient visits or pharmacotherapy – and all four drinking outcomes, with greater magnitude of improvement relative to effects of ABI. While these relationships cannot be interpreted as causal, these findings underscore the potential importance of the “RT” part of SBIRT. The assumption that alcohol screening, and BIs paired with RTs will increase receipt of specialty treatment for those needing more care has not been sufficiently examined, with the limited research to date reporting mixed findings (Glass et al., 2015; Krupski et al., 2010; Liu et al., 2011). A recent study of US Veterans Health Administration patients (Frost et al., 2020) found that ABI in primary care was associated with lower likelihood of receiving specialty treatment. The current study could not evaluate linkages between alcohol screening, BI and RT and receipt of specialty treatment because KPNC patients do not need a referral to specialty AUD treatment. However, we found minimal differences between those who did and did not receive ABI in proportions receiving specialty treatment during the subsequent 6 months, and significant improvements associated with receipt of specialty treatment. Our findings reinforce the need for more studies of the important linkage of components of SBIRT and their individual and collective impacts. This is especially the case for RT, which has been under-studied.

This study’s strengths include leveraging population-based EHR data from a large integrated healthcare delivery system that has successfully implemented SBIRT to examine real-world effects of receiving ABI on drinking outcomes using MSM with inverse probability weighting, which enables causal inference using observational data from non-randomized control trials. However, there are several limitations. Despite adjustment for key covariates from a well-established EHR, there may be residual confounding from unmeasured confounders. Similar to other EHR-based studies, data on ABIs were limited to what was documented in the EHR, and intervention quality was not assessed. Data on other covariates

such as alcohol consumption and exercise were based on self-report, which is subject to social desirability bias. However, questions were designed to increase patient comfort in responding (Mertens et al., 2015). KPNC has a well-established EHR and a diverse membership that reflects the U.S. population with access to care, allowing us to study a large population-based sample of patients and providers, yet it is not known how well the study's findings may generalize to other healthcare systems and populations. In addition, examining long-term and cumulative ABI effects was beyond the scope of the current work but warrants future research.

5. Conclusion

In a large healthcare system that implemented systematic primary care-based SBIRT, we found that receipt of ABI was associated with improvement in alcohol use outcomes over time. Differential effects were observed based on patient age, drinking patterns and AUD status; and receipt of specialty AUD treatment was associated with better alcohol use outcomes among those with an AUD. Alcohol SBIRT has the potential to reduce drinking on both an individual and population level when delivered broadly in primary care. More research is needed to help optimize components – in particular, tailoring to diverse sub-populations – and modes of delivery of ABI, and to study its long-term public health impact.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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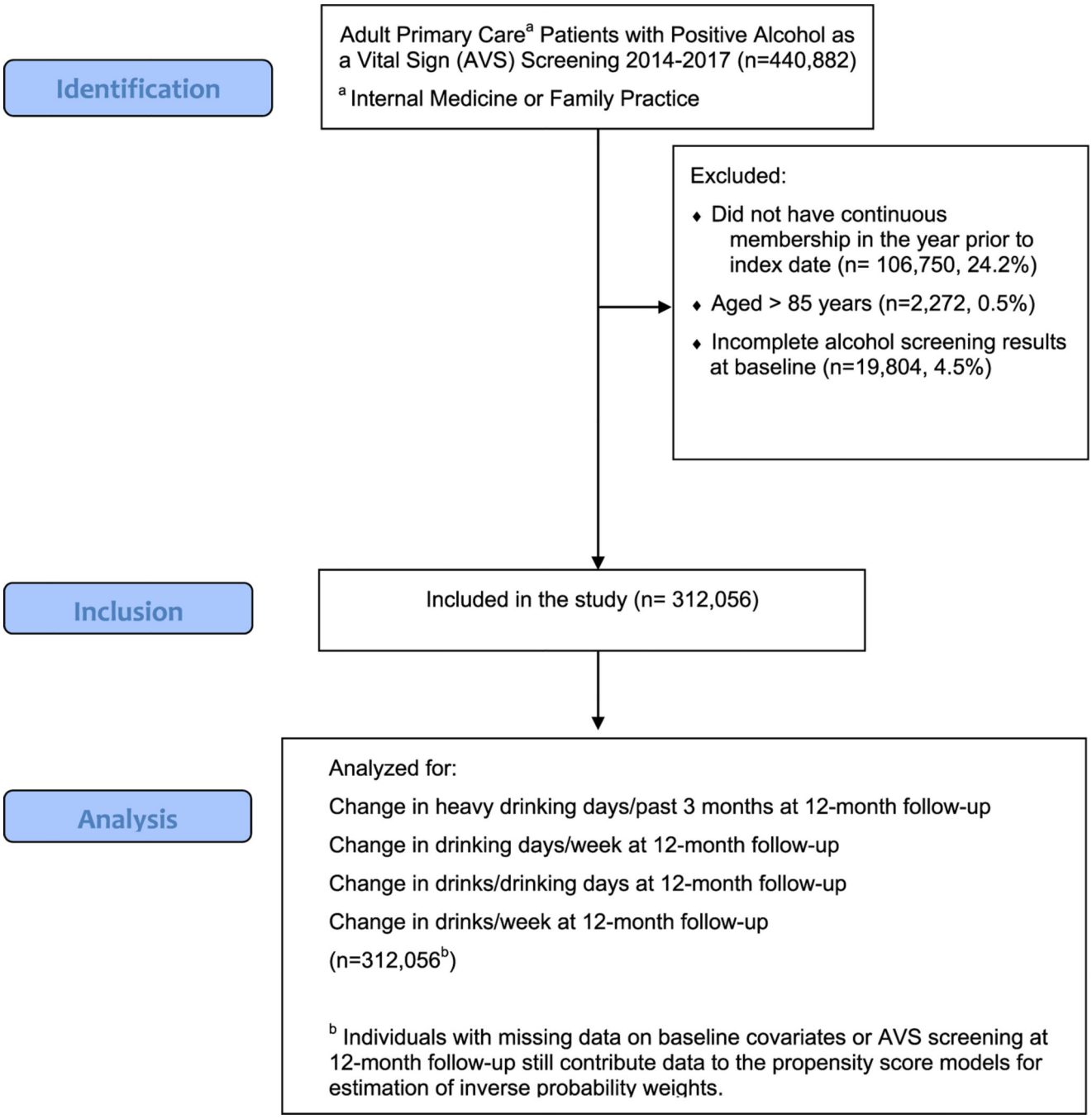

Fig. 1.
STROBE Diagram of Study Cohort.

Table 1

Patient characteristics.

	Alcohol Brief Intervention		
	No	**Yes**	
	(N = 163,901, 52.5%)	**(N = 148,155, 47.5%)**	**P value**
Alcohol Consumption Level (%)			< .001
Exceeding Daily Limits Only	59.7	61.6	
Exceeding Weekly Limits Only	28.5	23.2	
Exceeding Both Daily and Weekly Limits Only	11.8	15.3	
Age, Mean (SD)	46.4 (17.3)	44.9 (16.8)	< .001
Male (%)	59.1	62.6	< .001
Race/Ethnicity (%)			< .001
Asian/Pacific Islander	9.9	10.4	
Black	6.3	5.2	
Hispanic	18.4	17.6	
Other	3.1	3.5	
White	62.3	63.3	
Insurance (%)			< .001
Commercial	77.2	80.6	
Medicaid	2.4	2.2	
Medicare	19.9	16.5	
Other/Unknown	0.6	0.7	
Comorbidities (%)			
Any Alcohol Use Disorder	2.7	2.3	< .001
Any Drug Use Disorders	1.2	1.1	< .001
Any Mental Health Disorders	15.1	14.7	0.005
Any Substance Abuse-related Medical Conditions	52.8	48.1	< .001
Charlson Index (%)			< .001
0	75.7	78.3	
1	15.3	14.4	
2	4.7	4.0	
> =3	4.4	3.3	
Body Mass Index Category			< .001
Normal	27.7	28.3	
Obese	30.9	29.5	
Overweight	35.5	35.2	
Underweight	0.8	0.8	
Unknown	5.1	6.2	
Smoking Status			< .001
Non-Smoker	84.1	82.4	
Smoker	14.5	16.4	

	Alcohol Brief Intervention		
	No	Yes	
	(N = 163,901, 52.5%)	(N = 148,155, 47.5%)	P value
Unknown	1.4	1.2	
Physical Activity Level (%)			< .001
Inactive	29.3	27.8	
Insufficient Activity	24.2	25.0	
Sufficient Activity	45.0	45.7	
Unknown	1.4	1.5	
Specialty Alcohol Use Disorder Treatment, Months 1–6 (%)			
Outpatient Visits to Addiction Medicine	1.2	1.2	0.588
Outpatient Medications for Alcohol Use Disorder	2.8	2.5	< .001
Any of above	3.7	3.4	< .001
Utilization 1 Year Prior (%)			
Emergency Department Visits			< .001
0	84.6	86.2	
1	11.7	10.9	
2	2.4	2.0	
> =3	1.2	0.9	
Inpatient Encounters			< .001
0	97.2	97.9	
1	2.4	1.7	
2	0.3	0.3	
> =3	0.1	0.1	
Primary Care Visits			< .001
0	68.9	74.8	
1	20.7	17.6	
2	6.6	5.1	
> =3	3.8	2.5	

Table 2

Average causal effect of receiving ABI for unhealthy alcohol use on drinking outcomes at 12-month follow-up, adjusted for receipt of specialty alcohol use disorders treatment.

	ABI	No ABI	ABI vs. No ABI	
	Mean (95% CI)	**Mean (95% CI)**	**Diff. (95% CI)**	**P value**
Outcome = change in heavy drinking days	−4.49 (−4.89, −4.10)	−4.23 (−4.63, −3.83)	−0.26 (−0.45, −0.08)	0.005
Outcome = change in drinking days/week	−1.18 (−1.23, −1.14)	−1.14 (−1.19, −1.09)	−0.04 (−0.07, −0.01)	0.006
Outcome = change in drinks/drinking day	−1.26 (−1.31, −1.20)	−1.21 (−1.26, −1.15)	−0.05 (−0.08, −0.02)	0.001
Outcome = change in drinks/week	−5.21 (−5.53, −4.90)	−5.06 (−5.39, −4.73)	−0.16 (−0.27, −0.04)	0.009

ABI=Alcohol Brief intervention. Diff. = Model-estimated mean differences in changes from baseline to 12 months in the drinking outcomes, BI vs. no BI.

Table 3

Effect of receiving ABI for unhealthy alcohol use on drinking outcomes at 12-month follow-up, by patient characteristics.

		ABI, Yes vs. No		
		Diff. (95%CI)	**P value**	**Interaction P value**
Outcome = change in drinks/drinking day				
Baseline alcohol consumption level				0.009
	Exceeding only daily limits	−0.48 (−0.63, −0.34)	< .001	
	Exceeding only weekly limits	0.38 (0.11, 0.64)	0.005	
	Exceeding both daily and weekly limits	−1.30 −2.35, −0.24)	0.016	
Sex				0.144
	Female	−0.09 (− 0.32, 0.14)	0.449	
	Male	−0.35 (− 0.62, − 0.08)	0.011	
Age group				0.181
	18–24	−0.70 (− 1.14, − 0.26)	0.002	
	25–34	−0.27 (− 0.63, 0.09)	0.136	
	35–44	0.16 (− 0.36, 0.68)	0.557	
	45–64	−0.26 (− 0.62, 0.11)	0.174	
	65 +	−0.30 (− 0.71, 0.11)	0.158	
AUD diagnosis 1Y prior				0.116
	Yes	1.31 (− 0.75, 3.38)	0.259	
	No	−0.35 (− 0.53, − 0.16)	< .001	
Race/Ethnicity				0.923
	Asian/Pacific Islander	−0.39 (− 0.86, 0.07)	0.099	
	Black	−0.21 (− 1.05, 0.62)	0.616	
	Hispanic	−0.20 (− 0.67, 0.27)	0.402	
	White	−0.27 (− 0.51, − 0.03)	0.025	
	Other	0.081 (− 0.85, 1.01)	0.865	
Outcome = change in drinking days/week				
Baseline alcohol consumption level				0.125
	Exceeding only daily limits	−0.07 (− 0.10, − 0.04)	< .001	
	Exceeding only weekly limits	−0.03 (− 0.09, 0.03)	0.323	
	Exceeding both daily and weekly limits	0.02 (− 0.07, 0.11)	0.615	
Sex				0.649
	Female	−0.05 (− 0.09,<− 0.01)	0.034	
	Male	−0.03 (− 0.07,<0.01)	0.085	
Age group				0.159
	18–24	0.01 (− 0.06, 0.07)	0.808	
	25–34	−0.06 (− 0.12, − 0.01)	0.029	
	35–44	−0.04 (− 0.11, 0.03)	0.225	

		ABI, Yes vs. No		
		Diff. (95%CI)	**P value**	**Interaction P value**
	45–64	−0.08 (− 0.14, − 0.02)	0.005	
	65+	0.01 (− 0.06, 0.08)	0.819	
AUD diagnosis 1Y prior				0.039
	Yes	0.19 (− 0.03, 0.41)	0.095	
	No	−0.05 (− 0.07, − 0.02)	0.002	
Race/Ethnicity				0.607
	Asian/Pacific Islander	0.01 (− 0.08, 0.10)	0.819	
	Black	−0.05 (− 0.17, 0.08)	0.466	
	Hispanic	−0.03 (− 0.09, 0.03)	0.326	
	White	−0.05 (− 0.09, − 0.02)	0.004	
	Other	0.03 (− 0.13, 0.20)	0.698	
	ABI, Yes vs. No Diff. (95%CI)	P value	Interaction P value	
Outcome = change in drinks/drinking day				
Baseline alcohol consumption level				0.009
	Exceeding only daily limits	−0.10 (− 0.14, − 0.06)	< .001	
	Exceeding only weekly limits	−0.03 (− 0.08, 0.02)	0.233	
	Exceeding both daily and weekly limits	0.06 (− 0.06, 0.17)	0.341	
Sex				0.890
	Female	−0.05 (−0.08, − 0.01)	0.012	
	Male	−0.05 (−0.09, <−0.01)	0.030	
Age group				0.001
	18–24	−0.18 (−0.28, − 0.07)	0.001	
	25–34		0.060	
		−0.07 (−0.15, <−0.01)		
	35–44	−0.06 (−0.15, 0.02)	0.124	
	45–64	−0.03 (−0.08, 0.02)	0.221	
	65 +	0.04 (<−0.01, 0.07)	0.064	
AUD diagnosis 1Y prior				0.436
	Yes	0.05 (−0.21, 0.32)	0.708	
	No	−0.06 (−0.09, − 0.02)	< .001	
Race/Ethnicity				0.600
	Asian/Pacific Islander	−0.10 (−0.21, 0.01)	0.082	
	Black	−0.02 (−0.15, 0.11)	0.763	
	Hispanic	−0.09 (−0.19, <0.01)	0.062	
	White	−0.04 (−0.07, <−0.01)	0.025	
	Other	0.03 (−0.15, 0.21)	0.765	
Outcome = change in drinks/week				
Baseline alcohol consumption level				0.163

		ABI, Yes vs. No		
		Diff. (95%CI)	**P value**	**Interaction P value**
	Exceeding only daily limits	−0.24 (−0.33, − 0.15)	< .001	
	Exceeding only weekly limits	−0.36 (−0.60, − 0.12)	0.004	
	Exceeding both daily and weekly limits	0.21 (−0.33, 0.75)	0.440	
Sex				0.801
	Female	−0.15 (−0.29, − 0.02)	0.025	
	Male	−0.13 (−0.30, 0.05)	0.164	
Age group				0.487
	18–24	−0.28 (−0.59, 0.02)	0.071	
	25–34	−0.15 (−0.41, 0.10)	0.241	
	35–44	−0.06 (−0.40, 0.28)	0.728	
	45–64	−0.26 (−0.49, −0.03)	0.028	
	65 +	−0.01 (−0.22, 0.21)	0.935	
AUD diagnosis 1Y prior				0.218
	Yes	0.68 (−0.68, 2.04)	0.328	
	No	−0.18 (−0.29, − 0.06)	0.002	
Race/Ethnicity				0.329
	Asian/Pacific Islander	−0.11 (−0.43, 0.22)	0.520	
	Black	0.19 (−0.32, 0.70)	0.464	
	Hispanic	−0.35 (−0.68, − 0.01)	0.043	
	White	−0.17 (−0.31, − 0.02)	0.021	
	Other	0.26 (−0.41, 0.94)	0.443	

AUD=Alcohol use disorder. ABI=Alcohol Brief intervention. NS=Non-significant at $p < 0.05$ level. Diff. = Model-estimated mean differences in changes from baseline to 12 months in the drinking outcomes, ABI vs. no ABI.

Table 4

Associations between receiving specialty alcohol use disorder treatment and drinking outcomes at 12-month follow-up, overall and by patient characteristics.

		Specialty AUD Treatment, Yes vs. No		
		Diff. (95% CI)	P value	Interaction P value
Outcome = change in heavy drinking days				
Overall		−3.20 (−3.98, −2.43)	< .001	
Baseline alcohol consumption level				< .001
	Exceeding only daily limits	−0.89 (−1.43, −0.34)	0.002	
	Exceeding only weekly limits	−0.05 (−0.64, 0.53)	0.860	
	Exceeding both daily and weekly limits	−10.76 (−13.69, −7.82)	< .001	
Sex				0.021
	Female	−2.32 (−3.20, −1.45)	< .001	
	Male	−4.07 (−5.27, −2.87)	< .001	
Age group				0.005
	18–24	−2.86 (−5.37, −0.35)	0.026	
	25–34	−2.37 (−4.44, −0.30)	0.025	
	35–44	−7.40 (−10.64, −4.16)	< .001	
	45–64	−3.29 (−4.34, −2.24)	< .001	
	65 +	−1.49 (−2.47, −0.52)	0.003	
AUD diagnosis 1Y prior				0.003
	Yes	−6.54 (−9.31, −3.76)	< .001	
	No	−2.14 (−2.94, −1.35)	< .001	
Race/Ethnicity				0.105
	Asian/Pacific Islander	−4.05 (−7.44, −0.67)	0.019	
	Black	−1.72 (−3.34, −0.09)	0.038	
	Hispanic	−4.95 (−8.08, −1.82)	0.002	
	White	−2.87 (−3.66, −2.09)	< .001	
	Other	−8.61 (−14.56, −2.66)	0.005	
Outcome = change in drinking days/week				
Overall		−0.83 (−0.92, −0.74)	< .001	
Baseline alcohol consumption level				< .001
	Exceeding only daily limits	−0.12 (−0.22, −0.02)	0.015	
	Exceeding only weekly limits	−0.77 (−0.92, −0.62)	< .001	
	Exceeding both daily and weekly limits	−1.33 (−1.56, −1.09)	< .001	
Sex				0.192
	Female	−0.77 (−0.89, −0.64)	< .001	
	Male	−0.89 (−1.03, −0.75)	< .001	
Age group			< .001	
	18–24	−0.61 (−0.95, −0.27)	< .001	

		Specialty AUD Treatment, Yes vs. No		
		Diff. (95% CI)	**P value**	**Interaction P value**
	25–34	−0.93 (−1.18, −0.68)	< .001	
	35–44	−1.14 (−1.43, −0.85)	< .001	
	45–64	−0.81 (−0.96, −0.66)	< .001	
	65 +	−0.35 (−0.51, −0.19)	< .001	
AUD diagnosis 1Y prior				0.117
	Yes	−0.98 (−1.28, −0.68)	< .001	
	No	−0.73 (−0.83, −0.63)	< .001	
Race/Ethnicity				0.709
	Asian/Pacific Islander	−0.71 (−1.14, −0.27)	0.002	
	Black	−0.81 (−1.12, −0.49)	< .001	
	Hispanic	−0.82 (−1.09, −0.55)	< .001	
	White	−0.79 (−0.89, −0.68)	< .001	
	Other	−1.42 (−2.31, −0.54)	0.002	
		Specialty AUD Treatment, Yes vs. No Diff. (95% CI)		
Outcome = change in drinks/drinking day				
	Overall	−0.59 (−0.70, −0.48)	< .001	
Baseline alcohol consumption level				< .001
	Exceeding only daily limits	−0.11 (−0.25, 0.03)	0.123	
	Exceeding only weekly limits	−0.40 (−0.52, −0.27)	< .001	
	Exceeding both daily and weekly limits	−1.20 (−1.53, −0.87)	< .001	
Sex				0.006
	Female	−0.44 (−0.55, −0.34)	< .001	
	Male	−0.73 (−0.90, −0.55)	< .001	
Age group				< .001
	18–24	−0.36 (−1.05, 0.33)	0.304	
	25–34	−0.95 (−1.32, −0.57)	< .001	
	35–44	−1.21 (−1.59, −0.82)	< .001	
	45–64	−0.58 (−0.71, −0.46)	< .001	
	65 +	−0.25 (−0.34, −0.15)	< .001	
AUD diagnosis 1Y prior				0.001
	Yes	−1.08 (−1.45, −0.72)	< .001	
	No	−0.44 (−0.55, −0.34)	< .001	
Race/Ethnicity				0.546
	Asian/Pacific Islander	−0.59 (−1.07, −0.10)	0.017	
	Black	−0.56 (−0.83, −0.29)	< .001	
	Hispanic	−0.85 (−1.27, −0.44)	< .001	
	White	−0.57 (−0.68, −0.47)	< .001	
	Other	−1.12 (−1.98, −0.25)	0.011	

		Specialty AUD Treatment, Yes vs. No		
		Diff. (95% CI)	**P value**	**Interaction P value**
Outcome = change in drinks/week				
Overall		−4.21 (−4.84, −3.57)	< .001	
Baseline alcohol consumption level				< .001
	Exceeding only daily limits	0.266 (−0.27, 0.80)	0.336	
	Exceeding only weekly limits	−2.94 (−3.71, −2.17)	< .001	
	Exceeding both daily and weekly limits	−9.13 (−11.27, −7.00)	< .001	
Sex				< .001
	Female	−3.00 (−3.55, −2.44)	< .001	
	Male	−5.27 (−6.32, −4.22)	< .001	
Age group				< .001
	18–24	−1.42 (−4.34, 1.50)	0.340	
	25–34	−5.88 (−8.22, −3.55)	< .001	
	35–44	−7.17 (−9.65, −4.68)	< .001	
	45–64	−4.23 (−5.02, −3.43)	< .001	
	65 +	−1.26 (−1.82, −0.69)	< .001	
AUD diagnosis 1Y prior				0.002
	Yes	−6.90 (−9.14, −4.66)	< .001	
	No	−3.27 (−3.89 −2.65)	< .001	
Race/Ethnicity				0.422
	Asian/Pacific Islander	−4.10 (−6.74, −1.45)	0.002	
	Black	−3.86 (−5.36, −2.36)	< .001	
	Hispanic	−5.41 (−7.86, −2.95)	< .001	
	White	−3.80 (−4.44, −3.15)	< .001	
	Other	−7.86 (−12.92, −2.79)	0.002	

AUD=Alcohol use disorder. NS=Non-significant at $p < 0.05$ level. Diff. = Model-estimated mean differences in changes from baseline to 12 months in the drinking outcomes between those who did and did not receive specialty AUD treatment.