Published in final edited form as:

Alcohol Clin Exp Res. 2016 October ; 40(10): 2240–2246. doi:10.1111/acer.13198.

Neighborhood-level drinking norms and alcohol intervention outcomes in HIV patients who are heavy drinkers

Jennifer C. Elliott, PhD^{1,2}, Erin Delker, MPH^{1,3}, Melanie M. Wall, PhD^{1,2,4}, Tianshu Feng, MS¹, Efrat Aharonovich, PhD^{1,2}, Melissa Tracy, PhD, MPH⁵, Sandro Galea, MD, DrPH⁶, Jennifer Ahern, PhD, MPH⁷, Aaron L. Sarvet, MPH¹, and Deborah S. Hasin, PhD^{1,2,8}

¹New York State Psychiatric Institute, New York, NY, USA

²Department of Psychiatry, Columbia University Medical Center, New York, NY, USA

³San Diego State University/University of California, San Diego Joint Doctoral Program in Public Health (Epidemiology), San Diego, CA, USA

⁴Department of Biostatistics, Mailman School of Public Health, Columbia University, New York, NY, USA

⁵Department of Epidemiology and Biostatistics, School of Public Health, University at Albany, State University of New York, Rensselaer, NY, USA

⁶School of Public Health, Boston University, Boston, MA, USA

⁷Division of Epidemiology, School of Public Health, University of California, Berkeley, CA, USA

⁸Department of Epidemiology, Mailman School of Public Health, Columbia University, New York, NY, USA

Abstract

Background—Heavy alcohol consumption can be harmful, particularly for individuals with HIV. There is substantial variability in response to interventions that aim to reduce drinking. Neighborhood drinking norms may explain some of this variability among HIV patients. Therefore, we investigated whether neighborhood-level drinking norms modified response to alcohol intervention among HIV-infected heavy drinkers.

Methods—Heavily-drinking HIV comprehensive care patients (n=230) completed one of three brief alcohol interventions (an educational intervention, a motivational interviewing [MI] intervention, or an MI intervention with a technological enhancement called HealthCall). Drinking was reported at baseline and end-of-treatment (60 days). Neighborhood-level drinking norms were obtained from a separate general population study.

Results—Patients' reductions in drinks per drinking day in response to MI (as compared with the educational control) were more pronounced in neighborhoods with more permissive drinking norms. In contrast, patients' reductions in drinks per drinking day in response to MI plus HealthCall did not significantly vary between neighborhoods with different drinking norms.

Norms did not evidence significant interactions with intervention condition for three other exploratory drinking outcomes (drinking frequency, binge frequency, maximum quantity).

Conclusions—Neighborhood-level drinking norms help explain differential response to an alcohol MI intervention among HIV patients. This study suggests the utility of considering neighborhood context as an effect modifier of alcohol interventions.

Keywords

HIV; alcohol; neighborhood; norms; intervention

Introduction

Heavy drinking and alcohol dependence are among the leading causes of preventable mortality in the United States (McGinnis and Foege, 1993, Mokdad et al., 2004). However, rates of treatment for alcohol problems declined in the 1970s and 1980s (Hasin et al., 1990) and remain low (Hasin et al., 2007, Grant et al., 2015). Meta-analyses of randomized trials support the efficacy of pharmacologic and behavioral treatments for alcohol problems (Bertholet et al., 2005, Srisurapanont and Jarusuraisin, 2005, Rubak et al., 2005, Maisel et al., 2013). However, interventions are not effective for all persons receiving them. Much remains to be learned about why some individuals respond to alcohol interventions while others do not.

Research on alcohol use and response to alcohol intervention often focuses on individual-level predictors. However, all individual behaviors occur in larger environmental contexts, and appreciation is growing that incorporating information about such contexts is also important to understanding health behaviors and outcomes. Growing evidence for the importance of environmental factors in alcohol studies includes considerable epidemiologic evidence showing that neighborhood socioeconomic inequality (Galea et al., 2007b, Galea et al., 2007a), drinking-related laws (Plunk et al., 2013), alcohol outlet density (Schootman et al., 2013, Ahern et al., 2013, Kavanagh et al., 2011, Theall et al., 2011, Richardson et al., 2015), and social norms (Keyes et al., 2012, Shmulewitz et al., 2012, Ahern et al., 2008) are associated with individual-level drinking and alcohol use disorders.

Since environmental factors relate to the level of individuals' alcohol involvement, such factors may also relate to whether individuals can decrease their drinking in response to drinking-reduction interventions. Influences at a broad environmental level have been successfully incorporated into efforts to understand the effects of other types of interventions, particularly interventions targeting externalizing behaviors in youth. For example, one study (Shaw et al., 2015) found that effectiveness of an intervention to reduce child conduct problems was only found among families living in neighborhoods with moderate (versus extreme) levels of deprivation. Similarly, another study (Robinson et al., 2015) found that parental monitoring only reduced juvenile delinquency behaviors for families residing in higher- (vs. lower-) income neighborhoods. Although we are aware of no previous studies on environmental moderators of the efficacy of alcohol interventions, these studies suggest that measuring and incorporating environmental information into the analysis of clinical trial data may improve our understanding of differential alcohol

outcomes across patients. Because drinking is largely a social activity, neighborhood-level social attitudes toward drinking present a particularly relevant environmental factor to examine in explaining alcohol intervention outcomes.

To investigate this possibility, we used data from a comparative efficacy trial testing three brief alcohol interventions in a sample of HIV-infected heavy drinkers (Hasin et al., 2013). Because heavy drinking is associated with delayed HIV testing and treatment, reduced medication adherence, and organ damage in HIV patients (Bryant et al., 2010), a better understanding of factors affecting response to alcohol interventions is particularly important in this high-risk population. In the referenced clinical trial, efficacy in reducing drinking quantity was found for a technologically-enhanced motivational interviewing intervention (Hasin et al., 2013). In another analysis of this dataset, we demonstrated that neighborhood-level drinking norms were associated with HIV patients' baseline drinking (Elliott et al., in press), suggesting that neighborhood contextual factors may also influence their drinking after intervention. However, whether neighborhood norms modified the intervention effect (or any other effect of intervention) remained unknown. Therefore, in the current study, we evaluated whether intervention efficacy was modified by neighborhood-level drinking norms. Specifically, we tested whether patients' reductions in drinking quantity in response to motivational interviewing based interventions (compared with an educational control) differed according to neighborhoods' environmental approval of drinking. We also tested, on an exploratory basis, whether intervention condition interacted with neighborhood norms in predicting drinking frequency, maximum quantity, or binge frequency. This study was undertaken (a) to better understand differential alcohol treatment outcomes in HIV primary care, and (b) to determine initial proof-of-concept that investigation of neighborhood-level norms has utility in understanding alcohol intervention trial results.

Materials and Methods

Participants and procedures

Our sample was taken from a randomized clinical trial (n=254) that assessed the efficacy of three brief alcohol interventions in a large urban HIV comprehensive care clinic from 2007 to 2010 (Hasin et al., 2013). Eligible participants were HIV-infected adults who spoke English or Spanish, who had at least one occasion of heavy drinking (four or more drinks on one occasion) in the month preceding enrollment, and who were not psychotic, suicidal, or grossly cognitively impaired (Hasin et al., 2013). At baseline, patients drank heavily (drinks per drinking day: $M = 7.0$ [s.d. = 3.8]; percent days abstinent: $M = 68.1$ [s.d. = 24.3]), and approximately half of the sample (48.4%) met criteria for alcohol dependence (Hasin et al., 2013). Patients were randomized to one of three brief interventions as part of the trial: a DVD educational intervention, a motivational interviewing (MI) intervention, or an MI intervention with an interactive voice response (IVR) technological enhancement called HealthCall (Hasin et al., 2013). In the main trial, MI+HealthCall was significantly better than the educational control at reducing drinking quantity; MI-only was only marginally better than the educational control (Hasin et al., 2013). Drinking frequency did not differ by treatment condition.

Of the 254 patients who provided baseline data and participated in the trial, 244 reported a baseline residential address in New York City (NYC), and of these, 230 completed the follow up assessment 60 days after baseline. These 230 patients comprised the sample for the current study. Patients were distributed throughout fifty-one of the fifty-nine NYC community districts, across all five boroughs of New York City, with a median of 4 patients per community district (Elliott et al., in press). Statistical simulation studies consistently show little to no bias in the estimates of the fixed effects in multilevel models even when the cluster size contains less than 10 subjects (Bell et al., 2014, Clarke, 2008, Maas and Hox, 2004, Maas and Hox, 2005). The 230 patients were primarily male (77.4%), African American (49.6%) or Hispanic (44.8%), middle aged ($M = 45.6$; $SD = 8.23$), and had not completed any college education (89.1%). Retention was excellent: 98.8% of participants in the DVD group attended their 30-day and 60-day visits; 95.0% of participants in the MI-only group attended their 30-day and 60-day visits; and 92.4% and 88.6% of participants in the MI+HealthCall group attended their 30-day and 60-day visits, respectively.

Intervention conditions

Motivational Interviewing (MI) only—At baseline, patients completed a 20-25 minute individual MI session with a study counselor. Consistent with MI recommendations (Miller and Rollnick, 2002), counselors used client-centered techniques to elicit patient motivation and commitment to change drinking. Patients also received brief 10-minute booster sessions 30 and 60 days later, where progress was reviewed and drinking-reduction goals were re-evaluated.

MI+HealthCall—At baseline, patients completed the same MI session as the MI-only group. Following this session, patients were introduced to HealthCall and asked to use this program daily. HealthCall involved 60 days of patient use of a telephone interactive voice response (IVR) system (1–3 minutes each day) to self-monitor alcohol use and other health behaviors. Patients' HealthCall drinking data were summarized in personalized feedback graphs that were presented to patients by their MI counselors at 30 and 60 days, to facilitate brief (~10 minute) discussions of patients' drinking.

Educational intervention (control)—At baseline, patients were told by the study counselor that they drank more than was medically advisable, and were shown a 30-minute DVD on HIV self-care that did not specifically address alcohol. At the end of the session, patients received a pamphlet on drinking reduction. At 30 and 60 day follow-up sessions with their study counselor, patients reported on their drinking, and received continued advice to decrease drinking.

Measures

Alcohol consumption—Patients reported on alcohol consumption over the prior 30 days at baseline and end-of-treatment (60 days post-baseline) using the TimeLine FollowBack (TLFB) assessment (Sobell, 1995). This measure is used widely in clinical research and has demonstrated reliability (Sobell et al., 1979, Sobell et al., 1988, Sobell et al., 1986) and validity (Grant et al., 1995b, Carey, 1997). We calculated four alcohol variables from this measure: drinks per drinking day, drinking frequency (days drank), maximum drinks on an

occasion, and binge drinking frequency (i.e., days drank five drinks [for men] or four drinks [for women]). Drinks per drinking day, for which a main effect was found in the main clinical trial, was assessed as the primary outcome. The other three drinking variables (drinking frequency, maximum drinks, and binge frequency) were also assessed on an exploratory basis. Some patients reported no alcohol use during the end-of-treatment assessment period; we calculated drinks per drinking day for those who drank ($n=165$), and maximum drinks for all patients (including zero values for abstainers) ($n=230$).

Neighborhood-level drinking and drunkenness norms—Norms regarding the acceptability of drinking and drunkenness in each NYC community district were taken from the New York Social Environment Study (NYSES), a large NYC population-based study conducted in 2005 (Ahern et al., 2008). Norm items administered in the NYSES, adapted from the National Survey on Drug Use and Health (Substance Abuse and Mental Health Services Administration, 2007), inquired about respondents' attitudes regarding (a) the acceptability of adults drinking alcoholic beverages and (b) the acceptability of adults getting drunk at least once per week (response options: “acceptable,” “unacceptable,” and “don't care”). For each of the fifty-nine NYC community districts, these NYSES responses were summarized as the percent of residents who felt that any drinking was unacceptable, and the percent of residents who felt that weekly drunkenness was unacceptable. These neighborhood-level norms have demonstrated associations with individual-level alcohol use in the NYC general population (Ahern et al., 2008), and the drunkenness norm in particular has demonstrated associations with individual-level maximum drinking quantity in this HIV-infected sample (Elliott et al., in press). The average percentage of NYSES persons that felt that any drinking was unacceptable across the 51 community districts used in our analyses was 33.0 percent (s.d. = 13.5) and the average percentage of persons that felt that weekly drunkenness was unacceptable was 76.9 percent (s.d. = 7.5) (Elliott et al., in press). We geocoded our 230 trial participants' residential addresses to NYC community districts using the “NYCityMap” geocoding service (NYC.gov, 2015), allowing us to assign each participant two neighborhood-level norms (regarding drinking and drunkenness) based on their community district. Neighborhood-level drinking and drunkenness norms did not differ by treatment condition (p s = 0.25 and 0.67, respectively).

Control covariates—Individual-level covariates included patient age (in years), sex (male or female), race (Hispanic [the reference group], African American, White), education (any college education versus none), past year household income (median dollar value of indicated income range), and alcohol dependence status (present or absent). Alcohol dependence status was included as a control covariate because differential treatment effects by alcohol dependence status were previously found in this sample (Hasin et al., 2013). Alcohol dependence was assessed according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) (American Psychiatric Association, 1994), using the reliable and valid Alcohol Use Disorder and Associated Disabilities Interview Schedule (AUDADIS) (Canino et al., 1999, Grant et al., 2003, Grant et al., 1995a, Hasin et al., 1997, Hasin et al., 2007). In addition to these individual-level covariates, we also included community-level median household income as a community-level socioeconomic indicator covariate, obtained from the 2000 census (Department of City Planning (DCP)).

Analysis Plan

All analyses were performed using the SAS 9.3 statistical software program (SAS Institute Inc.). Initially, variables were examined descriptively. Then, potential interactions between alcohol intervention type and neighborhood-level norms (regarding drinking or drunkenness) on end-of-treatment drinking outcomes were estimated using multilevel models in SAS Proc Glimmix. Separate models were fit for each of the four outcomes, including the primary outcome (drinks per drinking day) and the other three exploratory outcomes (drinking frequency, maximum quantity, and binge frequency). Negative binomial models were used due to the distribution shapes of the drinking outcome variables. Each model included a random intercept to account for clustering of individuals within community districts. In models testing drinks per drinking day and drinking frequency outcomes, models included neighborhood unacceptability of drinking, intervention condition, and their interaction as predictors. In models testing maximum drinks per occasion and binge drinking frequency outcomes, models included neighborhood unacceptability of drunkenness, intervention condition, and their interaction as predictors. Following pre-planned analyses, intervention was tested for its interaction with unacceptability of any drinking in models testing drinks per drinking day and drinking frequency because these outcomes assessed typical drinking (which could include any level of drinking); interaction with unacceptability of drunkenness was chosen in models testing maximum drinks and binge frequency because this norm appeared most relevant to excessive drinking. These hypotheses are consistent with prior research in the NYSES showing that drinking norms were particularly associated with moderate drinking, while drunkenness norms were particularly associated with heavy drinking (Ahern et al., 2008). All models included covariates to control for confounding, at both the individual level (age, sex, race, education, household income, alcohol dependence, baseline measure of the alcohol outcome variable) and community district level (median household income). For any significant interactions, results were illustrated by estimating intervention effects at several levels of the neighborhood norm (25th percentile, 50th percentile, 75th percentile).

Results

Patient drinking at end-of-treatment

At 60 days (end-of-treatment), the average number of days patients drank in the past 30 days was 5.0 (s.d.=6.4). Among the 165 patients who drank, their average number of drinks per drinking day was 4.1 (s.d.=2.7). In regard to heavy drinking, the average number of binge drinking days in the past 30 days was 3.0 (s.d.=5.6), and the average number of drinks consumed on the past 30 days' maximum drinking occasion (including zero values for abstainers) was 3.7 (s.d.=4.1).

Neighborhood-level norms and individual-level intervention outcome

Results for full interaction models are presented in Table 1. For the primary outcome, mean drinks per drinking day, the interaction between neighborhood unacceptability of drinking and treatment condition was significant. Specifically, treatment effects for MI versus DVD differed according to level of neighborhood unacceptability of drinking (Count Ratio = 8.27, $p=0.01$), whereas treatment effects for MI+HealthCall versus DVD did not (Count Ratio =

2.65, $p=0.24$). The interactions between neighborhood norms and treatment condition were not significant for exploratory drinking frequency, binge frequency, or maximum drinks outcomes.

To better illustrate the significant interaction for the drinks per drinking day outcome, estimations of intervention effects at several levels of neighborhood unacceptability of drinking are presented in Table 2. As shown, MI-only demonstrated greater efficacy than the DVD control condition at reducing drinking quantity only at lower levels of neighborhood unacceptability of drinking (i.e., only in more permissive neighborhoods); this effect was lost as neighborhood unacceptability increased (i.e., as neighborhoods became more restrictive).

Discussion

In this sample of HIV comprehensive care patients, we found that the effect of MI-only on mean drinks per drinking day was stronger than an educational control condition only among patients living in neighborhoods with more permissive drinking norms. Notably, the norms that were important were those addressing approval of any drinking, and not approval of drunkenness. However, when MI was supplemented with a technological enhancement involving tracking and feedback (HealthCall), the efficacy of the intervention in reducing drinking quantity did not differ by neighborhood permissiveness. Neighborhood-level norms did not moderate the effect of the interventions on the exploratory drinking outcomes, i.e., drinking frequency, maximum quantity, or binge frequency (none of which evidenced main intervention effects). Although the current study requires replication, these preliminary findings highlight the potential relevance of environmental context to a highly important drinking outcome for HIV patients: the quantity they consume on the days that they drink. This study also represents the first use of neighborhood-level drinking norms to better understand alcohol intervention results.

Our findings emphasize the value of using broad environmental factors to understand individual-level response to alcohol intervention. The findings are consistent with previous studies showing the relevance of neighborhood-level factors such as alcohol outlet density (Theall et al., 2011, Kavanagh et al., 2011, Ahern et al., 2013, Schootman et al., 2013, Richardson et al., 2015), laws (Plunk et al., 2013), and drinking norms (Ahern et al., 2008, Keyes et al., 2012, Shmulewitz et al., 2012) to individual-level drinking. The findings are also consistent with studies showing that neighborhood-level factors can modify responses to interventions for externalizing problems other than drinking, e.g., childhood conduct problems, juvenile delinquency (Shaw et al., 2015, Robinson et al., 2015). Yet, importantly, this study provides preliminary findings on the potential utility of this strategy to help understand variability in alcohol intervention results. Although largely exploratory and in need of replication, our study may thus serve as a proof of concept, and as a model for future studies incorporating group-level contextual factors to better understand individual differences in alcohol treatment efficacy.

This study has certain limitations

First, concerning generalizability about alcohol intervention efficacy, data were collected from one trial of patients receiving brief educational and motivational interviewing interventions. More research is needed to replicate this finding, and to determine its generalizability to other behavioral and pharmacologic treatments for heavy drinking. Second, regarding generalizability to other populations, the current study was conducted with HIV patients, a population that is homogeneous in medical diagnosis, and is primarily minority and more likely to face certain social disadvantages. Additional research is needed to determine whether neighborhood-level factors also relate to response to alcohol intervention in other populations. However, the study nonetheless serves as a proof-of-concept for the utility of neighborhood-level norms in understanding alcohol intervention outcomes. Third, although we found that norms interacted with treatment condition in predicting the primary outcome, drinks per drinking day, this result was not found for other three exploratory drinking outcomes. This is likely due to the fact that drinks per drinking day was the primary outcome targeted for reduction in the trial, and the outcome that differed significantly across treatment groups (Hasin et al., 2013). Future studies should examine environmental modification of treatment effects when treatments target other specific drinking outcomes. Fourth, drinks per drinking day data, by definition, were only available for those who drank. Although this variable does not utilize the full sample, there is much debate in the alcohol literature on the most appropriate operationalization of drinking outcomes. The current definition (number of drinks among those who drink) is most appropriate to the current paper to maintain consistency with the primary outcome in the main clinical trial (for which a treatment effect was found). Finally, residential addresses were collected at baseline only. Although it is possible that one or more patients may have moved between baseline and end-of-intervention, this is a short window (60 days), and only a relevant concern if patients moved out of their community district. Although most individuals who move stay within the same county (United States Census Bureau, 2015), future studies should assess neighborhood repeatedly to ensure accuracy. The current study also has several notable strengths, including a novel research question, a large clinical trial sample with good retention, and availability of neighborhood norm data for our sample.

In sum, this study provides (a) preliminary findings demonstrating the relevance of neighborhood-level norms to the efficacy of different alcohol interventions on drinks per drinking day, and (b) a model for future alcohol intervention trials to incorporate group-level contextual factors such as neighborhood norms to better understand clinical trial outcomes. More specifically, this study yields valuable information for treating HIV patients. It suggests that MI alone may only be more efficacious than an educational control condition in reducing drinking quantity in permissive alcohol environments. These permissive environments are likely the neighborhoods that contain more pro-drinking influences, such as modeling of drinking behavior and pressure from peers to drink. The more intensive MI +HealthCall (which also includes daily tracking and periodic feedback) exerted effects on drinking quantity across a wider range of neighborhoods, suggesting that the features offered by HealthCall extended MI's reach to a greater range of patients. The MI interventions may exert their effects by enhancing self-awareness of drinking, by enhancing autonomy or self-efficacy to reduce drinking quantity (despite social pressure to drink), and/or through

collaborative goal-setting (which could provide positive social support to counter negative socio-environmental influences). Future research should examine the mechanisms through which these MI-based interventions are effective, and also clarify the mechanisms through which neighborhood norms exert their effects (e.g., by affecting participants' perceived norms; by affecting the presence/visibility of alcohol in the neighborhood; through moral/religious messages about alcohol). Future research could also examine why the effect of MI-only on drinking quantity is *only* found in permissive environments (e.g., whether permissive environments include a wider range of accepted drinking patterns, where there is more flexibility to change drinking in response to brief MI intervention; whether those drinking in restrictive environments are those who had been unable to change drinking despite social pressure to do so). This study also provides a preliminary proof of concept and demonstration that neighborhood-level factors may help explain previously unexplained variance in alcohol intervention trial results. Future studies should replicate this finding, and could apply this framework to alcohol intervention trials with different populations and treatment types. Continued work in these areas could further advance our understanding of the relevance of context to drinking, as well as how to best reduce drinking in different contexts.

Acknowledgments

This study was funded by National Institutes of Health grants R01AA014323 (Hasin), R01DA024606 (Aharonovich), R01DA017642 (Galea), K23AA023753 (Elliott), T32DA031099 (Hasin) and the New York State Psychiatric Institute. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. We thank Devon Spencer for her assistance in this project. We declare no conflict of interest.

References

- Ahern J, Galea S, Hubbard A, Midanik L, Syme SL. "Culture of drinking" and individual problems with alcohol use. *Am J Epidemiol*. 2008; 167:1041–1049. [PubMed: 18310621]
- Ahern J, Margerison-Zilko C, Hubbard A, Galea S. Alcohol outlets and binge drinking in urban neighborhoods: the implications of nonlinearity for intervention and policy. *Am J Public Health*. 2013; 103:e81–7.
- American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 4th. Author; Washington, DC: 1994.
- Bell BA, Morgan GB, Schoeneberger JA, Kromrey JD, Ferron JM. How Low Can You Go? An Investigation of the Influence of Sample Size and Model Complexity on Point and Interval Estimates in Two-Level Linear Models. *Methodology-Eur*. 2014; 10:1–11.
- Bertholet N, Daeppen JB, Wietlisbach V, Fleming M, Burnand B. Reduction of alcohol consumption by brief alcohol intervention in primary care: systematic review and meta-analysis. *Arch Intern Med*. 2005; 165:986–95. [PubMed: 15883236]
- Bryant KJ, Nelson S, Braithwaite RS, Roach D. Integrating HIV/AIDS and alcohol research. *Alcohol Res Health*. 2010; 33:167–78. [PubMed: 23584058]
- Canino G, Bravo M, Ramirez R, Febo VE, Rubio-Stipec M, Fernandez RL, Hasin D. The Spanish Alcohol Use Disorder and Associated Disabilities Interview Schedule (AUDADIS): reliability and concordance with clinical diagnoses in a Hispanic population. *J Stud Alcohol*. 1999; 60:790–9. [PubMed: 10606491]
- Carey KB. Reliability and validity of the time-line follow-back interview among psychiatric outpatients: A preliminary report. *Psychol Addict Behav*. 1997; 11:26–33.
- Clarke P. When can group level clustering be ignored? Multilevel models versus single-level models with sparse data. *J Epidemiol Community Health*. 2008; 62:752–758. [PubMed: 18621963]

- Department of City Planning (Dcp). [Accessed December 21, 2015] Census Demographics at the NYC Community District (CD) level. Feb 17. 2015 Available at: <https://data.cityofnewyork.us/City-Government/Census-Demographics-at-the-NYC-Community-District-5unr-w4sc>
- Elliott JC, Delker E, Wall MM, Feng T, Aharonovich E, Tracy M, Galea S, Ahern J, Hasin DS. Use of neighborhood-level drinking norms to explain individual-level drinking in HIV primary care. *JAIDS*. in press.
- Galea S, Ahern J, Tracy M, Rudenstine S, Vlahov D. Education inequality and use of cigarettes, alcohol, and marijuana. *Drug Alcohol Depend* 90 Suppl. 2007a; 1:S4–15.
- Galea S, Ahern J, Tracy M, Vlahov D. Neighborhood income and income distribution and the use of cigarettes, alcohol, and marijuana. *Am J Prev Med*. 2007b; 32:S195–202. [PubMed: 17543711]
- Grant BF, Dawson DA, Stinson FS, Chou PS, Kay W, Pickering R. The Alcohol Use Disorder and Associated Disabilities Interview Schedule-IV (AUDADIS-IV): reliability of alcohol consumption, tobacco use, family history of depression and psychiatric diagnostic modules in a general population sample. *Drug Alcohol Depend*. 2003; 71:7–16. [PubMed: 12821201]
- Grant BF, Goldstein RB, Saha TD, Chou SP, Jung J, Zhang H, Pickering RP, Ruan WJ, Smith SM, Huang B, Hasin DS. Epidemiology of DSM-5 Alcohol Use Disorder: Results From the National Epidemiologic Survey on Alcohol and Related Conditions III. *JAMA Psychiatry*. 2015; 72:757–66. [PubMed: 26039070]
- Grant BF, Harford TC, Dawson DA, Chou PS, Pickering RP. The Alcohol Use Disorder and Associated Disabilities Interview schedule (AUDADIS): reliability of alcohol and drug modules in a general population sample. *Drug Alcohol Depend*. 1995a; 39:37–44. [PubMed: 7587973]
- Grant KA, Tonigan JS, Miller WR. Comparison of three alcohol consumption measures: a concurrent validity study. *J Stud Alcohol*. 1995b; 56:168–72. [PubMed: 7760562]
- Hasin D, Carpenter KM, Mccloud S, Smith M, Grant BF. The alcohol use disorder and associated disabilities interview schedule (AUDADIS): reliability of alcohol and drug modules in a clinical sample. *Drug Alcohol Depend*. 1997; 44:133–41. [PubMed: 9088785]
- Hasin DS, Aharonovich E, O'leary A, Greenstein E, Pavlicova M, Arunajadai S, Waxman R, Wainberg M, Helzer J, Johnston B. Reducing heavy drinking in HIV primary care: a randomized trial of brief intervention, with and without technological enhancement. *Addiction*. 2013; 108:1230–40. [PubMed: 23432593]
- Hasin DS, Grant BF, Dufour MG, Endicott J. Alcohol problems increase while physician attention declines. 1967 to 1984. *Arch Intern Med*. 1990; 150:397–400. [PubMed: 2302015]
- Hasin DS, Stinson FS, Ogburn E, Grant BF. Prevalence, correlates, disability, and comorbidity of DSM-IV alcohol abuse and dependence in the United States: results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Arch Gen Psychiatry*. 2007; 64:830–42. [PubMed: 17606817]
- Kavanagh AM, Kelly MT, Krnjacki L, Thornton L, Jolley D, Subramanian SV, Turrell G, Bentley RJ. Access to alcohol outlets and harmful alcohol consumption: a multi-level study in Melbourne, Australia. *Addiction*. 2011; 106:1772–9. [PubMed: 21615583]
- Keyes KM, Schulenberg JE, O'malley PM, Johnston LD, Bachman JG, Li G, Hasin D. Birth cohort effects on adolescent alcohol use: the influence of social norms from 1976 to 2007. *Arch Gen Psychiatry*. 2012; 69:1304–13. [PubMed: 22868751]
- Maas CJM, Hox JJ. Robustness issues in multilevel regression analysis. *Stat Neerl*. 2004; 58:127–137.
- Maas CJM, Hox JJ. Sufficient sample sizes for multilevel modeling. *Methodology*. 2005; 1:86–92.
- Maisel NC, Blodgett JC, Wilbourne PL, Humphreys K, Finney JW. Meta-analysis of naltrexone and acamprosate for treating alcohol use disorders: when are these medications most helpful? *Addiction*. 2013; 108:275–93. [PubMed: 23075288]
- McGinnis JM, Foege WH. Actual causes of death in the United States. *JAMA*. 1993; 270:2207–12. [PubMed: 8411605]
- Miller, WR., Rollnick, S. *Motivational Interviewing: Preparing People for Change*. The Guilford Press; New York: 2002.
- Mokdad AH, Marks JS, Stroup DF, Gerberding JL. Actual causes of death in the United States, 2000. *JAMA*. 2004; 291:1238–45. [PubMed: 15010446]

- Nyc.Gov. [Accessed December 21, 2015] NYCityMap. 2015. Available at: <http://maps.nyc.gov/doitt/nycitymap/>
- Plunk AD, Cavazaos-Rehg P, Bierut LJ, Gruzca RA. The persistent effects of minimum legal drinking age laws on drinking patterns later in life. *Alcohol Clin Exp Res*. 2013; 37:463–9. [PubMed: 23347177]
- Richardson EA, Hill SE, Mitchell R, Pearce J, Shortt NK. Is local alcohol outlet density related to alcohol-related morbidity and mortality in Scottish cities? *Health Place*. 2015; 33:172–80. [PubMed: 25840352]
- Robinson BA, Winiarski DA, Brennan PA, Foster SL, Cunningham PB, Whitmore EA. Social context, parental monitoring, and multisystemic therapy outcomes. *Psychotherapy (Chic)*. 2015; 52:103–10. [PubMed: 25365153]
- Rubak S, Sandbaek A, Lauritzen T, Christensen B. Motivational interviewing: a systematic review and meta-analysis. *Br J Gen Pract*. 2005; 55:305–12. [PubMed: 15826439]
- Sas Institute Inc. SAS/STAT® Software. Version 9.3. Cary, NC: SAS Institute Inc; 2011.
- Schootman M, Deshpande AD, Lynskey MT, Pruitt SL, Lian M, Jeffe DB. Alcohol outlet availability and excessive alcohol consumption in breast cancer survivors. *J Prim Care Community Health*. 2013; 4:50–8. [PubMed: 23799690]
- Shaw DS, Sitnick SL, Brennan LM, Choe DE, Dishion TJ, Wilson MN, Gardner F. The long-term effectiveness of the Family Check-Up on school-age conduct problems: Moderation by neighborhood deprivation. *Dev Psychopathol*. 2015:1–16.
- Shmulewitz D, Wall MM, Keyes KM, Aharonovich E, Aivadyan C, Greenstein E, Spivak B, Weizman A, Frisch A, Hasin D. Alcohol use disorders and perceived drinking norms: ethnic differences in Israeli adults. *J Stud Alcohol Drugs*. 2012; 73:981–90. [PubMed: 23036217]
- Sobell L., Sobell M. Alcohol Timeline Followback (TLFB) Users Manual. Addiction Research Foundation; Toronto: 1995.
- Sobell LC, Maisto SA, Sobell MB, Cooper AM. Reliability of alcohol abusers' self-reports of drinking behavior. *Behav Res Ther*. 1979; 17:157–60. [PubMed: 426744]
- Sobell LC, Sobell MB, Leo GI, Cancilla A. Reliability of a timeline method: assessing normal drinkers' reports of recent drinking and a comparative evaluation across several populations. *Br J Addict*. 1988; 83:393–402. [PubMed: 3395719]
- Sobell MB, Sobell LC, Klajner F, Pavan D, Basian E. The reliability of a timeline method for assessing normal drinker college students' recent drinking history: utility for alcohol research. *Addict Behav*. 1986; 11:149–61. [PubMed: 3739800]
- Srisurapanont M, Jarusuraisin N. Naltrexone for the treatment of alcoholism: a meta-analysis of randomized controlled trials. *Int J Neuropsychopharmacol*. 2005; 8:267–80. [PubMed: 15850502]
- Substance Abuse and Mental Health Services Administration. National Survey on Drug Use & Health; 2007. Available at: <https://nsduhweb.rti.org/respweb/homepage.cfm> [Accessed December 21, 2015]
- Theall KP, Lancaster BP, Lynch S, Haines RT, Scribner S, Scribner R, Kishore V. The neighborhood alcohol environment and at-risk drinking among African-Americans. *Alcohol Clin Exp Res*. 2011; 35:996–1003. [PubMed: 21323681]
- United States Census Bureau. Migration/Geographic Mobility. 2015. Available at: <http://www.census.gov/hhes/migration/>

Table 1

Drinking outcomes predicted by neighborhood norms, intervention condition, and their interaction: Full interaction model results.

	Neighborhood Norm: Unacceptability of drinking			Neighborhood Norm: Unacceptability of drunkenness		
	Primary Outcome: Mean drinks per drinking day		Exploratory Outcome: Number of drinking days	Exploratory Outcome: Number of binge drinking days		Exploratory Outcome: Maximum number of drinks
	Count Ratio	p-value	Count Ratio	Count Ratio	p-value	Count Ratio
<i>Main effects</i>						
MI-only (ref: DVD)	0.43	<0.01	1.98	0.21	0.29	0.75
MI+HealthCall (ref: DVD)	0.54	0.03	1.17	2.01	0.66	0.21
Neighborhood norm ¹	0.30	0.13	1.13	0.54	0.70	2.24
<i>Interaction effect</i> ²						
Neighborhood norm ¹ × MI-only	8.27	0.01	0.13	8.63	0.26	1.57
Neighborhood norm ¹ × MI+HealthCall	2.65	0.24	0.79	0.52	0.75	7.35
<i>Control covariates</i>						
Neighborhood Household income ³	0.97	0.64	0.97	1.06	0.27	1.04
Individual Household income ³	0.97	0.29	0.96	0.99	0.89	1.01
Baseline alcohol dependence	1.38	<0.01	0.97	1.53	<0.01	1.52
Male (ref: Female)	1.13	0.27	1.48	1.06	0.70	1.12
White (ref: Hispanic)	0.96	0.85	1.11	1.05	0.85	1.19
Black (ref: Hispanic)	0.92	0.39	1.14	1.00	0.97	0.96
Age ⁴	1.00	0.92	0.95	1.02	0.64	0.93
No college education	0.79	0.07	0.75	1.30	0.19	0.60

Notes. Results are presented as exponentiated coefficients. Boxed results highlight results of primary importance to this paper. Bold indicates significance at p<0.05. Count ratios compare the different conditions against a reference condition.

¹Neighborhood norm is treated as a continuous variable.

²The omnibus test of the interaction of unacceptability of drinking with intervention condition in predicting mean drinks per drinking day was significant (d.f. = 2, p= 0.04); the other omnibus interaction results were not significant (ps>0.30).

³Individual and neighborhood household incomes are treated as continuous variables and scaled such that a one unit increase corresponds to a \$10,000 increase in household income.

⁴Age is treated as a continuous variable and scaled such that a one unit increase corresponds to a 5 year increase in age.

Intervention effects at selected levels of neighborhood unacceptability of drinking: Illustration of significant interaction between neighborhood drinking norm and intervention condition on drinks per drinking day.

Table 2

Neighborhood Norm: Unacceptability of drinking			
Count Ratio (95% CI) for Outcome: Mean drinks per drinking day ^I			
	Permissive neighborhood: (25th percentile)	Median neighborhood: (50th percentile)	Restrictive neighborhood: (75th percentile)
MI-only (vs. DVD)	0.68 (0.51-0.90)	0.90 (0.73-1.11)	1.07 (0.82-1.40)

Notes. Estimates are adjusted for control covariates at the individual level (age, sex, race, education, household income, alcohol dependence, baseline measure of alcohol variable) and community district level (median household income). Bold indicates that the effect of MI-only (vs. DVD) was significant in this neighborhood type.

^I Count ratios are estimated with the interaction model presented in Table 1. The 25th percentile of the neighborhood-level unacceptability of drinking was 21.0%, the median was 34.4% and the 75th percentile was 42.9%.