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Neighborhood Contextual Factors, Alcohol Use, and Alcohol Problems in the United States: Evidence from a Nationally-Representative Study of Young Adults

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Abstract

Background—There is considerable variation in alcohol use and problems across the United States, suggesting that systematic regional differences might contribute to alcohol involvement. Several neighborhood contextual factors may be important aspects of this “alcohol environment.”

Methods—Participants were 15,197 young adults (age 18–26) from Wave III of the National Longitudinal Study of Adolescent to Adult Health, a nationally-representative United States survey. Measures of past-year alcohol use and problems were obtained via structured in-home interviews. Tract-level neighborhood contextual factors (density of on- and off-premises alcohol outlets, neighborhood disadvantage, rural versus urban residence) were derived from census indicators and geocoded state-level alcohol outlet licenses. Multivariate logistic regression, ordered logistic regression, or negative binomial regression models, including age, sex, race, and household income as covariates, were fit to examine the relation of the neighborhood contextual factors with alcohol use and problems.

Results—The most consistent finding across four of the five measures of alcohol involvement was their association with neighborhood *advantage*; the active ingredient underlying this effect was primarily the proportion of educated residents in the neighborhood. The densities of alcohol outlets were associated with any alcohol use – they were not associated with binge drinking or alcohol problems, nor could they explain any of the neighborhood advantage effects. The influence of alcohol outlet densities on alcohol involvement did not differ for those above or below the legal age to purchase alcohol. Living in a rural versus an urban neighborhood was associated with a different alcohol use pattern characterized by a lower likelihood of any drinking, but among those who drank, consuming more alcohol per occasion.

Conclusions—Living in a more advantaged and educated urban neighborhood with greater densities of bars and restaurants is associated with greater alcohol involvement among 18–26-year-olds in the United States.

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Keywords

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Introduction

There is considerable regional variation in the amount of alcohol consumed and the proportion of individuals that suffer from an alcohol use disorder in the United States (e.g. Borders & Booth, 2007; Dwyer-Lindgren et al., 2015). This geographic variation is a clue that there may be important environmental factors contributing to alcohol involvement. Several neighborhood contextual factors, such as alcohol outlet density, neighborhood disadvantage, and rural versus urban residence may be important aspects of this “alcohol environment.”

Neighborhood alcohol outlet density

The most widely-discussed contributor to the “alcohol environment” is availability (Gruenewald et al., 2002; Gruenewald, 2011; Popova et al., 2009), in particular, the regional density of alcohol outlets (Campbell et al., 2009; Gruenewald, 2007). Alcohol availability theory posits that greater outlet density increases alcohol consumption by reducing the effective price of alcohol, that is, by decreasing the time and effort (“convenience costs”) of obtaining alcohol (Stockwell & Gruenewald, 2004). One of the ways in which geographic variation in alcohol involvement can arise is because alcohol outlet density is regulated at the state, and sometimes, at the local level (Treno et al., 2014).

There remain major gaps in the evidence base on the association between neighborhood alcohol outlet density and alcohol use and problems. In the United States, other than two studies across college campuses (Weitzman et al., 2003; Scribner et al., 2008), the studies have been regional. The alcohol outcomes are often limited to assessments of alcohol use rather than problems and focus almost exclusively on urban neighborhoods. Most studies conducted in the United States have yielded positive associations (Brenner et al., 2015; Gruenewald et al., 2002; Gruenewald et al., 2014; Schonlau et al., 2008; Scribner et al., 2000; Truong & Sturm, 2007), but studies have also yielded negative (Gruenewald et al., 2002), and no association (Pollack et al., 2005; Schonlau et al., 2008; Truong & Sturm, 2007) between outlet density and alcohol consumption.

Neighborhood disadvantage

It is relatively well established that alcohol outlet density is greater in more disadvantaged compared to more advantaged neighborhoods in the United States, at least in urban areas (Berke et al., 2007; Gorman et al., 1998; Romley et al., 2007). This suggests that alcohol use and problems may be greater in disadvantaged than in advantaged neighborhoods because of easier access to alcohol. In addition, much of the research on neighborhood disadvantage and alcohol involvement has been grounded in social disorganization theory (Sampson & Groves, 1989), which posits that living in a neighborhood characterized by poverty, ethnic diversity, and residential instability will impact the behavior of its residents through

neighborhood-level social processes (Gardner et al, 2010). A review of 27 studies of the relation between area-level socioeconomic status and alcohol use outcomes reported that 68% of the effects were non-significant and when there was a significant association, there were nearly as many studies that observed an association between neighborhood *advantage* (13.5%) as there were studies that observed an association between neighborhood *disadvantage* (18%) and alcohol involvement (Karriker-Jaffe, 2011). Mixed findings obtained when studying neighborhood disadvantage may be due to the inclusion of different alcohol outcomes, different ages of the samples, or differences in the operationalization of neighborhood disadvantage.

Rural versus urban residence

Most research that has examined influences of neighborhood contextual factors on alcohol involvement has been conducted in urban areas. Because poverty rates in rural areas have exceeded those in urban areas for as long as poverty rates were first officially recorded in 1960 (United States Department of Agriculture Economic Research Service, 2015), many of the issues thought to contribute to adverse outcomes in urban areas -- such as lack of access to resources and chronic economic strain (Jargowsky, 1998) -- may be as pertinent to rural neighborhoods. Therefore, rural versus urban residence may also contribute to geographic variation in alcohol use and problems. For example, a national survey conducted in 2001–2002 found higher rates of abstinence, and among those who drank, higher rates of past-year binge drinking and alcohol use disorder among rural compared to urban residents (Borders & Booth, 2007).

The present study

The current study was an examination of the extent to which alcohol outlet density, neighborhood disadvantage, and rural versus urban residence contributed to alcohol use and problems in a large nationally-representative United States sample of 18–26 year old young adults. This study is novel in that it (a) included the diverse array of neighborhoods found across the United States, from affluent urban neighborhoods with many local bars and restaurants to isolated and deprived rural neighborhoods with no local access to alcohol, (b) included a range of alcohol outcomes, from any use to experiencing alcohol-related problems, and (c) focused on the period of young adulthood, which is especially important and informative because it is when the risk for heavy alcohol consumption and alcohol use disorders is at its peak (e.g. Chassin et al., 2013; Naimi et al., 2003). Based on the weight of the (albeit mixed) evidence, we hypothesized that greater alcohol outlet density and neighborhood disadvantage would be associated with alcohol use and problems, and that residing in a rural versus an urban area would be associated with lower rates of any alcohol consumption but higher rates of problems.

Three sets of planned follow-up analyses addressed additional hypotheses. First, to our knowledge, there are no studies that have directly compared the strength of the associations between alcohol outlet densities and alcohol outcomes for those who are above and below the legal age to purchase alcohol. Our study of 18–26 year-olds is uniquely suited to address this question. Based on evidence of associations between outlet densities and alcohol use and alcohol problems that were of similar magnitude among a subsample of college students

who were underage compared to the full college student sample (Weitzman et al., 2003), we hypothesized that the strength of the association between alcohol outlet density and alcohol use and problems would not be moderated by whether one is old enough to legally purchase alcohol.

Second, a previous investigation directly tested and rejected the hypothesis that the influence of neighborhood disadvantage was explained by the greater densities of alcohol outlets in disadvantaged neighborhoods (Pollack et al., 2005). This is important to ascertain because it would represent a measurable and potentially modifiable mechanism underlying a neighborhood disadvantage effect. We revisited this critical issue by examining the influence of neighborhood disadvantage before and after adjusting for the influence of alcohol outlet densities. We hypothesized that the influence of neighborhood disadvantage would be partially but not completely explained by outlet densities.

Third, the many studies that have used a composite index of neighborhood disadvantage (e.g. Trim & Chassin, 2008; Stimpson et al., 2007) have left open the question of what might be driving the association with alcohol use and problems (Karriker-Jaffe, 2011). Therefore, in addition to a composite neighborhood disadvantage index, we also used specific indicators such as poverty, unemployment, and lack of education to explore the possible sources of the disadvantage effect.

Methods

Participants

Participants were drawn from the National Longitudinal Study of Adolescent to Adult Health (Add Health), a school-based study which used level of urbanization as one of the criteria for inclusion of a school. Of the 80 schools included in the Add Health study, 24 were urban, 42 were suburban, and 14 were rural. Variables of interest for the current study were obtained in Wave III (N = 15,197), which was conducted in 2001–2002 with a response rate of 77.4%. The mean age of the participants at Wave III was 22 years (range = 18–26¹, M = 22.0, SD = 1.78), and 53% of the participants were female. The participants came from 50 different states and from 5,938 different census tracts. The average number of participants per census tract was 2.51 (SD = 5.66, range = 1–112); 67% of the census tracts included a single participant (see Table 1).

Wave III participants completed extensive in-home interviews. All participants gave informed consent and the study was approved by the Institutional Review Board of the University of North Carolina at Chapel Hill. Neighborhood contextual variables were extracted from the 2000 United States census and state-level alcohol outlet licensing.

Measures

Alcohol use and problems—Participants were asked on how many days they had consumed alcohol in the past 12 months. A dichotomous ‘any alcohol use’ variable was based on endorsing drinking on at least one day in the past 12 months. Four indicators of

¹A small number of participants (24) were 27–28 years old.

past-year alcohol involvement were assessed: (1) the number of days consumed any alcohol, (2) the typical quantity of alcohol consumed, (3) the number of days consumed five or more drinks in a row (“heavy” episodic drinking), and (4) the number of days became “drunk or very high” on alcohol. The responses to the assessments of the frequency of any alcohol use, heavy drinking, and getting drunk were coded into the following categories: 0 (none), 1 (1 or 2 days in the past 12 months), 2 (once a month or less [3 to 12 times in the past 12 months]), 3 (2 or 3 days a month), 4 (1 or 2 days a week), 5 (3 to 5 days a week), and 6 (every day or almost every day). The response to the question about the typical quantity of alcohol consumed was coded as the actual number of drinks reported.

The occurrence (at least once) in the past year of eight alcohol problems was assessed: (1) had a problem at work or school, (2) had a problem with friends, (3) had a problem with a romantic partner, (4) had a hangover, (5) became nauseous or threw up (6) got into a sexual situation later regretted, (7) got into a physical fight because of drinking, and (8) got drunk at school or work. These were combined into a single continuous alcohol problems scale (coefficient $\alpha = 0.77$).

Household income—Past-year household income was included in the analyses to gauge the current financial resources of the participants. This represented the combined household income with a spouse or partner for 31% of the participants, the combined household income with parents for 33% of the participants, and the individual personal income for 36% of the participants.

State—The current state of residence was included in the analyses to account for differences between the states in alcohol control laws (Xuan et al., 2015). In order to preserve anonymity of the participants, the Add Health study developed randomly-assigned pseudo codes that uniquely identified the geographic units in which participants resided that were not linkable to outside data sources.

Alcohol outlet density—Alcohol outlet licensing data was gathered from individual states between September 2006 and June 2007. Data were obtained from 43 states and the District of Columbia; 34 of these provided both on-premises outlet (that is, alcohol sold to be consumed on site, including bars and restaurants) and off-premises outlet (that is, alcohol sold to be consumed elsewhere, such as liquor and convenience stores) licensing data. These data were aggregated at the census tract level. The number of on-premises and off-premises alcohol outlet licenses were divided by the total land area for each census tract to derive the density of outlets. The census tract-level density of on-premises and off-premises alcohol outlets was available for 87% of the participants.

Neighborhood disadvantage—Add Health matched data from the 2000 census to the participants’ region of residence for a number of variables related to neighborhood quality. Ten census indicators were combined into a single factor to characterize the participants’ census tracts. Several of the indicators were selected based on social disorganization theory (e.g., Sampson & Groves, 1989)². The factor included: (1) the proportion of single-parent homes, (2) the average of the proportion of individuals below the poverty line and the proportion of families living below the poverty line, (3) the proportion of African American

individuals, (4) the proportion of Latino/a individuals (the latter two individual variables performed better than a single racial diversity variable), (5) the average of the proportion of individuals over the age of 25 who did not have a high school diploma, and the proportion of individuals over the age of 25 who did not have a bachelor's degree, (6) the average of the proportion of houses that did not have a kitchen and did not have complete plumbing facilities, (7) the proportion of individuals over the age of 16 who were unemployed. After adding error correlations, fit indices indicated acceptable model fit (CFI = 0.93, RMSEA = 0.08, SRMR = 0.05). Factor scores were estimated for each participant and were used as the neighborhood disadvantage measure.

Rural versus urban residence—Rural-urban commuting area codes (RUCA; United States Department of Agriculture Economic Research Service, 2015), based on measures of population density, urbanization, and daily commuting from the 2000 census, were used to classify the 5,938 census tracts into the following four categories: metropolitan (5,201 census tracts), micropolitan (431 census tracts), small town (182 census tracts), and rural (124 census tracts). These four categories of urbanicity differed in their mean population densities: 2615, 413, 67, and 17 persons per square kilometer, respectively.

Data Analysis

Analyses were conducted with Stata statistical software (Stata/SE v. 13.0, StataCorp, College Station, TX) using survey procedures that incorporated sampling weights and accounted for the clustered design of the Add Health study. The effective sample size was 14,322 because sampling weights were unavailable for 875 (6%) of the participants. Multilevel modeling was not possible or necessary because the majority of the census tracts included a single participant.

Analyses were conducted using logistic regression for any alcohol use, ordered logistic regression for the frequency of drinking, heavy drinking, and getting drunk, and negative binomial regression for the typical quantity of alcohol use and the number of alcohol problems. Included in all of the models was the state of residence and the four neighborhood contextual factors (neighborhood disadvantage, on-premises and off-premise alcohol outlet densities, and urbanicity). The demographic characteristics of age, sex, race, and household income were included in the models as covariates.

State of residence was included in the models as a set of dummy codes with the state pseudo-coded '1' as the reference group. Age was included in the models as two dummy codes corresponding to ages 18–20 and ages 21–23, with the oldest group serving as the reference category. Race was included in the models as four dummy codes corresponding to Hispanic, Black, Asian, and Native American, with White as the reference category. Urbanicity was included in the models as three dummy codes corresponding to rural, small town, and micropolitan, with metropolitan serving as the reference category. The analyses of

²The goal was to include indicators of the following constructs from social disorganization theory: socioeconomic status, ethnic heterogeneity, family disruption, and residential (in)stability. However, the census indicator of residential instability (the proportion of individuals within a tract who had not resided at the same house for at least five years) had a negative factor loading on the disadvantage factor, and was therefore not retained.

any alcohol use were based on the full sample, whereas the analyses of the alcohol use indicators and alcohol problems were based on individuals who had consumed any alcohol in the past year.

After the overall models were tested, the follow-up analyses proceeded in three steps. The first step was to examine whether the effects of on-premises and off-premises outlet densities were different for individuals who had not yet reached the legal age to purchase alcohol compared to those who had. This was accomplished by replacing the age variables with an “underage” dummy variable indicating whether the participant was underage or not (coded ‘1’ for those 18–20 years of age, and ‘0’ for the remainder of the sample) and re-fitting the overall models with the underage dummy variable and two interaction terms involving the underage dummy variable and on-premises and off-premises outlet densities. The second step was to interrogate any instances in which neighborhood disadvantage was a significant predictor by replacing the composite neighborhood disadvantage factor in the models with the seven individual variables on which it was based. The third step was to test whether the effect of neighborhood disadvantage was mediated via differences in alcohol outlet densities. This was accomplished by re-fitting the overall models without the two outlet density indicators and comparing the parameter estimate for neighborhood disadvantage with and without alcohol outlet densities included in the models.

Results

All four of the neighborhood contextual factors were correlated. On-premises and off-premises alcohol outlet densities were significantly correlated with each other ($r = 0.74$) and were higher in more disadvantaged ($r = 0.17$ and 0.20) and in urban neighborhoods ($r = 0.33$ and 0.34), whereas neighborhood disadvantage was negatively associated with living in an urban neighborhood ($r = -0.22$).

Any alcohol use

There was a significant state of residence effect on any alcohol use in the past year ($p < .0001$). After the effect of state was removed, the census-tract-level density of on-premises alcohol outlets was significantly associated with any alcohol use in the past year (odds ratio [OR] = 1.19, $p < .001$; see Table 2). Figure 1 shows that the model-predicted proportions of alcohol use (holding all other variables in the model at their means) were 0.80 and 0.70 in the highest and lowest quartiles of on-premises density, respectively. Conversely, the density of off-premises alcohol outlets (OR=0.90, $p=.03$), neighborhood disadvantage (OR=0.95, $p=.002$) and living in a rural area (OR=0.50, $p<.001$) were associated with abstaining from alcohol in the past year.

Alcohol involvement

There was a significant state of residence effect on the frequency of alcohol use, of heavy episodic drinking, of getting drunk, and the typical quantity of alcohol consumed (all $ps < .0001$) among those who drank in the past year. After the effect of state was removed, living in a more advantaged neighborhood was significantly associated with the frequency of drinking (OR=0.97, $p=.02$) and of drinking to intoxication (OR=0.97, $p=.03$), with model-

predicted proportions of drinking at least monthly of 0.85 and 0.89 and of getting drunk at least monthly of 0.46 and 0.53 in the highest and lowest deciles of neighborhood disadvantage, respectively. Conversely, living in a more disadvantaged neighborhood was associated with a greater typical quantity consumed when drinking ($IRR = 1.01$, $p=.001$), with model-predicted mean numbers of drinks consumed of 4.88 and 4.38 in the highest and lowest deciles of neighborhood disadvantage, respectively (Table 3).

Living in a small town compared to a metropolitan area was associated with less frequent drinking ($OR=0.64$, $p=.003$) and drinking to intoxication ($OR=0.69$, $p=.04$), with model-predicted proportions of drinking at least monthly of 0.80 and 0.85 and of getting drunk at least monthly of 0.40 and 0.46 in a small town and in a metropolitan area, respectively. Living in a rural area compared to a metropolitan area was associated with a greater typical quantity consumed when drinking ($IRR = 1.18$, $p=.021$), with model predicted means of 5.40 and 4.64 drinks for those living in a rural or metropolitan area, respectively. Other than the influence of any alcohol use (versus abstention) noted previously, there was no effect of census-tract-level density of on-premises or off-premises alcohol outlets on the four indexes of alcohol involvement presented in Table 3.

Alcohol problems

There was a significant effect of state of residence on alcohol problems ($p < .0001$). After the effect of state was removed, living in a more advantaged neighborhood was associated with alcohol problems among past-year drinkers ($OR=0.99$, $p=.04$), with model-predicted mean numbers of alcohol problems of 1.87 and 1.94 in the highest and lowest deciles of neighborhood disadvantage, respectively. There was no effect of census-tract-level density of on-premises or off-premises alcohol outlets or urbanicity on past-year alcohol problems (see Table 4).

Does the influence of alcohol outlet density differ for underage compared to non-underage individuals?—All models were re-fit substituting an “underage” dummy variable for age and including interaction terms between underage and on-premises outlet densities and off-premises outlet densities. Only the interaction between the density of on-premises alcohol outlets predicting heavy drinking approached significance ($\chi^2 = 3.10$, $df=1$, $p = .08$), pointing to a stronger association between on-premises outlet density and the frequency of heavy drinking among underage compared to non-underage participants. There was no indication that the influence of on-premises and off-premises alcohol outlet densities on any alcohol use, the frequency of drinking, of getting drunk, the typical quantity consumed, or alcohol problems was affected by whether a participant had exceeded the legal age to purchase alcohol ($\chi^2 = 0.00$ to 0.90 , $df=1$, $p = .34$ to $.97$). For example, the odds ratios of the associations between any alcohol use and the densities of on-premises alcohol outlets was 1.22 (95% CI = 1.05–1.40, $p = 0.006$) among underage individuals and 1.17 (95% CI = 1.03–1.33, $p = 0.02$) among those 21 years of age and older.

What is the “active ingredient” in the neighborhood disadvantage effect?—In previous analyses, the composite neighborhood disadvantage factor was significantly associated with five of the six alcohol outcomes that were examined. When the composite

neighborhood disadvantage factor was replaced with all seven of the individual variables on which it was based, only lack of education was significantly inversely associated with any alcohol use in the past year (OR = 0.92, 95% CI = 0.89–0.95, $p < .001$), the frequency of drinking (OR = 0.90, 95% CI = 0.87–0.93, $p < 0.001$), the frequency of getting drunk (OR = 0.90, 95% CI = 0.87–0.93, $p < 0.001$), and alcohol problems (IRR = 0.96, 95% CI = 0.94–0.97, $p < 0.001$), and significantly positively associated with the typical quantity of alcohol consumed (IRR = 1.02, 95% CI = 1.01–1.03, $p = 0.002$). When separate models were estimated for each neighborhood disadvantage indicator individually, lack of education was most strongly and consistently associated with alcohol involvement, but the proportion unemployed, Latino, or living in poverty were also significantly associated with most of the alcohol outcomes (see Supplemental Table S1).

Is the neighborhood disadvantage effect explained by the density of alcohol outlets?—The effect of neighborhood disadvantage was re-estimated in models that excluded the two outlet density indicators. The parameter estimates for neighborhood disadvantage in the overall model and the reduced model without alcohol outlet densities were subsequently compared. The effect of neighborhood disadvantage was not significantly smaller when outlet densities were included in the model compared to when they were included, suggesting that alcohol outlet densities do not explain part of the association between neighborhood disadvantage and any alcohol use, the frequency of drinking, heavy drinking, getting drunk, or alcohol problems ($\chi^2 = 0.03$ – 1.71 , $df = 1$, $p = .19$ – $.87$). The association between neighborhood disadvantage and the typical quantity of alcohol consumed was actually *stronger* when alcohol outlet densities were included in the model ($\chi^2 = 5.29$, $df = 1$, $p = .02$; IRR = 1.014 versus 1.009).

Discussion

Alcohol outlet density, neighborhood disadvantage, and rural versus urban residence were important components of the alcohol environment for young adults in the United States, but not always as predicted. Young adults living in urban neighborhoods with higher densities of on-premises alcohol outlets with greater socioeconomic *advantage* were more likely to consume alcohol than those residing in rural neighborhoods with fewer alcohol outlets and greater disadvantage.

The magnitude of the influence of alcohol outlet density on alcohol involvement was modest. Each quartile increase in the census-tract-level density of on-premises alcohol outlets was associated with a 19% greater odds of drinking in the past year, and there was no association of outlet density on the frequency of drinking, heavy drinking, getting drunk, the typical quantity consumed, or alcohol problems. The modest associations observed between both on- and off-premises outlet densities may have been due to the relatively low levels of densities found in this national sample. A previous New York City study found that a significant association between outlet density and past-year binge drinking was only observed when the density surpassed 80 outlets per square mile (Ahern et al, 2013). This level of density is similar to that observed surrounding some United States college campuses, another setting where there is a robust effect of alcohol outlets (Weitzman et al., 2003).

As predicted, the associations between outlet densities and alcohol involvement did not differ for those who were 18–20 years of age (underage) or those 21 and older. In fact, the 18–20 year old age group, compared to those 21 and older, more frequently engaged in heavy drinking and drinking to intoxication, drank in greater quantities, and had more problems with alcohol. Previous studies have documented that individuals 18–20 years of age perceive that alcohol is easily available and can be obtained from adults 21 and older or directly from outlets, such as grocery stores or bars (Wagenaar et al., 1996).

The concentration of alcohol outlets in disadvantaged neighborhoods has often been cited as an explanation for higher rates of alcohol involvement in disadvantaged neighborhoods (e.g. Romley et al., 2007; Truong & Sturm, 2009), despite the lack of empirical evidence to support this (e.g. Pollack et al., 2005). When this hypothesis was directly tested in the present study, there was no evidence consistent with alcohol outlet densities partially explaining the association between neighborhood disadvantage and alcohol involvement. In fact, although the disadvantaged neighborhoods had more alcohol outlets, it was in the more advantaged neighborhoods that young adults were more likely to drink, get drunk, and experience problems with alcohol. The evidence suggests that outlet density and neighborhood disadvantage are independent and distinct contributors to the alcohol environment. Furthermore, the neighborhood advantage effect was best explained by the educational attainments of the neighborhood residents, that is, educational attainment was largely the “active ingredient” in the neighborhood advantage effect.

The association between alcohol involvement and neighborhood advantage has been observed in several previous studies (e.g., Gruenewald et al, 2014; Trim et al., 2008), and may also be related to the phenomenon of greater levels of alcohol involvement of college-attending compared to non-college-attending young adults (Patrick et al., 2012; Slutske, 2005). Potentially relevant empirical evidence from the economics literature has demonstrated that macro-level economic indicators such as local rates of unemployment temporally vary with lower levels of alcohol consumption even after taking into account individual-level income and employment status (Ruhm & Black, 2002). This suggests that during times of relative prosperity (or as in the present study, in regions of relative prosperity), more alcohol is consumed. It will be an important direction for future research to develop an understanding of why (and when and for whom) alcohol involvement is greater in more advantaged than in less advantaged neighborhoods (e.g., Trim et al., 2008).

Similar to the results of Borders and Booth (2007), living in a rural compared to a metropolitan area was associated with a decreased odds of drinking, but among drinkers, with consuming 18% more alcohol when they drank. The differences in the drinking experiences of rural versus urban young adults might be explained by: (a) characteristics of the different environments in which they reside (such as neighborhood poverty, proximity to alcohol vendors, availability of alternative activities), or (b) the different characteristics of those residing in these environments (such as lower educational attainment, marital, parental, or employment status).

More generally, the tacit assumption of an “alcohol environment” is that these are characteristics of the environment that are impacting upon an individual’s use of alcohol. It

is equally plausible that these might reflect the impact of the individual on her choice of environment (Gruenewald, 2007); this might be especially germane to young adults just beginning to exert their independence. The impact of the individual is nicely illustrated by a recent twin study that found that individual differences in moving to or remaining in a disadvantaged neighborhood was due in part to genetic factors (Slutske et al., 2015). Only a handful of studies have been able to disentangle the potentially causal influences of the alcohol environment from selection into such an environment (Buu et al, 2012; Jokela, 2014). For example, in a 10-wave longitudinal study, multilevel-modeling techniques were employed to demonstrate that most (but not all) of the association between more frequent alcohol use and neighborhood advantage was attributable to differences between people rather than the neighborhood (Jokela, 2014).

Limitations

Although there have been similar nationally-representative studies conducted in New Zealand (e.g. Connor et al, 2011) and Australia (e.g. Azar et al, 2015), to our knowledge, this is the first nationally-representative study conducted in the United States examining the joint influence of alcohol outlet density, neighborhood disadvantage, and rural versus urban residence on alcohol use and problems. As with any investigation, there were some limitations. First, although the assessments of alcohol use and problems were conducted in 2001–2002, the densities of alcohol outlets were based on licensing data acquired five years later, in 2006–2007. It is likely that the indexes of the current neighborhood alcohol outlet densities may have been imprecise, although a study conducted in California found that zip-code-level densities of off-premises outlets changed very little from 2000 to 2006 (Chen et al., 2010). Second, alcohol outlet density data were not available for all 50 states. Third, the use of census-tract-level densities, rather than distances to the nearest alcohol outlet, may have underestimated the influence of living adjacent to a high-outlet-density census tract. Fourth, although we use the term “neighborhood” in this paper (primarily for lack of a better term), we acknowledge that a census tract is a crude approximation of a neighborhood. In addition, focusing on smaller geographic areas such as census blocks or block groups rather than census tracts may have yielded greater power to detect neighborhood contextual effects. Fifth, compared to intensive investigations within individual cities, large national surveys in which there are few individuals within each geographic unit may make it impossible to statistically separate individual from area effects (Fendrich et al, 2010; Gardner et al, 2010). Sixth, it is likely that the influence of neighborhood contextual factors differ for individuals of different ages. The results of this study of young adults should not be generalized to other age groups. Seventh, this study was cross-sectional, providing merely a snapshot of the relation between neighborhood context and alcohol involvement.

Summary and Conclusions

Living in a more advantaged and educated urban neighborhood with greater densities of bars and restaurants was associated with greater alcohol involvement among 18–26-year-olds in the United States. The influence of alcohol outlet densities on alcohol involvement did not differ for those above or below the legal age to purchase alcohol. Living in a rural versus an urban neighborhood was associated with a different alcohol use pattern characterized by a lower likelihood of any drinking, but among those who drank, consuming more alcohol per

occasion. Future longitudinal (preferably, genetically-informed) investigations will be required to better understand the: (a) temporal precedence, (b) potential causal significance, (c) impact of the duration of exposure, and (d) longer-term consequences, of neighborhood contextual factors on alcohol use and problems.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Unadjusted and model-estimated proportions of any alcohol use in the past year as a function of (a) census-tract-level density of on-premises alcohol outlets (b) census-tract-level density of off-premises alcohol outlets, (c) neighborhood disadvantage, and (d) urbanicity. The model-estimated proportions are at the mean of all other variables in the model; the following variables were included in each of the models: age, sex, race, household income, on-premises outlet density, off-premises outlet density, neighborhood disadvantage, urbanicity, and state of residence.

The densities of on-premises alcohol outlet quartiles correspond to: 1 (mean = 0.00, range = 0–0.009), 2 (mean = 0.14, range = 0.01 – 0.39), 3 (mean = 0.91, range = 0.38–1.72), 4 (mean = 9.15, range = 1.73–434.36). The densities of off-premises alcohol outlet quartiles correspond to: 1 (mean = 0.00, range = 0–0.024), 2 (mean = 0.18, range = 0.02 – 0.50), 3 (mean = 1.06, range = 0.50–1.95), 4 (mean = 8.34, range = 1.95–249.68).

Table 1

Descriptive statistics for demographic, neighborhood contextual, and alcohol use and problem measures in a nationally-representative sample of United States young adults.

Variable	n	mean	SE	minimum	maximum
Demographic					
Age	14,322	21.82	0.129	18	28
Sex = female	14,322	0.49	0.01	---	---
Race					
White		0.65	0.03	---	---
Hispanic/Latino/a	14,307	0.12	0.02	---	---
Black		0.16	0.02	---	---
Asian		0.04	0.01	---	---
Native American		0.03	0.03	---	---
Household income (dollars)	13,530	32,738	911.66	0	900,000
Neighborhood contextual					
Density on-premise alcohol outlets ^a	12,504	2.41	0.35	0	434.36
Density off-premise alcohol outlets ^a	12,504	2.29	0.38	0	249.68
Neighborhood disadvantage ^b	14,058	---	---	---	---
Metropolitan area		0.81	0.03	---	---
Metropolitan area		0.10	0.02	---	---
Small town		0.04	0.01	---	---
Rural area		0.04	0.12	---	---
Alcohol use and problems					
Any alcohol use	14,064	0.74	0.01	---	---
Frequency of use (# days)	14,064	45.37	1.78	0	339
Frequency heavy drinking (# days)	14,011	27.87	0.99	0	339
Frequency drunk (# days)	14,001	16.38	0.85	0	339
Typical quantity (# drinks)	13,965	3.44	0.09	0	18
Alcohol problems	14,047	1.36	0.05	0	8

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Note: Descriptive statistics are based on the analytic sample for which sampling weights were available, and are based on raw untransformed data in original units to facilitate interpretation.

^a per square kilometer

^q standardized measure (mean = 0, SD = 1) derived from a factor analysis of 7 indicators

Table 2

Multiple logistic regression analysis predicting any past year alcohol use from demographic and neighborhood contextual factors in a nationally-representative sample of United States young adults.

Predictor	Odds ratio	95% CI	<i>p</i>
Intercept	4.23	2.77, 6.25	<.001
Age group (reference = 24–26 years)			
18–20 years	0.86	0.68, 1.08	0.181
21–23 years	1.13	0.92, 1.40	0.252
Sex (reference = male)	0.82	0.73, 0.92	0.001
Race (reference = White)			
Hispanic/Latino/a	0.56	0.45, 0.69	<.001
Black	0.44	0.35, 0.56	<.001
Asian	0.49	0.34, 0.68	<.001
Native American	0.81	0.56, 1.18	0.273
Household income ^a	1.03	1.01, 1.05	0.005
Density on-premise alcohol outlets ^b	1.19	1.08, 1.31	<.001
Density off-premise alcohol outlets ^b	0.90	0.82, 0.99	0.032
Neighborhood disadvantage ^b	0.95	0.93, 0.98	0.002
Urbanicity (reference = Metropolitan)			
Metropolitan	0.78	0.58, 1.05	0.100
Small town	1.01	0.72, 1.41	0.721
Rural	0.50	0.34, 0.72	<.001

Note: N = 11,632, the effects of state of residence have been removed.

^a variable converted to 10-level decile,

^b variable converted to 4-level quartile,

CI = confidence interval

Table 3

Ordered logistic regression analyses predicting the frequency of past-year drinking, heavy drinking, and getting drunk, and negative binomial regression analysis predicting the past-year typical quantity of alcohol consumed from demographic and neighborhood contextual factors in a nationally-representative sample of United States young adults.

Predictor	Frequency drinking ^c			Frequency heavy ^c			Frequency drunk ^c			Quantity		
	OR	95% CI	p	OR	95% CI	p	OR	95% CI	p	IRR	95% CI	p
Intercept	---	---	---	---	---	---	---	---	---	6.58	5.82, 7.45	<.001
Age group (ref = 24–26 years)												
18–20 years	0.92	0.78, 1.08	0.312	1.46	1.25, 1.71	<.001	1.79	1.51, 2.13	<.001	1.27	1.20, 1.35	<.001
21–23 years	1.18	1.04, 1.35	0.011	1.34	1.18, 1.51	<.001	1.46	1.30, 1.65	<.001	1.09	1.03, 1.15	0.003
Sex (ref = male)	0.40	0.35, 0.46	<.001	0.34	0.31, 0.38	<.001	0.45	0.40, 0.50	<.001	0.74	0.71, 0.78	<.001
Race = (ref = White)												
Hispanic/Latino/a	0.60	0.50, 0.72	<.001	0.69	0.56, 0.84	<.001	0.55	0.45, 0.67	<.001	1.04	0.97, 1.11	0.27
Black	0.55	0.45, 0.66	<.001	0.31	0.24, 0.39	<.001	0.44	0.36, 0.55	<.001	0.78	0.71, 0.86	<.001
Asian	0.49	0.38, 0.65	<.001	0.43	0.32, 0.58	<.001	0.57	0.42, 0.77	<.001	0.76	0.68, 0.86	<.001
Native American	0.92	0.68, 1.24	0.579	0.91	0.72, 1.15	0.414	0.79	0.63, 0.99	0.047	1.06	0.92, 1.22	0.41
Household income ^a	0.97	0.96, 0.99	0.005	0.98	0.97, 0.99	0.021	0.97	0.96, 0.99	0.01	1.00	1.00, 1.01	0.54
Density on-premise outlets ^b	1.04	0.97, 1.11	0.312	1.03	0.95, 1.11	0.455	1.05	0.98, 1.14	0.186	0.98	0.96, 1.01	0.19
Density off-premise outlets ^b	0.98	0.91, 1.06	0.589	0.97	0.91, 1.04	0.440	0.95	0.89, 1.02	0.151	0.99	0.96, 1.02	0.36
Neighborhood disadvantage ^a	0.97	0.94, 0.99	0.019	0.98	0.96, 1.01	0.200	0.97	0.95, 0.99	0.028	1.01	1.01, 1.02	0.001
Urbanicity (ref = Metropolitan)												
Metropolitan	0.84	0.68, 1.03	0.093	0.90	0.71, 1.13	0.354	0.91	0.73, 1.14	0.428	1.01	0.90, 1.12	0.92
Small town	0.64	0.48, 0.86	0.003	0.85	0.66, 1.10	0.216	0.69	0.48, 0.98	0.039	1.05	0.93, 1.19	0.39
Rural	0.77	0.57, 1.05	0.097	1.16	0.88, 1.53	0.304	0.77	0.56, 1.05	0.101	1.18	1.03, 1.34	0.02

Note: N = 8,534–8,611, analyses restricted to the subpopulation of past-year drinkers; the effects of state of residence have been removed.

^a variable converted to 10-level decile,

^b variable converted to 4-level quartile,

c_7 -level ordinal variable corresponding to none, 1 or 2 days in the past 12 months, 3 to 12 times in the past 12 months, 2 or 3 days a month, 1 or 2 days a week, 3 to 5 days a week, and every day or almost every day.

OR = odds ratio, IRR = incidence rate ratio, CI = confidence interval

Table 4

Negative binomial regression analysis predicting past year alcohol problems from demographic and neighborhood contextual factors in a nationally-representative sample of United States young adults.

Predictor	IRR	95% CI	<i>p</i>
Intercept	2.84	2.43, 3.31	<.001
Age group (reference = 24–26 years)			
18–20 years	1.24	1.15, 1.34	<.001
21–23 years	1.10	1.04, 1.16	0.001
Sex (reference male)	0.75	0.71, 0.79	<.001
Race = (reference = White)			
Hispanic/Latino/a	0.83	0.75, 0.91	<.001
Black	0.80	0.71, 0.91	0.001
Asian	0.81	0.71, 0.94	0.005
Native American	0.97	0.84, 1.11	0.627
Household income ^a	0.99	0.98, 0.99	0.006
Density on-premise alcohol outlets ^b	1.02	0.99, 1.05	0.277
Density off-premise alcohol outlets ^b	1.01	0.97, 1.05	0.603
Neighborhood disadvantage ^a	0.99	0.97, 0.99	0.041
Urbanicity (reference = Metropolitan)			
Micropolitan	0.98	0.86, 1.12	0.741
Small town	0.89	0.72, 1.08	0.235
Rural	0.94	0.82, 1.07	0.320

Note: N = 8,599, analyses restricted to the subpopulation of past-year drinkers; the effects of state of residence have been removed.

^a variable converted to 10-level decile,

^b variable converted to 4-level quartile,

IRR = incidence rate ratio, CI = confidence interval