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Alcohol Use Patterns and DSM-5 Alcohol Use Disorder on Both Sides of the US-Mexico Border

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Abstract

Background—Alcohol consumption patterns on the US-Mexico border and their relationships with DSM-5 Alcohol Use Disorders (AUDs) have been understudied. Yet, effects of drinking by Mexican-origin individuals may differ between cities on vs. off the border both in the US and Mexico. We characterize prior 12-months drinking patterns, and examine their relationships with AUD, in border and off-border cities of Texas and adjacent Mexican states.

Methods—Data come from the US-Mexico Study of Alcohol and Related Conditions (UMSARC) involving 2,336 Mexican Americans in Texas and 2,460 Mexicans in bordering states of Nuevo Leon and Tamaulipas in Mexico. Drinking pattern was defined as an interaction between volume and maximum amount, or intensity (never vs. ever 5+/4+ [men/women], 8+, and 12+ drinks in a day). DSM-5 AUD was assessed using an adaptation of the Alcohol Section of the WHO Composite International Diagnostic Interview (CIDI) core. Separately by gender, five logistic regressions models controlling for age were estimated predicting symptoms in 2 or more AUD criteria domains from volume, heavy pattern and, successively, effects of country, and (by country) residing on vs. off the border, or in each of 3 cities/country.

Results—A segmentation analysis for Texas males based on rate of experiencing AUD generated several distinct volume-groups, each partitioned by an empirically selected maximum, helped identify a drinking pattern typology. In gender-stratified models of AUD rates using this typology, adjusting for age, significant volume and intensity effects were seen, more strongly in the US. Border vs. interior differences implied more AUD for given patterns at the border in the US and the reverse in Mexico, with some city differences also evident.

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Conclusion—Drinking pattern analyses confirm that border proximity may affect drinking problems but in opposite directions in the US and Mexico, possibly related to economic and psychological stresses specific to respective communities.

Keywords

alcohol drinking; alcohol dependence; US-Mexico border; Mexican-origin; population survey

Introduction

People with a Mexican background represent the largest subgroup of Hispanics in the US (67%) (Consejo Nacional de Población, 2005), with a Mexican-born immigrant population in 2012 of 11.4 million and a further 22.3 million Mexican-origin people born in the US, for a total of 33.7 million residing in the US (Gonzalez-Barrera and Lopez, 2013). Mexican Americans have a younger age distribution than European-origin populations.

Although variations have been observed (Caetano and Tam, 1995; Saadatmand et al., 2000), generally Mexican-origin men have shown an excess of heavier drinking and associated alcohol problems compared to other racial/ethnic groups excepting American Indians and Native Alaskans (Greenfield et al., 2015). Communities and cities on both sides of the border are linked through economic interdependence, with considerable cross-border movement (Ward, 1999). Those living on either side reside in a zone with legal exceptions and fewer restrictions than imposed on entry past secondary checkpoints further away from the border zone (Martínez, 1994). This facilitated cross-border mobility for shopping, visiting or employment (Richardson, 1999), and helped to further harmonize the two cultures, leading to similarities in preferences, language, and customs (Pinedo et al., in press). Other similarities have been high mortality and fertility, and a shift toward a younger demographic distribution (Loustounau and Sánchez-Bane, 1999; Valdez, 1993). A prior study in Texas at the US-Mexico border found that while volume of consumption among Mexican-origin adults at the border was no greater than that for their non-border counterparts, rates of abuse and dependence were higher (Caetano et al., 2008; Wallisch and Spence, 2006), a finding motivating our risk curve study. Though studies involving the border region in Mexico are rare, an analysis of the 1998 Mexican National Survey on Addictions (Encuesta Nacional de Adicciones: ENA) found the percentage of heavy drinkers at the Mexican border was twice as high as that from other regions in Mexico (Medina-Mora et al., 2002). A more recent study found Mexicans migrating to the US and returning to Mexico, as well as those with family members living in the US, were more likely to report alcohol use disorders than Mexicans with no migration history (Borges et al., 2007).

Study of drinking patterns and their relationship to alcohol problems in Mexican-origin groups is especially important since, today, Mexico continues to contribute more US immigrants than any other country—nearly one third (29%). The border remains important not only in the US but in Mexico from a demographic perspective, since over 30% of Mexican-origin people originate from border areas in Mexico (Marcelli and Cornelius, 2001; Sánchez-Huesca et al., 2006). In Texas 16 counties lie along the Mexican border, as defined by the US Mexico Border Health Association, comprising 64% of all US border counties

from the Pacific to the Gulf coasts. Twelve bi-national metropolitan areas account for about 90% of those living along both sides of the border and of these, nine are sister-city pairs, with six of these in Texas (Driessen and de Cosío, 1995). Furthermore, the US border counties house the greatest density of the Mexican-origin people in the US, and are among the poorest in America, although more prosperous than their Mexican counterparts (Cepeda and Valdez, 2004). As Borges et al. note (2015), there continues to be attention to alcohol use and drinking practices on the US side of the US Mexican Border (Caetano et al., 2012) including some attention to cross-border drinking among US residents (Caetano et al., 2013). An earlier survey of the Texas US border (Wallisch, 1998) found that 23% of US Hispanic border residents engaged in monthly heavy drinking (defined for that study at the 5+ drinks threshold). Caetano et al. (2012) observed more heavy (again, 5 or more drinks per occasion) drinking in younger women (18–29) on the border compared to off border areas. The recent *US-Mexico Study on Alcohol and Related Conditions* (UMSARC), involved surveys of Mexican-origin residents in three Texas cities located in the poorest US counties on the US side of the Mexican border and one interior Texas city, as well as surveying Mexicans in counterpart cities in adjacent Mexican states. Texas was chosen as the US focal point as it is the largest US border state and includes almost two-thirds of all US border counties. To our knowledge, this is the first study to use common survey methods to study drinking patterns and problems, simultaneously on both sides of the US border, although an earlier study considered and compared drinking and drug use behaviors in the US and Mexico populations as a whole using parallel survey variables in each country (Cherpitel et al., 2007). Based on UMSARC data, Cherpitel et al. (2015) recently examined risk curves for AUD by analyzed effects on AUD of alcohol volume consumed, and rate of 5+ drinking, each considered separately. Higher alcohol volumes and rates of 5+/4+ drinking, as well as of AUD, were seen in both border and non-border US cities compared to their Mexican counterparts. The UMSARC project recognized the border as having environmental risks that could potentiate alcohol problems in both the US and Mexico, hypothesizing that stresses of living at the US-Mexico border associated with the drugs, violence and high rates of poverty and unemployment (Zemore et al., 2016), together with availability of low cost alcohol in Mexico, would intensify rates of heavy drinking and so increase related problems among those living close to the border compared to locations further away on both sides (Cherpitel et al., 2015).

In the US general population, heavy drinking patterns—defined as high levels of volume and high amounts per drinking occasion—have been identified as playing a key role in rates of AUD (Greenfield et al., 2014) with striking gender differences. Since heavier drinking is also associated with numerous health conditions (Greenfield, 2001b; Nelson et al., 2013) and mortality (Rehm et al., 2006; Roerecke et al., 2011), high rates of heavier drinking and AUD among Mexican-origin men (fewer Mexican-origin women drink or drink heavily), as well as limited access and utilization of alcohol-related treatment, represent recognizable alcohol-related health disparities in the US (Greenfield, 2001a; Schmidt et al., 2006; Schmidt et al., 2007).

The present study extends the results from UMSARC by considering an empirically-based drinking pattern typology that combines average volume of intake and a series of thresholds of heavy drinking (4+/5+ 8+ and 12+ drinks per occasion at any time in the prior year),

representing a simplification of an empirical drinking pattern typology recently developed on the US population as a whole (Greenfield et al., 2014). The approach recognizes that at any given volume, individuals tend either to space their drinking occasions yielding a more even drinking style over time, or to obtain their equivalent volume by more intermittent heavy per occasion drinking or “binge” patterns, as this style has come to be known. The approach builds upon a conceptualization of a key aspect of drinking patterns that has a long history in alcohol studies (Cahalan et al., 1969), and has been termed a Volume-Variable Maximum typology by Greenfield (1986). This characterization of drinking pattern recognizes that to capture relative bingeing and spacing of drinks well, higher volumes of alcohol intake require greater drinking intensities (e.g., 8+ and 12+ drink maxima (Naimi et al., 2010)). By combining effects of heavier versus lighter drinking quantities appropriate for each volume level, the interaction of volume and maximum can be studied in relation to outcomes including alcohol-related problems, as is the focus here. The approach may be particularly useful in population subgroups such as Mexican-origin groups where high maximums are not uncommon (Greenfield et al., 2006; Greenfield et al., 2011).

Therefore the primary objective of this paper is to use UMSARC data to 1) empirically characterize drinking patterns defined by this interaction of volume and drinking intensities to develop a serviceable, conceptually-based volume-intensity drinking typology. 2) We use this typology to study drinking pattern in relation to AUD, stratifying by sex. 3) The two dimensions (volume and drinking intensity) of the pattern typology are then used in a number of logistic regression models to additionally consider country and, by country, on-off border effects on AUD, taking account of age and alcohol intake pattern, separately for men and women.

Previous studies distinguishing, for each volume, those drinking with a relative bingeing versus spaced drinking pattern focused on students (Greenfield, 1986) and the US general population (Greenfield et al., 2014). Here we seek to extend our knowledge of the rates of specific risky drinking patterns, place, and their joint role in elevating AUD among Mexican and Mexican American adults living in three pairs of sister metropolitan areas at the Texas-Mexico border and one adjacent non-border metropolitan area on each side of the border. The logistic regression models built on this drinking pattern typology are stratified by sex given expected cultural differences by gender, and control for age. Using these models, we examine country differences, proximity to border effects, and city differences in age-controlled models that also estimate the effect of volume and the volume-specific binge vs spaced drinking pattern indicators.

Here, an innovation is to use empirical techniques to determine first the general effects on AUD rates of relative bingeing versus spacing of daily drinking amounts within each of a series of distinguishable ranges of yearly average intake. Comparing relationships between drinking patterns and AUD in detail in various communities on each side of the border has potential to add to our knowledge of situational factors affecting rates of AUD linked to extreme drinking patterns among those in Mexico, and US Mexican-origin groups living in border states, an increasingly important priority for study today.

Material and Methods

Sample

The US-Mexico Study on Alcohol and Related Conditions (UMSARC) is a cross-sectional survey that interviewed randomly selected respondents between the ages of 18 and 65 during 2011–2013, simultaneously, on both sides of the US-Mexico border. Face-to-face interviews were carried out of *Mexican-origin* respondents in the three Texas metropolitan areas, including the two border areas Laredo (Webb County) (n=751) and McAllen/Brownsville (Cameron/Hidalgo Counties) (n=814) and one non-border metropolitan area, San Antonio (San Antonio county) (n=771). On the Mexico side, parallel sampling was carried out on respondents living in the respective border sister metropolitan areas (sister cities) of Nuevo Laredo (n=828) and Reynosa/Matamoros (state of Tamaulipas) (n=821) and in the non-border metropolitan area counterpart of Monterrey (state of Nuevo Leon) (n=811).

Sampling employed a multistage area-probability sampling design with stratification by city. On the US side, primary sampling units (PSU) were defined as census block groups with at least 70% Mexican-origin population with blocks serving as the secondary sampling unit (SSU). In Mexico, PSUs were defined using the catalog of the census Basic Geo-statistical Areas (“Areas Geoestadísticas Básicas-AGEB”), similar to block groups in the US, with blocks within the AGEB serving as SSUs. On both sides, 3 households per SSU were randomly selected. Eligible respondents were then enumerated, selecting the resident with the most recent birthday as the respondent. Household face-to-face, computer-assisted interviews of about 45 minutes in length were conducted by trained interviewers and conducted in the US by the Public Policy Research Institute (PPRI) at Texas A&M University, and in Mexico by the National Institute of Psychiatry (INP) in Mexico City. The combined cooperation rate was 84% for the US sample (53.1% response rate) and 71.4% for the Mexico sample (63.3% response rate). The cooperation rate was based on only those households in which enumeration indicated that an eligible respondent was confirmed to reside, while the response rate was based on including the fraction of those households in which enumeration was not conducted that were estimated to contain eligible residents.

Measures

Volume of alcohol consumption—*Volume of alcohol consumption* was obtained using an adaptation of the Knupfer series (Greenfield, 2000; Room, 1990) from questions regarding the frequency of drinking, and the amount usually consumed per day, separately for wine, beer and spirits over the last year, and summed across beverages. For each beverage type, the respondents were asked how often they usually had the type of alcohol beverage during the last 12 months, with selection options ranging from “more than once a day”, “once a day”, to “less than once a month but more than once a year” and “never during last year”, and how many drinks they usually have per day when they drank that beverage. Drink size was also elicited for each beverage type and converted to standard drinks, each containing about 14 grams of pure ethanol, and volume was adjusted to reflect this.

Heavy drinking pattern—*Heavy drinking pattern* was based on a categorical maximum drinking question (Greenfield et al., 2006). Respondents were asked the largest number of

drinks they had on any single day for all types of alcohol beverages combined during the last 12 months, with selection options being “24 or more drinks”, “12–23 drinks”, “8–11 drinks”, “5–7 drinks”, “4 drinks”, “3 drinks”, “2 drinks” and “1 drink”. Heavy drinking indicators, such as Any 5+, 8+ or 12+ for men and Any 4+ or 8+ for women, were then combined with volume consumption to classify respondents into drinking pattern groups (see Data Analysis, below).

DSM-5 alcohol use disorder (AUD)—*DSM-5 alcohol use disorder (AUD)* was constructed from questions regarding the 11 diagnostic criteria for a Diagnostic and Statistical Manual, 5th revision (DSM-5) diagnosis of AUD (American Psychiatric Association, 2013), using an adaptation of the Alcohol Section of the Composite International Diagnostic Interview (CIDI) core (World Health Organization, 1993). DSM-5, as opposed to DSM-IV, collapsed the alcohol abuse and dependence criteria into a single, unidimensional construct, in which legal problems are dropped and a criterion on craving added, with a score of ≥ 2 positive for AUD (Hasin et al., 2013).

Data analysis

Segmentation analysis was first performed among the Texas US males to develop the drinking typology best capturing variation in rates of ≥ 2 DSM-5 AUD, by partitioning the sample into multiple groups using the set of drinking measures. The categorical analysis strategy maximizes differences in prevalence of the outcome (AUD) and selects significantly different drinking-pattern groups, based on the combination of volume of consumption (partitioned into multiple groups at stage 1) and maximum (selected and partitioned, for each volume group, at stage 2). Using the CHAID (CHi-squared Automatic Interaction Detection) algorithm implemented in AnswerTree[®] (SPSS Inc., 2001a; SPSS Inc., 2001b), a similar segmentation analysis has been shown to generate distinct drinking-pattern groups highly predictive of alcohol abuse and dependence for the US population samples (Greenfield et al., 2014). In the current study, segmentation analysis was only used for developing a plausible conceptually motivated and empirically based typology, given the relative small sample sizes we have at the border and non-border areas. A Bonferroni-type adjustment was used at stage 1, given the number of different ways volume can be empirically partitioned. At stage 2, the dichotomous splits of volume categories by any vs no 5+/4+, 8+, or 12+ drinks/day were accepted at an 0.05 alpha level, but also required a minimum resultant cell size (50 cases). The subsequent analysis involved comparing the rates of ≥ 2 DSM-5 AUD in the drinking pattern typology just described, between US and Mexican samples, and for US and Mexican samples separately, testing AUD differences across border and non-border areas. The distinct pattern groups derived using segmentation analysis provided a way to examine both volume and within volume, drinking intensity. The comparison was done first in bivariate analysis using Chi-square tests; then using logistic regression, we estimated the influences of the two pattern variables (volume and intensity) separately for men and women, controlling for age.

The US and Mexican data were weighted to reflect the multistage clustered sampling design. Then a raking algorithm approach was used to iteratively adjust the sampling weights to match Census marginal distributions of education and the combined sex by age distribution,

separately within each site. To adjust for design effects inherent in multistage clustered sampling, Stata's *svy* commands were used for all model parameter estimation except for the segmentation analysis in which only sampling weights were applied.

Results

Table 1 illustrates as an example the use of CHAID segmentation analysis to generate distinct volume-heavy drinking pattern groups that empirically differentiated rates of AUD (2+ DSM-5 criteria), using Mexican-origin male drinkers on the US side (pooling on- and off-border samples). Four empirically distinct mean volume of consumption categories were generated at the first segmentation level (no more than 2 drinks/week; more than 2 drinks/week to no more than 1 drink/day; more than 1 drink/day to no more than 4 drinks/day; and greater than 4 drinks per day). Then for each volume category, a bunching-vs-spacing drinks indicator was selected: the CHAID algorithm selected from 5+ (men)/4+ (women), 8+ and 12+ maxima, selecting the pattern variable that best partitioned each stage-1 volume group according to the resultant subgroups' rates of AUD. For example, in the US, at the lowest volume level (≤ 2 drinks/week), the prevalence of 2+ AUD symptoms was 1.5% among those who never drank 5+, versus 8.0% who met this AUD criterion among those who ever consumed 5+ drinks in a day during the past 12 months. As expected based on the a priori conceptualization, larger maximum drink thresholds were empirically found to split higher volume categories in terms of the AUD outcome. For example among US drinkers, "None vs Any 8+ days" for those drinking > 1 but ≤ 4 drinks/day on average, and "None vs Any 12+ days" for those consuming > 4 drinks/day volume on average (see Table 1) differentiated rates meeting the AUD criterion. These results interacting volume and maximum per occasion drinking highlight the concept of relative spacing vs bunching of drinks, or bingeing, i.e., consuming at high quantities on fewer days of the week (Cahalan et al., 1969; Greenfield, 1986). The lower half of Table 1 applies the US-male- based typology to the Mexican male drinker sample. In both the US and Mexico, within a given volume level, separation of AUD rates by relative spacing vs bingeing (the intensity dimension) as seen by the odds ratios (ORs), is greatest for the two lower volumes, and relatively less at the higher volumes (as found previously for the general US population (Greenfield et al., 2014)). When the same typology is applied to Mexican men, the within volume intensity differences in AUD levels are lower than in the US case, based on the ORs; although in the right direction the AUD intensity differences for the top two volumes are not significant, as seen by the respective 95% Confidence Intervals (CIs).

For women (results not shown), because of their greater abstinence rates, and lower frequencies and amounts of drinking, we collapsed the top two volume categories found for US men, leaving 3 volume levels: (no more than 2 drinks/week, no more than 1 drink/day, and greater than 1 drink/day). Thus the lower two volume levels are the same as those for the men, facilitating comparisons at lower drinking levels, and the third combines men's two higher volume groups. The intensity distinctions at the second segmentation level for women involved 4+ (lower two volumes) and 8+ drinking. So as to facilitate comparisons, we used these US-based drinking pattern results for men and women, respectively, in all further analyses at both sides of the border.

Bivariate analyses using χ^2 tests compared the distinct drinking pattern groups derived from the US segmentation analysis in examining and comparing prevalence of 2+ AUD symptoms as the dependent measure across all areas. Table 2a shows the bivariate comparison between each drinking pattern group (volume $\times$ maximum per occasion categories) separately, for male and female drinkers. As Table 2a indicates, between Mexican-origin male drinkers on the US side, and those on the Mexico side, similar AUD rates were observed for lower drinking levels, but at higher intake levels, rates for those in the US showed higher levels of 2+ DSM symptoms. Specifically, at volume of from >1 to 4 drinks/day and ever drinking 8+ drinks in a day, and at volumes of >4 drinks either with or without 12+ drinks in any day, Mexican-origin men on the US side had higher AUD levels than counterparts residing in Mexico. As for differences between border and non-border areas, higher AUD rates were seen at the border areas for the Mexican-origin men on the US side at the two intermediate volumes with high drinking intensity patterns (>2/week up to 1 drink/day volumes with any 5+ days, and from 1 to 4 drinks/day volumes with any 8+ in a day drinking). Other US male patterns did not differ significantly on- vs off-border. Significant border effects were not found in Mexico, however.

In bivariate analyses similar to those for men in Table 2a, the difference in rates of meeting the AUD criterion for women at a given drinking pattern group across regions are shown in Table 2b. In the comparisons between Mexican-origin female drinkers on the US side and those in Mexico, there were some inconsistencies observed. Women on the US side at the intermediate volume level (> 2/week to 1 drink/day) who ever drank 4+ in a day reported significantly higher AUD rates than Mexican women, but at low volumes (averaging 2 drinks/week), Mexican women ever drinking 4+ indicated higher AUD prevalence than US women. On the US side, border effects were modest and again somewhat inconsistent. Those drinking with the heaviest drinking pattern (volume > 1 drink/day average with any 8+ days) at the border had a higher AUD rate than those off the border (68% vs 44%, $p < 0.05$). Conversely, for US Mexican-origin women with the lightest drinking pattern (averaging 2 drinks/week and never having 4+), those off the border showed higher rates of 2+ AUD symptoms than those at the border (11% vs <2%, $p < 0.01$). In contrast, at the Mexico side, non-border female drinkers reported higher AUD rates than those living in the border areas at the highest drinking pattern levels; specifically, this was for intermediate volume (> 2/week to 1 drink/day) with any 4+ days, and in both pattern groups at the highest volume (> 1 drink/day) level (all $p < .05$).

Finally, separately for men and women, five logistic regression models were then fitted to predict 2+ DSM-5 symptoms across regions controlling for age (besides sex, the other major demographic influence), examining effects of the volume and maximum (intensity) indicator (relative binging verses spacing of drinks). In these models, the variable for the intensity dimension used the appropriate intensity indicators for each volume level, i.e., those shown in tables 2a and 2b). Logistic regression results are shown in Table 3a for men and Table 3b for women. Drinkers on the Mexico side had significantly lower rates of AUD than Mexican-origin drinkers on the US side, controlling for age and drinking pattern, for both men and women (see Model 1), with adjusted odds ratios (AORs) of 0.6 and 0.5, respectively ($p < 0.001$ men and $p < 0.05$ women). As seen in Model 2, on the US side, male drinkers living in border areas were more likely to report AUD compared to men living in

non-border areas again controlling for age and pattern (AOR=1.9, $p < .001$). This border effect on US side was not seen for women, however (AOR=0.8 *NS*). On the Mexico side in Model 3, a reverse effect was observed for men, with Mexican male drinkers living in border areas significantly *less* likely to report 2+ DSM-5 symptoms than those in non-border areas, again controlling for age and pattern (AOR=0.6, $p < .01$). For Mexican female drinkers, while border effects were similar in size to those for males (AOR=0.6), these estimates were not statistically significant. Last, in Models 4 (US), and 5 (Mexico), we tested whether each border site demonstrated similar findings when compared to the non-border city in each country. For both Mexican-origin men and women on the US side, no significant difference was observed between those from Laredo and Brownville/McAllen, as indicated by the non-significant test of equality. On the Mexico side, those living in the Reynosa/Metamoros area reported lower AUD compared to Nuevo Laredo. This effect was observed for both men and women, but was only significant for men (test of equality < 0.05).

Discussion

This study extends work that considered separately on-border and off-border effects of a) volume and b) heavy drinking, implemented earlier by frequency of 4+ drinks in a day for women/5+ drinks for men (Cherpitel et al., 2015). In our approach we examined influences of drinking volume and maximum quantity on AUD together in models that interacted volume and various intensities of heavy drinking, based on the bunching (or bingeing) versus spacing conceptualization described above. With an aim of employing a common typology to facilitate comparisons, an initial step was to empirically determine a general typology of drinking patterns characterized by varying volumes of intake and a series of drinking intensities defined by 5+ (men) or 4+ (women); 8+ and 12+ drink maxima similar to Greenfield, et al. (2014), a schema that empirically differentiated rates of AUD (2+ DSM-5 symptom criterion). However, given the sample of drinkers here was much smaller than in the earlier US population study, the intensity measures (4+/5+, 8+ and 12+) were simplified to be ever/never in the prior 12 months, rather than *frequency* of heavy drinking used by Greenfield, et al. (2014). The segmentation analysis used here was conducted for US Mexican-origin men (and also applied to Mexican men) proved informative (Table 1). A similar analysis for US women (not shown) suggested that the top two volume levels found for men should be combined for women. These typologies allowed comparisons by gender for the two lowest volume levels.

To summarize key results in the bivariate analyses, it appears that the differences between the US Mexican-origin and Mexican men's levels of AUD are observed at the highest volume and intensity levels in the US, while conversely, for women in the US vs Mexico the differences in AUD are primarily shown with 4+ binge drinking at the two lowest volumes, consistent with heavier drinking on the US side, as seen in Tables 2a and 2b respectively. For US men, a greater prevalence of AUD is associated with heavier drinking on the border (compared to off border) among the higher intensity groups at the two intermediate volume levels. For US women on the border, only the highest volume and 8+ maximum group shows greater prevalence in AUD than off border, compensated for by lower levels of AUD at the lightest drinking level and pattern (< 2 drinks/week and never 4+). In Mexico, though few statistical differences are seen in on-border vs off-border AUD comparisons, for men there

appears to be an elevation in AUD among the *lightest* drinkers off-boarder, while for women, there appears to be more AUD at the higher volumes off- than on-border and this is especially so among the higher intensity groups.

Looking at the distribution across the drinking typology levels given by the cell *ns* for the US and Mexico in the first block of Tables 2a (men) and 2b (women), these descriptive results suggest that the so-called fiesta or occasional high maximum drinking that has been seen to characterize Mexican populations (Perez, 2000) is indeed much more common in the US, with prevalent high maximum drinking, especially for men (Neff et al., 1991) but to some extent also for women.

Summarizing the logistic regression models shown in Tables 3a and 3b, age is inversely related to AUD in the US-Mexico comparison and US-only models, justifying the importance of making age adjustments in these models. For all male models, both volume and the respective pattern indicators (with varying intensities) are significant, while for women, although volume is always significant, the pattern indicators differ significantly only in the US-Mexico comparison and US-only models. For both genders, the country effect with higher AUD in the US is evidenced (Model 1). For men the on-border vs off-border effects are significant and in opposite directions in the US (higher border AUD) compared to Mexico (border lower AUD). For women the direction is toward lower drinking on the border in both countries, but the on-border vs off-border contrast did not attain significance in either country (Models 2 and 3).

These results complement, but are consistent with earlier findings based on risk-curve analyses separately by volume and frequency of 5+/4+ binge drinking. Cherpitel et al. (2015) found that among current drinkers, prevalence of AUD, based as here on two or more DSM-5 criteria, was higher in border sites in the US than in Mexico, but rates were similar between the US and Mexico in non-border locations. AUD prevalence was greater at the US border compared to the non-border, but the opposite was true in Mexico, with a significantly greater prevalence of AUD in the non-border city than the border cities. A comparison by inspection of males with females suggested that border effects may be greater for males than females in the US while the opposite appeared to be the case in Mexico.

An advantage of the typological approach as used here is that it addresses the need to capture drinking intensities (i.e., 8+ and 12+ drinks) beyond the standard 'binge' definition (5+/4+), increasingly recognized as important for young adult drinkers (Patrick et al., 2016) and general populations (Naimi et al., 2010), and especially important among Latino groups. This approach allows us to consider, across the average intake spectrum, the effects of bunching drinks (higher intensity) versus spacing them (lower intensity). In this way the two components of pattern are 'separable' in models including a volume term and a pattern (varying intensity) term, as shown in the Table 3 analysis summaries. The approach also calibrates both volume and intensity by gender, somewhat similar to some approaches that have defined binges by different thresholds for men and women (but without interacting volume and pattern as here). Note that in certain studies intensity has a special meaning—the maximum on any occasion (say in the last 30 days) of those who binge at the 5+/4+ level, in the same time frame (Kanny et al., 2013). Our preference is to use intensity directly

in the conceptualization of varying patterns of drinking with intensity indexing the way an individual obtains a given volume, either by spacing (lower intensity) or bunching drinks (higher intensity) following an earlier epidemiological tradition (Cahalan et al., 1969; Greenfield, 1986). Our results using this approach are not at odds with those of Cherpitel et al. (2015), so providing some validation, but also complement them by combining volume and intensity in one model. Both methods reveal gender, as well as country, differences (Tables 2a, 2b).

Limitations

An inherent limitation of the method is that the relative bunched drinkers (or bingers) have on average slightly higher volumes than the spaced drinkers (at each volume level). However, as seen in the fourth column of Table 1 for men, the mean volumes in each of the two empirically based heavy-drinking-pattern groups identified for each volume segment, although differing slightly, are not greatly different. Importantly, both elements of the drinking style (volume and maximum) do contribute independently to predicting meeting AUD criteria (Tables 3). A further limitation is that once the drinking typology was determined for US men (and adapted for women), these drinking pattern schemas were applied in all participants (according to respondent sex). Some specific typological results may derive from chance alone, although results were consistent with our conceptual expectations. Larger samples would be needed to distinctly specify empirical patterns in each country and cultural differences by gender. However, this would make comparisons of relative differences owing to volume and intensity more difficult. Thus the analytic choices involve tradeoffs. By using the same typology across sites (albeit one differing for men and women) we facilitate the logistic regression comparisons shown in Tables 3. Several additional limitations should be highlighted. The typological approach categorizes underlying continua, inherently reducing precision. The intensity indicators based on self-reported categories could not employ frequency of heavy drinking, as possible in larger samples. We do not examine differences in abstention rate by country and on- vs off-border residence. For population-and subgroup-levels of AUD, differing abstention rates make a large difference and the opportunity to study drinking pattern including abstention (beyond present scope) is forgone here in studying risk relationships for drinkers only. Finally, some evidence suggests age may interact with other variables and this may be particularly relevant at the border, which we could not study here.

Conclusions and Future Directions

What the combined volume and pattern approach brings is a nuanced ability to predict, from a detailed drinking pattern, what the likely levels of AUD in the respective populations will be, given a particular intake and *intensity*. In turn, this empirically-based typological approach allows us to parse out the two elements of drinking style often called overall intake (volume) and drinking intensity (assessed here by not just 5+/4+ drinks, but higher 8+ and 12+ drink levels), then apply these two elements of drinking pattern in predictive models to investigate the relative contribution of each component (Greenfield et al., 2014). The conceptualization of relative bunching versus spacing of drinks, with its long history in alcohol epidemiology, was implemented here with newer technology, using segmentation analysis to empirically estimate ‘effects’ of volume $\times$ intensity interactions on AUD rates.

The resultant schema has been fruitful in prediction likelihood of alcohol problems and identifying the influence on AUD rates of living on either side of the US-Mexican border and proximate to it, while taking account of drinking pattern. The origins of the differences seen in these analyses and their opposite directions in the two countries require more, in-depth study if they are to be better understood, but are probably related both to socioeconomic disparities and unique and potentially different stresses near the border in each country (Lantz et al., 2001). Our Center will be studying these in great detail in the coming years.

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Results from CHAID segregation analysis predicting 2+ DSM5 symptoms, for US Mexican Origin and Mexican males separately (combined border and non-border area samples)^a

Table 1

Average Volume	Heavy drinking Pattern	N	Average Volume in prior 12 months (drinks/week)	2+ DSM-5 Symptoms (%)	OR (95% CI) ^b
US Mexican Origin males					
2 drinks/week	Never 5+ days Any 5+ days (*)	192 84	0.633 1.20	1.5 8.0	5.53 (1.30, 23.47)
>2 /week to 1 drink/day	Never 5+ days Any 5+ days (***)	73 146	4.12 4.15	5.6 24.6	5.48 (2.36, 12.70)
>1 /day to 4 drinks/day	Never 8+ days Any 8+ days (***)	111 193	13.87 14.25	26.5 55.5	3.46 (2.12, 5.67)
>4 drink/day	Never 12+ days Any 12+ days (†)	63 75	52.25 62.10	63.2 79.6	2.28 (1.01, 5.15)
Mexican males					
2 drinks/week	Never 5+ days Any 5+ days (*)	263 118	0.70 0.94	2.6 8.2	3.31 (1.20, 9.18)
>2 /week to 1 drink/day	Never 5+ days Any 5+ days (***)	95 138	3.65 4.19	7.7 18.3	2.69 (1.23, 5.91)
>1 /day to 4 drinks/day	Never 8+ days Any 8+ days (***)	110 114	13.29 14.03	27.0 35.2	1.47 (0.80, 2.70)
>4 drink/day	Never 12+ days Any 12+ days (†)	55 31	56.25 68.71	37.2 56.8	2.22 (0.75, 6.59)

^a all volume levels were significantly different; statistics indicate level of significance for pattern difference at given volume level

^b Odds Ratio of 2+ DSM-5 for higher pattern versus lower pattern within volume category (e.g. Any 5+ vs Never 5+ for 2 drinks/week)

† p<0.10,

* p<0.05,

** p<0.01,

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Comparisons of 2+ DSM-5 rates between US Mexican-origin and Mexico total samples, and between border and non-border areas for US and Mexican samples separately, controlling for volume and heavy drinking pattern, for male drinkers

Table 2a

		Between US and Mexico				US sample				Mexican sample						
		US		Mexico		Border		Non-border		Border		Non-border				
		<i>p</i> ^a		<i>p</i> ^b		<i>p</i> ^c		<i>p</i> ^c		<i>p</i> ^c		<i>p</i> ^c				
Volume	Heavy drinking pattern	N	DSM-5 (%)	N	DSM-5 (%)	N	DSM-5 (%)	N	DSM-5 (%)	N	DSM-5 (%)	N	DSM-5 (%)			
2 drinks/week	Never 5+	192	1.5	263	2.6	0.391	127	2.3	65	0.0	0.185	197	1.1	66	7.1	0.003
	Any 5+	84	8.0	118	8.2	0.933	50	10.9	34	2.9	0.120	96	8.2	22	8.2	0.997
1 drink/day	Never 5+	73	5.6	95	7.7	0.440	57	5.7	16	5.3	0.947	62	9.3	33	3.5	0.241
	Any 5+	146	24.6	138	18.3	0.196	91	31.9	55	14.8	0.005	95	16.8	43	21.4	0.554
4 drink/day	Never 8+	111	26.5	110	27.0	0.929	89	27.1	22	24.3	0.747	62	29.5	48	23.6	0.495
	Any 8+	193	55.5	114	35.2	0.001	119	63.8	74	42.8	0.005	54	27.5	60	41.8	0.104
>4 drink/day	Never 12+	63	63.2	55	37.2	0.003	49	65.8	14	54.2	0.347	37	41.4	18	28.5	0.430
	Any 12+	75	79.6	31	56.8	0.009	53	77.2	22	86.5	0.310	22	46.0	9	76.7	0.104

^a χ^2 test is for US vs Mexico difference;

^b χ^2 test is for border vs non-border in US;

^c χ^2 test is for border vs non-border in Mexico

Table 2b

Comparisons of 2+ DSM-5 rates between US and Mexico total samples, and between border and non-border areas for US and Mexican samples separately, controlling for volume and heavy drinking pattern, **for female drinkers**

		Between US and Mexico				US sample				Mexican sample						
		US		Mexico		Border		Non-border		Border		Non-border				
Volume	Heavy drinking pattern	N	DSM-5 (%)	N	DSM-5 (%)	N	DSM-5 (%)	N	DSM-5 (%)	N	DSM-5 (%)	N	DSM-5 (%)			
2 drinks/week	Never 4+	315	4.4	218	2.3	0.390	211	1.4	104	10.8	0.002	155	2.5	63	1.8	0.786
	Any 4+	125	2.9	61	12.7	0.006	79	2.9	46	2.8	0.964	40	15.1	21	8.8	0.499
1 drink/day	Never 4+	45	10.2	29	4.0	0.192	29	11.6	16	6.5	0.536	18	4.2	11	3.6	0.894
	Any 4+	128	23.2	31	4.5	0.015	71	22.8	57	23.7	0.879	20	0.0	11	12.5	0.037
>1 drink/day	Never 8+	61	24.5	17	29.6	0.631	39	21.2	22	30.1	0.384	10	7.6	7	72.1	0.001
	Any 8+	79	61.8	11	38.6	0.117	54	68.1	25	43.6	0.040	8	27.0	3	80.3	0.046

^a χ^2 test is for US vs Mexico difference;

^b χ^2 test is for border vs non-border in US;

^c χ^2 test is for border vs non-border in Mexico

Table 3a

Logistic regression models predicting 2+ DSM-5 symptoms, controlling for age, alcohol volume and drinking pattern, **male drinkers**

	Model 1 US & Mexico	Model 2 US only	Model 3 Mexico only	Model 4 US only	Model 5 Mexico only
Age	0.98 (0.97, 0.99) ***	0.96 (0.95, 0.97) ***	0.99 (0.98, 1.01)	0.96 (0.95, 0.97) ***	0.99 (0.98, 1.01)
Volume per day	1.33 (1.22, 1.45) ***	1.56 (1.42, 1.72) ***	1.14 (1.05, 1.25) **	1.55 (1.41, 1.71) ***	1.14 (1.05, 1.23) **
Pattern indicator	3.00 (2.35, 3.83) ***	4.18 (2.95, 5.93) ***	2.12 (1.45, 3.06) ***	4.16 (2.92, 5.93) ***	1.99 (1.38, 2.88) ***
Country effect					
Mexico vs US	0.58 (0.45, 0.74) ***				
Border effect					
US: Border vs non-Border		1.87 (1.32, 2.66) ***			
Mexico: Border vs non-Border			0.59 (0.40, 0.85) **		
City effect					
US (San Antonio as ref)					
Laredo				1.97 (1.42, 2.73) ***	
Brownsville/McAllen				1.77 (1.07, 2.95) *	
Test of equality				<i>p=0.662</i> NS	
Mexico (Monterrey as ref)					
Nuevo Laredo					0.80 (0.54, 1.19)
Reynosa/Metamoros					0.40 (0.23, 0.71) **
Test of equality					<i>p=0.016</i>

Model 1: country effect; Model 2: Border effect for US; Model 3: Border effect for Mexico; Model 4: US city effect; Model 5: Mexico city effect

*
p<0.05,

**
p<0.01,

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Table 3b

Logistic regression models predicting 2+ DSM-5 symptoms, controlling for age, alcohol volume and drinking pattern, **female drinkers**

	Model 1 US & Mexico	Model 2 US only	Model 3 Mexico only	Model 4 US only	Model 5 Mexico only
Age	0.96 (0.94, 0.98) ***	0.95 (0.93, 0.97) ***	1.00 (0.97, 1.04)	0.95 (0.93, 0.97) ***	1.00 (0.97, 1.04)
Volume (drinks) per day	1.70 (1.43, 2.02) ***	1.81 (1.47, 2.23) ***	1.62 (1.18, 2.22) **	1.81 (1.48, 2.23) ***	1.53 (1.13, 2.06) **
Pattern indicator	2.57 (1.48, 4.49) ***	2.74 (1.45, 5.16) **	2.28 (0.69, 7.50)	2.74 (1.43, 5.26) **	1.98 (0.57, 6.87)
Country effect					
Mexico vs US	0.47 (0.24, 0.93) *				
Border effect					
US: Border vs non-Border		0.76 (0.41, 1.43)			
Mexico: Border vs non-Border			0.59 (0.20, 1.77)		
City effect (OR, 95% CI)					
US (San Antonio as ref)					
Laredo				0.76 (0.42, 1.36)	
Brownsville/McAllen				0.77 (0.34, 1.72)	
Test of equality				<i>p=0.649</i> NS	
Mexico (Monterrey as ref)					
Nuevo Laredo					0.92 (0.26, 3.23)
Reynosa/Metamoros					0.29 (0.06, 1.49)
Test of equality					<i>p=0.327</i> NS

Model 1: country effect; Model 2: Border effect for US; Model 3: Border effect for Mexico; Model 4: US city effect; Model 5: Mexico city effect

*
p<0.05,**
p<0.01,

1000>d

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