Relationship of Usual Volume and Heavy Consumption to Risk of Alcohol-Related Injury: Racial/Ethnic Disparities in Four U.S. National Alcohol Surveys

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ABSTRACT. Objective: National population data on racial/ethnic disparities and risk of alcohol-related injury are scarce. Alcohol-related injury and drinking patterns are examined in a sample of respondents from four (1995, 2000, 2005, 2010) U.S. National Alcohol Surveys using risk function analysis. **Method:** Self-reported consumption of 15,476 current drinkers was assessed as the average number of drinks consumed monthly and, separately, the frequency of consuming five or more drinks in a day (5+ days) in the last year. Alcohol-related injury was defined as drinking within 6 hours before the event. Risk curves were defined, separately for Whites, Blacks, and Hispanics, using fractional polynomial regression. **Results:** Risk was greatest for Hispanics to 110 drinks per month (3–4 drinks per day) and above 240 drinks per month, whereas risk was greatest for Whites between these levels. Blacks were at lower risk at all monthly volume levels when demographic and socioeconomic

status characteristics were controlled for. Whites had the highest risk of an alcohol-related injury based on 5+ drinking days at all levels up to nearly daily 5+ drinking, whereas Blacks had the lowest risk at all levels of 5+ drinking. **Conclusions:** A disparity in alcohol-related injury was found for Hispanics compared with Whites at the same average monthly volume of consumption at lower and higher volume levels, but not at the same number of 5+ drinking days, and a lower risk of alcohol-related injury was found for Blacks for both consumption measures when demographic and socioeconomic status characteristics were taken into account. Although exposure to hazards other than alcohol, which could account for some of the racial/ethnic disparity observed, was not taken into account, these mixed findings suggest this is an important area deserving future research attention. (*J. Stud. Alcohol Drugs*, 77, 58–67, 2016)

THE ASSOCIATION OF ALCOHOL AND INJURY has been well documented in emergency department (ED) studies that have analyzed drinking in the injury event, as well as those ED studies that have examined the risk of injury related to usual drinking and patterns of consumption (Cherpitel, 2007; Romelsjö, 1995). Data from a Swiss ED study found that risk of injury was greatest for those who usually drank little but who on occasion drank heavily (Gmel et al., 2006). A meta-analysis of EDs across seven countries (including 10 EDs in the United States) found that both quantity and frequency of drinking were significant predictors of alcohol-related injury (ARI; Cherpitel et al., 2003), with a threshold effect observed at relatively low levels of mean daily consumption and higher consumption times (Cherpitel et al., 2006a). A case-control study in Australia, however, found that after adjusting for the main effect of acute alcohol intake on injury among ED patients, regular alcohol intake, even at high usual daily levels, carried lower risks of injury than abstinence (Watt et al., 2004). Multilevel analysis of ARI in ED data from a large number of studies and countries found that although volume of alcohol was a significant predictor (Cherpitel et al., 2005, 2012), drinking

pattern also predicted an ARI (with volume controlled for), with episodic heavy and frequent heavy drinking both more predictive of ARI than other drinking patterns (Cherpitel et al., 2012).

Taken together, these findings from ED studies suggest that although the amount of drinking on any particular occasion is an important risk factor in injury occurrence, pattern of drinking may also play an important part in injury risk. ED patients, however, have been found more likely to be frequent heavy drinkers than those in the general population from which they come (Cherpitel, 1992), raising the important question as to the representativeness of data on risk of injury from drinking based on studies of ED patients. The few prior studies of the relationship of drinking with injury in the U.S. general population suggest increasing risk at relatively low levels of consumption (as little as one drink per day) (Cherpitel & Ye, 2009), with both frequency of drinking and high maximum occasions playing a part in risk of ARI (Cherpitel et al., 2010).

Difference in risk of injury from drinking by race/ethnicity has received little attention, although the need for more research on injury risk disparities has been highlighted. A review of racial/ethnic differences in injury mortality in the United States found that the rate of alcohol positivity and intoxication was disproportionately higher and alcohol-attributable injury was overrepresented among Blacks and Hispanics compared with Whites (Keyes et al., 2012). This conclusion was based on the lower rates of alcohol use, binge drinking, and problem drinking found in epidemio-

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logic surveys of these two minority groups. Both Black and Hispanic men have been found to continue heavy drinking at older ages (Caetano & Kaskutas, 1995), with a greater risk for alcohol problems (Galvan & Caetano, 2003; Mulia et al., 2009) compared with White men. One ED study found that Black patients were less likely to have a positive blood alcohol concentration or to report heavy drinking or drunkenness either before the event or in the past year than either White or Hispanic patients (Cherpitel, 1998). However, data from the general population found that relative risk (RR) of injury based on drinking before the event was significant for Blacks (RR = 1.54) and Hispanics (RR = 1.98) but not for Whites (RR = 0.89) (Cherpitel & Ye, 2014). This study did not examine usual drinking patterns, which are known to vary by race/ethnicity and which have been found to predict ARI in ED studies.

Analyses here will help address the gap in our understanding of racial/ethnic disparities in the risk of injury morbidity from alcohol consumption in the general population by examining the association of ARI with both average volume and heavy drinking occasions, using a risk function analysis of data from four U.S. National Alcohol Surveys (NAS). Fractional polynomial regression is used to model the relationship between the average monthly volume in drinks consumed and, separately, frequency of consuming five or more drinks in a day (5+ days) in the last year, as well as the odds of injury, separately for Whites, Blacks and Hispanics, controlling for demographic and socioeconomic status (SES) characteristics. Findings here are important for a better understanding of disparities in the association of alcohol and related harms across ethnic and racial subgroups in the United States and for informing racial/ethnic-specific intervention and prevention efforts to reduce alcohol-related consequences.

Method

Data collection

Data analyzed are from a merged sample of the Alcohol Research Group's 1995, 2000, 2005, and 2010 NAS. All surveys sampled those ages 18 and older, with an oversampling of Blacks and Hispanics. Data for the 1995 survey were obtained from face-to-face interviews in respondents' homes in the 48 contiguous states. A multistage area-probability sample of households was drawn, using 100 primary sampling units. Completed interviews were obtained from 4,925 respondents, representing a 77% response rate. Data from the 2000, 2005, and 2010 surveys were collected using random digit dial computer-assisted telephone interviews within the 50 states and the District of Columbia, with an oversampling of low-population states. Completed interviews were obtained from 7,612 respondents in the 2000 survey (58% response rate), 6,919 respondents in the 2005 survey (56% response rate), and 7,969 respondents in the 2010 sur-

vey (52% response rate) (all considered acceptable rates for telephone surveys; Frey, 1989). Nonresponse was attributable to refusals, incapacitation, language barriers, and failure to establish contact. Hispanic respondents were given a choice of being interviewed in English or in Spanish, with bilingual interviewers. Because potential bias may be related to differing modes of the survey (face-to-face interviews in 1995 and the subsequent telephone surveys), the effect of mode of administration was examined between the 1995 and 2000 surveys, and few differences were found in either reported consumption or alcohol-related harm (Midanik & Greenfield, 2003; Midanik et al., 2001).

Instruments

Once contact had been made with the respondent and informed consent obtained, interviews were conducted by trained interviewers using a structured interview schedule of about 45 minutes in length.

Alcohol-related injury. Respondents were asked, among other items, whether they had had an injury during the last year for which they had thought about getting treatment (regardless of whether they actually obtained treatment) and, if so, whether they had consumed any alcoholic beverages within the 6 hours preceding their most recent injury. Those who answered yes to both questions were considered to have an ARI.

Volume of consumption. Volume of consumption was obtained from questions regarding frequency of consuming wine, beer, and distilled spirits, with response categories ranging from *never in the past year* to *every day*. Frequency was split into the proportion of drinking days on which the respondents had 5+ drinks, 3 or 4 drinks, and 1 or 2 drinks, with response categories of *nearly every time*, *more than half the time*, *less than half the time*, *once in a while*, and *never* (Room, 1990). The average monthly number of drinks for each beverage type was calculated and summed across beverage types for the total volume of alcohol consumption.

Heavy drinking pattern. Respondents were also asked a series of graduated frequency questions to estimate frequency of drinking for all beverage types combined (12+, 8–11, and 5–7 drinks per day) on a continuum ranging from *every day or nearly every day* to *never in the last year* as a measure of heavy drinking (Greenfield, 2000). The frequency of 5+ drinking days was created as the sum of days consuming 5–7, 8–11, and 12+, capped at 365 days.

Data analysis

Data on the risk of reporting an ARI, based on average monthly volume measured by number of drinks, and frequency in number of days of consuming 5+ drinks per day in the last year are analyzed for respondents who consumed at least one drink in the last 12 months (current drinkers).

Fractional polynomial regression (Royston & Altman, 1994) was used to model the relationship between continuous volume of consumption, and separately, the number of 5+ drinking days, as well as the odds of ARI, with and without controlling for demographic (gender, age, marital status, and urbanicity) and SES (education, employment, income) characteristics.

Fractional polynomials estimate the probability of ARI using logistic regression via the model: $\text{logit}(\text{ARI}) = b_0 + b_1x^p + b_2x^q$ (or $b_0 + b_1x^p + b_2x^p(\ln x)$ if $p = q$). X is volume in standard drinks or 5+ days, and p and q values are to be chosen from -2, -1, -0.5, 0, 0.5, 1, 2, and 3 ($x^0 = \ln x$), reflecting different function forms of risk curves. The best fit model is determined by selecting p and q producing the largest maximized likelihood function. Demographics and SES variables were entered as covariates in the controlled models, and all models were fitted using the Stata Version 13 (StataCorp LP, College Station, TX) *fracpoly* command. The predicted probabilities of ARI across various levels of volume of consumption or 5+ days, based on fractional polynomial models, are then shown as risk curves.

All analyses were weighted by sampling weights constructed for each survey adjusting for the probability of selection (number of households, multiple phone lines, and adult residents in households) and nonresponse. Poststratification weights were also used to map sample respondents with the U.S. adult (≥ 18 years of age) population proportions of ethnicity by region by age by gender groups, and within Hispanics by country of birth for the specific survey year. Given the varying sample size across the four surveys, for both the total sample and racial/ethnic subgroups, the sampling weights for individual surveys were normalized to make all surveys equally represented in the combined data. Because our focus is separate analysis by racial/ethnic subgroups, the normalization of sampling weights was performed for Whites, Blacks, and Hispanics separately. In the combined 1995–2010 NAS data, 16,610 respondents were current drinkers. With only those identified as White, Black, or Hispanic kept in the analysis, and further excluding those missing on the outcome variables, a final n of 15,476 was retained for analysis of ARI: 10,001 Whites, 2,819 Hispanics, and 2,656 Blacks.

Results

As seen in Table 1, Whites were significantly more likely to be current drinkers than either Blacks or Hispanics. Among the 15,476 current drinkers, 216 reported an ARI during the last year, representing 1.6% (weighted) of the total current drinker sample. Table 1 also shows demographic, SES, and drinking characteristics for current drinkers by race/ethnicity. Substantial and significant differences were found in which both Blacks and Hispanics were more likely to be younger, have less education, have a lower family in-

TABLE 1. Alcohol-related injury and demographic, socioeconomic status, and drinking characteristics among current drinkers across race/ethnicity for the combined National Alcohol Surveys, 1995–2010 samples

Variable	White	Black	Hispanic
<i>n</i> of current drinkers	10,001	2,656	2,819
	%	%	%
% of total sample	68.8	52.1***	55.2***
Alcohol-related injury	1.5	1.6	2.1
Gender			
Male	51.0	51.8	61.7***
Age, in years			
18–29	20.2	28.0***	36.7***
Education			
At least some college	64.0	50.6***	44.2***
Employment status			
Full- or part-time employed	69.6	68.7	72.3*
Family income ^a			
Less than U.S. \$30,000	25.5	47.6***	46.7***
Marital status			
Married	69.1	46.9***	63.2***
Urbanicity			
Urban	78.4	89.3***	91.4***
Average volume consumption			
$\leq 14/7$ a week (men/women)	83.8	84.6	85.0
$\leq 28/14$ a week (men/women)	10.5	8.7	9.1
$> 28/14$ a week (men/women)	5.7	6.7	5.9
5+ days last year			
Never	63.5	73.5***	56.7***
Less than monthly	20.5	12.0	18.8
Less than weekly	8.1	5.7	11.3
At least weekly	7.9	8.8	13.2

^aYear 2005 dollars.

* $p < .05$; *** $p < .001$, chi-square test between Blacks and Hispanics with Whites separately.

come, be unmarried, and live in urban areas compared with Whites. Although no difference was found by race/ethnicity for average weekly volume of consumption among current drinkers, Blacks were significantly less likely to report 5+ drinking days in the last year, whereas Hispanics were more likely to do so, compared with Whites.

Figure 1 shows risk curves by race/ethnicity for ARI based on average monthly volume, without controlling for demographic and SES characteristics (Figure 1a) and controlling for these characteristics (Figure 1b). Risk of ARI is higher for Hispanics, followed by Blacks, at lower monthly average volume of up to about 40 drinks for Blacks and more than 100 for Hispanics, compared with Whites. When we controlled for demographic and SES characteristics, the risk of injury was reduced for all groups but most substantially for Blacks. A similar pattern of risk differences was seen for Whites and Hispanics, whereas the risk for Blacks was now much lower than that for Whites at all volume levels, and the risk curve flatter.

Figure 2 shows the same risk curves for ARI based on the number of 5+ drinking days in the last year. Again, the risk was higher for Hispanics compared with Whites at lower numbers of 5+ drinking days, but lower than Whites above about 30 such days per year, whereas the risk for Blacks was consistently lower until a high level of 5+ days was reached (more

FIGURE 1A. Predicted probability of alcohol-related injury from average monthly volume using fractional polynomial logistic regression, without controlling for demographics and socioeconomic status

than 290 such days). When we controlled for demographic and SES characteristics (Figure 2b), Hispanics had lower risk up to more than 300 5+ days per year, whereas Blacks had the lowest risk of ARI at all levels of 5+ drinking days.

As a validity check, estimates from fractional polynomial risk curves were compared with those derived from categorical step-function analysis (Figure 3) for both monthly volume (Figure 3a) and 5+ drinking days (Figure 3b). A similar trend was observed for the three racial/ethnic groups as was found for fractional polynomial estimation, but the fractional polynomial method showed smoother curves.

Discussion

Fractional polynomial regression was used to analyze the risk of ARI with average monthly volume of consump-

tion and 5+ drinking days in the last year among current drinkers, controlling for demographic characteristics and SES. Comparison of risk relationships across race/ethnicity groups found that risk was greatest for Hispanics up to about 110 drinks per month (3–4 drinks per day), and above about 240 drinks per month, whereas risk was greatest for Whites between these levels. Blacks were found to be at lower risk at all monthly volume levels when demographic and SES characteristics were controlled for. Whites had the highest risk of an ARI based on 5+ drinking days at all levels up to nearly daily 5+ drinking, whereas Blacks had the lowest risk at all levels of 5+ drinking. These results suggest a disparity in ARI for Hispanics compared with Whites at the same average monthly volume of consumption at lower and higher volume levels. This was not true for Blacks, however, for either consumption measure

FIGURE 1B. Predicted probability of alcohol-related injury from average monthly volume using fractional polynomial logistic regression, controlling for demographics and socioeconomic status

FIGURE 2A. Predicted probability of alcohol-related injury from 5+ days last 12 months using fractional polynomial logistic regression, without controlling for demographics and socioeconomic status

when demographic and SES characteristics were taken into account.

One possible explanation for these differential findings is that Blacks tend to have later onset of both drinking and heavy drinking (Jones-Webb, 1998; Wallace et al., 1999), and to have longer and more stable heavy drinking trajectories (Caetano & Kaskutas, 1995), whereas White men tend to exhibit marked declines in heavy drinking as they transition out of their 20s (Caetano, 1991). Although age is controlled for in our models, it may be that younger heavier drinkers are more injury prone through increased risk taking or lower alcohol tolerance, both of which may be more prevalent among Whites (i.e., age may play a differential role in ARI across race/ethnicity, exhibiting a modifying rather than a confounding effect).

Hispanic men have also been shown to have longer stable

heavy drinking careers (Caetano & Kaskutas, 1995) and lower rates of recovery from dependence (Dawson et al., 2005) than White men. In addition, the typical drinking style among Hispanics tends to be episodic heavy (fiesta-type) drinking, where most of the alcohol is consumed during heavier drinking occasions (Caetano & Medina-Mora, 1986; Medina-Mora et al., 2000), potentially leading to greater tolerance and lower risk of injury associated with heavy drinking occasions. Because this drinking style appears to be the norm among Hispanic men, they may also be less likely to be in risky situations that result in injury and that may be more likely to accompany 5+ drinking occasions among Whites and Blacks. It is interesting to note that controlling for demographic and SES characteristics had little effect on the risk of an ARI for Whites or Hispanics, whereas the effect on Blacks was more marked, with a lower and flatter

FIGURE 2B. Predicted probability of alcohol-related injury from 5+ days last 12 months using fractional polynomial logistic regression, controlling for demographics and socioeconomic status

FIGURE 3A. Comparison of risk curves from fractional polynomial (FP) and categorical step-function (Cat) approaches when average monthly volume is used to predict alcohol-related injury, without and with controlling for demographics and socioeconomic status, for Whites (top), Blacks (middle), and Hispanics (bottom), separately

FIGURE 3B. Comparison of risk curves from fractional polynomial (FP) and categorical step-function (Cat) approaches when 5+ days last year is used to predict alcohol-related injury, without and with controlling for demographics and socioeconomic status, for Whites (top), Blacks (middle), and Hispanics (bottom), separately

risk curve for both volume and 5+ days compared with uncontrolled estimates. SES has been presumed to account for racial/ethnic differences in alcohol consumption and negative consequences (Braver, 2003; Voas et al., 2002); however, findings here do not support this contention in relation to injury risk, and the opposite was actually found for Blacks. Although controlling for SES informs these comparative analyses across racial/ethnic subgroups, the uncontrolled data provide a more valid measure of the true burden of ARI to society associated with usual drinking patterns across these subgroups.

Although it is possible that Blacks may have been more likely to underreport their usual drinking than Hispanics or Whites, Black men have been found more likely to consume beverages with a higher mean alcohol content than either Hispanic or White men (Kerr et al., 2009). Given that we were not able to adjust drink-size alcohol content in all four of the national surveys analyzed, data here should have provided results running counter to those found of a lower risk of ARI at a presumed similar level of alcohol consumption for Blacks.

Prior research in the general population across all racial/ethnic groups combined has shown that both frequency of drinking and high maximum occasions play a part in risk of ARI (Cherpitel et al., 2010), but in the present study, findings appear to hold more for Whites than for either Hispanics or Blacks. One study in the U.S. general population found, controlling for SES, a greater risk of ever having had a serious injury for lifetime infrequent heavy drinkers among Hispanics, and frequent heavy drinkers among Blacks, compared with Whites (Kerr et al., 2015). The authors suggested that this finding may have been related to unmeasured individual-level risk factors (e.g., drug use, propensity to engage in risky activities, or occupation-related risks) and environment-level factors (e.g., the prevalence of gun ownership, high crime rates, and lack of or poor maintenance of infrastructure such as sidewalks). Although these factors may apply to the present study, controlling for SES characteristics likely diluted potential effects from environmental risk factors, especially for Blacks.

As with similar studies, some limitations apply. The definition of an ARI used here was any reported drinking within 6 hours before the injury. The number of drinks consumed during this time was not analyzed, and drinking before injury may not have been causally related to the event. However, prior research in the ED has found that a large proportion of those who report drinking during this time attribute a causal association of their drinking with the event (Bond & Macdonald, 2009; Cherpitel et al., 2006b). Another potential limitation is that the data are based on recall of both usual drinking patterns and the respondent's most recent injury during the last year. Minor injuries would be less likely to be remembered, as well as drinking before such an event; thus, injuries included here may be those considered more

serious and would not be representative of all injuries in this population. It should also be noted that, although ARI in the last year is based on drinking before the event, drinking patterns are based on the last year. Consequently, findings here are correlational in nature, and drinking patterns may have been influenced by occurrence of an ARI.

A review of the literature on the racial/ethnic disparity in rates of alcohol-attributable injury mortality suggests that although fatal consequences of excessive alcohol consumption are higher for Blacks and Hispanics compared with their White counterparts (Keyes et al., 2012), data for injury-specific fatalities have not been consistent. Risk of injury has been examined across all causes of injury, with alcohol having a greater association with some kinds of injuries compared with others (Cherpitel et al., 2015; Taylor et al., 2010), and may be a function of unmeasured individual-level factors in addition to alcohol use, such as risk-taking disposition, occupational-related hazards, or exposure to environmental dangers, as noted above. These factors may also vary by race/ethnicity and were not taken into account in the present study. For example, rates of alcohol-related motor vehicle crash fatalities have been found to be lower for Blacks and Hispanics compared with Whites (Campos-Outcalt et al., 2003). To be at risk for such an injury would require an individual to be either the driver or a passenger in a motor vehicle. Future research on ARI morbidity in general population samples should explore risk by individual causes of injury across racial and ethnic groups, taking into account exposure to other hazards in addition to alcohol.

Although findings here partly support those from previous studies of higher rates of alcohol-related problems at lower levels of consumption among Hispanics (Galvan & Caetano, 2003; Mulia et al., 2008, 2009), they do not support similar findings among Blacks (Galvan & Caetano, 2003; Herd, 1994; Jones-Webb et al., 1997; Zapolski et al., 2014) and emphasize the importance of considering race/ethnicity in studies of injury risks related to alcohol use and heavy drinking patterns. In addition, it is important to note that analyses here were conducted on current drinkers, among whom a smaller percentage are Black (52.1%) and Hispanic (55.2%) than White (68.8%), suggesting, from a public health perspective, that these ethnic minorities contribute a smaller share of the burden of ARI to society.

Disparity was found in ARI for Hispanics compared with Whites at the same average monthly volume of consumption, but not at the same number of 5+ drinking days, whereas no disparity was found for Blacks for either average monthly volume or 5+ drinking days in the last year when demographic and SES characteristics were taken into account. Findings here suggest that the association of volume and high maximum days with risk of injury may not be the same across race/ethnic groups, and this is an important area deserving future research attention. Based on these and prior data, risk of injury appears to increase at relatively low levels

of consumption, especially for Hispanics and Whites, and although risk continues to rise with volume and number of 5+ drinking days, the impact of preventive efforts to reduce ARI will be greater if aimed at more moderate drinkers, compared with heavier drinkers who are fewer in number.

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