Breath Alcohol Concentrations of Designated Drivers

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ABSTRACT. Objective: This study established breath alcohol concentrations (BrACs) and alcohol-related behaviors of designated drivers (DDs) to determine (a) whether DDs are abstaining from drinking, (b) whether alcohol-related behaviors of non-DDs and DDs were different, and (c) whether the alcohol consumption of DDs resulted in BrAC levels that affected driving performance or caused psychomotor impairment. **Method:** We conducted six anonymous field studies during a 3-month period in a southeastern college community restaurant and bar district. Intercept interviews were conducted with 1,071 bar patrons. Alcohol-related behaviors, BrAC, and whether one was serving as a DD were measured. The sample was primarily White (72.7%), male (62.4%) college students (64.7%). Descriptive statistics and an independent sample *t* test compared the BrACs of DDs versus non-DDs. A one-way analysis of variance examined the differences in the alcohol-related behaviors (Alcohol Use Disorders Identification Test–consumption

[AUDIT-C] score) across DDs abstaining from drinking (BrAC = .00 g/210 L), drinking DDs (BrACs $\geq$.02 and $<$.05 g/210 L), and impaired DDs (BrACs $\geq$.05 g/210 L). A logistic regression assessed the impact of alcohol-related behaviors (AUDIT-C) on whether one was serving as a DD. **Results:** Of the 165 DDs, approximately 40% did not abstain from drinking. Approximately 17% of DDs had BrACs between .02 g/210 L and .049 g/210 L, whereas 18% recorded BrACs at .05 g/210 L or greater. The mean AUDIT-C score for impaired DDs significantly differed from both abstaining DDs and drinking DDs. Participants with greater AUDIT-C scores were more likely to serve as a DD and have a BrAC that significantly inhibited driving ability and psychomotor function. **Conclusions:** These findings identify the need for consensus across researcher, layperson, and communication campaigns that a DD must be someone who has abstained from drinking entirely. (*J. Stud. Alcohol Drugs*, 74, 509–513, 2013)

AMONG RESEARCHERS AND LAYPERSONS alike, there is currently no universally accepted definition of a designated driver (DD) (Ditter et al., 2005). Although most researchers in the United States assert that DDs should completely abstain from consuming alcohol (Fell et al., 1997; Lange et al., 2000; Winsten, 1994), international researchers contend that DDs can drink as long as the driver's blood alcohol concentration (BAC) is below the legal limit (Boots, 1994; Boots and Midford, 1999). Echoing the latter position, laypersons also do not believe it necessary for DDs to abstain from alcohol use (Barr and MacKinnon, 1998; DeJong and Winsten, 1999; Glascoff et al., 1994; Lange et al., 1998). Although drivers in the United States can legally operate a motor vehicle at BAC levels less than 80 mg/dl (i.e., .08%), there is sufficient evidence pointing to the need for DDs to refrain from alcohol use entirely. For instance, impairment of various driving-related performance skills (e.g., divided attention) begins with any departure from a .00% BAC (Moskowitz and Fiorentino, 2000; Ogden and Moskowitz, 2004), with the majority of the driving population impaired on at least one important measure of driving ability at 20 mg/dl (.02%) BAC (Mos-

kowitz et al., 2000). Moreover, the vast majority of studies document significant alcohol-related impairment at a BAC level of 50 mg/dl (.05%) (Chamberlain and Solomon, 2002; Fell and Voas, 2006; Moskowitz and Fiorentino, 2000; Ogden and Moskowitz, 2004).

Previous research purporting to assess the BAC levels of DDs have computed estimate measures using Widmark's equation instead of collecting biologic samples, such as breath alcohol concentrations (BrAC) (Caudill et al., 2000). Unfortunately, calculating BAC levels via standard formulas, such as Widmark's, does not provide an accurate measure of BAC (Carey and Hustad, 2002; Clapp et al., 2006, 2009; Hustad and Carey, 2005; Kraus et al., 2005). An investigation measuring BrAC levels of DDs with a hand-held breath testing device (Alco-Sensor III & IV breath alcohol analyzers; Intoximeters, Inc., St. Louis, MO) indicated that both male and female DDs exhibited BrACs ($M = .06\%$) above levels that would impair psychomotor functions and overall driving ability (Timmerman, et al., 2003). Presumably, the underlying rationale for the use of DDs is to eliminate impaired driving; however, if DDs consume alcohol, then they may no longer be fit to operate a motor vehicle. Consequently, the purpose of this investigation was to assess the BrACs of restaurant and bar district patrons self-identifying as DDs to determine (a) whether DDs are abstaining from drinking, (b) whether the alcohol-related behaviors of non-DDs and DDs were different, and (c) whether the alcohol consumption of DDs resulted in BrAC levels that could adversely affect driving performance (i.e., BAC $\geq$.02% and $<$.05%) or cause psychomotor impairment (i.e., BAC $\geq$.05%).

Received: October 9, 2012. Revision: February 4, 2013.

This work was supported by National Institutes of Health Clinical and Translational Science Awards UL1TR000064 and KL2TR000065 to the University of Florida.

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Method

Data collection

Modeling study protocols reported by Thombs et al. (2009) and O'Mara et al. (2009), we conducted six anonymous field studies across a 3-month period in a southeastern college community restaurant and bar district. Data collection transpired on Friday evenings before scheduled home Saturday football games, beginning at approximately 10:00 P.M. and ending by 2:30 A.M. Patrons exiting bars on public sidewalks were recruited to take part in a structured, 3–5 minute survey assessing alcohol-related behaviors and basic demographic information. Trained recruiters obtained verbal informed consent from each participant before data collection. At the conclusion of each interview, the participant's BrAC was measured using a handheld alcohol breath testing instrument (Alco-Sensor IV). Participants were not informed of their exact BrAC reading because of concerns that some might continue drinking if they perceived themselves to be at a low level of intoxication (Russ et al., 1988). "Walk-away" cards containing information about the principal investigator, the university's institutional review board, transportation services, and local resources for help with an alcohol problem were provided to all participants. Study procedures had been vetted and approved by the appropriate institutional review boards.

Measures

Designated driver status was assessed via the item "Are you serving as a designated driver tonight?" Responses were limited to dichotomous "yes" or "no" options.

Alcohol-related behaviors were assessed via Alcohol Use Disorders Identification Test–consumption (AUDIT-C) scores (Bush et al., 1998). This scale consists of 3 items from the 10-item AUDIT. These items assess frequency of drinking ("How often did you have a drink containing alcohol?"), typical drinking quantity ("How many standard drinks containing alcohol do you have on a typical day?"), and heavy episodic drinking ("How often do you have six or more drinks on one occasion?"). Each item has five possible response options, scored from 0 to 4 points. Overall score is an aggregate of all responses, with total possible scores ranging from 0 to 12.

BrAC samples (g/210 L of breath) were collected using handheld alcohol breath testing instruments (Alco-Sensor IV), which are approved for evidential breath testing in the United States (National Highway Traffic Safety Administration) and internationally. To prevent the collection of artificially inflated BrAC measurements because of residual mouth alcohol, if participants reported alcohol consumption within the past 8 minutes they were given a 3-oz. cup of water to rinse their mouth before collecting the BrAC sample (Wright and Cameron, 1998).

Participants

This investigation reports on a sample of adult restaurant and bar district patrons ages 18 years or older ($n = 1,071$). On average, respondents were 28 years of age ($SD = 8.9$), with an average BrAC reading of .04% ($SD = .04$) and mean AUDIT-C scores of 4.9 ($SD = 2.5$). The sample was primarily White (73%), male (62%) college students (65%); however, Hispanics (10%), Blacks (4%), and Asians (6%) also were represented. Approximately 15% of the sample ($n = 165$) self-identified as a DD on the night they were surveyed.

Data analysis

An independent sample *t* test compared the BrACs of self-identified DDs versus non-DDs to determine whether statistically significant differences in actual BrACs existed between the two groups. Cohen's *d* effect size was computed as a follow-up to account for the large sample size and to provide greater insight into any statistically significant mean differences between these two groups. Descriptive statistics (means and standard deviations) were calculated for all DDs to determine the extent to which self-reported DDs in this sample consumed alcohol. In addition to examining differences in demographic characteristics among DDs abstaining from drinking (BrAC = .00 g/210 L) compared with DDs who had recorded BrACs $\geq .02$ and $< .05$ g/210 L (drinking DDs) and BrACs $\geq .05$ g/210 L (impaired DDs), we conducted a one-way analysis of variance to examine the differences in alcohol-related behaviors (AUDIT-C score) across these three groups. Eta-squared and Tukey's post hoc measures were calculated to aid in the interpretation of any significant group differences. Finally, we used logistic regression to assess the impact of one's alcohol-related behaviors (dependent variable) on whether he or she self-reported serving as a DD while exhibiting a BrAC $\geq .05$ g/210 L (independent variable). For the logistic regression model, we controlled for the following covariates: sex, race, age, and college status. All analyses were conducted with SPSS (Version 20; IBM Corp., Armonk, NY).

Results

In comparing the mean differences between the BrAC levels of DDs with those of non-DDs, respondents who were not serving as a DD exhibited significantly higher BrAC readings ($M = .04$ g/210 L, $SD = .04$) than those serving as a DD ($M = .02$ g/210 L, $SD = .03$), $t(1039) = 6.30$, $p < .001$. The magnitude of the differences in the means (mean difference = .02, 95% CI [0.01, 0.02]) was medium ($d = 0.55$), based on effect-size interpretations outlined by Cohen (1988). However, it is noteworthy that nearly 40% of DDs did not refrain from alcohol use. Of the 165 self-identified DDs, only 65% had a .00 g/210 L BrAC reading. Approxi-

TABLE 1. Characteristics of nondrinking and drinking designated drivers (DDs)

Variable	Abstaining DDs	Drinking DDs	Impaired DDs
	BrAC = .00 g/210 L (<i>n</i> = 108)	BrAC ≥ .02 and ≤ .049 g/210 L (<i>n</i> = 28)	BrAC ≥ .05 g/210 L (<i>n</i> = 29)
BrAC, %			
Mean	.00	.03	.09
Median	.00	.03	.08
Mode	.00	.023	.07
Sex			
Male	64%	57%	70%
Female	36%	43%	30%
Race			
White	65%	66%	77%
Hispanic	12%	7%	7%
Asian	10%	7%	10%
Black	3%	7%	3%
College student			
Yes	70%	69%	45%
No	30%	31%	55%
Age, in years, <i>M</i> (<i>SD</i>)	28 (10.60)	30 (11.48)	31 (8.68)
AUDIT-C score, <i>M</i> (<i>SD</i>)	3.73 (2.15)	4.64 (1.74)	6.72 (2.37)***

Notes: BrAC = breath alcohol concentration; AUDIT-C = Alcohol Use Disorders Identification Test–consumption.

***AUDIT-C scores of impaired DDs were significantly ($p < .001$) different from both abstaining and drinking DDs.

mately 17% of DDs had BrACs between .02 and .049 g/210 L, whereas 18% recorded BrACs at .05 g/210 L or greater (Table 1). A one-way analysis of variance was conducted to determine whether the alcohol-related behaviors (AUDIT-C score) differed between abstaining DDs (BrAC = .00 g/210 L), drinking DDs (BrACs ≥ .02 and < .05 g/210 L), and impaired DDs (BrACs ≥ .05 g/210 L). There was a statistically significant difference in the AUDIT-C scores of the three groups of DDs, $F(2, 157) = 22.34, p < .001$. The calculated effect size (eta squared) indicated that approximately 22% of the variance was accounted for by the treatment variation. Tukey's post hoc comparisons revealed that the mean AUDIT-C score for impaired DDs ($M = 6.72, SD = 2.37$) significantly differed from that of both abstaining DDs ($M = 3.73, SD = 2.15$) and drinking DDs ($M = 4.64, SD = 1.74$). Abstaining DDs and drinking DDs did not significantly differ from each other with regard to AUDIT-C score.

Considering the escalating AUDIT-C scores among abstaining, drinking, and impaired DDs (Table 1), we conducted a logistic regression to assess the strength of the relationship between one's cumulative AUDIT-C score and his or her impaired DD status (i.e., DD with a BrAC ≥ .05 g/210 L). Sex, age, race, and college status were entered into the model as covariates. Overall, $-2 \times \log\text{-likelihood}$ and associated chi-square statistics, $\chi^2(8) = 38.12, p < .001$, were statistically significant, indicating that the model was a good fit for the data. The Hosmer-Lemeshow goodness of fit test, $\chi^2(8) = 4.514, p = .808$, provided further support for the model's fit and general reliability. Of all the model variables, only AUDIT-C scores (odds ratio = 1.725, Wald = 22.386) significantly ($p < .001$) predicted impaired DD status, such

that participants with greater AUDIT-C scores ($\beta = .545$) were more likely to be designated drivers exhibiting a BrAC that significantly inhibited driving ability and psychomotor function. In other words, respondents were 1.7 times more likely to be an impaired DD with each one-integer increase in AUDIT-C score. None of the demographic covariates (age, sex, race, or college status) reached statistical significance.

Discussion

Overall, the findings reported herein echo those of previous investigations that document DDs' failure to (a) abstain from drinking (Caudill et al., 2000; Rivara et al., 2007) or (b) consume alcohol at a level that minimizes psychomotor impairment (Stevenson et al., 2001; Timmerman et al., 2003). These results support Grube's (2007) contention that laypersons "do not have a good idea of what constitutes a safe designated driver" (p.23).

Although U.S. adults age 18 years or older who engage in heavy episodic and/or problem drinking have been identified as more likely to engage in alcohol-impaired driving (Centers for Disease Control and Prevention, 2011; Hingson and Winter, 2003), to date there has been little literature examining these associations among designated drivers. Among our sample, a large proportion of those self-identifying as a DD recorded a BrAC level at or above .02 g/210 L, which constitutes a level at which driving-related skills are negatively affected. It was even more alarming to note the increasing AUDIT-C scores across groups of DDs, such that impaired DDs exhibited significantly different mean AUDIT-C scores than both abstaining and drinking DDs. Moreover, AUDIT-C score

significantly predicted whether one would act as an impaired DD (BrAC $\geq .05$ g/210 L). These findings should be considered within the diagnostic context of the AUDIT-C. Generally, AUDIT-C scores above 5 are indicative of an alcohol use disorder (Dawson et al., 2012; Johnson et al., 2013; Reinert and Allen, 2007). As evident in our sample, impaired DDs averaged an AUDIT-C score of 6.72. Drinking DDs averaged an AUDIT-C score of 4.64, a score exceeding AUDIT-C criteria for unhealthy drinking (Dawson et al., 2012; Johnson et al., 2013; Reinert and Allen, 2007).

Considering the low BAC levels at which driving-related abilities are negatively affected, these findings identify the need for consensus across researcher, layperson, and communication campaigns that a DD must be someone who abstains from drinking entirely. This is especially important considering that alcohol-related driver impairment, such as divided attention, is further exacerbated by the unsafe actions of drunken passengers (e.g., roughhousing with the driver) (Rothe and Carroll, 2009). DDs who consume alcohol (regardless of level) or are selected because they are deemed "least intoxicated" (Knight et al., 1993) place both themselves and their passengers at greater risk for injury. Should the current status quo continue, it is likely that the scientific literature will continue to indicate that DD campaigns fail to effectively prevent impaired driving (Calafat et al., 2009; DeJong and Wallack, 1992; Ditter et al., 2005; Grube, 2007).

There are several noteworthy limitations that should be considered along with the results outlined above. First, the sample was homogeneous and lacked racial and ethnic diversity. Second, the university setting of this investigation (a large southern university with a preeminent college football program) limits our ability to generalize to other cities and/or college towns across the nation. Moreover, as a result of the setting for this investigation, we had an overrepresentation of students and younger respondents. Third, as a result of the methods used, we cannot determine the response rate for this investigation, which highlights potential selection bias. Along those same lines, we also were unable to confirm whether someone who self-identified as a DD actually transported passengers on the evening of data collection. Lastly, outside of the biologic BrAC sample, our measures relied on self-report and could be subject to recall bias.

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