

Drinking Status and Fatal Crashes: Which Drinkers Contribute Most to the Problem?*

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ABSTRACT. Objective: The object of this study was to estimate the relative contribution of various classes of drinkers (including those with alcohol-use disorders) to alcohol-related fatal motor vehicle crashes. **Method:** Using the National Epidemiologic Survey on Alcohol and Related Conditions conducted in 2000, the percentage of state residents falling into six nonoverlapping alcohol-user categories—dependent drinkers, abusive drinkers, dependent and abusive drinkers, heavy episodic drinkers, current normative drinkers, and current nondrinkers—was determined based on the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, classifications. The percentage of residents in each state in each of these user categories and their relationships to the number of drinking drivers involved in fatal crashes in that state were determined through regression analysis using data from the

Fatality Analysis Reporting System. **Results:** The proportion of drinkers in a state in each of the six consumption categories was positively related to the number of drinking drivers in fatal crashes in that state. Conversely, the percentage of the state's population who were current nondrinkers was negatively related to the number of drinking road users in crashes. **Conclusions:** Although alcohol abusive and heavy episodic drinkers had substantially higher associations with impaired drivers in fatal crashes, half of such drivers were associated with the percentage of current normative drinkers in the state. Despite the relevancy of these findings, they must be qualified by statistical limitations associated with the use of state as the unit of analysis. (*J. Stud. Alcohol* 67: 722-729, 2006)

A SIGNIFICANT ISSUE IN TRAFFIC SAFETY has been the characterization of road users who most contribute to the alcohol-related crash problem. As early as 1967, a report by the Department of Transportation (1968) identified the “problem drinker” as an important target for alcohol safety programs. Vingilis (1983), in a review of studies on the drinking status of impaired drivers, concluded that 30%-50% of the drivers in alcohol-related crashes or arrests have “drinking problems.” In 1990, Wiczorek et al. reported that 51% of driving under the influence (DUI) offenders who were referred for treatment met the Diagnostic and Statistical Manual of Mental Disorders, Third Edition, Revised (DSM-III-R; American Psychiatric Association, 1987), criteria for alcohol dependence. A number of such interview studies have been conducted (Cavaiola and Wuth, 2002; Jones and Lacey, 2002; Miller and Windle, 1990; Vingilis, 1983). These studies have produced a broad range of estimates of the involvement of problem drinkers and dependent drinkers based on the particular sample of arrested drivers or the measures used.

A follow-back study (i.e., based on reports from family and associates) conducted by Baker et al. (2002) gave some support to those who argue that “problem drinkers” are the main contributors to fatal crashes. In their study of 818 fatally injured drivers, 21%-61% of the fatally injured drivers with blood alcohol concentrations (BACs) of $\geq .15\%$ could have been classified as problem drinkers before their crash involvement, compared with 1%-7% of the fatally injured drivers with BACs of $.00\%$. The authors noted, however, that many high BAC drivers in fatal crashes were not found to be problem drinkers. These two findings are at the core of an ongoing debate about the type of drinker that contributes the most to the incidence of fatal crashes. This debate centers on the magnitude of the contribution of “hard core” drinking drivers to the alcohol-related crash problem. Simpson and Mayhew (1991) define “hard core drivers” as “individuals who frequently drive after drinking, usually with high BACs ($\geq .15\%$), and who have a history of arrests and convictions for impaired driving.” The term has been adopted by several governmental and private organizations such as the National Transportation Safety Board, the National Highway Traffic Safety Administration (NHTSA), and the National Commission Against Drunk Driving. The use of the term varies somewhat, but it basically encompasses multiple offenders who repeatedly drive under the influence and first offenders who are arrested with high BACs ($.15\%$).

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On one side of the debate, Simpson and Mayhew (1991) emphasized the contribution of hard core drivers to the crash problem by claiming that they account for more than 50% of alcohol-related crashes occurring at night. Researchers and policy makers concerned by this finding emphasize the need for programs targeting these hard core drivers. On the other side of the debate, some authors (e.g., Hedlund and Fell, 1995; Jones and Lacey, 1998, 2000) have argued that although hard core drivers are overrepresented among high BAC drivers in fatal crashes, they account for only a small proportion of all fatal crashes. What type of drinker contributes the most to the fatal crash problem?

The answer to this question involves important policy issues. At stake is the optimal allocation of increasingly scarce resources. Policy makers must decide whether to allocate resources to specific deterrence programs designed to reduce recidivism among the relatively small number of high-risk DUI offenders, general deterrence programs aimed at the much larger number of lower risk drivers in the general drinking public, or both. Optimizing resource allocation between these programs is not straightforward for three reasons. First, programs aimed at the drinking public (such as increased enforcement using checkpoints and public information campaigns) are substantially different from those directed at hard core drivers (such as intensified court monitoring, jail time, and extended treatment programs). Second, laws and programs related to these policies are enacted at the state level, where state traffic safety funds are generally extremely limited. Third, although the relationship of acute BAC to crash involvement is known (Borkenstein et al., 1974), there is substantially less information on the drinking characteristics of drivers and crash involvement.

In contrast to the wealth of information on BACs at the time of crashes, information is relatively limited on the drinking characteristics of drivers in fatal crashes. Our review of both sides of the hard core driver debate demonstrates that such information is very limited because of the inability to study fatally injured drivers directly. We used two data sets for this study: the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC; National Institute on Alcohol Abuse and Alcoholism [NIAAA], 2004), a recent national household survey of alcohol consumption by U.S. residents, and the Fatality Analysis Reporting System (FARS; NHTSA, 2002a). From the NESARC, we determined the prevalence of alcohol-use disorders in each state. These data were then related to the proportion of the state's fatal crashes that involve a drinking road user as recorded in the FARS. Because of the current limitation in the data on the contribution of different types of drinkers to the fatal crash problem and the comprehensiveness of the two data sets at our disposal, we believe the information provided by this study, albeit imperfect, will be highly relevant to state policy makers and useful to the research community in suggesting new lines of research.

Method

We used the NESARC to estimate the number of adult Americans ages 18 or older with alcohol-use disorders in each state. Conducted in 2001-2002, the NESARC is a household face-to-face survey conducted by the U.S. Bureau of the Census of a representative sample of the U.S. population, including citizens and noncitizens (NESARC website <http://niaaa.census.gov/index.html>). NESARC's target is the civilian noninstitutionalized population, ages 18 and older, residing in the 50 U.S. states and the District of Columbia. The survey covers drinking in the last 12 months and provides measures for alcohol dependence and alcohol abuse, with abuse and dependence as defined by the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV; American Psychiatric Association, 1994), criteria. In all, 43,000 Americans participated in the first wave of that survey, sponsored by the NIAAA. The overall response rate was 81%. The NESARC shows that, based on self-reported drinking in the past 12 months, an estimated 17.6 million American adults (8.5%) meet standard diagnostic criteria for an alcohol-use disorder (Hasin and Grant, 2004).

Using the data from the 2001-2002 NESARC, we developed six nonoverlapping alcohol consumption categories: dependent drinkers, abusive drinkers, dependent and abusive drinkers, heavy episodic drinkers, current normative drinkers, and current nondrinkers. Variable ALCABDEP12DX in the NESARC file identifies "alcohol abuse/dependence" in the last 12 months. This variable separates individuals by "alcohol dependence only," "alcohol abuse only," "alcohol abuse and dependence," and "no alcohol diagnosis." For the next category, we applied questions S2AQ8D (men) and S2AQ9 (women) to identify those who reported, at least once in the last 12 months, that they drank 5+ drinks (for men) or 4+ drinks (for women) on one occasion. Those were placed in a "heavy episodic drinker" category that excluded individuals who met the criterion for alcohol abuse or dependence. Then, among the remaining individuals with "no alcohol diagnosis" (after eliminating the heavy episodic drinkers), we partitioned the remaining individuals into two categories: those who reported consuming alcohol in the last 12 months (identified in the NESARC file as "current normative drinkers") and those who reported no drinking in the last 12 months ("current nondrinkers").

Table 1 lists the six nonoverlapping categories, together with the number and percentage of respondents in each category and the estimated number in the U.S. population that falls into that category. Because there were more dependent cases classified as dependent/abusive than dependent, we added another category that combined both of these groups in our regression analyses. All the categories are based on self-reports covering the last 12 months. The first three columns cover the "diagnosable" categories under

the DSM-IV criteria (American Psychiatric Association, 1994). The remainder represents our categorizations of the cases classified as “no diagnosis” according to the NESARC manual.

These classifications, derived from the NESARC, correspond roughly to those provided by Jones and Lacey (2002) in their review of the characteristics of drinking drivers. They provided four categories: abstainers (35%), social drinkers (57%), problem drinkers (4%), and alcoholics (4%). In Table 1, the two dependence categories total nearly 4%, and the abusive drinker category totals over 4.5%. These totals are similar to that of the Jones and Lacey problem drinkers and alcoholics. Also, the NESARC’s “heavy episodic drinkers” and “current normative drinkers” include 57% of the population, which is the same as the Jones and Lacey “social drinkers.” Naimi et al. (2003) estimated that 14.3% of U.S. adults in 2001 had at least one “binge-drinking episode” (defined by the authors as heavy episodic, 5+ drinks) during the last 30 days based on the Behavioral Risk Factor Surveillance System used in state surveys. Although this is substantially higher than the percentage of heavy episodic drinkers in Table 1, a substantial proportion of the 5+ drinkers in the NESARC fall into the dependent and abusive drinker category; therefore, the estimates of Naimi et al. and our estimates based on NESARC are not comparable.

Based on NESARC’s by-state data of self-reported drinking in the last 12 months, we determined the percentage of the population in each state that fell into each of the six nonoverlapping consumption categories in Table 1. To determine the relationship of these state distributions of drinker types to drivers in alcohol-related crashes, we used 3 years of data (1999-2001, inclusive) from FARS (NHTSA, 2002a). Because the NESARC was conducted in 2000-2001 and the questionnaire referred to drinking during the previous 12 months, those 3 years of FARS data covered the period on which the respondents were reporting and contained enough cases to reduce annual variation and provide a reliable measure for each state. The FARS is a census of all fatal crashes on public roadways that result in a death within 30 days. It provides detailed information, including BACs at the time of the crash, on all drivers of motor vehicles

involved in fatal crashes in the United States. Actual measured BACs are available on 65% of fatally injured drivers but on only 25% of surviving drivers (NHTSA, 2002b). Missing values are estimated using a system developed by Rubin et al. (1998). Thus, a BAC is available for every driver in the FARS file.

For each state (including the District of Columbia) in the file, we computed the ratio of drinking drivers at two BAC levels ($>.00\%$ and $\geq 15\%$) to nondrinking drivers (BAC = $.00\%$) in fatal crashes. This drinking/nondrinking (D/ND) ratio assumes that within a jurisdiction, drivers with positive BACs and BACs of $.00\%$ face similar crash exposure relative to factors outside of their alcohol consumption, such as the quality of roadways and vehicles, the weather, and the urban or rural characteristics of the community (Voas et al., 2000).

In addition to such roadway and vehicle characteristics, two state-level factors—alcohol safety laws (Shults et al., 2002) and the economy (Voas et al., 2000)—have been shown to have a differential impact on the occurrence of alcohol-related crashes compared with non-alcohol-related crashes. We developed a measure of the overall legal environment in each state by creating a variable based on the total number of alcohol-related laws and regulations enacted in each state as listed on the Mothers Against Drunk Driving’s (MADD’s) website. These data, derived from the triennial Rating the States survey conducted by MADD (2002), cover 37 types of legislation (states average 26), such as state $.08\%$ BAC limits, primary safety belt laws, and zero tolerance laws for underage drivers. Shults et al. (2002) found that MADD’s Rating the States grades, which are based on the number of laws, are associated with reported drinking and driving in the 1997 Behavioral Risk Factor Surveillance System state-based telephone survey. A measure of the state economic status used in prior studies of state alcohol laws (Voas et al., 2000) was obtained from the Bureau of the Census (2001).

As merging these data sources at the individual level was impossible, we combined them at the aggregated state level, making “state” the unit of analysis. Because of the small sample size ($N = 51$) and to save degrees of freedom, we separately regressed the six NESARC consumption

TABLE 1. Percentage of respondents (ages ≥ 18) who fall into one of the six nonoverlapping categories based on the 2000 NESARC survey

	Dependent drinkers	Abusive drinkers	Dependent and abusive drinkers	Heavy episodic drinkers	Current normative drinkers	Current nondrinkers	Total
<i>N</i> (raw data)	553	1,843	931	3,297	20,332	16,147	43,093
<i>N</i> (weighted)	2,666,000	9,668,000	5,246,000	17,098,000	101,360,000	71,845,000	207,883,000
Total, %	1.28	4.65	2.52	8.22	48.76	34.56	100.00

Notes: *N* (raw data) denotes sample size on the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC), and *N* (weighted) denotes the U.S. population size estimated from the NESARC. Source: NESARC.

categories on the D/ND ratio for two groups of drinking drivers in fatal crashes: (1) where D equaled all drivers with BACs of $>.00\%$, and (2) where D equaled all drivers with BACs of $\geq.15\%$. The number of state alcohol safety laws (according to MADD) and the state's unemployment rate (Bureau of the Census, 2001) were used as covariates in all the analyses. Based on the regression coefficients obtained for each of the consumption categories, the total drinking drivers in each group ($>.00\%$ BAC and $\geq.15\%$ BAC) were distributed across the five positive consumption categories for the year 2000. (Because the current nondrinker category was negatively related to the number of drinking drivers in fatal crashes, it was not included in this analysis.) We used these coefficients (which represent the change in the alcohol-related/non-alcohol-related fatality ratio by unit of change in the consumption category) to estimate the hypothetical reduction in the number of alcohol-related fatalities that would occur in the United States if all individuals in a given consumption category became "current normative drinkers." We used STATA 7 (Stata Corp., College Station, TX) to perform the analyses.

Results

Table 2 summarizes the results of each of the seven regression analyses conducted on the D/ND ratio of all drivers in fatal crashes with a positive BAC (i.e., one for each of the six mutually nonoverlapping drinking categories in Table 1, plus the analysis in Row 1 of the combination of the two dependent groups: dependent drinkers and dependent and abusive drinkers). Table 3 provides similar analyses for drivers with BACs of $\geq.15\%$. These two tables

provide the coefficients and 95% confidence intervals for each drinker type with the associated coefficients for the unemployment and state laws covariates. The unemployment covariate selected as a proxy for socioeconomic environment was significant only in the analyses of the relationship of current normative drinkers and current nondrinkers to crash-involved drivers with positive BACs, and only to the analysis of current nondrinkers to crash-involved drivers with BACs of $\geq.15\%$. The state law covariate, however, was significant in all the analyses shown in Tables 2 and 3. In each analysis, the number of state alcohol safety laws had a strong negative relationship to the D/ND ratio.

As might be expected, the proportion of the state's population that was classified as "current nondrinkers" was negatively related to the number of drinking drivers and the number of drivers with BACs of $\geq.15\%$. In contrast, the proportion of alcohol consumers falling into the current normative drinker, heavy episodic drinker, and abusive drinker categories in each state was positively related to drivers with BACs of $\geq.15\%$ (Table 3), as well as to all drinking drivers in fatal crashes (Table 2). Surprisingly, the proportion of the state's population with a DSM-IV classification of dependent, dependent/abusive, or a combination of both categories was not significantly related to either all drinking drivers or drivers with BACs of $\geq.15\%$ in crashes.

The second column of Table 4 presents the estimated national population falling into each of the consumption categories (i.e., drinker categories in Models I-VI in Tables 2 and 3), with the exception of the current nondrinker category (i.e., nondrinker category in Model VII in Tables 2 and 3). The third column shows the percentage of the U.S.

TABLE 2. Relationship of drinking categories to ratio of drinking drivers in fatal crashes with positive ($>.00\%$) blood alcohol concentration

Model	y	Independent variables		
		Drinker categories ^a	Unemployment	State laws
I	D/ND	All dependent and abusive drinkers .0043 (-.0115 - .0201)	.0147 (-.0110 - .0403)	-.0116 (-.0187 - -.0045)
II	D/ND	Dependent drinkers .0069 (-.0259 - .0397)	.0148 (-.0109 - .0405)	-.0120 (-.0192 - -.0048)
III	D/ND	Dependent and abusive drinkers .0024 (-.0125 - .0173)	.0145 (-.0111 - .0402)	-.0115 (-.0187 - -.0044)
IV	D/ND	<i>Abusive drinkers</i> .0099 (.0009 - .0188)	.0209 (-.0043 - .0460)	-.0114 (-.0181 - -.0046)
V	D/ND	<i>Heavy episodic drinkers</i> .0087 (.0021 - .0154)	.0148 (-.0092 - .0388)	-.0113 (-.0179 - -.0047)
VI	D/ND	<i>Current normative drinkers</i> .0034 (.0006 - .0063)	.0265 (.0003 - .0527)	-.0134 (-.0202 - -.0065)
VII	D/ND	Current nondrinkers -.0042 (-.0065 - -.0020)	.0307 (.0067 - .0548)	-.0136 (-.0199 - -.0073)

Notes: CI = confidence interval. D/ND denotes the dependent variable (y): the drinking/nondrinking ratio. **Bold** denotes 1% significance; *italics* denotes 5% significance. ^aThis table includes the six nonoverlapping categories (Models II-VII). Model I combines drinker categories in Models II and III.

TABLE 3. Relationship of drinking categories to ratio of drinking drivers in fatal crashes with blood alcohol concentrations of .15%

Model	y	Independent variables Regression coefficient (95% CI)		
		Drinker categories ^a	Unemployment	State laws
I	D/ND	All dependent and abusive drinkers .0066 (-.0039 – .0170)	.0061 (-.0109 – .0231)	-.0073 (-.0120 – -.0039)
II	D/ND	Dependent drinkers -.0021 (-.0241 – .0200)	.0059 (-.0113 – .0232)	-.0074 (-.0122 – -.0026)
III	D/ND	Dependent and abusive drinkers .0062 (-.0036 – .0161)	.0059 (-.0111 – .0228)	-.0071 (-.0118 – -.0024)
IV	D/ND	Abusive drinkers .0082 (.0023 – .0140)	.0112 (-.0052 – .0276)	-.0072 (-.0116 – -.0028)
V	D/ND	Heavy episodic drinkers .0064 (.0020 – .0108)	.0062 (-.0097 – .0220)	-.0072 (-.0117 – -.0028)
VI	D/ND	<i>Current normative drinkers</i> <i>.0019 (.0001 – .0039)</i>	<i>.0128 (-.0051 – .0307)</i>	-.0084 (-.0131 – -.0038)
VII	D/ND	Current nondrinkers -.0027 (-.0042 – -.0012)	<i>.0164 (.0001 – .0327)</i>	-.0087 (-.0130 – -.0045)

Notes: CI = confidence interval. D/ND denotes the dependent variable (y): the drinking/nondrinking ratio. **Bold** denotes 1% significance; *italics* denotes 5% significance. ^aThis table includes the six nonoverlapping categories (Models II-VII). The combined consumption category is Model I.

drinking population falling into each consumption category to permit comparison with the number and percentage of drivers in fatal crashes with BACs of >.00% (Columns 4 and 5) and shows the number and percentage of drivers with BACs of ≥.15% (Columns 7 and 8). The estimates in Columns 4 and 7 are based on the regression analysis results in Tables 1 and 2. Also presented are the drinking-driver rates per million drinkers (Columns 6 and 9). Current nondrinkers are excluded, because, presumably, they are not drinking drivers. The first three rows of Table 4 contain estimates for the dependent drinker and the dependent and abusive drinker categories, and for the combination of

both these dependent groups. The regression results for these consumption categories were not statistically significant; therefore, they must be viewed with caution but are presented for comparison with the three consumption categories for which the regression results were significant. As can be seen, the abusive and heavy episodic drinker categories are associated with the highest rates of drinking drivers in fatal crashes. The current normative drinker category is associated with much lower drinking driver rates, but, because of its large size, more than half of all the drinking drivers at both the ≥.01% and ≥.15% BAC levels are associated with that category of consumers.

TABLE 4. Number and percentage of U.S. drinkers in six consumption categories and their relationship to drinking drivers in fatal crashes expressed in rate per million drinkers

Drinker classifications ^a	U.S. drinking population based on the NESARC (71,845,000 nondrinkers not included)		No. of drivers in fatal crashes with BACs ≥ .01%, 3-year average, 1999-2001 (total = 12,500)			No. of drivers in fatal crashes with BACs ≥ .15%, 3-year average, 1999-2001 (total = 8,000)		
	n	%	n ^b	%	Rate ^c	n ^c	%	Rate ^c
All dependent and abusive drinkers	14,914,000	11.0	1,680	13.4	113	1,120	14.1	75
Dependent drinkers	9,668,000	7.1	1,410	11.3	146	430	5.4	44
Dependent and abusive drinkers	5,246,000	3.9	270	2.2	51	690	8.7	132
Abusive drinkers	2,666,000	2.0	560	4.5	210	470	5.9	176
Heavy episodic drinkers	17,098,000	12.6	3,170	25.3	185	2,340	29.4	137
Current normative drinkers	101,360,000	74.5	7,110	56.8	70	4,040	50.7	40

Notes: For dependent drinkers and dependent and abusive drinkers, add column for rates and rows for the combination of both. NESARC = National Epidemiologic Survey on Alcohol and Related Conditions; BAC = blood alcohol concentration. ^aThe current nondrinker category is not shown; ^bdrivers in each fatal crash category were estimated from our regression models; ^crate expressed per 10⁶.

Discussion

This study has been designed to provide some insight about a timely debate for which no national data at the individual level are available. To deal with this data limitation, this study has focused at the aggregated state level. This strategy implies a trade-off: The results obtained by this study provide an initial indication of the relationship between a state's population with alcohol-use disorders (AUDs) and drinking drivers in fatal crashes; however, these results must be interpreted carefully in light of the methodological limitations associated with the use of an aggregated unit of analysis. Both aspects of this trade-off are discussed in this section.

The results of this study show that there is a relationship between classifications of consumers based on their reported drinking behavior, as measured by the NESARC household survey, and the proportion of drinking drivers in fatal crashes in a state. The relationships between the consumption categories and drinking drivers in fatal crashes are generally in line with expectations. Our study indicates that the higher the proportion of current nondrinkers in a state, the lower the proportion of drinking drivers in fatal crashes will be in that state. This is in contrast to all of the drinking categories that were positively related to the occurrence of drinking drivers in fatal crashes. Current normative drinkers demonstrated a significant relationship to the proportion of drinking drivers in fatal crashes, even for those drivers in fatal crashes with BACs of $\geq 0.15\%$. As expected, the estimated rate of crash-involved drinking drivers per million for the asymptomatic normative group of current normative drinkers was lower than that of the heavier drinking groups. Because the heavy episodic and the DSM-IV diagnosable categories of drinkers have been separated from the current normative drinker group, it may appear unlikely that normative drinkers would reach BACs of $\geq 0.15\%$. Although the rate of crash-involved normative drinkers per million was only about one fourth that of those in the abusive category (40 vs 176; see Table 4), there was still a significant relationship between that rate and the proportion of $\geq 0.15\%$ BAC drivers in fatal crashes. There are two possible explanations for this apparently anomalous finding: (1) individuals who are not classifiable as dependent, abusive, or heavy episodic drinkers may occasionally reach very high BACs, in the range of $\geq 0.15\%$; or (2) interview respondents may have understated their drinking, particularly regarding very high consumption levels. Our data do not permit us to determine which of these possibilities account for the relationship to high BAC drivers in fatal crashes. Although the estimated drinking driver rate per million is substantially lower for current normative drinkers because of the relatively large numbers of such drinkers (they account for three of four alcohol consumers), they apparently account for half of the drinking drivers in fatal

crashes—an example of the prevention paradox. This emphasizes the need for programs directed at current normative drinkers who drive, including efforts to reduce alcohol availability (particularly to underage drinkers), responsible beverage service, high-visibility enforcement, and public education.

Heavy episodic drinkers constitute the largest group among the heavy or symptomatic drinkers. They demonstrate a strong relationship to all drinking drivers in fatal crashes as well as to high BAC drivers in fatal crashes. This is particularly significant, because the drinking classifications for this study were constructed to be independent; therefore, 5+ drinkers who met the criteria for one of the three DSM-IV categories—dependent, abusive, and dependent and abusive drinkers (see Table 1)—are not among the heavy episodic drinkers included in this category. Heavy episodic drinking is the consumption behavior most likely to lead to high BACs and is most prevalent in young males, who also are at higher risk for crash involvement. Its significance suggests its potential importance as an indicator of crash risk. In the context of this study, it may be a general surrogate for heavy drinking that does not meet the DSM-IV criteria for abuse or dependence. It also may capture some of the personality characteristics associated with heavy episodic drinking behavior that are correlated with risk of crash involvement. This result supports the current attention being paid to heavy episodic drinking by young people, particularly college students.

Abusive drinkers constitute the one DSM-IV category that demonstrated a statistically significant relationship to drinking drivers in fatal crashes. The significance of this result may be clouded by the inclusion in the abusive definition of questions related to drinking and driving (Hasin et al., 2003). In the NESARC, all respondents who answered "yes" to question S2B01B21 ("In the last year: More than once drove vehicle while drinking") or to question S2BQ1B23 ("In the last year: More than once drove a vehicle after having too much to drink") were classified as alcohol abusers. Those are the only two questions on the NESARC that relate to drinking and driving in the last year. Because the drinker classification was based on drinking during the last 12 months, heavy drinkers who were current drivers were more likely to meet the criteria for this category than similar drinkers who did not have access to a vehicle or drove infrequently. This may artificially raise its relationship to alcohol-related crashes relative to other heavy drinking classifications such as heavy episodic drinkers.

The dependent and dependent/abusive groups did not demonstrate a statistically significant relationship to drinking drivers in fatal crashes, either separately or when combined. As indicated, this may have resulted from the large variability of these two classes across states, which limited our power to detect a relationship with the small *N*. If we

consider the values obtained, keeping in mind the lack of significance, the results appear reasonable. They tend to exhibit drinking-driver rates between those of the current normative drinkers and those of abusive and heavy episodic drinkers. Dependent drinkers may be more likely than the other classes of drinkers to lack access to a vehicle or to not be driving regularly. Besides the probability that a significant proportion is unlicensed, a substantial number may be institutionalized, lack employment, or lack the funds to own and operate a vehicle. Consequently, although they may be among the heaviest consumers of alcohol, their exposure as motor vehicle operators may be limited, thus protecting them against involvement in impaired-driving crashes. Their relationship to drinking drivers in fatal crashes could be more clearly determined if the NESARC contained questions on the number of miles driven in the last 12 months.

Our results add to the significance of state DUI countermeasure efforts as measured in MADD's Rating the States (2002) program. Our results complement those of Shults et al. (2002), who showed that the letter grade assigned to a state by MADD was related to reported drinking and driving by that state's residents. In our study, we used the number of laws and programs in each state as the measure of the legal environment and demonstrated that it was related to the number of drinking drivers in fatal crashes. This relationship of state DUI countermeasure level to drinking drivers in fatal crashes strengthens the apparent validity of this study. The unemployment variable inserted as a proxy for the status of the economy showed a generally positive relationship with the number of drinking drivers in fatal crashes, but the relationship was small and not generally important in this study.

Based on the results of this study, it is possible to estimate the number of fatalities associated with each category of drinker as shown in Table 4. These estimates suggest that the programs that deal with heavy episodic drinkers and abusive drinkers are likely to be the most efficient, because drinkers in those categories have the highest potential (rates in Table 4) to become drinking drivers in fatal crashes. Additional study of the abusive drinker class is needed, because, as currently defined in the NESARC, it is not possible to distinguish between the roles being played by the questions on driving after drinking and the other elements of the abusive behavior syndrome. These results also suggest that 5+/4+ drinking should be given more prominence in diagnostic measures to identify DUI offenders who should receive special treatment and monitoring as part of their probation requirements. Finally, our results suggest that among the apparently normal current drinkers (based on the NESARC), a substantial number of them will be involved as high BAC drivers in highway crashes. There is a need to determine whether this is underreporting of alcohol consumption by the respondent or whether other-

wise apparently normative drinkers may become involved in crashes at high BACs.

In summary, this study provides pieces of evidence in support of both sides of the debate about the type of drinker who contributes the most to the alcohol-related fatal crash problem. Our results show a positive relationship between heavy abusive drinking (which, along with repeated impaired driving, typifies the hard core driver) and alcohol-related fatal crashes. When this relationship is adjusted by the number of drivers in each drinking category, however, those who contributed the most to the alcohol-related crash problem are the current normative drinkers, who are much more numerous than symptomatic drinkers. This finding suggests that focusing on the heavy drinker and ignoring the current normative drinker in the design of programs aimed to curb the alcohol-related crash problem could be a mistake.

Despite the relevancy of these findings, they must be qualified by several shortcomings this study has faced. First, having to use state as the unit of analysis has forced us to work with a reduced sample size ($N = 51$). Second, the goal of this study was to study relationships at the state aggregate level. Focusing on the aggregate level minimizes the "ecological fallacy" (Robinson, 1950), which warns about the inadequacy of making inferences about individuals based solely on aggregate statistics. By focusing at the aggregate level, however, we could not capture the existing variation within the different type of drinkers. Third, the relatively small relationship of dependent drinkers to drivers in alcohol-related crashes may have resulted from the number of members of that group not having access to a vehicle. Because we do not have information on miles driven as a function of group status, we cannot evaluate that factor in this study. Fourth, the number of individuals in each drinking group was very different. Therefore, variances across states in the percentage of the population falling into those drinker classifications were substantially higher than for other categories of consumers—a limitation exacerbated by our limited sample size ($N = 51$). Thus, it is probable that the failure of the dependent drinkers, abusive drinkers, and their combination to reach significance resulted from insufficient statistical power when analyzing those categories.

Given these limitations, the question arises as to whether there is a more ideal way to relate alcohol-use disorders to alcohol-related crashes. One procedure that could be implemented inexpensively might be to expand the NESARC questions to cover crash involvement when drinking and when not drinking. This would permit both individual and state-level analyses. The primary limitation of this procedure would be its dependence on the unknown accuracy of self-reports of crash involvement. Another limitation is that the low frequency of crashes would require substantially increasing the number of interviews to collect state-level

data. A second procedure, for which planning is under way (C. Debra Furr-Holden, principal investigator, NIAAA grant AA015543-01A1), is the addition to the next national roadside breath-test survey of the questions from the NESARC that serve to identify AUDs. These data can then be used to develop relative risk estimates as was done for BACs based on the 1996 National Survey (Zador et al., 2000).

Although causality cannot be assigned, we found some strong and informative associations in this study. The NESARC is a large household survey with a very high participation rate. The FARS is a census of all fatal crashes (its main limitation for this study is the need to impute BACs where actual measures are not available). Obviously, the establishment of a single cross-sectional relationship cannot demonstrate causality. The use of state data to compare different consumption characteristics and drinking drivers in crashes may have introduced state-level variables that we have failed to control, either by using the D/ND ratio as our dependent variable or by including covariates for laws and unemployment. Nevertheless, it is at the state level that laws related to drinking and driving are enacted. Keeping in mind these limitations, the study has yielded a number of interesting findings. By providing some information about which categories of drinkers contribute the most to the alcohol-related fatal crash problem, this study may well prove useful for regulators and policy makers.

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