

Inconsistencies Between Actual and Estimated Blood Alcohol Concentrations in a Field Study of College Students: Do Students Really Know How Much They Drink?

Courtney L. Kraus, Natasha C. Salazar, Jamie R. Mitchell, Whitney D. Florin, Bob Guenther, David Brady, Scott H. Swartzwelder, and Aaron M. White

Background: Alcohol use by college students is commonly measured through the use of surveys. The validity of such data hinge on the assumption that students are aware of how much alcohol they actually consume. Recent studies call this assumption into question. Students tend to overestimate the appropriate sizes of standard drinks, suggesting that they might underestimate how much alcohol they consume. If this is true, then students' actual blood alcohol concentrations (BACs) should be higher than BACs estimated based on self-report data. The present study examined this issue

Methods: Breathalyzer readings and self-reported drinking data were collected from 152 college students during the fall of 2004. Estimated BACs were calculated by means of a standard formula, and the relation between actual and estimated BACs was examined. Factors contributing to discrepancies between the two values were identified

Results: Estimated BAC levels were significantly higher, not lower, than breath BAC measures. The accuracy of estimated BACs decreased as the number of drinks and amount of time spent drinking increased. Being male and drinking only beer predicted greater accuracy of estimated BACs **Conclusions:** Although laboratory data suggest that students underestimate how much they drink, the hypothesis was not supported by data collected in the field. It appears that students might actually overestimate rather than underestimate their levels of consumption when surveyed in the midst of a night of drinking. The findings corroborate observations made by other researchers and suggest that the findings of laboratory studies on college drinking do not necessarily extend to real-world settings.

Key Words: Alcohol, College, Consequences, High Risk, Binge, Survey.

INTRODUCTION

ALCOHOL MISUSE ON college campuses remains a pervasive problem. Each year, thousands of students are killed or injured in alcohol-related incidents (Hingson et al., 2002). Vandalism, riots, and sexual assaults on college campuses, all linked to alcohol, frequently make the national headlines. Most of what is known about college drinking comes from self-report survey data (Johnston et al., 2004; Wechsler et al., 2002). Several assumptions must be made when using survey data to study college drinking

and to determine the relative risks associated with various levels of consumption. One such assumption is that self-reported drinking data are accurate. If students' estimates of their own drinking levels were inaccurate, researchers would need to reevaluate the use of survey data for studying college drinking.

Recent studies raise questions about the validity of self-reported drinking data. White et al. (2003; 2005) observed that many college students do not know the definitions of standard servings of alcohol. When asked to either pour single servings of alcohol or to state the amount of alcohol in a single serving, students tend to overestimate the amount of alcohol that should be present. In one study (White et al., 2005), on average, students indicated that the amount of liquor in a single mixed drink should be 4.5 ounces rather than the standard 1.25 or 1.5 ounces. Correcting students' misperceptions of single-serving sizes led them to alter their self-reported drinking levels, suggesting that their initial self-reported drinking levels were inaccurate.

If, as laboratory studies suggest, students underestimate

From the Department of Psychiatry, Duke University Medical Center, Durham, North Carolina (CLK, NCS, JRM, WDF, SHS, AMW); and the Department of Electrical and Computer Engineering, Duke University, Durham, North Carolina (BG, DB).

*Received for publication ;
accepted .*

Reprint requests: Aaron M. White, PhD, Department of Psychiatry, Box 3374, Duke University Medical Center, Durham, NC 27710; Fax: 919-286-4662; E-mail: aaron.white@duke.edu

Copyright © 2005 by the Research Society on Alcoholism.

DOI: 10.1097/01.alc.0000179205.24180.4a

how much they drink, then they should reach higher blood alcohol concentrations (BACs) than expected, based on their self-reported drinking data during a typical night. Under controlled conditions, modified versions of the Widmark formula can accurately estimate actual BAC levels in subjects by using their weight, gender, number of drinks consumed, and amount of time during which the consumption occurred (NHTSA, 1994). To date, very few field studies have examined whether estimated BAC levels accurately predict actual BAC levels. Thombs et al. (2003) measured BAC levels in college students returning to their residence halls after a night of drinking. Estimated BACs were compared with actual BACs, but the estimates were provided by the subjects themselves and not calculated using established formulas. Students' intuitions about their BACs were relatively accurate. However, without calculating formal estimates of students' BACs, it is impossible to know whether students were truly aware of how much they had consumed.

Carey and Hustad (2002) measured BAC levels by using breath samples in a convenience sample of 44 individuals walking in an area with a high density of restaurants and bars. Roughly two-thirds of the subjects were college students, and the majority of the sample consisted of male students. Subjects were called the next day and asked to provide information about how much they drank the night before. Estimated BAC levels were calculated by using a modified version of the Widmark formula endorsed by the National Highway Traffic Safety Administration (NHTSA). Overall, estimated and actual BAC levels were statistically similar, though the estimated values tended to run higher than actual levels. This finding suggests that students overestimated rather than underestimated how much they drank. The authors found that the discrepancy between estimated and actual BAC levels was greater at higher levels of intoxication, suggesting that the accuracy of self-reported drinking data decreases as consumption increases. The generalizability of the outcomes is severely limited by several factors. First, only 44 subjects were assessed, and nine of those subjects had BAC levels of 0.0%. Subjects were only recruited from an area of campus adjacent to bars, and a large percentage of subjects were older than college age. Further, consumption data were collected the following day. Given the impact of alcohol on memory, the fact that hangovers compromise memory, and the fact that subjects might have consumed more alcohol after providing the breath samples, the accuracy of such data could be severely diminished.

In the current project, actual BAC levels were collected from college students walking on campus on Thursday through Saturday nights. Estimated BAC levels were calculated on the basis of self-reported consumption data. Estimated and actual BAC levels were compared to determine whether students' self-reported drinking data yielded accurate information about their levels of consumption.

METHODS

Subjects and Procedures

Data were collected from 152 undergraduate students walking on campus at a private university in the south between 11 PM and 2 AM on Thursday, Friday, and Saturday during the fall semester of 2004. Subjects were approached by two female undergraduate research assistants and asked if they would be interested in participating in a brief study in which their blood alcohol concentrations were recorded. Subjects were then asked basic questions about how many drinks they had during the evening, what time they started drinking, how long it had been since their last drink, what types of drinks they had consumed, how much they weighed, and their year in school. Only subjects that reported consuming alcohol during the evening were included in the study. After these data were collected, subjects' blood alcohol concentrations were assessed with the use of an Alcosensor i.v. (Intoximeters, Inc.). The unit was calibrated immediately before the beginning of the experiment. A minimum of 15 minutes was required to pass between the time of the subject's last drink and when the breath sample was taken.

All subjects were 18 years of age or older, and the study was approved by the Institutional Review Board at the University.

Variables and Statistical Analyses

Descriptive statistics were first calculated to examine basic demographic data and students' self-reported drinking habits. Of the 152 undergraduate students tested, 48 were female (32%) and 104 were male (68%). Ages ranged from 18 to 23 years, with an average of 19.7 years ($SD = 1.46$). One hundred twenty-four students (82%) were white, eight (5%) were Asian Americans, 13 (9%) were black, and six (4%) were classified as other. Forty-eight students (32%) were freshmen, 22 (15%) were sophomores, 14 (9%) were juniors, and 68 (45%) were seniors.

A modified version of the Widmark formula endorsed by the NHTSA (1994) (Perkins et al., 2001) was used to calculate estimated BAC values from self-reported drinking data. A paired t test was used to determine whether estimated and actual BAC levels differed. The Pearson correlation coefficient was calculated to determine if the two values were highly related, even if statistically different overall.

Linear regression analyses were performed to determine whether demographic characteristics or drinking levels influenced the amount of discrepancy between estimated and actual BAC levels. Categorical independent measures consisted of gender (male = 0, female = 1), year in school (freshman = 0, sophomore = 1, junior = 2, senior = 3), what the individual drank that evening (beer alone = 0, beer and/or other = 1), and ethnicity. Given the predominance of white students in the sample, ethnicity was collapsed into two groups for analyses: white and nonwhite (white = 0, nonwhite = 1). Noncategorical independent measures consisted of how many drinks the individual had during the evening and the total amount of time the individual spent drinking that night.

All analyses were performed with the use of SPSS 11.0 (SPSS, Chicago, IL), with an α -level of 0.05 for significance (Fig. 1).

RESULTS

On average, students consumed 5.60 ($SD = 3.26$) drinks over 2.61 ($SD = 2.11$) hours. Average estimated BACs were 0.12% ($SD = 0.07$), whereas average BACs assessed by breath samples were 0.09% ($SD = 0.046$). Although all subjects reported drinking during the evening, nine had actual and estimated BAC levels of 0.00%. Data from these subjects were not included in analyses comparing actual and estimated BAC levels. Overall, estimated BAC levels were significantly higher than actual BAC levels [$t(142) = 5.27, p < 0.001$], yet the two measures were significantly correlated ($R^2 = 0.22, p < 0.001$).

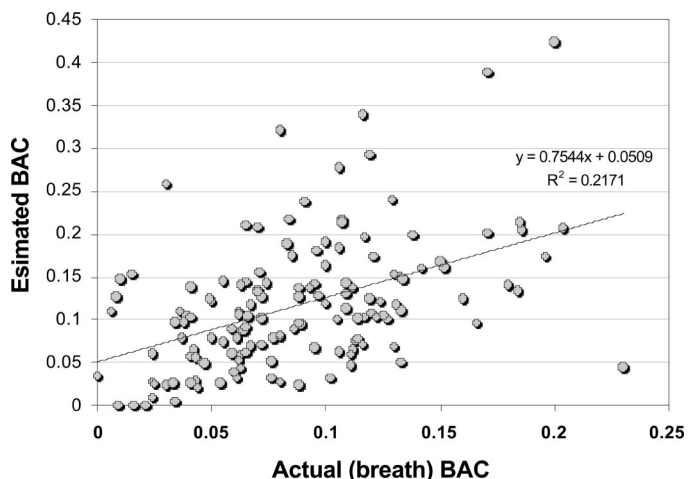


Figure 1. Estimated BACs calculated on the basis of students' self-reported drinking levels were significantly correlated with BACs assessed by means of a breathalyzer. Overall, estimated BACs were significantly higher than actual BACs, suggesting that students might overestimate how much alcohol they consumed. The discrepancy between actual and estimated BACs increased with the number of drinks that students consumed and the amount of time they spent drinking. Discrepancies were smaller among male students and students who drank only beer during that particular evening (all $p \leq 0.05$)

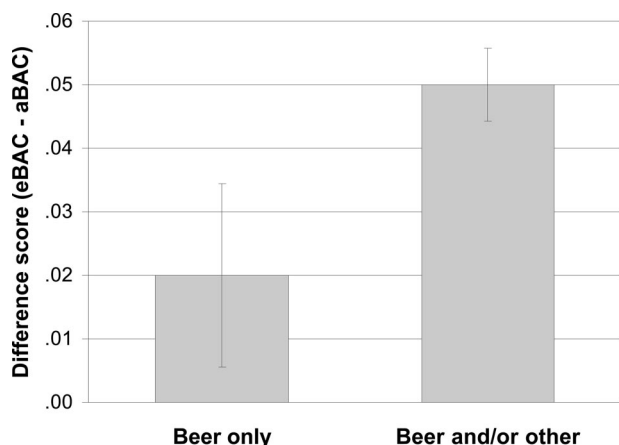


Figure 2. Discrepancy between actual and estimated BACs was smaller among students who consumed only beer before being tested. This probably is attributable to the fact that students tend to be more aware of standard serving sizes for beer than other types of alcoholic beverages and that beer tends to be served in quantities closer to standard serving sizes than other beverages. These factors would make it easier for students to keep track of how much they had to drink, which would increase the accuracy of self-reported drinking levels ($p < 0.05$).

Linear regression [$R^2 = 0.49$, $F(6,136) = 22.11$, $p < 0.001$, Tolerance values >0.50] indicated that estimated BAC levels were more accurate for male students ($t = 5.35$, $p < 0.001$) and students who drank beer only ($t = 2.17$, $p < 0.05$) and that the accuracy of estimated BAC levels decreased as the number of drinks ($t = -10.17$, $p < 0.001$) and the amount of time spent drinking ($t = 4.33$, $p < 0.001$) increased (Fig. 2).

DISCUSSION

Recent laboratory studies suggest that college students might underestimate how much they drink (White et al., 2003; 2005). If findings from these studies have real-world

implications, then students should reach higher BACs than expected, based on their self-reported consumption during a particular night of drinking. Surprisingly, in the present study, we observed exactly the opposite. Blood alcohol concentrations estimated from self-report data were significantly higher than actual BAC readings. The data suggest that students might actually overestimate rather than underestimate their levels of consumption.

There are several potential explanations for the discrepancy between actual and estimated BAC levels observed in the present study. The modified version of the Widmark formula is commonly used to estimate BAC levels (Carey and Hustad, 2002; Perkins et al., 2001; White et al., 2004), and it is widely accepted that the formula can accurately model true BAC levels when accurate information is entered into the equation (Iffland and Jones, 2002; NHTSA, 1994). However, some authors have reported that the formula is far from perfect. Friel et al. (1995) gave fixed doses of alcohol to male and female college students and then measured their BAC levels by using a breathalyzer over the course of two hours. Their observations suggest that the Widmark formula might slightly overestimate subjects' BACs but by less than the BAC produced by half of a standard drink. In contrast to the findings of Friel et al. (1995), Davies and Bowen (2000) reported that formulas used to predict BAC levels tend to underestimate subjects' true BAC levels. They used two different models, one using only gender, weight, and levels of consumption, as in the current study, and one involving a more complex analysis in which factors such as height and age were also taken into consideration. Both formulas produced estimated BAC levels that were too low. Thus, although it is possible that imperfections in the formula used in the current study and others contributed to the discrepancy between estimated and actual BAC levels, the nature of this contribution is unclear. Further, it is highly unlikely that the contribution could account for the large differences between estimated and actual BACs observed in the current study.

The breathalyzer used in the current study was calibrated before testing, and its accuracy was compared with that of another recently calibrated device, significantly limiting the possibility that error in the device contributed to the discrepancy between estimated and actual BACs. It is widely accepted that breathalyzer readings closely approximate true blood alcohol levels (Gullberg, 2003). A standard delay of 15 minutes was required between the time that a subject took their last sip of alcohol and the time that the breathalyzer reading was taken. Even if this delay were too short, the resulting BAC would be expected to be higher rather than lower than the estimated BAC. Thus, assuming that both the formula and the breathalyzer were essentially accurate, it seems likely that students provided inaccurate information pertaining to at least one of the variables in the equation.

To approximate BAC levels by using formulas such as the one used in the current study, a researcher must enter

several values into the modified Widmark formula, including gender, weight, number of hours spent drinking, and amount of alcohol consumed (NHTSA, 1994; Perkins et al., 2001; White et al., 2004). We found that BACs estimated by using this formula were significantly higher than BACs measured with a breathalyzer. It is possible that students tended to underestimate the amount of time they spent drinking, which would lead to spuriously high estimated BAC levels. Errors in estimates of time spent drinking could have increased as the night progressed and thus contributed to the observed increase in discrepancies between estimated and actual BACs with longer drinking sessions. It is also possible that students did not accurately report their weight. This would have contributed to both the higher overall estimated BACs relative to actual BACs and to increases in the discrepancy between the two values with increasing numbers of drinks. A third potential contributor to the discrepancy between estimated and actual BACs is inaccurate reporting of the number of drinks that students consumed. Higher estimated BACs would result if students overestimated how much they drank. Although inconsistent with our hypothesis, the data are consistent with those reported by Carey and Hustad (2002). Those researchers observed a trend toward larger overall estimated BAC levels relative to observed BAC levels, and the size of the discrepancy increased with levels of self-reported consumption.

The gender of the drinker had a notable impact on the consistency between estimated and actual BACs in the current study. Male students were significantly more likely than female students to have their reported BACs agree with their actual BACs. This could stem from several factors linked to gender, including drinking experience and accuracy of self-reported weights. Men tend to drink more often and more heavily than do women (Johnson et al., 2004). Consequently, male drinkers might be better than female drinkers at keeping track of their levels of consumption during a given night. It is also possible that male students tended to report their weights more accurately than did female students. Indeed, previous research suggests that women are more likely than men to underreport their weight (Betz et al., 1994). As discussed above, underreporting body weight would lead to spuriously high estimated BAC levels.

In contrast to the gender effect observed here, Sommers et al. (2000) reported that men were more likely than women to underreport how much alcohol they consumed, leading men to exhibit higher actual BACs than estimated BACs. However, these data were collected in a hospital setting from subjects being treated for unintentional alcohol-related injuries. The impact of the setting and circumstances could have influenced the likelihood that subjects would provide accurate data regarding their levels of consumption. Among subjects leaving taverns and bars, Meier et al. (1987) observed that as in the current study, male students' reports of consumption were more consis-

tent with their actual BACs than were those from female students.

The type of beverage that students consumed contributed to the magnitude of the discrepancies between estimated and actual BACs. Specifically, those who drank beer alone exhibited more accurate estimated BACs. Previous studies have revealed that students pour single servings of beer more accurately than single servings of other drinks, and students are also more familiar with the standard serving size of beer relative to other drinks (White et al., 2003; and White et al., 2005, in press). In addition, beer is often consumed in cans and bottles, which are, on average, close to a standard serving. Thus, the greater accuracy of estimated BACs in beer drinkers might be related to the fact that it is easier to keep track of how much alcohol one consumes if drinking beer versus wine and spirits, which tend to have greater variability in alcohol concentrations and serving sizes (White et al., 2005, in press).

In two previous studies from our laboratory, college students were found to significantly overestimate how much alcohol should be present in a single drink. When asked to pour single servings of different types of alcohol beverages, students poured drinks that were too large (White et al., 2003; 2005). When asked to simply define standard drinks in terms of fluid ounces, students tended to overstate the number of ounces that should be present. For instance, the average number of ounces of liquor in student-defined mixed drinks was 4.5 ounces rather than the 1.25 or 1.5 ounces in actual standard drinks (White et al., 2005). When students were provided with feedback regarding the discrepancies between their definitions of drinks and the actual definitions of drinks, they tended to revise their self-reported levels of consumption to reflect their new knowledge. This led to a significant increase in self-reported levels of consumption. Based on these observations, we hypothesized that students tend to underestimate how much alcohol they consume. The present study was undertaken to assess whether findings from the laboratory had real-world implications. We hypothesized that if students really do underestimate how much they drink, then their actual BACs should be higher than expected, based on self-reported levels of consumption during a particular night of drinking. The findings did not support the hypothesis. Students' actual BACs tended to be lower than expected, based on self-reported consumption. The findings suggest that despite the fact that students have difficulty accurately defining single servings of alcohol in a laboratory setting, their lack of knowledge regarding standard drink sizes does not seem to lead them to achieve higher BAC levels than expected, based on their self-reported levels of consumption. If anything, they tend to overestimate rather than underestimate their true drinking levels during a particular night.

It is worth noting that the discrepancy between estimated and actual BAC levels, though in the opposite direction of what was anticipated, provides further evidence that stu-

dents' survey responses are inaccurate. Whether in the lab or in the field, students' self-reported drinking levels appear to be inconsistent with how much they actually drink. Laboratory data suggest that they underestimate their true levels of consumption, whereas data collected in the field suggest that they might overestimate how much they consume. Error in either direction creates a problem for researchers using survey data to assess college drinking levels. Educating college students about the correct definitions of standard drinks should help them provide more accurate information on alcohol surveys, which will help researchers paint a more accurate picture of college drinking.

Lange and Voas, 2001

REFERENCES

- Carey KB, Hustad JTP (2002) Are retrospectively reconstructed blood alcohol concentrations accurate? Preliminary results from a field study. *J Stud Alcohol* 63:762–766.
- Davies BT, Bowen CK (2000) Peak blood alcohol prediction: an empirical test of two computer models. *J Stud Alcohol* 61:187–191.
- Friel PN, Logan BK, Baer J (1995) An evaluation of the reliability of Widmark calculations based on breath alcohol measurements. *J Forensic Sci* 91–94.
- Gullberg RG (2003) Breath alcohol measurement variability associated with different instrumentation and protocols. *Forensic Sci Int* 131:30–35.
- Iffland R, Jones AW (2002) Evaluating alleged drinking after driving—the hip-flask defense: Part 1. Double blood samples and urine-to-blood alcohol relationship. *Med Sci Law* 42:207–224.
- Johnston LD, O'Malley PM, Bachman JG, Schulenberg JE (2004) Monitoring the future national survey results on drug use, 1975–2003. Volume II: College students and adults ages 19–45 (NIH Publication No. 04–5508). Bethesda, MD: National Institute on Drug Abuse; p 267.
- Lange JE, Voas RB (2001) Defining binge drinking quantities through resulting blood alcohol concentrations. *Psych Addict Behav* 15:310–316.
- Meier SE, Brigham TA, Handel G (1987) Accuracy of drinkers' recall of alcohol consumption in a field setting. *J Stud Alcohol* 48:325–328
- NHTSA (1994) Computing a BAC estimate. US Department of Transportation, National Highway Traffic Safety Administration Available at: <http://www.nhtsa.dot.gov/people/injury/alcohol/bacreport.html>. Accessed March 26, 2005.
- Perkins HW, DeJong W, Linkenbach J (2001) Estimated blood alcohol levels reached by 'binge' and 'nonbinge' drinkers: A survey of young adults in Montana. *Psychol Addict Behav* 15:317–320.
- Sommers MS, Dyehouse JM, Howe SR, Lemmink J, Volz T, Manharth M (2000) Validity of self-reported alcohol consumption in nondependent drinkers with unintentional injuries. *Alcohol Clin Exp Res* 24:1406–1413.
- Thombs DL, Olds RS, Snyder BM (2003) Field assessment of BAC data to study late-night college drinking. *J Stud Alcohol* 64:322–330.
- Wechsler H, Lee JE, Kuo M, Seibring M, Nelson TF, Lee H (2002) Trends in college binge drinking during a period of increased prevention efforts: Findings from four Harvard School of Public Health College Alcohol Study surveys: 1993–2001. *J Am Coll Health* 50:203–217.
- White AM, Kraus CL, Flom JD, Mitchell JR, Kestenbaum LA, Shah K, Swartzwelder HS (2005) College students lack knowledge of standard drink volumes: Implications for definitions of risky drinking based on survey data. *Alcohol Clin Exp Res* 29:631–638.
- White AM, Kraus CL, McCracken LA, Swartzwelder HS (2003) Do college students drink more than they think? Use of a free-pour paradigm to assess how college students define standard drinks. *Alcohol Clin Exp Res* 24:1751–1756.
- White AM, Signer ML, Kraus CL, Swartzwelder HS. (2004) Experiential aspects of alcohol-induced blackouts among college students. *Am J Drug Alcohol Abuse* 30:205–224.