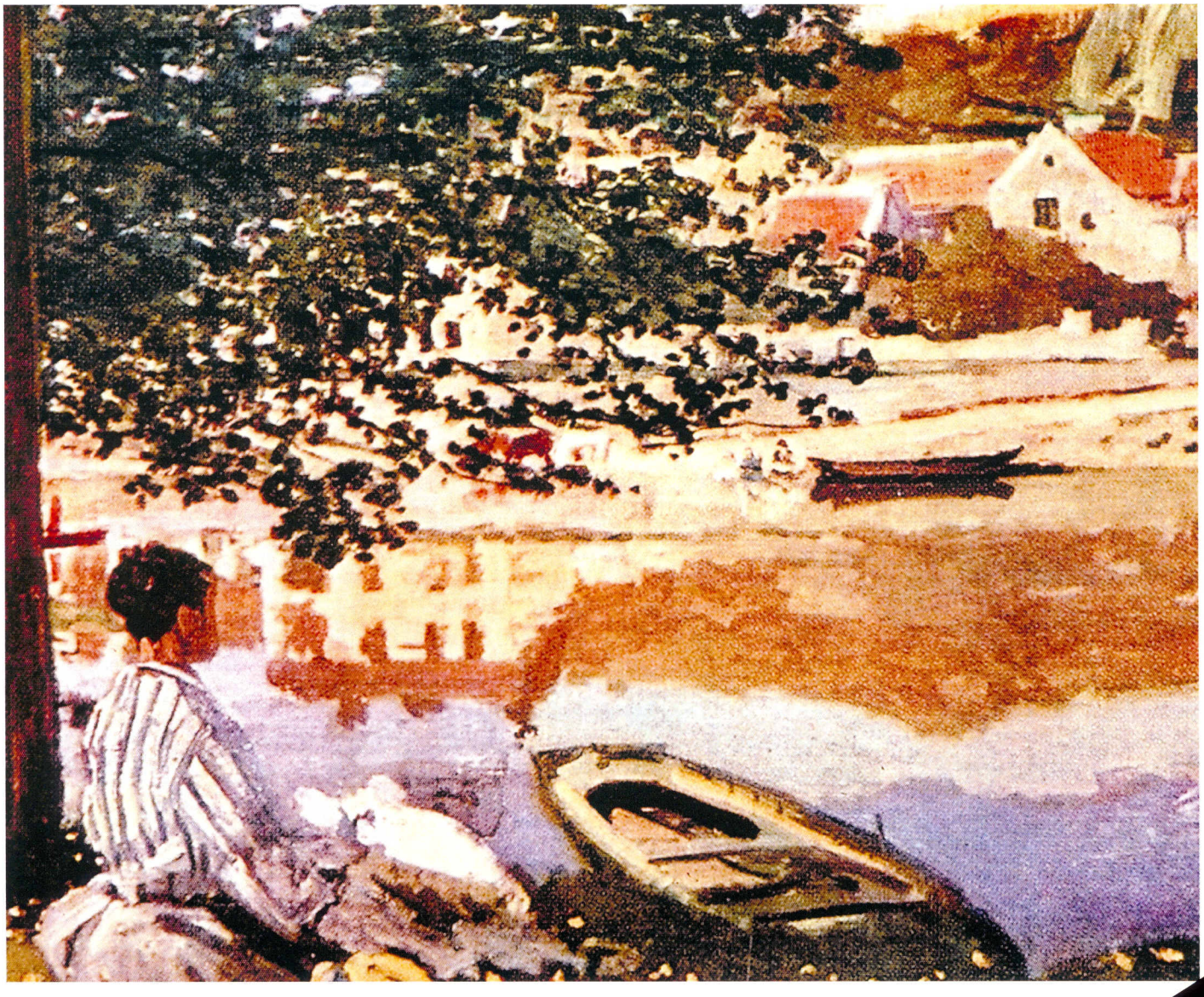
Volume 27, Numbers 1/2

June 2006
SUBA 27(1/2) (2006)
PRINT ISSN 0889-7077
ELECTRONIC ISSN 1547-0164

http://www.amersa.org

SUBSTANCE ABUSE™

Journal of The Association for Medical Education and Research in Substance Abuse



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http://suba.haworthpress.com

Indexed in MEDLINE®

Measuring College Student Drinking: Illustrating the Feasibility of a Composite Drinking Scale

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ABSTRACT. This study explored the feasibility of a *Composite Drinking Scale* (CDS) designed to capture fully the phenomenon of problem drinking among college students while allowing easy public understanding. A survey conducted at 32 four-year U.S. colleges included four consumption measures: 30-day frequency; average number of drinks per week; number of drinks usually consumed when partying; and greatest number of drinks in one sitting in the past two weeks. Responses were normalized and added to create a continuous distribution, which was then subdivided into quartiles (CDS/Q1-Q4). The CDS is an easily understood scoring system, but compared to the simplistic "binge drinking" measure, it captures a broader range of relative risks and more clearly establishes the quadratic relationship between consumption and alcohol-related problems. Development of the CDS will require further exploring the best set of questions to include, establishing U.S. norms for the general population, and then transforming those scores to a simple measurement yardstick whose meaning can be easily communicated to the public.

KEYWORDS. Alcohol consumption, measurement, psychometric properties, college, student

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The authors are grateful to their many colleagues on the Social Norms Marketing Research Project (SNMRP) who helped conduct the student surveys reported in this article, especially Jennifer Allard, Ingrid Bruns, Karen Kaphingst, Amy Stern, and Cameron Ware. They are also grateful to the 32 site-based coordinators, whose hard work provided the foundation for this study. The authors thank John D. Clapp of San Diego State University for his insightful comments on an earlier draft of this article.

This study was supported by grant R01-AA-12471 from the National Institute on Alcohol Abuse and Alcoholism (NIAAA) and the U.S. Department of Education to Education Development Center, Inc. (EDC).

The views expressed in this article are those of the authors and do not necessarily reflect the official position of the NIAAA or the U.S. Department of Education.

Substance Abuse, Vol. 27(1/2) 2006
Available online at http://suba.haworthpress.com

doi:10.1300/J465v27n01_05

INTRODUCTION

Developing measures of alcohol consumption that both capture the phenomenon of problem drinking and allow easy communication with the public is an enormous challenge. To be scientifically useful, a measure should be precise, reliable, and valid, of course, but it should also capture the full meaning of problem drinking, which is a multifaceted behavior. It should also allow for accurate predictions of alcohol-related problems. To be useful in public discourse, however, the measure should also be simple and its meaning easily communicated to the public.

Among the earliest and most commonly used measures of alcohol consumption are quantity-frequency methods (QF). In essence, QF measures ask respondents to report on how many days they typically drink within a given time period and how much they typically drink on a given drinking day. On the plus side, QF measures are relatively easy to administer, do not require much time, and provide a fairly reliable estimate of drinking frequency and total alcohol consumption (1).

On the other hand, QF measures do not inquire about heavy episodic drinking, which might not be "typical" for many individuals but nevertheless is strongly associated with alcohol-related problems. Heavy drinking, which is sometimes called "binge drinking," is commonly defined as having five or more drinks in a row (2). A "heavy drinker" is typically defined as someone who drinks at this level at least once in a two-week period. For women, Wechsler and his colleagues defined heavy drinking as four or more drinks in a row (3), but this standard has not been universally adopted (2).

One study found that 31 percent of heavy drinkers identified through daily diary reports were misclassified as moderate drinkers when using QF measures (4). Other researchers have reported even higher rates of misclassification (5). In a study of high school seniors and dropouts, Ellickson and her colleagues found that QF measures failed to identify 54 percent of those who engaged in heavy drinking (6).

Some researchers have improved on QF measures by folding in a question about heavy episodic drinking (7). One survey study demonstrated that adding questions about atypical drinking to ordinary QF questions increased the total consumption estimate for a sample of adults by 14 percent, illustrating that traditional QF measures tend to underestimate the "true" level of total alcohol consumption (8).

On the side of simplicity, several researchers have utilized the heavy-drinking measure by itself (2). The principal downside of using this measure is its dichotomous nature, which creates a very crude yardstick by which to measure changes in alcohol consumption. Using this measure by itself creates additional problems, including creating inflated public perceptions of the true extent of dangerous drinking (especially when it is referred to as "binge drinking") and perpetuating the false notion that drinking below that level is entirely safe (9).

The purpose of the present study was to explore the feasibility of developing a more refined measure of alcohol consumption, one that combines several questions designed to capture different aspects of problem drinking but also provides a simple yardstick that the public at large might find easier to understand. A national survey of four-year college and university students asked four questions, which were brought together into a *Composite Drinking Scale* (CDS): (1) number of occasions on which alcohol was used in the past 30 days, (2) average number of drinks consumed in a week, (3) number of drinks usually consumed when partying, and (4) the greatest number of drinks consumed at one sitting during the last two weeks. Responses to these four questions were first used to assess the abstaining versus drinking status of each respondent, and then to compute a continuous CDS score representing the overall level of alcohol use for each drinker. For purposes of simplification, and to facilitate comparisons with a dichotomous measure of heavy episodic ("binge") drinking, the continuous distribution of CDS scores was then divided into quartiles, and each drinker was assigned a corresponding quartile score.

We report here the basic properties, internal consistency reliability, and construct validity of the CDS. Proponents of the heavy ("binge") drinking measure have argued that it provides an easy shorthand for identifying problematic drinkers (3). Accordingly, we compare the utility of the CDS in predicting alcohol-related problems in comparison to the heavy drinking

measure. Finally, we outline the steps required to move beyond this illustration to create a new measure of alcohol consumption that will meet the field's scientific and public communications needs.

METHODS

The Survey of College Alcohol Norms and Behavior (SCANB) is administered annually each spring to students from 32 four-year institutions of higher education that are participating in the Social Norms Marketing Research Project (SNMRP). The SNMRP is a five-year project designed to assess the effectiveness of social norms marketing campaigns in reducing high-risk drinking (10).

The 32 schools come from all four U.S. census regions (Northeast, North Central, West, and South). They range in size from approximately 2,000 to 31,000 undergraduates and vary in terms of sector (private vs. public), percentage of residential students, and student body demographics. The analysis reported here uses SNMRP baseline data.

Survey Content

The SCANB is a self-administered, voluntary, and anonymous mail survey that asks about students' alcohol-related attitudes, perceptions, and behaviors. The baseline SCANB administered to a first cohort of 18 schools (Study 1) in 2000 consisted of 64 questions on student characteristics, alcohol use and its consequences, reasons for drinking and abstaining from alcohol use, perceptions of campus alcohol norms, campus and community alcohol policies, and perceived social capital. The baseline SCANB administered to a second cohort of 14 schools (Study 2) in 2001 consisted of 54 items; the number of questions was decreased to encourage higher response rates.

Alcohol Consumption

The SCANB defined a *drink* as "a bottle of beer (12 oz), a glass of wine (4 oz), a wine cooler (12 oz), or a shot of liquor (1 oz) served straight or in a mixed drink."

Concerning their own alcohol use, the respondents answered four key questions: (1) "During the past 30 days, on how many occasions did you use each of the following substances–alcohol (beer, wine, liquor)?" The response options for this scale (scored 1-7) were "Never," "1-2 times," "3-5 times," "6-9 times," "10-19 times," "20-39 times," and "40 or more times." For the next three questions, a numerical fill-in response box allowed students to mark in 00 to 99 drinks, thus creating an interval-level scale. (2) "What is the average number of drinks you consume in a week?" (3) "When you party, how many drinks do you usually have?" (4) "Think back over the last two weeks. What was the greatest number of drinks you consumed at one sitting? For how many hours did you drink?" A second numerical fill-in response box allowed students to report the duration of the drinking episode.

To be classified as an *abstainer*, a student had to report no alcohol use in response to all four consumption questions. A student reporting alcohol use in response to one or more questions was classified as a *drinker*. Students who did not respond to one of the four questions were still classified, but those who failed to respond to two or more questions were excluded from the analysis.

The drinkers' responses to the four consumption questions were combined into a *Composite Drinking Scale* (CDS). Due to the various question formats, the overall distribution for each of the four questions was normalized, yielding a z-score for each drinker on each question. A CDS score was then calculated as the sum of a drinker's four z-scores. If a drinker did not respond to one of the four questions, a z-score was imputed using the mean z-score for the other three. Cronbach's coefficient alpha for the CDS was calculated to assess its internal consistency reliability (11). Next, the distribution of CDS scores was divided into quartiles, and each drinker was assigned a score (Q1-Q4) on that basis.

The SCANB also asked respondents how many times they had four or more drinks at one sitting in the last two weeks, and how many times they had five or more drinks. Heavy ("binge") drinking was defined as the consumption of five or more drinks for men and four or more drinks for women (3,12). *Non-*

heavy drinkers were respondents who consumed alcohol but did not drink heavily. Among heavy ("binge") drinkers, *infrequent heavy drinkers* were those who drank heavily one or two times, while *frequent heavy drinkers* drank heavily three or more times.

Self-Reported Drinking Status

The survey asked respondents to describe their alcohol use, both presently and during their last year of high school. Response categories for both questions included "abstainer," "abstainer/former problem drinker in recovery," "light drinker," "moderate drinker," "heavy drinker," and "problem drinker."

Alcohol-Related Problems

The survey asked respondents how many times they had experienced or engaged in 26 alcohol-related problems during the past 30 days due to their own alcohol use, including driving a car while under the influence of alcohol, riding with a drunk driver, and four problems related to academic performance (missing a class, getting behind in school work, performing poorly on a test or important project, and turning in an assignment late). The response alternatives (scored 1-5) were "never," "1-2 times," "3-5 times," "6-9 times," and "10 or more times." Respondents who reported that they did not drink alcohol skipped this question.

For CDS-defined drinkers, responses for each of the 26 alcohol-related problems were dichotomized (dummy variable for having the problem, with not having the problem as the reference group). The total number of indicated problems (up to 26) was calculated for each respondent who answered 18 or more items (i.e., who failed to answer eight or fewer items); those who failed to answer nine or more questions were assigned a missing value on this new variable. Next, the total was dichotomized, with a dummy variable for having experienced five or more problems (and with having four or fewer problems as the reference group). This cut-off point, which separated the top one-third and bottom two-thirds of the distribution, was used to facilitate comparisons to previous research on college students (12).

Finally, the total number of academic problems (up to four) was calculated for each respondent who answered three or four of the items; those who failed to answer two or more questions were assigned a missing value on this new variable. This total was then dichotomized, with a dummy variable for having experienced any academic problems (and with not having any problems as the reference group). This cut-off point separated the top one-fourth from the bottom three-fourths of the distribution.

Control/Background Variables

The SCANB included 16 control/background variables of interest. With recoding, some response categories were combined. The variables included *gender* (dummy variable for male, with female as the reference group); *age* (continuous variable in years); *race/ethnicity* (dummy variables for African American/Black, Asian, Hispanic/Latino, and Other, with Caucasian/White as the reference group); *personal relationship status* (dummy variable for married/separated/divorced/widowed, with single as the reference group); *student status* (dummy variable for part-time status, with full-time status as the reference group); *student classification* (dummy variables for sophomore, junior, and senior, with freshman as the reference group); and *grade point average* (continuous variable on a four-point scale).

Additional variables included *location of residence* (dummy variable for on-campus, with off-campus as the reference group); *type of residence* (dummy variables for fraternity/sorority house, residence hall/dorm, and other, with house/apartment as the reference group); *living situation* (dummy variables for living alone and living with family/other, using living with one or more roommates as the reference group); *parental education* (dummy variables for one parent and both parents being a college graduate, with neither parent as the reference group); *number of close student friends* (dummy variables for having none and 1-4 close student friends, with having 5 + as the reference group); *year of survey administration* (dummy variable for 2001, with 2000 as the reference group); and *timing of survey completion* (dummy variable

for during/after spring break, with before spring break as the reference group).

Finally, the SCANB also asked about *involvement in a fraternity/sorority* (dummy variable for Greek member/pledge, with non-Greek member/pledge as the reference group) and *involvement in intercollegiate athletics* (dummy variable for athlete, with non-athlete as the reference group). Students were said to be a college athlete if they indicated "intercollegiate athlete" when asked about extracurricular activities, or if they indicated spending time each week on a varsity athletic team.

Sampling Method

The baseline SCANB was mailed to 300 randomly selected undergraduate students at each of the 32 participating schools, for a total of 9,600 students. The baseline survey was administered at 18 schools in the spring of 2000 (Study 1) and at the 14 remaining schools in the spring of 2001 (Study 2). Each school's registrar's office provided a list of all matriculated, degree-seeking undergraduates, including both full- and part-time students. This sampling frame excluded students with out-of-state addresses listed as their current or local address. For each school, the random sample of 300 students was stratified by class year (freshman, sophomore, junior, senior).

Survey Administration

Each school was put on a separate mailing schedule based on its academic calendar, with the first survey mailing sent out three to four weeks after the beginning of the spring semester. Prior to the first survey mailing for Study 1, a "teaser" postcard was mailed out to alert students that the survey would be arriving soon; this was not done for Study 2 one year later. The second survey mailing was scheduled to arrive approximately two weeks prior to each school's spring break. The third was sent out 2-3 weeks after spring break. The fourth mailing, sent out approximately two weeks after the third mailing, was an abbreviated (two-page) version of the SCANB.

Non-respondents received a reminder postcard a few days after the first survey mailing and 2-3 weeks after the second survey mailing. In addition, project staff made reminder telephone calls after the second and third survey mailings to answer questions and encourage completion of the survey. Both rounds of reminder calls involved up to three attempts to reach each student in person. On the third attempt, the caller left a message requesting that the survey be completed.

The cover letter that accompanied each survey mailing served as the informed consent document. Students were told that they were not required to participate and that they could leave a question blank if they did not want to answer it. To preserve students' anonymity, no identifying information was put on either the survey instrument or its stamped return envelope. Rather, with every survey mailing, students received a separate postcard with a unique code number on it, with instructions to mail the postcard separately from the survey itself to indicate that they had completed the survey or did not wish to participate and that no additional follow-up would be necessary.

A series of monetary incentives was used to increase response rates. A $1 bill was included with the first survey mailing as an up-front incentive (13). Students who filled out the survey became eligible for three types of prize drawings: one $100 cash prize per school for students who returned the survey within one week; five $50 cash prizes per school for students who returned the survey by the end of the semester; and one $500 grand prize for one student nationwide who completed the survey by the end of the semester. With Study 2, the grand prize was increased to $1,000 to encourage a higher response rate.

The human subjects committees at Education Development Center, Inc., and all 32 participating colleges and universities approved the study procedure.

Response Rate

A total of 330 of the 9,600 surveyed students were removed from the sample. Reasons for removal included the following: two or more pieces of undeliverable mail were returned; telephone contact revealed that the student was no longer enrolled, had already graduated, or was spending the semester abroad; the registrar verified that non-responding students who

could not be reached by telephone were not enrolled during the survey period; or participants indicated on their survey that they were not enrolled or were enrolled in graduate or professional school.

These adjustments resulted in a final sample size of 9,270 students. The number of completed surveys was 5,210 for a response rate of 56.2%. Response rates for individual schools ranged from 45.3% to 71.4%. Of the surveys received, 4,858 (93.2%) were full-length surveys. The remaining 352 surveys (6.8%) were abbreviated versions sent in the final mailing.

The reported analyses are based on the full-length survey responses from 4,798 students, after excluding 19 students who failed to indicate whether they were enrolled as undergraduates and 41 students who said they were former problem drinkers in recovery, either presently or during high school.

If a respondent failed to respond to two or more CDS questions, then that case was excluded from all CDS-related analyses; there were 18 such cases (0.4%), leaving 4,780 respondents. If a respondent met additional "missing value" criteria, then that case was excluded from analyses that involved the variables in question. As a result of these missing data, the reported sample sizes for individual analyses vary slightly.

Statistical Analysis

All statistical analyses were performed using SAS (14). Descriptive statistics were examined for all variables.

Frequency data for the alcohol consumption variables were examined for extreme or implausible values. When asked to specify the average number of drinks per week for a typical student at their school, four respondents gave a response greater than 80 drinks for males, while three respondents did so for females. Given their implausibility, these responses were reduced to 80 drinks. When asked to report how many drinks students at their school have when they party, 15 respondents gave a response greater than 30 for males, while nine respondents did so for females. Given their implausibility, these responses were reduced to 30 drinks. Finally, when asked about the greatest number of drinks they had consumed at one sitting during the last two weeks, seven respondents indicated that the sitting had lasted more than 24 hours. These data were declared missing. The alternative of reducing the responses to 24 hours was rejected, as that would also affect the apparent rate of alcohol consumption.

Assessing the construct validity of the CDS involved looking at the relationship between the CDS variable and a set of predictor variables previously found to be associated with heavy ("binge") drinking in the College Alcohol Study (CAS) (15). These six drinking-related characteristics were as follows: *male*; *under 24 years*; *Caucasian/White* (if respondents identified themselves as "Caucasian/White" only, not mixed with others); *drinker in high school* (if they identified themselves as a light, moderate, heavy, or problem drinker during their last year of high school); *Greek member/resident* (if they indicated "fraternity/sorority member or pledge" when asked about extracurricular activities, or if they indicated "fraternity/sorority house" as their residence); and *college athlete* (if they indicated "intercollegiate athlete" when asked about extracurricular activities, or if they indicated spending time each week on a varsity athletic team). Note that the race/ethnicity variable *Caucasian/White* was defined somewhat differently from the corresponding SCANB control/background variable.

With CDS treated as a cate gorical variable, Cochran-Armitage trend tests were used to compare the proportions of respondents with each drinking-related characteristic across CDS/Q1-Q4 drinkers. Second, with CDS treated as a continuous variable, two-sample t-tests were used to compare the mean CDS scores of college student drinkers with and without each of the drinking-related characteristics.

Construct validity analyses also looked at four measures of alcohol-related problems experienced during the past 30 days. First, the proportions of respondents who drove under the influence of alcohol were compared across non-heavy drinkers, infrequent heavy drinkers, and frequent heavy drinkers using chi-square tests and Cochran-Armitage trend tests; the same analyses were conducted to compare CDS/Q1-Q4 drinkers. Similar sets of analyses were also conducted on the proportions of respondents who rode with a drunk driver, experienced five or more alcohol-related problems

(out of 26 possible), and experienced one or more academic problems (out of four possible).

Next, a set of multivariate logistic regression analyses were used to examine the relationship between drinking status and these four measures of alcohol-related problems experienced during the past 30 days. One set of analyses compared frequent heavy drinkers and infrequent heavy drinkers to non-heavy drinkers. Another set of analyses compared CDS/Q2, CDS/Q3, and CDS/Q4 drinkers to CDS/Q1 drinkers. Both models adjusted for the 16 SCANB control/background variables.

Multivariate linear regression analyses were also used to examine the relationship between drinking status and the total number of alcohol-related problems (out of 26 possible) experienced during the past 30 days. One set of analyses compared frequent heavy drinkers and infrequent heavy drinkers to non-heavy drinkers. Another set of analyses compared CDS/Q2, CDS/Q3, and CDS/Q4 drinkers to CDS/Q1 drinkers. Again, both models were adjusted for the 16 SCANB control/background variables.

Further, the mean, minimum, and maximum values of the four CDS items were tabulated by CDS quartile to illustrate the profile of the "typical" drinker at each CDS level. In addition, ANOVA using Scheffe's Method was performed for each CDS item to make pairwise comparisons of the means across the four CDS quartiles, applying a significance level of 0.05. In addition, CDS/Q1-Q4 drinking status was cross-tabulated with self-reported drinking status and the measure of heavy ("binge") drinking.

Lastly, Spearman correlation coefficients were computed between the categorical five/four measure of heavy ("binge") drinking (1 = non-heavy drinker, 2 = infrequent heavy drinker, and 3 = frequent heavy drinker) and both the continuous CDS and categorical CDS/Q1-Q4 variables (range = 1, 4).

RESULTS

Background Characteristics of the Student Sample

The background characteristics of the student sample (N = 4,798) are as follows: The sample included more women (61.1%) than men (38.9%). The mean age of the students was 21.8 years (SD = 5.6); the vast majority of students (85.5%) were under 24 years of age. Respondents could indicate membership in multiple race/ethnicity categories. Just over three-fourths of the students (76.3%) were Caucasian/White. Distribution across other race/ethnicity categories was as follows: African American/Black, 6.5%; Asian, 10.3%; Hispanic/Latino, 6.4%; Native American/American Indian, 4.7%; and Native Hawaiian/Pacific Islander or Other, 4.7%. Fully 91.1% of the students were single, with 8.9% being either married, separated, divorced, or widowed. Just over one-third (34.6%) did not have a parent who was a college graduate, while 27.2% had one parent and 38.2% had two parents who graduated from college.

Over nine out of ten students (92.4%) were full-time. There were slightly more juniors (25.8%) and seniors (28.6%) in the sample than freshmen (22.9%) and sophomores (22.7%). The mean grade point average was 3.2 (SD = 0.6, A = 4.0). Fraternity/sorority members and pledges constituted 13.2% of the student sample. Approximately one in ten students (11.6%) was a college athlete. The majority of students (55.3%) lived off-campus. Nearly six out of ten lived in a house or apartment (58.5%), while 37.9% lived in a residence hall, 2.2% lived in a fraternity or sorority house, and 1.4% lived elsewhere. Nearly six in ten (59.3%) lived with one or more roommates; 10.7% lived alone, and 30.0% lived with family or indicated "Other." More than half of the students (55.2%) had five or more close student friends, while 39.2% had 1-4 and 5.6% reported having none.

Just over half of the sample (52.1%) completed the survey in 2000 (Study 1), with the others completing it in 2001 (Study 2). Finally, most students (84.8%) filled out the survey before spring break, with 15.2% doing so during or after spring break.

Composite Drinking Scale

The drinkers' responses to the four consumption questions were combined into a *Composite Drinking Scale* (CDS) by normalizing the response distributions for each question and adding the z-scores. For most of the analyses re-

ported here, the CDS scores were divided into quartiles (Q1-Q4). By definition, abstainers did not report any alcohol consumption.

Internal Consistency Reliability

The Cronbach's coefficient alpha was 0.89, indicating that the CDS has high internal consistency reliability. The item-total correlations of the four CDS items ranged between 0.65 and 0.81.

Construct Validity

As predicted, six characteristics associated with heavy ("binge") drinking were also strongly associated with increased CDS scores among drinkers: being male, under 24 years of age, Caucasian/White only (not combined with other race/ethnicity categories), a drinker in high school, a Greek member or resident, and a college athlete. The mean CDS score for college drinkers with each drinking-related characteristic was significantly higher than the corresponding mean for drinkers without each characteristic (all $p < .0001$, using two-sample t-tests). Moreover, the percentages of college drinkers with each drinking-related characteristic increased from CDS/Q1 to CDS/Q4; all six Cochran-Armitage trend tests were significant ($p < .0001$). It is noteworthy that the percentage of CDS-defined abstainers who had each drinking-related characteristic was always less than the corresponding percentage of CDS/Q4 drinkers, but not consistently less than the corresponding percentages of CDS/Q1-Q3 drinkers. For example, 13.6% of abstainers did drink in high school, compared to 42.0% of Q1 drinkers, 59.1% of Q2 drinkers, 71.5% of Q3 drinkers, and 84.8% of Q4 drinkers. In contrast, the pattern by gender was as follows: 42.2% of abstainers were male, as were 27.3% of Q1 drinkers, 29.6% of Q2 drinkers, 35.7% of Q3 drinkers, and 59.8% of Q4 drinkers.

Table 1 shows the percentages of non-heavy drinkers, infrequent heavy drinkers, and frequent heavy drinkers who drove under the influence of alcohol, rode with a drunk driver, experienced five or more alcohol-related problems (out of 26 possible), and experienced one or more academic problems (out of four possible) during the past 30 days. As drinking levels increased, so did the percentages of respondents experiencing alcohol-related problems. For example, the percentage of drinkers who experienced five or more alcohol-related problems increased from 7.7% for non-heavy drinkers to 43.0% for infrequent heavy drinkers and 75.9% for frequent heavy drinkers. All chi-square comparisons and Cochran-Armitage trend tests were significant ($p < .0001$). Multivariate logistic regression analyses were used to estimate adjusted odds ratios, comparing infrequent and frequent heavy drinkers to non-heavy drinkers and adjusting for the 16 SCANB control/background variables. All of the odds ratios were significant ($p < .0001$). The relationship between frequency of heavy drinking and experiencing alcohol-related problems was clear. For example, adjusting for the 16 SCANB variables, infrequent heavy drinkers were 7.4 times as likely and frequent heavy drinkers were nearly 29.8 times as likely as non-heavy drinkers to experience five or more alcohol-related problems.

Table 1 also shows the results of similar analyses using the CDS/Q1-Q4 measures. Again, as drinking level increased, so did the percentages of respondents experiencing alcohol-related problems. For example, the percentage of drinkers who experienced five or more alcohol-related problems increased from 4.4% for CDS/Q1 drinkers to 14.3% for Q2 drinkers, 46.8% for Q3 drinkers, and 77.7% for Q4 drinkers. All chi-square comparisons and Cochran-Armitage trend tests were significant ($p < .0001$). Multivariate logistic regression analyses were used to estimate adjusted odds ratios, comparing CDS/Q2-Q4 drinkers to CDS/Q1 drinkers and adjusting for the 16 SCANB control/background variables. All of the odds ratios were significant ($p < .0001$). For example, adjusting for the 16 SCANB variables, CDS/Q2 drinkers were 3.6 times as likely to experience five or more alcohol-related problems compared to Q1 drinkers, while Q3 drinkers were 18.3 times as likely and Q4 drinkers were nearly 82.8 times as likely.

Multivariate linear regression analyses were used to estimate the total number of various alcohol-related problems experienced by different types of drinkers, first comparing infrequent and frequent heavy drinkers with non-heavy drinkers and then comparing CDS/Q2-Q4

TABLE 1. Risk of Alcohol-Related Problems Among College Student Drinkers*

A. Comparing Infrequent and Frequent Heavy ("Binge") Drinkers with Non-Heavy Drinkers†

Alcohol-Related Problem**	Non-Heavy Drinkers (n = 1,573)	Infrequent Heavy Drinkers (n = 1,328)		Frequent Heavy Drinkers (n = 869)	
	%	%	Adj. OR (95% CI)	%	Adj. OR (95% CI)
Drove under the influence of alcohol	6.5	21.4	4.88 (3.68, 6.46)	31.1	8.00 (5.89, 10.86)
Rode with a drunk driver	4.1	20.1	5.96 (4.31, 8.25)	37.0	14.27 (10.18, 20.02)
Experienced 5 or more different alcohol-related problems§	7.7	43.0	7.44 (5.84, 9.47)	75.9	29.77 (22.63, 39.16)
Experienced 1 or more different academic problems§	9.8	27.2	2.96 (2.34, 3.74)	49.5	7.66 (5.96, 9.84)

B. Comparing CDS/Q2-Q4 Drinkers with CDS/Q1 Drinkers‡

Alcohol-Related Problem**	CDS/Q1 Drinkers	CDS/Q2 Drinkers		CDS/Q3 Drinkers		CDS/Q4 Drinkers	
	% (n = 956)	% (n = 944)	Adj. OR (95% CI)	% (n = 959)	Adj. OR (95% CI)	% (n = 942)	Adj. OR (95% CI)
Drove under the influence of alcohol	2.9	9.7	4.43 (2.67, 7.35)	23.5	14.33 (8.80, 23.34)	33.8	26.22 (15.92, 43.19)
Rode with a drunk driver	2.2	7.6	4.30 (2.41, 7.70)	21.0	13.61 (7.83, 23.66)	38.7	36.58 (20.90, 64.00)
Experienced 5 or more different alcohol-related problems§	4.4	14.3	3.64 (2.40, 5.52)	46.8	18.31 (12.32, 27.23)	77.7	82.76 (54.29, 126.16)
Experienced 1 or more different academic problems§	6.0	14.2	2.62 (1.81, 3.79)	29.8	6.32 (4.44, 8.98)	50.1	16.30 (11.36, 23.40)

* Sample sizes vary slightly across type of alcohol-related problem due to missing values. Adj. OR indicates adjusted odds ratio; CI, confidence interval. All ORs are adjusted for the 16 SCANB control/background variables; see Methods (Survey Content, Control/Background Variables) for listing of dummy variables and reference groups.

** In total, the SCANB survey asked about 26 alcohol-related problems, including driving under the influence of alcohol, riding with a drunk driver, and four problems related to academic performance (see below). A problem was counted if it occurred one or more times vs. not at all during the 30 days preceding the survey.

† Heavy ("binge") drinking is defined for men as the consumption of 5 or more drinks at one sitting at least once during the two weeks preceding the survey, and as 4 or more drinks for women. Non-heavy drinkers consume alcohol but do not drink heavily. Infrequent heavy drinkers drink heavily one or two times in a two-week period, while frequent heavy drinkers drink heavily three or more times. Comparisons of non-heavy drinkers, infrequent heavy drinkers, and frequent heavy drinkers for each alcohol-related problem, using chi-square tests and Cochran-Armitage trend tests, are all significant at $p < .0001$. All ORs are adjusted for the 16 SCANB control variables, with non-heavy drinkers as the reference group; all are significant at $p < .0001$.

‡ See Methods (Survey Content, Alcohol Consumption) for details on the classification of Q1-Q4 drinkers based on the Composite Drinking Scale (CDS); CDS/Q4 signifies the heaviest level of alcohol consumption. Comparisons of CDS/Q1-Q4 drinkers for each alcohol-related problem, using chi-square tests and Cochran-Armitage trend tests, are all significant at $p < .0001$. All ORs are adjusted for the 16 SCANB control variables, with CDS/Q1 drinkers as the reference group; all are significant at $p < .0001$.

§ The SCANB survey asked about four problems related to academic performance: missing a class, getting behind in school work, performing poorly on a test or important project, and turning in an assignment late.

with CDS/Q1 drinkers. Both sets of estimates were adjusted for the 16 SCANB control/background variables. All estimated regression coefficients were significant ($p < .0001$). For example, adjusting for the 16 SCANB variables, infrequent and frequent heavy drinkers on average experienced 2.9 and 6.1 more alcohol-related problems, respectively, than did non-heavy drinkers ($N = 3,240$; $R^2 = .41$). Similarly, compared with CDS/Q1 drinkers, Q2-Q4 drinkers on average experienced 1.3, 3.6, and 7.1 more alcohol-related problems, respectively ($N = 3,260$; $R^2 = .47$).

Drinking Levels Reported by CDS/Q1-Q4 Drinkers

Table 2 presents the mean, minimum, and maximum values of each of the component

TABLE 2. Distributions of Individual Composite Drinking Scale (CDS) Items: Profiles of CDS/Q1-Q4 College Student Drinkers*

CDS Item Description	CDS Quartile	Mean (SD)†	Min	Max
Frequency of alcohol use in the past 30 days‡	Q1	1.8 (0.5)	1	4
	Q2	2.7 (0.7)	1	5
	Q3	3.8 (0.9)	1	7
	Q4	4.8 (1.1)	1	7
Average number of drinks consumed in a week	Q1	0.6 (0.8)	0	5
	Q2	2.4 (1.6)	0	12
	Q3	6.2 (3.0)	0	22
	Q4	17.9 (11.3)	0	80
Greatest number of drinks consumed at 1 sitting in last 2 weeks	Q1	0.7 (1.1)	0	6
	Q2	3.0 (1.9)	0	10
	Q3	5.8 (2.3)	0	17
	Q4	11.3 (4.8)	0	30
Average number of drinks consumed when partying	Q1	1.7 (1.3)	0	6
	Q2	3.5 (1.6)	0	10
	Q3	4.9 (1.7)	0	17
	Q4	8.8 (3.3)	3	24

* The Composite Drinking Scale (CDS) consists of the four items listed in the table. See Methods Section (Survey Content, Alcohol Consumption) for details on the construction of the CDS and the classification of CDS/Q1-Q4 drinkers; CDS/Q4 signifies the heaviest level of alcohol consumption.

† For each item, ANOVA pairwise comparisons of the means across the four CDS quartiles were executed using Scheffe's Method. All pairwise comparisons are significant at the 0.05 level.

‡ Question: "During the past 30 days, on how many occasions did you use each of the following substances–alcohol (beer, wine, liquor)? Do not include drugs used as prescribed by a medical doctor." The response options (scored 1-7) were: never, 1-2 times, 3-5 times, 6-9 times, 10-19 times, 20-39 times, and 40 or more times.

CDS items across the CDS/Q1-Q4 groups. ANOVA using Scheffe's Method was performed for each CDS item to make pairwise comparisons of the means across the four CDS quartiles. All of these comparisons were significant ($p < .05$).

Self-Reported Drinking by CDS Status

Cross-tabulation of self-reported drinking with CDS status revealed that approximately one out of five respondents (19.1%) who classified themselves as an "abstainer" reported drinking at least some alcohol when answering the four CDS questions: Q1 (16.5%), Q2 (2.0%), Q3 (0.6%), and Q4 (0.0%). Most of the self-reported "light" drinkers were classified by the CDS as Q1 (36.1%) or Q2 (37.4%) drinkers, while about one in five (19.2%) were classified as Q3 drinkers and just less than five percent (4.9%) were classified as Q4 drinkers; a small number of the so-called "light" drinkers (2.3%) were classified by the CDS as abstainers. Among self-reported "moderate" drinkers, nearly half (47.7%) fell into the CDS/Q4 category, putting them in the highest quartile; the others were classified by the CDS as Q1 (1.6%), Q2 (10.4%), or Q3 (40.8%) drinkers. Almost all of the self-reported "heavy" drinkers (96.6%) were classified as Q4 drinkers.

Comparison of CDS and Heavy ("Binge") Drinking Measures

The respondents' heavy ("binge") drinking status was cross-tabulated with CDS status, as shown in Table 3. More than half (54.3%) of the non-heavy drinkers were CDS/Q1 drinkers, and more than one-third (35.6%) were Q2 drinkers. Interestingly, almost one-tenth (9.5%) were Q3 drinkers, putting them in the top one-half of drinkers according to the CDS. Most heavy ("binge") drinkers were either Q3 (36.5%) or Q4 drinkers (42.0%), while almost one in five (17.1%) was a Q2 drinker, putting them in the bottom one-half of drinkers according to the CDS.

Infrequent and frequent heavy drinkers were also examined separately. Nearly half (47.5%) of the infrequent heavy drinkers were classified

TABLE 3. Comparisons of Heavy ("Binge") Drinking Status and Behavior-Based CDS Drinking Status Among College Student Drinkers*

Heavy ("Binge") Drinking Status	Behavior-Based CDS Drinking Status–Number (Row %)			
	Q1 Drinker	Q2 Drinker	Q3 Drinker	Q4 Drinker
Non-Heavy Drinker	854 (54.3)	560 (35.6)	150 (9.5)	9 (0.6)
Heavy Drinker	98 (4.5)	375 (17.1)	801 (36.5)	923 (42.0)
Infrequent Heavy Drinker	76 (5.7)	324 (24.4)	631 (47.5)	297 (22.4)
Frequent Heavy Drinker	22 (2.5)	51 (5.9)	170 (19.6)	626 (72.0)

* See Table 1 for definitions of heavy ("binge") drinking, non-heavy drinkers, infrequent heavy drinkers, and frequent heavy drinkers. Heavy drinkers include all drinkers who drink heavily, whether infrequently or frequently. See Methods Section (Survey Content, Alcohol Consumption) for details on the construction of the CDS and the classification of CDS/Q1-Q4 drinkers; CDS/Q4 signifies the heaviest level of alcohol consumption.

as CDS/Q3 drinkers, while almost one-fourth (24.4%) were Q2 drinkers and more than one-fifth (22.4%) were Q4 drinkers. Frequent heavy drinkers were predominantly Q4 drinkers (72.0%), although one in five (19.6%) was a Q3 drinker. Interestingly, just less than 6 percent (5.9%) were classified as CDS/Q2 drinkers.

Spearman correlation coefficients showed that the heavy ("binge") drinking measure correlated 0.77 with the continuous CDS score and 0.74 with the categorical CDS quartile measure.

DISCUSSION

The *Composite Drinking Scale* (CDS) combines four alcohol consumption measures, each of which can capture a different aspect of problem drinking: (1) number of occasions on which alcohol was used in the past 30 days, (2) average number of drinks consumed in a week, (3) number of drinks consumed when partying, and (4) the greatest number of drinks consumed at one sitting during the last two weeks. For most of the analyses reported here, the continuous distribution of CDS scores was then divided into quartiles to create a simplified four-point scoring system (CDS/Q1-Q4). Based on a large sample of students attending four-year colleges and universities in the U.S., the CDS was found to have high internal consistency reliability and good construct validity, as indicated by the strong association between the CDS/Q1-Q4 and characteristics known to be associated with heavy ("binge") drinking and reported alcohol-related problems.

The data reported here illustrate several advantages to the CDS over other measures of consumption. Clearly, self-reported drinking status is an inadequate measure. About one in four self-reported "light" drinkers had a CDS score that put them in the top half of the distribution (Q3 or Q4), while nearly one-half of self-reported "moderate" drinkers fell in the highest quartile (Q4). Even declarations of being an "abstainer" cannot be fully trusted, as approximately one out of five respondents who so classified themselves reported drinking at least some alcohol when answering the four CDS questions.

Measures of heavy ("binge") drinking also appear to be inadequate for classifying students as problem drinkers. Heavy drinking was defined for men as having five or more drinks at one sitting in the last two weeks and for women as four or more drinks (3). A key problem is possible misclassification. About one out of ten non-heavy drinkers was classified as a CDS/Q3 or Q4 drinker, which placed them in the top half of the distribution of all college student drinkers. At the same time, about one in five heavy drinkers was classified as a CDS/Q1 or Q2 drinker, which placed them in the bottom half of the distribution of all college student drinkers.

At the root of these misclassifications is the fact that the heavy drinking measure is a single dichotomous measure, whereas the CDS is continuous measure composed of four strongly correlated items. The correlation between the heavy drinking measure and the continuous CDS score was 0.77. This means that the heavy drinking measure could not explain approximately 41 percent of the variance in CDS scores.

This same problem would arise, of course, if any one of the component CDS items were used as an individual measure. Note that the item-total correlations of the four CDS items ranged between 0.65 and 0.81. The problem is also revealed when looking at the range of scores for each of the component CDS items, broken down by CDS quartile (see Table 2). In each of the CDS/Q1-Q4 groups, for example, there were some respondents who reported consuming zero drinks in an average week. Relying on this measure alone, some number of actual drinkers would be misclassified as non-drinkers.

As noted, proponents of the heavy ("binge") drinking measure have argued that it provides an easy shorthand for identifying problem drinkers (3). It is therefore instructive to compare the predictive utilities of the heavy drinking measure and the simplified CDS/Q1-Q4 scores. Consider the consequence of experiencing five or more alcohol-related problems. Compared with non-heavy drinkers, infrequent and frequent heavy drinkers were 7.4 and 29.8 times as likely, respectively, to report this number of problems, adjusting for the 16 SCANB control/background variables. The comparable odds ratios for CDS/Q2, Q3, and Q4 drinkers, compared to CDS/Q1 drinkers, were 3.6, 18.3, and 82.8, respectively. Clearly, the CDS is able to capture a broader range of relative risks than the heavy drinking measure, while also more clearly establishing the quadratic relationship between alcohol consumption and experiencing alcohol-related problems.

This advantage of the CDS is also evident for other measures of alcohol-related problems. For example, compared with non-heavy drinkers, infrequent and frequent heavy drinkers were 3.0 and 7.7 times as likely, respectively, to report experiencing one or more academic problems, adjusting for the 16 SCANB control/background variables. The comparable odds ratios for CDS/Q2, Q3, and Q4 drinkers, compared to CDS/Q1 drinkers, were 2.6, 6.3, and 16.3, respectively.

Likewise, compared with non-heavy drinkers, infrequent and frequent heavy drinkers experienced 2.9 and 6.1 more alcohol-related problems, respectively, again adjusting for the 16 SCANB control/background variables. Compared with CDS/Q1 drinkers, Q2-Q4 drinkers experienced 1.3, 3.6, and 7.1 more alcohol-related problems, respectively. Results of multivariate linear regression analyses showed that use of the CDS, as opposed to the "binge" drinking measure, increased the amount of variance accounted for from 41% to 47% (a 14.6% relative increase).

Regarding limitations, the SCANB survey, because it was designed to assess the impact of a campus-based prevention program, did not include the full range of possible consumption measures that might be included in a composite drinking scale. While the four questions asked here did create a useful scale, far more work is needed to identify the optimal question set to apply.

In principle, this type of composite measure should also be superior to quantity-frequency (QF) measures, which gauge general drinking levels but do not include inquiries about heavy drinking episodes specifically. As noted before, some investigators have combined QF questions with a question about heavy ("binge") drinking, but that is sub-optimal due to several problems with that dichotomous measure (9). A weakness of the present study is that the SCANB survey did not happen to include QF measures against which to compare the CDS measure. This can also be addressed in future research.

Gruenewald and his colleagues (16,17) have developed a QF measure that asks respondents a series of questions about their alcohol consumption during the past 28 days, first reporting on how many days they had at least one drink, then on how many days they had more than one drink, three or more drinks, and six or more drinks. From this information, three dimensions of alcohol consumption can be reported: drinking frequency, mean drinks per occasion, and a drinking variance estimate. Each individual's drinking pattern is described as a point in three-dimensional space defined by these variables. Improving on simpler QF measures, this scheme captures atypical or extreme drinking episodes. However, while this measure might have scientific advantages, it does not capture the concept of problem drinking through a simple, one-dimensional index and therefore would be difficult for the public to understand.

Another limitation of the present study is that the study sample included only college stu-

dents. Remember that the CDS involves normalizing the response distributions for each question and adding the z-scores. This means, then, that the subjective meaning of the CDS, as a continuous scale, or the CDS/Q1-Q4 scores is tied to the population being studied, in this case a sample of students from 32 four-year colleges and universities. Looking at a given study sample, individuals can be compared to one another in terms of their CDS or CDS/Q1-Q4 scores, but they cannot be compared to members of other samples.

Correcting this deficiency would require establishing U.S. national norms for the composite drinking scale. Once that were done, a given CDS score would have real world meaning relative to a standard distribution of CDS scores, just as an IQ score has meaning against the standard IQ distribution. For example, people would come to understand that a Q4 score signifies a pattern of heavier drinking (and is more likely to be associated with alcohol-related problems) than a Q3 score, just as they understand that an IQ of 120 signifies greater intelligence than an IQ of 110.

Additional research would then be needed to determine which of several scoring options–the CDS/Q1-Q4 based on quartiles, another point-based system (e.g., one based on deciles), or a continuous CDS score–would work best. It is very likely that a CDS/Q1-Q4 score tied to the national norms would be simple enough for the public to understand, but in practice a four-point scale might not be fine-grained enough to serve research purposes.

In conclusion, a composite drinking scale appears to be a viable measure of college student drinking with several scientific advantages over the heavy ("binge") drinking measure used in many studies (2). Additional work is needed to identify the optimal set of questions to include in such a measure, not only for college students but perhaps also for the general U.S. population. In order to make comparisons across study samples, as well as to improve public understanding of the data, it would be necessary to establish national norms for the composite drinking scale. This would be a major undertaking, but absent this effort, the field will continue to be saddled with inadequate measures that give an incomplete or distorted picture of problem drinking.

REFERENCES

1. Allen JP, Wilson VB (eds.) Assessing Alcohol Problems: A Guide for Clinicians and Researchers (2nd ed.). Bethesda, MD: National Institute on Alcohol Abuse and Alcoholism; 2003.

2. O'Malley PM, Johnston LD. Epidemiology of alcohol and other drug use among American college students. J Stud Alcohol 2002; S14:23-39.

3. Wechsler H, Austin SB. Binge drinking: The five/four measure. J Stud Alcohol 1998; 59:122-123.

4. Flegal KM. Agreement between two dietary methods in the measurement of consumption. J Stud Alcohol 1990; 51:408-414.

5. Redman S, Sanson-Fisher RW, Wilkinson C, Fahey PP, Gibberd RW. Agreement between two measures of alcohol consumption. J Stud Alcohol 1987; 48:104-108.

6. Ellickson PL, McGuigan KA, Adams V, Bell RM, Hays RD. Teenagers and alcohol misuse in the United States: By any definition, it's a big problem. Addiction 1996; 91:1489-1503.

7. Dimeff LA, Baer JS, Kivlhan DR, Marlatt GA. Brief Alcohol Screening and Intervention for College Students (BASICS): A Harm Reduction Approach. New York: Guildford; 1999.

8. Fitzgerald JL, Mulford H. Self-report validity issues. J Stud Alcohol 1987; 48:207-211.

9. DeJong W. Finding common ground for effective campus-based prevention. Psychol Addict Behav 2001; 15:292-296.

10. Perkins HW (ed.). The Social Norms Approach to Preventing School and College Age Substance Abuse: A Handbook for Educators, Counselors, and Clinicians. San Francisco, CA: Jossey-Bass; 2003.

11. Cronbach LJ. Coefficient alpha and the internal structure of tests. Psychometrika 1951; 16:297-334.

12. Wechsler H, Davenport A, Dowdall G, Moeykens B, Castillo S. Health and behavioral consequences of binge drinking in college: A national survey of students at 140 campuses. JAMA 1994; 272:1672-1677.

13. Edwards P, Roberts I, Clarke M, DiGuiseppi C, Pratap S, Wentz R, Kwan I. Increasing response rates to postal questionnaires: Systematic review. BMJ 2002; 324:1183-1191.

14. SAS. SAS/STAT User's Guide: Version 8.2. Cary, NC: SAS Institute, Inc.; 2001.

15. Wechsler H. Alcohol and the American college campus: A report from the Harvard School of Public Health. Change 1996; July/August:20-25,60.

16. Gruenewald PJ, Mitchell PR., Treno AJ. Drinking and driving: Drinking patterns and drinking problems. Addiction 1996; 91:1637-1649.

17. Gruenewald PJ, Nephew T. Drinking in California: Theoretical and empirical analyses of alcohol consumption patterns. Addiction 1994; 89:707-723.

SUBSTANCE ABUSE ™

Volume 27, Numbers 1/2 **June 2006**

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0889-7077(2006)27:1/2

The Haworth Medical Press®
An Imprint of The Haworth Press, Inc.
10 Alice Street, Binghamton, NY 13904-1580
www.HaworthPress.com