2012

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Citation/Publisher Attribution

Hoeppner, B., Barnett, N. P., Jackson, K. M., Colby, S. M., Kahler, C. W., Monti, P. M., Read, Tevyaw, J. T., Wood, M., Corriveau, D., & Fingeret, A. (2012). Daily College Student Drinking Patterns Across the First Year College, *Journal of Studies on Alcohol and Drugs, 73*(4), 613-624. doi: 10.15288/jsad.2012.73.613
Available at: http://dx.doi.org/10.15288/jsad.2012.73.613

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ABSTRACT. Objective: Despite the long recognized importance and well-documented impact of drinking patterns on health and safety, college student drinking patterns are understudied. This study used a daily-level, academic-year-long, multisite sample to identify subpopulations of college student drinking patterns and to describe how these groups differ from one another before, during, and after their first year of college. **Method:** Two cohorts of first-year college students (n = 588; 59% female) reported daily drinking on a biweekly basis using web-based surveys and completed surveys before and after their first year of college. **Results:** Cluster analyses based on time series analysis estimates of within-person drinking differences (per weekday, semester, first 6 weeks) and other descriptors of day-to-day drinking identified five drinking patterns: two low (47% and 6%), two medium (24% and 15%), and one high (8%) drinking cluster. Multinomial logistic regression analyses examined cluster differences in pre-college characteristics (i.e., demographics, alcohol outcome expectancies, alcohol problems, depression, other substance use) and first-year college experiences (i.e., academic engagement, alcohol consequences, risky drinking practices, alcohol problems, drinking during academic breaks). Low-drinking students appeared to form a relatively homogeneous group, whereas two distinct patterns were found for medium-drinking students with different weekend and Thursday drinking rates. The Thursday drinking cluster showed lower academic engagement and greater participation in risky drinking practices. **Conclusions:** These findings highlight quantitative and qualitative differences in day-to-day drinking patterns and suggest a link between motivational differences and drinking patterns, which may be addressed in developing tailored interventional strategies. (*J. Stud. Alcohol Drugs, 73,* 613–624, 2012)

EACH YEAR, COLLEGE STUDENT DRINKING leads to deaths, injuries, physical assaults, and sexual assaults and remains cause for serious concern (DeJong et al., 2009; National Institute on Alcohol Abuse and Alcoholism [NIAAA], 2002). Frequency and typical (average) volume of alcohol consumed by college students are most commonly studied, but an important and understudied aspect of college student drinking is the pattern of drinking, which captures the timing and quantities of drinking. For example, drinking five drinks per week if consumed at a rate of one drink per day represents low-risk drinking (NIAAA, 2009), but if consumed in a single occasion, it represents a hazardous pattern. The importance of drinking patterns has long been recognized (Jellinek, 1960), and its impact on health has been well documented (Bobak et al., 2004; Rehm et al., 2001; Room et al., 2003; Russell et al., 2004; Tolstrup et al., 2004). College students often show risky drinking patterns and have higher rates of heavy-drinking occasions than either 12th graders or non-college-attending peers (Johnston et al., 2011). At the same time, college students are a heterogeneous population with regard to drinking. Although 37% of full-time college students report having consumed five or more drinks in a row in the last 2 weeks, the majority of college student drinkers report no heavy-drinking episodes, and more than one fifth of college students abstain from past-year drinking entirely (Johnston et al., 2011).

The heterogeneity of drinking patterns points to the existence of subpopulations of college student drinkers. Identifying subgroups of alcohol users is useful for both conceptual and practical reasons. Subtyping allows researchers to identify and test theories about different types of individuals. Through a process of comparing and contrasting, the nature and dimensions of a problem behavior can be better understood. Subtyping can also be useful in designing interventions by providing the basis for tailoring intervention messages. A number of large-scale surveys have depicted broad trends in drinking across representative samples of

Received: September 8. 2011. Revision: February 2, 2012.

This study was supported by National Institute on Alcohol Abuse and Alcoholism Grants R01AA013970 and T32AA007459 and National Institute on Drug Abuse Grant K01DA027097.

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college student drinkers (Johnston et al., 2010; Presley et al., 1996; Wechsler et al., 1994, 2000). These studies, however, lack the fine-grained specificity that is necessary to discern patterns of daily drinking because they are often cross-sectional or because they rely on summary measures to capture drinking rather than assessing daily consumption.

Examinations of daily drinking are few and typically rely on relatively short (1- to 2-month) time spans to provide snapshots of drinking patterns in small samples of college students (<200). Results have indicated that college drinking follows a weekly pattern reflective of student role demands, but it is also influenced by family roles, external events, and fluctuations in academic pressures (Lee et al., 2006; Rabow and Neuman, 1984). Factors contributing to the campus culture (e.g., presence of fraternities, sororities, campus alcohol polices, residential vs. commuter populations) can also strongly influence college day-to-day drinking (Rabow and Duncan-Schill, 1995).

One study (Del Boca et al., 2004) captured drinking during the entire first year of college in a sample of students (N = 301) using eight repeated administrations of monthly Timeline Followback. The findings from this study showed that alcohol consumption was consistently different for three parts of the week (i.e., lowest on Sunday–Wednesday, elevated on Thursday, highest on Friday–Saturday), and that weekly drinking changed considerably as a function of academic requirements and holidays. Del Boca and colleagues also highlighted the impact of specific events on elevating college student drinking, including calendar (e.g., New Year's Eve) and local events (e.g., Guavaween [Latin-style Halloween celebration]). Others have extended these findings by establishing that specific events are associated with heavy-drinking episodes (Beets et al., 2009) and that they prompt excessive drinking even among students who do not ordinarily report drinking (Neighbors et al., 2007).

Thus, research on daily patterns of drinking has highlighted the importance of weekly periodicity and fluctuations because of academic requirements and specific dates or campus events. Yet how consistent are these patterns across the academic year or across college students? In terms of timing, a study on college student drinking trajectories (Dierker et al., 2008) identified two groups whose drinking patterns differed in their timing of high-volume drinking, with one group drinking early in the academic year and another group with stable drinking that increased in volume toward the year's end. This divergence in trajectories suggests that groups of students engage in high-volume drinking at different times, where elevated drinking during the first few weeks of the academic year in particular has been noted as a crucial period in the process of adaptation to campus life (Borsari et al., 2007b; NIAAA, 2002). The Dierker et al. (2008) study, however, did not further describe identified groups.

To investigate different types of college student drinkers, Greenbaum et al. (2005), in a re-analysis of the Del Boca data (2004), identified two groups of light-stable college drinkers whose patterns of drinking diverged with regard to whether they consumed alcohol on holidays. Alcohol expectancies and gender differentiated these two types of drinkers and the other groups identified in the study (medium-increasing, high-decreasing, and heavy-stable drinkers). Clearly, subpopulations of college student drinkers exist who may be relatively similar in some respects (e.g., overall volume of drinking) but differ on pattern of drinking. More research is needed to more fully understand the differences between different types of college student drinkers.

In particular, it is important to understand how individual characteristics and risk behaviors that have previously been highlighted as important are related to subgroups based on drinking patterns. Specifically, risk behaviors including pregaming (Borsari et al., 2007a; LaBrie and Pedersen, 2008; Pedersen and LaBrie, 2007; Read et al., 2010) and drinking games (Borsari et al., 2003) are predictive of specific (heavy use per occasion) drinking patterns, as are drinking intentions (Reed et al., 2011). Specific use patterns may also predict different acute consequences of alcohol misuse (Perkins, 2002), such as college sanctions or medical treatment (Hoover, 2003). It is less clear how factors such as other substance use (O'Malley and Johnston, 2002); academic satisfaction, commitment, and performance (Paschall and Freisthler, 2003); and cognitive (e.g., expectancies) and affective (e.g., depression) variables (Shim and Maggs, 2005; Werch, 2001) are related to specific patterns of drinking. Understanding how subgroup drinking patterns relate to risky drinking behaviors and consequences, academic commitments, and cognitive and affective profiles will support the tailoring of prevention and intervention efforts targeting college students.

In this study, we used an academic-year-long, daily, large, multisite sample to identify subpopulations of college student drinkers who follow different day-to-day patterns of drinking during their first year of college and described how these groups differ from one another before, during, and after their first year of college on etiologically relevant factors. To capture patterns of drinking, we used cluster analysis to group students on specific day-to-day drinking descriptors (weekday periodicity, percentage of drinking days, and maximum number of drinks per day) as well as onset and consistency of patterns (drinking during the first 6 weeks of the year, latency to first drink in the first semester, drinking during different semesters).

Although our approach was exploratory and descriptive, we expected that groups based on patterns would in part reflect differences in volume of drinking. Of greater interest here, however, were groups that exhibited similar volume but divergent patterns of drinking. For these groups, we hypothesized that academic and specific alcohol experiences would differentiate between groups of college student drinkers who

drank alike in terms of volume but differed in terms of day-to-day patterns of drinking.

Method

Participants

Participants were incoming first-year college students who were recruited during the summer to participate in a 2-year longitudinal study to evaluate naturalistic changes in alcohol use for typical college students (43% recruitment rate). Students were eligible to participate if they were attending high school in the United States, planning to live on campus in college, and enrolled at one of three participating New England universities and colleges. The current study focuses on 588 students recruited in two cohorts who reported drinking at least one drink during the first year of college (76.6% of n = 292 in 2005–2006 and n = 296 in 2006–2007). The sample was on average 18.4 (SD = 0.4) years old and was 58.8% female. Participants reported their race as White (69.7%), Asian (11.2%), African American (6.1%), Pacific Islander (0.3%), American Indian (0.2%), and multiracial (6.3%); 6.1% did not specify their racial background, and 9.7% reported being Hispanic. (Participants could be Hispanic-White, Hispanic-Black, Hispanic-multiracial, etc.)

Procedure

Incoming students received letters inviting them to enroll in the study, and parents of minors received similar letters. Participants completed an online consent procedure followed by a baseline assessment battery before arriving on their college campus. Starting with the first week after arrival on campus, participants received biweekly emails containing links to an online survey. Participants were given 1 week to complete each survey and were reminded twice to do so via email. Surveys were conducted throughout the school year, including breaks, resulting in 18 possible surveys in the academic year. Biweekly reports rather than weekly reports were used to reduce response burden (i.e., in any given week, only half of the participants were asked to complete surveys). At the end of each semester, participants were paid $2 for each completed survey and a $20 bonus if they completed 85% or more of the surveys each semester. After completing each survey, participants also had a 1 in 50 chance of winning $100. At the end of the academic year, a larger survey similar to the high school baseline battery was administered (93% completion rate). All procedures were approved by the institutional review boards of the participating institutions.

Measures

Clustering variables. On each biweekly survey, participants reported the number of drinks they consumed on each of the previous 7 days. The 18 surveys resulted in 126 possible days per student over the first year of college. From these reports, day of the week, semester (first or second), and whether observations were from the first 6 weeks of the year were coded for each day. Percentage of drinking days and maximum number of drinks per day also were coded and used as clustering variables. Latency to first drink was determined by asking participants at each biweekly interval to report the date of their first drink after arriving on campus. The question was repeated every survey until it was answered or the first semester was over. Only days during the academic semesters (including weekends but excluding orientation weeks, exam periods, and winter and spring breaks) were used to calculate day-to-day drinking pattern descriptors because drinking outside of academic times differs from drinking while students are at college (Del Boca et al., 2004).

Pre-college characteristics. The pre-college survey assessed demographics (i.e., age, sex, race) and marijuana and tobacco use (30-day and lifetime, ≥100 cigarettes lifetime) and included scales to measure drinking intentions (a modified version of the Graduated Frequency for Alcohol; Hilton, 1989; Rehm et al., 1999), from which we derived the intended average drinks per week and number of heavy-drinking days per month. We also assessed outcome expectancies, using an abbreviated scoring of the brief version of the Comprehensive Effects of Alcohol Questionnaire (Ham et al., 2005) as recommended (L. Ham, personal communication, 2009) to assess positive (four items, α = .79) and negative (six items, α = .68) outcome expectancies for alcohol; alcohol problems, using the Young Adult Alcohol Problems and Screening Test (YAAPST; Hurlbut and Sher, 1992), where we summed the 20 past-year items recommended by Kahler et al. (2004); and depression, using the 20-item Center for Epidemiologic Studies Depression Scale (Radloff, 1977) (α = .87) that measures depressive symptoms in the preceding week.

First-year college experiences. Experiences during the first year of college were assessed in two ways: as part of the biweekly reports and in a survey administered at the end of the year. In the biweekly reports, participants indicated whether they had experienced any of 13 negative and 11 positive consequences of alcohol consumption in the past week, including both concrete events (e.g., drunk driving, police trouble) and subjective experiences (e.g., had a good time, disappointed others). Positive and negative items were separately summed for the year. From their drinking reports, we coded the number of days students reported drinking 5+/4+ (male/female) per week. We also coded drinking during winter and spring breaks based on school- and cohort-specific dates, where we calculated the average number of drinks per week for winter breaks, which varied in length somewhat, and the total number of drinks consumed during spring break, which always consisted of 1 week and 2 weekends.

The end-of-the-year survey assessed academic satisfaction using the five-item academic subscale ($\alpha = .94$) of the Extended Satisfaction with Life Scale (Alfonso et al., 1996); academic commitment, as measured by two items: "About how much time, on average, do you spend on schoolwork outside of class each day?" (1 = *none at all,* 5 = *more than 3 hours*) and "Overall, how important has it been for you to get good grades in college?" (1 = *not at all important,* 4 = *very important*); first semester grade point average; participation in drinking games (yes/no for the past year, number of days past year); pre-gaming, defined as "when you drink, in your home or room or in a friend's home or room before you go out for the night. This includes drinking while waiting for people to gather for the evening or drinking to 'get buzzed' before going to a party/function" (yes/no for the past year, number of days past year); and whether participants received any medical attention after drinking (e.g., by emergency medical services or a hospital), received a citation or violation for an alcohol-related reason, or were required to see a counselor or educator for an alcohol or drug-related issue during the first year of college.

Analytic strategy

To identify subgroups of participants with similar longitudinal drinking patterns, we used time series–based typology (Hoeppner et al., 2008), a process that combines time series analysis (TSA) and cluster analysis. We chose this approach because our interest lies in patterns of drinking. Other longitudinal approaches (e.g., latent trajectory analysis, latent growth curve models) focus on fitting trends over time, which often tend to be parametric in nature (e.g., linear or quadratic increases and/or decreases over time). Such trends, however, largely ignore day-to-day differences in patterns because the goal of the analysis is to quantify a general trend above and beyond individual variations around the general trend. Our goal is different. We are primarily interested in when exactly drinks are consumed and only secondarily in the overall trend across the year. Time series–based typology allows us to focus on such patterns by starting with identifying within-person differences in drinking during the specific intervals of interest (e.g., weekday differences). Here, each person's data are first analyzed separately to detect the characteristics of that person's drinking profile. In the second step, subgroups are identified by forming groups person by person based on the characteristics of interest. By contrast, a latent trajectory approach would cluster persons based on similarities in trends across the year rather than their day-to-day drinking profiles. Also by contrast, a longitudinal mixed-effects analysis could identify whether drinking on Thursday is in general higher than drinking on Sunday through Wednesday, but it would remain unclear if that effect is the result of a few individuals with pronounced Thursday drinking or the result of a universal Thursday drinking effect.

The specific characteristics of interest in this study were weekday- and semester-specific drinking. That is, for each person, we used TSA to test for within-person differences in drinking between specific times of the year using three dummy-coded variables: semester (fall vs. spring), first 6 weeks (≤6 weeks vs. >6 weeks), and weekday (Sunday–Wednesday vs. Thursday vs. Friday–Saturday). Reference categories were "fall," "after 6 weeks," and "Sunday–Wednesday." The resulting person-specific estimates (i.e., descriptors of drinking fluctuations) were then used in a cluster analysis to identify subpopulations. If person-specific increases were not statistically significant, zero was used in the subsequent cluster analysis to include only robust indicators of day-to-day drinking fluctuations.

Cluster analyses were conducted using Ward's (1963) minimum variance method based on the squared Euclidean distance, a hierarchical agglomerative procedure in which clusters are formed person by person. That is, the "distance" (i.e., the degree to which they differ on the clustering variables) of all persons to each other is calculated, and the two closest persons are combined in a cluster. Then the next two closest persons or clusters are joined until only one cluster remains. To determine the number of clusters, we used the inverse scree test (Lathrop and Williams, 1987), the pseudo-*F* test (Calinski and Harabasz, 1974), and the cubic clustering criterion (Sarle, 1983), along with inspection of the dendogram. Because cluster analyses are sensitive to means, the non-TSA-based clustering variables (i.e., percentage of drinking days, maximum number of drinks per day, latency to first drink of the year) were standardized ($M = 1$, $SD = 0$) before the cluster analysis. The TSA estimates of person-specific fluctuations were not standardized because their numerical values relative to each other have meaning. Analyses were first conducted separately by cohort to determine the replicability of the solution and were then combined.

Differences in identified groups were explored using univariate multinomial logistic regressions, where cluster membership was the dependent variable and pre-college and during-college descriptors were tested one at a time as independent variables. Pairwise statistically significant differences were calculated, where the Hochberg procedure was used to protect the Type I error rate (Hochberg, 1988). Demographic variables that statistically significantly predicted cluster membership were included as covariates in later analyses to adjust for demographic cluster differences.

All analyses were conducted using SAS Version 9.3 (SAS Institute Inc., Cary, NC), and all tests were evaluated using $\alpha = .05$. Missing data were handled using maximum likelihood estimation using all available data (Schafer and Graham, 2002), except for the cluster analysis, which is not maximum-likelihood estimation based and thus excluded cases ($n = 39$, 6.6% of the sample) with missing latency values. Survey completion biases of the end-of-the-year survey (93%), based on baseline characteristics, were tested

using logistic regression. Univariate statistically significant predictors of survey completion were tested in a stepwise multivariate logistic regression model; variables remaining in the multivariate model were included as covariates in end-of-the-year outcome analyses.

Results

Participants reported data on average on 114 (*SD* = 24.9, median = 126, minimum = 7, maximum = 126) of the possible 126 days. Sporadic nonresponses (e.g., providing data for fewer than 7 days within the 1-week recall period) occurred in only 12 (1.6%) participants. Thus, only 9.3% of the data were missing. Only five participants provided too few data points for the TSAs to converge and were excluded from further analyses.

Descriptors of day-to-day drinking

The results of the TSA (Table 1) demonstrated substantial heterogeneity in the descriptors of day-to-day drinking. For example, for the majority of the sample (70.5%), a weekend drinking effect was found, indicating that drinking on Fridays and Saturdays exceeded Sunday–Wednesday drinking by 2.24 drinks per day on average. In contrast, for only 10.1% of the sample, a significant TSA intercept was found, indicating that only for these individuals, drinking on Sundays through Wednesdays exceeded zero drinks per day during the fall semester. Differences in drinking between spring and fall semesters were rarely significant (in 5.8% of participants). Students differed as to which semester was associated with higher amounts of average drinking, with 64.7% of these students indicating higher drinking during the spring semester and the other 35.3% indicating higher drinking during the fall semester.

Identification of drinking patterns

Descriptive summaries of all variables used in the cluster analysis are presented in Table 1. Per-cohort cluster analyses resulted in different cluster solutions, a five-cluster and a six-cluster solution. An inspection of the means of the clustering variables per cluster showed that the five clusters identified in one cohort had largely equivalent profiles among the six clusters identified in the other cohort. The key difference was that, in the six-cluster solution, one of the clusters was split into two. Given these similarities, the samples were combined in a final cluster analysis. Here, all indices indicated a five-cluster solution, which was retained.

The resulting clusters were labeled based on their clustering profile (Figure 1) and the average number of drinks per day. Two low (48%, *M* = 0.34 drinks per day, *SD* = 0.25; and 6%, *M* = 0.25 drinks per day, *SD* = 1.01, respectively), two medium (24%, *M* = 1.49 drinks per day, *SD* = 0.69; and 15%, *M* = 1.42 drinks per day, *SD* = 1.21, respectively), and one high drinking (8%, *M* = 2.57 drinks per day, *SD* = 1.01) cluster(s) were found. Cluster 1 (LOW-Weekend) was marked by low means across all clustering variables with marginally increased weekend drinking. Cluster 2 (LOW-Late) is marked by low means for alcohol use but high (i.e., late) latency. Cluster 3 (MED-Weekend) is marked by moderate maximum numbers of drinks and percentage of drinking days but high weekend drinking. Cluster 4 (MED-Thur) is marked by similarly moderate levels of maximum numbers of drinks and percentage of drinking days as Cluster 3 (MED-Weekend) but has lower weekend drinking and higher Thursday drinking. Cluster 5 (HIGH) is marked by high maximum numbers of drinks and percentage of drinking days and by both Thursday and weekend drinking.

Table 1. Descriptive summaries of the clustering variables

Type of clustering variables	*n*	%	*M*	(*SD*)
TSA-based variables				
Intercept				
Positive	59	10.1	1.49	(0.97)
Nonsignificant (i.e., 0)	524	89.9	0.00	(0.00)
Thursdays				
Positive	130	22.3	2.13	(1.57)
Nonsignificant (i.e., 0)	453	77.7	0.00	(0.00)
Negative	0	0.0	N.A.	
Weekends				
Positive	411	70.5	2.24	(1.66)
Nonsignificant (i.e., 0)	172	29.5	0.00	(0.00)
Negative	1	0.2	-1.34	N.A.
Spring semester				
Positive	22	3.8	1.45	(1.09)
Nonsignificant (i.e., 0)	549	94.2	0.00	(0.00)
Negative	12	2.1	-0.90	(0.86)
First 6 weeks				
Positive	24	4.1	1.19	(0.92)
Nonsignificant (i.e., 0)	552	94.7	0.00	(0.00)
Negative	7	1.2	-1.38	(1.17)
Non-TSA-based variables				
Percentage of drinking days	583	100.0	17.72	(13.57)
Maximum no. of drinks per day	583	100.0	8.70	(5.21)
Latency, in days	544	93.3	14.23	(20.23)

Notes: *n* = 583, because the time series analysis (TSA) did not converge for *n* = 5. N.A. = not applicable.

Drinking patterns over time

An inspection of the drinking patterns of the five clusters across the first year of college (Figure 2) shows that the overall pattern of low, medium, and high drinking remains consistent throughout the year (Figure 2A), although some fluctuations are evident (e.g., a steeper decline in drinking during winter break weeks for the HIGH cluster relative to the other clusters). By contrast, inspection of weekday averages (Figure 2B) highlights variations in daily patterns by cluster. Namely, the two medium-drinking clusters (MED-Weekend and MED-Thur) differ substantially on Thursday, Friday, and Saturday drinking. Furthermore, on Sunday–Wednesday drinking, one of the medium patterns (MED-

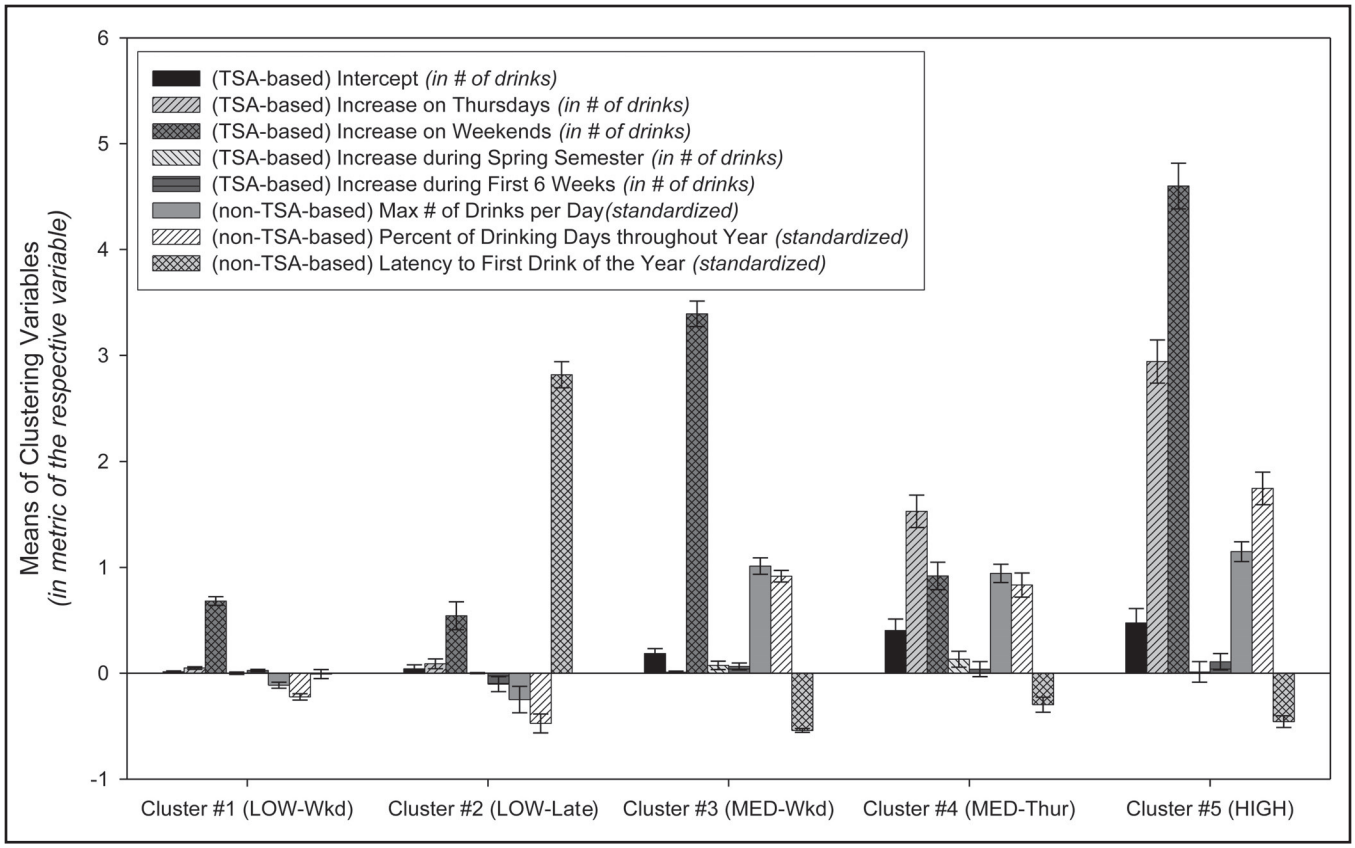

FIGURE 1. Cluster profiles (i.e., means of the clustering variables) are shown for the retained five-cluster solution. The two low-drinking clusters (1 and 2) have very similar cluster profiles but are primarily differentiated by differences in the time to first drink on campus. Similarly, medium-drinking clusters (3 and 4) are similar on most clustering variables but are differentiated by differing rates of Thursday and weekend drinking. TSA = time series analysis; Max = maximum; LOW-Wkd = low means across all clustering variables with marginally increased weekend drinking; LOW-Late = low means for alcohol use but high (i.e., late) latency; MED-Wkd = moderate maximum numbers of drinks and percentage of drinking days but high weekend drinking; MED-Thur = moderate levels of maximum numbers of drinks and percentage of drinking days similar to Cluster 3 (MED-Wkd) but lower weekend drinking and higher Thursday drinking; HIGH = high maximum numbers of drinks and percentage of drinking days and by both Thursday and weekend drinking.

Thur) is equivalent to the high-drinking pattern (HIGH), whereas the other (MED-Weekend) is not. The reverse is true for weekend drinking, where the MED-Weekend cluster is more similar to the high-drinking group than the other medium group (MED-Thur).

Cluster differences in pre-college characteristics

Pre-college characteristics per cluster are presented in Table 2, including all pairwise significant differences. Low-drinking clusters were predominantly female (70.9% and 71.4%, respectively). A five-level categorical variable of race was not statistically significantly related to cluster membership, but a binary variable (White vs. non-White) was, with a high proportion of White participants in the HIGH and MED-Thur clusters.

Cluster differences were generally consistent with the low, medium, and high delineation of the clusters. Of interest here are differences between clusters with similar volume but different pattern of drinking. The two low-drinking clusters were distinguished from each other by intentions to drink, previous alcohol problems, and marijuana use. Specifically, compared with the LOW-Weekend cluster, the LOW-Late cluster had lower YAAPST scores (odds ratio [OR] = 0.55 [0.38, 0.80]), lower intentions for number of drinks per week (OR = 0.67 [0.53, 0.85]), lower heavy drinking days per month (OR = 0.50 [0.28, 0.88]), and lower prevalence of ever using marijuana (OR = 0.35 [0.15, 0.82]).

The two medium-drinking clusters appeared to differ in terms of sex, race, depression, and smoking, where the MED-Thur cluster was more likely to be female, be White, and report higher depression and tobacco use than the MED-Weekend cluster. But after the Hochberg adjustment, these differences did not remain statistically significant.

Cluster differences in first year of college experiences

Several of the pre-college characteristics were statistically significant predictors of end-of-year survey completion (i.e., greater drinking intentions, higher positive alcohol

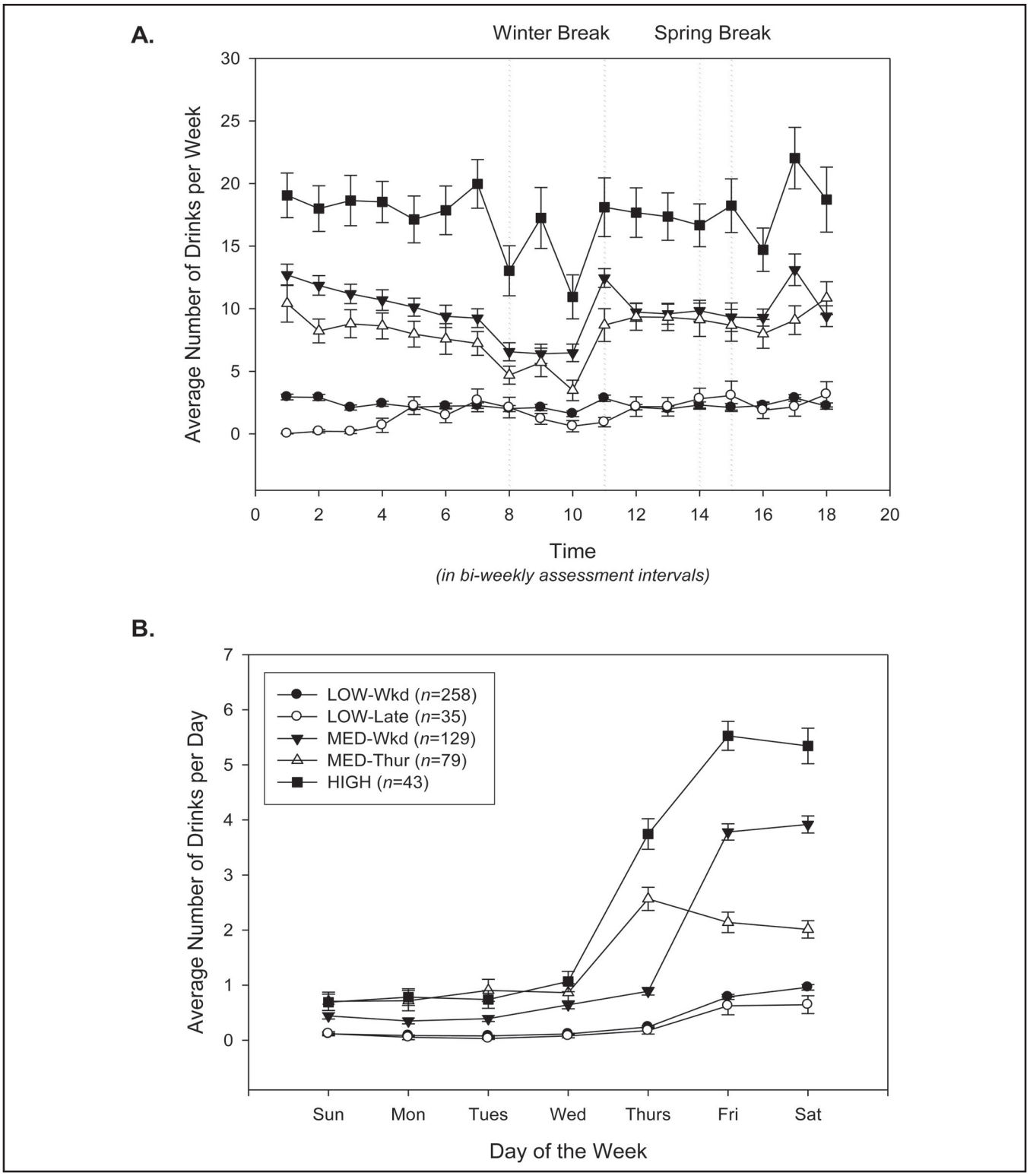

FIGURE 2. Drinking patterns over time are depicted by examining weekly trends across the academic year (A) and daily trends within a given week (B). Across the year, the five identified patterns remain relatively consistent; that is, the ordering based on alcohol volume remains intact. Within a week, however, the two medium-drinking clusters evidence diverging patterns. LOW-Wkd = low means across all clustering variables with marginally increased weekend drinking; LOW-Late = low means for alcohol use but high (i.e., late) latency; MED-Wkd = moderate maximum numbers of drinks and percentage of drinking days but high weekend drinking; MED-Thur = moderate levels of maximum numbers of drinks and percentage of drinking days similar to Cluster 3 (MED-Wkd) but lower weekend drinking and higher Thursday drinking; HIGH = high maximum numbers of drinks and percentage of drinking days and by both Thursday and weekend drinking.

Table 2. Pre-college characteristics per cluster

Variable	Cluster 1† (LOW-Wkd) (*n* = 258; 47.4%)	Cluster 2 (LOW-Late) (*n* = 35; 6.4%)	Cluster 3 (MED-Wkd) (*n* = 129; 23.7%)	Cluster 4 (MED-Thur) (*n* = 79; 14.5%)	Cluster 5 (HIGH) (*n* = 43; 7.9%)	Multinomial logistic Wald χ^2
Female sex, % (*n*)	70.9 (183)^{a}	71.4 (25)^{ab}	38.0 (48)^{c}	54.4 (43)^{bc}	45.2 (19)^{bc}	43.0**
Hispanic, % (*n*)	10.5 (27)	8.6 (3)	10.9 (14)	5.1 (4)	14.0 (6)	3.1
Race, % (*n*)						19.0
White†	65.5 (169)	68.6 (24)	69.0 (89)	83.5 (66)	88.4 (38)	
Asian	13.6 (35)	11.4 (4)	10.9 (14)	3.8 (3)	2.3 (1)	
Multiracial	5.4 (14)	5.7 (2)	7.8 (10)	6.3 (5)	4.7 (2)	
African American	7.8 (20)	8.6 (3)	3.9 (5)	2.5 (2)	0 (0)	
Other	7.8 (20)	5.7 (2)	8.5 (11)	3.8 (3)	2.3 (1)	
Race, White† vs. other, % (*n*)	65.5 (169)^{a}	68.6 (24)^{ab}	69.0 (89)^{ab}	83.5 (66)^{b}	88.4 (38)^{b}	15.3**
Drinking intentions, *M* (*SD*)						
Drinks per week	4.2 (8.7)	1.1 (3.1)	9.9 (10.2)^{a}	10.7 (14.4)^{ab}	17.3 (14.4)^{b}	61.4**
Heavy drinking days per month	1.1 (2.8)	0.2 (1.1)	3.3 (3.9)^{a}	3.8 (6.0)^{a}	6.8 (6.5)	61.1**
Outcome expectancies, B-CEOA, *M* (*SD*)						
Positive expectancies	2.5 (0.6)^{a}	2.4 (0.5)^{ab}	2.6 (0.5)^{bc}	2.8 (0.5)^{c}	2.7 (0.4)^{abc}	26.7**
Negative expectancies	2.6 (0.6)	2.8 (0.5)	2.7 (0.5)	2.8 (0.5)	2.5 (0.5)	7.8
YAAPST, dichotomized 20 items, *M* (*SD*)	1.7 (1.7)	0.8 (1.5)	3.0 (1.9)^{a}	3.4 (2.4)^{ab}	4.0 (2.8)^{b}	89.5**
CES-D, 20 items, *M* (*SD*)	10.5 (8.3)	11.0 (8.5)	9.3 (6.9)	12.6 (9.4)	8.9 (5.9)	10.0*‡
Marijuana use, % (*n*)						
Ever	41.9 (108)	20.0 (7)	61.2 (79)^{a}	59.5% (47)^{a}	81.4% (35)	51.0**
Past 30 days	21.7 (56)^{ab}	5.7 (2)^{a}	41.1 (53)^{c}	35.4% (28)^{bc}	58.1% (25)^{c}	37.7**
Smoking, % (*n*)						
Ever	33.7 (87)^{a}	20.0 (7)^{a}	40.3 (52)^{ab}	58.2 (46)^{b}	58.1 (25)^{b}	26.4**
≥100 lifetime	10.1 (26)^{a}	0.0 (0)$^{N.A.}$	3.9 (5)^{a}	15.2 (12)^{ab}	25.6 (11)^{ab}	16.1**
Past 30 days	7.0 (18)	0.0 (0)	5.4 (7)	11.4 (9)	18.6 (8)	8.4

Notes: Clusters that share a superscript are not pairwise statistically significantly different from each other. LOW-Wkd = low means across all clustering variables with marginally increased weekend drinking; LOW-Late = low means for alcohol use but high (i.e., late) latency; MED-Wkd = moderate maximum numbers of drinks and percentage of drinking days but high weekend drinking; MED-Thur = moderate levels of maximum numbers of drinks and percentage of drinking days similar to Cluster 3 (MED-Wkd) but lower weekend drinking and higher Thursday drinking; HIGH = high maximum numbers of drinks and percentage of drinking days and by both Thursday and weekend drinking; B-CEOA = brief version of the Comprehensive Effects of Alcohol Questionnaire; YAAPST = Young Adult Alcohol Problems and Screening Test; CES-D = Center for Epidemiologic Studies Depression Scale; N.A. = not applicable. †Reference group; ‡no pairwise significant differences after Hochberg adjustment.
*$p < .05$; **$p < .01$.

outcome expectancies, higher YAAPST scores, past-30-day marijuana use, and tobacco use [ever, and ≥100 cigarettes]). Following a multivariate stepwise logistic regression, two variables remained in the model: intentions for number of heavy drinking days per month (OR = 1.07 [1.01, 1.13]) and marijuana use in the past 30 days (OR = 2.40 [1.16, 4.98]). Accordingly, these two variables were included as covariates in subsequent analyses along with sex and race (White/non-White) to adjust for statistically significant demographic cluster differences.

Cluster membership was significantly predicted by academic outcomes, positive and negative alcohol experiences reported throughout the year, drinking when classes were not in session, risky drinking practices, and alcohol problems (Table 3). These predictions were generally in line with the overall cluster pattern of low, medium, and high drinking, where lower drinking clusters reported fewer alcohol experiences (negative and positive), lower drinking during winter and spring breaks and New Year's Eve, and less participation in drinking games and pre-gaming.

Of interest here were the similarities and differences between clusters with similar average alcohol consumption. The LOW-Weekend cluster reported negative consequences (OR = 1.44 [1.23, 1.69]) and positive experiences with alcohol (OR = 1.03 [1.01, 1.06]) more frequently than the LOW-Late cluster, which may be a function of less opportunity for the LOW-Late cluster to have alcohol consequences, given their later drinking onset. Other trends are observable in the descriptive statistics, such as a substantially higher prevalence of engaging in drinking games (64%) and pre-gaming (58%) in the LOW-Weekend cluster compared with the LOW-Late cluster (43% and 37%, respectively), but these trends were not statistically significant.

The medium-drinking clusters differed on more variables than the low-drinking clusters. In general, the MED-Thur cluster reported less academic engagement than the MED-Weekend cluster, including lower academic satisfaction (OR = 0.92 [0.88, 0.97]), less time spent on homework (OR = 0.64 [0.47, 0.86]), and lower grade point averages (OR = 0.31 [0.19, 0.52]) than the MED-Weekend cluster. Notably, the MED-Thur cluster reported the least amount of time spent on homework of all the clusters, including the HIGH cluster (OR = 0.55 [0.36, 0.84]). Despite reporting similar numbers of negative consequences, the MED-Thur cluster

Table 3. First year of college experiences per cluster

Variable	Cluster 1 (LOW-Wkd) (n = 258; 47.4%)	Cluster 2 (LOW-Late) (n = 35; 6.4%)	Cluster 3 (MED-Wkd) (n = 129; 23.7%)	Cluster 4 (MED-Thur) (n = 79; 14.5%)	Cluster 5 (HIGH) (n = 43; 7.9%)	Multinomial logistic Wald χ^2
Academics, *M* (*SD*)						
Satisfaction	27.8 (7.5)^{ab}	27.9 (7.0)^{ab}	29.3 (4.7)^{a}	26.1 (6.5)^{b}	29.0 (6.5)^{ab}	14.5**
Commitment						
How important are good grades?	3.5 (0.7)	3.4 (0.8)	3.4 (0.7)	3.5 (0.7)	3.4 (0.8)	3.8
Time spent on homework, ordinal	4.0 (1.0)^{b}	3.9 (1.2)^{ab}	3.8 (1.0)^{b}	3.4 (1.1)^{a}	3.8 (1.1)^{b}	13.9**
GPA, Semester 1	3.3 (0.6)^{a}	3.3 (0.5)^{ab}	3.4 (0.5)^{a}	3.0 (0.7)^{b}	3.2 (0.5)^{ab}	21.3**
Alcohol experiences, no. reported throughout the academic year, *M* (*SD*)						
No. of negative consequences	4.2 (6.3)	1.5 (3.6)	11.6 (12.8)^{a}	13.1 (12.4)^{a}	16.9 (13.3)^{a}	82.6**
No. of positive experiences	24.0 (21.3)	12.4 (13.8)	53.2 (25.0)^{ab}	47.3 (26.5)^{a}	62.2 (34.2)^{b}	98.4**
Drinking when classes are NOT in session, *M* (*SD*)						
Winter break, weekly avg. no. of drinks	1.9 (2.7)^{a}	1.1 (2.6)^{a}	6.5 (6.3)^{b}	4.3 (6.0)^{b}	13.5 (10.1)	68.0**
New Year's Eve,† no. of drinks	1.3 (2.4)^{a}	1.3 (2.2)^{ab}	4.4 (4.8)^{b}	4.9 (6.0)^{b}	7.9 (4.9)^{b}	29.3**
Spring break,‡ no. of drinks over 10 days	2.7 (5.7)^{a}	1.8 (4.2)^{ab}	13.9 (25.7)^{b}	7.3 (13.5)^{ab}	28.0 (25.9)^{b}	25.8**
Risky drinking practices						
5+/4+ drinking occasions per week, *M* (*SD*)	0.2 (0.2)^{a}	0.1 (0.2)^{a}	1.0 (0.5)	0.8 (0.5)	1.7 (0.8)	143.6**
Drinking games						
During past year, % yes (n)	64.3 (166)^{a}	42.9 (15)^{a}	88.4 (114)^{b}	77.2 (61)^{b}	74.4 (32)^{ab}	28.7**
No. of days past year, *M* (*SD*)	9.6 (13.6)^{a}	6.5 (7.0)^{ab}	24.1 (32.6)^{b}	22.6 (25.9)^{b}	48.1 (48.1)^{b}	31.4**
Pre-gaming, *M* (*SD*)						
During past year, % yes (n)	58.1 (150)^{a}	37.1 (13)^{a}	87.6 (113)^{b}	67.1 (53)^{c}	79.1 (34)^{bc}	48.4**
No. of days past year, *M* (*SD*)	8.6 (11.6)^{a}	3.8 (2.2)^{ab}	23.4 (24.9)^{b}	17.2 (19.0)^{b}	35.9 (29.8)^{b}	38.1**
Alcohol problems, % (n)						
Seen counselor, alcohol or other drug	1.6 (4)^{a}	2.9 (1)^{ab}	12.4 (16)^{b}	3.8 (3)^{ab}	4.7 (2)^{ab}	13.9**
Medical attention	0.8 (2)	2.9 (1)	2.3 (3)	1.3 (1)	4.7 (2)	1.8
School violation	1.2 (3)^{a}	0.0 (0)^{ab}	2.3 (3)^{ab}	11.4 (9)^{b}	4.7 (2)^{ab}	14.1**

Notes: Analyses include covariates to adjust for demographic cluster differences (i.e., sex, race) and retention biases; clusters that share a superscript are not pairwise statistically significantly different from each other. †50% planned missingness; ‡2006-2007 cohort only. LOW-Wkd = low means across all clustering variables with marginally increased weekend drinking; LOW-Late = low means for alcohol use but high (i.e., late) latency; MED-Wkd = moderate maximum numbers of drinks and percentage of drinking days but high weekend drinking; MED-Thur = moderate levels of maximum numbers of drinks and percentage of drinking days similar to Cluster 3 (MED-Wkd) but lower weekend drinking and higher Thursday drinking; HIGH = high maximum numbers of drinks and percentage of drinking days and by both Thursday and weekend drinking; GPA = grade point average; avg. = average.
**$p < .01$; all directions of the measures are in the direction suggested by the wording (e.g., high means for "time spent" reflect longer times, high means for "importance" reflect greater importance).

reported a lower number of positive alcohol experiences than the HIGH cluster (OR = 0.98 [0.97, 0.99]). Meanwhile, the MED-Weekend cluster reported engaging in more risky drinking practices than the MED-Thur cluster—such as more frequent heavy episodic drinking occurrences (four or more/five or more drinks for females/males) (OR = 2.89 [1.49, 5.60]), although not as often as the HIGH cluster (OR = 0.21 [0.12, 0.44])—and reported a greater prevalence of participating in pre-gaming during the first year of college (OR = 5.57 [1.93, 16.10]).

Discussion

This study used daily-level reports of alcohol consumption across the entire first year of college to identify subpopulations defined by divergent drinking patterns in a large sample of first-year college students. Five distinct subgroups of student drinking types emerged, reflecting a continuum from low to high levels of alcohol use but also including differentiations between student drinkers who drank alike in volume but differed in their pattern of drinking, suggesting that the typology had qualitative differences rather than simply falling on a continuum.

The key difference in drinking patterns between the two low-drinking clusters was a delayed onset of drinking in one cluster but not in the other. Here, delayed onset was related to fewer alcohol problems, lower drinking intentions, and a lower likelihood of having used marijuana before college. After the first 2 months of college, however, these two clusters reported highly similar levels of weekly drinking (Figure 2A) and virtually indistinguishable weekday averages of alcohol consumption (Figure 2B). Thus, their observed difference in the number of alcohol experiences likely simply reflects diminished opportunity rather than a qualitatively different experience associated with alcohol consumption. In sum, low-drinking students appear to form a relatively homogeneous group.

In contrast to the two low-drinking clusters, the two medium-drinking clusters were distinguished by different patterns of day-to-day drinking, where one cluster reported elevated drinking almost exclusively on Friday and Saturday and the other cluster reported elevated drinking on Thursday,

with weekend drinking lower than the other medium-drinking cluster. These patterns were associated with different end-of-the-year outcomes, even after controlling for demographic differences, pre-college drinking intentions, and marijuana use. Namely, the medium-drinking cluster with primarily a weekend drinking pattern engaged in more risky drinking practices compared with the medium Thursday drinking cluster, including more frequent heavy episodic drinking occurrences and a greater prevalence of participating in pregaming during the first year of college. Both the pattern of drinking confined to weekends and the engagement in risky drinking practices are consistent with the impulsivity and sensation-seeking motivation described by Baer (2002). Other factors that might be expected to be related to this motivational style, however, did not emerge as such. For example, drinking on New Year's Eve was only different between clusters that differed in volume of alcohol consumption but not between clusters with different patterns of drinking. Similarly, alcohol outcome expectancies were related only to volume but not pattern of alcohol consumption.

Meanwhile, the medium-drinking cluster with elevated Thursday drinking showed lower academic engagement on numerous indicators, including satisfaction and achievement. Even compared with the high-drinking cluster, the Thursday drinking cluster showed less academic engagement. In the past, the NIAAA has recommended that Friday classes and exams be increased at universities to prevent Thursday night drinking (NIAAA, 2002), which is supported by research that shows that students with no Friday classes drink approximately twice as much on Thursdays as students with early Friday classes (Wood et al., 2007). The causal direction, however, is not clear because heavy-drinking students may simply be less likely to enroll in Friday classes (Paschall et al., 2006). Wood et al. (2007) observed between-person as well as within-person associations between drinking and Friday class schedule, supporting the idea that drinking effects are not only attributable to heavier-drinking students selecting more "drinking compatible" course schedules. Nevertheless, some students undoubtedly do select courses to fit their drinking pattern. Our finding that Thursday drinking students are less academically engaged suggests that these students may drink regardless of its interference with academics, even if Friday classes were to be enforced.

In comparison with the high-drinking cluster, both medium-drinking clusters reported less other substance use at baseline, reported less drinking when classes were not in session, and had lower frequencies of heavy episodic drinking occasions. At the same time, the medium Thursday drinking cluster reported fewer positive alcohol experiences than the high-drinking cluster, despite similar rates of negative consequences. In general, the ratio of positive to negative alcohol experiences seemed to follow a trend of diminishing returns as alcohol use increased yet was worst for the Thursday drinking cluster.

Strengths and limitations

Strengths of this study are the use of short recall periods (i.e., 7-day Timeline Followback) and the detailed description of participants before, during, and after their first year of college. This study capitalized on the high rates of internet access in this population (Pew Internet and American Life Project, 2009) to collect data frequently, thereby minimizing recall biases while keeping participant burden reasonable. The success of this strategy is evidenced by an enrollment rate on par with similar investigations (Beets et al., 2009) and excellent longitudinal retention. Additionally, our recruitment from different institutions allowed us to capture trends indigenous to a larger spectrum of college experiences.

Among the limitations are the small sample sizes of some of the identified clusters, which negatively affected the statistical power of group comparisons. Furthermore, we did not survey students every week; therefore, it is possible that students who only drank during weeks that were not surveyed were inadvertently excluded as nondrinkers. Finally, our sample was from three colleges in the Northeast and reflects small to mid-size private and public institutions. The sample as a whole had very good racial and ethnic diversity, but to the extent that our college characteristics and sample demographics do not reflect other colleges, generalizability is limited.

Implications and future research

There is extensive research showing that individual-level interventions are effective in reducing alcohol use in identified populations such as members of fraternity/sorority organizations and students who have experienced identified events such as medical treatment or alcohol policy violations (Barnett and Read, 2005; Carey et al., 2007). We found significant heterogeneity in the drinking patterns of our college students, and it is important to reflect on how interventions designed to reduce alcohol consumption on campuses could be attentive to these differences. For example, our finding that the majority of drinkers showed a weekend-drinking effect suggests that policies that specifically address on-campus party planning, service of alcohol (Barnett et al., 2009), and event monitoring might reduce the high levels of alcohol consumption and associated harm (Toomey et al., 2007). Qualitative (Morritz et al., 1993) and cross-sectional (Wei et al., 2010) data support the promotion of alcohol-free events, particularly as a way to reduce alcohol consumption during times when alcohol consumption is most likely to occur (DeJong et al., 1998). The value of these initiatives notwithstanding, our findings also show that not all student drinkers exhibit a weekend-drinking pattern, and thus would potentially be missed by interventions focusing solely on weekends and campus events. Further research that estab-

lishes whether patterns developed in the first year of college are maintained in later years, and whether these patterns are associated with different long-term outcomes is necessary to determine which type(s) of college student drinkers remain at greatest need for intervention efforts.

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