Evaluation of Timing and Dosage of a Parent-Based Intervention to Minimize College Students' Alcohol Consumption

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ABSTRACT. Objective: The study evaluated the timing and dosage of a parent-based intervention to minimize alcohol consumption for students with varying drinking histories. **Method:** First-year students ($N = 1,900$) completed Web assessments during the summer before college (baseline) and two follow-ups (fall of first and second years). Students were randomized to one of four conditions (pre-college matriculation [PCM], pre-college matriculation plus boosters [PCM+B], after college matriculation [ACM], and control conditions). Seven indicators of drinking (drink in past month, been drunk in past month, weekday [Sunday to Wednesday] drinking, Thursday drinking, weekend [Friday, Saturday] drinking, heavy episodic drinking in past 2 weeks, and peak blood alcohol concentration $<.08$) were used in a latent transition analysis (LTA) to examine a stage-sequential model of drinking. LTA models with dummy-coded intervention variables were used to examine the effects

of the intervention conditions on changes in drinking patterns. **Results:** Results indicated that four patterns of drinking were present at all waves: (a) nondrinkers, (b) weekend light drinkers, (c) weekend heavy episodic drinkers, and (d) heavy drinkers. Results indicated that the PCM condition was most effective at influencing baseline heavy drinkers' transition out of this pattern to lower risk patterns at first follow-up, whereas the ACM condition was not effective at preventing drinking escalation for baseline nondrinkers at first follow-up. No decay of effects was observed at long-term follow-up for the PCM condition. Finally, the results also indicated that increased dosage of the parental intervention was not significantly associated with either reduction or escalation of use. **Conclusions:** The results underscore the value of pre-college parental interventions and targeted efforts to reduce high-risk drinking among college students. (*J. Stud. Alcohol Drugs*, 74, 30–40, 2013)

FOR MANY COLLEGE STUDENTS, excessive drinking represents a continuation of prior behavior (Hersh and Hussong, 2006; Kenney et al., 2010; Sher and Rutledge, 2007; White et al., 2006). In response, researchers have argued for prevention before college matriculation (Turrisi et al., 2001, 2010), although college administrators have focused on providing intensive programming to incoming students (Hingson and Howland, 2002; Larimer and Cronce, 2007; Saltz et al., 2009; Toomey et al., 2007). These efforts have not led to noticeable decreases in alcohol-related problems since the National Institute on Alcohol Abuse and Alcoholism's (NIAAA's) Task Force was created in 1998 (Hingson et al., 2009; NIAAA, 2002).

Parents are among the primary sources of health information for college students (Borkowski et al., 2002; Vader et al., 2011). Accordingly, Turrisi and colleagues (2001) developed a parent-based intervention (PBI) that consisted

of providing a handbook to parents before the first-year fall semester. The PBI was based on research examining college student decision-making (Turrisi, 1999; Turrisi et al., 1999, 2000a) and parent–child communication (Turrisi et al., 2000b). Specifically, the theory underlying the PBI emphasizes two key components: style and content. Parents are instructed to use an empathic and conversational communication style while providing accurate information about student alcohol consumption (e.g., biological aspects). Several independent studies have indicated that students whose parents received the PBI before college matriculation reported less alcohol use and fewer alcohol-related consequences at 5-month follow-up relative to controls (Ichiyama et al., 2009; Testa et al., 2010; Turrisi et al., 2001, 2010). Although these findings underscore the importance of parents' influence on college students' drinking, questions remain about the optimal timing and dosage of the PBI and efficacy for students who enter college with varying drinking experiences.

Teens' experiences with alcohol can vary dramatically as they enter college. For instance, some teens have little experience with alcohol when they enter college and are vicariously exposed to negative consequences such as blackouts, fights, and unwanted sexual experiences. Such experiences might make parental communications deliv-

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ered after matriculation more meaningful and effective for teens newly exposed to this culture. Other teens may have initiated drinking in high school and have experience with alcohol and consequences before they enter college, making PBIs more relevant if they are offered before matriculation. Nationwide organizations are currently attempting to involve parents in preventing high-risk college drinking (e.g., American College of Emergency Physicians, 2011; Mothers Against Drunk Driving, 2012; NIAAA, 2010), but their recommendations vary in terms of specific content or timing of conversations. Additionally, there is little information about whether parental communications should change based on students' drinking experiences. Previous studies have found that PBIs delivered the summer before college matriculation were most effective at preventing baseline nondrinkers from transitioning to heavy drinking during the freshman year among a high-risk population of student athletes (Cleveland et al., 2012). Other research has shown that PBIs are efficacious alone or together with brief motivational interventions in reducing drinking among high-risk, first-year students who initiated drinking at an early age (Mallett et al., 2010). The limited number of studies examining timing and dosage of PBIs with respect to teens' drinking patterns argue for empirical efforts that address this in more detail.

The present study extended previous research in several ways. First, it used a longitudinal design to evaluate the timing and dosage of a PBI for students with varying drinking patterns at three different periods: summer before college (baseline), fall semester of the first year (first follow-up), and fall semester of the second year (second follow-up). The addition of long-term assessments permitted the examination of lasting effects of the intervention. Second, the study used a person-centered approach to address three novel research questions: (a) Do changes in drinking patterns vary for different types of drinkers during the first 15 months in college, (b) do timing and dosage of PBI influence who is likely to change drinking patterns, and (c) do pre-college baseline drinking patterns moderate the influence of PBIs on students' transition to the heavy-drinking pattern (highest risk for problems) in college?

Question 1: Drinking patterns

We used latent transition analysis (LTA) to examine drinking patterns at the three time points. Based on Cleveland et al. (2012) examining high-risk students, we hypothesized that similar drinking patterns would emerge (e.g., no alcohol use, low use on weekends only, high use on weekends only, and weekday and high weekend use). However, we expected to observe slightly different proportions of drinkers in each pattern considering the present study examined a general student sample.

Question 2: Parent-based interventions and drinking patterns

Three PBI conditions were compared with assessment-only controls among students with diverse pre-college drinking patterns. The first condition consisted of the pre-college matriculation (PCM) intervention during the transition between high school and college, consistent with past PBI studies (Ichiyama et al., 2009; Testa et al., 2010; Turrisi et al., 2001). Based on research suggesting that this period represents an opportunity to convey concern about teens' welfare and reinforce parental norms, we hypothesized that the PCM condition would result in reduced alcohol consumption across the first year of college. We also hypothesized that the PCM would result in lower rates of alcohol initiation for baseline nondrinkers as well as reduced consumption and slower escalation of use among students entering college with established drinking patterns (Cleveland et al., 2012; Mallett et al., 2010).

The second condition consisted of the pre-college PBI with the addition of a parental "booster" delivered during the first semester (PCM+B). Conversations in the fall would allow parents to reinforce their summer conversations and strengthen unfavorable beliefs about drinking. We hypothesized that the addition of boosters should strengthen the effects observed for the PCM alone. Based on the higher dosage, we predicted that stronger effects would be observed for the PCM+B than for the PCM alone.

The third condition consisted of the PBI delivered after college matriculation (ACM) during the fall of the first semester. For some students, the negative aspects of drinking become more salient in the first semester of college. Thus, we anticipated no main effects for the ACM condition but instead hypothesized that the ACM condition might be effective for certain subgroups of students, such as those with no previous drinking experience.

Question 3: Moderator effects

We hypothesized that two significant moderator effects would be observed when examining the transition of drinking patterns from baseline to follow-up. First, for lower risk drinkers, we anticipated that the influence of the PBI would be roughly equivalent across conditions. These students are at lower risk for transitioning to a heavy drinking pattern; therefore, the differences in PBI timing and dosage should have low impact on dramatic changes in drinking patterns. However, for heavier drinkers (e.g., weekend heavy episodic drinkers), these students are at greater risk for transitioning to and remaining heavy drinkers in college. Therefore, early intervention may be more beneficial for individuals with these drinking patterns. Thus, we hypothesized that the PCM and the PCM+B conditions, because of their earlier delivery, would have a greater influence than the ACM condition for

individuals who had established higher risk drinking patterns at baseline.

Method

Participants

Participants were randomly selected incoming first-year students ($N = 1,900$) at a large, public northeastern university. Eligible participants (a) were enrolled as first-time incoming students, (b) consented to participate, and (c) completed a baseline assessment during the summer before college. Of the 2,907 students invited, 1,900 consented to participate and completed the Web-based baseline assessment, yielding a 65.4% overall response rate, consistent with similar studies (Larimer et al., 2007; McCabe et al., 2002, 2005; Thombs et al., 2005). Before baseline completion, individuals were assigned to one of four conditions using a computerized randomization algorithm (1 = pre-matriculation [PCM], 2 = pre-matriculation treatment plus boosters [PCM+B], 3 = after matriculation treatment [ACM], and 4 = control). See Figure 1 for the CONSORT (Consolidated Standards of Reporting Trials) flow chart.

Of the 1,900 participants enrolled in the study, demographic characteristics were as follows: 52% female, 87% White, 5% Asian, 3% African American, 5% Hispanic, and 5% multiracial or other. The mean age for the sample was 17.94 years ($SD = 0.32$).

Screening and recruitment procedure

Students. Participants were randomly selected from the university registrar's database of incoming freshmen. Invitation letters explaining the study, procedures, and compensation and containing a URL and personal identification number for accessing the survey were mailed to potential participants during the summer before college matriculation in 2007 (Cohort 1) and in 2008 (Cohort 2). Emailed invitations and email and postcard reminders were also sent. Participants received \$30 for the baseline survey and \$35 each for two follow-up surveys. Two follow-up assessments were conducted 5 and 15 months after baseline.

Parents. Parents were recruited after students completed the baseline survey based on the timing of the intervention conditions. Parents in the PCM and PCM+B conditions were invited during the summer before their student's college entrance, parents in the ACM condition were invited during their student's first semester in college, and parents in the control condition were invited after all teen assessments were complete in the fall of their student's second year. At the time of recruitment, parents in the intervention conditions were sent a package containing the following items: (a) a letter explaining the study and a consent form, (b) a brief survey assessing parent-teen communication, (c) a cover

letter explaining the study procedures, (d) the PBI handbook, (e) a handbook evaluation form, (f) a \$10 check for filling out and returning the materials, and (g) a \$10 check for taking their teen out for ice cream to discuss the contents of the handbook. The letter informed parents that they would also be sent a larger survey assessing their communication with their teen during the spring semester of their student's first or second year of college. Parents received \$30 for completion of this larger survey. For parents in the PCM+B condition, their letter also explained that they would receive extra information throughout their student's first semester that should be read, evaluated, and sent back for an additional \$10. Of the 1,900 parents invited to participate across the three treatment conditions, 1,216 (64.0%) consented and mailed the surveys and handbook evaluations back. No differences were observed on teen baseline drinking outcomes between parents who returned materials versus those who did not.

Parent intervention

Intervention procedure. Parents randomized to receive the intervention were mailed a PBI handbook (Turrisi et al., 2001). Parents were asked to read the handbook, evaluate the material, and discuss the material with their teen. The 35-page handbook included an overview of college student drinking, strategies and techniques for communicating effectively and discussing ways to help teens develop assertiveness and resist peer pressure, and in-depth information on how alcohol affects the body.

Overall, the handbook provided parents with an overview of the incidence and consequences associated with student drinking. Specifically, topics such as teens' motivations to drink, general physiological and psychological effects of alcohol, parental norms with respect to alcohol use among teens, how to recognize when a drinking problem exists, and how to handle a drinking problem were presented. The handbook also provided techniques for initiating a conversation, techniques for giving and receiving criticism, and strategies for forming agreements.

To assess fidelity, parents indicated how interesting, readable, useful, and understandable each section of the handbook was on a 5-point scale ranging from 0 (*not at all*) to 4 (*extremely*). Ratings were uniformly positive, with means ranging from 3.07 to 3.71 (SD s ranged from 0.55 to 0.94). Less than 2% of the sample responded *not at all* for each of the handbook ratings. Comparison of parental ratings across intervention conditions revealed no significant group differences (all F s < 4.0, all p s > .10). Parents were asked if they had discussed 10 topics covered in the handbook using 4-point scales ranging from 1 (*not at all*) to 4 (*a great deal*). More than 70% of parents reported that they had discussed all topics. Comparison of ratings by condition revealed no significant group differences for 8 of the 10 topics (all p s > .10). However, parents in the PCM condition were signifi-

FIGURE 1. CONSORT (Consolidated Standards of Reporting Trials) flow chart. ^a1,007 students either did not respond or declined participation; ^bfor parents to be counted as responders, they had to return at least one of the following: (a) consent form, (b) parent handbook, (c) handbook/booster evaluation, or (d) survey.

cantly less likely to report discussing two topics (drunk driving and the importance of not being pressured into drinking) compared with parents in the PCM+B condition ($ps < .05$). No other significant differences were observed between intervention conditions. The findings offer sufficient evidence that parents read the materials, rated them positively, and communicated their content to their teens.

Measures

Alcohol use. Participants reported the maximum number of drinks consumed on an occasion within the past 30 days and the number of hours they spent drinking on that occasion, using the Quantity/Frequency/Peak questionnaire (Dimeff et al., 1999; Marlatt et al., 1998). From these responses, peak blood alcohol concentration (BAC) was calculated following established guidelines (Dimeff et al., 1999; Matthews and Miller, 1979). Frequency of drunkenness was measured using a single item asking students, "During the past 30 days, how many times have you gotten drunk or very high from alcohol?" (0 = *never*; 1 = *1–2 times*, 2 = *3–4 times*, 3 = *5–6 times*, 4 = *7–8 times*, and 5 = *9 or more times*). *Typical daily drinking* was the number of drinks participants indicated they consumed on each day of a typical week within the past 30 days using the Daily Drinking Questionnaire (Collins et al., 1985). *Heavy episodic drinking* was defined as how often in the past 2 weeks participants indicated that they consumed four or more drinks if female, or five or more drinks if male, in a 2-hour period. A standard drink definition was included for all measures (i.e., a 12-oz. beer, a 10-oz. wine cooler, 4 oz. of wine, and 1 oz. of 100 proof [1.25 oz. 80 proof] distilled spirits).

Analytic strategy

LTA was used to identify subgroups of individuals based on transitions in drinking patterns across the three mea-

surement occasions during the first 15 months of college. Alcohol use was modeled as a categorical latent variable indicated by seven dichotomous indicators of drinking (Table 1). The LTA model includes three sets of parameters. First, the latent status membership probabilities represent the proportion of the sample in each latent status (i.e., drinking pattern) at each measurement occasion. Second, the item-response probabilities represent the probability of a positive response to each item, conditional on latent status membership. Third, transition probabilities reflect the probability of transitioning from one latent status at time t to another latent status at the following time point ($t + 1$).

We used relative fit indices (Akaike's information criterion and Bayesian information criterion), parsimony, and model interpretability to determine the optimal number of latent drinking statuses (Collins and Lanza, 2010). All analyses were conducted using PROC LTA (Lanza et al., 2011). PROC LTA handles missing data using full information maximum likelihood, which assumes that the missing data are missing at random (i.e., MAR; ignorable). In the first phase of the analyses, we tested and confirmed that "missingness" was uncorrelated with gender, drinking indicators, or condition. Therefore, the data were MAR. Full information maximum likelihood is a model-based procedure in which model estimates are adjusted based on information from all participants with and without complete data (Collins and Lanza, 2010). Thus, the full sample ($N = 1,900$) was included in all analyses. Model identification was confirmed by examination of models using multiple starting values.

In the second phase of the analyses, a truncated LTA model was specified with measures at only the first two time points. Three dummy-coded variables (PCM, PCM+B, and ACM vs. control) represented the PBI conditions and were entered as a block of covariates to this LTA model. The LTA model used binary logistic regression to determine the effect of each PBI condition on transitioning to a specific latent status, relative to all other drinking statuses. Hypothesis test-

TABLE 1. Demographic characteristics of sample and percentages reporting alcohol use behaviors at baseline across four intervention conditions

Variable	PCM	PCM+B	ACM	Control	Test statistic
Demographics					
Age at baseline, in years	17.96	17.96	17.93	17.93	$F(3) = 1.05$
Gender (% female)	50.3%	51.4%	53.0%	54.9%	$\chi^2(3) = 2.30$
Alcohol use behaviors					
Drink in past month	53.3%	55.1%	54.4%	53.8%	$\chi^2(3) = 0.36$
Been drunk in past month	42.0%	42.8%	39.8%	42.1%	$\chi^2(3) = 0.99$
Weekday (Sun to Wed) drinking	4.5%	3.8%	5.6%	6.0%	$\chi^2(3) = 3.05$
Thursday drinking	3.9%	2.3%	5.2%	4.0%	$\chi^2(3) = 5.35$
Weekend (Fri, Sat) drinking	39.7%	40.1%	37.2%	40.0%	$\chi^2(3) = 1.11$
HED in past 2 weeks	27.2%	29.0%	26.5%	27.0%	$\chi^2(3) = 0.88$
Peak BAC greater than .08	29.3%	34.9%	31.2%	31.9%	$\chi^2(3) = 3.58$

Notes: There were no significant differences in any of the above variables by intervention condition. PCM = pre-college matriculation condition; PCM+B = pre-college matriculation plus booster condition; ACM = after college matriculation condition; Sun = Sunday; Wed = Wednesday; Fri = Friday; Sat = Saturday; HED = heavy episodic drinking; BAC = blood alcohol concentration.

TABLE 2. Model fit statistics for latent transition analysis models with two to six latent drinking patterns

No. of latent drinking patterns	-LL	G^2	df	AIC	BIC
2	12,251.72	5,985.77	2,097,132	6,023.77	6,129.22
3	11,294.91	4,072.15	2,097,116	4,142.15	4,336.41
4	10,916.96	3,316.27	2,097,096	3,426.27	3,731.52
5	10,830.79	3,143.92	2,097,072	3,301.92	3,740.38
6	10,729.16	2,940.66	2,097,044	3,154.66	3,748.52

Notes: **Bold** indicates the selected model. LL = log likelihood; AIC = Akaike's Information Criterion; BIC = Bayesian Information Criterion.

ing concerning each specific PBI condition was conducted by comparing the fit of pairs of models with and without each dummy-coded intervention term using the likelihood ratio test (LRT) statistic. A significant LRT value indicated that removal of the specific term resulted in a worse fitting model; thus, that specific PBI condition was associated with transition probabilities across statuses. In contrast, nonsignificant LRT values indicated that removal of the specific term did not deprecate model fit; thus, the more parsimonious model without the term was preferred. Additional analyses using the above method were conducted to examine two additional research questions involving changes in drinking patterns that occurred between the 5- and 15-month follow-up occasions.

In the third phase of the analyses, we examined whether baseline drinking patterns (before college enrollment) moderated the effect of the PBI conditions on transitions to the heaviest drinking pattern during college. A second series of parallel analyses examined the effect of the PBI conditions on the drinking pattern transition probabilities (as above) separately for each baseline drinking pattern.

Results

Table 1 displays basic demographic characteristics and baseline percentages of students endorsing each of the seven alcohol use behaviors used in the LTA by intervention condition. There were no significant differences in any of the following variables across conditions: drink in past month, been drunk in past month, weekday (Sunday to Wednesday) drinking, Thursday drinking, weekend (Friday, Saturday) drinking, heavy episodic drinking in past 2 weeks, and peak BAC < .08.

Attrition analyses indicated that, at baseline, students who did not complete the 15-month follow-up survey were more likely to report any alcohol use compared with those with complete data ($p < .05$). No other differences in alcohol use behaviors were found between the attrition groups. In addition, individuals with missing data, across both follow-ups, were significantly more likely to identify as male ($p < .05$). There was no evidence of differential attrition by treatment condition.

Changes in drinking patterns during the first 15 months of college

Based on indices of fit, model interpretability, and model identification, it was determined that four latent drinking statuses (hereafter referred to as "drinking patterns") were present during the first 15 months of college (Table 2). Specifically, the model with four drinking patterns had the lowest Bayesian information criterion value, and using multiple starting values, the same four-pattern solution was found in 50 of 50 models. In contrast, the best-fitting five-pattern and six-pattern solutions were found in less than half of the models.

Table 3 presents the parameters of the four-pattern solution. Members of the first pattern, labeled nondrinkers (NDs), were unlikely to report any drinking. Members of the second pattern, labeled weekend light drinkers (WLDs), reported using alcohol in the previous month (probability = .96) and were likely to report drinking only on Fridays and Saturdays (probability = .77); however, they were unlikely to report heavy episodic drinking in the previous 2 weeks, being drunk in the past month, or having a peak BAC above .08 on their heaviest recent occasion. In contrast, members displaying the third pattern, labeled weekend heavy episodic drinkers (WHEDs), were likely to report being drunk in the past month (probability = .99) as well as heavy episodic drinking (probability = .72) and having a peak BAC greater than .08 (probability = .84). Finally, members of the fourth pattern, labeled heavy drinkers (HDs), were distinguished from the other drinking patterns by elevated probabilities of endorsing all drinking indicators, including weekday and Thursday drinking (probabilities = .30 and .86, respectively).

The middle panel ("Proportion of statuses at") of Table 3 displays the proportion of students who belonged to each of the drinking patterns at each occasion. At baseline, the ND pattern was most prevalent (51%), followed by WHEDs (30%) and WLDs (15%). HDs comprised the smallest group at baseline, representing 5% of the students. The proportion of NDs decreased at both follow-up occasions, to 32% of the sample at the 5-month follow-up and only 25% at the 15-month follow-up. In contrast, the proportion of the HD

TABLE 3. Item-response probabilities and transition probabilities for selected latent transition analysis model

Variable	Latent status			
	ND	WLD	WHED	HD
Item-response probabilities				
Drink in past month	.09	.96	1.00	1.00
Been drunk in past month	.00	.46	.99	1.00
Weekday (Sun to Wed) drinking	.00	.04	.05	.30
Thursday drinking	.00	.08	.01	.86
Weekend (Fri, Sat) drinking	.02	.77	.98	1.00
Heavy episodic drinking in past 2 weeks	.00	.06	.72	.92
Peak BAC > .08	.00	.19	.84	.92
Proportion of statuses at				
Time 1 (baseline)	.51	.15	.30	.05
Time 2 (fall follow-up)	.32	.21	.23	.24
Time 2 (fall follow-up)	.25	.18	.27	.29
Transitions from baseline (rows) to 5-month follow-up (columns)				
Nondrinker	.57	.23	.14	.06
Weekend light drinker	.07	.45	.37	.12
Weekend HED	.06	.07	.35	.52
Heavy drinker	.03	.04	.10	.83
Transitions from 5-month follow-up (rows) to 15-month follow-up (columns)				
Nondrinker	.69	.20	.08	.03
Weekend light drinker	.11	.44	.33	.12
Weekend HED	.05	.07	.63	.25
Heavy drinker	.01	.03	.13	.83

Notes: Item-response probabilities are constrained to be equal at all time points. Entries in **bold** indicate status-defining probabilities (>.60). Entries in **bold and italic** indicate membership in the same latent pattern at both times (i.e., stability). ND = nondrinker; WLD = weekend light drinker; WHED = weekend HED; HD = heavy drinker; Sun = Sunday; Wed = Wednesday; Fri = Friday; Sat = Saturday; BAC = blood alcohol concentration; HED = heavy episodic drinker.

pattern increased from 5% at baseline to 24% and 29% of the students at the first and second follow-ups, respectively. The proportion of both WHEDs and WLDs remained consistent.

The bottom of Table 3 separately displays the transition probabilities from baseline to the 5-month follow-up and from the 5-month follow-up to the 15-month follow-up. Entries along the diagonal of each transition probability matrix reflect the probability of membership in the same drinking pattern at both times. HDs showed the highest stability across the three waves, with 83% of those at baseline remaining in that pattern at the first follow-up and 83% remaining between the first and second follow-ups. In contrast, individuals in the WLD or WHED patterns were most likely to transition to a different pattern at subsequent waves, particularly between the baseline and the 5-month follow-up. During both transitions, WHEDs who changed patterns were most likely to transition to HDs, such that more than half (52%) did so between baseline and the first follow-up and one fourth (25%) did so between the two follow-ups. WLDs were also likely to transition to more risky drinking patterns across both transitions. For example, between baseline and the 5-month follow-up, more than one third (37%) transitioned to WHEDs, and 12% transitioned to HDs. Across

both transitions, NDs who changed status were most likely to escalate to the WLD pattern (23% and 20%, respectively). *Do PBI conditions influence changes in drinking patterns?*

The second phase of the analyses concerned the effect of the intervention groups on the probability of transitioning from one drinking pattern to another between baseline and the fall follow-up. First, treatment condition (PCM, PCM+B, ACM, and control) was added as a four-level grouping variable to the LTA model to confirm that the prevalence rates for each baseline drinking pattern were similar across treatment conditions, as would be expected of random assignment. Comparing the baseline prevalence rates for the constrained and freely estimated models across groups revealed a nonsignificant G^2 difference test ($\Delta G^2 = 10.69$, $df = 9$, $p = .30$). The baseline proportion of students in each drinking pattern did not differ across treatment conditions.

We next added the dummy-coded intervention variables to the LTA modeling transitions between baseline and 5-month follow-up. Four binomial logistic regression models were estimated, specifying each drinking pattern (ND, WLD, HED, and HD) as the reference group. As seen in Table 4, significant effects of the intervention were found only for transitions to the HD pattern. In that case, the fit of the model with all three dummy-coded covariates was significantly improved

TABLE 4. Comparison of latent transition analysis models with covariates at 5-month follow-up

Reference group	Model	-LL	LRT	df	p
Nondrinkers	All terms	7,800.55	12.00	12	.45
Weekend light drinkers	All terms	7,801.58	9.94	12	.62
Weekend HEDs	All terms	7,802.47	8.16	12	.77
Heavy drinkers	All terms	7,795.22	22.66*	12	.03
	Pre-college removed	7,799.94	9.44*	4	.05
	Pre + booster removed	7,795.69	0.94	4	.92
	Post-college removed	7,798.21	5.98	4	.20

Notes: Values in table refer to changes in model fit when intervention condition dummy variables are added/removed to four-pattern latent transition analysis model, specifying each respective drinking pattern as the reference group. LL = log likelihood; LRT = likelihood-ratio test; HEDs = heavy episodic drinkers.

* $p \leq .05$.

compared with the fit of the baseline model without the covariates ($LRT = 22.66$, $df = 12$, $p = .031$). This indicated that transition probabilities into the HD pattern differed among the four treatment groups. We conducted additional analyses to determine which PBI condition was responsible for the improvement in model fit by systematically removing each of the three dummy-coded variables from the LTA model with HDs as the reference group. These analyses revealed that removing the dummy variable indicating the PCM condition resulted in a significant decrement in model fit ($LRT = 9.44$, $df = 4$, $p = .05$).

Do pre-college drinking patterns moderate the influence of PBIs?

In the final set of analyses, we replicated the steps above for each of the four baseline drinking patterns. As seen in Table 5, among baseline NDs, the model with all PBI covariate terms resulted in a marginally significant improvement in model fit relative to the model with no covariates (LRT

$= 6.86$, $df = 3$, $p = .08$). Additional models revealed that removal of the ACM condition resulted in significant decrement in fit ($LRT = 4.62$, $df = 1$, $p = .03$). The odds ratio associated with the effect of the ACM condition was 2.67, suggesting that among baseline NDs, the ACM condition was significantly related to increased odds of transitioning to an HD at the 5-month follow-up.

Significant results were also found when adding all three PBI covariates to the model among the baseline HDs ($LRT = 11.66$, $df = 3$, $p = .01$). Subsequent models indicated that this omnibus difference was attributable to the PCM condition ($LRT = 4.76$, $df = 1$, $p = .03$). Among baseline HDs, the PCM condition was significantly related to decreased odds of remaining in the HD pattern at the 5-month follow-up (odds ratio = 0.05). Put differently, the PCM condition was associated with baseline HDs being 20 times ($1 / 0.05$) less likely to remain an HD at the long-term follow-up, relative to transitioning to any other drinking pattern.

The above analyses were repeated to examine the effect of the treatment conditions on transitions in drinking patterns

TABLE 5. Comparison of models with reference = heavy drinkers at 5-month follow-up

Baseline drinker pattern	Model	-LL	LRT	df	p	OR
Nondrinkers only	All terms	7,803.12	6.86 [†]	3	.08	
	Pre-college removed	7,804.16	2.08	1	.15	
	Pre + booster removed	7,803.32	0.40	1	.53	
	Post-college removed	7,805.43	4.62*	1	.03	2.67
Weekend light drinkers only	All terms	7,804.22	4.66	3	.20	
	Pre-college removed	7,804.22	0.00	1	1.00	
	Pre + booster removed	7,804.00	0.44	1	.51	
	Post-college removed	7,804.73	1.02	1	.31	
Weekend HEDs only	All terms	7,804.73	3.64	3	.30	
	Pre-college removed	7,805.70	1.94	1	.16	
	Pre + booster removed	7,805.04	0.62	1	.43	
	Post-college removed	7,804.82	0.18	1	.67	
Heavy drinkers only	All terms	7,800.72	11.66*	3	.01	
	Pre-college removed	7,803.10	4.76*	1	.03	0.05
	Pre + booster removed	7,800.63	0.18	1	.67	
	Post-college removed	7,800.63	0.18	1	.67	

Notes: Values in table refer to changes in model fit when intervention condition dummy variables are added/removed to four-pattern latent transition analysis model, specifying the heavy drinking pattern as the reference group. Baseline drinker pattern refers to specific set of models estimated separately within each baseline drinking pattern. LL = log likelihood; LRT = likelihood-ratio test; OR = odds ratio; HEDs = heavy episodic drinkers.

[†] $p < .10$; * $p < .05$.

between the 5-month and the 15-month follow-up occasions. Each drinking pattern was again specified as the reference group. These results indicated that the intervention conditions were not associated with changes in drinking patterns during these two times (i.e., the effects of the PBI conditions did not decay during the time between the two follow-up occasions).

Discussion

The present study used a longitudinal design to evaluate whether (a) changes in drinking patterns varied for different types of drinkers during the first 15 months in college, (b) timing and dosage of a PBI had differential influences on who is likely to change drinking patterns, and (c) pre-college baseline drinking patterns moderated the influence of the different PBI conditions on students' transitions to the heavy-drinking pattern (highest risk for problems) in college. Consistent with our first hypothesis and prior research by Cleveland et al. (2012), which examined a high-risk student-athlete sample, our analyses of our first aim revealed four distinct drinker patterns at each wave: NDs, WLDs, WHEDs, and HDs. Although individuals transitioned between patterns at each of the three waves, the overall prevalence of NDs decreased, HDs increased, and WHEDs and WLDs remained relatively consistent across the three measurement occasions. These data are consistent with research showing the escalation of drinking after college matriculation (Hersh and Hussong, 2006; Sher and Rutledge, 2007; White et al., 2006).

A second goal of the study was to evaluate whether the timing and dosage of the PBI affected transitions in students' drinking patterns at short- and long-term follow-ups. We hypothesized that the addition of boosters would strengthen the effects of the intervention and result in reduced alcohol consumption across all drinkers; however, the findings did not support our hypothesis. The addition of boosters did not provide any additional benefit to the PCM condition. One potential reason for this finding is that the boosters were delivered during the initial weeks of the fall semester of the first year, which may have occurred too soon after the initial intervention to add to the effects. Additionally, the boosters were targeted at general alcohol-related conversations to have with the teen (i.e., on the phone, via email, when they come home to visit) rather than targeting high-risk occasions that are more conducive to heavy drinking (e.g., football weekends), which have been the focus of event-specific prevention efforts (e.g., Neighbors et al., 2009). Future studies that examine the utility of boosters should use boosters that encourage parents to talk with their college students before high-risk drinking occasions. This type of booster may benefit students by serving as a proactive reminder of parental norms about acceptable drinking behaviors.

Finally, the current study examined whether pre-college baseline drinking patterns would moderate the influence of PBI condition on students' transition to HDs. We hypothesized that the three PBI conditions would have equivalent outcomes for lower risk drinkers but that the PCM and the PCM+B conditions, because of their earlier delivery, would have greater influence than the ACM for heavier drinkers. Interestingly, we observed that HDs transitioned out of the HD pattern if their parents received the PCM intervention. This suggests that the PBI is useful as both a prevention and an intervention approach for incoming students who have established patterns of heavy drinking. In contrast, the NDs were more likely to transition into the HD pattern if their parents received the ACM intervention. This is especially concerning because it suggests that the ACM intervention may be delivered too late, resulting in more negative effects for those who are at the lowest risk before matriculation. It is possible that students who have little prior experience with alcohol and whose parents delay conversations about alcohol until after college matriculation are especially susceptible to negative influences (e.g., peer, environmental) they encounter on campus. Thus, the current study supports parents engaging in proactive conversations with their teens about drinking before sending them to college and suggests that post-matriculation conversations may have little benefit.

Limitations and future directions

Despite ensuring that adequate controls were used throughout the study, minor limitations remain. First, although fidelity was assessed to ensure that parents received and reviewed the PBI materials, we were not able to evaluate the actual delivery of the intervention to the teen. The conversations that occurred between parents and teens likely varied in terms of quality and length of each conversation. Because of the applied nature of the intervention, direct observations of these conversations would be intrusive. Second, the study only examined the influence of a PBI during the first 15 months of college, when students are likely to live in on-campus residence halls. Parental influence on college students' drinking behaviors in later years is unclear, particularly during pivotal events and situations (e.g., 21st birthday celebrations, moving off campus). Third, data were collected at one university with limited racial and ethnic diversity. Future research should be conducted on additional and more diverse campuses to evaluate the generalizability of the current study. Future research that considers parent and student moderators of the intervention effects on transitions in drinking status is also warranted. We also note that alternative models using continuous measures (e.g., latent profile analyses) could also be estimated. However, many of our alcohol use indicators were non-normally distributed and, as such, were best treated as categorical variables (Lanza et al., 2010). Finally, analyses were conducted on the

“intent-to-treat” sample. Although this was consistent with all of our other research examining the efficacy of the PBI (e.g., Turrisi et al., 2009) and other clinical intervention trials (e.g., Larimer and Cnonce, 2007), we recognize that this is a conservative approach. Thus, future efforts should be geared to increasing parental participation in the intervention.

In sum, the results indicate the benefits of implementing pre-college PBIs for high-risk drinkers. Future research that builds on these findings is needed to better understand additional ways the efficacy of brief PBIs can be improved.

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