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Heterogeneity of Pregamers by Consumption and Reinforcement Reasons: A Latent Profile Analysis

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Background: Pregaming is a common, high-risk drinking activity among college students that has been largely unchangeable despite targeted intervention approaches. Therefore, identifying profiles of pregamers could enhance understanding of the risks associated with this practice and inform intervention development.

Methods: This study identified subtypes of pregamers in undergraduates ($N = 911$; 60% female, 42.9% White) attending 3 U.S. universities in 2012. Self-report data assessed recent alcohol use (overall, heavy, and pregaming), pregaming motives, and demographics. Alcohol-related consequences were assessed via the Young Adult Alcohol Consequences Questionnaire.

Results: Latent profile analysis using pregaming-specific indicators assessing motives (e.g., to avoid getting caught) and consumption (e.g., estimated pregaming blood alcohol concentration) yielded 5 unique profiles. Three profiles were characterized by pregaming on 50% or more of all drinking events that differed by pregaming consumption and motives: *Instrumental* (5.3%; heavy consumption, intoxication-driven motives), *Global* (16.0%; moderate consumption, indistinct motives), and *Risk-averse* (18.3%; moderate-to-heavy consumption, negatively reinforcing motives). Two profiles reported lower levels of pregaming: *Occasional* (32.4%; moderate consumption, indistinct motives) and *Infrequent* (28.0%; lowest pregaming involvement). Cross-profile differences were then examined for demographics, general drinking and pregaming-specific motives, and alcohol-related consequences. Profile comparisons indicated differences in overall alcohol consumption, ethnicity, gender, current living arrangements, Greek involvement, and a variety of alcohol-related consequences ($ps < 0.01$).

Conclusions: Overall, pregaming is a very heterogeneous behavior among college students in that some students utilize this drinking practice as a means to mitigate risk and others use it to promote intoxication. Results suggest that distinguishing pregamers by consumption as well as motives can facilitate the development of more tailored intervention approaches for students who engage in this high-risk practice.

Key Words: College Student, Pregaming, Latent Profile Analysis, Alcohol, Drinking.

ALCOHOL USE IS common in college, with national studies estimating that about 65% of students drink alcohol on a monthly basis (White and Hingson, 2014) and many engaging in consumption levels at or beyond the conventional "binge" or heavy episodic drinking (HED) threshold ($5+/4+$ drinks in a single setting men/women (Patrick et al., 2016; White and Hingson, 2014; White et al., 2006). This style of drinking often results in blood alcohol concentrations (BACs) well above the legal limit for intoxication,

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placing students at increased risk for a multitude of negative consequences that range from hangovers to more severe problems like alcohol overdoses, blackouts, sexual assault, and alcohol-related legal issues (Abbey, 2002; Hingson et al., 2009, 2016; Perkins, 2002).

Certain types of drinking activities can elevate college students' risks for experiencing negative health consequences, such as drinking games (Zamboanga et al., 2014) and 21st birthday celebrations (Brister et al., 2011). One behavior that has garnered increased research attention over the past decade is pregaming, defined as drinking alone or with people before going to an event or gathering where more alcohol may or may not be served (Zamboanga and Olthuis, 2016). A review of the literature suggests that more than 60% of college student drinkers report pregaming at least once in the past 30 days (Zamboanga and Olthuis, 2016) and that engagement in pregaming results in increased risk for problems beyond what can be explained by overall use (Haas et al., 2012). Pregaming often involves rapid drinking and can quickly produce BACs near or exceeding the legal limit for intoxication (DeJong et al., 2010; Haas et al., 2013), and thus, it is has been linked with numerous alcohol-related consequences such as blackouts (Barnett et al., 2013; LaBrie and

Pedersen, 2008; LaBrie et al., 2011). To add additional risk, many students use pregaming as a "warm up" for subsequent consumption (henceforth called *postdrinking*) and consume more standard drinks on drinking occasions that involve this practice (Barnett et al., 2013; Borsari et al., 2007; DeJong et al., 2010; Haas et al., 2012; LaBrie and Pedersen, 2008; Read et al., 2010).

Although pregaming has been reported in high school students (Zamboanga et al., 2011), pregaming involvement rapidly escalates upon college matriculation (Barnett et al., 2013; Haas et al., 2016b), making this practice a logical target for intervention programming. However, many campus approaches focus predominantly on reducing overall alcohol use and address pregaming as an ancillary topic, if at all. At this time, no published interventions have demonstrated efficacy in reducing pregaming. Brief Motivational Interventions (BMIs), often variations of Brief Alcohol Screening and Intervention in College Students (Dimeff et al., 1999), are generally efficacious interventions for reducing overall use and consequences (Carey et al., 2009, 2011, 2016; Ray et al., 2014; White et al., 2007). However, a recent study has suggested that effects of these interventions remain small (Huh et al., 2015), and to date, BMIs addressing general alcohol use and consequences have not demonstrated an ability to reduce pregaming frequency or quantity (see Pedersen, 2016). A recent study (Borsari et al., 2016) that delivered BMIs with college students who were sanctioned for a drinking offense and also had not responded to a brief advice session found that BMIs did not affect pregaming frequency even when pregaming was explicitly discussed (quantity was not assessed). Given the unique nature of this sample (i.e., mandated students less responsive to a standard intervention) and lack of robust impact, there is a need to enhance current BMIs and other intervention efforts to reduce pregaming frequency and quantity in the general student population by better understanding who pregames and why.

Fundamental to this goal is a need to better understand the heterogeneity within college pregamers. One means of differentiating different types of pregamers is through latent profile analysis (LPA) or latent class analysis (Clogg, 1995; Goodman, 1974). These statistical approaches are similar to cluster analysis that identify profiles of individuals using latent rather than observed variables. These approaches using a variety of indicators (e.g., consequences, consumption, protective behavior strategies) have been used to identify subtypes for other high-risk drinking practices such as drinking games (Borsari et al., 2013), alcohol and energy drink consumption (Peacock and Bruno, 2015), and practices that mitigate risk (Ray et al., 2012). In one of the few studies utilizing a time-varying application of LPA (latent class transition analysis), pregaming subgroups were identified for entering students at 4 time points (precollege, fall, winter, and spring), with changes examined across the freshman year (Haas et al., 2016b). This study limited indicators to consumption, including overall alcohol (quantity frequency index [QFI] and number of binge events in the past 2 weeks)

and pregaming-specific indicators: frequency (i.e., number of pregaming events in a discrete time period), proportion (i.e., percentage of overall drinking events that involve pregaming), BACs attained during pregaming (preBAC), and postdrinking. Analyses identified 3 classes (Low, Medium, and High), which remained relatively stable across the freshman year and differentiated the prevalence of 2 consequences directly attributable to pregaming (campus alcohol policy violations and blackout as a direct result of pregaming).

However, one could argue that constraining indicators to consumption alone has limited utility for intervention development. To extend the findings of Haas and colleagues' (2016b) latent class transition analysis (LCTA), the class indicators for this study have been revised to allow for the identification of subtypes based on consumption, as well as factors which may be more amenable to interventions, like drinking motives (Cox and Klinger, 1988), particularly pregaming-specific motives. Two different pregaming motives measures have been developed (Bachrach et al., 2012; LaBrie et al., 2012), with some overlap to domains measured in the Drinking Motives Questionnaire (e.g., social, enhancement; Bachrach et al., 2012; Cooper, 1994; LaBrie et al., 2012) as well as unique subscales. For example, some pregaming motives may be seen as negatively reinforcing, or even protective, like situational control (e.g., mitigating risk of drink tampering), and minimizing barriers to consumption (e.g., avoid getting caught if underage; LaBrie et al., 2012). These make sense when viewed in context of stricter alcohol policies and sanctions on campuses today. Specifically, it is possible that some campus environmental management strategies enacted to reduce overall consumption (e.g., higher drink prices at local establishments or banning alcohol use at campus functions) may have had the unintended consequence of increasing pregaming prevalence (Wells et al., 2009). Essentially, students may consider pregaming as a means to mitigate risk vis-à-vis reducing monetary costs or reducing chances of getting caught for underage drinking on campus (e.g., barriers to consumption subscale on the Pregaming Motives Inventory [PMI]; LaBrie et al., 2012; Zamboanga et al., 2013). Such risk aversion motives may have significantly different implications for interventions than motives that promote intoxication or social facilitation.

Rationale for Current Study

Variability within pregamers is currently not well understood, and important for designing programming (e.g., incorporating pregaming in personalized feedback or implementing targeted social media campaigns) to address this risky drinking behavior (Pedersen, 2016). This study extended the existing latent class modeling study on pregaming (Haas et al., 2016) to address 3 primary limitations: utilization of exclusively consumption-based indicators, performance at a single site, and possible generalizability issues to students who are not entering freshmen. This study was exploratory in nature and used a diverse sample of

college undergraduates to identify subtypes of pregamers using LPA with indicators used in prior work (i.e., pregaming consumption and postdrinking) as well as new indicators (pregaming-specific motives). Profiles identified in this first step were subjected to further analyses to identify profile differences on several characteristics, including demographics, overall alcohol use, consequences, and general drinking motives. As a final step, planned comparisons evaluated differences (i) as a function of the proportion of overall drinking events involving pregaming and (ii) how the profile with the most frequent, heavy pregaming (as identified in Step i) compared to other profiles with a higher proportion of pregaming activity (i.e., engaged in on at least half of all drinking events). These were conducted to examine whether there were meaningful differences in overall drinking, consequences, and motives between these groups which may be useful in intervention programming.

MATERIALS AND METHODS

Procedure and Participants

Undergraduates were recruited in Fall 2012 from psychology research participation pools at 3 schools in the United States. Participants were provided a link to 128-bit encrypted site, which contained a brief description of the study and inclusion criteria (i.e., enrolled as a degree-seeking undergraduate and between the ages of 18 and 25). Students were then directed to the study consent and questionnaires. IRB approval was attained at each site prior to data collection and participants received 1 hour of research credit.

Data were collected from 1,763 individuals (Site 1 [public, urban, west coast]: n = 1,089, 61.6% women, 22.4% White; Site 2 [private, suburban, west coast]: n = 274, 71.2% women, 63.4% White; Site 3 [public, urban, eastern]: n = 400, 51.8% women, 57.3% White). Sites were selected with varying enrollments, demographics, and campus cultures to maximize sample diversity and generalizability of profiles. The overall sample at each site was comparable to published undergraduate student census data for ethnicity, but was slightly over represented for women.[1]

Participants were excluded if they were abstainers (n = 380), drank but reported no pregaming (n = 382), or had missing data for 1 or more of the LPA indicators (n = 90). The final sample consisted of 911 students with pregaming experience (51.7% of the overall sample; M_{age} = 19.24, 60% female). Participants were ethnically diverse (42.9% White, 26.5% Asian/Pacific Islander, 17.5% Latino/a, 6.9% Black, and 6.3% other/not disclosed), and the majority (57.3%) resided on campus. Greek (i.e., fraternity/sorority) affiliation was endorsed by 18.3% of students.

Measures

Participants self-reported age, gender, ethnicity, weight (used to calculate pregaming BAC), living arrangements, and involvement in Greek organizations.

Participants were provided with a chart detailing standard drink metrics (i.e., 1 standard drink = 12 ounces beer, 5 ounces wine, or 1.5 ounces hard alcohol) and asked a series of questions about their overall alcohol use, as well as pregame-specific consumption and motives. Descriptions of these variables are provided below.

Indicators Used in the Latent Profile Analysis

Pregaming Consumption. Pregaming-specific consumption was measured using several indicators used in prior studies (Haas et al., 2012, 2013, 2016b). Participants were asked how often they pregamed relative to their overall drinking frequency ("How often do you pregame?") with responses generated by a 7-point scale with the following anchors: "never, but I do drink," "very rarely (less than 10% of the times I drink)," "occasionally (about ¼ of the times I drink)," "about half the times I drink," "most of the time (over 50% but not every time)," and "every time I drink." These anchors were coded to approximate percentages (0, 10, 25, 50, 75, and 100%, respectively) and used in the analyses as the proportion (i.e., the percentage of drinking events involving pregaming) and past 30-day frequency indicators (detailed in Data Analysis section). In addition, 2 separate, open-ended items assessed the number of standard drinks consumed per typical pregaming event ("When you pregame, how many drinks do you typically consume?") and duration ("How long does it take you to consume those drinks, in minutes?").

Post drinking. Two additional items assessed drinking subsequent to a pregaming event: a dichotomous item asking if they engaged in the behavior ("On occasions where you do pregame, do you drink afterwards?"), and the typical number of drinks consumed afterward ("If yes, how many do you drink AFTER pregaming?"). These 2 items were merged to create a single count indicator.

Motives. Pregaming-specific motives were empirically derived through focus groups conducted prior to the study as part of a separate study on pregaming (Haas AL, Welter NC, under review). Four groups of undergraduates (n = 5 to 8 per group) attended an hour long focus group to discuss pregaming at their institution and reasons, or motives, for engaging in this behavior. The groups were audiotaped, and content coded for major themes. Six themes emerged, which were developed into separate dichotomous indicators assessing motives. Participants were given the stem: "Why do you pregame? (check all that apply to you)" and completed the following items: (i) "less chance of getting caught drinking," (ii) "less expensive than drinking somewhere else (like a bar, club, or restaurant)," (iii) "like getting buzzed or drunk quickly," (iv) "for the social aspects/friends do it," (v) "for safety reasons (so I know what is in my drink)," and (vi) "so I can start drinking earlier in the day." Items were relatively independent (average tetrachoric correlation = 0.13) and were therefore entered as individual indicators.

Variables Used in Profile Comparisons

Overall Alcohol Use. Recent drinking was assessed using a modified QFI (Cahalan et al., 1969). Past 2-week incidences of HED were assessed using the 5/4 criteria (i.e., 5+ drinks for a man, 4+ drinks for a woman on a single occasion; Wechsler et al., 1995).

Young Adult Alcohol Consequences Questionnaire (Read et al., 2006). Differences in alcohol consequence domains were assessed using the Young Adult Alcohol Consequences Questionnaire (YAACQ), a 48-item self-report measure developed with college samples that measures 8 domains of consequences. Participants were asked if they experienced any of the consequences in the past year (yes/no) in: Social/Interpersonal (α = 0.89), Academic/Occupational (α = 0.87), Risky Behavior (α = 0.89), Impaired Control (α = 0.89), Poor Self-care (α = 0.92, Diminished Self-perception (α = 0.88), Blackout Drinking (α = 0.92), and Physiological Dependence (α = 0.83). The YAACQ has good psychometric properties and strong concurrent validity with other alcohol problems

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[1]Institution-level data for ethnic and gender breakdowns at each site is available from the authors upon request.

measures (Read et al., 2006, 2007) and the total YAACQ problem score demonstrated excellent reliability in this sample ($\alpha = 0.93$).

Drinking Motives Questionnaire-Revised (Cooper, 1994). General drinking motives were assessed using the Drinking Motives Questionnaire-Revised (DMQ-R) subscales. Participants were presented with the stem "How often do you drink," followed by 20 items assessing reasons for consuming alcohol. Responses were measured on a 5-point Likert scaled ranging from (1) "never" to (5) "almost always." Items were summed to create 4 subscales. Two subscales represent positively reinforcing motives: Social (e.g., "because it makes social gatherings more fun"; sample $\alpha = 0.72$) and Enhancement (e.g., "because it helps you enjoy a party"; $\alpha = 0.74$). The other 2 represent negatively reinforcing motives: Coping (e.g., "because it helps when you feel depressed or nervous"; $\alpha = 0.86$) and Conformity (e.g., "because your friends pressure you to drink"; $\alpha = 0.81$).

Data Analyses

Prior to conducting the primary analyses, variables were calculated (if necessary) and descriptives conducted on the indicator variables. Typical pregame quantity and duration were entered along with weight into a gender variant equation (Watson et al., 1981) to calculate the preBAC. Number of pregaming days was calculated by taking the number of overall drinking events in the past 30 days and multiplying it by the pregaming proportion variable (e.g., 0.10 = 10% of events). Although the correlation between these indicators was significant ($r = 0.60$), they shared little more than one-third of their respective variances and tap into conceptually distinct aspects of pregaming behavior. Specifically, number of days provides insight into frequency, but does not capture how characteristic pregaming is of a student's overall drinking pattern (which is captured by proportion). It stands to reason that both variables are necessary to fully disentangle heterogeneity in pregaming, and to identify potential areas of intervention development.

Descriptive analyses were conducted, and cases with extreme outliers (i.e., QFI scores >5 SD from mean; $n = 5$) were excluded from further analysis. Number of pregaming days and preBAC were treated as continuous indicators, and proportion of events involving pregaming was treated as an ordered categorical indicator. About 20% of the sample reported no postdrinking; as such, this variable was zero-inflated and was modeled using a Poisson distribution. Reasons for pregaming were treated as dichotomous indicators.

A series of cross-sectional LPA models were estimated using the MIXTURE package in *Mplus* version 8.1 (Muthén and Muthén, 2004). LPA is a classification approach useful for identifying empirically distinct subgroups of students based on responses to observed pregaming consumption and motive indicators. Model parameters were estimated using robust maximum likelihood estimation with 500 sets of randomly generated starting values estimated for 20 iterations, and the 50 most likely solutions iterated to convergence. Two to 6 class models were estimated, and final model selection was based on the evaluation of information criteria (Nylund et al., 2007), entropy (Ramaswamy et al., 1993), and theoretical interpretably of the within- (estimated means and frequencies) and between-class model parameters (class size). Prior simulation work by Nylund and colleagues (2007) suggests that the Bayesian information criterion (BIC) correctly identifies the optimal number of classes under the conditions observed in this study (i.e., large sample size, complex pattern of class separation), with the preferred model exhibiting the lowest BIC. The entropy statistics provide an estimate of classification quality, with higher values indicating more accurate classification of individuals.

After deciding on a final model configuration, cross-class comparisons on demographic variables and overall alcohol use were conducted using the Mplus DCAT and BCH functions for categorical (Lanza et al., 2013) and continuous distal (Bakk and Vermunt, 2016) outcomes, respectively. Planned comparisons were also conducted to further differentiate differences among the profiles in overall consumption, alcohol-related consequences, and motives. Class-specific means and cross-class comparisons for the DMQ subscales were estimated conditional on QFI using the regression auxiliary model described by Asparouhov and Muthén (2014). Finally, the aforementioned BCH auxiliary function was used for the continuously distributed consequence and motive variables; however, HED and alcohol-related consequences often follow a count distribution, which is not supported by the Mplus auxiliary functions. For these models, most probable profile membership for each participant was exported to an external data file so that cross-class comparisons could be performed using negative binomial regression models.

RESULTS

Drinking Characteristics: Total Sample

On average, participants consumed 5.45 drinks per occasion (SD = 2.81), with 61.9% reporting at least 1 HED episode in the past 2 weeks. The majority of participants reported hard alcohol as their beverage of choice, in the form of either shots (34.5%) or mixed drinks (32.2% of entire sample). All participants reported pregaming within the last 3 months, with the participants pregaming on an average of 50.5% of all drinking events and consuming 3.01 beverages in 50 minutes (for the pregaming episode). Postdrinking was reported by 78.2% of participants, with a mean consumption of 2.74 (SD = 2.15) additional drinks. Participants reported a mean YAACQ total score of 11.80 (SD = 8.56).

Determination of Latent Profiles

Profile membership was estimated using indicators assessing pregaming-specific consumption (pregaming events in the past 30 days, proportion of overall drinking events involving pregaming, preBAC, and postdrinks) and pregaming motives. Best model likelihood was replicated across all solutions using randomly generated starting values. BIC and entropy estimates for the 2 to 6 profile solutions are presented in Table 1. Previous research (Nylund et al., 2007) suggests that the BIC is the most effective information criteria statistic for identifying the appropriate number of profiles; in this study, the BIC indicates that the 5-profile solution provides the best fit for the data. Although the

Table 1. Model Fit Statistics: 1 to 6 Latent Class Solutions

# of classes	BIC	Entropy
1	14755.17	–
2	13590.30	0.759
3	13412.91	0.808
4	13424.40	0.727
5	**13392.36**	**0.736**
6	13437.10	0.762

Selected model in bold. BIC, Bayesian information criterion.

Table 2. Estimated Values for Latent Profile Indicators: 5 Profile Solution

Profile label (% of sample)	Events/past 30	Proportion of overall drinking events involving pregaming (in %)							% Endorsing pregaming-specific motives					
		<10	25	50	75	100	preBAC	Postdrinks	Caught	Cost	Buzz	Social	Safety	Early
Profile 1: Instrumental (5.3%)	8.94	0	0	0	18	82	0.119	4.20	31	74	92	59	33	49
Profile 2: Global (16.0%)	4.86	0	2	15	59	24	0.072	3.98	5	55	54	59	23	35
Profile 4: Risk-averse (18.3%)	2.59	0	4	24	55	18	0.097	2.87	64	72	59	74	75	25
Profile 5: Occasional (32.4%)	1.50	0	30	40	26	4	0.065	3.40	20	46	53	58	27	9
Profile 3: Infrequent (28.0%)	0.48	78	22	0	0	0	0.050	3.06	32	50	33	54	32	6
Total sample	2.34	23	17	19	29	13	0.071	3.34	30	55	51	60	37	18

N = 911. preBAC = estimated pregaming BAC per typical event; Events/past 30 = number of pregaming events in past 30 days; Postdrinks = the typical number of drinks consumed subsequent to a pregaming event. Reasons for pregaming included: "less chance of getting caught drinking" (Caught), "less expensive than drinking somewhere else (like a bar, club, or restaurant)" (Cost), "like getting buzzed or drunk quickly" (Buzz), "for the social aspects/friends do it" (Social), "for safety reasons (so I know what is in my drink)" (Safety), and "so I can start drinking earlier in the day" (Early). Expected percentages and means listed for preBAC, Events/past 30, and Postdrinks. Percentage of pregaming events and reasons represented as % of profile membership endorsed.

entropy statistic indicates that classification quality is somewhat better for the 3-profile solution, this model was rejected because it did not yield sufficient discrimination between profiles, both for pregaming consumption and motives structures. However, a stable, well-differentiated solution was obtained for the 5-profile solution that yielded clinically meaningful categories that varied by pregaming behaviors and motives and was selected for the final model.[2]

Description of Pregaming Profiles Subtypes

Estimated profile means and frequencies for the indicator variables are provided in Table 2. Of the 5 profiles, 3 featured pregaming as a common part of their overall drinking repertoire (i.e., nearly all members reporting pregaming on at least 50% of total drinking events) and were further differentiated by the intensity of their pregaming consumption and variance in motives. All profiles reported high frequencies of social and cost-reduction motives (endorsement by 45% or more members); however, between-profile variability was found for the other motives and by pregaming consumption. *Instrumental* (5.3% of sample) reported the most pregaming engagement of all profiles, averaging 2 episodes per week, high preBAC, heavy postdrinking, and high endorsement of intoxication-driven motives, including pregaming as a vehicle to get drunk quicker and to start drinking earlier in the day. *Global* (16.0%) also reported pregaming as a common part of their drinking experience, but had lower average consumption as indexed by fewer pregaming events in the past 30 days, lower preBAC, and endorsement of both appetitive (i.e., getting buzzed quicker, drinking earlier in the day, social) and negatively reinforcing motives (i.e., reducing costs). *Risk-averse* (18.3%) profile

members also reported frequent pregaming and incurring preBAC levels at-or-above the legal limit for intoxication. However, they reported fewer postdrinks and were distinguished by a unique motive structure of pregaming to mitigate negative consequences, as evidenced by high endorsement for safety (i.e., knowing what is in his/her drink), minimizing chances of getting caught, and minimizing expense.

Two other profiles endorsed pregaming as a less common part of their drinking repertoire. *Occasional* profile members (32.4% of sample) pregamed on fewer drinking events, attaining a lower preBAC, but reported postdrinking and motives comparable to the *Global* profile. *Infrequent* (28.0%) profile members rarely pregamed and reported the lowest consumption (overall as well as pregaming specific), with no distinct motives differentiating them from the other profiles.

Profile Comparisons

The 5 different profiles were compared on demographics, alcohol use, drinking motives, and alcohol-related consequences.

Demographics. As shown in the top portion of Table 3, profiles where pregaming was a regular part of their overall drinking events (*Instrumental*, *Global*, and *Risk-averse*) were more likely to be White or Greek affiliated. *Risk-averse* pregamers were slightly younger, female, more likely to reside on campus and be members of a Greek organization. *Infrequent* and *Occasional* profile members had a higher representation of Asian/Pacific Islander students than the other profiles, and reported lower levels of membership in at-risk groups (i.e., Greek, athlete).

Alcohol Use. Significant differences were present on all overall drinking indices, with post hoc Bonferroni tests showing significant distinction between the 5 profiles for both HED events, and overall alcohol involvement

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[2]Nylund and colleagues (2007) also recommend evaluating Bootstrapped Likelihood Ratio Tests (BLRT) to determine whether a k class model is preferred over a more parsimonious $k − 1$ class model. Unfortunately, the BLRT analyses produced warning messages for the majority of replications and were not trustworthy.

Table 3. Differences in Demographics, Drinking Motives, and Overall Alcohol Use by Pregaming Profiles

Domain/characteristics	Overall	Profile					χ^2
		Instrumental	Global	Risk-averse	Occasional	Infrequent	
Demographics							
Age	19.2 (1.7)	18.9[a,b,c,d,e]	19.6[a,b,e]	18.5[a,c,d]	19.3[a,b,d,e]	19.2[a,b,d,e]	34.85**
Gender (% Female)	60.2%	59.4[a,c]	26.6[a]	92.2[b]	55.6[c]	60.4[c]	40.53**
Ethnicity							63.38**
White	42.9%	60.2[a]	65.5[a]	41.7[a,b]	39.1[b]	31.6[b]	
Black	6.9%	9.8	3.7	9.7	6.0	7.3	
Asian	26.4%	12.2	11.8	17.8	33.8	35.1	
Hispanic	17.5%	8.6	11.8	23.6	17.2	19.1	
Other	6.3%	9.2	7.6	7.1	3.9	6.8	
Living (N = 893)							69.97**
On campus	58.4%	69.6[a]	53.1[a]	78.2[a]	47.1[b]	50.7[b]	
With family	23.1%	4.8	13.3	9.1	36.0	32.5	
With friends	18.5%	25.7	33.6	12.7	16.9	16.8	
Greek member	18.3%	26.3	24.0	32.5	15.8	8.2	37.86**
Drinking motives							
Social	15.0 (4.1)	16.5	15.0	15.2	17.2	13.7	—[A]
Enhancement	16.7 (4.3)	17.2	16.5	16.6	15.9	14.2	—
Conformity	12.4 (4.6)	12.5	19.8	12.3	14.4	11.3	—
Coping	19.0 (5.0)	20.5	18.7	19.7	21.8	16.5	—
Overall alcohol use							
QFI	31.7 (38.0)	117.1	75.7	29.2	14.3[a]	9.9[a]	457.24**
HED	1.5 (1.8)	3.9	1.0	1.8	3.0	0.5	311.21**

[A]The auxiliary regression procedure does not support omnibus tests for means across groups. HED defined as 4+ drinks for women, 5+ drinks for men on a single occasion in the past 2 weeks. Age, # HED, and QFI reported as M(SD). All other variables reported as % within pregaming profile.
[a,b,c,d,e]Superscript letters denote profiles whose column proportions do not differ significantly from each other at the 0.05 level based on Bonferroni adjustment.
*$p < 0.05$, **$p < 0.01$.
Parameter estimates, χ^2 test statistic and pairwise comparisons based on Mplus DCAT and BCH procedures for all analyses involving demographic factors and QFI. Analyses involving drinking motives were conducted using Asparouhov and Muthén's (2014) auxiliary regression procedure using QFI as a covariate.

($ps < 0.005$). See middle of Table 3 for profile means and omnibus results.

General Drinking Motives. Using covariate-adjusted means, small but significant differences were observed for all 4 overall motives (bottom of Table 3), with *Infrequent* pregamers reporting significantly lower scores on all 4 motives compared to the other profiles ($ps < 0.05$).

Consequences. Significant profile differences were found for all subscales of the YAACQ, even after controlling for overall alcohol use (see Table 4, first column for omnibus tests and Fig. 1 for a graphical depiction). Most notable differences were found for blackout drinking, impaired control, diminished self-care, and total number of problems experienced.

Planned Profile Comparisons

Separate sets of custom contrasts compared the heaviest pregaming group (*Instrumental*) to other profiles reporting pregaming engagement on at least 50% of events: *Global* (Comparison 1) and *Risk-averse* (Comparison 2). Modest differences were found between *Instrumental* and *Risk-averse* pregamers with differences limited to impaired control (Comparison 1). Differences in consumption were observed

between *Instrumental* and *Global* profiles (Comparison 2), with instrumental pregamers reporting higher scores on impaired control and total problems. Regarding drinking motives, no significant differences were found on any of the planned comparisons (bottom of Table 4).

DISCUSSION

To our knowledge, this was the first study to differentiate subgroups of college pregamers using a latent modeling approach with consumption and motive indicators. The current sample reported high levels of alcohol consumption and consequences, confirming pregaming as a high-risk drinking behavior. However, there was considerable variability regarding how pregaming has been incorporated into the students' drinking regimen and motives for engaging in the practice. Five distinct profiles of pregaming were evident, 3 of which (*Instrumental*, *Global*, and *Risk-averse*) reported frequent pregaming that was a regular part of the student's drinking pattern but varied by pregaming intensity and motives. The 2 other profiles (*Occasional* and *Infrequent*) consisted of students who were less engaged in pregaming. Given that current prevention and intervention efforts aimed at general alcohol consumption do not appear to impact pregaming (Borsari et al., 2016), identification of profiles that vary by engagement and motives could have

Table 4. Results of Omnibus Profile Differences and Planned Comparisons

Domain	Omnibus test χ^2 or F	Comparison 1: Instrumental versus global 1v5 Z	Comparison 2: Instrumental versus risk-averse 1v4 Z
YAACQ Scales			
Social	32.37**	0.58	0.01
Self-perception	9.50*	1.33	1.12
Self-care	36.98**	0.48	0.66
Risky behaviors	36.25**	0.76	0.01
Academic	26.87**	0.85	0.84
Physiological dependency	12.22*	1.10	0.22
Blackout	55.43**	1.11	0.33
Impaired control	28.18**	3.10**	2.04*
Total problems	45.95**	2.37*	1.44
# HED events/ past 2 weeks	97.91**	12.15**	67.96**
	χ^2	χ^2	χ^2
DMQ-R subscales			
Social	–	0.66	0.37
Enhancement	–	0.17	0.08
Conformity	–	0.03	0.00
Coping	–	0.76	0.11
QFI	211.60**	80.32**	292.74**

$^\dagger p < 0.10$, $^* p < 0.05$, $^{**} p < 0.01$.

Planned comparisons conducted with 1 *df*. Comparisons for HED events and YAACQ subscales based on most likely profile membership as a predictor in negative binomial model. YAACQ total problems based on general linear model analysis of covariance. QFI comparisons based on the Mplus BCH procedure. DMQ-R subscales conducted using covariate-adjusted means, controlling for overall alcohol use measured by QFI based on the Asparouhov and Muthén's (2014) auxiliary regression procedure.

significant implications for future prevention and intervention efforts.

The *Instrumental* profile emerged with disproportionately more pregaming involvement and consequences; however, it should be noted that 3 of the profiles (*Instrumental, Global*, and *Risk-averse*, representing 39.6% of the sample) reported regular pregaming accompanied by alcohol-related consequences, such as alcohol-induced blackout symptoms, being relatively common. Blackouts are a highly prevalent negative consequence associated with pregaming (Barnett et al., 2013; Haas et al., 2012; LaBrie et al., 2011). Pregaming places students at disproportionate risk for blackouts due to the rapid rate of ingestion and correspondingly steep increase in BAC (Hingson et al., 2016). In and of themselves, blackouts are serious, but they are also associated with other potentially severe alcohol-related consequences, including injury, engagement in sexual risk taking (Haas et al., 2016a), and sexual violence (Valenstein-Mah et al., 2015; Wilhite and Fromme, 2015). It is not surprising that blackout symptoms were reported in the *Instrumental* profile, given their heavy pregaming and endorsement of motives that facilitate intoxication (i.e., to get buzzed quicker, drink earlier in the day,

and reduce costs). Interestingly, *Risk-averse* students (18.3% of students) reported comparable blackout symptoms to the *Instrumental* profile despite lower pregaming frequency and motives that were intended to reduce other more distal consequences (i.e., safety, avoid getting caught). As such, both profiles may be at risk despite disparate motives and absolute levels of consumption.

Motives to pregame were found to be an important element in distinguishing the 5 profiles, but differences were constrained to pregaming-specific motives and not general drinking motives. This was consistent with prior studies finding minimal differences in drinking motives by pregaming frequency (Kuntsche and Labhart, 2013; Read et al., 2010), which may be better predictors of overall alcohol involvement and consequences. However, differences on pregaming-specific motives were an essential component in differentiating profiles and could be used in intervention programming. For example, 1 profile (*Risk-averse;* 18.3% of sample) pregamed as a means to minimize potentially adverse consequences like being slipped something in a drink ("spiking") or being caught. Spiking is a concern on college campuses, particularly for young women (Burgess et al., 2009), and findings from this study suggest that the subset of pregamers who utilize this practice to mitigate risk are likely to be young, women, and/or Greek affiliated. Indeed, this profile had the highest percentage of females. Also consistent with these risk-averse motives, this profile was characterized by high BAC levels while pregaming (i.e., above the legal limit for intoxication) yet lower rates of postdrinking. That said, these individuals still experienced significant consequences, suggesting that motives to reduce specific proximal risks may not generalize to other potentially hazardous consequences (e.g., physical, social, self-care) result from achieving high BACs attained while pregaming in "safer" contexts.

Implications for Intervention Development

There is evidence which suggest that traditional BMIs may not be effective in changing pregaming behavior (Borsari et al., 2016), indicating that future interventions may benefit from providing detailed information and personalized feedback about pregaming. The current findings inform the level and content for future pregaming and prevention and intervention efforts.

The different profiles of pregamers could benefit from different levels of interventions. Although not every pregamer has problems that warrant intervention, the 3 profiles that utilize pregaming as a more regular part of their overall drinking experiences may benefit from screening, and possible referral to more intensive services if indicated. Interventions such as BMIs could be used, as-is or modified to add sessions and/or follow-up to address more problematic consumption. Specifically, *Instrumental* pregamers had well-defined risk profiles that could be addressed with BMIs that target consumption as well as challenge their pro-intoxication motives. As such, they may require the most
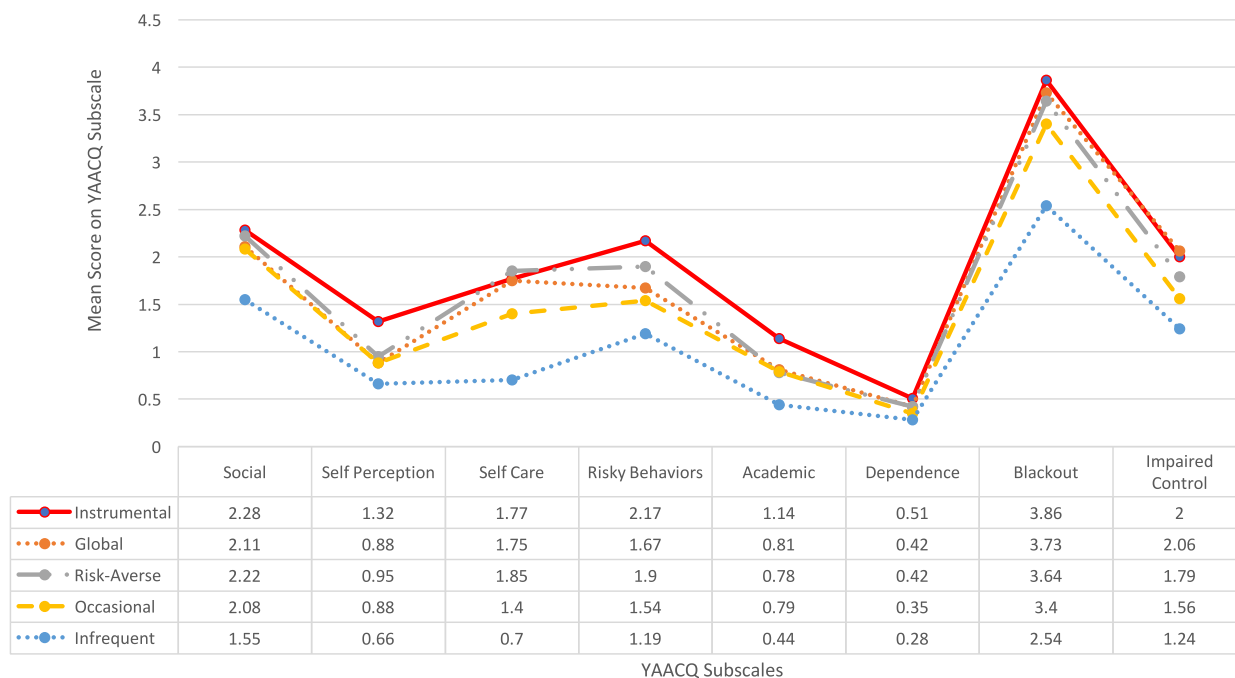
Fig. 1. Variations in alcohol-related problems by pregaming profile membership. Values represented as covariate-adjusted means from the YAACQ subscales.

	Social	Self Perception	Self Care	Risky Behaviors	Academic	Dependence	Blackout	Impaired Control
Instrumental	2.28	1.32	1.77	2.17	1.14	0.51	3.86	2
Global	2.11	0.88	1.75	1.67	0.81	0.42	3.73	2.06
Risk-Averse	2.22	0.95	1.85	1.9	0.78	0.42	3.64	1.79
Occasional	2.08	0.88	1.4	1.54	0.79	0.35	3.4	1.56
Infrequent	1.55	0.66	0.7	1.19	0.44	0.28	2.54	1.24

YAACQ Subscales

intensive interventions, including referrals for formal treatment, as pregaming seems to be a highly rewarding, integrated and intentional part of their drinking repertoire. Therefore, a systematic discussion of the benefits and risks of pregaming, ideally using personalized feedback and motivational interviewing, may be required to facilitate interest in reducing pregaming. The experience of blackouts in relation to pregaming may be particularly effective, as blackouts have been found to moderate the efficacy of personalized normative feedback (PNF) interventions addressing overall alcohol use in college (Miller et al., 2018b) and veteran (Miller et al., 2018a) populations. In contrast, *Risk-averse* pregamers experienced negative consequences from their drinking despite protective motives. It is possible that these individuals view pregaming as a positive practice, as it prevents specific consequences. However, feedback highlighting the other consequences that are still experienced, as well as higher levels of intoxication, and continued risk for negative consequences may make these individuals more amenable to changing their pregaming strategies. Finally, *Global* (16.0% of sample) pregamers reported pregaming more temperately on most drinking events ($M_{\text{preBAC}} = 0.07$; $M = 4.8$ pregame events/month), no distinct motives, yet relatively high rates of postdrinking. These individuals may benefit from more general alcohol-related interventions that address pregaming, but are more focused on overall consumption.

In contrast, members of the *Occasional* and *Infrequent* profiles engage in more temperate pregaming behaviors and comprise 60% of the sample. As pregaming appears to be a peripheral activity for members of these profiles, the nature of their interventions may be qualitatively different. Although

they pregame less extensively, they also experience negative consequences and may warrant interventions such as universal educational efforts, that are less intensive, cost-effective, and can be widely disseminated to a larger number of students. Content could focus on informing them about the risks associated with pregaming and drinking in general, and/or delivering less intensive approaches that address reducing overall consumption as the primary target. Examples include mailed educational information (or PNF) about the risks and to suggest alternative and safer options. Recent innovations in mobile health interventions, which incorporate phones to deliver information about alcohol use, may be an especially promising approach to inform large numbers of students about pregaming and its risks (Kazemi et al., 2017).

Regardless of the level of intervention, it is also important to consider what type and amount of content to provide the students. This issue has been addressed by recent research on topics incorporated in BMIs that address general alcohol use in college students (for reviews, see Huh et al., 2015; Miller et al., 2013; Ray et al., 2014). Specifically, over 30 topics have been recommended for inclusion and there appears to be an interaction between the overall number of topics, personalization, and efficacy of BMIs (Ray et al., 2014). Findings indicate that more topics (e.g., 15 to 20 topics) are linked to reductions in alcohol use and problems if they are highly personalized (e.g., provided in the context of personalized feedback). In contrast, fewer (e.g., 6 to 10) topics facilitate change when they are less personalized (e.g., discussing general risks of alcohol use). Taken together, the more intensive in-person interventions addressing pregaming could incorporate more highly personalized

feedback topics that can be discussed during the BMI and facilitate the development of highly specific and personal plans for reducing pregaming behaviors. We posit that the variables utilized in creating the profiles in this study are good candidates for such feedback (pregaming-specific quantity and frequency, motives, and related consequences). In addition, there are some standardized measures that assess motives specific to pregaming in the literature that could provide valuable personalized feedback (e.g., PMI [LaBrie et al., 2012]; Pregaming Motives Measure [PGMM; Bachrach et al., 2012]). For example, some motives for pregaming (e.g., getting drunk quickly or saving money) may be more relevant to personal intoxication levels and consequences versus other motives (e.g., to be social), as well as highlight relevant information (e.g., BAC) or strategies (spacing or alternating alcoholic beverages).

Limitations

Findings should be viewed in the context of study limitations. First, we operationalized pregaming motives using investigator-generated single items that are not part of published measures (e.g., the PMI or PGMM), as data collection for this study started prior to the publication of both measures. It should be noted that the individual motive items used were empirically derived from independent focus groups and had considerable overlap with domains identified in the PMI and PGMM, including negatively reinforcing motives pertaining to pregaming for safety reasons. However, we acknowledge that individual items are not as psychometrically stable as scales and replication with the PMI or PGMM is indicated to validate differences in pregamers using standardized measures with subscales. Second, generalizability of findings may be limited by participants having been recruited from diverse institutions from undergraduate human subjects pools, 2 of which are in the San Francisco bay area. As such, younger students were oversampled as were certain ethnic groups with greater representations on the west coast. Comparison with the most recent census data indicates that the sample was over represented by individuals identifying as either Asian American/Pacific Islander or Hispanic descent, and under represented by individuals identifying as Black. Cross-profile differences were noted for ethnicity on several other indices; however, the current sample did not have adequate representation to conduct invariance tests to see if ethnicity-specific profiles emerged. Third, HED was not operationalized with a time constraint as has been recommended (NIAAA, 2004). Studies have demonstrated that defining HED (a.k.a. "binge") is sufficient using the 5/4 metric, and that time does not improve the prediction of problems (Corbin et al., 2014). Still, future studies may want to include the time element to be consistent with NIAAA guidelines. Finally, although there is little evidence of systematic response bias in college student samples (Borsari and Muellerleile, 2009), the data were gathered via self-report without collateral verification.

CONCLUSION

Pregaming is a prevalent and high-risk drinking behavior, and there is currently no evidence that traditional alcohol intervention efforts reduce this highly reinforced drinking behavior (Pedersen, 2016). This study utilized pregaming-specific alcohol use and motives to identify 5 distinct profiles of students who pregame. These profiles can be used to inform efforts to implement interventions of different level and content to reduce pregaming among students on campus.

CONFLICT OF INTEREST

The authors report no conflicts of interest.

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