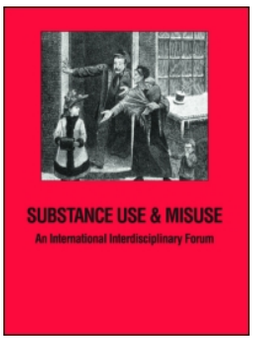

Substance Use & Misuse

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/isum20

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**To cite this article:** Gail Castañeda, Sarah E. Colby, Melissa D. Olfert, Tracey E. Barnett, Wenjun Zhou, Megan D. Engel & Anne E. Mathews (2021): The Role of Alcohol-Related Proactive Dietary Restriction to Feel the Psychoactive Effects of Alcohol Faster on Binge Drinking Frequency among Freshmen College Students, Substance Use & Misuse, DOI: 10.1080/10826084.2021.1914104

**To link to this article:** https://doi.org/10.1080/10826084.2021.1914104



Published online: 19 May 2021.

SUBSTANCE USE & MISUSE
https://doi.org/10.1080/10826084.2021.1914104

Taylor & Francis
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ORIGINAL ARTICLE



# The Role of Alcohol-Related Proactive Dietary Restriction to Feel the Psychoactive Effects of Alcohol Faster on Binge Drinking Frequency among Freshmen College Students

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**ABSTRACT**

*Background:* There is a positive cross-sectional relationship between alcohol-related proactive dietary restriction to feel the effects of alcohol faster (APDR) and binge drinking, a health and safety issue impacting college students. *Objective:* To examine: 1) the longitudinal predictive ability of varying levels of APDR on binge drinking frequency; and 1a) the strength of the relationship between varying levels of APDR and binge drinking frequency during freshman year of college ($n = 1,149$). *Methods:* Ordinal logistic regression was used to model the relationship between APDR and binge drinking frequency. *Results:* Main findings suggest APDR of students who reported eating less than usual (low APDR) prior to drinking to feel the effects of alcohol faster was a significant predictor of binge drinking frequency (1.27 (95% CI, 0.06 to 0.42), Wald $\chi^2$ (1) = 8.46, $p$=.009) at baseline, but not at 7-month follow-up (1.02 (95% CI, −0.18 to 0.23), Wald $\chi^2$ (1) = .51, $p$=.83). APDR for students who reported skipping one or more meals (high APDR) to feel the effects of alcohol faster was not a significant predictor of binge drinking frequency at baseline nor at 7-month follow-up. *Conclusion:* Low APDR is a significant predictor of binge drinking frequency that is established early in the first semester of college with no significant change occurring in binge drinking frequency over the course of students' freshman year at 7-month follow-up. Campus health professionals are urged to emphasize the detrimental health effects of low APDR early in the first semester of college.

**KEYWORDS**
College binge drinking; alcohol-related proactive dietary restriction; disordered eating

## Introduction

The weight conscious drinking phenomenon describes the occurrence of disordered eating behaviors meant to compensate for alcohol-related energy intake and/or to augment the psychoactive effects of alcohol (Barry & Piazza-Gardner, 2012; Barry et al., 2013; Peralta, 2002). Weight conscious drinking also accounts for the temporal relation of compensatory behaviors and/or behaviors that enhance the psychoactive effects of alcohol in response to drinking episodes, commonly referred to as 'proactive' and 'reactive' compensatory behaviors (Bryant et al., 2012; Castañeda et al., 2020; Peralta, 2002; Piazza-Gardner & Barry, 2014). Proactive disordered eating behaviors can include self-induced vomiting or dietary restraint *prior to* a planned drinking episode, whereas reactive disordered eating behaviors can include self-induced vomiting or dietary restraint *after* a drinking episode to compensate for the energy intake from alcohol.

While weight conscious drinking embodies a range of hazardous compensatory behaviors in response to the alcohol-related calories consumed, this phenomenon also takes place across varying levels of alcohol consumption. Of special concern for college students is the pairing of weight conscious drinking behaviors with binge drinking episodes (Burke et al., 2010; Kelly-Weeder, 2011). Binge drinking, also known as heavy episodic alcohol consumption, has been empirically identified as a problematic drinking pattern, particularly among the young adult (18-24) college student population (Nelson et al., 2009; Wechsler et al., 2002). In a previous assessment of college students, 42% self-reported engaging in binge drinking behaviors within the past two weeks (Wechsler et al., 2002). Binge drinking is associated with a wide range of health and social problems, including sexually transmitted diseases, unintended pregnancies, accidental injuries, and violent crimes (R. Hingson et al., 2005; Wechsler et al.,

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2002; White & Hingson, 2013). Furthermore, while college students have been found to drink less frequently than their non-student counterparts, they drink more heavily at higher frequencies, such that rates of binge drinking are much higher in college student samples, as opposed to non-student samples (R. W. Hingson et al., 2002).

First year college students are at-risk for hazardous drinking (Krieger et al., 2018), and those that endorse weight conscious drinking behaviors have increased odds of binge drinking. (Barry & Piazza-Gardner, 2012; Barry et al., 2013). Previous cross-sectional investigations indicate that college students who intentionally restrict their caloric intake prior to drinking episodes are then more likely to binge drink (Bryant et al., 2012; Burke et al., 2010; Castañeda et al., 2020; Eisenberg & Fitz, 2014). For instance, Burke et al. (2010) found that while 33% of college students who reported engaging in proactive dietary restriction also reported alcohol consumption on 10 to 19 days within the past month, 21% of college students engaging in proactive dietary restriction also reported binge drinking on over 20 days within the past month. That is, students who report engaging in both proactive dietary restriction and binge drinking, drink heavily more frequently. In another study, findings from Castañeda et al. (2020) indicated a strong positive cross-sectional relationship between proactive Alcohol Effects (i.e.behaviors, such as proactive dietary restriction, aimed at enhancing the psychoactive effects of alcohol prior to a drinking episode) and binge drinking frequency among college students.

In a study assessing the range of alcohol-related compensatory behaviors employed by college students, a preliminary set of 34-items were generated based on salient themes identified in Peralta (2002)'s qualitative investigation on weight conscious drinking (Bryant et al., 2012). Findings from Bryant et al. (2012) revealed college binge drinkers scored significantly higher than non-binge drinkers on two weight conscious drinking items assessing alcohol-related proactive dietary restraint to feel the psychoactive effects of alcohol faster. Bryant et al. (2012)'s examination utilized the following two levels of APDR: 1) eating less than usual during one or more meals prior to drinking to feel the effects of alcohol faster; and 2) skipping one or more meals prior to drinking to feel the effects of alcohol faster. While the investigators did not report any comparison between the strength of the relationship between each APDR level and student binge drinking, both items were linked to binge drinking.

The detrimental health effects of alcohol consumption by college students are compounded when binge drinking is paired with proactive dietary restriction intended to feel the psychoactive effects of alcohol faster. Dietary restriction prior to a binge drinking episode is known to increase the the absorption rate of alcohol, blood alcohol concentration, and risk for negative alcohol-related consequences (Cederbaum, 2012; Giles et al., 2009). Furthermore, alcohol-related proactive dietary restraint paired with binge drinking places students at risk for primary (or secondary) malnutrition due to the body's preferential oxidation of alcohol over other nutrients (Lieber, 2003).

Examining the strength of the relationships between varying levels of alcohol-related proactive dietary restriction and binge drinking frequency can serve to identify APDR as a behavioral marker for college alcohol health prevention screenings and intervention programming. In addition, the investigation of the longitudinal relationship between proactive dietary restraint (aimed at feeling the psychoactive effects of alcohol faster) and binge drinking frequency among nonclinical college freshmen could futher inform campus alcohol health prevention and intervention programming by aiding college health professionals in determining the most appropriate programming timeline. To date, no studies have specifically assessed: 1) the strength of the relationships between varying levels of alcohol-related proactive dietary restriction and binge drinking frequency among non-clinical freshman college students; and 2) the longitudinal relationship between varying levels of proactive dietary restraint aimed at feeling the psychoactive effects of alcohol faster and binge drinking frequency among non-clinical freshman college students.

Given a growing body of cross-sectional research has corroborated the relationship between proactive dietary restriction to feel the psychoactive effects of alcohol faster and college student binge drinking, this study specifically assessed the predictive ability of varying levels of alcohol-related proactive dietary restriction to feel the psychoactive effects of alcohol faster (APDR) to contribute to binge drinking frequency at 7-month follow-up among a freshman college cohort. It was hypothesized that: 1) both low and high baseline APDR would remain predictors of binge drinking frequency at 7-month follow-up; and 1a) high baseline APDR would be more strongly associated with binge drinking frequency at 7-month follow-up than low APDR. For the purposes of this paper, low APDR has been defined as "eating less than usual during one or more meals prior to drinking to feel the effects of alcohol faster" and high APDR has been defined as "skipping one or more meals prior to drinking to feel the effects of alcohol faster".

## Method

### *Participants and procedure*

Data for this longitudinal study were obtained from a cohort sample of 1,149 college freshman students at eight U.S. universities during the development phase of 'GetFRUVED', a cohort study to encourage healthful eating habits and increased physical activity among college students. Participating universities are all members of an established multi-state research group (NC1193) and include University of Tennessee, University of Florida, West Virginia University Syracuse University, University of Maine, South Dakota State University, Kansas State University, and Auburn University. APDR was assessed as part of the study's web-based questionnaire covering freshmen student perceptions and

behaviors on a wide range of health-related topics. Participants completed survey questions and participated in anthropometric assessment by trained research assistants at the beginning of the fall 2015 and end of spring 2016 semesters onsite at each campus. The GetFRUVED Study was registered at Clinicaltrials.gov with the identifier code NCT02941497.

## Inclusion criteria

Eligibility for the study, previously described in detail by Loso et al. (2018), was defined as individuals age 18 years or older, college enrollment as a freshman student, and low (less than two cups of fruits and/or less than three cups of vegetables) average daily fruit and/or vegetable consumption. Additionally, the participants had to meet at least one of the following criteria: (a) BMI ≥ 25 kg/m$^2$; (b) self-identified as first-generation college student; (c) student-identified overweight/obese parent; (d) low income background; and (e) self-identified racial minority. All participants provided informed consent and the University of Tennessee Institutional Review Board approved the study for all participating universities, except the University of Florida, Auburn University, and Kansas State University where separate institutional review board approval was obtained.

## Measures

Participants completed survey questions onsite *via* Qualtrics survey software. Survey items included correlates for binge drinking frequency (i.e. geographic region, place of residence, Greek campus organization affiliation, athlete status), APDR to feel the psychoactive effects of alcohol faster, fruit and vegetable intake, eating disorder risk, physical activity, low family affluence, parents overweight or obese, and demographic characteristics, such as sex, race, and ethnic origin. Anthropometric data collected included participant height, body weight, waist, hip, and neck circumferences.

*Alcohol-related proactive dietary restraint.* Two items measuring alcohol-related proactive dietary restraint were extracted from the Compensatory Eating Behaviors in Response to Alcohol Consumption Scale (CEBRACS), a 21-item measure assessing the co-occurrence of disordered eating behaviors, such as dietary restraint, purging, and exercise to compensate for the intake of alcohol-related calories and/or enhance the psychoactive effects of alcohol (Rahal et al., 2012). One item read: "I have eaten less than usual during one or more meals before drinking to feel the effects of alcohol faster". The other item read: "I have skipped one or more meals before drinking to feel the effects of alcohol faster". Both items were rated on a 5-point Likert scale based on behavior frequency: 1 = never; 2 = rarely (approximately 25% of occasions); 3 = sometimes (approximately 50% of occasions); 4 = often (approximately 75% of occasions); 5 = nearly always, with the option to indicate "choose not to answer". Participant responses were based on alcohol consumed within the past three months.

*Binge drinking frequency.* One item measuring binge drinking frequency was extracted from the Alcohol Use Disorders Identification Test (AUDIT-C), a three-item short form assessing risk for alcohol abuse. The item read: "How often did you have six or more drinks on one occasion in the past year?" Item response options included: 1 = Never; 2= Less than monthly; 3= Monthly; 4= Weekly; 5 = Daily or almost daily, with the option to indicate "choose not to answer". Use of the AUDIT-C's binge frequency item has demonstrated adequate clinical diagnostic accuracy (i.e. area under the receiver operator characteristic curve (AUROC) of 0.8 or greater) for detecting heavy drinking (0.827) and active alcohol abuse and/or alcohol dependence (0.831) (Bush et al., 1998).

*The Eating Attitudes Test (EAT-26).* The EAT-26 is a screening tool commonly used across college student samples to assess eating disorder risk (Garner et al., 1982). Items capture both cognitive and behavioral symptomology related to eating disorders. Total scores of 20 or more are indicative of elevated risk for an eating disorder. The scale also yields a referral index based on the following three criteria: 1) total score; 2) responses to behavioral questions related to eating symptoms and weight loss (e.g. I have gone on eating binges where I feel that I may not be able to stop); and 3) the respondent's BMI. With the current data, Cronbach's alpha coefficients (i.e. internal consistency) for the scale's three subdomains were 0.86 (Dieting), 0.81 (Bulimia and Food Preoccupation), and 0.58 (Oral Control).

*NCI Fruit and Vegetable All-Day screener.* The NCI fruit and vegetable all-day screener (NCIfv) is a 19-item screening tool that estimates median intake of fruit and vegetable servings by obtaining the frequency of participants' fruit and vegetable consumption within the past month, week or day and corresponding serving sizes (Thompson et al., 2002). Frequencies and servings for all the following forms of fruit and vegetable consumption are requested: raw, cooked, snacks, home meals, restaurant meals/take-out, and combinations with other foods. Total number of daily fruit and vegetable servings are computed as the sum of the product of number of times per day and Pyramid/MyPyramid servings for each fruit or vegetable. Our data yielded a Cronbach's alpha coefficient of 0.71 across all 19 items.

*The International Physical Activity Questionnaire Short Form (IPAQ).* The International Physical Activity Questionnaire provides information with respect to health–related physical activity within the past week (Bassett, 2003). The 6-item short form collects data on the frequency and duration of vigorous, moderate, and walking activities performed within the last 7 days. Based on minutes spent on a given physical activity per week (MET) and physical activity duration, average MET scores have been established by the IPAQ Research Committee for each physical activity category (i.e. vigorous, moderate, and low). Internal consistency across all six items rendered an alpha coefficient of 0.59 for the data under study.

*Anthropometric measures.* Physical assessments were conducted at each time point by trained researchers to collect participants' waist, hip, and neck circumference. Measurements were recorded twice and repeated a third time if the difference between the first two measures was greater than 0.5 centimeters, and then the average between the two measures was recordedParticipant height (meters) and weight (kilograms) measurements were taken with calibrated scales and full-length stadiometers at each time point. BMI and waist hip ratio were calculated using measurements recorded during physical assessments. BMI was computed by dividing participants' weight in kilograms by their height in meters squared and waist hip ratio was calculated by dividing participants' waist circumference in centimeters by their hip circumference in centimeters.

*Demographic Characteristics.* Participants reported their age, sex, race, ethnicity (hispanic or non-hispanic), geographic region, athlete status (yes/no), place of residence (on- or off-campus), Greek campus organization affiliation (sorority or fraternity), family affluence, and parent overweight or obese status (yes/no/not sure). Given low race category percentages, only White, Black, and Asian race categories were analyzed. Place of residence was assessed *via* the following question: "Where do you live?" Six response options were provided (Campus residence hall, sorority or fraternity, other college housing, off-campus housing, parent or guardian's home or choose not to answer). Due to low percentages of various off campus response options, place of residence was dichotomized as on campus versus off campus for analyses. Greek campus organization affiliation was derived from respondents who reported living in a sorority or fraternity home. Family affluence was measured with the following four items: "Do you have your own bedroom (for just you, or you and your partner/spouse)?", "How many computers/laptops are in your home?", "How many cars, vans, or trucks does your family own?", and "How many times did you travel away on vacation with your family during the past 12 months?" (Boyce et al., 2006). Bedroom ownership was dichotomized into a yes or no response and the remainder of the items consisted of response options denoting frequencies. Points were assigned per response with a yes being coded as 1 and remaining frequency options paralleled numerical options. A summated score across all four items totaling two points or less was categorized as low affluence.

### Analysis

Descriptive statistics were used to characterize study participants at baseline. An ordinal logistic regression using a complementary log-log link function was conducted to examine the predictive ability of varying levels of APDR to contribute to binge drinking frequency at baseline and 7-month follow up. A dependent sample t-test was conducted to compare mean differences across binge drinking frequency at baseline and 7-month follow up.

### Missing data

Missing data ranged from 0-10% (Bennett, 2001) across baseline demographic predictors for the ordinal regression model. However, missing values were over 30% for APDR among students who reported eating less than usual before drinking to feel the effects of alcohol faster (35.2%), skipping one or more meals before drinking to feel the effects of alcohol faster (35.4%), binge drinking frequency at baseline (35.8%), and binge drinking frequency at 7-month follow up (46.2%). A significant Little's missing completely at random (MCAR) test indicated missing values were not missing completely at random ($\chi 2\ [57] = 142.09$, $p \leq .001$). The missing data mechanism was more closely assessed *via* the use of missing indicators for each of the following items: eating less than usual during one or more meals before drinking to feel the effects of alcohol faster, skipping one or more meals before drinking to feel the effects of alcohol faster, binge drinking frequency at baseline, and binge drinking frequency at follow-up. Missing value indicators were coded as 1 for original missing variables and 0 for data present (Enders, 2010).

A comparison of the ordinal regression model's complete case analysis against two non-parametric multiple imputation methods (missForest with and without missing indicators) for mixed-type variables is provided. Fifty missForest imputations were conducted for improved model validity (Stekhoven & Bühlmann, 2012). Results for the 50 missForest multiple imputation results containing missing data indicators are provided in Tables 2–4. Statistical tests were computed using SPSS statistical software v26 and imputation procedures were conducted using R Version 1.1.453 (Team, 2014).

## Results

### Participant characteristics

The mean age (19.2 ± .9 years) of all participants and of male (19.3 ± .8 years) and female participants (19.2 ± .6 years) were similar. Mean level of APDR for those who reported eating less than usual prior to drinking to feel the effects of alcohol faster (1.24 ± 0.7) was slightly higher than those who reported skipping one or more meals prior to drinking to feel the effects of alcohol faster (1.12 ± 0.5). Mean baseline BMI was normal (healthy weight) across males (24.5 $kg/m^2$ ± 4.2) and females (24.0 $kg/m^2$ ± 4.4). Frequencies for each binge drinking category were the following: never (32.9%), less than monthly (20%), monthly (7.3%), weekly (3.8%), and daily or almost daily (0.2%). Given the daily binge drinking frequency category was not adequately represented in our non-clinical sample, binge drinking frequency categories were collapsed to: 1) never or less than monthly; 2) monthly; and 3) weekly or daily. Age was also not included in the ordered model due to sample age homogeneity (i.e. the sample was composed of freshmen averaging 19 years of age). Descriptive statistics for baseline participant characteristics are provided in Table 1.

**Table 1.** Participant characteristics and behaviors at the start of their freshmen year ($n = 1,149$).

| Factor | Frequency *n* (%) | Missing *n* (%) |
|---|---|---|
| *Sex* | | |
| Male | 377 (32.8) | 27 (2.3) |
| *Ethnic origin* | | |
| Hispanic or Latino | 204 (17.8) | 34 (3) |
| *Race* | | |
| Black or African American | 162 (14.1) | 0 |
| Asian/Asian American | 137 (11.9) | 0 |
| White | 817 (71.1) | 0 |
| *Greek affiliation* | | |
| Greek campus organization affiliation | 11 (1.0) | 28 (2.4) |
| *Athlete status* | | |
| Athlete | 68 (5.9) | 36 (3.1) |
| *Geographic region* | | |
| At-risk | 528 (46) | 98 (8.5) |
| *Residence* | | |
| On campus | 961 (83.6) | 21 (1.8) |
| *Parents overweight/obese* | 569 (49.5) | 164 (14.3) |
| *Family affluence* | 15 (1.3) | 107 (9.3) |
| Binge drinking frequency | | 411 (35.8) |
| Never or less than monthly | 608 (52.9) | |
| Monthly | 84 (7.3) | |
| Weekly or daily | 46 (4.0) | |
| *Alcohol-related proactive dietary restriction (APDR)* | **Mean (SD)** | |
| Eaten less than usual (low) | 1.24 (0.67) | 405 (35.2) |
| Skipped one or more meals (high) | 1.12 (0.49) | 407 (35.4) |
| *BMI (kg/m²)* | 24.17 (4.32) | 30 (2.6) |
| *EAT-26 Total* | 7.99 (8.00) | 9 (0.8) |
| *Waist hip ratio* | 0.79 (0.07) | 14 (1.2) |
| *IPAQ Total (met min)* | 2729.64 (2017.63) | 57 (5) |
| *NCIfv Total (CE/day)* | 2.45 (2.20) | 5 (0.4) |

## *Alcohol-related proactive dietary restriction and binge drinking frequency*

Model fit for the cross-sectional and longitudinal models examining the predictive ability of varying levels of APDR to contribute to binge drinking frequency was assesed using a chi-square test for statistical significance. A significant chi-square value indicated the model provided a significant improvement over the baseline intercept-only model for the cross-sectional ($\chi2(14) = 105.53$, $p<.001$) and longitudinal ($\chi2(16) = 182.73$, $p<.001$) models. Goodness of fit was assessed using the deviance chi-square statistics. Non-significant deviance chi-square values ($\chi2(479) = 384.35$, $p = .99$) and ($\chi2(752) = 534.18$, $p = .99$) indicated the observed data were consistent with the fitted model for the cross-sectional and longitudinal models, respectively. Furthermore, pseudo $R^2$ indices indicated that the cross-sectional model predicted between 9% and 14% of the variance in baseline binge drinking frequency and the longitudinal model predicted between 15% and 22% of the variance in binge drinking frequency at follow-up. The test of parallel lines was used to assess whether the odds for each binge drinking frequency category were consistent across different thresholds. A non-significant chi-square value indicated the odds for each binge drinking frequency category were consistent across different thresholds for both the cross-sectional ($\chi2(14) = 13.99$, $p = .48$) and longitudinal ($\chi2(16) = 34.13$, $p = .20$) models.

We hypothesized that both low and high baseline APDR would remain predictors of binge drinking frequency at 7-month follow-up. Our auxiliary hypothesis stated that high baseline APDR would be more strongly associated with binge drinking frequency at 7-month follow-up than low baseline APDR. Results did not support either of the two hypotheses. The results suggested those who reported eating less than usual prior to drinking to feel the effects of alcohol faster (i.e. low APDR) were associated with greater odds for a higher binge drinking frequency at baseline (1.27 (95% CI, 0.06 to 0.42), Wald $\chi^2$ (1) = 8.46, $p$=.009), but not associated with binge drinking frequency at 7-month follow up (1.02 (95% CI, −0.18 to 0.23), Wald $\chi^2$ (1) =.51, $p$=.83). On the other hand, findings suggested those who reported skipping one or more meals prior to drinking to feel the effects of alcohol faster (i.e. high APDR) were not associated with binge drinking frequency at baseline (1.20 (95% CI, −.07 to .43), Wald (1) = 2.40, $p$ =.16) nor at 7-month follow-up (1.13 (95% CI, −0.14 to 0.39), Wald (1) = 1.42, $p$ =.35). As compared to females, males had significantly greater odds for an increased binge drinking frequency at baseline (1.62 (95% CI, 0.31 to 0.65), Wald $\chi^2$ (1) = 38.61, $p$ <.001), but not at 7-month follow up (1.19 (95% CI, −0.03 to 0.37), Wald $\chi^2$ (1) = 5.17, $p$ = .09). Furthermore, monthly (1.92 (95% CI 0.36 to 0.95), Wald (1) = 28.74, $p$ < .001) and weekly or daily (2.47 (95% CI, 0.51 to 1.3), Wald (1) = 28.37, $p$ < .001) baseline binge drinking frequencies were significantly associated with greater odds of an increased binge drinking frequency at 7-month follow-up, as compared to never or less than monthly baseline binge drinking frequency.

Non-significant alcohol-related proactive dietary restriction missing indicators suggested individuals who did not self-report APDR at baseline did not significantly differ on

**Table 2.** Ordinal regression analyses to examine the effect of alcohol-related proactive dietary restriction at baseline by college freshmen on binge drinking frequency at 7-month follow up.

| Predictor variables | Complete case analysis using negative log-log link function ($n = 465$) | 50 Random forest multiple imputations using complementary log-log link function ($n = 1,149$) | 50 Random forest multiple imputations & missing indicators using complementary log-log link function ($n = 1,149$) |
|---|---|---|---|
| Baseline binge drinking frequency | | | |
| Never or less than monthly | reference category | reference category | reference category |
| Monthly | 4.77 (1.09, 2.04)*** | 2.00 (.41, .98)*** | 1.92 (.36, .95)*** |
| Weekly or daily | 8.71 (1.62, 2.71)*** | 2.51 (.54, 1.30)*** | 2.47 (.51, 1.3)*** |
| APDR[a] | | | |
| Low | 1.38 (-.14, .78) | 1.01 (-.19, .21) | 1.02 (-.18, .23) |
| High | 1.12 (-.46, .68) | 1.19 (-.09, .43) | 1.13 (-.14, .39) |
| Ethnic origin | | | |
| Hispanic or Latino | 1.52 (-.06, .89) | 1.24 (-.003, .43) | 1.18 (-.06, .39) |
| Race | | | |
| Black or African American | 0.94 (-.84, .72) | 1.09 (-24, .42) | 1.09 (-.28, .44) |
| Asian/Asian American | 3.24 (.36, 1.99)** | 1.26 (-.11, .58) | 1.28 (-.13, .62) |
| White | 2.56 (.20, 1.68)* | 1.25 (-.05, .50) | 1.22 (-.11, .50) |
| Sex | | | |
| Male | 2.09 (.32, 1.16)** | 1.20 (-.004,.36) | 1.19 (-.03, .37) |
| Athlete status | | | |
| Athlete | 1.62 (-.15, 1.12) | 1.13 (-.21, .44) | 1.11 (-.24, .44) |
| Geographic region | | | |
| At-risk | 1.44 (-.07, .80) | 1.17 (-.02, .34) | 1.14 (-.07, .32) |
| Residence | | | |
| On campus | 0.90 (-.72, .51) | 1.01 (-.25, .27) | 1.02 (-.26, .30) |
| Off-campus | reference category | reference category | reference category |
| Greek affiliation | | | |
| Greek | 2.55 (-.08, 1.95) | 1.99 (-.06,1.43) | 1.87 (-.13, 1.38) |
| Low APDR[a] – missing indicator | | | 22.20 (-310.38, 316.58) |
| High APDR[a]– missing indicator | | | 0.04 (-316.72, 310.24) |
| Binge drinking frequency at follow up – missing indicator | | | 0.78 (-.47, −.03)* |

Note: results are presented as odds ratios with 95% confidence intervals in parentheses.
*$p<.05$; **$p<.01$; ***; $p<.001$.
[a]Alcohol-related proactive dietary restriction (APDR).

APDR from those who provided self-reported APDR: 1) eating less than usual (22 (95% CI, −310 to 316), Wald $\chi^2$ (1) = 36.07, $p$= .98); and 2) skipping one or more meals (0.04 (95% CI, −316 to 310), Wald $\chi^2$ (1) = 0.11, $p$= .98). A non-significant baseline binge drinking frequency missing indicator (0.63 (95% CI, −1.27 to −0.34), Wald $\chi^2$ (1) = 2.86, $p$=.26) suggested individuals who did not self-report binge drinking frequency at baseline did not significantly differ on binge drinking frequency from those who did self-report a baseline binge drinking frequency. A significant binge drinking frequency at follow-up missing indicator (0.78 (95% CI, −0.47 to −0.03), Wald $\chi^2$ (1) = 0.66, $p$=.03) suggested individuals who did not self-report binge drinking frequency at follow-up had decreased odds for binge drinking frequency.

A non-significant mean difference was observed across baseline and 7-month follow up binge drinking frequencies (t (580) = 0.89, $p = 0.39$). All results for the longitudinal ordinal regression model are provided in Table 2. Results for the cross-sectional ordinal regression and paired sample t-test are shown in Tables 3 and 4.

## Discussion

This study focused on the strength of the relationship and longitudinal effect of varying levels of APDR on binge drinking frequency among a U.S. college freshman cohort. Findings from this study revealed that students reporting higher frequencies of eating less than usual prior to drinking to feel the psychoactive effects of alcohol faster (low APDR) early in the first semester of college (baseline) had greater odds for increased binge drinking frequency at baseline; however, this predictive relationship was not observed between baseline low APDR and binge drinking frequency at 7-month follow-up. In fact, no significant mean difference was detected between students' binge drinking frequenices at baseline and follow-up. On the other hand, findings suggested those who reported skipping one or more meals prior to drinking to feel the psychoactive effects of alcohol faster (high APDR) were not associated with binge drinking frequency at baseline nor at 7-month follow-up.

**Table 3.** Ordinal regression analyses to examine the effect of alcohol-related proactive dietary restriction at baseline on college students' binge drinking frequency at baseline (cross-sectional).

| Predictor variables | Complete case analysis using negative log-log link function ($n = 672$) | 50 Random forest multiple imputations using complementary log-log link function ($n = 1,149$) | 50 Random forest multiple imputations & missing indicators using complementary log-log link function ($n = 1,149$) |
|---|---|---|---|
| APDR[a] | | | |
| Low | 1.83 (.28, .93)*** | 1.33 (.10, .47)** | 1.27 (.06,.42) ** |
| High | 1.26 (-.15, .61) | 1.17 (-.09, .41) | 1.20 (-.07, .43) |
| Ethnic origin | | | |
| Hispanic or Latino | 0.77 (-.15, .61) | 0.94 (-.29, .15) | 0.91 (-.33, .13) |
| Race | | | |
| Black or African American | 0.94 (-.87, .74) | 1.06 (-.27, .37) | 1.02 (-.33, .35) |
| Asian/Asian American | 1.44 (-.40,1.14) | 1.15 (-.19, .46) | 1.09 (-.26, .43) |
| White | 1.66 (-.21, 1.22) | 1.20 (-.11, .47) | 1.15 (-.17, .44) |
| Sex | | | |
| Male | 4.27 (1.04, 1.86)*** | 1.65 (.32, .66)*** | 1.62 (.31, .65) *** |
| Athlete status | | | |
| Athlete | 1.28 (-.43,.92) | 1.19 (-.14, .49) | 1.17 (-.17, .48) |
| Geographic region | | | |
| At-risk | 1.40 (-.05,.72) | 1.14 (.04, .30) | 1.11 (-.07, .28) |
| Residence | | | |
| On campus | 1.48 (-.32, 1.11) | 1.08 (-.20, .35) | 1.08 (-.21, .37) |
| Off-campus | reference category | reference category | reference category |
| Greek affiliation | | | |
| Greek | 0.85 (-1.34, 1.02) | 1.00 (-.72, .72) | 1.01 (-.73, .74) |
| Low APDR[a] – missing indicator | | | 0.34 (-3.40, 1.22) |
| High APDR[a] – missing indicator | | | 3.90 (-.81, 3.53) |
| Baseline binge drinking frequency – missing indicator | | | 0.63 (-1.27, .34) |

Note: results are presented as odds ratios with 95% confidence intervals in parentheses.
*$p<.05$; **$p<.01$; ***$p<.001$.
[a]Alcohol-related proactive dietary restriction (APDR).

**Table 4.** Paired Sample T-test to Compare Binge Drinking Frequency at Baseline and 7-month Follow-up.

| | t | df | Sig. (2-tailed) | Mean Difference (SE) | 95% C.I. |
|---|---|---|---|---|---|
| Complete case analysis ($n = 505$) | | | | | |
| BDFT2 – BDFT1[a] | 4.6 | 504 | <.001*** | 0.12 (0.03) | (0.07, 0.17) |
| Fifty random forest multiple imputations ($n = 1,149$) | | | | | |
| BDFT2 – BDFT1[a] | 0.87 | 580 | 0.39 | 0.02 (0.02) | (-0.02, 0.06) |

[a]The mean difference was calculated as (binge drinking frequency at 7-month follow up – baseline binge drinking frequency).
*Note: *$p<.05$; **$p<.01$; ***$p<.001$.

These findings corroborate literature findings suggesting students become acclimated to perceived college drinking norms within their first months of college; thus, it is likely the nonsignificant change in binge drinking frequency observed over the course of students' freshman year was due to the early internalization of perceived college drinking norms (Sher & Rutledge, 2007). However, the strong cross-sectional relationship between APDR and student binge drinking observed by Bryant et al. (2012) is only corroborated for low APDR by this study. Bryant et al. (2012) found that college students who restrict their energy intake prior to alcohol consumption (to feel the psychoactive effects of alcohol faster) have a greater likelihood to participate in binge drinking. The group compared binge drinkers with non-binge drinkers across dietary restriction prior to alcohol consumption and found increased mean level scores for binge drinkers. It is possible former findings by Bryant et al. (2012) were not examined individually at both APDR threshholds. However, when examined at both APDR thresholds, our study indicates the relationship between high APDR and binge drinking frequency is not present at baseline nor at follow-up for non-clinical college students. The

nonclinical nature of the student cohort under study may explicate why high APDR was not significantly related to binge drinking in our sample at baseline nor follow-up.

Findings from this investigation extend upon current literature findings indicating a cross-sectional relationship between proactive dietary restriction to feel the psychoactive effects of alcohol faster and binge drinking. Specifically, this study addresses a current gap in the college alcohol literature with respect to: 1) the strength of the relationships between varying levels of alcohol-related proactive dietary restriction and binge drinking frequency; and 2) a longitudinal investigation of the predictive ability of APDR on increased binge drinking frequency. This study measured APDR on a severity spectrum, from eating less than usual to skipping one or more meals to feel the effects of alcohol faster. Measuring alcohol-related proactive dietary restriction on a severity spectrum allowed for unique findings with respect to its longitudinal relationship to binge drinking frequency.

Nevertheless, there are limitations to this study. While our study inclusion criteria consisted of freshmen students who were potentially at-risk for poor health behaviors; on average, the final study sample consisted of normal weight freshmen students with a racial composition representative of freshmen attending U.S. universities (Staklis & Chen, 2010). Furthermore, the expected missing data when assessing alcohol intake of college students, most of whom were less than the legal drinking age of 21 years, across binge drinking frequency and alcohol-related proactive dietary restriction substantially lowered sample size and possibly biased model parameter estimates. Thus, study results should be interpreted with caution; however, missing data was accounted for by conducting 50 multiple random forest imputations of the ordinal logistic regression model for comparison against the complete case analysis (CCA) model estimates. Model comparisons rendered similar statistically significant predictors, with more conservative estimates for the imputed models. Significant predictors across both CCA and imputed models also closely corresponded with findings in the current college alcohol literature. For instance, study results corroborated existing evidence in the college alcohol literature regarding an increased risk for binge drinking among males. Furthermore, missing indicators were assessed for baseline alcohol-related proactive dietary restriction and binge drinking frequency at baseline and follow-up. Missing indicator findings across both levels of APDR suggested individuals who did not self-report APDR at baseline did not significantly differ on APDR from those who did provide self-reported APDR. While binge drinking frequency missing indicators suggested individuals who did not self-report binge drinking frequency at baseline were not significantly different in binge drinking frequency from those who did self-report a baseline binge drinking frequency, individuals who did not self-report binge drinking frequency at follow-up had decreased odds for binge drinking frequency. As such, the analysis of the missing data for baseline alcohol-related proactive dietary restriction and binge drinking frequency at follow-up in our sample demonstrated it was not likely that those who skipped these items on the survey were more likely to engage in APDR or binge drinking than those who provided responses. Moreover, baseline binge drinking frequency was controlled for in the longitudinal regression model. This indicated that significant effects observed were beyond the variance explained by the outcome at baseline, thus improving model validity and fit.

This study establishes that low APDR may, in fact, serve as a significant predictor for binge drinking frequency early in the first semester of college; however, current alcohol-related proactive dietary restriction does not predict binge drinking at 7 month follow-up. With this in mind, campus health professionals are urged to emphasize the hazardous health effects of engaging in alcohol-related proactive dietary restriction early in freshmen students' first weeks of exposure to the college milieu. Future longitudinal studies with more time points are needed to confirm the potential for levels of alcohol-related proactive dietary restriction and binge drinking frequency to remain stable after the first few weeks of exposure to the college milieu. The corroboration of these relationships will further enhance campus health promotion and intervention programming *via* targeted screening efforts. The inclusion of alcohol-related proactive dietary restriction to feel the psychoactive effects of alcohol faster as a correlate for increased binge drinking frequency is suggested for college campus health screenings. Future longitudinal research examining the effect of alcohol-related proactive dietary restriction to feel the psychoactive effects of alcohol faster on binge drinking frequency is warranted with larger sample sizes that are more representative of the U.S college population.

## Acknowledgements

None.

## Declaration of interest

The authors report no conflicts of interest.

## Authorship

Authors GC, TEB, and AEM designed the study, SEC, MDO, WZ, ME and AEM collected data, GC conducted the statistical analysis, GC wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript.

## Ethical standards disclosure

This study was conducted according to the guidelines laid down in the Declaration of Helsinki. The Institutional Review Board at the University of Tennessee approved research activities at the University of Tennessee, West Virginia University, South Dakota State University, Syracuse University, and University of Maine. University of Florida, Auburn University, and Kansas State University Institutional Review Boards provided approval for research on their respective campuses. Written informed consent was obtained from all subjects.

## Funding

Funding for this study was provided by USDA Grant 2014-67001-21851. USDA had no role in the study design, collection, analysis or interpretation of the data, writing the manuscript, or the decision to submit the paper for publication.

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