BEYOND HEAVY EPISODIC DRINKING: MULTI-LEVEL MODELS LINKING PREGAME HEAVY ALCOHOL USE, DAY DRINKING, AND HIGH-INTENSITY DRINKING WITH ACUTE AND MEDIUM-TERM NEGATIVE CONSEQUENCES AND RISKY BEHAVIORS ACROSS COLLEGE

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ABSTRACT

Alcohol use commonly begins during high school, increases and peaks in the early twenties, and then decreases during young adulthood as individuals transition into adult work and social roles. The peak in alcohol use trajectories during the early twenties is particularly pronounced for college students. Although many heavy drinking college students “mature out” of this behavior, some develop patterns of heavy drinking that continue into adulthood and which may lead to serious health and/or developmental problems, such as alcohol use disorder. Heavy episodic drinking (HED), or women/men consuming four/five or more drinks in a row, is the most widely used indicator of heavy college drinking, and has been shown to predict an array of negative consequences across multiple domains. However, research is increasingly showing that some students drink at levels far beyond this threshold on many occasions. Recent findings have also demonstrated that drinking in specific contexts, such as when pregaming, is associated with HED and can be particularly risky. This dissertation sought to advance research on heavy college drinking by demonstrating the need for researchers to better differentiate among levels of drinking and to more fully consider the effects of HED in certain situations, such as before going out (Pregame HED) and during the daytime (Day Drinking).

Data came from the University Life Study which followed first-year, first-time, full-time college students under the age of 21 at a large, land grant university ($N = 736$, $M = 18.44$ years old, $SD = .43$ years). Students were selected using a stratified random sampling technique that resulted in a balanced sample in regard to gender (50.8% female) and four major race/ethnicity groups (25.1% Hispanic/Latinx, 15.7% African American non-Hispanic [NH], 23.3% Asian American/Pacific Islander NH, 27.4% European American NH, and 8.5% multiracial NH). A longitudinal measurement-burst design was used in which students completed a longer web-
based survey and up to 14 consecutive web-based daily surveys in each of their first seven semesters (3 ½ years) of college.

Paper 1 introduces the concept of Pregame HED, or getting drunk before going out, and tested whether students were more likely to engage in high-intensity drinking (HID; i.e., double the HED threshold) and risky behaviors and whether they experienced more negative consequences on Pregame HED days than on days they consumed a more moderate amount of drinks while pregaming (N = 4,454 drinking days nested within N = 521 students who reported drinking on at least one occasion in Semesters 4-7 when data on pregaming were available). Multilevel models nesting days within semesters within persons contrasted Pregame HED days, that is, days students got drunk before going out, with drinking days on which they consumed a more moderate amount of alcohol while pregaming. Pregame HED was reported by 41% of drinkers and on 15% of drinking days and 38% of pregaming days. Students were more likely to engage in HID and to use illegal drugs and experienced more negative consequences on Pregame HED days than on Moderate Pregaming days. Similar to past research, students were more likely to engage in HID, experience negative consequences, play drinking games, and mix alcohol with energy drinks on Moderate Pregaming days than on Non-Pregaming drinking days.

Paper 2 introduces the concept of Day Drinking, or drinking that begins during the daytime (i.e., between 6:00 AM and 3:45 PM), and tested whether students were more likely to engage in HED, HID, and risky behaviors and whether they experienced more negative consequences on Day Drinking days than on days drinking began during the evening or nighttime (N = 7,549 drinking days nested within 618 student drinkers). Day Drinking was reported by 50% of drinkers and on 9% of drinking days across the study. Results of multilevel models nesting days within semesters within persons showed that students were more likely to
engage in HED and HID, play drinking games, and use illegal drugs on Day Drinking days than on Nighttime-Only drinking days. Students who reported Day Drinking more frequently were more likely to report HED, HID, mixing alcohol with energy drinks, and negative consequences of alcohol use on drinking days across the study.

Paper 3 tested whether three novel risky drinking indicators (HID, Day Drinking, and Pregame HED) predicted medium-term health, legal, and academic consequences, beyond associations with HED ($N = 473$ student drinkers). Logistic and negative binomial regressions tested whether risky drinking behaviors earlier in college predicted consequences several years later by fourth year of college. Results showed that Pregame HED in the middle of college predicted greater alcohol-related problems and a hazardous and harmful pattern of drinking, independent of HED, in fourth year. First-year HID independently predicted a hazardous and harmful pattern of drinking in fourth year, whereas first-year Day Drinking was not independently associated with any of the four outcomes. Supplemental analyses demonstrated that Pregame HED and HID provided greater specificity in predicting medium-term consequences than HED, and HED provided greater sensitivity.

Taken together, this dissertation highlights how common these three extreme, yet understudied, risky drinking behaviors were among the traditionally-aged, full-time students in this multi-ethnic sample from a large, land grant university. This work demonstrates the importance of better differentiating among levels of alcohol consumption and of considering the context in which heavy drinking occurs. By only using single, dichotomous indicators of risky drinking (i.e., HED or any pregaming), researchers fail to capture much of the unique variance that predicts both acute and distal outcomes. It is argued that by using the three novel indicators of risky drinking assessed here (i.e., Pregame HED, Day Drinking, and HID) in conjunction with
the broader and more widely used HED and any pregaming indicators, researchers will be able to better identify nuances in the associations between risky college drinking and its correlates and consequences, such as whether particular correlates and consequences are more a result of the amount of alcohol consumed or whether it is the situation in which it is consumed that is particularly conducive to that behavior or consequence. This dissertation illustrated this type of nuanced association by showing that the amount of alcohol consumed while pregaming predicted the number of negative consequences students experienced, whereas students’ likelihood of playing drinking games was predicted by pregame drinking more generally, regardless of amount. Future work could use a similar analytic technique to assess nuances in other correlates and consequences of risky college drinking.
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CHAPTER 1

INTRODUCTION

Heavy drinking has been a major public health concern on college campuses for decades due to its high prevalence and the many negative consequences that often result (Kilmer, Cronce, & Larimer, 2013; Krieger, Young, Anthenien, & Neighbors, 2018; Wechsler, Seibring, I-Chao, & Ahl, 2004). For example, findings from the nationally-representative Monitoring the Future study indicate that, in 2016, approximately one-third of college students reported consuming five or more drinks in a row in the prior two weeks and approximately two-fifths reported being intoxicated in the prior month (Schulenberg et al., 2018). Additionally, heavy drinking has consistently been linked with many negative consequences ranging from those related to physical health (e.g., injury, sexual assault, dependence, death), the law (e.g., vandalism, drunk driving, arrests), and academics (e.g., missing class more often, lower grade points averages), among others (Hingson, Zha, & Smyth, 2017; Presley & Pimentel, 2006; Singleton, 2007; Singleton & Wolfson, 2009; Wechsler et al., 2002; White & Hingson, 2013).

Developmentally, alcohol use typically begins in adolescence during the high school years, escalates and peaks around age 21, and then decreases during the mid to late twenties as individuals transition into adult social roles (Chassin, Hussong, & Beltran, 2009; Schulenberg et al., 2014; Staff et al., 2010). Although during high school college-bound students tend to drink less than their non-college-bound peers, after high school college students tend to drink more than their peers who do not attend college (Schulenberg et al., 2018). Similarly, college students tend to experience steeper increases in alcohol use in the late teens and early twenties as well as steeper decreases in the mid and late twenties than non-students (White, Labouvie, & Papadaratsakis, 2005). Thus, for many people, alcohol is consumed more frequently and in
greater amounts during the college years than at any other time of their lives. Although many young people who drink heavily during college “mature out” of this behavior, some develop patterns of heavy drinking that continue into adulthood and which may lead to alcohol use disorder and/or other serious health problems (Bachman et al., 1997; Jennison, 2004; O’Malley, 2004; Schulenberg & Maggs, 2002).

It is important to acknowledge that drinking behaviors in college occur alongside a number of developmental changes as most traditionally-aged college students are in the process of transitioning from adolescence to adulthood (Maggs, 1997; Schulenberg & Maggs, 2002). Biologically, most college students are still undergoing brain and cognitive development, especially in cortical areas of the brain responsible for higher-order cognitive functions, such as the prefrontal cortex (Casey, Getz, & Galvan, 2008). The development of the cortical control regions of young people’s brains at this age typically lags behind that of the subcortical limbic regions that modulate emotion, which means these youth may still be somewhat impulsive and reward sensitive, especially in emotionally salient contexts (Casey et al., 2008). The college years are also a time of substantial identity development for many, as students explore options in love, work, and worldviews before making longer-term commitments in these areas (Arnett, 2000; Côté, 2009; Schwartz, Côté, & Arnett, 2005). College students also must learn to navigate the increased academic freedom and demands that are characteristic of the college environment (Schulenberg & Maggs, 2002; White et al., 2005). Socially, the college years are a time of substantial change in social networks and relationships as many traditionally-aged college students must navigate a number of social changes that create stress and reduce social control (Schulenberg & Maggs, 2002; White et al., 2005). These changes include separating from old
friends and cultivating new friendships and peer networks, as well as increased independence and less support, guidance, and monitoring from parents (Maggs, 1997; White et al., 2005).

Interestingly, alcohol use can help college students facilitate social interactions and develop supportive and meaningful relationships (Borsari & Carey, 2006; Chassin, Presson, & Sherman, 1988; Maggs & Hurrelmann, 1998; Schulenberg & Maggs, 2002). For example, heavy drinking among first semester college students appears to largely center around such forms of gregarious socializing as partying and developing social networks (Reifman & Watson, 2003). In addition to simply making friends, alcohol use may also function as a way for college students to develop intimacy, closeness, and support in their relationships (Borsari & Carey, 2006; Bradley, Carman, & Petree, 1991; Fondacaro & Heller, 1983; Moos, Moos, & Kulik, 1977; Nezlek, Pilkington, Bilbro, 1994). The adaptive role of alcohol use in facilitating social interactions and relationships during college is important to consider in light of the numerous changes listed above that occur during the developmental transition to adulthood. Schulenberg and Maggs (2002) articulated a transition catalyst model of substance use suggesting that alcohol use specifically can help facilitate the formation of friendships, romantic and sexual relationships, and social bonding during the developmental transition to adulthood. Taken together, it is important to view college drinking as occurring within a developmental system that is shaped by changing biological, cognitive, and social influences in the lives of college students. College drinking may serve diverse subjective functions, as various drinking behaviors and drinking that occurs in different contexts may be more or less conducive to particular types of socializing, such as meeting new people or developing intimacy with current friends and/or romantic partners.
The studies presented in this dissertation aim to better describe understudied college drinking behaviors that appear to occur in unique contexts and to identify indicators of risky drinking at the beginning of the college years (e.g., first year of college) that predict medium-term consequences at the end of college. This information will be useful to college administrators seeking to make their campuses safer and/or provide help for students with harmful patterns of alcohol use, as well as to prevention scientists seeking to curb heavy drinking and its consequences through targeted approaches. Paper 1 introduces the concept of *Pregame Heavy Episodic Drinking* (Pregame HED), or consuming four/five or more drinks for females/males prior to “going out,” and examines the extent to which this drinking behavior is associated at the daily level with further same-night alcohol consumption, negative alcohol-related consequences, and other risky behaviors, including illegal drug use, playing drinking games, and mixing alcohol and energy drinks. Paper 2 introduces the concept of *Day Drinking*, or drinking that begins before 4:00 PM, and tests daily associations between this drinking behavior and alcohol consumption, negative consequences, and risky behaviors. Paper 3 assesses the utility of several risky drinking indicators in prospectively predicting medium-term consequences in the health, academic, and legal domains.

**Heavy Episodic Drinking and High-Intensity Drinking**

Much research on heavy college drinking over the past two decades has utilized an indicator known as heavy episodic drinking (HED), which is typically defined as consuming four/five or more drinks in a row for females/males (National Institute on Alcohol Abuse and Alcoholism, 2015; Wechsler, Dowdall, Davenport, & Rimm, 1995; Wechsler & Nelson, 2001). In some studies, a gender-neutral definition has been used in which HED has been operationalized as consuming five or more drinks in a row (Johnston et al., 2019). HED is also
sometimes referred to as binge drinking (Courtney & Polich, 2009; Patrick, 2016; Wechsler & Isaac, 1992) or risky single occasion drinking (Gmel, Kuntsche, & Rehm, 2011). These two very similar operationalizations of HED have been used in an array of research settings and populations, including daily diary studies (e.g., the University Life Study; Greene & Maggs, 2018) and nationally-representative panel studies (e.g., Monitoring the Future; Keyes & Miech, 2013; Schulenberg et al., 2018). Since this level of drinking can be identified by a single item, it has been relatively easy for researchers to include in population and large-scale surveys. Past studies have used any HED or HED frequency in a given time period (e.g., past two weeks, past month) to predict acute negative consequences of alcohol use (e.g., passing out, getting injured, death; Hingson et al., 2017; Wechsler et al., 2000) and longer-term alcohol problems (e.g., alcohol use disorder, academic problems, cognitive deficits; Patrick et al., 2011; Schulenberg et al., 2015).

Although the HED indicator has demonstrated its predictive utility and is easily administered, several researchers have noted that many college students drink at levels far beyond the HED threshold and that the HED indicator does not adequately differentiate among heavy drinkers or heavy drinking occasions (Patrick & Azar, 2018; White, Kraus, & Swartzwelder, 2006). For example, a study using national data from the Centers for Disease Control’s Behavioral Risk Factor Surveillance Study reported that, on 18-24 year-olds’ most recent drinking episode that exceeded the HED threshold, the average number of drinks consumed was 10.1 drinks for men and 8.1 drinks for women (Naimi et al., 2010). Put another way, this study documented that on their most recent heavy drinking occasion, the average 18-24 year-old drank at twice the HED level. Thus, this study suggests that the amount of alcohol consumed on HED occasions varies considerably between college-aged individuals, and other
research has shown that the number of drinks consumed by college students on HED occasions also varies within persons (Linden-Carmichael, Calhoun, Patrick, & Maggs, 2018; White et al., 2006). Further, since there is a dose-response relationship between the amount of alcohol individuals consume and the number of negative consequences they experience (Gruenewald & Mair, 2015; Jackson, 2008; Read et al., 2008), there also appears to be both between- and within-person variability in the number of consequences students are likely to experience on days they drink at or above the HED level. For example, a college-aged male who reaches the HED threshold by consuming five drinks is likely to be at far less risk for acute negative consequences on that occasion than on one in which he consumes 12 drinks.

For this reason, several researchers have begun using indicators of heavy drinking based on higher thresholds, such as double or triple the HED cutoff. Some (e.g., Linden-Carmichael, Vasilenko, Lanza, & Maggs, 2017; Patrick & Azar, 2018) have used the term high-intensity drinking (HID) to refer to a threshold set at double the HED threshold (i.e., 8+/10+ drinks in a row for females/males). Thus far, research suggests that HED and HID have some important characteristics in common. For example, HID appears to follow a similar developmental pattern as HED, though with a somewhat later onset. That is, the behavior originates during the later high school years, peaks around age 21 or 22, and then declines by the mid- to late-twenties (Patrick, Terry-McElrath, Kloska, & Schulenberg, 2016). However, the decline in rates of HID appears to occur faster than that of HED (Patrick et al., 2016). There are also important differences between HED and HID. That is, HID is more predictive of acute negative consequences and outcomes than HED (Linden-Carmichael et al., 2017; Linden-Carmichael, Calhoun, Patrick, & Maggs, 2018), as would be expected given the dose-response relationship. Yet, there is still much about HID that is unknown, such as which drinking contexts may
facilitate drinking to this more intense level as well as the ability of HID to differentially predict medium- and longer-term consequences of alcohol use.

**Pregame Heavy Episodic Drinking**

Over the past decade, a small body of literature has emerged describing a common, high-risk drinking behavior known as pregaming, which is defined as the act of drinking alcohol before an organized activity or social event at which further alcohol consumption may or may not occur (Borsari et al., 2007; DeJong, DiRicco, & Schneider, 2010; Pederson & LaBrie, 2007). Pregaming is usually social, but it generally occurs in a more private setting with closer friends than the event it precedes (DeJong et al., 2010; Pedersen & LaBrie, 2007). Pregaming sessions typically last less than two hours (e.g., more than 90%; Pedersen & LaBrie, 2007), during which students consume three to four drinks, on average (Hammersley & Ditton, 2005; Kenney, Hummer, & LaBrie, 2010; Pedersen & LaBrie, 2008; Pedersen, LaBrie, & Kilmer, 2009). Research on the motivations behind pregaming indicates that students typically engage in this behavior to have fun, to become intoxicated, to enhance social interactions, to exercise control over the type and amount of alcohol they consume, to improve their chances of finding a romantic or sexual partner, and because alcohol may be expensive and/or difficult to obtain at the primary event (Bachrach, Merrill, Bytschkow, & Read, 2012; LaBrie, Hummer, Pedersen, Lac, & Chithambo, 2012).

Although research on pregaming is limited, this drinking behavior appears to be very common, as approximately two-thirds to three-fourths of college students report ever pregaming (DeJong et al., 2010; LaBrie & Pedersen, 2008; Pedersen et al., 2009; Pedersen, LaBrie, & Lac, 2008). Several studies have reported that the typical frequency of pregaming among those who engage in the behavior is around three to four times per month (Kenney et al., 2010; Pedersen et
and one-half of all drinking days (DeJong et al., 2010; LaBrie & Pedersen, 2008; Pedersen et al., 2009; Pedersen et al., 2008).

Pregaming has been linked with increased alcohol consumption and an increased likelihood of experiencing negative alcohol-related consequences in a number of between- and within-person studies. Between-person studies assess interindividual variability, that is, they are aimed at describing differences between the behaviors or characteristics of different individuals. In contrast, within-person studies focus on interindividually differences in intraindividual variability, that is, they are aimed at describing differences between behaviors or characteristics of the same individual across multiple occasions (e.g., hours, days, years). Within-person studies, which use techniques like multilevel modeling, can also test between-person hypotheses by appropriately modeling the nested, or hierarchical, nature of the data. Past between-person studies have demonstrated that high school and college students who engage in pregaming are more likely than those who do not engage in pregaming to be heavy drinkers, as pregame drinkers consume greater quantities of alcohol, on average, than non-pregame drinkers and are more likely to engage in HED (Haas, Smith, Kagan, & Jacob, 2012; Read, Merrill, & Bytschkow, 2010). Further, individuals who engage in pregame drinking report experiencing more negative consequences of alcohol use than those who never pregame (Paves et al., 2012; Pedersen & LaBrie, 2007; Read et al., 2010). In regards to within-person findings, on days drinkers engage in pregaming, they consume more alcohol than on days they do not pregame (Labhart, Graham, Wells, & Kuntsche, 2013; Merrill, Vermont, Bachrach, & Read, 2013). Further, students are nearly three times as likely to blackout (Hummer et al., 2013; LaBrie, Hummer, Kenney, Lac, & Pedersen, 2011) and more than twice as likely to get into a fight
(Hughes, Anderson, Morleo, & Bellis, 2008; Wahl et al., 2013) on days they pregame compared to drinking days they do not pregame. Thus, individuals who ever pregame report more alcohol-related consequences than those who never do, and on occasions when individuals do pregame, they are likely to experience more negative consequences on that occasion than on occasions they do not pregame. This suggests that pregaming increases risk for negative consequences of alcohol use.

*Limitations of Dichotomous Pregaming Measures*

Although a number of between- and within-person studies suggest that pregame drinking is linked with greater alcohol consumption and negative consequences, there is a measurement-related limitation that has confined past studies to testing only certain hypotheses. Many of the studies on pregaming have operationalized this behavior as a dichotomous variable and have simply assessed whether or not students have ever pregamed or have pregamed on particular occasions. This conception is problematic because such indicators do not account for how much alcohol was consumed while pregaming. The average number of drinks students report consuming while pregaming is only 1-2 drinks below the HED threshold, and many students report exceeding the HED threshold while pregaming (Kenney, Hummer, & LaBrie, 2010; Pedersen et al., 2009; Pedersen & LaBrie, 2008). Although having one or two drinks during a pregaming session may not elevate risk for negative consequences substantially, reaching or exceeding the HED threshold is likely much more dangerous.

There are several reasons why students who reach the HED threshold prior to going to an event at which more drinking is possible, if not likely, would be at greater risk for negative consequences than students who have only one or two pregame drinks or none at all. First, if students exceed or approach the HED threshold before leaving their pregame location, this
means they become intoxicated earlier in the night and, thus, increase the total time and distance they travel (e.g., to and from a bar or party) while intoxicated. Second, pregaming typically consists of drinking rapidly (DeJong et al., 2010; Pedersen & LaBrie, 2007), which means that the full effect of the alcohol may not “hit” students until after they have left their pregaming location. Rapid drinking is also a risk factor for blacking out (Perry et al., 2006). Third, if students continue drinking at the main event they attend, they are likely to become even more intoxicated and may come close to or reach the HID threshold.

Therefore, in the same way that researchers have begun examining HID as a more extreme and risky form of heavy drinking than HED, and to capture inter- and intraindividual variability in heavy drinking, there is a need to move beyond simply assessing whether students pregame (either ever or on particular occasions) as an indicator of risky drinking, as it does not differentiate among pregaming occasions. Although studies have shown that pregaming (in any volume) is linked with greater alcohol consumption and increased negative consequences (Haas et al., 2012; Hummer et al., 2013; LaBrie et al., 2011; Labhart et al., 2013; Merrill et al., 2013; Read et al., 2010), these associations may largely be due to a sizeable number of Pregame HED occasions. For example, although students tend to report experiencing more negative consequences on days they pregame than on days they do not, most of these consequences may occur on days students engaged in Pregame HED and fewer may have occurred on days they had only one or two drinks while pregaming. Thus, one hypothesis that has yet to be tested is whether Pregame HED is more predictive of HID and acute negative consequences of alcohol use than a dichotomous indicator of any pregaming. This dissertation focuses on testing this hypothesis and, in doing so, may help clarify whether pregaming in and of itself is a risky drinking behavior (as opposed to whether it is drinking a certain amount of alcohol while
pregaming that is risky). If Pregame HED is a better indicator of risk than any pregaming, the Pregame HED indicator will allow researchers in future studies to differentiate among pregaming occasions that likely confer different levels of risk.

**Day Drinking**

Much of the research on heavy drinking has assessed HED, or HID, at the daily level or across longer intervals, such as weeks, months, years, or a person’s lifetime. From a developmental perspective, heavy drinking tends to be limited to adolescence and the transition to adulthood with heavy drinking often starting during high school, peaking around age 21, and then decreasing across the mid- to late-twenties (Chassin et al., 2009; Schulenberg et al., 2014; Staff et al., 2010). During the college years, heavy drinking occurs more frequently and/or to a greater extent during certain portions of the year, such as on holidays like Halloween, Independence Day, and New Year’s Eve (Greenbaum et al., 2005; Lee et al., 2006; Neighbors et al., 2005; Patrick & Azar, 2018). At the week level, college students most commonly consume alcohol on the so-called social weekend days of Thursday, Friday, and Saturday (Del Boca, Darkes, Greenbaum, & Goldman, 2004; Finlay, Ram, Maggs, & Caldwell, 2012; Maggs, Williams, & Lee, 2011). Yet, there has been little research examining within-person (i.e., between-day) variability in what time of day college students start drinking. Thus, one may assume that most heavy college drinking occurs in the evenings or at night on social weekend days (e.g., Alexander & Bowen, 2004; Borsari et al., 2007; Skidmore & Murphy, 2011).

However, college students appear to begin drinking during the day (e.g., before 4:00 PM) somewhat often, as is evidenced by the large number of students who participate in tailgating, or partying prior to an athletic event such as a football game (Neighbors, Oster-Aaland, Bergstrom, & Lewis, 2006). Further, it seems that the concept of “day drinking” has made its way into the
vernacular of the general public, as is evidenced by a Google search for the term. For instance, there are books giving recipes for day drinking cocktails (e.g., Odell, 2017), songs that reference day drinking (e.g., the 2014 single “Day Drinking” by the group Little Big Town), and magazine articles discussing the topic (e.g., James, 2016), among other examples. Yet, it is unclear how prevalent this drinking behavior is on college campuses and to what degree it is associated with risky drinking behaviors, such as playing drinking games, mixing alcohol with energy drinks, and/or illicit substance use. More generally, it is also unknown at what time the typical college student starts/stops drinking on a given day, whether those times vary by day of the week, and how much variability there is in such times across days and between individuals.

**Indicators of Longer-Term Alcohol Use Problems**

Past research has documented many medium and long-term negative consequences of repeated HED among adolescents and college students. Among these are increased risk of alcohol use disorder, hindered brain development, poorer cognitive functioning, and worse academic performance (De Bellis et al., 2005; McQueeny et al., 2009; Medina et al., 2008; Singleton, 2007; Singleton & Wolfson, 2009; Squeglia, Jacobus, & Tapert, 2009; Wechsler et al., 2000; White, 2003). Although HED as traditionally assessed has demonstrated its utility in predicting such negative outcomes, it has at least two important shortcomings. First, as discussed above, HED does not adequately differentiate among heavy drinkers or heavy drinking occasions, as drinking occurs at levels well above the HED threshold for some people and on many occasions (e.g., Linden-Carmichael et al., 2018; Naimi et al., 2010; White et al., 2006). Indicators that are better able to differentiate among levels of heavy drinkers and heavy drinking occasions, such as HID, may help identify individuals with different levels of risk for longer-

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1 Google search for the term “day drinking” on December 12, 2018.
term problems, such as alcohol dependence, cognitive deficits, and difficulty transitioning to 
adult work and social roles. Although the literature on HID is growing rapidly, there is scant 
work assessing the longer-term consequences of repeatedly drinking at this level, nor how doing 
so may put individuals at heightened risk compared to those who regularly drink at or above the 
HED level but under the HID level. Interestingly, one study suggests that nearly all college 
students who drink at the HID level begin doing so in high school, which is not necessarily true 
of HED (Patrick, Terry-McElrath, Schulenberg, & Bray, 2017). So, if HID is reported in the first 
semester or year of college, this may serve as a warning sign or “red flag” that a student is at 
substantial risk for later alcohol problems, above and beyond those of regular HED.

Second, HED as a measure is not context-specific. Reaching the HED threshold in 
specific contexts, such as while pregaming, may confer heightened longer-term risk above and 
beyond that of the traditional definition of HED. For example, pregaming is often ritualistic and 
often includes motivations to get drunk (Bachrach, Merrill, Bytschkow, & Read, 2012; Barry, 
Stellefson, Piazza-Gardner, Chaney, & Dodd, 2013; LaBrie et al., 2012). Additionally, LaBrie, 
Earle, Hummer, and Boyle (2016) reported that frequent pregaming increased positive attitudes 
towards drinking, which in turn led to increasing levels of drinking and alcohol-related 
consequences over time. Further, Pregame HED is likely to be positively associated with HID, 
such that many Pregame HED occasions likely culminate in reaching the HID threshold later that 
day. Students who reach the HED threshold while pregaming with any regularity may be at 
heightened risk for alcohol problems, especially if their views of heavy drinking become more 
positive and if the behavior becomes habitual, as one might infer from the findings of LaBrie et 
al. (2016). Therefore, Pregame HED could also potentially serve as an indicator of a more
severe pattern of drinking than those that can be identified solely by the traditional HED (or any pregaming) indicator.

Day drinking, especially day drinking that ultimately results in HED or HID, may also have potential as an indicator of medium and/or long-term alcohol problems in college students. Day drinking consists of drinking alcohol, often in large quantities (e.g., tailgating; Glassman et al., 2010), during times of the day that are not typically associated with partying or substance use. Repeatedly engaging in this behavior could normalize a style of drinking that may be particularly maladaptive in work and family settings outside the college context. Additionally, day drinking on weekends, and especially on weekdays, may interfere with a college student’s academic performance. Students who limit their drinking to nights and evenings may be able to complete some schoolwork during the daytime before beginning to drink; however, students would likely have less time to spend on schoolwork on days their drinking begins during the daytime, especially if they drink at the HED level or beyond. Therefore, it is important for developmental and public health researchers to assess the extent to which Day Drinking, Pregame HED, and HID can predict more severe patterns of alcohol use that lead to greater medium- and long-term alcohol-related problems than can HED.

**Empirical Studies**

This dissertation consists of three empirical papers that all made use of the University Life Study data set to address three related sets of questions concerning heavy drinking among college students. The full rationales and methods to be used will be developed in more detail in Chapters 2, 3, and 4. Paper 1 introduces the concept of Pregame HED, that is, drinking to the HED level during a pregame session. It used between-person analyses to assess who engages in Pregame HED, and it used within-person analyses to assess whether engaging in Pregame HED
is associated with (a) reaching the HID threshold that day (i.e., total number of drinks for the day exceeds the HID threshold), (b) experiencing acute negative consequences of alcohol use, and (c) engaging in other risky behaviors, including playing drinking games, mixing alcohol with energy drinks, and using illegal drugs. Between-person variables expected to predict the likelihood of Pregame HED were male gender, participation in Greek organizations, honors college enrollment, and being a student athlete. Within persons, it was expected that students would be more likely to reach the HID threshold, experience more acute negative consequences of alcohol use, and would be more likely to play drinking games, mix alcohol with energy drinks, and use illegal drugs on days they engage in Pregame HED compared to days they pregame but do not reach the HED threshold while doing so.

Paper 2 introduces the concept of Day Drinking, that is, beginning a drinking episode prior to 4:00 PM. It used between-person analyses to examine who engages in Day Drinking, and it used within-person analyses to assess whether this behavior is associated with reaching the HED and HID thresholds and with engaging in other risky behaviors on the same day. Between-person variables expected to predict the likelihood of Day Drinking were male gender, participation in Greek organizations, honors college enrollment, and being a student athlete. Within persons, it was expected that students would be more likely to reach the HED and HID thresholds and to play drinking games, mix alcohol and energy drinks, and use illegal drugs on Day Drinking days compared to days that drinking begins in the evening or nighttime.

Paper 3 assessed whether students who engaged in HID and Day Drinking during the first and second semesters of college and Pregame HED in the fourth and fifth semesters (the first two semesters in which data were available) were more likely to exhibit alcohol, legal, and academic problems by the end of college while controlling for HED. Put another way, this paper examined
whether HID, Pregame HED, and Day Drinking have the ability to predict unique variance in these medium-term consequences above and beyond that explained by HED. Given that the typically used HED indicator lacks specificity, this paper helped determine whether these three indicators can be added to surveys or screening instruments in order to identify drinkers who may be at especially high risk for alcohol problems with greater specificity. These indicators are not intended to replace the traditional HED indicator, but they may exhibit greater specificity and thus could be used in conjunction with the HED indicator. It was expected that students who reported HID, Pregame HED, and Day Drinking earlier in college would be more likely to report hazardous/harmful drinking, alcohol problems, alcohol violations, and experiencing an anticipated delay in college graduation later in college, when controlling for HED.

Collectively, these three papers will help developmental, public health, and prevention scientists that study college drinking better understand three relatively common, but understudied, drinking phenomena. Additionally, this work has the potential to be useful in a more practical, public health capacity. For instance, all three drinking behaviors studied here can be assessed with single items using straightforward language, which increases the ease with which they could be included in nationally-representative surveys, such as Monitoring the Future (Johnston et al. 2019; Schulenberg et al., 2018), or in screening instruments given to incoming first-year students at colleges and universities (e.g., Cronce, Bittinger, Liu, & Kilmer, 2014; Heck, 1991; Marlatt et al., 1998; Saitz et al., 2006; Schaus et al., 2009; Smith, Collins, Kreisberg, Volpicelli, & Alterman, 2010). Similarly, since tailgating is a specific form of Day Drinking that is commonplace on many college campuses and is endorsed and/or regulated by college administrators, this work could inform the alcohol control policies that universities and/or local governments implement on such occasions (Chaloupka & Wechsler, 1996; Mitchell,
Toomey, & Erickson, 2005; Shaffer, Donato, LaBrie, Kidman, & LaPlante, 2005; Toomey, Lenk, & Wagenaar, 2007; Wechsler, Lee, Nelson, & Lee, 2003). Thus, this work will help researchers better screen for alcohol problems among college students and develop more tailored interventions and alcohol control policies aimed at reducing heavy college drinking and its negative consequences. This will hopefully help improve the academic success of college students and the physical and psychological health of students and those in their environment.
CHAPTER 2

PREGAME HEAVY EPISODIC DRINKING: EXTREME PREGAMING AND ITS ASSOCIATION WITH NEGATIVE CONSEQUENCES AND OTHER RISKY BEHAVIORS

Pregaming is defined as drinking that occurs before going to a larger organized activity or social event at which further drinking may occur, and it is a drinking behavior in which college students frequently engage in rapid, heavy alcohol consumption (Borsari et al., 2007; DeJong, DeRicco, & Schneider, 2010; Pederson & LaBrie, 2007). Pregaming typically occurs in unique contexts, most notably those that are smaller and more private than bars or parties (Borsari et al., 2007; DeJong et al., 2010; Pederson & LaBrie, 2007). On many pregaming occasions, students approach or exceed the heavy episodic drinking (HED) threshold of four/five or more drinks for females/males prior to “going out” (DeJong et al., 2010; Pedersen & LaBrie, 2007). A significant number of studies in the college drinking literature have examined predictors and consequences of HED (e.g., Cranford, McCabe, & Boyd, 2006; Patrick, Griffin, Huntley, & Maggs, 2018; Townshend & Duka, 2005). However, no studies to date have examined whether drinking at the HED level while pregaming is associated with extreme alcohol consumption the same day (i.e., high-intensity drinking [HID], or consuming eight/ten drinks on an occasion for women/men) or acute alcohol-related consequences (e.g., injury, passing out). This paper introduces the concept of Pregame HED, or women/men consuming four/five drinks during a pregaming session, and assesses its association with same-day HID, acute negative alcohol-related consequences, and other risky behaviors.
Pregaming: Definition, Prevalence, Predictors, and Motivations

What is pregaming?

Pregaming is the act of drinking alcohol before an organized activity or social event at which further alcohol consumption may occur (Borsari et al., 2007; DeJong et al., 2010; Pederson & LaBrie, 2007). Among college students, the activities or events that typically follow pregaming can include parties, going out to bars, sporting events, concerts, and formals or dances (DeJong et al., 2010; Pedersen & LaBrie, 2007). Pregaming is also commonly referred to as predrinking, preloading, prepartyting, or frontloading in the college drinking literature (Borsari et al., 2007; Pedersen & LaBrie, 2007).

Pregaming is often social, although it is usually done in smaller groups with friends or roommates, and it often, but not always, occurs in private residences, such as dorm rooms or apartments (DeJong et al., 2010; Pedersen & LaBrie, 2007). Alcohol consumption usually occurs rapidly in the pregaming context (DeJong et al., 2010; Hughes et al., 2008; Wells et al., 2009), and several studies have reported that students’ drinking during pregaming episodes often approaches or reaches the HED threshold of four/five drinks in a row for females/males (i.e., average of 3-4 drinks while pregaming; DeJong et al., 2010; Pedersen & LaBrie, 2007, 2008; Read, Merrill, & Bytschkow, 2010). In addition to rapid alcohol consumption, pregaming can also include other risky drinking behaviors, such as playing drinking games, although findings vary in regard to how often these two drinking behaviors co-occur (DeJong et al., 2010; Fairlie, Maggs, & Lanza, 2015; Pedersen & LaBrie, 2007). Taken together, pregaming seems to be a high-risk drinking behavior.
How many and how often do college students pregame?

Pregaming appears to be very common among college students. Approximately two-thirds of all college student study participants and roughly three-fourths of drinkers report pregaming in the two to four weeks prior to being surveyed (LaBrie & Pedersen, 2008; Pedersen et al., 2009; Read et al., 2010). The typical frequency of pregaming among those who engage in the behavior is around three to four times per month (i.e., almost weekly; Kenney et al., 2010; Pedersen et al., 2009). Further, pregame drinking days have been estimated to account for between one-third and one-half of all drinking events (DeJong et al., 2010; LaBrie & Pedersen, 2008; Pedersen et al., 2008, 2009; Read et al., 2010). Therefore, pregaming appears to be a normative aspect of college drinking culture.

Who are pregamers?

College students and young adults who participate in pregaming, or pregamers, tend to be heavy drinkers. For example, college students who were heavier drinkers in high school are more likely to begin pregame drinking upon matriculating to college than those who drank less before college (Haas, Smith, & Kagan, 2013), and students who engage in HED exhibit higher frequencies of pregame drinking than students who never drink at the HED level (Haas, Smith, Kagan, & Jacob, 2012). Pregamers also tend to consume higher quantities of alcohol than non-pregamers on both pregame and non-pregame days (Read et al., 2010). Further, one study using an adult sample reported that bar patrons who displayed symptoms of hazardous/harmful drinking as assessed by the AUDIT-C were more likely to pregame drink than those not showing such symptoms (Barry et al., 2013).

In regard to cognitive predictors of pregaming, students with high positive expectancies about the likely outcomes of drinking are more likely to pregame than those who hold less
positive expectancies (Zamboanga, Schwartz, Ham, Borsari, & Van Tyne, 2010). Further, pregamers are more likely to report that their motivation for drinking is to get drunk than they are to report other motivations (e.g., to relax; Reed et al., 2011; Wahl, Sonntag, Roehrig, Kriston, & Berner, 2013). In terms of personality traits, pregamers are more likely to be impulsive (i.e., to seek immediate rewards and positive feelings) than those who do not pregame (Haas et al., 2013). In regards to sociodemographic characteristics, there does not appear to be a gender difference in the prevalence of pregame drinking, as at least one study has reported approximately equal rates among male and female college students (Borsari et al., 2007). However, males appear to drink more than females overall on pregame drinking days (LaBrie & Pederson, 2008; Read et al., 2010). Lastly, students affiliated with a Greek organization, such as a fraternity or sorority, are generally more likely to be pregamers than non-Greek affiliates (Haas, Smith, Kagan, & Jacob, 2012; Paschall & Saltz, 2007).

Taken together, pregamers tend to be heavy drinkers and thus tend to show many of the same characteristics as heavy drinkers, including alcohol-related cognitions and personality traits. However, it is still unclear whether other between-person characteristics specific to the college environment, such as honors college enrollment and being a student athlete, are linked with pregame drinking. Uncovering such associations will help researchers understand which college students are most likely to pregame and may hint at possible target populations for intervention.

Why do people pregame?

Although there is some variability in college students’ motivations for pregaming, studies collectively point to several reasons students drink before going out, with the most common revolving around having fun, social enhancement, and practicality (Bachrach et al., 2012;
LaBrie, Hummer, Pedersen, Lac, & Chithambo, 2012). First, students report pregaming because it is fun (Bachrach et al., 2012; DeJong et al., 2010; LaBrie et al., 2012). The enjoyment and fun reflect the social aspects of hanging out with close friends in a smaller, more private setting than the primary event as well as the direct positive effects of intoxication. In fact, many students explicitly report that their reason for pregaming is to get drunk (DeJong et al., 2010; Reed et al., 2011; Wahl et al., 2013). A second, but similar, motivation for pregaming reported across studies relates to the social lubrication effects of alcohol (Bachrach et al., 2012; LaBrie et al., 2012). That is, students drink before going to an activity or an event because they believe this will help them socialize with other people, including potential romantic and sexual partners.

Third, some students report pregaming because they anticipate alcohol being difficult to obtain (e.g., because they are underage) or expensive at the primary event (LaBrie et al., 2012; Pedersen et al., 2009; Read et al., 2010). Lastly, some students desire to drink in a more controlled setting in which they are able to better dictate the type and amount of alcohol they consume, as well as to reduce the likelihood of any other substances being added to their drink (LaBrie et al., 2012).

In addition to just identifying motivations for pregaming, several studies have linked motivations for pregaming with actual pregaming behavior, such as pregaming frequency and quantity, estimated blood alcohol concentration (eBAC), and alcohol-related consequences (Bachrach et al., 2012; LaBrie et al., 2012; Pedersen et al., 2009). Several studies have also reported that motivations for pregaming differ from motivations for drinking in general (Bachrach et al., 2012; LaBrie et al., 2012). For example, the four general motivations for drinking (i.e., social, coping, conformity, and enhancement) on Cooper’s (1994) Drinking Motives Questionnaire – Revised (DMQ-R) were uncorrelated with motives for pregaming (i.e., interpersonal enhancement, situational control, intimate pursuit, and barriers to consumption) on
the Prepartying Motivations Inventory (PMI; LaBrie et al., 2012). Taken together, college students tend to engage in pregaming for reasons that are slightly different than those for general drinking. These motives may be context- and/or event-specific (LaBrie et al., 2012), and motives related to having fun and getting drunk are common. Although motives for pregaming will not be assessed in this paper, differences in motives for pregame and general drinking help show how the contexts in which pregame and general drinking occur also differ.

**Consequences of Pregaming**

*Does pregaming predict increased levels of alcohol consumption?*

On days students pregame, they are estimated to consume approximately three to four drinks while pregaming (Kenney et al., 2010; Pedersen & LaBrie, 2008; Pedersen et al., 2009) and six to nine drinks total throughout the course of the night (Pedersen & LaBrie, 2007; Read et al., 2010). That is, exceeding the HED threshold is common in these studies of U.S. college students. Similarly, Labhart et al. (2013) reported that drinking at the HED level occurred in approximately one quarter of young adult pregaming sessions as well as in one third of drinking sessions that occurred later at the primary event in a Swiss sample. An earlier analysis from the study used in the present analyses found that students were more likely to reach the HID threshold on pregame drinking days than on days they did not pregame (Fairlie et al., 2015).

College students and young adults appear to drink more on days they pregame compared to days they do not (Barnett, Orchowski, Read, & Kahler, 2013; Labhart, Graham, Wells, & Kuntsche, 2013). Although this may seem obvious in some ways, it is not inevitable given that some students report pregaming in order to save money at the primary event (LaBrie et al., 2012), presumably by drinking less once there. However, two studies suggest that pregame drinking is not in fact a substitute for later drinking, as approximately half of total drinking for
the occasion occurred after pregaming (i.e., students consumed just as much alcohol afterwards as they did while pregaming; Pedersen & LaBrie, 2007; Read et al., 2010). Thus, although students obviously drink more on days they consume more drinks, there appears to be something about the pregaming context, such as the rapid pace of drinking or the motivation to get drunk, that differentiates drinking in this context from other drinking contexts in regard to being associated with greater overall levels of alcohol use throughout the night.

*Does pregaming predict negative consequences of alcohol use?*

In addition to being associated with increased alcohol consumption, pregaming has been linked with negative consequences of alcohol use at the person and event levels across a number of studies. At the person level, individuals who engage in pregame drinking report experiencing more negative consequences of alcohol use than those who never pregame (Paves et al., 2012; Pedersen & LaBrie, 2007; Read et al., 2010). At the event level, students are nearly three times as likely to blackout (Hummer et al., 2013; LaBrie et al., 2011) and more than twice as likely to get into a fight (Hughes, Anderson, Morleo, & Bellis, 2008; Wahl et al., 2013) on nights they pregame compared to nights they drink but do not pregame beforehand.

Given that students tend to drink more on days they pregame and that there is a dose-response relationship between alcohol consumption and expected negative consequences (Gruenewald & Mair, 2015; Jackson, 2008; Read et al., 2008), it may seem apparent that the reason students experience more negative consequences on days they pregame is simply because they are consuming more alcohol. In fact, this is exactly the case presented by a few studies. Read et al. (2010) found that the association between pregaming and alcohol-related consequences became non-significant after controlling for the total number of drinks consumed that day. Similarly, Labhart et al. (2013) found that the association between pregaming and
negative consequences was fully mediated by greater overall amounts of alcohol consumed on pregaming days. However, several studies suggest that pregaming predicts unique variance in negative consequences of alcohol use above and beyond that explained by the amount of alcohol consumed (Haas et al., 2012; Merrill et al. 2013).

Although the extent to which pregaming predicts unique variance in negative consequences of alcohol use remains unclear, there are several reasons why Pregame HED, in particular, might confer additional risk above and beyond that due to one’s level of alcohol consumption. First, if students drink at the HED level while pregaming, this means they reach intoxication earlier in the night and increase the distances they need to travel (e.g., to a bar or party as well as home later) while intoxicated. Second, pregaming typically consists of drinking rapidly, which means that students may not feel the effects of the alcohol until after leaving their pregaming location for the primary event. This is also concerning because rapid drinking is a known risk factor for blacking out (Perry et al., 2006). Third, since prior work suggests that students tend to continue drinking large quantities of alcohol at the primary event (Labhart et al., 2013; Pedersen & LaBrie, 2007; Read et al., 2010), they are likely to become even more intoxicated later in the night and to increase the length of time they are intoxicated. Therefore, much like researchers have begun examining HID as a more extreme form of heavy drinking than HED (e.g., Hingson & White, 2013; Linden-Carmichael et al., 2017; McCabe, Veliz, & Patrick, 2017; Patrick et al., 2016, 2017; White et al., 2006), there may be value in moving beyond using any pregaming as an indicator of risky drinking and to move towards assessing Pregame HED as an indicator of even riskier pregame drinking. In doing so, it will be important to document whether Pregame HED is more strongly associated with negative consequences than
more moderate levels of pregaming and, if so, to determine whether this association remains significant after controlling for that day’s total alcohol consumption.

**Limitations of Past Work**

Although several dozen studies assessing various aspects of pregaming have produced new insights into this phenomenon over the past decade, many had methodological limitations that make the reliability and validity of their findings somewhat uncertain. For example, many only assessed whether or not students pregamed on a single occasion (e.g., Borsari et al., 2007; LaBrie & Pedersen, 2008), how often they did so (e.g., Hustad et al., 2014; LaBrie et al., 2016; Paves et al., 2012; Pedersen & LaBrie, 2008; Zamboanga et al., 2010), or how many drinks they typically consumed when pregaming (e.g., Hustad et al., 2014; Paves et al., 2012). Most of these studies asked participants to retrospectively report over a period of days or weeks (e.g., LaBrie et al., 2016; LaBrie & Pedersen, 2008; Pedersen & LaBrie, 2007, 2008; Read et al., 2010; Zamboanga et al., 2010). This is potentially problematic because recollection and mental aggregation of drinking behaviors over longer periods of time are more vulnerable to recall bias than those in daily diary studies in which participants report behavior over shorter and more recent periods (Gmel & Rehm, 2004; Leigh, 2000). In contrast, intensive longitudinal designs, such as the longitudinal measurement-burst design (e.g., Sliwinski, 2008) used here, allow for daily measurements with short recall periods across many occasions repeated over a longer time period. For example, the design used here allowed for daily measurements of the number of drinks consumed while pregaming and in total, as well as correlates and consequences of drinking, on up to 98 days across three and a half years for 744 individuals. Since measurements occur very frequently and close in time to the events being reported (e.g., daily), self-reports from studies using such designs should be less subject to recall bias than measures in which
participants are asked to recall and aggregate their drinking behaviors over longer periods of time (Gmel & Rehm, 2004; Leigh, 2000). The use of an intensive longitudinal design (Bolger & Laurenceau, 2013; Sliwinski, 2008; Stawski, MacDonald, & Sliwinski, 2016) here, with data collected daily across up to 98 occasions across college, resulted in measurements and associations that were likely more reliable and valid than those from studies with more simple designs.

Second, the methodological limitations of past work have restricted the scope to a focus primarily on between-person associations (e.g., Borsari et al., 2007; Hustad et al., 2014; LaBrie et al., 2011; Pedersen & LaBrie, 2007, 2008), which has limited the ability to draw conclusions about within-person associations. For example, students who pregame more often also tend to be heavier drinkers and to experience more alcohol-related consequences (LaBrie et al., 2011; Paves et al., 2012). However, it is unclear whether they are just people who take more risks in general, or whether in fact given individuals’ risk for harm is also intensified when they pregame or drink at the HED level while pregaming. Further, most of what is known about within-person associations has come from studies that collected data over relatively short time periods, such as a few weeks (e.g., Fairlie, Maggs, & Lanza, 2015; Labhart et al., 2013; Merrill et al., 2013). Given that there are age-related changes in college students’ drinking (e.g., Greenbaum et al., 2005; Schulenberg et al., 2018; Schulenberg, O’Malley, Bachman, Wadsworth, & Johnston, 1996), such studies may be less representative of the typical college drinking week/weekend and the overall college drinking experience.

This paper analyzed daily data collected in two-week bursts across four consecutive semesters of college spanning two full years, which means it included more daily observations over a longer period of time than nearly all past work testing associations between pregaming
and its correlates and consequences. This likely made these findings more representative of the
typical pregaming day and the overall college experience than most past pregaming studies. The
daily measurements with short recall periods that required little mental aggregation of behaviors
likely improved the measurement reliability and validity of its variables. Further, the design of
the study used here allowed for rigorous tests of within-person associations at the daily level that
controlled for stable between-person differences, which only a few past studies have done (i.e.,
Barnett et al., 2013; Fairlie et al., 2015; Labhart et al., 2013; Merrill et al., 2013).

**Pregame Heavy Episodic Drinking**

A significant gap in the extant literature that was briefly mentioned earlier is that
although many students approach, reach, or exceed the HED threshold while pregaming (Kenney
et al., 2010; Labhart et al., 2013; Pedersen & LaBrie, 2008; Pedersen et al., 2009), no studies to
date have specifically assessed how often students actually do so and what the consequences are.
Given that the HED threshold of four/five drinks in a row for women/men was intended to
indicate a level of drinking associated with a greater risk of experiencing acute consequences if
consumed across an entire (day or evening long) drinking occasion (Wechsler, 2000; Wechsler,
Davenport, Dowdall, Moeykens, & Castillo, 1994; Wechsler, Dowdall, Davenport, & Rimm,
1995), drinking at this level *before* going out, and presumably drinking more later, is likely
associated with an even greater risk of experiencing acute negative consequences. This drinking
behavior likely increases the amount of time individuals spend outside of their home while
intoxicated, the total distance they need to travel while intoxicated (i.e., to and from their
intended destination), and the risk of blacking out. Therefore, this paper aims to introduce the
concept of Pregame HED to the college drinking literature, assess between-person (i.e., gender,
Greek organization participation, honors college enrollment, student athlete status) differences in
rates of Pregame HED, and examine whether Pregame HED is linked with HID, acute negative consequences of alcohol use, and other risky behaviors (i.e., playing drinking games, mixing alcohol and energy drinks, and illicit substance use) at the daily level.

**Significance**

Extant research on pregaming has predominantly assessed correlates and consequences of any pregaming, that is, whether students have ever pregamed or whether they did so on a particular occasion. Although these papers described pregaming as a risky drinking behavior, this paper argues that pregaming itself is not inherently risky. Rather, this paper reasons that it is the *amount* of alcohol consumed while pregaming (and throughout the rest of the drinking episode) that makes pregaming risky. Therefore, this paper sought to extend past work by introducing a new indicator of risky pregame drinking (i.e., Pregame HED) that does more to account for the amount of alcohol consumed while pregaming and that represents an intrinsically risky drinking behavior. This paper used rigorous tests of within-person associations between Pregame HED and its correlates and consequences as it aimed to provide evidence that the Pregame HED and more moderate levels of pregaming predicted differential levels of risk and harm. Additionally, this paper indirectly tested replications of associations between any pregaming and its correlates and consequences using one of the largest samples of daily pregame drinking measurements to date.

Given that heavy college drinking remains a major public health concern and that pregaming appears to be normative among college students, it is important for researchers to better understand pregame drinking and its associations with overall alcohol consumption, negative consequences, and other risky behaviors in order to inform prevention, intervention, and alcohol control policy research (e.g., Pedersen, 2016; Saltz, Paschall, McGaffigan, & Nygaard,
Since some evidence suggests that the quantity of alcohol consumed while pregaming is positively associated with the amount consumed later at the primary event (LaBrie & Pedersen, 2008), interventions or protective behavioral strategies (e.g., Donovan, Wood, Frayjo, Black, & Surette, 2012; Larimer et al., 2007; Murphy et al., 2012; Pearson, 2013) aimed at limiting pregame drinking may be effective at reducing overall drinking and risk for negative consequences.

**Research Questions**

In addition to introducing the concept of Pregame HED, this paper aimed to identify between-person predictors and within-person correlates and consequences of this behavior. The following series of research questions that compared people and occasions were assessed:

1. Were there group differences in the rate of Pregame HED? More specifically, were counts of Pregame HED on sampled drinking days higher for:
   
   (a) Males compared to females?
   
   (b) Greek organization participants compared to non-participants?
   
   (c) Student athletes compared to non-athletes?
   
   (d) Non-honors students compared to honors students?

On Pregame HED days compared to more moderate pregaming days:

2. Were students more likely to drink at the HID level?

3. Did students experience more acute negative consequences of alcohol use, when controlling for daily alcohol consumption?

4. Were students more likely to engage in other risky behaviors (i.e., playing drinking games, mixing alcohol and energy drinks, and using illegal drugs)?
Method

Participants and Procedure

Data came from the University Life Study (ULS), a longitudinal study designed to examine developmental change and fluctuations in associations between risk behaviors, daily activities, college experiences, and motivations in students at a large, public university in the Northeast United States (Greene & Maggs, 2015; Howard, Patrick, & Maggs, 2015; Patrick, Maggs, & Lefkowitz, 2015). Funded by the National Institute on Alcohol Abuse and Alcoholism (Grant AA016016 to J. Maggs), the ULS used a longitudinal measurement-burst design in which participants completed a longer, web-based survey followed by a series of 14 consecutive daily, web-based surveys each semester. The ULS was approved by the university’s institutional review board (IRB) and was protected by a federal Certificate of Confidentiality from the National Institutes of Health (NIH).

Potential study participants were identified using information obtained from the university registrar. A stratified random sampling procedure was used to select participants with the goal of creating a sample that was balanced in terms of gender and race/ethnicity. The eligibility criteria for participation in the study included being a first-year, first-time, full-time student living within 25 miles of the university and being 21 years of age or younger and a United States citizen or permanent resident. An informational letter containing a $5 cash pre-incentive was mailed to selected students to inform them about the study.

Of the selected students, 66% (N = 744) provided informed consent to participate in the study using an electronic signature and completed the first web-based semester survey and up to 14 consecutive daily web-based surveys. Links to the daily surveys were emailed to students each morning around 4 AM with the idea that most students would be asleep at this time.
Therefore, students reported about the prior day and were instructed that a “day” was defined as being from the time they woke up until the time they went to sleep. In the event that students did not complete a daily survey on the day the link was sent, they could do so on each of the following two days as well. Howard et al. (2015) reported that 68.0% of daily surveys were completed the day students received them (in reference to the previous day), 19.6% were completed one day later, and 11.7% were completed two days later. Timeliness of students’ reporting was not associated with rates of HED.

In Semester 1 of the study (also the first semester of student’s first year at the university), the average age of participants was 18.44 years (SD = .43), and the sample contained 378 females (50.8%) and 366 males (49.2%). The stratified random sampling procedure yielded a sample that was more racially/ethnically balanced than the university’s student body, which was predominantly White (82%; Penn State Fact Book, 2012). Race/ethnicity was categorized based on students’ responses to two questions suggested by the National Institutes of Health (2001). First, in brief, students were asked whether they were Hispanic. Second, they were asked to select their ethnicity from among the following categories: American Indian or Alaskan Native, Asian, Black or African American, Native Hawaiian or Pacific Islander, White, and Other, with multiple responses permitted. In creating the race/ethnicity strata for the present study, any student who reported Hispanic ethnicity was categorized as Hispanic/Latinx. The Asian and Native Hawaiian or Pacific Islander race categories were combined, and students reporting more than one race were categorized as multiracial. Thus, there were five race/ethnicity strata: Hispanic/Latinx, African American/Black non-Hispanic (NH), Asian American/Pacific Islander NH, European American NH, and multiracial NH. The Semester 1 sample of 744 contained 187 (25.1%) Hispanic/Latinx students, 117 (15.7%) African American NH students, 173 (23.3%)
Asian American/Pacific Islander NH students, 204 (27.4%) European American NH students, and 63 (8.5%) multiracial NH students.

Students were compensated for each survey they completed and were given bonuses for completing 13 or 14 of the possible 14 daily surveys each semester (Table 2-1). The compensation students received for completing the semester survey increased from $20 in Semester 1 to $40 in Semester 7, and the compensation for completing each daily survey was $3 throughout the study. The maximum compensation students could receive each semester ranged from $70 in Semester 1 to $100 in Semester 7. Retention in the ULS was fairly high with 79.6% (n = 592) of the initial sample of 744 students completing at least one daily survey in the final (7th) semester (Table 2-2). The number of daily surveys completed each semester ranged from 1 to 14, and students completed an average of 12.8 daily surveys each semester across the seven semesters of the entire study (Howard et al., 2015).

Pregaming was assessed in the ULS beginning in Semester 4, so this paper’s analyses only included daily data from Semesters 4-7, that is, Spring of students’ second year of college through Fall of students’ fourth year. In Semesters 4-7, the sample included 689 students and 34,384 days of observations. This sample consisted of 356 females (51.7%) and 333 males (48.3%). It contained 179 (26.0%) Hispanic/Latinx students, 104 (15.1%) African American/Black NH students, 160 (23.2%) Asian American/Pacific Islander NH students, 185 (26.9%) European American NH students, and 61 (8.9%) multi-racial NH students. In Semester 4, the average age of participants was 19.94 years (SD = .42).

Measures

On each daily survey, students were asked to report the number of drinks they consumed the previous day (Dimeff, Baer, Kivlahan, & Marlatt, 1999; Hustad & Carey, 2005). First,
students were instructed: “By one drink we mean half an ounce of absolute alcohol, for example, [a] 12 ounce can or bottle of beer or cooler, [a] 5 ounce glass of wine, [or] a drink containing one shot of liquor or spirits.” Then, students were asked, “How many drinks of alcohol did you drink?” in reference to the previous day. Students selected the number of drinks they consumed from a pull-down menu that ranged from 0 to 25+.

**High-intensity drinking (HID).** A dichotomous HID outcome variable was computed from the number of drinks reported each day. On days that females/males reported consuming 8/10 or more drinks, HID was coded as 1 (Linden-Carmichael, Calhoun, Patrick, & Maggs, 2018; Patrick, 2016; White et al., 2006). On days females/males reported consuming 7/9 or fewer drinks, HID was coded as 0.

**Pregaming variables.** Each day students reported drinking, they were given the following prompt: “You said you had xx drinks on [previous day, e.g., Saturday]. How many of those were pre-gaming, that is, consumed before going out?” Students were able to select the number of pregaming drinks from a pull-down menu that ranged from 0 to the total number of drinks they previously reported consuming that day. Four dichotomous pregaming variables were computed from this single item (Table 2-3). First, an Any Pregaming variable was computed to indicate days students engaged in any pregame drinking. On days students consumed any drinks (i.e., 1+) while pregaming, Any Pregaming was coded as 1. On days students consumed no drinks (i.e., 0) while pregaming, this variable was coded as 0. Second, a Pregame Heavy Episodic Drinking (Pregame HED) variable was computed to indicate days students reached or exceeded the HED threshold while pregaming. On days females/males consumed 4/5 or more drinks while pregaming, Pregame HED was coded as 1. On days females/males consumed 3/4 or fewer drinks while pregaming, this variable was coded as 0.
Third, a *Moderate Pregaming* variable was computed to indicate days students pregamed but did not reach the HED threshold while pregaming. On days females consumed 1-3 pregame drinks and males consumed 1-4 pregame drinks, Moderate Pregaming was coded as 1. On days that students did not pregame or that females/males consumed 4/5 or more drinks while pregaming, this variable was coded as 0. Fourth, a *No Pregaming* variable was computed to indicate days students did not pregame. On days students did not consume any drinks (i.e., 0) while pregaming, No Pregaming was coded as 1. On days that students consumed any drinks (i.e., 1+) while pregaming, this variable was coded as 0.

**Negative consequences of alcohol use.** Each day students reported drinking, they were asked, “As a result of drinking alcohol on [previous day], did you…” followed by 15 positive and 11 negative consequences of alcohol use they could have experienced (Maggs, 1993; Lee, Maggs, Neighbors, & Patrick, 2011; Patrick & Maggs, 2011). Only the 11 negative consequences were used in this paper (Table 2-4). Each drinking day, consequences that students experienced were coded as 1, and consequences students did not experience were coded as 0. These consequences were then summed to produce a count variable indicating the total number of negative consequences students experienced each day. The decision to operationalize daily negative consequences as the sum of the 11 dichotomous consequence indicators was made for three reasons. First, previous work suggests that the number of alcohol-related consequences individuals experience increases with the amount of alcohol consumed (Gruenewald & Mair, 2015; Read et al., 2010). Second, although using individual consequences as outcomes allows for more specific predictions, it does not give an indication of the extent to which multiple consequences may co-occur. Third, some of the consequences assessed here are not strictly dependent upon alcohol use but are also context-dependent and social in nature. For example,
finding yourself in a situation in which no one was sober enough to drive may not be relevant for students who were drinking at home or were within walking distance. As another example, doing or saying something embarrassing requires students to have been drinking with other people and could be difficult to clearly attribute to alcohol use. In these cases, individuals may have consumed large amounts of alcohol but not experienced a particular consequence due to contextual factors. Thus, although examining individual negative consequences would have some utility, it was decided that using a count variable would be the best option for assessing a broader and more representative range of negative consequences that students experienced.

**Drinking games.** Each day students reported drinking, they were asked, “Did you participate in any drinking games?” with response options of “Yes” (1) and “No” (0).

**Mixing alcohol and energy drinks.** Each day students reported drinking, they were asked, “On [previous day], how many (1) high energy (caffeinated) drinks like Red Bull, not containing alcohol did you drink? (2) high energy drinks with alcohol (e.g., Red Bull + vodka, or a premixed drink) did you drink?” Students responded to each question using a pull-down menu that ranged from 0 to 25+. Responses from these two items were summed and a dichotomous variable was created indicating any mixing of alcohol and energy drinks that day. More specifically, days students drank alcohol and energy drinks were coded as 1, and days students drank alcohol but not energy drinks were coded as 0.

**Illegal drug use.** On each daily survey, students were asked, “Did you use any illegal drugs on [previous day]?” Students had the option to respond “Yes” (1) or “No” (0). If students reported using illegal drugs on a given day, they were then asked, “Which of the following substances did you use?” Students were given the following options and were instructed to check all that applied: “marijuana,” “hashish,” “any kind of cocaine (including crack, freebase,
or powder),” “steroid pills or shots (without a prescription),” “methamphetamines (also called speed, crystal, crank, or ice),” “other types of illegal drugs (such as LSD, PCP, ecstasy, mushrooms, inhalants, heroin),” “prescription medicines not prescribed to you,” and “other illegal drugs.” For this paper, only the dichotomous variable assessing any illegal drug use each day was used.

Gender. In Semester 1, all participants provided a response to the question, “What is your gender?” which had response options of “Male” (1) and “Female” (0).

Greek organization participation. Each semester, students were asked, “What extracurricular activities do you participate in?” They were instructed to check all activities that applied from a list of 16 (e.g., intramural athletics, student government, volunteering) and “No Clubs.” The first of these activities was “Fraternity/Sorority (social).” For the purpose of this paper, Greek organization participation was coded as 1 for students who ever participated in a fraternity or sorority and as 0 for students who never participated in such an organization. The decision to assess Greek participation at the person level rather than during each semester was made for two reasons. First, this variable was largely meant to differentiate between types of individuals. The differences between individuals who had been in Greek organizations for different lengths of time (i.e., semesters) were likely smaller than those between individuals who had ever participated in Greek organizations and those who had not. Second, although there was some variability in the number of semesters that students participated in Greek organizations, these differences did not appear to be large and it did not appear that many students fluctuated in and out of these organizations. Further, even in semesters during which individuals were not formally a part of a Greek organization, it is possible, if not likely, that their social networks included peers that participated, increasing their opportunities for attending Greek-related social
activities. Therefore, the decision was made to operationalize Greek organization participation as whether students ever participated in such an organization.

**Student athlete status.** Two of the 16 extracurricular activities that students reported their participation in (as described above) were “Intercollegiate Athletics” and “Intramural Athletics/Club Sports.” Students who ever participated in athletics, whether intercollegiate, club, or intramural, were coded as 1, and students who never participated in athletics were coded as 0. The decision to operationalize the student athlete status variable as whether or not students ever participated in intercollegiate athletics, club sports, or intramural athletics was made for the same reasons this was done for Greek organization participation stated above.

**Honors college enrollment.** Each semester, students were asked, “Are you in the academic honors program ([name of honors program]) at [name of university]?” with response options of “Yes” (1) and “No” (0). This program is highly selective and comprises approximately 2% of the university’s student body (Penn State Schreyer Honors College, 2018). For example, in the Fall of 2017, the middle 50% range of SAT scores for the incoming cohort of honors college students was 1340-1490, whereas the middle 50% range for incoming students in the entire student body was 1250-1430 (Penn State Schreyer Honors College, 2018). For the purpose of this paper, students who were ever in the academic honors program were coded as 1, and students who were never in the program were coded as 0. The decision to operationalize honors college enrollment as whether or not students were ever enrolled in the university’s honors program was made for the same reasons this was done for Greek organization participation stated above.

**Social weekend day.** Since past research in other samples (Del Boca, Darkes, Greenbaum, & Goldman, 2004; Maggs et al., 2011), as well as the ULS (Finlay, Ram, Maggs, &
Caldwell, 2012), has demonstrated that the vast majority of college student heavy drinking occurs on the “social weekend” (i.e., Thursdays, Fridays, and Saturdays), it was important to account for whether each day was or was not a social weekend day. Social weekend day was operationalized using a dichotomized variable in which weekdays (i.e., Sundays, Mondays, Tuesdays, and Wednesdays) were coded as 0 and social weekend days (i.e., Thursdays, Fridays, and Saturdays) were coded as 1.

**Statistical Analyses**

*Question 1: Were There Group Differences in the Rate of Pregame HED?*

Group differences in the rate of Pregame HED across all sampled days throughout the study were tested using a single negative binomial regression that used the following equation:

\[
\log(Y) = \beta_0 + \beta_1(\text{Male}) + \beta_2(\text{Greek Participant}) + \beta_3(\text{Student Athlete}) + \beta_4(\text{Honors Student})
\]

This model was estimated using the PROC GENMOD procedure in SAS 9.4 and only included students who reported drinking during Semesters 4 through 7. All four dichotomous variables in this model were uncentered, so the intercept represented the estimated number of Pregame HED occasions for non-Greek, non-athlete, non-honors student females.

*Question 2: Was HID More Likely on Pregame HED Days than on Moderate Pregaming Days?*

Questions 2 through 4 were tested using three-level logistic and Poisson multilevel models (MLMs) that nested days within semesters within persons. These models were all estimated using the PROC GLIMMIX procedure in SAS 9.4. Random intercepts were included at the person (Level 3) and semester levels (Level 2), and a daily-level (Level 1) random variable
was used to capture the effects of under- or over-dispersion. Only drinking days (and therefore only drinkers) were included in models testing these three questions.

A logistic MLM using the following equation tested whether students’ likelihood of HID was higher on Pregame HED days than on Moderate Pregaming days:

\[
\text{Level 1: } \logit(Y)_{ijk} = \pi_{0jk} + \\
\pi_{1jk}(\text{Social Weekend Day})_{ijk} + \\
\pi_{2jk}(\text{No Pregaming Day})_{ijk} + \\
\pi_{3jk}(\text{Pregame HED Day})_{ijk} +
\]

\[
\text{Level 2: } \pi_{0jk} = \beta_{00k} + \\
\beta_{01k}(\text{Semester-Mean No Pregaming})_{jk} + \\
\beta_{02k}(\text{Semester-Mean Pregame HED})_{jk} + \\
\gamma_{0jk}
\]

\[
\pi_{1jk} = \beta_{10k}
\]

\[
\pi_{2jk} = \beta_{20k}
\]

\[
\pi_{3jk} = \beta_{30k}
\]

\[
\text{Level 3: } \beta_{00k} = \gamma_{000} + \\
\gamma_{001}(\text{Male})_{k} + \\
\gamma_{002}(\text{Greek Participant})_{k} + \\
\gamma_{003}(\text{Student Athlete})_{k} + \\
\gamma_{004}(\text{Honors Student})_{k} + \\
\gamma_{005}(\text{Person-Mean No Pregaming})_{k} + \\
\gamma_{006}(\text{Person-Mean Pregame HED})_{k} + \\
\mu_{00k}
\]

\[
\beta_{01k} = \gamma_{10}\n\]

\[
\beta_{02k} = \gamma_{20}\n\]

\[
\beta_{10k} = \gamma_{100}\n\]

\[
\beta_{20k} = \gamma_{200}\n\]

\[
\beta_{30k} = \gamma_{300}\n\]

The intercept in this model represented the likelihood of HID on Moderate Pregaming weekdays (i.e., Sundays through Wednesdays) for the average person in an average semester. At Level 3, six variables accounted for person-level differences. The \textit{Person-Mean Pregame HED} control
variable was computed by summing the number of Pregame HED occasions each person reported in Semesters 4-7. This variable was grand-mean centered by subtracting the sample-wide mean number of Pregame HED occasions from each person’s total number of Pregame HED occasions. The Person-Mean No Pregaming control variable was computed and grand-mean centered in the same manner. The four dichotomous group difference variables assessed in Question 1 (i.e., Gender, Greek Organization Participation, Student Athlete Status, and Honors College Enrollment) were similarly grand-mean centered by subtracting the sample-wide mean of each variable from each person’s value for that variable.

At Level 2, two variables were included to account for fluctuations in drinking behavior across semesters. Semester-Mean Pregame HED was computed by summing the number of Pregame HED occasions each person reported in each semester. This variable was person-mean centered by subtracting each person’s mean number of Pregame HED occasions across all semesters from the number of Pregame HED occasions they reported in each semester. Semester-Mean No Pregaming was computed and person-mean centered in the same manner. At Level 1, representing fluctuations in drinking behavior across days, all three dichotomous variables (i.e., Pregame HED Day, No Pregaming Day, and Social Weekend Day) were left uncentered.

Question 3: Did Students Experience More Negative Consequences on Pregame HED Days than on Moderate Pregaming Days Independent of Daily Alcohol Consumption?

A Poisson MLM using the following equation tested whether students experienced a greater number of negative consequences of alcohol use on Pregame HED days than on Moderate Pregaming days:
Level 1: \[
\log(Y)_{ijk} = \pi_{0jk} + \\
\pi_{1jk}(Social\ Weekend\ Day)_{ijk} + \\
\pi_{2jk}(Total\ Daily\ Drinks)_{ijk} + \\
\pi_{3jk}(No\ Pregaming\ Day)_{ijk} + \\
\pi_{4jk}(Pregame\ HED\ Day)_{ijk}
\]

Level 2: \[
\pi_{0jk} = \beta_{00k} + \\
\beta_{01k}(Semester-Mean\ Total\ Drinks)_{jk} + \\
\beta_{02k}(Semester-Mean\ No\ Pregaming)_{jk} + \\
\beta_{03k}(Semester-Mean\ Pregame\ HED)_{jk} + \\
\mu_{0jk}
\]

\[
\pi_{1jk} = \beta_{10k} \\
\pi_{2jk} = \beta_{20k} \\
\pi_{3jk} = \beta_{30k} \\
\pi_{4jk} = \beta_{40k}
\]

Level 3: \[
\beta_{00k} = \gamma_{000} + \\
\gamma_{001}(Male)_{k} + \\
\gamma_{002}(Greek\ Participant)_{k} + \\
\gamma_{003}(Student\ Athlete)_{k} + \\
\gamma_{004}(Honors\ Student)_{k} + \\
\gamma_{005}(Person-Mean\ Total\ Drinks)_{k} + \\
\gamma_{006}(Person-Mean\ No\ Pregaming)_{k} + \\
\gamma_{007}(Person-Mean\ Pregame\ HED)_{k} + \\
\mu_{00k}
\]

\[
\beta_{01k} = \gamma_{010} \\
\beta_{02k} = \gamma_{020} \\
\beta_{03k} = \gamma_{030} \\
\beta_{10k} = \gamma_{100} \\
\beta_{20k} = \gamma_{200} \\
\beta_{30k} = \gamma_{300} \\
\beta_{40k} = \gamma_{400}
\]

The intercept in this model represented the expected number of negative consequences the average student in an average semester experienced on Moderate Pregaming weekdays in which they consumed their average number of total drinks. At Level 1, the total number of drinks consumed each day was included as a control variable in order to isolate the unique variance in
negative consequences explained by pregaming, since negative consequences have been shown to increase as alcohol consumption increases (Gruenewald & Mair, 2015; Jackson, 2008; Read et al., 2008). This variable was person-mean centered by subtracting the average number of drinks each student consumed across all sampled drinking days from the total number of drinks they consumed each day. This was the only daily-level variable that was centered because leaving this variable uncentered would have resulted in the intercept representing non-drinking days. This would not have been meaningful since only drinking days were included here. The three dichotomous daily-level variables (i.e., Pregame HED Day, No Pregaming Day, and Social Weekend Day) were left uncentered. All semester-level (Level 2) variables were person-mean centered, and all person-level (Level 3) variables were grand-mean centered. These variables were computed and centered as described above.

**Question 4: Are Other Risky Behaviors More Likely on Pregame HED Days than on Moderate Pregaming Days?**

Three separate logistic MLMs were used to test whether students were more likely to play drinking games, mix alcohol and energy drinks, and use illegal drugs on Pregame HED days than on Moderate Pregaming days. The equations used to test these models were identical to those used to test Question 2, aside from the outcome variables.

**Results**

**Descriptive Statistics**

Drinking was reported on 4,706 (13.7%) of the 34,384 days sampled in Semesters 4-7. In total, 547 (79.4%) of the 689 students who completed at least one daily survey in Semesters 4-7 reported drinking on at least one occasion. Thus, the analytic sample consisted of 4,706 drinking person-days nested within 1,529 person-semesters nested within 547 student drinkers. Any
Pregaming was reported on 1,934 (41.1%) of the 4,706 drinking days, and 387 students (70.7% of drinkers and 56.2% of all students) reported Any Pregaming at least once (Table 2-5). The number of Any Pregaming occasions students reported ranged from 0 to 21 days ($M = 3.54$, $SD = 4.15$) across a maximum of 52 (i.e., 4 semesters × 14 days) sampled days per person. Pregame HED was reported on 727 days (37.6% of all pregaming days and 15.4% of all drinking days), and 226 students (41.3% of drinkers and 32.8% of all students) reported at least one Pregame HED occasion. The number of Pregame HED occasions students reported ranged from 0 to 13 ($M = 1.33$, $SD = 2.44$).

HID was reported on 1,185 (25.2%) of the 4,706 drinking days in Semesters 4-7, and 258 students (47.2% of drinkers and 37.4% of all students) reported HID at least once. Acute negative consequences of alcohol use were reported on 1,926 (40.9%) days, and 415 students (75.9% of drinkers) reported experiencing at least one negative consequence on at least one sampled day. Drinking games were reported on 1,512 (32.1%) days, and 359 students (65.6% of drinkers) reported playing drinking games at least once. Students consumed alcohol and energy drinks on 452 days (9.6% of drinking days), and 209 students (38.2% of drinkers) mixed alcohol and energy drinks at least once. Illegal drug use was reported on 443 days (9.4% of drinking days). Of the 547 students who reported drinking on at least one daily survey, 114 (20.8% of drinkers) used illegal drugs at least once. Illegal drug use was reported by 142 (20.6% of all students) of the 689 students (including non-drinkers) who completed at least one daily survey in Semesters 4-7.

In Semesters 4-7, 333 (48.3%) students were male, 136 (19.7%) reported participating in a Greek organization, 274 (39.7%) reported participating in intercollegiate athletics, club sports, or intramural athletics, and 60 (9.2%) reported being enrolled in the honors college. Of the 547
students in the analytic sample who reported drinking on at least one daily survey, 253 (46.3%) were male, 114 (20.8%) participated in a Greek organization, 224 (41.0%) participated in intercollegiate athletics, club sports, or intramural athletics, and 46 (8.4%) were enrolled in the honors college.

**Question 1: Were There Group Differences in Rates of Pregame HED?**

The results of a negative binomial regression testing group differences in rates of Pregame HED showed that the number of Pregame HED occasions reported across all sampled days did not differ between males and females, $\beta_1$, between Greek organization participants and non-participants, $\beta_2$, between student athletes and non-athletes, $\beta_3$, or between honors and non-honors students, $\beta_4$ (Table 2-6).

**Question 2: Was HID More Likely on Pregame HED Days than on Moderate Pregaming Days?**

A logistic MLM testing whether HID was more likely on Pregame HED days than on Moderate Pregaming days revealed four main findings (Table 2-7). First, at the daily level, students were 397% more likely to engage in HID on Pregame HED days, $\gamma_{300}$, and they were 54% less likely to drink at the HID level on No Pregaming drinking days, $\gamma_{200}$, in comparison to Moderate Pregaming days. Put another way, the likelihood of HID on a given drinking day increased as the amount of pregame drinking increased. Second, no evidence of a within-person, semester-level association was found between the number of Pregame HED occasions students reported in a given semester and the likelihood of HID on drinking days in that semester, $\gamma_{020}$. That is, HID did not rise and fall in tandem with the frequency of Pregame HED across semesters. Third, at the person level, students who reported more Pregame HED occasions across all four semesters were more likely to drink at the HID level on drinking days, $\gamma_{006}$. However,
there was no person-level association between students’ overall number of No Pregaming drinking occasions and their likelihood of HID on drinking days, $\gamma_{005}$. Fourth, there were group differences in students’ likelihood of HID on drinking days. Males, $\gamma_{001}$, and student athletes, $\gamma_{003}$, were more likely than females and non-athletes, respectively, to engage in HID on drinking days. In contrast, honors students were less likely than non-honors students to engage in HID on drinking days, $\gamma_{004}$. There was no association between Greek organization participation and students’ likelihood of engaging in HID on drinking days, $\gamma_{002}$.

**Question 3: Did Students Experience More Negative Consequences on Pregame HED days than on Moderate Pregaming Days Independent of Daily Alcohol Consumption?**

Four main findings were apparent from a model testing whether students experienced more negative consequences of alcohol use on Pregame HED days than on Moderate Pregaming days (Table 2-8). First, independent of the total number of drinks consumed that day, students experienced 14% more negative consequences on Pregame HED days, $\gamma_{400}$, and 17% fewer consequences on No Pregaming drinking days, $\gamma_{300}$, than on Moderate Pregaming days. Put another way, the number of consequences students experienced increased as the amount of pregaming drinks increased, while holding total alcohol consumption that day constant. Second, at the within-person, semester level, the number of Pregame HED days students reported in a given semester was not associated with the average number of negative consequences they experienced on drinking days that semester, $\gamma_{030}$. However, students experienced more negative consequences on drinking days in semesters they consumed a greater number of total drinks, $\gamma_{010}$. Third, at the person level, the number of Pregame HED occasions students reported overall was not associated with the average number of consequences students reported experiencing on drinking days, $\gamma_{007}$, although students who consumed a greater overall number of drinks on
sampled days throughout the study experienced more negative consequences on drinking days, on average, \( \gamma_{005} \). Fourth, there were no group differences in the average number of negative consequences students experienced on drinking days.

**Question 4: Are Other Risky Behaviors More Likely on Pregame HED Days than Moderate Pregaming Days?**

Results of three logistic MLMs testing whether students were more likely to play drinking games, mix alcohol and energy drinks, and use illegal drugs on Pregame HED days than on Moderate Pregaming days revealed five primary findings (Table 2-9). First, at the daily level, students were more likely to use illegal drugs, but were no more likely to play drinking games or mix alcohol and energy drinks, on Pregame HED days than on Moderate Pregaming days, \( \gamma_{300} \). Second, students were less likely to play drinking games and to mix alcohol and energy drinks on No Pregaming drinking days than on Moderate Pregaming days, \( \gamma_{200} \). Interestingly, students were more likely to use illegal drugs on No Pregaming drinking days than on Moderate Pregaming days, \( \gamma_{003} \). Third, at the within-person, semester level, there was no evidence of an association between the number of Pregame HED occasions students reported in a given semester and their likelihood of engaging in any of the three risky behaviors on drinking days in that semester, \( \gamma_{020} \). Fourth, at the person level, there was no association between the overall number of Pregame HED occasions that students reported and their likelihood of engaging in any of the three risky behaviors on drinking days, \( \gamma_{006} \). Fifth, there were some group differences in the likelihood of engaging in risky behaviors on drinking days. Student athletes were more likely to play drinking games, less likely to use illegal drugs, and no more or less likely to mix alcohol and energy drinks on drinking days than non-athletes, \( \gamma_{003} \). Males were more likely than females to use illegal drugs, but were no more likely to play drinking games or to mix alcohol.
and energy drinks, on drinking days, $\gamma_{001}$. Honors students were less likely to mix alcohol and energy drinks, but were no more likely to play drinking games or to use illegal drugs, than non-honors students on drinking days, $\gamma_{004}$. There was no association between Greek organization participation and students’ likelihood of engaging in any of the three risky behaviors on drinking days, $\gamma_{002}$.

**Discussion**

**Review of Aims and Summary of Findings**

Pregame drinking is a common behavior among US college students (DeJong et al., 2010; LaBrie & Pedersen, 2008; Pedersen et al., 2008, 2009) that has been linked with increased alcohol consumption (Barnett et al., 2013; Labhart et al., 2013) and negative consequences (Haas et al., 2012; Hughes et al., 2008; Hummer et al., 2013; LaBrie et al., 2011; Merrill et al. 2013; Paves et al., 2012; Pedersen & LaBrie, 2007; Read et al., 2010; Wahl et al., 2013) in both between- and within-person analyses. However, most work on pregaming has only assessed the risk associated with *any* pregaming without taking into account the *amount* of alcohol consumed while pregaming. This paper introduced the concept of Pregame HED, tested between-person differences in how often students engage in this behavior, and tested within-person associations of this behavior with HID, negative consequences of alcohol use, and three other risky behaviors.

Approximately two-fifths of drinkers and one-third of all students engaged in Pregame HED on at least one sampled drinking day, and Pregame HED occurred on approximately one-sixth of all drinking days and on more than one-third of pregame drinking days. Students were more likely to drink at the HID level and experienced more negative consequences on Pregame HED days than on more moderate pregaming days. Illegal drug use, but not playing drinking games or mixing alcohol and energy drinks, was more likely on Pregame HED days than on
Moderate Pregaming days. However, students were more likely to play drinking games and mix alcohol and energy drinks on Moderate Pregaming days than on No Pregaming days, which suggests that these behaviors co-occur with pregaming in general but not Pregame HED specifically. Lastly, there were no group differences in the number of sampled days students reported engaging in Pregame HED.

**The Amount of Alcohol Consumed While Pregaming Matters**

In addition to introducing the concept of Pregame HED, the most important contribution this paper makes to the college drinking literature is finding that Pregame HED was more predictive of HID and increased negative consequences than pregaming at more moderate levels. This is important given two sets of related findings. First, any pregaming has been linked with greater alcohol consumption and increased negative consequences in a number of between-person (LaBrie et al., 2011, 2016; Paves et al., 2012; Read et al., 2010) and within-person (Barnett et al., 2013; Fairlie et al., 2015; Labhart et al., 2013) studies. Second, the quantity of alcohol consumed during a drinking occasion is positively associated with the number of consequences one is expected to experience (Gruenewald & Mair, 2015; Jackson, 2008; Read et al., 2008). Yet, there is scant evidence demonstrating that the *amount of alcohol consumed while pregaming* on a given day predicts consuming more alcohol overall and experiencing a greater number of consequences that day. The present paper provides initial evidence linking these two sets of findings together. This paper also connects Pregame HED, and to a lesser extent any pregaming, to HID, which has generated increasing interest among researchers studying adolescent and young adult alcohol use (e.g., Fairlie et al., 2015; Linden-Carmichael et al., 2017; McCabe et al., 2017; Patrick et al., 2016, 2017) since the formal introduction of the concept by White and colleagues to this literature in 2006.
A critic might argue that it is somewhat circular reasoning to predict an overall level of drinking on a given day based on the level of drinking in a particular context on the same day. However, in prior studies, some students reported that they pregamed because they anticipated alcohol being expensive or difficult to obtain (e.g., if they are underage) at the primary event (DeJong et al., 2012; LaBrie et al., 2012; Pedersen et al., 2009; Read et al., 2010). This motivation or strategy of pre-drinking should lead to less alcohol being consumed after going out and a similar total by the end of each type of drinking occasion. Yet, the results of one study suggest that the average amount of alcohol consumed while pregaming is positively associated with the amount consumed later after the pregaming session (Pedersen & LaBrie, 2007), and the results of another suggest that the majority of alcohol consumed on pregaming days occurs after the pregaming session (Read et al., 2010). By using within-person analyses comparing students’ total daily drinks on Pregame HED (and non-pregaming) days to more moderate pregaming days, the present results provide more compelling evidence that pregaming in this traditionally-aged college sample tends not to be a substitute for later drinking but rather a characteristic of extremely heavy drinking days. Thus, Pregame HED may be one possible method that drinkers use (whether consciously or unconsciously) to achieve a very high level of alcohol intake. It is equally possible that the need to save money is particularly acute on days when much alcohol is to be obtained. Although the results of this paper are correlational, they suggest the possibility that prevention strategies that reduce Pregame HED occurrences may also reduce HID and its negative consequences.

But wait, there is more. Aside from the empirical findings discussed above and as mentioned earlier in the paper, there are several other reasons Pregame HED is speculated to be more risky than any pregaming. Pregaming in general is not an intrinsically dangerous drinking
behavior, whereas Pregame HED is. Although the average number of drinks students consume while pregaming is reported to be between three and four drinks (DeJong et al., 2010; Pedersen & LaBrie, 2007, 2008; Read et al., 2010), there are pregaming occasions in which students consume only one or two drinks before going out. Even though having a pregame drink or two may not be recommended, its risk is likely dependent upon how much alcohol is consumed later. Conversely, Pregame HED signifies consuming approximately enough alcohol to become intoxicated before going out (NIAAA, 2015), and even more alcohol use typically follows at the primary event (Pedersen & LaBrie, 2007; Read et al., 2010). This is expected to create a larger window of vulnerability as students are likely intoxicated for a longer period of time and while having to travel farther distances (i.e., both to and from the primary event, instead of just from). Even further, pregaming has often been described as involving rapid alcohol consumption (DeJong et al., 2010; Read et al., 2010), which poses two more problems for Pregame HED days. First, if students drink enough to become intoxicated and do so quickly, the effects of intoxication may hit them while they are traveling to the primary event. This means they could leave the pregame location not feeling drunk but become increasingly impaired and less inhibited on the way to the primary event. Second, rapidly consuming heavy quantities of alcohol is a risk factor for blacking out (Perry, 2006; White, Signer, Kraus, & Swartzwelder, 2004).

Notably, Pregame HED was remarkably common in this sample. Fairly consistent with past findings, approximately 71% of drinkers and 56% of all students reported any pregaming on at least one sampled day, and any pregaming was reported on roughly 41% of drinking days (DeJong et al., 2010; LaBrie & Pedersen, 2008; Pedersen et al., 2008, 2009). Thus, much like HED (Schulenberg et al., 1996, 2001), any pregaming would be considered statistically normative and perhaps even culturally sanctioned in college student populations. In contrast,
Pregame HED was reported by approximately 41% of drinkers and 33% of all students, with Pregame HED occurring on roughly 15% of drinking days. Thus, more like HID (Patrick & Azar, 2018; Schulenberg et al., 2018; White et al., 2006), Pregame HED appears to be common but not statistically normative, and it is likely not as culturally sanctioned as HED or any pregaming. Therefore, it seems that on more occasions than previous research has demonstrated, students are not going out to get drunk, but rather are getting drunk to go out.

**Pregaming Also Co-Occurs with Other Risky Behaviors**

The present results clearly indicate that pregaming is associated with each of the risky behaviors assessed here, albeit in various ways. First, although Pregame HED was not specifically associated with playing drinking games or mixing alcohol and energy drinks, students were more likely to engage in each of these risky behaviors on any pregaming days than on drinking days they did not pregame. These findings were consistent with past studies linking any pregaming with playing drinking games (DeJong et al., 2010; Fairlie et al., 2015; Read et al., 2010) and mixing alcohol and energy drinks (Linden-Carmichael & Lau-Barraco, 2017). Second, the results indicated that students were more likely to use illegal drugs on days they pregamed heavily and on drinking days they did not pregame at all in comparison to more moderate pregaming days. One possible explanation for this finding is that students might view Pregame HED days as “harder” partying days, and they may use illegal drugs to heighten the effects of alcohol. This rationale would be consistent with past work suggesting that college students often co-use alcohol and marijuana to complement, or enhance, the effects of one another (Gunn et al., 2018; Hughes et al., 2014; Metrik, Gunn, Jackson, Sokolovsky, & Borsari, 2018; O’Hara, Armeli, & Tennen, 2016; Williams, Pacula, Chaloupka, & Wechsler, 2004). On the other hand, on other days students used illegal drugs, they may have stayed in but still
consumed alcohol. For example, if students used marijuana on a night at home in which they watched a movie or listened to music, they may have also had some drinks. It is unclear why students were less likely to use illegal drugs on more moderate pregaming days. Perhaps moderate pregaming days were seen as more social drinking days where intoxication was not the main goal, and students therefore refrained from co-use. Similarly, since pregaming typically involves drinking in someone’s residence with smaller groups of people, students may have anticipated less approving attitudes toward illegal drug use on Moderate Pregaming days, depending on the pregaming location and participants. More research is needed to understand the intricacies of these associations, but these findings demonstrate that, independent of stable between-person differences, students are more likely to play drinking games and mix alcohol with energy drinks (and to a lesser extent to use illegal drugs) on days they pregame than on days they do not.

**The Lack of Group Differences in Rate of Pregame HED**

None of the four between-person variables tested (i.e., gender, Greek organization participation, student athlete status, and honors college enrollment) predicted the number of Pregame HED occasions students reported throughout the study. Given that Pregame HED was fairly common and that there were no group differences in this behavior, these findings may indicate that Pregame HED is a widespread behavior that is not limited to certain types of college students (e.g., male football players or Greek members). Supplemental analyses (not shown) found that males, student athletes, and Greek organization participants were more likely to engage in any pregaming than females, non-athletes, and non-Greek participants, respectively. Since Pregame HED is less common and more extreme than any pregaming, it may be that Pregame HED is predicted by other between-person variables that were not tested here, such as
personality (e.g., Camatta & Nagoshi, 1995; Cyders, Flory, Rainer, & Smith, 2009; Kahler, Read, Wood, & Palfai, 2003; Martsh & Miller, 1997; Patock-Peckham, Hutchinson, Cheong, & Nagoshi, 1998) or internalizing/externalizing symptomatology (including heavy drinking and other substance use patterns; e.g., Colder et al., 2017; Kushner & Sher, 1993; Pullen, 1994). It should be noted that the ULS was designed to test daily-level associations between drinking and motivations, contexts, and other behaviors related to the college experience (Greene & Maggs, 2017; Patrick & Maggs, 2009), and the in-depth focus on a single university sample with daily surveys was not designed to identify broader population-level between-person predictors of the rates of specific drinking behaviors. The inclusion of any pregaming or Pregame HED in nationally-representative surveys, such as Monitoring the Future (e.g., Schulenberg et al., 2018), may help in identifying between-person predictors of these drinking behaviors.

Strengths and Limitations

Strengths

The current study had four strengths related to its sample. First, the sample was selected using a stratified random sampling procedure that yielded a probability-based sample that was balanced in regards to race/ethnicity and gender. Much of the past work on pregaming has used non-probability-based (i.e., non-random) sampling techniques (e.g., Borsari et al., 2007; LaBrie & Pedersen, 2008; Read et al., 2010), and some have had samples that were predominantly White (e.g., Borsari et al., 2007; DeJong et al., 2010; Merrill et al., 2013; Pedersen & LaBrie, 2007) and/or less balanced in terms of gender (e.g., LaBrie & Pedersen, 2008; Paves et al., 2012). Therefore, the use of a probability-based sampling procedure here should have increased the diversity of groups of students represented. Second, the sample was homogenous in that it consisted of first-time, full-time, traditionally-aged college students who were not on
international student visas and who were mostly single throughout the study. This homogeneity is likely to sharpen generalizability compared to classroom-based samples that are likely to have unknown numbers of part-time, non-traditionally-aged, married, and/or international students.

Third, there were high retention and completion rates throughout the study, which resulted in little missing data across persons and days (Howard et al., 2015). For example, 80% of the initial sample was retained through the final measurement burst in Semester 7, and students completed an average of 12.8 out of 14 daily surveys throughout the study.

There were also four strengths related to the study’s use of a longitudinal measurement-burst design (Sliwinski, 2008; Stawski et al., 2016). First, the design allowed for a large N at the daily level. For instance, 34,384 daily surveys were collected in Semesters 4-7 in which pregaming was assessed. Because the analytic sample only included days students reported alcohol use, it consisted of 4,706 drinking days. In contrast, much of the past work on pregaming has used samples that included significantly fewer (e.g., Fairlie et al., 2015; Labhart et al., 2013; Merrill et al., 2013) or no daily measurements (e.g., LaBrie et al., 2011; Paves et al., 2012). Second, and similarly, this paper included data collected over four measurement bursts spread out over two years (i.e., four semesters). Since there are age-related changes (e.g., Greenbaum et al., 2005; Schulenberg et al., 1996, 2018) in drinking across the college years, the present analyses are likely to better represent the typical pregaming day than previous studies testing within-person associations using data collected across shorter time periods (e.g., Fairlie et al., 2015; Labhart et al., 2013; Merrill et al., 2013) or between-person associations using data collected at a single time point (e.g., LaBrie et al., 2011; Paves et al., 2012). Third, the study design allowed for better measurement of pregaming, other drinking and risky behaviors, and negative consequences than many past papers on pregaming. Daily measurements yielded short
recall periods and did not require students to aggregate highly-variable behaviors across longer time periods, both of which strengthened the measurement validity of the variables used here (Gmel & Rehm, 2004; Leigh, 2000; Stawski et al., 2016). In contrast, much past work has either required students to recall a single previous pregaming day that occurred at variable times in the past (e.g., Borsari et al., 2007; LaBrie & Pedersen, 2008) or to aggregate behaviors across days, weeks, or months (e.g., LaBrie et al., 2016; Pedersen & LaBrie, 2007, 2008; Read et al., 2010; Zamboanga et al., 2010). Fourth, this is one of only a few pregaming papers (e.g., Barnett et al., 2013; Fairlie et al., 2015; Labhart et al., 2013; Merrill et al., 2013) able to test within-person associations well with advanced statistical techniques. The use of multilevel models to test within-person associations at the daily level controlled for stable between-person differences by having each person serve as their own control. In contrast, much of the pregaming literature has utilized designs that only allowed for between-person tests (e.g., Hustad et al., 2014; LaBrie et al., 2011; Paves et al., 2012; Pedersen & LaBrie, 2008).

Limitations

Despite its strengths, this paper also had some limitations. First, data came from a single large, public university in a large town in the Northeast US, so it is unclear the extent to which the findings generalize to other students in smaller and/or private institutions as well as in schools in more urban areas or in other regions of the country. Similarly, given the homogeneity of the sample, it is unknown to what extent the findings generalize to less “traditional” students (i.e., older, part-time, married, etc.) who comprise a large proportion of U.S. post-secondary students (U.S. Department of Education, 2018). Second, data were only collected in two-week bursts and only during the academic year, so it unclear the extent to which these weeks generalize to other weeks during the semester and/or weeks outside of the school year (e.g.,
Winter break, summer). Third, no information was collected concerning students’ motivations for pregaming or the settings in which pregaming occurred. Yet, either of these could have moderated the associations tested here. For example, students who engaged in Pregame HED because of concerns regarding the safety of drinks at the primary event (e.g., a house party) may have been less likely to drink to the HID threshold and to experience negative consequences. Similarly, Pregame HED may have been more likely when students pregamed in relatively larger groups (e.g., 10-15 people) as opposed to smaller groups (e.g., 2-3 people). Fourth, although the response rate was high with students completing an average of 12.8 out of 14 daily surveys per semester, it is possible, if not likely, that students failed to complete some surveys following very heavy drinking days (e.g., HID days). Students did have the option to complete the daily surveys up to two days after being emailed the link, though, and rates of heavy drinking were not associated with the timing of reporting (Howard et al., 2015). Additionally, when drinking at such high levels, students may have had difficulty recalling the specific number of drinks they consumed in total and/or while pregaming as well as whether they played drinking games, mixed alcohol with energy drinks, or used illegal drugs. Although self-reports are a reliable and valid method of measuring alcohol use (Del Boca & Darkes, 2003; Simons, Wills, Emery, & Marks, 2015), students may be likely to underestimate their consumption on heavy drinking occasions (Northcote & Livingston, 2011), especially since many college students overestimate what is meant by a “standard drink” (White et al., 2005). If students consistently underestimated the amount they drank, these risky drinking thresholds (i.e., Pregame HED, HID) may have been reached by even more students and/or on even more drinking days.
Future Directions

Many important questions regarding pregaming and Pregame HED remain unanswered. First, students’ motivations for pregaming are often to get drunk (DeJong et al., 2010; Reed et al., 2011; Wahl et al., 2013), but it is unclear to what extent Pregame HED, as well as other drinking (e.g., HID) and/or risky behaviors (e.g., illegal drug use), is premeditated (Ajzen, 1985, 1991; Collins & Carey, 2007; Huchting, Lac, & LaBrie, 2008). For example, do students plan to drink to or beyond the HED level prior to going out, or do they simply plan to attend a pregame party and inadvertently end up engaging in Pregame HED? Second, pregaming typically occurs in private residences and with fewer, closer friends (DeJong et al., 2010; Pedersen & LaBrie, 2007), but it is unclear how characteristics of the physical or social pregaming environment affect drinking and its consequences throughout the rest of the night (e.g., Clapp, Reed, Holmes, Lange, & Voas, 2006; Senchak, Leonard, & Greene, 1998). For example, does the number of people or the presence of potential romantic partners in a pregame environment affect students’ likelihood of Pregame HED? Third, this paper demonstrated that Pregame HED is linked with greater short-term (i.e. daily-level) consequences than more moderate pregaming, but it is not known whether Pregame HED also predicts longer-term consequences (Jennison, 2004; O’Neill, Parra, & Sher, 2001; Zucker et al., 2006). For example, are students who engage in Pregame HED more frequently more likely to experience academic or developmental problems or to eventually develop an alcohol use disorder? Knowledge about premeditated plans, contexts, and consequences would help to identify the specific behaviors and cognitive processes that make Pregame HED risky so that prevention scientists can design program components to reduce and/or prevent them. It would also help to identify more distal symptoms of such maladaptive
behaviors so that these can be targeted and altered early so as to prevent the development of more serious health and developmental problems.

More broadly, the focus on pregaming highlights the idea that some college drinking episodes consist of a progression or sequence of drinking locations, and it would be useful to know more about these changes in venue in order to identify points that may be most amenable to intervention. For example, how many different locations do students tend to drink in when they go out, and how long do they typically stay at a particular location? It would also be very interesting to track where students go on nights out (e.g., private residences, licensed premises), as well as the distances between these locations, the modes of transportation used to get there, whether or not students tend to stay with the same group of peers throughout the episode, and whether any of these variables have an effect on the consequences students experience. Further, evidence-based interventions like BASICS (Dimeff, Baer, Kivlahan, & Marlatt, 1999) encourage students to use protective behavioral strategies, such as going home with friends or using a designated driver. It is important to know whether students use these strategies on Pregame HED days, what barriers exist to having students use them, and whether Pregame HED moderates their effectiveness in protecting students from harm. Understanding these multi-dimensional aspects of nights out may require innovative methods and strategies, such as participant observation, qualitative interviewing, wearable devices (e.g., GPS, transdermal alcohol sensors), or experience sampling, among others. Lastly, future research should assess whether Pregame HED is mostly limited to college students or if it is as common among non-students including same-age peers who do not attend college and young adults who previously attended but are no longer enrolled in college. Pregaming is clearly a drinking behavior that is engaged in by heavy drinkers and that co-occurs with other risky behaviors. The challenge for
researchers moving forward will be to continue to determine why pregame is risky and to figure out what aspects of pregame drinking are preventable or amenable to intervention.
### Tables

Table 0-1

**Participant Compensation in the University Life Study**

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<thead>
<tr>
<th>Semester</th>
<th>Daily Survey</th>
<th>Semester Survey</th>
<th>Completing 13/14 Daily Surveys</th>
<th>Completing All Daily Surveys</th>
<th>Maximum Possible Compensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$3</td>
<td>$20</td>
<td>$4</td>
<td>$8</td>
<td>$70</td>
</tr>
<tr>
<td>2</td>
<td>$3</td>
<td>$20</td>
<td>$4</td>
<td>$8</td>
<td>$70</td>
</tr>
<tr>
<td>3</td>
<td>$3</td>
<td>$30</td>
<td>$7</td>
<td>$13</td>
<td>$85</td>
</tr>
<tr>
<td>4</td>
<td>$3</td>
<td>$30</td>
<td>$7</td>
<td>$13</td>
<td>$85</td>
</tr>
<tr>
<td>5</td>
<td>$3</td>
<td>$40</td>
<td>$9</td>
<td>$18</td>
<td>$100</td>
</tr>
<tr>
<td>6</td>
<td>$3</td>
<td>$40</td>
<td>$9</td>
<td>$18</td>
<td>$100</td>
</tr>
<tr>
<td>7</td>
<td>$3</td>
<td>$40</td>
<td>$9</td>
<td>$18</td>
<td>$100</td>
</tr>
</tbody>
</table>
Table 0-2
Number of Students Who Completed Daily and Semester Surveys Each Semester in the University Life Study

<table>
<thead>
<tr>
<th>Semester</th>
<th>Daily Surveys</th>
<th>Semester Surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>718</td>
<td>744</td>
</tr>
<tr>
<td>2</td>
<td>626</td>
<td>651</td>
</tr>
<tr>
<td>3</td>
<td>640</td>
<td>649</td>
</tr>
<tr>
<td>4</td>
<td>652</td>
<td>652</td>
</tr>
<tr>
<td>5</td>
<td>613</td>
<td>620</td>
</tr>
<tr>
<td>6</td>
<td>599</td>
<td>609</td>
</tr>
<tr>
<td>7</td>
<td>592</td>
<td>608</td>
</tr>
<tr>
<td>Type of Drinking Day</td>
<td>Number of Drinks Consumed</td>
<td>Female</td>
</tr>
<tr>
<td>----------------------</td>
<td>---------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>No Pregaming</td>
<td></td>
<td>0 while pregaming</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Any Pregaming</td>
<td></td>
<td>1+ while pregaming</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Moderate Pregaming</td>
<td>1-3 while pregaming</td>
<td>1-4 while pregaming</td>
</tr>
<tr>
<td></td>
<td>No pregame drinking or</td>
<td>No pregame drinking or 5+ while pregaming</td>
</tr>
<tr>
<td></td>
<td>4+ while pregaming</td>
<td></td>
</tr>
<tr>
<td>Pregame HED</td>
<td>4+ while pregaming</td>
<td>5+ while pregaming</td>
</tr>
<tr>
<td></td>
<td>≤ 3 pregame drinks</td>
<td>≤ 4 pregame drinks</td>
</tr>
</tbody>
</table>

*Note.* Pregaming is defined here as drinking that occurs before “going out.” HED = Heavy episodic drinking.
Table 0-4
*Acute Negative Consequences of Alcohol Use Assessed*

<table>
<thead>
<tr>
<th>Type of Consequence</th>
<th>Negative Consequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical</td>
<td>Have a hangover?</td>
</tr>
<tr>
<td></td>
<td>Pass out?</td>
</tr>
<tr>
<td></td>
<td>End up in bad physical shape the next day?</td>
</tr>
<tr>
<td>Behavioral</td>
<td>Do or say something embarrassing?</td>
</tr>
<tr>
<td></td>
<td>Lose control of yourself?</td>
</tr>
<tr>
<td></td>
<td>Have your coordination affected by drinking?</td>
</tr>
<tr>
<td>Driving</td>
<td>Find yourself in a situation where no one was sober enough to drive?</td>
</tr>
<tr>
<td>School</td>
<td>Not get your schoolwork done?</td>
</tr>
<tr>
<td>Police</td>
<td>Get in trouble with the police or [university] authorities for drinking?</td>
</tr>
<tr>
<td>Sex</td>
<td>Do something sexually you wouldn’t have done if you hadn’t been drinking?</td>
</tr>
<tr>
<td></td>
<td>Have a sexual experience you wish you hadn’t?</td>
</tr>
</tbody>
</table>

*Note.* Students were asked whether they experienced each negative consequence as a result of drinking on the prior day, with response options of “yes” (1) and “no” (0). The 11 items were summed to produce a count of the number of negative consequences students experienced each day.
Table 0-5

Counts of Pregaming and Outcome Variables at the Person and Daily Levels

<table>
<thead>
<tr>
<th></th>
<th>Students, n (%)</th>
<th>Days, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pregaming Variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any Pregaming</td>
<td>387 (70.7)</td>
<td>1,934 (41.1)</td>
</tr>
<tr>
<td>Pregame HED</td>
<td>226 (41.3)</td>
<td>727 (15.4)</td>
</tr>
<tr>
<td><strong>Outcome Variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-Intensity Drinking (HID)</td>
<td>258 (47.2)</td>
<td>1,185 (25.2)</td>
</tr>
<tr>
<td>Any Negative Consequences</td>
<td>415 (75.9)</td>
<td>1,926 (40.9)</td>
</tr>
<tr>
<td>Risky Drinking Behaviors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Played Drinking Games</td>
<td>359 (65.6)</td>
<td>1,512 (32.1)</td>
</tr>
<tr>
<td>Mixed Alcohol and Energy Drinks</td>
<td>209 (38.2)</td>
<td>452 (9.6)</td>
</tr>
<tr>
<td>Used Illegal Drugs</td>
<td>114 (20.8)</td>
<td>443 (9.4)</td>
</tr>
</tbody>
</table>

*Note.* Total students, $N = 547$ students who reported drinking on at least one sampled day in Semesters 4-7 in which pregaming was assessed; total days, $N = 4,706$ drinking days reported in Semester 4-7.
Table 0-6

Negative Binomial Regression Testing Between-Person Predictors of Pregame Heavy Episodic Drinking Count

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pregame Heavy Episodic Drinking (Pregame HED) Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept, $\beta_0$</td>
<td>1.16 [.89, 1.51]</td>
</tr>
<tr>
<td>Male, $\beta_1$</td>
<td>.84 [.59, 1.20]</td>
</tr>
<tr>
<td>Greek Participant, $\beta_2$</td>
<td>1.35 [.91, 2.00]</td>
</tr>
<tr>
<td>Student Athlete, $\beta_3$</td>
<td>1.42 [.99, 2.04]</td>
</tr>
<tr>
<td>Honors Student, $\beta_4$</td>
<td>1.04 [.58, 1.86]</td>
</tr>
</tbody>
</table>

*Note. N = 547 students. IRR = Incidence rate ratio; CI = Confidence interval; Pregame HED = Females/males consuming 4+/5+ drinks while pregaming (i.e., before “going out”).

* $p < .05$; ** $p < .01$; *** $p < .001$. 
Table 0-7

**Logistic Multilevel Model Testing Whether High-Intensity Drinking Was More Likely on Pregame Heavy Episodic Drinking Days Than on Moderate Pregaming Days**

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>High-Intensity Drinking (HID)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR [95% CI]</td>
</tr>
<tr>
<td><strong>Daily Level</strong></td>
<td></td>
</tr>
<tr>
<td>Intercept, $\gamma_{000}$</td>
<td>.06 [.05, .08]***</td>
</tr>
<tr>
<td>Social Weekend Day, $\gamma_{100}$</td>
<td>2.91 [2.38, 3.56]***</td>
</tr>
<tr>
<td>No Pregaming Day$^a$, $\gamma_{200}$</td>
<td>.46 [.37, .56]***</td>
</tr>
<tr>
<td>Pregame HED Day$^a$, $\gamma_{300}$</td>
<td>4.97 [3.86, 6.41]***</td>
</tr>
<tr>
<td><strong>Semester Level</strong></td>
<td></td>
</tr>
<tr>
<td>Semester-Mean No Pregaming, $\gamma_{010}$</td>
<td>1.56 [.90, 2.70]</td>
</tr>
<tr>
<td>Semester-Mean Pregame HED, $\gamma_{020}$</td>
<td>1.19 [.58, 2.45]</td>
</tr>
<tr>
<td><strong>Person level</strong></td>
<td></td>
</tr>
<tr>
<td>Male, $\gamma_{001}$</td>
<td>1.92 [1.30, 2.84]**</td>
</tr>
<tr>
<td>Greek Participant, $\gamma_{002}$</td>
<td>1.50 [.99, 2.29]</td>
</tr>
<tr>
<td>Student Athlete, $\gamma_{003}$</td>
<td>1.64 [1.11, 2.42]*</td>
</tr>
<tr>
<td>Honors Student, $\gamma_{004}$</td>
<td>.25 [.12, .51]**</td>
</tr>
<tr>
<td>Person-Mean No Pregaming, $\gamma_{005}$</td>
<td>1.28 [.57, 2.90]</td>
</tr>
<tr>
<td>Person-Mean Pregame HED, $\gamma_{006}$</td>
<td>27.44 [9.23, 81.59]**</td>
</tr>
</tbody>
</table>

*Note. N = 4,454 drinking days within 521 students. OR = Odds ratio; CI = Confidence interval; Social Weekend Day = Thursday, Friday, or Saturday (in comparison to Sunday through Wednesday); Pregame HED = Females/males consuming 4+/5+ drinks while pregaming (i.e., before “going out”).

$^a$ Reference group is Moderate Pregaming days, or females/males consuming 1-3/1-4 drinks before going out.

* $p < .05$; ** $p < .01$; *** $p < .001$. 
Table 0-8

Poisson Multilevel Model Testing Whether Students Experienced More Negative Consequences of Alcohol Use on Pregame Heavy Episodic Drinking Days Than on Moderate Pregaming Days

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Daily Number of Negative Consequences Experienced</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IRR [95% CI]</td>
</tr>
<tr>
<td><strong>Daily Level</strong></td>
<td></td>
</tr>
<tr>
<td>Intercept, $\gamma_{000}$</td>
<td>.64 [.56, .74]***</td>
</tr>
<tr>
<td>Social Weekend, $\gamma_{100}$</td>
<td>1.00 [.92, 1.10]</td>
</tr>
<tr>
<td>Total Drinks, $\gamma_{200}$</td>
<td>1.17 [1.15, 1.18]***</td>
</tr>
<tr>
<td>No Pregaming Day, $\gamma_{300}$</td>
<td>.83 [.75, .90]***</td>
</tr>
<tr>
<td>Pregame HED Day, $\gamma_{400}$</td>
<td>1.14 [1.02, 1.27]*</td>
</tr>
<tr>
<td><strong>Semester Level</strong></td>
<td></td>
</tr>
<tr>
<td>Semester-Mean Total Drinks, $\gamma_{010}$</td>
<td>1.05 [1.02, 1.08]**</td>
</tr>
<tr>
<td>Semester-Mean No Pregaming, $\gamma_{020}$</td>
<td>1.04 [.82, 1.32]</td>
</tr>
<tr>
<td>Semester-Mean Pregame HED, $\gamma_{030}$</td>
<td>.75 [.54, 1.03]</td>
</tr>
<tr>
<td><strong>Person Level</strong></td>
<td></td>
</tr>
<tr>
<td>Male, $\gamma_{001}$</td>
<td>.90 [.72, 1.12]</td>
</tr>
<tr>
<td>Greek Participant, $\gamma_{002}$</td>
<td>1.05 [.84, 1.31]</td>
</tr>
<tr>
<td>Student Athlete, $\gamma_{003}$</td>
<td>1.09 [.89, 1.35]</td>
</tr>
<tr>
<td>Honors Student, $\gamma_{004}$</td>
<td>.81 [.56, 1.16]</td>
</tr>
<tr>
<td>Person-Mean Total Drinks, $\gamma_{005}$</td>
<td>1.15 [1.11, 1.20]***</td>
</tr>
<tr>
<td>Person-Mean No Pregaming, $\gamma_{006}$</td>
<td>.74 [.49, 1.11]</td>
</tr>
<tr>
<td>Person-Mean Pregame HED, $\gamma_{007}$</td>
<td>.68 [.36, 1.29]</td>
</tr>
</tbody>
</table>

Note. $N = 4,420$ days within 521 persons. $IRR =$ Incidence rate ratio; CI = Confidence interval; Social Weekend Day = Thursday, Friday, or Saturday (in comparison to Sunday through Wednesday); Pregame HED = Females/males consuming 4+/5+ drinks while pregaming (i.e., before “going out”).

a Reference group is Moderate Pregaming days, or females/males consuming 1-3/1-4 drinks before going out.

* $p < .05$; ** $p < .01$; *** $p < .001$. 
Table 0-9

Logistic Multilevel Models Testing Whether Students Were More Likely to Engage in Risky Behaviors on Pregame Heavy Episodic Drinking Days Than on Moderate Pregaming Days

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Any Drinking Games</th>
<th>Any Alcohol Mixed with</th>
<th>Any Illegal Drug Use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$N = 4,439$ days</td>
<td>$N = 4,451$ days</td>
<td>$N = 4,427$ days</td>
</tr>
<tr>
<td>Daily Level</td>
<td>$OR [95% CI]$</td>
<td>$OR [95% CI]$</td>
<td>$OR [95% CI]$</td>
</tr>
<tr>
<td>Intercept, $\gamma_{000}$</td>
<td>.17 [.13, .22]**</td>
<td>.06 [.04, .08]**</td>
<td>.01 [.00, .01]**</td>
</tr>
<tr>
<td>Social Weekend Day, $\gamma_{100}$</td>
<td>3.06 [2.53, 3.71]**</td>
<td>1.05 [.86, 1.27]</td>
<td>1.39 [1.16, 1.67]**</td>
</tr>
<tr>
<td>No Pregaming Day$^a$, $\gamma_{200}$</td>
<td>.80 [.66, .96]*</td>
<td>.51 [.41, .63]**</td>
<td>1.26 [1.03, 1.56]*</td>
</tr>
<tr>
<td>Pregame HED Day$^a$, $\gamma_{300}$</td>
<td>.98 [.76, 1.25]</td>
<td>.91 [.69, 1.19]</td>
<td>1.63 [1.26, 2.11]**</td>
</tr>
<tr>
<td>Semester Level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semester-Mean No Pregaming, $\gamma_{010}$</td>
<td>1.52 [.99, 2.34]</td>
<td>.88 [.46, 1.71]</td>
<td>.71 [.30, 1.68]</td>
</tr>
<tr>
<td>Semester-Mean Pregame HED, $\gamma_{020}$</td>
<td>1.47 [.80, 2.69]</td>
<td>1.44 [.56, 3.72]</td>
<td>.44 [.14, 1.45]</td>
</tr>
<tr>
<td>Person Level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male, $\gamma_{001}$</td>
<td>1.22 [.95, 1.57]</td>
<td>1.22 [.82, 1.82]</td>
<td>2.39 [1.24, 4.61]**</td>
</tr>
<tr>
<td>Greek Participant, $\gamma_{002}$</td>
<td>1.17 [.89, 1.53]</td>
<td>1.23 [.80, 1.88]</td>
<td>1.95 [.98, 3.88]</td>
</tr>
<tr>
<td>Student Athlete, $\gamma_{003}$</td>
<td>1.57 [1.22, 2.02]**</td>
<td>.88 [.58, 1.31]</td>
<td>.51 [.26, 1.00]*</td>
</tr>
<tr>
<td>Honors Student, $\gamma_{004}$</td>
<td>.74 [.48, 1.12]</td>
<td>.48 [.23, .99]*</td>
<td>1.03 [.35, 3.08]</td>
</tr>
<tr>
<td>Person-Mean No Pregaming, $\gamma_{005}$</td>
<td>.66 [.39, 1.12]</td>
<td>1.29 [.56, 2.94]</td>
<td>.38 [.10, 1.42]</td>
</tr>
<tr>
<td>Person-Mean Pregame HED, $\gamma_{006}$</td>
<td>1.99 [.94, 4.19]</td>
<td>2.00 [.64, 6.20]</td>
<td>1.74 [.30, 10.14]</td>
</tr>
</tbody>
</table>

Note. $N = 521$ students. $OR =$ Odds ratio; $CI =$ Confidence interval; Social Weekend Day = Thursday, Friday, or Saturday (in comparison to Sunday through Wednesday); Pregame HED = Females/males consuming 4+/5+ drinks while pregaming.

$^a$ Reference group is Moderate Pregaming days, or females/males consuming 1-3/1-4 drinks before going out.

* $p < .05$; ** $p < .01$; *** $p < .001$
CHAPTER 3

DAY DRINKING: DAYTIME DRINKING AMONG COLLEGE STUDENTS AND ITS ASSOCIATION WITH RISKY DRINKING BEHAVIORS

In the past decade, “day drinking” seems to have garnered increased media attention. For example, a Google search of the term “day drinking” produces hits that include internet articles (e.g., Burton, 2019; James, 2016), cocktail recipe books (e.g., Odell, 2017), and hit songs (e.g., country group Little Big Town’s 2014 song “Day Drinking”) all specifically focused on day drinking. In general, these media sources tend to glamorize day drinking as a fun activity that involves partying or social drinking during the daytime. This depiction of day drinking may or may not involve neglecting responsibilities, such as work or school. Based on media sources and the author’s own anecdotal experience, the term day drinking appears to be used colloquially among young adult students. However, there seems to be little, if any, empirical work in the college drinking scholarly literature on day drinking. There has been limited empirical work on the related behavior of tailgating, which refers to social drinking prior to major sporting events, and which often occurs in the daytime (Glassman, Dodd, Sheu, Rienzo, & Wagenaar, 2010; Neal & Fromme, 2007; Neighbors et al., 2006). Although this work suggests that tailgating is common on college campuses, it is unclear how prevalent and how risky the broader behavior of day drinking is among college students. In this context, this paper introduces to the empirical literature on college drinking the concept of day drinking, which can be generally defined as drinking during the daytime (i.e., before 4:00 PM) and which is thought to typically occur in a somewhat unique drinking context. This paper also aims to assess whether day drinking is

2 Google search of the term “day drinking” on July 5, 2019.
associated with heavy drinking and with other risky behaviors, including mixing alcohol and energy drinks, playing drinking games, and using illegal drugs.

**Brief Review of Heavy Drinking among College Students**

**Prevalence and Negative Consequences**

Alcohol use is normative on college campuses and has been for decades (Grucza, Norberg, & Bierut, 2009; Nelson, Xuan, Lee, Weitzman, & Wechsler, 2009; Straus & Bacon, 1953). Upwards of two-thirds of traditionally-aged college students report consuming alcohol in the past month, and roughly a third report heavy episodic drinking (HED), that is, females/males consuming four/five or more drinks in a row, in the past two weeks (Schulenberg et al., 2018) or month (Hingson et al., 2017). Although part of this experimentation with (heavy) alcohol use may be part of the developmental transition from adolescence to adulthood within some cultures (Arnett, 2005; Schulenberg & Maggs, 2002), such drinking is not without its consequences. In 2014, an estimated 1,519 U.S. college students died from alcohol-related events, and an estimated 22,219 students were hospitalized as a result of alcohol overdoses (Hingson, Zha, & Smyth, 2017). Similarly, a study using data from 2001 found that an estimated 10.5% (599,000) of students surveyed in the U.S. reported experiencing an alcohol-related injury in the prior year (Hingson, Zha, & Weitzman, 2009). In addition, approximately 12% (646,000) of U.S. college students reported being physically assaulted and 2% (97,000) reported being sexually assaulted by another student who had been drinking in the prior year. The proportion of students who reported each of these consequences several years later, in 2005, was not significantly different.

In addition to negative physical health consequences, heavy drinking is linked with poorer academic (Jennison, 2004; Presley & Pimentel, 2006; Singleton, 2007; Singleton & Wolfson, 2009; Thombs et al., 2009) and mental health outcomes (Presley et al., 1998;
Weitzman, 2004). Even nondrinkers experience negative consequences resulting from the heavy drinking of other students, including property damage, assault, and loss of sleep, among others (Perkins, 2002; Wechsler et al., 1995). Thus, heavy drinking on college campuses is certainly a public health problem of concern to college administrators (Wechsler et al., 2000, 2004), as well as to parents and the general public. Fully understanding the contexts in which heavy drinking occurs may enable prevention and intervention scientists and college administrators to better target this set of risky behaviors and ultimately reduce the negative impact it has on students and community members. Yet, it is unclear how drinking in certain contexts (e.g., the smaller, private settings in which pregame drinking typically occurs; tailgating parties; or during the daytime more generally) may be differentially linked with and/or exacerbate heavy drinking, negative consequences of alcohol use, and other risky behaviors.

Measurement

One of the most common ways of operationalizing heavy drinking is to define it using the gender-specific heavy episodic drinking (HED) threshold of four/five or more drinks on an occasion for women/men (Wechsler et al., 1995). Variants of this definition sometimes specify a time period in which the four/five or more drinks must occur (e.g., within two hours; NIAAA, 2015) and/or use the non-gender-specific threshold of five or more drinks on an occasion (e.g., Johnston et al., 2019; Schulenberg et al., 2018). In recent years, some researchers have also started assessing an even more extreme level of drinking known as high-intensity drinking (HID), that is, females/males consuming eight/ten or more drinks in a row (i.e., double the HED threshold; Linden-Carmichael, Vasilenko, Lanza, & Maggs, 2017; Patrick & Terry-McElrath, 2017; White, Kraus, & Swartzwelder, 2006). Although less prevalent, 10-20% of college students report drinking at this level in the past two weeks (Patrick & Terry-McElrath, 2017;
White et al., 2006). Consistent with the dose-response relationship between alcohol consumption and the number of negative consequences expected to be experienced (Gruenewald & Mair, 2015; Jackson, 2008; Read et al., 2008), students are more likely to report short-term negative consequences of alcohol use when drinking at the HID level than when drinking above the HED threshold but less than the HID threshold (Linden-Carmichael, Calhoun, Patrick, & Maggs, 2018).

**Age-Related Changes**

Developmentally, alcohol use and heavy drinking typically begin during high school, increase and peak in the early twenties, and then decrease across the mid- to late-twenties as individuals take on adult work and social roles (Johnston et al., 2019; Staff et al., 2010; White, LaBouvie, & Papadaratsakis, 2005). Although college-bound high school students drink less than their non-college-bound peers, there is a reversal after high school in which college students drink more than their non-college student peers (Schulenberg et al., 2001). Thus, especially for college students, alcohol use during the early twenties is often heavier than at any other time during the life span. Drinking subsides to more moderate levels after college and across the twenties for many, if not most, heavy drinkers (Bachman et al., 1997; Chassin, Flora, & King, 2004; Lee, Chassin, & MacKinnon, 2015; O’Malley, 2004); however, some young people who develop patterns of heavy drinking during college continue these patterns after college and are at high risk for experiencing chronic alcohol problems, such as developing alcohol use disorder (Jennison, 2004; O’Neill, Parra, & Sher, 2001; Zucker et al., 2006). Even for those whose drinking subsides after college, heavy drinking during the college years is associated with poorer health (Hingson et al., 2009, 2017; Presley et al., 1998; Weitzman, 2004) and academic (Jennison, 2004; Presley & Pimentel, 2006; Singleton, 2007; Singleton & Wolfson, 2009;
Thombs et al., 2009) outcomes and may interfere with individuals’ ability to successfully navigate the transition to adulthood (Jennison, 2004; Staff et al., 2010).

The Influence of Self-Selection and Socialization

Developmental and substance use researchers generally acknowledge that both self-selection and socialization effects play a part in shaping college students’ drinking patterns (Borsari & Carey, 2001, 2003; McCabe et al., 2005; Park, Sher, & Krull, 2009; Sher & Rutledge, 2007). In regards to selection, incoming college students who drank more in high school tend to seek out friends, living environments, and microenvironments that are conducive to and/or provide opportunities for heavier alcohol use (Kahler, Read, Wood, & Palfai, 2003; Park et al., 2009). For example, incoming first-year students who drank more heavily in high school are more likely to self-select into Greek organizations (i.e., fraternities and sororities; Larimer, Anderson, Baer, & Marlatt, 2000; McCabe et al., 2005; Read, Wood, Davidoff, McLacken, & Campbell, 2002), whose members have consistently been shown to hold more positive attitudes toward alcohol use, drink more heavily and more frequently, and experience more negative consequences of drinking than students not in Greek organizations (Borsari & Carey, 1999; Cashin, Presley, & Meilman, 1998; McCabe et al., 2005; Wechsler, Kuh, & Davenport, 1996).

However, socialization also contributes to college drinking, as there are aspects of the general college environment, as well as the microenvironments within it, that influence college students’ alcohol use. For instance, peer influences that encourage and/or facilitate alcohol use, such as overt offers of alcohol, social modeling of alcohol use, and perceived social norms, are linked with higher levels of drinking and alcohol-related negative consequences (Borsari & Carey, 2001; Lo, 1995; Wood, Read, Palfai, & Stevenson, 2001). Similarly, students in Greek organizations do not appear to continue their heavy drinking patterns once they matriculate out
of the college environment, which suggests that the socialization effects of positive attitudes towards alcohol and inflated perceived norms of peer alcohol use within the Greek system contribute to heavy drinking among its members (Larimer, Turner, Mallett, & Geisner, 2004; Sher, Bartholomew, & Nanda, 2001; Turrisi, Mallett, Mastroleo, & Larimer, 2006). Thus, heavier drinking students often appear to seek out microenvironments within the larger college environment that allow for heavy drinking, and the positive attitudes toward alcohol and elevated norms of peer alcohol use in such environments seem to reinforce such behavior (McCabe et al., 2005; Turrisi, et al., 2006).

It is important for researchers to examine the full range of contexts in which heavy college drinking occurs and to assess how aspects of these contexts, such as peer and environmental influences or motivations for drinking, may be unique. This examines one understudied drinking behavior that occurs in a unique context: day drinking. Although research in the past decade has started to examine pregaming (e.g., Borsari et al., 2007; Pedersen & LaBrie, 2007; Barnett, Orchowski, Read, & Kahler, 2013) and tailgating (e.g., Glassman, Dodd, Sheu, Rienzo, & Wagenaar, 2010; Neal & Fromme, 2007; Neighbors, Oster-Aaland, Bergstrom, & Lewis, 2006), two common college drinking behaviors that occur in unique contexts, it appears that the empirical literature has yet to explore day drinking (which includes, but is not limited to, tailgating). Documenting the prevalence of this drinking behavior as well as whether it is differentially associated with HED, HID, and other risky behaviors is a first step towards more fully identifying the range of contexts in which heavy college drinking occurs and is likely to help inform prevention, intervention, and policy efforts aimed at reducing heavy drinking and its negative consequences.
Variation in College Drinking across People, Contexts, and Time

Variation across People

A substantial amount of research has reported variation between college students in the frequency and quantity of alcohol use as well as its consequences (Ham & Hope, 2003; White & Hingson, 2013). Generally, students who are White, male, less religious, and higher on the personality traits of sensation seeking, extroversion, and neuroticism, as well as students who participate in Greek organizations and athletics, drink more frequently and in greater quantities (Ham & Hope, 2003; Turrisi et al., 2006; White & Hingson, 2013). For instance, past research suggests that White male college students drink more often and at higher levels than other demographic groups (Ham & Hope, 2003; Kahler et al., 2003), although the gender difference in some aspects of college student drinking (e.g., heavy episodic drinking) seems to have been eroding in recent years (Schulenberg et al., 2018; White & Hingson, 2013). In regard to personality, college students with higher levels of sensation seeking, extroversion, and neuroticism tend to drink at higher levels and to experience more alcohol problems than those with lower levels of these traits (Baer, 2002; Kahler et al., 2003; McAdams & Donnellan, 2009; Yanovitzky, 2006). In contrast, students who report higher levels of religiosity tend to drink less often and at lower levels than those who are less religious (Baer, 2002; Galen & Rogers, 2004; Ham & Hope, 2003). The quantity and frequency of alcohol use also varies as a function of students’ activity involvement. College students who are current or previous (i.e., high school) athletes tend to start drinking earlier and are more likely to engage in HED and to experience negative consequences of alcohol use than non-athletes (Baer, 2002; Ham & Hope, 2003; Hildebrand et al., 2001; Turrisi et al., 2006). Similarly, as mentioned previously, students who are members of fraternities and sororities tend to hold more positive views about alcohol use, to
drink more heavily and more frequently, and to experience more negative consequences than those not involved in Greek organizations (Baer, 2002; Cashin et al., 1998; Ham & Hope, 2003; Turrisi et al., 2006). Taken together, certain college students are more likely to drink and experience alcohol-related consequences than others, and it will be important to identify whether previously documented between-person differences in general drinking extend to day drinking more specifically. If so, this will help prevention, intervention, and policy efforts target a newly identified drinking behavior among students known to be at risk for heavy drinking and its consequences. In addition to varying across people, college drinking also varies across contexts.

**Variation across Contexts**

Drinking contexts can be conceptualized as where, when, and with whom individuals drink (Calahan et al., 1969). Even though most college drinking occurs at private parties and bars (Clapp, Shillington, & Segars, 2000; Demers et al., 2002), there are at least two other college drinking contexts in which heavy drinking occurs regularly: pregame settings and tailgating parties. Pregaming refers to drinking prior to a social activity or function at which more drinking typically occurs (Borsari et al., 2007; DeJong, DiRicco, & Schneider, 2010; Pedersen & LaBrie, 2007). Pregaming is very prevalent among college students with several studies reporting that the majority of their sample (i.e., two-thirds of all students and three-fourths of drinkers) reported pregaming in the past month (DeJong et al., 2010; LaBrie & Pedersen, 2008; Pedersen, LaBrie, & Kilmer, 2009; Pedersen, LaBrie, & Lac, 2008). In addition to simply occurring before drinking at parties and bars, pregaming also tends to occur in different physical locations, such as students’ residences, and pregame settings tend to be more private and to consist of smaller groups of closer friends (Borsari et al., 2007; DeJong et al., 2010; Pedersen & LaBrie, 2007). Further, students’ motivations for pregaming appear to be slightly
different than those for general drinking, with more of an emphasis on getting drunk (Bachrach, Merrill, Bytschkow, & Read, 2012; LaBrie, Hummer, Pedersen, Lac, & Chithambo, 2012). Lastly, students consume larger amounts of alcohol (Barnett, Orchowski, Read, & Kahler, 2013; Labhart, Graham, Wells, & Kuntsche, 2013) and experience more alcohol-related consequences on days they pregame than on days they do not (Hughes, Anderson, Morleo, & Bellis, 2008; Hummer et al., 2013; LaBrie, Hummer, Kenney, Lac, & Pedersen, 2011; Wahl et al., 2013). Thus, pregaming is distinct from the more often studied drinking that occurs in bars and at parties in its setting, motivations, and association with overall alcohol consumption and negative consequences. Even though the high rates of pregaming (e.g., DeJong et al., 2010; LaBrie & Pedersen, 2008; Pedersen et al., 2008, 2009) suggest that a substantial amount of college drinking occurs outside of bars and private parties, pregaming is a relatively understudied part of college drinking culture.

Tailgating parties are another example of a common drinking context other than bars or private parties. Tailgating refers to partying before sporting events that often involves drinking alcohol, and it has been a part of college football culture for decades (Glassman, Dodd, Sheu, Rienzo, & Wagenaar, 2010; Neal & Fromme, 2007; Neighbors, Oster-Aaland, Bergstrom, & Lewis, 2006). In the U.S., most colleges do not sell alcohol or allow alcohol to be brought into athletic stadiums or fields; however, many permit alcohol to be consumed in the areas surrounding athletic premises (Osgood, 2014). The term tailgating comes from the name of the back gate of pick-up trucks. Although details on how or when tailgating originated are unclear, the name seems to refer to people eating and drinking outside of sports stadiums in or near trucks whose tailgates are put down (Osgood, 2014). Tailgating most typically occurs outdoors in the parking lots and areas surrounding football or other athletic facilities, and tailgating areas
generally consist of a sea of parked cars, trucks, and recreational vehicles in which hundreds to thousands of people congregate, often drinking alcohol, cooking and eating food, socializing, and playing games (Keen, 2012). Given that most U.S. college football games start between noon and 8:00 PM, the vast majority of drinking at tailgate parties likely occurs (or at least begins) during the late morning and afternoon, as opposed to nighttime drinking that is more characteristic of private parties and bars. Although more restricted to certain days during certain times of the year, tailgating appears to be quite prevalent among college students and characterized by very heavy drinking. For instance, one study estimated that approximately three-fourths of individuals who attend tailgate parties drink (Neighbors et al., 2006), and several studies suggest that HED is a normative aspect of college football tailgating, with rates of HED while tailgating ranging from 36% to 59% and being comparable to those on well-known drinking holidays, such as New Year’s Eve and Halloween (Glassman et al., 2010; Merlo, Ahmedani, Barondess, Bohnert, & Gold, 2011; Neal & Fromme, 2007). Further, Glassman et al. (2010) reported that approximately one in six college students who attended tailgate parties engaged in HID while tailgating. Tailgating also may be linked with higher incidences of crime, as one study found that higher rates of assaults, vandalism, and arrests were reported on home football game days in locales with Division I football programs (Rees & Schnepel, 2009). Thus, tailgating seems to be another popular drinking context characterized by very heavy drinking that is distinct from the more traditional context of bars and private parties and that has attracted relatively little attention from researchers to date. This points to the notion that there may be other normative drinking contexts that have so far been overlooked by college drinking researchers.
Variation across Temporal Scales

Extant research also suggests that college drinking varies across different temporal scales. For example, heavy drinking occurs more frequently and to a greater extent during certain times of the year than others, such as in spring semester compared to fall semester (Doumas, Turrisi, Coll, & Haralson, 2007), at the beginning of each semester (Del Boca et al., 2004; Tremblay et al., 2010), on or around national holidays (e.g., Halloween, St. Patrick’s Day, and New Year’s Eve; Del Boca et al., 2004; Glindemann, Wiegand, & Geller, 2007; Tremblay et al., 2010), on local holidays (e.g., Guavaween, Del Boca et al., 2004; State Patty’s Day, Lefkowitz, Patrick, Morgan, Bezemer, & Vasilenko, 2012), and during spring break (Grekin, Sher, & Krull, 2007; Lee, Maggs, & Rankin, 2006; Patrick, Morgan, Maggs, & Lefkowitz, 2011). Similarly, heavy drinking is also more likely and/or more elevated on specific personal events, such as 21st birthdays (Neighbors et al., 2006; Rutledge, Park, & Sher, 2008; Smith, Bogle, Talbott, Grant, & Castillo, 2006), and on days with home football games (Glassman et al., 2010; Merlo et al., 2011; Neal & Fromme, 2007). At the week level, the majority of college drinking occurs on Thursdays, Fridays, and Saturdays, which have been termed the social weekend (Del Boca et al., 2004; Finlay, Ram, Maggs, & Caldwell, 2012; Maggs et al., 2011). Taken together, this work suggests there is much temporal variability in the frequency and/or intensity of heavy drinking across months, weeks, and days.

To assess variability in day drinking and its correlates and consequences, across numerous levels, this paper used a hierarchical analytic technique (i.e., multilevel modeling) to analyze data collected with an intensive repeated-measures design (i.e., a measurement-burst design). These models assessed between-person differences in the rate of day drinking across college and assessed within-person associations between day drinking and its correlates and
consequences across days and semesters. One advantage of such within-person analytic techniques is that it allows each person to serve as their own control by assessing comparisons of each person’s behavior on a particular day or in a particular semester with that same person’s behavior on other days or in other semesters (Raudenbush & Bryk, 2002). Such within-person comparisons effectively controlled for all stable, person-level variables that may confound associations (Raudenbush & Bryk, 2002).

**Day Drinking**

This paper introduces the concept of day drinking to the college drinking literature. Day drinking is defined here as drinking that begins between 6:00 AM and 4:00 PM. Based on anecdotal evidence, and a broad read of the college drinking literature, it is surmised that such drinking not only occurs at a different time of day than much college drinking but also may occur in slightly different contexts. Anecdotal evidence suggests that day drinking, like pregaming, is commonplace at many universities and colleges. Yet, there has been no empirical research documenting the prevalence of this drinking behavior or assessing how risky it is. However, drinking that occurs in related contexts (i.e., pregaming and tailgating) is heavier and perhaps riskier than drinking that occurs in more typical settings (i.e., on weekend nights at bars and/or parties). If this is the case, prevention and intervention efforts (Doumas & Andersen, 2009; Neighbors, Lee, Lewis, Fossos, & Walter, 2009; Neighbors et al., 2007, 2012; Turrisi et al., 2009), as well as alcohol control policies (Chaloupka & Wechsler, 1996; Mitchell, Toomey, & Erickson, 2005; Shaffer, Donato, LaBrie, Kidman, & LaPlante, 2005; Toomey, Lenk, & Wagenaar, 2007; Wechsler, Lee, Nelson, & Lee, 2003), may need to be aimed at day drinking in addition to drinking in more typical settings.
Event-specific prevention (ESP) builds on the foundation laid by general prevention approaches but focuses on preventing drinking on specific events, such as 21st birthdays, home football games, and holidays, in which drinking is particularly severe (Neighbors et al., 2007, 2012). Although ESP programs appear to be in the relatively early stages of development, there is some empirical support for their ability to curb 21st birthday drinking (Neighbors et al., 2009, 2012). Since widespread day drinking in college environments may be particularly likely to occur on certain days (e.g., home football game days, local holidays, the weekend after finals), ESP efforts may be able to target day drinking. College administrators and local law enforcement officials may also be able to limit day drinking through the alcohol control policies they enact and enforce (Chaloupka & Wechsler, 1996; Saltz & DeJong, 2002; Wechsler, Lee, Nelson, & Kuo, 2002). For example, restrictions could limit the times at which Greek organization parties are allowed to begin. However, basic research on day drinking must occur first to determine its prevalence, which students are most likely to engage in this behavior, and how risky it is.

Since day drinking has yet to be examined empirically, it is unknown what groups of college students are more likely to engage in day drinking. However, hypotheses can be made based on inferences from the college drinking literature more broadly. As previously discussed, male college students have traditionally engaged in heavy drinking more frequently and consumed more alcohol when they do drink than females (Ham & Hope, 2003; LaBrie & Pederson, 2008; Patrick & Terry-McElrath, 2017; Patrick, Terry-McElrath, Kloska, & Schulenberg, 2016; Read et al., 2010), although gender differences in some aspects of college drinking, such as rates of HED and pregaming, appear to be diminishing or non-existent (Borsari et al., 2007; Schulenberg et al., 2018; White & Hingson, 2013). Past work has also demonstrated
that members of Greek organizations (Borsari & Carey, 1999; Cashin, Presley, & Meilman, 1998; McCabe et al., 2005; Wechsler, Kuh, & Davenport, 1996) and student athletes (Hildebrand, Johnson, & Bogle, 2001; Leichliter, Meilman, Presley, & Cashin, 1998; Nelson & Wechsler, 2001; Wechsler, Davenport, Dowdall, Grossman, & Zanakos, 1997) drink more often, consume more alcohol per occasion, and experience more negative consequences than non-Greek and non-athlete students. In contrast, students enrolled in academic honors colleges appear to drink less frequently and in lesser quantities (Lanza, Patrick, & Maggs, 2009; Long & Lange, 2002; Rhoades & Maggs, 2006) and to be less likely to engage in risky drinking behaviors (e.g., mixing alcohol with energy drinks; Patrick, Macuada, & Maggs, 2016) than non-honors students. Thus, it was expected that day drinking would occur more often among males than females, Greek participants than non-participants, athletes than non-athletes, and non-honors students than honors students. Given that Greek organizations, athletic departments, and honors colleges are all governed by college administrators to varying degrees, differences in day drinking (and risky behaviors) among these groups are important to identify because these groups are likely fairly accessible as targets of prevention, intervention, and policy efforts (Larimer & Cronce, 2007).

**Research Questions**

To the author’s knowledge, this present study was the first in the college drinking literature that solely focused on day drinking. This paper introduced and defined the concept of day drinking as drinking that begins between 6:00 AM and 3:45 PM (i.e., before 4:00 PM). The following series of research questions that compared people and occasions were assessed:

1. Were there group differences in the rate of day drinking? More specifically, were counts of day drinking on sampled drinking days higher for:
(a) males compared to females;
(b) Greek organization participants compared to non-participants;
(c) athletes compared to non-athletes; and
(d) non-honors students compared to honors students?

On day drinking days compared to days drinking started in the evening or nighttime:

2. Were students more likely to engage in HED and HID?
3. Did students experience more acute negative consequences of alcohol use, even after controlling for total daily alcohol consumption?
4. Were students more likely to engage in other risky behaviors (i.e., playing drinking games, mixing alcohol and energy drinks, and using illegal drugs)?

**Method**

**Participants**

Data came from the University Life Study (ULS), a longitudinal study of risk behaviors and daily activities in 744 students at a large, public university in the Northeast United States (Greene & Maggs, 2015; Howard, Patrick, & Maggs, 2015; Patrick, Maggs, & Lefkowitz, 2015). The ULS used a longitudinal measurement-burst design in which participants completed a longer, web-based survey followed by a series of 14 sequential daily web-based surveys in each of seven consecutive semesters. The ULS was approved by the university’s institutional review board and was protected by a federal Certificate of Confidentiality from the National Institutes of Health (NIH).

**Procedure**

Using information obtained from the university registrar, a stratified random sampling procedure was used to select participants with the goal of creating a sample that was more
balanced in terms of gender and race/ethnicity than the university’s student body, which was predominantly White (82%; Penn State Fact Book, 2012). Eligible individuals were first-year, first-time, full-time students living within 25 miles of the university who were 21 years of age or younger and a US citizen or permanent resident. Of the selected students, 66% ($N = 744$) provided informed consent and completed the first web-based semester survey and up to 14 consecutive daily web-based surveys. In Semester 1, the average age of participants was 18.44 years ($SD = .43$), and the sample was 50.8% female. The sample contained 27.4% European American Non-Hispanic (NH) students, 25.1% Hispanic/Latinx students, 23.3% Asian American/Pacific Islander NH students, 15.7% Black/African American NH students, and 8.5% multi-racial NH students. Retention in the ULS was fairly high with 79.6% ($n = 592$) of the initial sample of 744 students completing at least one daily survey in the final (7th) semester. Students completed an average of 12.8 daily surveys each semester across the entire study, and the number completed each semester ranged from 1 to 14 days (Howard et al., 2015).

**Measures**

On each daily survey, students were asked to report the number of drinks they consumed the previous day (Dimeff, Baer, Kivlahan, & Marlatt, 1999). First, students were instructed: “By one drink we mean half an ounce of absolute alcohol, for example, [a] 12 ounce can or bottle of beer or cooler, [a] 5 ounce glass of wine, [or] a drink containing one shot of liquor or spirits.” Then, students were asked, “How many drinks of alcohol did you drink?” in reference to the previous day. Students selected the number of drinks they consumed from a pull-down menu that ranged from 0 to 25+.

*Heavy drinking.* Two dichotomous, gender-specific heavy drinking variables were computed from the number of drinks reported each day. First, a daily heavy episodic drinking
(HED; Wechsler, Dowdall, Davenport, & Rimm, 1995) variable was computed. On days females/males consumed four/five or more drinks, HED was coded as 1. On days females/males consumed less than four/five drinks, this variable was coded as 0. Second, a high-intensity drinking (HID; Linden-Carmichael et al., 2017; Patrick et al., 2016, 2017; White et al., 2006) variable was computed. On days females/males reported consuming eight/ten or more drinks, HID was coded as 1. On days females/males reported consuming seven/nine or fewer drinks, HID was coded as 0.

**Day drinking.** On days students reported any drinking, they were also asked questions about the time they started drinking with the prompts, “What time did you start your first drink?” For each item, students selected the hour from a pull-down menu that ranged from 1 to 12. They then selected the minutes from a second pull-down menu that included the response options “0,” “15,” “30,” and “45.” Finally, students indicated whether this time was before or after noon by selecting either “am” or “pm.” To increase accuracy, students were reminded that midnight is 12:00 AM and noon is 12:00 PM. Day drinking was operationalized as any drinking day in which alcohol use began between 6:00 AM and 3:45 PM (i.e., before 4:00 PM). These cut-offs were chosen so as to identify drinking days that actually began during the day, as opposed to late the night before (e.g., at 3:00 AM) or during the early evening.

**Negative consequences of alcohol use.** Students were asked on each day they reported drinking, “As a result of drinking alcohol on [previous day], did you…” followed by 11 negative consequences of alcohol use they could have experienced (Maggs, 1993; Lee, Maggs, Neighbors, & Patrick, 2011; Patrick & Maggs, 2011). Negative consequences students reported experiencing were coded as 1, and those students reported not experiencing were coded as 0. A count variable indicating the total number of negative consequences students reported
experiencing each day was then created by summing each student’s responses for the 11 consequences, as was done in Paper 1 (i.e., Chapter 2).

**Drinking games.** Each day students reported drinking, they were asked, “Did you participate in any drinking games?” with response options of “Yes” (1) and “No” (0).

**Mixing alcohol and energy drinks.** Beginning in Semester 4, that is, spring of the second year of college, each day students reported drinking, they were asked, “On [previous day], how many (1) high-energy (caffeinated) drinks like Red Bull, not containing alcohol did you drink? [and how many] (2) high-energy drinks with alcohol (e.g., Red Bull + vodka, or a premixed drink) did you drink?” Students responded to each question using a pull-down menu that ranged from 0 to 25+. Responses from these two energy drink questions were summed and a dichotomous variable was created indicating any mixing of alcohol and energy drinks that day. More specifically, days students reported drinking alcohol and energy drinks (whether combined or separate) were coded as 1, and days students reported drinking alcohol but not energy drinks were coded as 0. Because the items assessing whether students mixed alcohol and energy were not added to the survey until Semester 4, only data from Semesters 4-7 was used in analyses in which this variable was an outcome.

**Illegal drug use.** On each daily survey, students were asked, “Did you use any illegal drugs on [previous day]?” Students had the option to respond “Yes” (1) or “No” (0).

**Gender.** In Semester 1, students were asked, “What is your gender?” with response options of “Male” (1) and “Female” (0).

**Greek organization participation.** Each semester, students were asked, “What extracurricular activities do you participate in?” They were instructed to check all activities that applied from a list of 16 (e.g., intercollegiate athletics, student government, volunteering) and
“No Clubs.” The first of these activities was “Fraternity/Sorority (social).” In semesters students indicated they participated in such an organization, Greek organization participation was coded as 1. In semesters they did not report participating in a Greek organization, this variable was coded as 0. For the purpose of this paper, a person-level variable was created in which students who reported ever participating in a Greek organization were coded as 1, and students who reported never participating in such an organization were coded as 0. The rationale for this decision was described in Paper 1 (i.e., Chapter 2), and it was also used in deciding to create person-level variables for student athlete status and honors college enrollment (described below).

**Student athlete status.** Two of the 16 extracurricular activities that students reported their participation in (as described above) were “Intercollegiate Athletics” and “Intramural Athletics/Club Sports.” Students who reported participating in either type of athletics in at least one semester were coded as 1, and students who never participated in either type of athletics were coded as 0.

**Honors college enrollment.** Each semester, students were asked, “Are you in the academic honors program ([name of honors program]) at [name of university]?” with response options of “Yes” (1) and “No” (0). Students who were enrolled in the academic honors program in at least one semester were coded as 1, and students who were never enrolled were coded as 0.

**Social weekend day.** Because past research in other samples (Del Boca et al., 2004; Maggs et al., 2011), as well as the present sample (Finlay et al., 2012), has demonstrated that the vast majority of college student heavy drinking occurs on the “social weekend” (i.e., Thursdays, Fridays, and Saturdays), it was important to control for whether each day was or was not a social weekend day. Social weekend day was operationalized using a dichotomized variable in which
social weekend days (i.e., Thursdays, Fridays, and Saturdays) were coded as 1 and weekdays
(i.e., Sundays, Mondays, Tuesdays, and Wednesdays) were coded as 0.

**Statistical Analyses**

*Question 1: Were There Group Differences in How Often Students Day Drank?*

Group differences in the rate of day drinking across all sampled days throughout the study were tested using a single negative binomial regression that used the following equation:

\[
\log(Y) = \beta_0 + \beta_1(\text{Male}) + \beta_2(\text{Greek Participant}) + \beta_3(\text{Student Athlete}) + \beta_4(\text{Honors Student})
\]

This model was estimated using the PROC GENMOD procedure in SAS 9.4 and only included students who reported drinking on at least one sampled day throughout the study. All four dichotomous variables in this model were uncentered, so the intercept represented the estimated number of day drinking occasions for non-Greek, non-athlete, non-honors student females.

*Question 2: Were HED and HID More Likely on Day Drinking Days?*

Questions 2 through 4 were tested using three-level logistic and Poisson multilevel models (MLMs) that nested days within semesters within persons. These models were all estimated using the PROC GLIMMIX procedure in SAS 9.4. Random intercepts were included at the person (Level 3) and semester levels (Level 2), and a daily-level (Level 1) random variable was used to capture the effects of under- or overdispersion. Only drinking days (and therefore only drinkers) were included in models testing these three questions.
A logistic MLM using the following equation tested whether students’ likelihood of HID was higher on days drinking began before 4:00 PM (i.e., day drinking days) than on days in which drinking began at or after 4:00 PM:

Level 1: \[ \logit(Y)_{ijk} = \pi_{0jk} + \pi_{1jk}(\text{Day Drinking Day})_{ijk} + \pi_{2jk}(\text{Social Weekend Day})_{ijk} \]

Level 2: \[ \pi_{0jk} = \beta_{00k} + \beta_{01k}(\text{Semester-Mean Day Drinking})_{jk} + r_{0jk} \]
\[ \pi_{1jk} = \beta_{10k} \]
\[ \pi_{2jk} = \beta_{20k} \]

Level 3: \[ \beta_{00k} = \gamma_{000} + \gamma_{001}(\text{Male})_k + \gamma_{002}(\text{Greek Participant})_k + \gamma_{003}(\text{Student Athlete})_k + \gamma_{004}(\text{Honors Student})_k + \gamma_{005}(\text{Person-Mean Day Drinking})_k + \mu_{00k} \]
\[ \beta_{01k} = \gamma_{010} \]
\[ \beta_{10k} = \gamma_{100} \]
\[ \beta_{20k} = \gamma_{200} \]

The intercept in this model represented the likelihood of HID for the average person in an average semester on weekday (i.e., Sundays through Wednesdays) drinking days that began at or after 4:00 PM. At Level 3, five variables accounted for person-level differences. The Person-Mean Day Drinking control variable was computed by summing the number of day drinking occasions each person reported throughout the study. This variable was grand-mean centered by subtracting the sample-wide mean number of day drinking occasions from each person’s total number of day drinking occasions. The four dichotomous group difference variables assessed in
Question 1 (i.e., Gender, Greek Organization Participation, Student Athlete Status, and Honors College Enrollment) were similarly grand-mean centered by subtracting the sample-wide mean of each variable from each person’s value for that variable. At Level 2, representing fluctuations in drinking behavior across semesters, Semester-Mean Day Drinking was computed by summing the number of day drinking occasions each person reported in each semester. This variable was person-mean centered by subtracting each person’s mean number of day drinking occasions across all semesters from the number of day drinking occasions they reported in each semester.

At Level 1, representing fluctuations in drinking behavior across days, both dichotomous variables (i.e., Day Drinking Day and Social Weekend Day) were left uncentered.

**Question 3: Did Students Experience More Negative Consequences on Day Drinking Days?**

A Poisson MLM using the following equation tested whether students experienced a greater number of negative consequences of alcohol use, independent of total daily alcohol consumption, on day drinking days than on drinking days that did not include day drinking:

Level 1:

$$\log(Y)_{ijk} = \pi_{0jk} + \pi_{1jk}(Social\ Weekend\ Day)_{ijk} + \pi_{2jk}(Daily\ Total\ Drinks)_{ijk} + \pi_{3jk}(Day\ Drinking\ Day)_{ijk}$$

Level 2:

$$\pi_{0jk} = \beta_{00k} + \beta_{01k}(Semester-Mean\ Total\ Drinks)_{jk} + \beta_{02k}(Semester-Mean\ Day\ Drinking)_{jk} + r_{0jk}$$

$$\pi_{1jk} = \beta_{10k}$$

$$\pi_{2jk} = \beta_{20k}$$

$$\pi_{3jk} = \beta_{30k}$$

Level 3:

$$\beta_{00k} = \gamma_{000} + \gamma_{001}(Male)_{k} + \gamma_{002}(Greek\ Participant)_{k} +$$
The intercept in this model represented the expected number of negative consequences the average student in an average semester experienced on weekday drinking days that began at or after 4:00 PM and in which they consumed their average number of total drinks. At Level 1, the total number of drinks consumed each day was included as a control variable in order to isolate the unique variance in negative consequences explained by day drinking, since negative consequences have been shown to increase as alcohol consumption increases (Gruenewald & Mair, 2015; Jackson, 2008; Read et al., 2008). This variable was person-mean centered by subtracting the average number of drinks each student consumed across all sampled drinking days from the total number of drinks they consumed each day. This was the only daily-level variable that was centered because leaving this variable uncentered would have resulted in the intercept representing non-drinking days. This would not have been meaningful since only drinking days were included here. All semester-level (Level 2) variables were person-mean centered, and all person-level (Level 3) variables were grand-mean centered. These variables were computed and centered as described above.

**Question 4: Were Other Risky Behaviors More Likely on Day Drinking Days?**

Three separate logistic MLMs were used to test whether students were more likely to play drinking games, mix alcohol and energy drinks, and use illegal drugs on day drinking days
than on drinking days that did not include day drinking. The equations used to test these models were identical to those used to test Question 2, aside from the outcome variables.

**Results**

**Descriptive Statistics**

Drinking was reported on 7,633 (12.3%) of the 62,160 days sampled in Semesters 1-7. In total, 619 (84.1%) of the 736 students who completed at least one daily survey reported drinking on at least one sampled occasion. Thus, the analytic sample consisted of 7,633 drinking days nested within 2,601 person-semesters nested within 619 students. Day drinking was reported on 690 (9.0%) of the 7,633 drinking days (Table 1). In total, 307 students (49.6% of drinkers and 41.7% of all students) reported day drinking on at least one occasion. The number of day drinking occasions students reported ranged from 0 to 10 (M = 1.11, SD = 1.67). Students reached the HED threshold on 511 (74.1%) of the 690 day drinking days, and 235 students (38.0% of drinkers) reported HED on a day drinking day at least once. Students reached the HID threshold on 298 (43.2%) of the 690 day drinking days, and 148 students (23.9% of drinkers) reported HID on a day drinking day at least once.

In regard to outcome variables, HED was reported on 4,930 (64.6%) of the 7,633 drinking days in Semesters 1-7, and 516 students (83.3% of drinkers and 70.1% of all students) reported HED at least once. HID was reported on 1,838 (24.1%) of the sampled drinking days, and 326 students (52.7% of drinkers and 44.2% of all students) reported HID at least once. Negative consequences of alcohol use were reported on 3,284 (43.0%) drinking days, and 496 students (80.1% of drinkers) experienced negative consequences on at least one occasion. Drinking games were reported on 2,577 (33.8%) drinking days, and 455 students (73.5% of drinkers) played drinking games on at least one occasion. Illegal drug use was reported on 731
(9.6%) drinking days. Of the 619 students who reported drinking on at least one daily survey, 151 (24.4%) reported using illegal drugs at least once. Illegal drug use was reported by 188 (25.5% of all students) of the 736 students (including non-drinkers) who completed at least one daily survey. Students reported mixing alcohol and energy drinks on 452 (9.6%) of the 4,706 drinking days in Semesters 4-7, and 209 students (33.8% of drinkers) reported mixing alcohol and energy drinks at least once.

Of the 744 students who completed at least one of the longer semester surveys, 366 (49.2%) students were male, 181 (24.3%) participated in a Greek organization, 413 (55.5%) participated in intercollegiate athletics, club sports, or intramural athletics, and 72 (9.7%) were ever enrolled in the honors college. Of the 619 students in the analytic sample who reported drinking on at least one daily survey, 300 (48.5%) were male, 167 (27.0%) participated in a Greek organization, 355 (57.4%) participated in intercollegiate athletics, club sports, or intramural athletics, and 55 (8.9%) were ever enrolled in the honors college.

**Question 1: Were There Group Differences in How Often Students Day Drank?**

Results of a negative binomial regression testing whether there were group differences in the rate of day drinking are presented in Table 3-2. On average, Greek organization participants reported 51% more day drinking occasions than non-participants, $\beta_2$. However, there was no difference in the rate of day drinking between males and females, $\beta_1$, between student athletes and non-athletes, $\beta_3$, or between honors and non-honors students, $\beta_4$.

**Question 2: Were HED and HID More Likely on Day Drinking Days?**

Results of two logistic MLMs testing whether HED and HID were more likely on day drinking days than drinking days students did not day drink revealed four primary findings (Table 3-3). First, at the daily level, students were 32% more likely to engage in HED and 179%
more likely to engage in HID on day drinking days than on drinking days they did not day drink, $\gamma_{200}$. Second, at the within-person, semester level, there was no evidence of an association between the number of day drinking occasions students reported in a given semester and their likelihood of engaging in HED or HID on drinking days that semester, $\gamma_{010}$. Third, at the person level, students who reported more overall day drinking occasions throughout the study were more likely to engage in HED and HID on drinking days than students who reported fewer day drinking occasions, $\gamma_{005}$. Fourth, there were a number of group differences in students’ likelihood of engaging in HED and HID. Greek organization participants, $\gamma_{002}$, and student athletes, $\gamma_{003}$, were more likely to engage in HED and HID on drinking days than non-participants and non-athletes, respectively. In contrast, honors students were less likely than non-honors students to engage in HED and HID, $\gamma_{004}$. There was no gender difference in the likelihood of HED, but the likelihood of HID was greater for males than females, $\gamma_{001}$.

**Question 3: Did Students Experience More Negative Consequences on Day Drinking Days?**

Four main findings were apparent from a model testing whether students experienced more negative consequences of alcohol use on day drinking days than on drinking days in which they did not day drink (Table 3-4). First, independent of the total number of drinks consumed that day, students experienced 39% fewer negative consequences on day drinking days than on drinking days they did not day drink, $\gamma_{300}$. Second, at the within-person, semester level, there was no evidence of an association between the number of day drinking occasions students reported in a given semester and the average number of negative consequences they experienced on drinking days that semester, $\gamma_{020}$. Third, at the person level, students who day drank more often throughout the study experienced more negative consequences on drinking days, on average, than students who day drank less often, $\gamma_{006}$. Fourth, there was only one group
difference in the number of negative consequences students reported. Males reported experiencing fewer negative consequences than females, on average, $\gamma_{001}$, but there were no differences in the average number of negative consequences reported on drinking days between Greek organization participants and non-participants, $\gamma_{002}$, between student athletes and non-athletes, $\gamma_{003}$, or between honors and non-honors students, $\gamma_{004}$.

**Question 4: Were Other Risky Behaviors More Likely on Day Drinking Days?**

Results of three models testing whether students were more likely to play drinking games, mix alcohol with energy drinks, and use illegal drugs on day drinking days than on drinking days students did not day drink revealed several main findings (Table 3-5). First, at the daily level, students were more likely to play drinking games and to use illegal drugs, but not to mix alcohol with energy drinks, on day drinking days than drinking days students did not day drink, $\gamma_{200}$. Second, at the within-person, semester level, there was no evidence of an association between the number of day drinking occasions students reported in a given semester and their likelihood of playing drinking games, mixing alcohol with energy drinks, or using illegal drugs on drinking days that semester, $\gamma_{010}$. Third, at the person level, students who day drank on more occasions throughout the study were more likely to mix alcohol with energy drinks, but not to play drinking games or use illegal drugs, on drinking days than students who day drank on fewer occasions, $\gamma_{005}$. Fourth, there were some group differences in students’ likelihood of engaging in risky behaviors. Males were more likely than females to play drinking games and to use illegal drugs, but there was no gender difference in the likelihood of mixing alcohol and energy drinks, $\gamma_{001}$. Similarly, Greek organization participants were more likely than non-participants to play drinking games and to use illegal drugs, but there was no difference in the likelihood of mixing alcohol and energy drinks between participants and non-participants, $\gamma_{002}$. Similarly, student
athletes were more likely to play drinking games and less likely to use illegal drugs than non-athletes, but there was no difference in the likelihood of mixing alcohol and energy drinks between athletes and non-athletes, $\gamma_{003}$. Lastly, there was no difference in the likelihood of engaging in any of the three risky behaviors on drinking days between honors and non-honors students, $\gamma_{004}$.

**Discussion**

**Review of Aims and Summary of Findings**

This paper introduced the concept of day drinking and tested whether it was associated with heavy drinking, negative consequences of alcohol use, and other risky behaviors in a U.S. college student sample. Taken together, day drinking was somewhat common in this sample of college students, and it appears to co-occur with several risky behaviors. Approximately half of day drinkers reported day drinking on at least one occasion, and day drinking occurred on 9% of sampled drinking days. Students who engaged in day drinking were more likely to drink at the HED and HID levels, play drinking games, and use illegal drugs on day drinking days than on days drinking began in the evening or nighttime. Additionally, day drinking was more common among Greek organization participants than non-participants. Interestingly, when controlling for daily alcohol consumption, students reported fewer average negative consequences on day drinking days than on drinking days that did not include day drinking. More research is needed to determine the extent to which day drinking itself is fundamentally risky.

**Day Drinking Co-Occurs with Other Risky Behaviors**

Descriptive statistics showing the percentage of day drinking days in which heavy drinking took place were astonishing. Students engaged in HED on nearly three-fourths of day drinking days, whereas they did so on less than two-thirds of all drinking days. Similarly,
students engaged in HID on more than two-fifths of day drinking days, whereas they did so on less than one-fourth of all drinking days. The results of models testing associations between drinking during the daytime and heavy drinking further supported the idea that day drinking is more characterized by heavy drinking than is evening or nighttime drinking. Drinking during the daytime was positively associated with both traditionally-defined heavy episodic drinking and with more intense drinking at twice this amount at both the person and daily levels. Put another way, students who day drank more often also tended to drink heavily more often, and students were more likely to drink heavily on day drinking days than on days in which drinking started in the evening or nighttime. These tendencies were independent of stable, between-person differences, such as typical alcohol consumption or heavy drinking frequency.

These findings extend and follow logically from prior limited research on tailgating, which is a specific type of day drinking. Drinking while tailgating tends to be very heavy, with levels comparable to holidays traditionally linked to heavy drinking such as New Year’s Eve and St. Patrick’s Day (Del Boca et al., 2004; Glindemann et al., 2007; Lefkowitz et al., 2012; Tremblay et al., 2010). For instance, cross-sectional studies have reported that roughly three-fourths of tailgate party attendees consume alcohol (Neighbors et al. 2006), between one-third and three-fifths of tailgaters engage in HED (Merlo et al., 2011; Neal & Fromme, 2007), and one-sixth of tailgaters drink to the HID level (Glassman et al., 2010). Although this investigation focused more on daily-level, within-person associations among student drinkers, the prevalence of heavy drinking among day drinkers as a group and on day drinking days reported here appears to be consistent with the prevalence of heavy drinking at tailgate parties reported in past work. However, it is unknown what percentage of the day drinking days reported here also included tailgating (Glassman et al., 2010; Neighbors et al. 2006; Merlo et al., 2011; Neal & Fromme,
2007) or occurred on special occasions, such as local (e.g., State Patty’s Day, Guavaween) or national (e.g., Halloween, St. Patrick’s Day) holidays (Del Boca et al., 2004; Glindemann et al., 2007; Lefkowitz et al., 2012; Tremblay et al., 2010).

Day drinking was also associated in varying ways with other types of risky behaviors, such as playing drinking games, mixing alcohol with energy drinks, and using illegal drugs. Students were more likely to play drinking games and use illegal drugs on day drinking days than on evening or nighttime drinking days. Given that drinking games are intended to facilitate rapid alcohol consumption to get participants drunk (Borsari, 2004; Zamboanga et al., 2014) and have been linked with higher levels of alcohol consumption (Cameron, Leon, & Correia, 2011; Clapp et al., 2003; Engs & Hanson, 1993; Hummer, Napper, Ehret, & LaBrie, 2013; LaBrie, Ehret, & Hummer, 2013; LaBrie, Hummer, Kenney, Lac, & Pedersen, 2011; Pedersen, 1990), the daily-level association between day drinking and playing drinking games suggests a potential reason why day drinking days tend to be heavy drinking days. That is, it may be that students are more likely to play drinking games on day drinking days which, in turn, leads to greater overall amounts of drinking that day. Although testing this mediational relationship was beyond the scope of this paper, this would be an interesting hypothesis to test in future research. The daily-level association between day drinking and illegal drug use is especially important because it links day drinking to a non-alcohol-related risky behavior that may exacerbate or be intended to exacerbate the effects of (heavy) drinking (Gunn et al., 2018; Hughes et al., 2014; Metrik, Gunn, Jackson, Sokolovsky, & Borsari, 2018; O’Hara, Armeli, & Tennen, 2016; Williams, Pacula, Chaloupka, & Wechsler, 2004). It is also intriguing that there was no evidence of these two associations at the person level, independent of the daily-level associations. That is, when accounting for the daily-level associations between day drinking and playing drinking games and
using illegal drugs, frequent day drinkers were no more likely than students who day drank less frequently or not at all to engage in either of these two behaviors. This suggests that something about the day drinking context itself is conducive to these risky behaviors, but that such behaviors do not necessarily distinguish (ever) day drinkers from those who only drink in the evening or nighttime.

In contrast, the association between day drinking and mixing alcohol with energy drinks showed the reverse pattern. Students who day drank more often also reported mixing alcohol with energy drinks more frequently (shown by the person-level effects), but students were no more likely to mix alcohol with energy drinks on day drinking days than on nighttime drinking days (shown by the daily-level effects). Day drinking was positively associated with the likelihood of mixing alcohol with energy drinks at the person level, but there was no evidence of a daily-level association between these two variables. Given that one motivation for mixing alcohol with energy drinks is to feel less tired or more energetic (Marczinski, 2011; Peacock, Bruno, & Martin, 2013), perhaps this behavior is less necessary on day drinking days, when drinking starts much earlier, than on days drinking starts later at night and may continue well beyond midnight. Given that mixing alcohol with energy drinks is positively associated with a number of other risky behaviors at the person level, including heavy drinking and other substance use (Berger, Fendrich, Chen, Arria, & Cisler, 2011; Brache & Stockwell, 2011; O’Brien, McCoy, Rhodes, Wagoner, & Wolfson, 2008; Snipes & Benotsch, 2013; Woolsey, Waigandt, & Beck, 2010), perhaps day drinking and mixing alcohol with energy drinks are both part of a constellation of risky drinking behaviors that the heaviest drinkers tend to engage in (e.g., Chiauzzi, Pronabesh, & Black, 2013; Evans-Polce, Lanza, & Maggs, 2016). Taken together, both day drinkers and day drinking contexts appear to be characterized by an elevated
likelihood of risky behaviors, namely heavy alcohol consumption. Future research would be well served to try to determine whether these associations are merely spurious or if there are specific mechanisms linking these behaviors together (e.g., playing drinking games mediating the association between day drinking and heavy drinking).

**Is Day Drinking Actually Safer Than Nighttime Drinking?**

Surprisingly, students experienced *fewer* negative consequences on day drinking days, on average, despite being *more* likely to engage in several risky behaviors. This was true in models that included and did not include (not shown) the total number of drinks students consumed each day. This finding might appear to suggest that day drinking is safer or less risky than drinking in the evening or nighttime. For instance, one may speculate that students are more tired when drinking late at night, which may exacerbate the impairment of their motor skills and coordination leading to increased risk of injury. Alternatively, it could be speculated that because fewer other people are drinking, students are less likely to be victims of physical or sexual assault on day drinking days. However, it seems equally possible that these results stem from the contextual and temporal aspects of day drinking as well as how negative consequences were measured.

Although the behavioral consequences (e.g., doing/saying something embarrassing, having one’s coordination affected) assessed here may depend less on the time of day in which drinking occurred, this may not be as true for other consequences. For instance, if a student began drinking at 9:00 AM (e.g., on the day of a home football game), stopped drinking at 6:00 PM, and surpassed the HID threshold, they potentially would have had an additional six to eight hours (in comparison to HID days they began drinking at night) to eat food and drink water and for their body to metabolize the alcohol before waking up the next day and responding to the
daily survey asking about the previous day’s behaviors. Thus, it is possible that students reported fewer physical consequences (i.e., having a hangover, ending up in bad physical shape the next day) on day drinking days than on drinking days that began in the evening or at night because they may have stopped drinking earlier, leading to a greater number of hours between the alcohol consumption itself and the assessment of potential negative consequences. Similarly, to the extent that social norms regarding day drinking and its consequences differ from those of evening or nighttime drinking, students may be less likely to believe certain consequences happened to them if those consequences were thought to be normative and harmless (Lee, Geisner, Patrick, & Neighbors, 2010; Mallett, Bachrach, & Turrisi, 2008). Students’ willingness to experience certain consequences, which has been linked with students’ likelihood of experiencing those consequences (Mallett, Varvil-Weld, Turrisi, & Read, 2011), may also differ between day drinking days and drinking days beginning in the evening or at night. Further, motivations for drinking differentially predict the use of protective behavioral strategies, which are behaviors drinkers can use to reduce the likelihood of heavy drinking and its negative consequences, such as having a designated driver and not leaving one’s drink unattended (Martens et al., 2004; Patrick et al., 2011). As one would expect, use of these strategies predicts experiencing fewer consequences (Araas & Adams, 2008; Martens, Ferrier, & Cimini, 2007). Thus, it may be that students have different motivations (e.g., those related to conformity) for drinking on day drinking days which may lead to a greater likelihood of using protective behavioral strategies on such days and, in turn, a lower likelihood of experiencing negative consequences. Finally, from a measurement perspective, this paper assessed the total number of consequences students experienced, as opposed to the likelihood of experiencing specific consequences. Despite experiencing fewer total consequences on day drinking days, it may be
that students are more likely to experience some individual consequences (e.g., blacking out) and are less likely to experience others (e.g., hangover) on day drinking days than drinking days that do not include day drinking. More research examining the likelihood of specific consequences on day versus evening and nighttime drinking days would help clarify the likelihood of specific risks of heavy drinking in the day versus nighttime drinking contexts (e.g., Clapp et al., 2006), whether associations vary across different consequences (e.g., Park & Grant, 2005), and whether other variables (e.g., motives, behavioral strategies to mitigate risk) moderate such associations (e.g., Patrick et al., 2011).

Findings at the person level were in the opposite direction: Students who day drank more often tended to experience more negative consequences on drinking days than students who day drank less frequently or not at all. This finding is more consistent with past work demonstrating that heavier drinkers report experiencing more negative consequences (Wechsler, Dowdall, Davenport, & Rimm, 1995; Wechsler, Dowdall, Maenner, Gledhill-Hoyt, & Lee, 1998), given this paper’s finding that more frequent day drinkers tended to be heavier drinkers (discussed above). The between-person association between day drinking and increased negative consequences also makes sense in light of past findings identifying Greek participants as one of the highest risk groups of students for heavy drinking and its negative consequences (Borsari et al., 2009; Cashin, Presley, & Meilman, 1998; Wechsler, Kuh, & Davenport, 1996) as well as the result here that Greek participants reported more day drinking occasions throughout the study than non-participants (discussed below). It seems that frequent day drinking may be an indicator of a larger, maladaptive pattern of alcohol use characterized by frequent, heavy drinking and other risky behaviors. Future work should test to the extent to which frequent day drinking contributes to longer-term problems by assessing whether day drinking frequency predicts later
increases in positive attitudes toward alcohol use, heavy drinking, and negative consequences (e.g., LaBrie, Earle, Hummer, & Boyle, 2016).

Is Day Drinking Mostly a Greek Thing?

Greek organization participants reported more day drinking occasions throughout the duration of the study than non-participants. Although testing different hypotheses, this finding appears to complement Glassman et al.’s (2010) finding that Greek members were twice as likely as non-Greeks to engage in HID on typical home football game days. Glassman et al. (2010) also found that few students (16%) reported typically drinking during the game and nearly half (46%) reported typically not drinking after the game, which suggests (but does not confirm) that much of the typical drinking on game days occurs before the game (i.e., during the day). The number of day drinking occasions reported did not differ between males and females, between student athletes and non-athletes, or between honors and non-honors students. Thus, it may be that day drinking is a phenomenon most typical of students in or associated with Greek organizations (Greek students reported 35.8% of day drinking days). It should be noted that the daily measurements used here were designed to assess daily level associations reliably, not to test between person differences in rates of drinking behaviors. These between-person findings should be interpreted with this in mind. Future work should aim to build upon these preliminary findings by using designs and measurements that allow for more refined contrasts between groups. For instance, future research should aim to differentiate between athletes in the more traditional sense (i.e., intercollegiate athletes) and non-athletes (including intramural athletes) and to look at within-person changes across semesters in the association between being an athlete and drinking behaviors. Future work should also use measures more appropriately designed for
testing between-person hypotheses, such as questions asking about the frequency of day drinking in the past 30 days or the past six months.

**Intervention Implications**

Given the relatively high rates of HED and HID among college students (Hingson et al., 2017; Patrick & Terry-McElrath, 2017; Schulenberg et al., 2018; White et al., 2006) and the associations of day drinking with HED and HID presented here, prevention scientists could target day drinking in their attempts to reduce heavy college drinking and its resulting consequences. To the degree that many day drinking days are tailgating days, event-specific interventions (Neighbors et al., 2007, 2009, 2012) and alcohol control policies (Chaloupka & Wechsler, 1996; Mitchell et al., 2005; Shaffer et al., 2005; Toomey et al., 2007; Wechsler et al., 2003) may be able to help control the risks and/or reduce the prevalence of heavy day drinking. On campuses where tailgating days make up a smaller proportion of day drinking days, other types of prevention strategies, such as brief motivational interventions (e.g., Baer, Kivlahan, Blume, McKnight, & Marlatt, 2001; Chiauzzi, Green, Lord, Thum, & Goldstein, 2005; Larimer et al., 2001; Turrisi et al., 2009) or personalized normative feedback interventions (e.g., Doumas & Andersen, 2009; Neighbors, Larimer, & Lewis, 2004; Neighbors, Lewis, Bergstrom, & Larimer, 2006), may be more effective. Another alternative may be offering alcohol-free programming (Fenzel, 2005; Layland, Calhoun, Russell, & Maggs, 2019; Patrick, Maggs, & Osgood, 2010; Weitzman & Kawachi, 2000) on weekend afternoons and/or on some holidays so that students have appealing alternatives to heavy drinking during these times. However, before prevention scientists can effectively target day drinking, more basic research is needed to more fully understand who day drinks, in what settings and with whom day drinking tends to occur, and what specific risks are associated with this behavior.
Strengths and Limitations

Strengths

This paper has a number of strengths, most of which are related to the sample and the measurement-burst design (Sliwinski, 2008; Stawski, MacDonald, & Sliwinski, 2016) utilized by the ULS. In regard to the sample, the use of a stratified random sampling procedure resulted in a probability-based sample that was fairly balanced in terms of gender and race/ethnicity, which should have broadened the generalizability of the findings. The sample was also fairly homogenous so much as it consisted only of first-time, full-time, traditionally-aged US college students. This should have made the generalizability much more defined, as opposed to more heterogeneous samples of college students that include more part-time, non-traditional-aged, and/or international students (e.g., Barry, Stellefson, Piazza-Gardner, Chaney, & Dodd, 2013). Finally, rates of retention and completion were high (Howard et al., 2015), meaning there was little missing data which likely only minimally biased results.

In regard to the study design, the measurement-burst design resulted in a large daily-level \( N \) (i.e., 7,633 drinking days out of a total of 62,160 sampled days). The study also spanned seven consecutive semesters over three-and-a-half years, meaning that the sample of days should have better represented the typical drinking day than other studies that collected only a single burst (e.g., Fairlie et al., 2015) or did not obtain daily-level assessments (e.g., Hustad et al., 2014). This is important in light of research demonstrating age-related changes in drinking behavior across college (e.g., Greenbaum et al., 2005; Schulenberg et al., 1996, 2018). Further, the study design should have provided better measurements of drinking, risky behaviors, and consequences as daily measurements resulted in short recall periods and did not require as much mental aggregation of behaviors across longer periods of time as other types of measures (Gmel
such as quantity-frequency measures or the Time Line Follow Back method (Read, Merrill, & Bytschkow, 2010; Sobell & Sobell, 1992). Finally, the use of multilevel models allowed for testing within-person associations while controlling for stable between-person differences (Raudenbush & Bryk, 2002) which should have improved the validity of the findings.

**Limitations**

In addition to its strengths, this paper had some limitations. First, data came from one large, public university in the northeastern US. Thus, this paper’s findings may not generalize to students in other types of higher education institutions, such as smaller and/or private institutions as well as schools in more urban areas and/or in other regions of the country. Second, students completed up to two weeks of daily reports each semester, so it is unclear how representative the sampled weeks were of the rest of the semester or weeks when students were not in school (e.g., Summer or Winter break). As a result of this, the use of aggregated daily reports in analyses testing between-person differences in the number of times students reported day drinking was not ideal. Third, the criteria used to define day drinking was logical but somewhat arbitrary and may not be the best way of defining this behavior. For example, alternative definitions of day drinking could be drinking that started prior to 3:00 PM to ensure no overlaps with early happy hours or prior to 5:00 PM as that is often considered the end of the business day. Fourth, this paper did not account for the settings in which day drinking occurred. There is likely substantial heterogeneity in the environments and social contexts in which day drinking occurs. Perhaps only day drinking with large numbers of peers (e.g., tailgating or daytime parties) is characterized by heavy drinking. In contrast, drinking in smaller groups, with adult family
members, and/or while eating at a restaurant during the day may not be associated with heavy drinking.

**Future Directions**

Future research should build upon the work presented here in several ways. One of the first steps future research on day drinking should take is to develop a clearer, more evidence-based operational definition of day drinking. Researchers may need to conduct qualitative studies, such as focus groups (e.g., DeJong, DeRicco, & Schneider, 2010), to better understand the full range of contexts in which day drinking occurs and what differentiates this behavior from drinking in the evening or nighttime. In developing a better operational definition, future work should also aim to determine whether day drinking is more likely on weekends and/or when the weather is favorable and whether day drinking among college students typically takes place in large groups?

Second, discovering whether students are more (or less) likely to experience *specific* negative consequences of alcohol use (e.g., blacking out, having a hangover, being physically or sexually assaulted) on day drinking days than on evening or nighttime drinking days would help clarify the extent to which day drinking is a risky behavior (e.g., Linden-Carmichael et al., 2018). Although this paper found that students experienced fewer total consequences on day drinking days than on evening or nighttime drinking days, it may be that there are differential associations between day drinking and individual consequences. Third, it appears that day drinking co-occurs with other risky behaviors but is associated with experiencing fewer consequences at the daily level; however, it is still unknown whether day drinkers, and perhaps those who drink to the HED or HID levels during the day, are more likely to experience medium- or long-term alcohol problems, such as developing alcohol use disorder or experiencing
academic or developmental problems (although this was tested in Paper 3; e.g., Jennison, 2004). Fourth, establishing the prevalence of day drinking in same-age, non-college student samples as well as in samples of individuals in their mid to late twenties will be important in determining whether (heavy) day drinking and other risky behaviors associated with it (i.e., playing drinking games, using illegal drugs) are restricted to the college environment or if they are also common among other types of individuals (e.g., workers, parents, married people) and in other settings (e.g., military) (e.g., White, Labouvie, & Papadaratsakis, 2005). Similarly, it is important for future work to determine how many day drinkers are daily, dependent drinkers. Although it is still unclear how inherently risky day drinking is, getting drunk during the daytime does not seem to be uncommon and it is probably not the college experience that many parents and college administrators have in mind.
### Table 0-1

**Counts of Day Drinking and Outcome Variables at the Person and Day Levels**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Students</th>
<th>Drinking Days</th>
<th>Day Drinking Days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td>Day Drinking</td>
<td>307 (49.6)</td>
<td>690 (9.0)</td>
<td>690 (100.0)</td>
</tr>
<tr>
<td><strong>Outcome Variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HED</td>
<td>516 (83.3)</td>
<td>4,930 (64.6)</td>
<td>511 (74.1)</td>
</tr>
<tr>
<td>HID</td>
<td>326 (52.7)</td>
<td>1,838 (24.1)</td>
<td>298 (43.2)</td>
</tr>
<tr>
<td>Any Negative Consequences</td>
<td>496 (80.1)</td>
<td>3,284 (43.0)</td>
<td>304 (44.1)</td>
</tr>
<tr>
<td>Risky Behaviors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Played Drinking Games</td>
<td>455 (73.5)</td>
<td>2,577 (33.8)</td>
<td>288 (41.7)</td>
</tr>
<tr>
<td>Used Illegal Drugs</td>
<td>151 (24.4)</td>
<td>731 (9.6)</td>
<td>92 (13.3)</td>
</tr>
<tr>
<td>Mixed Alcohol with Energy Drinks&lt;sup&gt;a&lt;/sup&gt;</td>
<td>209 (38.2)</td>
<td>452 (9.6)</td>
<td>55 (11.9)</td>
</tr>
<tr>
<td><strong>N</strong></td>
<td>619 (100.0)</td>
<td>7,633 (100.0)</td>
<td>690 (100.0)</td>
</tr>
</tbody>
</table>

*Note.* Total students, $N = 619$ students who reported drinking on at least one sampled day; total drinking days, $N = 7,633$; total day drinking days, $N = 690$. Day Drinking = Days drinking started between 6:00 AM and 3:45 PM; HED = Heavy episodic drinking, or days women/men consumed 4+/5+ drinks; HID = High-intensity drinking, or days women/men consumed 8+/10+ drinks.

<sup>a</sup> Alcohol mixed with energy drinks was only available in Semesters 4-7. Percentages are out of 547 students who reported drinking, 4,706 drinking days, and 462 day drinking days in those semesters.
Table 0-2

*Negative Binomial Regression Testing Between-Person Predictors of the Number of Day Drinking Occasions Students Reported*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Number of Day Drinking Occasions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$IRR$ [95% CI]</td>
</tr>
<tr>
<td>Intercept, $\beta_0$</td>
<td>1.00 [.82, 1.23]</td>
</tr>
<tr>
<td>Male, $\beta_1$</td>
<td>.82 [.64, 1.05]</td>
</tr>
<tr>
<td>Greek Participant, $\beta_2$</td>
<td>1.51 [1.17, 1.95]**</td>
</tr>
<tr>
<td>Student Athlete, $\beta_3$</td>
<td>1.15 [.89, 1.48]</td>
</tr>
<tr>
<td>Honors Student, $\beta_4$</td>
<td>.89 [.59, 1.36]</td>
</tr>
</tbody>
</table>

*Note.* $N = 619$ students. $IRR =$ Incidence rate ratio, $CI =$ Confidence interval.  
* $p < .05$; ** $p < .01$; *** $p < .001$.  

Table 0-3
Logistic Multilevel Model Testing Whether Heavy Episodic and High-Intensity Drinking Were More Likely on Day Drinking Days than on Drinking Days That Students Did Not Day Drink

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Heavy Episodic Drinking (HED)</th>
<th>High-Intensity Drinking (HID)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Daily Level</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept, $\gamma_{000}$</td>
<td>0.50 [0.42, 0.59]***</td>
<td>0.04 [0.04, 0.05]***</td>
</tr>
<tr>
<td>Social Weekend Day, $\gamma_{100}$</td>
<td>3.57 [3.13, 4.08]***</td>
<td>3.20 [2.74, 3.74]***</td>
</tr>
<tr>
<td>Day Drinking Day, $\gamma_{200}$</td>
<td>1.32 [1.06, 1.64]*</td>
<td>2.79 [2.30, 3.39]***</td>
</tr>
<tr>
<td><strong>Semester Level</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semester-Mean Day Drinking, $\gamma_{010}$</td>
<td>1.42 [0.89, 2.26]</td>
<td>1.46 [0.86, 2.46]</td>
</tr>
<tr>
<td><strong>Person Level</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male, $\gamma_{001}$</td>
<td>0.94 [0.73, 1.22]</td>
<td>1.85 [1.34, 2.53]***</td>
</tr>
<tr>
<td>Greek Participant, $\gamma_{002}$</td>
<td>1.66 [1.26, 2.18]***</td>
<td>1.40 [1.01, 1.95]*</td>
</tr>
<tr>
<td>Student Athlete, $\gamma_{003}$</td>
<td>1.60 [1.23, 2.07]***</td>
<td>1.70 [1.23, 2.35]**</td>
</tr>
<tr>
<td>Honors Student, $\gamma_{004}$</td>
<td>0.63 [0.41, 0.97]*</td>
<td>0.42 [0.24, 0.76]**</td>
</tr>
<tr>
<td>Person-Mean Day Drinking, $\gamma_{005}$</td>
<td>8.70 [2.77, 27.26]***</td>
<td>6.08 [1.64, 22.53]**</td>
</tr>
</tbody>
</table>

*Note. N = 7,549 days nested within 618 students. OR = Odds ratio, CI = Confidence interval.

Social Weekend Day = Thursday, Friday, or Saturday (vs. Sunday through Wednesday).

* p < .05; ** p < .01; *** p < .001.
Table 0-4

**Poisson Multilevel Model Testing Whether Students Experienced More Negative Consequences of Alcohol Use on Day Drinking Days than on Drinking Days They Did Not Day Drink**

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Daily Number of Negative Consequences Experienced</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Daily Level</strong></td>
<td></td>
</tr>
<tr>
<td>Intercept, $\gamma_{000}$</td>
<td>.66 [.60, .72]***</td>
</tr>
<tr>
<td>Social Weekend Day, $\gamma_{100}$</td>
<td>1.00 [.93, 1.07]</td>
</tr>
<tr>
<td>Daily Total Drinks, $\gamma_{200}$</td>
<td>1.20 [1.19, 1.21]***</td>
</tr>
<tr>
<td>Day Drinking Day, $\gamma_{300}$</td>
<td>.61 [.55, .67]***</td>
</tr>
<tr>
<td><strong>Semester Level</strong></td>
<td></td>
</tr>
<tr>
<td>Semester-Mean Total Drinks, $\gamma_{010}$</td>
<td>1.00 [.98, 1.02]</td>
</tr>
<tr>
<td>Semester-Mean Day Drinking, $\gamma_{020}$</td>
<td>.91 [.70, 1.19]</td>
</tr>
<tr>
<td><strong>Person Level</strong></td>
<td></td>
</tr>
<tr>
<td>Male, $\gamma_{001}$</td>
<td>.77 [.65, .92]**</td>
</tr>
<tr>
<td>Greek Participant, $\gamma_{002}$</td>
<td>1.06 [.90, 1.26]</td>
</tr>
<tr>
<td>Student Athlete, $\gamma_{003}$</td>
<td>1.07 [.90, 1.26]</td>
</tr>
<tr>
<td>Honors Student, $\gamma_{004}$</td>
<td>.82 [.62, 1.09]</td>
</tr>
<tr>
<td>Person-Mean Total Drinks, $\gamma_{005}$</td>
<td>1.17 [1.13, 1.20]***</td>
</tr>
<tr>
<td>Person-Mean Day Drinking, $\gamma_{006}$</td>
<td>2.44 [1.23, 4.86]*</td>
</tr>
</tbody>
</table>

*Note. N = 7,505 days nested within 618 students. IRR = Incidence rate ratio, CI = Confidence interval.

*a Social Weekend Day = Thursday, Friday, or Saturday (vs. Sunday through Wednesday).

* $p < .05$; ** $p < .01$; *** $p < .001$. 
Table 0-5
Logistic Multilevel Models Testing Whether Students Were More Likely to Engage in Risky Behaviors on Day Drinking Days than on Drinking Days They Did Not Day Drink

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Any Drinking Games</th>
<th>Any Alcohol Mixed with</th>
<th>Any Illegal Drugs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$N = 7,525$ days</td>
<td>$N = 4,646$ days</td>
<td>$N = 7,508$ days</td>
</tr>
<tr>
<td>Intercept, $\gamma_{000}$</td>
<td>.19 [.16, .22]**</td>
<td>.08 [.06, .10]**</td>
<td>.01 [.01, .01]**</td>
</tr>
<tr>
<td>Social Weekend Day*, $\gamma_{100}$</td>
<td>2.49 [2.15, 2.87]**</td>
<td>1.14 [.88, 1.48]</td>
<td>1.27 [1.10, 1.46]**</td>
</tr>
<tr>
<td>Day Drinking Day, $\gamma_{200}$</td>
<td>1.37 [1.13, 1.66]**</td>
<td>1.13 [.78, 1.66]</td>
<td>1.49 [1.23, 1.82]**</td>
</tr>
<tr>
<td>Semester Level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semester-Mean Day Drinking, $\gamma_{010}$</td>
<td>.99 [.63, 1.56]</td>
<td>.89 [.39, 2.02]</td>
<td>.71 [.28, 1.80]</td>
</tr>
<tr>
<td>Person Level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male, $\gamma_{001}$</td>
<td>1.27 [1.04, 1.54]*</td>
<td>1.36 [1.00, 1.85]</td>
<td>2.92 [1.72, 4.95]**</td>
</tr>
<tr>
<td>Greek Participant, $\gamma_{002}$</td>
<td>1.30 [1.06, 1.59]*</td>
<td>1.25 [.91, 1.71]</td>
<td>1.82 [1.06, 3.11]*</td>
</tr>
<tr>
<td>Student Athlete, $\gamma_{003}$</td>
<td>1.44 [1.18, 1.76]**</td>
<td>.83 [.61, 1.14]</td>
<td>.41 [.24, .69]**</td>
</tr>
<tr>
<td>Honors Student, $\gamma_{004}$</td>
<td>.71 [.51, 1.00]</td>
<td>.65 [.37, 1.12]</td>
<td>.79 [.32, 2.00]</td>
</tr>
<tr>
<td>Person-Mean Day Drinking, $\gamma_{005}$</td>
<td>2.21 [.89, 5.51]</td>
<td>4.21 [1.08, 16.37]*</td>
<td>6.09 [.71, 52.64]</td>
</tr>
</tbody>
</table>

Note. $N = 618$ students. $OR =$ Odds ratio, $CI =$ Confidence interval.

* Social Weekend Day = Thursday, Friday, or Saturday (vs. Sunday through Wednesday).

* $p < .05$; ** $p < .01$; *** $p < .001$. 
CHAPTER 4

ASSOCIATIONS BETWEEN THREE INDICATORS OF RISKY DRINKING AND MEDIUM-TERM NEGATIVE CONSEQUENCES AMONG COLLEGE STUDENTS

Heavy drinking among college students is a major concern for parents, college administrators, developmental scientists, and society at large due to its myriad negative consequences for both drinkers and those in or near college environments (Dawson, Grant, Stinson, & Chou, 2004; Hingson, Zha, & Smyth, 2017; Hingson, Zha, & Weitzman, 2009; Wechsler et al., 2000, 2004). In addition to daily-level negative consequences, such as alcohol poisoning and blacking out, another concern regarding heavy college drinking is its potential to lead to longer-term developmental and health problems, such as difficulty transitioning to adulthood and alcohol use disorder. For example, several studies have documented that many college students meet the DSM-IV criteria for alcohol abuse and alcohol dependence (Blanco et al., 2008; Dawson, Grant, Stinson, & Chou, 2004; Knight et al., 2002; Slutske, 2005). Heavy drinking during college is also negatively associated with college academic performance (e.g., grade point average and degree completion; Gill, 2002; Howland et al., 2010; Jennison, 2004; Paschall & Freisthler, 2003; Presley & Pimentel, 2006; Singleton, 2007; Singleton & Wolfson, 2009; Thombs et al., 2009; Williams, 2003; White & Hingson, 2013 Wood et al., 1997) as well as poorer labor market outcomes after college (Jennison, 2004). For many college students, heavy alcohol use can be considered a developmental disturbance that is limited to the college years and context (Schulenberg et al., 2001; Schulenberg, Patrick, Maslowsky, & Maggs, 2014). Although heavy drinking subsides to some extent after college for many individuals (O’Malley, 2004; Maggs & Schulenberg, 2005; White, Labouvie, & Papadaratsakis, 2005), some continue to drink heavily and continue to or eventually meet the diagnostic criteria for AUD (Babor et al.,...
Similarly, heavy drinking through the mid- and late-twenties is generally not compatible with the demands and values of adult work and social roles, such as full-time employment, marriage, and parenthood (Bachman, Wadsworth, O’Malley, Johnston, & Schulenberg, 1997; Staff et al., 2010; Yamaguchi & Kandel, 1985).

Much of the literature examining consequences of heavy drinking operationalizes this concept using the indicator of heavy episodic drinking (HED), defined for females/males as consuming four/five or more drinks in a row (Hingson et al., 2002; Jennison, 2004; Knight et al., 2002; Patrick, 2016; Singleton, 2007; Singleton et al., 2009). Although HED has demonstrated its usefulness as an indicator of risk (Patrick, 2016; Wechsler et al., 1994; Wechsler & Nelson, 2001, 2008), it cannot fully capture all aspects of heavy drinking and its associated risks, such as drinking far beyond the HED threshold (Patrick, 2016; Linden-Carmichael, Calhoun, Patrick, & Maggs, 2018; White & Hingson, 2013) or drinking in unique or particularly risky contexts (e.g., pregaming and tailgating; Borsari et al., 2007; Glassman, Dodd, Sheu, Rienzo, & Wagenaar, 2010; LaBrie, Earle, Hummer, & Boyle, 2016). Therefore, in order to fully assess the risks of heavy college drinking, it is important to begin utilizing additional indicators of such behavior that identify heavy drinking that occurs at more extreme levels and in unique contexts, both of which likely confer more risk than can be identified by the HED indicator alone.

This paper assessed the predictive utility of three additional risky drinking indicators—high-intensity drinking, Pregame HED, and day drinking—in identifying medium-term consequences in the health, legal, and academic domains. Medium-term consequences were conceptualized as those that occurred across several years (e.g., from first to fourth year of college) but not necessarily across different periods of the life span (e.g., from late adolescence
to middle adulthood). Thus, medium-term consequences were defined here as those occurring one to three years after drinking was initially assessed.

**Heavy Episodic Drinking as an Indicator of Heavy Drinking**

HED has been linked with many acute negative consequences for the drinker and those in the drinker’s surrounding environment. For example, students who engage in HED more frequently are more likely to engage in risky sexual (e.g., unplanned and/or unprotected sexual activity) and antisocial (e.g., vandalism, legal violations) behavior, to miss class and fall behind on schoolwork, to require medical treatment as a result of an alcohol overdose, and to drive a motor vehicle under the influence of alcohol (Kiene, Barta, Tennen, & Armeli, 2009; Patrick & Maggs, 2015; Wechsler, Lee, Kuo, & Lee, 2000; Wechsler et al., 2002). HED also negatively impacts other students by what have been termed “secondhand effects” (Wechsler et al., 2000, 2002). That is, students who attend colleges and universities with a greater number of HED drinkers report higher levels of such secondary effects due to other people’s drinking, including problems sleeping or studying, property damage, and assault (physical, verbal, or sexual). Within-person studies also demonstrate that college students and young adults are more likely to experience an array of primary negative consequences on days they engage in HED than on non-HED days. For example, on HED days compared to non-HED days, college students and young adults are more likely to engage in risky sexual behavior, such as unprotected sex (Kiene et al., 2009), and to experience a hangover (Jackson, 2008).

HED has also been linked with an assortment of longer-term consequences. For instance, HED frequency during college is positively associated with symptoms of alcohol use disorder concurrently (i.e., during college; Knight et al., 2002) and prospectively in young adulthood (Jennison, 2004). Further, HED frequency is negatively associated with college academic
performance (i.e., grade point average and degree completion; Gill, 2002; Howland et al., 2010; Jennison, 2004; Paschall & Freisthler, 2003; Presley & Pimentel, 2006; Singleton, 2007; Singleton et al., 2009; Thombs et al., 2009; Williams, 2003; Wood et al., 1997). Although there is some inconsistency among the findings, the number of studies documenting a negative association between HED frequency and grade point average and other indicators of academic performance far outnumber those suggesting no association (White & Hingson, 2013). Jennison (2004) also found that HED frequency predicted poorer labor market outcomes after college, as operationalized by occupational prestige. Thus, HED has demonstrated its predictive utility of numerous acute and chronic alcohol-related consequences.

**Issues with Using Heavy Episodic Drinking as an Indicator of Heavy Drinking**

Although HED is a useful indicator of general heavy drinking, there are two issues with using it as the sole indicator of heavy drinking in college student populations, as well as general late adolescent and young adult populations. First, HED does not sufficiently capture the variability in the quantity of alcohol consumed per occasion that exists above the four/five drink threshold (Naimi, Nelson, & Brewer, 2010; Patrick, 2016; Read, Beattie, Chamberlain, & Merrill, 2008; White, Kraus, & Swartzwelder, 2006). For example, one study reported that the average number of drinks consumed by US adults on their most recent HED day was 9.5 (Naimi et al., 2010), and another study reported that the average number of drinks consumed by regularly drinking college students across all drinking days was just under seven (Read et al., 2008). Approximately half of male and one quarter of female college students who report heavy drinking in the past two weeks exceeded double the HED threshold at least once in that time (White, Kraus, & Swartzwelder, 2006), and roughly 10% of all 19- and 20-year-olds report drinking at double the HED threshold in the past two weeks (Patrick & Terry-McElrath, 2017).
Thus, many HED occasions consist of drinking well above the four/five HED threshold. Given the general dose-response relationship between the number of drinks consumed and the number of consequences experienced (Gruenewald & Mair, 2015; Jackson, 2008; Read et al., 2008), some HED occasions may be extremely risky (e.g., consuming 15 drinks) whereas others may be only mildly risky (e.g., 5 drinks). However, the traditional HED indicator fails to differentiate between such occasions. This is the primary reason behind the recent push for researchers to start using higher thresholds as an indicator of drinking that is more extreme and more risky than HED (Patrick, 2016; Patrick & Azar, 2018; White et al., 2006).

Second, HED is relatively normative among college students. For example, 30-45% of college students report HED in the past two weeks (Schulenberg et al., 2018) or past month (Hingson, Zha, & Smyth, 2017). Although many college students drink more than would be optimal for their health, on any given occasion many may not experience event-level negative consequences (e.g., getting injured, alcohol poisoning, having a hangover; e.g., Lee et al., 2010; Merrill et al., 2013; Neal & Carey, 2007) and most will not experience severe longer-term health or developmental problems from such behavior (e.g., developing a long-lasting alcohol use disorder; O’Malley, 2004; Schulenberg & Maggs, 2002). Thus, although screening instruments that use HED as an indicator of risky drinking may have adequate sensitivity in identifying individuals who will eventually develop such distal problems, they may lack specificity in distinguishing students who will versus will not develop longer-term problems.

**Three Alternative Indicators of Risky Drinking**

*High-Intensity Drinking*

High-intensity drinking, a heavy drinking indicator set at double the HED threshold (i.e., eight/ten or more drinks in a row for women/men; Linden-Carmichael, Vasilenko, Lanza, &
not only captures additional variability in short-term negative consequences but also may capture unique variability in medium- and long-term consequences. Whereas HED is a statistically normative behavior that is often culturally-sanctioned in the late teens and early twenties and may be viewed as more of a developmental disturbance than an indication of an emerging psychopathology (Meich et al., 2018; Substance Abuse and Mental Health Services Administration [SAMHSA], 2015; Schulenberg et al., 1996, 2001, 2018; Swendsen et al., 2012), regular HID is a marker of riskier behavior and is statistically non-normative for individuals at any age of the life span. For example, half or less than half as many college students report engaging in HID in the past two weeks (i.e., 10-20%; Patrick & Terry-McElrath, 2017; White et al., 2006) as report engaging in HED (i.e., 30-45%; Schulenberg et al., 2018). Given that HID predicts more short-term negative consequences than HED (Linden-Carmichael et al., 2018), a pattern of repeated HID may indicate the existence or emergence of an underlying psychopathology, such as alcohol use disorder.

There is limited research on the medium- and long-term consequences of HID. A few papers have linked HID with greater short- (Linden-Carmichael et al., 2018; Patrick, Cronce, Fairlie, Atkins, & Lee, 2016) and medium-term consequences (Hingson, Zha, & White, 2017; Linden-Carmichael et al., 2017) using cross-sectional data. However, this current paper is the first to use measurements of HID to prospectively predict medium-term consequences assessed two to three years later in a college student sample. HID was expected to predict a greater number of medium-term consequences than HED-Only, that is, HED that occurs below the HID level (i.e., 4-7/5-9 drinks for females/males). In part, HID may predict medium- and long-term consequences due to the accumulating effects of repeatedly experiencing daily-level consequences; however, there may also be other factors involved. For example, students who
drink heavily and/or who have positive attitudes toward heavy drinking may self-select into peer
groups exhibiting similar behaviors and attitudes related to alcohol use, and peer influences (i.e.,
socialization) in these groups may then reinforce and/or exacerbate these behaviors and attitudes
(Baer, Kivlahan, & Marlatt, 1995; McCabe et al., 2005; Park, Sher, Wood, & Krull, 2006; Read,
Wood, Davidoff, McLacken, & Campbell, 2002; Reifman, Watson, McCourt, 2006).
Additionally, if drinking at extreme levels (i.e., HID) becomes routine, it may interfere with the
drinker’s learning and academic performance (De Bellis et al., 2005; Medina et al., 2008;
McQueeny et al., 2009; Singleton, 2007; Singleton et al., 2009; Squeglia, Jacobus, & Tapert,
2009; Wechsler et al., 2000; White, 2003) or their relationships (Fischer et al., 2005; Nezlek,
Pilkington, & Bilbro, 1994), and alcohol dependence may develop (Chassin, Pitts, & Prost, 2002;
Dawson & Archer, 1993; Dawson, Grant, & Harford, 1995; Jennison, 2004; Knight et al., 2002).

**Pregame HED**

Although there is a general dose-response relationship between the amount of alcohol
consumed and the number of event-level negative consequences individuals experience
(Gruenewald & Mair, 2015; Jackson, 2008; Read et al., 2008), the volume of alcohol consumed
may not be the only issue contributing to longer-term alcohol-related problems. The contexts in
which students drink may also contribute to high-risk patterns of alcohol use. For example, the
pregaming literature suggests that pregame drinking, or drinking prior to a social activity
(Borsari et al., 2007; Pedersen & LaBrie, 2007), is distinct in a number of ways, including its
location, pace, and motivations, from the more typical drinking that occurs at bars and parties
(Bachrach, Merrill, Bytschkow, & Read, 2012; DeJong, DiRicco, & Schneider, 2010; LaBrie,
Hummer, Pedersen, Lac, & Chithambo, 2012; Pedersen & LaBrie, 2007). This research has also
demonstrated that students who pregame tend to be heavier drinkers and to experience more
negative alcohol-related consequences than students who do not pregame (Haas, Smith, Kagan, & Jacob, 2012; Paves et al., 2012; Pedersen and LaBrie, 2007; Read et al., 2010). Further, LaBrie et al. (2016) found that increased alcohol consumption and more favorable attitudes toward alcohol use mediated the association between pregaming frequency and greater alcohol-related consequences one year later. Taken together, these findings suggest that the act of pregaming and the contexts in which drinkers pregame may help normalize heavy alcohol use and create positive attitudes and expectancies for such behavior, both of which seem likely to lead to even heavier later drinking and greater medium-term consequences. Therefore, it appears there are aspects of the pregame drinking context that confer risk for developing harmful patterns of alcohol use beyond those stemming from the amount of alcohol consumed.

Although the contexts in which pregame drinking occurs appear to be risky, pregaming is even more normative than HED, with an estimated two-thirds of all college student study participants and three-fourths of drinkers reporting pregaming in the past two to four weeks (DeJong et al., 2010; LaBrie & Pedersen, 2008; Pedersen, LaBrie, & Kilmer, 2009; Pedersen, LaBrie, & Lac, 2008). However, one type of pregame drinking is thought to be especially problematic: Pregame HED, or reaching the HED threshold during a pregaming session. Since pregame drinking often occurs at a rapid pace (DeJong et al., 2010; Hughes et al., 2008; Wells et al., 2009), which can increase the risk of blacking out (Perry et al., 2006), and often is motivated by a desire to get drunk (Bachrach et al., 2012; LaBrie et al., 2012), this pattern of drinking is particularly risky. Further, when students engage in Pregame HED, they become intoxicated before going out for the night and are therefore increasing the distance they must travel while intoxicated and the amount of time they are intoxicated, as discussed in more detail in Paper 1. Lastly, students report social lubrication motivations for pregaming (Bachrach et al., 2012;
DeJong et al., 2010), and consistently drinking heavily before going to social events is potentially dangerous if it becomes habitual and if students begin to believe they need to consume large amounts of alcohol to interact with others. For these reasons, it was predicted that students who engaged in Pregame HED earlier in college would be more likely to report medium-term consequences across several domains by the end of college.

**Day Drinking**

Prior literature on day drinking, defined here as drinking that begins before 4:00 PM, is more scant. To the author’s knowledge, this is only the second paper to empirically examine day drinking among college students. The first to do so was Paper 2 of this dissertation, which found that students were more likely to drink heavily and to engage in other risky behaviors on day drinking days than on evening or nighttime drinking days. However, the current paper speculates that there may be aspects of the day drinking context that confer greater risk for medium- and long-term problems than more typical drinking contexts, such as bars and parties on social weekend nights, as was speculated above for pregaming contexts. For example, drinking in more typical social contexts tends to occur at night, which presumably leaves the bulk of the daytime for students to complete other tasks, such as studying or completing schoolwork, exercise, household chores (e.g., laundry, cleaning, grocery shopping), or working for pay. However, when students day drink, they likely have less time available that day to complete such tasks or activities. Given that alcohol is psychoactive and a depressant, it seems less likely that students would be able or inclined to complete such tasks or activities later in the day after day drinking, especially as the number of drinks they consume increases. Thus, consistent with the time trade-off hypothesis (e.g., there is a finite amount of time in each day and activities compete for students’ time; Greene & Maggs, 2015; Safron, Schulenberg, &
Bachman, 2001), it would be expected that day drinking would interfere with students’ accomplishment of school and other related goals to a greater extent than the more traditional drinking that typically occurs at night. Given that tailgating is a specific type of day drinking that often includes HED and HID (Glassman, Dodd, Sheu, Rienzo, & Wagenaar, 2010; Merlo, Ahmedani, Barondess, Bohnert, & Gold, 2011; Neal & Fromme, 2007) and is very common on college campuses, some students may day drink at the HED or HID level nearly every weekend during the fall football season as well as on other occasions throughout the year, such as holidays and special events (e.g., St. Patrick’s day, spring rush for the Greek system, graduation day), although this will not be tested here. For these reasons, it was predicted that students who day drank during their first semester of college would be more likely by the end of college to report medium-term consequences that may interfere with their successful navigation of the transition to adulthood as well as their overall health.

The Importance of General, Legal, and Academic Alcohol Problems

Aside from increasing acute exposure to negative health consequences (i.e., experiencing a hangover, bodily injury, acquiring an STI), a main concern with heavy drinking among college students is the potential for it to lead over time to a pattern of abuse that may ultimately result in negative health, academic, and/or legal problems that may interfere with students’ ability to successfully transition into adult social and work roles. For instance, in regards to health-related general alcohol problems, individuals who drink heavily during the late teens and early twenties are at greater risk for developing alcohol use disorder and/or physiological or psychological dependence (Babor et al., 1992; Jennison, 2004; Schulenberg & Maggs, 2002; Zucker, 1987). Prolonged heavy use also increases individuals’ risk of morbidity (e.g., esophageal and liver
cancer, stroke, cirrhosis of the liver) and premature mortality (Hingson et al., 2009, 2017; Room, Babor, & Rehm, 2005).

Negative developmental consequences of sustained heavy alcohol use are also of interest. For example, alcohol problems, including some of the criteria for alcohol use disorder, consist of alcohol use interfering with responsibilities at home, work, or school, relationships with family or friends, and mental health (Read, Kahler, Strong, & Colder, 2006; White & Labouvie, 1989). Consequently, young people who drink more heavily are likely to have more difficulty transitioning into adult social and work roles, including marriage, parenthood, and full-time employment, which have traditionally been used as indicators of adult status (Bachman et al., 1997; Kandel & Yamaguchi, 1987; Krohn, Lizotte, & Perez, 1997; Settersten & Ray, 2010; Staff et al., 2010; Wood, Sher, & McGowan, 2000). Similarly, negative academic outcomes that have been linked with HED, including missing class (Powell, Williams, & Wechsler, 2004; Thombs et al., 2009; Wechsler et al., 2000), earning lower grades (Presley, Meilman, & Cashin, 1996; Singleton, 2007; Singleton & Wolfson, 2009; Wechsler et al., 2002), and dropping out (Jennison, 2004; Tucker, Ellickson, Orlando, Martino, & Klein, 2005), may also result in delays in transitioning to adulthood as a result of delayed college graduation (or a failure to graduate) and/or reduced employment opportunities.

The inverse association between heavy alcohol use and taking on adult social and work roles is consistent with the concept of role incompatibility (or role socialization), which refers to the demands, expectations, and/or values of a social role conflicting with an individual’s pattern of behavior (Kandel, 1984; Yamaguchi & Kandel, 1985). For instance, heavy drinking may be seen as compatible with the role of full-time college student. That is, heavy drinking is somewhat normative during the late teens and early to mid-twenties (SAMHSA, 2015; Schulenberg et al.,
2018; Swendsen et al., 2012), and many view such behavior as a cultural rite of passage during these years, especially for those who attend college full-time (Crawford & Novak, 2006; Prentice & Miller, 1993). Further, such behavior can be fit into college students’ routines with minimal interruptions, since many full-time residential college students have relatively large amounts of free time and minimal social obligations to families or others (Arnett, 2005; Babcock & Marks, 2011). Conversely, heavy drinking is less compatible with the demands, expectations, and values of adulthood (Staff et al., 2010; Yamaguchi & Kandel, 1985). For instance, heavy drinking during college and young adulthood is negatively associated with later employment and occupational prestige (Jennison, 2004; Sloan, Malone, Kertesz, Wang, & Costanzo, 2009), and it has known negative health implications for parenting behaviors (Latendresse et al., 2008; Tildesley & Andrews, 2008) and fertility (Eggert, Theobald, & Engfeldt, 2004; Hakim, Gray, & Zacur, 1998; Jensen et al., 1998). Further, heavy drinking is not normative during adulthood and may be inconsistent with the values of professional work (SAMHSA, 2015; Schulenberg et al., 2018; Staff et al., 2010; Swendsen et al., 2012; Yamaguchi & Kandel, 1985). Given that Staff et al. (2010) found that young adults who drank more heavily were less likely to have achieved traditional markers of adulthood, such as marriage and parenthood, it is speculated that regular or frequent HID, Pregame HED, and day drinking may similarly be associated with a delayed transition to adulthood due to role incompatibility, although that was not specifically tested in this investigation.

Lastly, a pattern of heavy drinking is likely to increase the chances of an individual getting into legal problems related to alcohol. For example, persistent heavy drinkers are more likely than non-heavy drinkers to be cited or arrested for driving under the influence of alcohol (e.g., DWI/DUI), to get in trouble with the police for other violations (i.e., non-DWI/DUI
violations), and to get in trouble with college authorities (Presley & Pimentel, 2006). Such consequences could also contribute to negative developmental outcomes, as such violations may result in heavy fines and/or may stay on an individual’s record, which may affect employment opportunities. Therefore, in considering whether HID, Pregame HED, and day drinking had the ability to predict medium-term problems above and beyond those predicted by HED, it was important to assess an array of alcohol-related problems, such as those related to health, academics, and the law.

Research Questions

This paper evaluated whether heavy drinking at different levels and in different contexts earlier in college predicted medium-term health, legal, and academic consequences by the end of college so as to better understand how heavy drinking may affect individuals’ ability to successfully navigate the developmental transition from adolescence to adulthood as well as their overall health. This paper also sought to test the predictive utility of three dichotomous indicators of heavy drinking in identifying medium-term consequences above and beyond that of the widely-used HED indicator. These tests were meant to provide initial evidence as to whether these three heavy drinking indicators warrant use in screening instruments or panel studies to detect medium-term consequences independently or in conjunction with the HED indicator. Three sets of research questions were assessed.

Question 1. In comparison to HED-Only Drinkers, did HID Drinkers in the first two semesters of college report greater (a) alcohol-related problems (i.e., RAPI scores; White & Labouvie, 1989) in fourth year, and greater odds of (b) hazardous/harmful drinking (i.e., AUDIT scores; Saunders et al., 1993) in fourth year, (c) receiving an alcohol violation during college, and (d) anticipating a delay of college graduation by the end of third year?
Question 2. Was day drinking in the first and second semesters of college positively associated with the same four outcomes tested in Hypothesis 1, while controlling for HED?

Question 3. Was Pregame HED in the fourth and fifth semesters of college (the first two semesters this variable was available) positively associated with the same four outcomes tested in the previous two sets of research questions, while controlling for HED?

Method

Participants

Data came from the University Life Study (ULS), a longitudinal study designed to assess developmental change and fluctuations in associations between risk behaviors and daily activities among 744 students at a large, public university in the Northeast United States (Greene & Maggs, 2015; Howard, Patrick, & Maggs, 2015; Patrick, Maggs, & Lefkowitz, 2015). The ULS used a longitudinal measurement-burst design whereby in each of seven consecutive semesters participants completed a longer, web-based survey followed by a series of 14 consecutive shorter daily surveys. Thus, participants completed up to seven of the longer semester surveys and up to 98 of the shorter daily surveys throughout the three-and-a-half year duration of the study. All surveys were completed electronically and were accessed through links emailed to students. The ULS was approved by the university’s institutional review board and protected by a federal Certificate of Confidentiality from the National Institutes of Health (NIH).

Procedure

Information obtained from the university registrar was used to identify potential study participants. Eligible students were first-year, first-time, full-time students who were (a) living within 25 miles of the university campus, (b) 21 years of age or younger, and (c) a United States
citizen or permanent resident. A stratified random sampling procedure was used to select participants with the aim of generating a sample that was more racially/ethnically balanced than the university’s student body, which was predominantly White (82%; Penn State Fact Book, 2012). Two-thirds (66%; \( N = 744 \)) of the selected students provided informed consent to participate in the study using an electronic signature and completed the first web-based semester survey and up to 14 consecutive daily web-based surveys. The initial sample contained 25.1% Hispanic/Latinx, 15.7% African American/Black Non-Hispanic (NH), 23.3% Asian American/Pacific Islander NH, 27.4% European American NH, and 8.5% multi-racial NH students.

Retention in the ULS was fairly high with 85.6% (\( n = 637 \)) of the initial sample of 744 students completing the final (7th) semester survey (Table 4-1). For the daily surveys, 96.5% (\( n = 718 \)) of students completed at least one daily survey in the first semester, and 79.6% (\( n = 592 \)) completed at least one daily survey in the final semester. Students completed an average of 12.8 daily surveys each semester across the entire study, with the number ranging from 0 to 14 within semesters (Howard et al., 2015).

**Alcohol Use Measures**

On each daily survey, students were asked to report the number of drinks they consumed the previous day (Dimeff, Baer, Kivlahan, & Marlatt, 1999). First, students were instructed: “By one drink we mean half an ounce of absolute alcohol, for example, [a] 12 ounce can or bottle of beer or cooler, [a] 5 ounce glass of wine, [or] a drink containing one shot of liquor or spirits.” Then, students were asked, “How many drinks of alcohol did you drink?” in reference to the previous day. Students selected the number of drinks they consumed from a pull-down menu that ranged from 0 to \( 25+ \).
Heavy Episodic Drinkers (HED Drinkers). At the daily-level, on days females consumed four or more drinks and males consumed five or more drinks, HED was coded as 1 (Wechsler, Dowdall, Davenport, & Rimm, 1995). On days females consumed fewer than four drinks and males consumed fewer than five drinks, this variable was coded as 0 (Table 4-2). These daily observations were then used to create a dichotomous, between-person HED Drinkers variable. For Hypotheses 1 (HID) and 2 (Day Drinking), HED Drinkers were students who reported at least one HED occasion across the potential 28 daily surveys in Semesters 1 and 2. Non-HED Drinkers were students who reported drinking but did not report any HED occasions on sampled days in these two semesters. An inverse coding of this variable was used in Hypothesis 1, such that the predictor variable was Non-HED Drinkers as opposed to HED Drinkers. In conjunction with the HID Drinkers variable (described below), this inverse coding allowed for the differentiation of three levels of drinkers: Non-HED Drinkers, HED-Only Drinkers (i.e., students who drank above the HED threshold but not above the HID threshold), and HID Drinkers. For Hypothesis 3 (Pregame HED), HED Drinkers were students who reported at least one HED occasion in Semesters 4 and 5 (the first two semesters in which data on Pregame HED was available), and Non-HED Drinkers were students who reported drinking but did not report any HED occasions on sampled days in these two semesters.

High-Intensity Drinkers (HID Drinkers). At the daily-level, on days females/males consumed 8/10 or more drinks, HID was coded as 1 (Patrick, 2016; Linden-Carmichael et al., 2017; White et al., 2006). On days females/males consumed 7/9 or fewer drinks, this variable was coded as 0. These daily observations were then used to create a dichotomous, between-person HID Drinkers variable. HID Drinkers were students who reported at least one HID
occasion across the 28 possible daily surveys in Semesters 1 and 2, and Non-HID Drinkers were students who reported no HID occasions on sampled days in these two semesters.

*Day Drinkers.* On days students reported drinking, they were also asked about the time they started drinking with the prompt, “What time did you start your first drink?” Students selected the hour from a pull-down menu ranging from 1 to 12, and they selected the minutes from a second pull-down menu that included the response options “00,” “15,” “30,” and “45.” Finally, students indicated whether the specified time corresponded to “am” or “pm.” Prior to answering, students were reminded that midnight is 12:00 AM and noon is 12:00 PM. Day drinking days were operationalized as drinking days in which alcohol use began between 6:00 AM and 3:45 PM (i.e., before 4:00 PM). These cut-offs were chosen so as to identify drinking days that actually began during the day, as opposed to late the night before (e.g., at 3:00 AM) or during the early evening. Daily observations were then used to create a dichotomous, between-person *Day Drinkers* variable. Day Drinkers were students who reported at least one drinking day that began between 6:00 AM and 3:45 PM across the 28 possible daily surveys in Semesters 1 and 2. Nighttime-Only Drinkers were students who reported drinking but never reported drinking beginning during these times on sampled days in Semesters 1 and 2.

*Pregame Heavy Episodic Drinkers (Pregame HED Drinkers).* Beginning in Semester 4, each day students reported drinking, they were given the following prompt: “You said you had [xx] drinks on *previous day*. How many of those were pre-gaming, that is, consumed before going out?” Students were able to select the number of pregaming drinks they consumed from a pull-down menu that ranged from 0 to the total number drinks they previously reported for that day. On days females/males consumed 4/5 or more drinks while pregaming, Pregame HED was coded as 1. On days females/males consumed less than 4/5 drinks while pregaming, this variable
was coded as 0. Daily observations were then used to create a dichotomous, between-person
*Pregame HED Drinkers* variable. Pregame HED drinkers were students who reported at least
one Pregame HED occasion across the 28 days sampled in Semesters 4 and 5. Non-Pregame
HED drinkers were students who reported drinking but never reported Pregame HED on sampled
days in these two semesters.

**Medium-Term Consequences Outcome Measures**

*Hazardous/Harmful Drinking.* In Semester 7, students completed the *Alcohol Use
Disorder Identification Test* (AUDIT; Saunders et al., 1993) on the longer, semester web survey.
The AUDIT, developed by the World Health Organization (Saunders et al., 1993), is a widely
used 10-item instrument used to screen for hazardous and harmful alcohol use and possible
dependence. Scores on the AUDIT can range from 0 to 40, and a cut-off score of 8 is generally
used to indicate hazardous and harmful drinking, although a cut-off score of 10 can be used to
achieve greater specificity (de Meneses-Gaya, Zuardi, Loureiro, & Crippa, 2009). Substantial
evidence supports the construct and criterion validity of the AUDIT across adult samples and
settings (Bergman & Kallmen, 2002; Carey, Carey, & Chandra 2003; Chung, Colby, Barnett, &
Monti, 2002; Reinert & Allen, 2007; Shields, Guttmannova, & Caruso, 2004), and its use with
adolescent and college student samples has also been validated (Cook, Chung, Kelly, & Clark,
2005; Kokotailo et al., 2004; Reinert & Allen, 2007). The AUDIT has shown high levels of
internal consistency (median $\alpha = 0.83$ across studies; Reinert & Allen, 2007; Shields & Caruso,
2003) and test-retest reliability (when scored dichotomously; Dybek et al., 2006; Reinert &
Allen, 2007; Rubin et al., 2006; Selin, 2003) across a number of samples and settings and when
using multiple cut-off scores. The sensitivity and specificity of the AUDIT have been shown to
approximate or exceed those of other survey-based alcohol screening instruments (Allen, Maisto, & Connors, 1995).

Response options on the AUDIT are not identical across all 10 items. Most items have response options that include “Never” (0), “Less than monthly” (1), “Monthly” (2), “Weekly” (3), and “Daily or almost daily” (4). Two of the items had the following response options: “No” (0), “Yes, but not in the last year” (1), and “Yes, during the last year” (2). Responses for each item were summed, and a cut-off score of 10 was used to indicate a hazardous/harmful pattern of drinking in this college student sample, as suggested by Kelly, Donovan, Chung, Cook, and Delbridge (2004).

Alcohol-Related Problems. In Semester 7 as part of the longer semester survey, students completed a modified version of the Rutgers Alcohol Problem Index (RAPI; White & Labouvie, 1989). The RAPI is a 23-item survey designed to assess adolescent and young adult problem drinking, and it includes items pertaining to social and/or interpersonal problems, alcohol abuse, alcohol dependence, low self-esteem, and acute effects of intoxication (Devos-Comby & Lange, 2008; White & Labouvie, 1989). The RAPI has been used extensively as a measure of alcohol-related problems in the college drinking literature (Devos-Comby & Lange, 2008). A number of studies have provided evidence of the RAPI’s internal consistency (α’s = .85-.95; Carey & Correia, 1997; Levy & Earleywine, 2003; Read, Kahler, Strong, & Colder, 2006) and correlations with measures of alcohol consumption (r’s = .28-.70; Borsari, Neal, Collins & Carey, 2001; Levy & Earleywine, 2003). Although there have been few validation studies of the RAPI, there is some evidence of its construct, face, and criterion validity in college student samples (Martens, Neighbors, Dams-O’Connor, Lee, & Larimer, 2007; Neal, Corbin, & Fromme, 2007).
Students reported how often they had experienced each of 23 alcohol-related problems in the past year on the RAPI using the following response options: “None” (0), “1-2 times” (1), “3-5 times” (2), and “More than 5 times” (3). Items included such alcohol problems as “Missed a day (or part of a day) of school or work” and “Passed out or fainted suddenly.” The RAPI was scored by summing students’ responses for each of the 23 items. Thus, students’ scores could have theoretically ranged from 0 to 69.

**Alcohol Violations.** In Semester 7, students reported on legal violations they had received related to alcohol use since their first semester of college. Students were asked, “How many times since Fall 2007 have you ever been cited for (a) an underage drinking violation, (b) public drunkenness (excessive consumption), and (c) DUI?” Students selected the number of times cited for each of these three violations from a pull-down menu that ranged from 0 to “more than 10.” Only 29 students (4.79% of all respondents) reported receiving any citations, so the decision was made to dichotomize this alcohol violations variable to differentiate among students who ever versus never received an alcohol violation. Students who reported ever being cited for an underage drinking violation, public drunkenness, or a DUI were coded as 1, and students who reported never being cited for any of the three violations were coded as 0.

**Anticipated Delay of College Graduation.** In the spring semester of students’ first three years of college (i.e., Semesters 2, 4, and 6), they were asked, “In what semester do you plan to graduate with your bachelor’s degree?” Students had the following response options: “Fall 2010 (Less than 4 years),” “Spring 2011 (4 year plan if you started Fall 2007),” “Summer 2011,” “Fall 2011,” “Spring 2012 (5 year plan),” “Summer 2012,” “Fall 2012,” “2013 or later (6+ year plan),” and “Do not plan to graduate.” In Semester 6 (Spring 2010), the following response options were added to identify students who had already graduated in less than 4 years: “I have already
graduated” and “Spring 2010.” To determine whether students anticipated having to delay their graduation, students whose expected graduation date in Semester 6 was later than the expected graduation date they reported in Semester 2 were coded as 1. Students whose expected graduation date in Semester 6 was the same or earlier than what they reported in Semester 2 were coded as 0.

Control Measures

Gender. In Semester 1, students were asked, “What is your gender?” with response options of “Male” (1) and “Female” (0).

Greek Organization Participation. Each semester, students were asked, “What extracurricular activities do you participate in?” They were instructed to check all activities that applied from a list of 16 (e.g., intercollegiate athletics, student government, volunteering) and “No Clubs.” The first of these activities was “Fraternity/Sorority (social).” For students who reported ever participating in a Greek organization, this variable was coded as 1. For students who reported never participating in such an organization, Greek organization participation was coded as 0.

Student Athlete Status. “Intercollegiate Athletics” and “Intramural Athletics/Club Sports” were also 2 of the 16 extracurricular activities. Students who reported participating in either type of athletics in at least one semester were coded as 1, and students who never participated in either type of athletics were coded as 0.

Honors College Enrollment. Each semester, students were asked, “Are you in the academic honors program ([name of honors program]) at [name of university]?” with response options of “Yes” (1) and “No” (0). Students who were enrolled in the academic honors program in at least one semester were coded as 1, and students who were never enrolled were coded as 0.
Statistical Analyses

Logistic and negative binomial regressions were used to predict the four medium-term consequences for each set of research questions. Logistic regressions were estimated using the PROC LOGISTIC procedure and negative binomial regressions were estimated using the PROC GENMOD procedure in SAS 9.4.

Question 1: Did HID Predict More Medium-Term Consequences than HED-Only?

Question 1a assessed whether first-year HID Drinkers reported more alcohol-related problems (i.e., RAPI scores) in fourth year than HED-Only Drinkers. A negative binomial regression was used to estimate RAPI scores using the following equation:

$$\log(Y) = \beta_0 + \beta_1(\text{HID Drinkers}) + \beta_2(\text{Non-HED Drinkers}) + \beta_3(\text{Male}) + \beta_4(\text{Greek Participant}) + \beta_5(\text{Student Athlete}) + \beta_6(\text{Honors Student})$$

The inclusion of the HID and Non-HED Drinkers variables allowed HED-Only Drinkers to be the reference group, which enabled direct comparison of RAPI scores between the two types of HED Drinkers (i.e., HED-Only and HID Drinkers). This model was estimated in two steps. First, a model that only included HID and Non-HED Drinkers tested differences in RAPI scores among Non-HED, HED-Only, and HID Drinkers. Second, the four control variables (i.e., Gender, Greek Organization Participation, Student Athlete Status, and Honors College Enrollment) were added to the model to control for other between-person characteristics related to drinking and its consequences.

Questions 1b through 1d assessed whether first-year HID Drinkers were more likely than HED-Only Drinkers to (b) exhibit hazardous/harmful drinking in fourth year, (c) be cited for an
alcohol violation during college, and (d) plan to graduate later than originally anticipated.

Separate logistic regressions were used to estimate the likelihood of each of these three outcomes. Each model included the same set of predictor variables as the model used for Question 1a, and each was estimated using the same two-step progression.

**Question 2: Did Day Drinking Predict Medium-Term Consequences Independent of HED?**

Questions 2a through 2d used the same outcomes as the first set of research questions but compared first-year Day Drinkers to Nighttime-Only Drinkers while controlling for whether students engaged in HED during first year. Thus, the equation used for Question 2a was:

\[
\log(Y) = \beta_0 + \\
\beta_1(\text{Day Drinkers}) + \\
\beta_2(\text{HED Drinkers}) + \\
\beta_3(\text{Male}) + \\
\beta_4(\text{Greek Participant}) + \\
\beta_5(\text{Student Athlete}) + \\
\beta_6(\text{Honors Student}) 
\]

This model was estimated across three steps. First, a bivariate model tested whether day drinking in first year predicted RAPI scores in fourth year. Second, the HED Drinkers variable was added to the model to determine whether day drinking predicted RAPI scores independent of HED. Lastly, the four control variables were added to achieve the full model. Models used for Questions 2b through 2d used the same set of predictor variables as Question 2a but used logistic instead of negative binomial regressions. These models were estimated using the same three-step progression.

**Question 3: Did Pregame HED Predict Medium-Term Consequences Independent of HED?**

Question 3a assessed whether Pregame HED Drinkers in Semesters 4 and 5 experienced greater alcohol-related problems in fourth year than Non-Pregame HED Drinkers while
controlling for whether students engaged in general HED during those two semesters. This was tested using a negative binomial regression that used the following equation:

$$\log(Y) = \beta_0 + \beta_1(\text{Pregame HED Drinkers}) + \beta_2(\text{HED Drinkers}) + \beta_3(\text{Male}) + \beta_4(\text{Greek Participant}) + \beta_5(\text{Student Athlete}) + \beta_6(\text{Honors Student})$$

This model was also estimated in three sequential steps. First, a bivariate model tested whether Pregame HED in Semesters 4 and 5 predicted RAPI scores in Semester 7. Second, the HED Drinkers variable was added to the model to determine whether Pregame HED predicted RAPI scores independent of HED. Lastly, the four control variables were added. Models used for Questions 3b through 3d used the same set of predictor variables as Question 3a but used logistic instead of negative binomial regressions. These models were estimated using the same three-step progression.

**Results**

**Descriptive Statistics**

**Questions 1 and 2**

In Semesters 1 and 2, a total of 727 students completed 18,816 daily surveys, and drinking was reported by 473 students on 1,932 sampled days. To be consistent with Papers 1 and 2, the analytic sample only included students who reported drinking in the daily surveys. Thus, the analytic sample for Hypotheses 1 and 2 consisted of the 473 students who reported drinking on at least one sampled day in first year. Of these 473 students, 355 (75.1%) reported HED at least once (Table 4-3). Of these HED Drinkers, 179 (37.8% of all drinkers; 50.4% of HED Drinkers) also reported HID at least once; therefore, 176 of the HED Drinkers were HED-
Only Drinkers, meaning they reported HED but never HID. Eighty-three (17.5% of drinkers) students reported day drinking in first year. Scores on the RAPI in Semester 7 ranged from 0 to 49, and the mean RAPI score was 6.17 (median = 3.50, \(SD = 8.12\)). One-hundred eighty-two (38.4%) students scored 10 or higher on the AUDIT in Semester 7, which indicated a hazardous/harmful pattern of drinking as well as possible dependence. Twenty-seven students (5.7%) received one or more alcohol violations by fourth year, and 93 (19.7%) students anticipated a delayed graduation by third year.

**Question 3**

In Semesters 4 and 5, 676 students completed 17,710 daily surveys, and drinking was reported by 455 students (67.3%) on 2,177 sampled days. The analytic sample included the 455 students who reported drinking in Semesters 4 and 5. Of these 455 students, 361 (79.5% of drinkers) reported HED and 168 (36.9%) reported Pregame HED at least once (Table 4-4). Scores on the RAPI in Semester 7 ranged from 0 to 49, and the mean RAPI score was 6.05 (median = 3.00, \(SD = 7.96\)). One-hundred eighty-one (39.8%) of the students met the cut-off of 10 on the AUDIT in Semester 7. Twenty-three students (5.1%) received one or more alcohol violations by fourth year, and 97 (21.3%) students anticipated a delayed graduation by third year.

**Question 1: Did HID Predict More Medium-Term Consequences than HED-Only?**

Four main sets of findings were apparent from models testing whether first-year HID Drinkers experienced more medium-term consequences of alcohol use than HED-Only Drinkers. All observed associations were in expected directions. First, HID Drinkers in first year reported higher scores on the RAPI in fourth year than HED-Only Drinkers before control variables were added to the model; however, once the four control variables were added, there was no significant difference in predicted RAPI scores between first-year HID and HED-Only Drinkers.
In both models, Non-HED Drinkers reported lower RAPI scores than HED-Only Drinkers. Second, in models with and without control variables, first-year HID Drinkers were more likely than HED-Only Drinkers to exceed the AUDIT cutoff of 10 in fourth year, indicating a hazardous/harmful pattern of drinking (Table 4-6). Non-HED Drinkers were less likely than HED-Only Drinkers to exhibit hazardous/harmful drinking in models with and without control variables. Third, in models with and without control variables, there was no difference in the odds of being cited for an alcohol violation between first-year HID and HED-Only Drinkers or between Non-HED and HED-Only Drinkers (Table 4-7). Fourth, there was no difference in the odds of planning to graduate later than originally anticipated between HID Drinkers and HED-Only Drinkers or between Non-HED and HED-Only Drinkers in models with or without control variables (Table 4-8).

**Question 2: Did Day Drinking Predict Medium-Term Consequences Independent of HED?**

Models testing whether first-year Day Drinkers were more likely than Nighttime-Only Drinkers to report medium-term consequences while controlling for HED revealed four sets of main findings. All observed associations were in expected directions. First, there was no difference in predicted RAPI scores in fourth year between Day and Nighttime-Only Drinkers in models with and without HED and the four control variables (Table 4-9). However, first-year HED Drinkers reported higher RAPI scores than Non-HED Drinkers. Second, in models with and without HED, first-year Day Drinkers were more likely than Nighttime-Only Drinkers to exceed the AUDIT cutoff of 10, indicating a hazardous/harmful pattern of drinking, in fourth year; however, once control variables were added, there was no difference in the odds of exceeding the AUDIT cutoff between Day and Nighttime-Only Drinkers (Table 4-10). In models with and without control variables, first-year HED Drinkers were more likely than Non-
HED Drinkers to exceed the AUDIT cutoff. Third, there was no difference in the odds of receiving an alcohol violation during college between Day and Nighttime-Only Drinkers in any of the three models (Table 4-11). First-year HED Drinkers were more likely than Non-HED Drinkers to receive an alcohol violation in the model without control variables, but this association became non-significant once control variables were added. Fourth, there was no difference in the odds of delayed graduation by third year between Day and Nighttime-Only Drinkers or between HED and Non-HED Drinkers (Table 4-12).

**Question 3: Did Pregame HED Predict Medium-Term Consequences Independent of HED?**

Four main sets of findings were apparent from models testing whether Pregame HED Drinkers in Semesters 4 and 5 were more likely than Non-Pregame HED Drinkers to experience medium-term consequences independent of HED. All observed associations were in expected directions. First, Pregame HED Drinkers in Semesters 4 and 5 reported higher RAPI scores in Semester 7 than Non-Pregame HED drinkers in models with and without HED and the four control variables (Table 4-13). Similarly, HED Drinkers reported higher RAPI scores than Non-HED Drinkers across models. Second, Pregame HED Drinkers were more likely than Non-Pregame HED Drinkers to exceed the AUDIT cutoff of 10 in fourth year in models with and without HED and the four control variables (Table 4-14). Similarly, HED Drinkers were more likely than Non-HED Drinkers to exceed the AUDIT cutoff across models. Third, across models, there was no difference in the odds of receiving an alcohol violation during college between Pregame HED and Non-Pregame HED Drinkers or between HED and Non-HED Drinkers (Table 4-15). Fourth, across models, in Semester 6 there was no difference in the odds of planning to graduate later than originally anticipated between Pregame HED and Non-Pregame HED Drinkers or between HED and Non-HED Drinkers (Table 4-16).
Discussion

Review of Aims and Summary of Findings

This paper tested whether three risky drinking behaviors – HID, day drinking, and Pregame HED – predicted medium-term alcohol consequences independent of traditionally-defined HED in a college student sample. The findings of this paper are novel, because there is scant research on the medium- or long-term problems associated with each potentially harmful behavior. HID and Pregame HED prospectively predicted hazardous/harmful drinking (i.e., AUDIT scores ≥ 10) and greater alcohol-related problems (i.e., RAPI scores) in fourth year, although the association between HID and greater alcohol-related problems became non-significant after control variables were added. However, neither HID nor Pregame HED were linked with receiving an alcohol violation or anticipating delayed college graduation. Findings also showed that day drinking did not predict alcohol-related problems, hazardous/harmful drinking, receiving an alcohol violation, or anticipating a delayed graduation. In sum, the present findings suggest there is some utility in using indicators of risky drinking other than HED that account for higher levels of drinking and the contexts in which drinking occurs. However, more work is needed to determine how these indicators should be operationalized, when they should be assessed, and how they can best be used together to identify emerging patterns of maladaptive drinking among college students.

Taking into Account More than Just Level of Drinking and Whether Students Pregame

Perhaps the most important contributions of this paper are the pair of findings showing that students who engaged in Pregame HED in the middle of college had greater odds of hazardous/harmful drinking and were expected to show greater alcohol-related problems 12 to 18 months later, when controlling for general HED. Although findings regarding the event-level
consequences of pregaming have been more mixed (Haas et al., 2012; Labhart et al., 2013; Merrill et al., 2013; Read et al., 2010), the present findings add to the more consistent body of evidence linking pregaming with greater medium-term consequences (Barry, Stellefson, Piazza-Gardner, Chaney, & Dodd, 2013; Kenney, Hummer, & LaBrie, 2010; LaBrie et al., 2016). More importantly, the present findings are novel and extend the extant literature because they demonstrate the utility of a new pregaming indicator (i.e., Pregame HED) that accounts for level of drinking while pregaming and represents a more inherently risky drinking behavior.

Past work has primarily only assessed consequences associated with whether or not students pregame (ever or on a given day) and pregaming frequency (e.g., Kenney et al., 2010; LaBrie et al., 2016; Merrill et al., 2013). The problem with using such variables as indicators of risky drinking is that pregaming is not an inherently risky drinking behavior. For instance, on a given day, consuming one alcoholic beverage before going out is not likely to put students at risk for great harm as long as the overall amount of alcohol they consume throughout the remainder of the drinking episode is moderate (i.e., less than the HED threshold). Although consuming one alcoholic drink before going out may not be ideal if it becomes habitual, it is not likely to be indicative of serious longer-term problems so long as one generally uses alcohol responsibly (e.g., keeps overall consumption at reasonable levels, refrains from drinking and driving, etc.). In contrast, consuming four or five drinks before going out is a more extreme type of pregaming behavior that is inherently risky regardless of how much alcohol is consumed at the primary event. If getting drunk before going out becomes routine, this would also be problematic in terms of health and development as doing so regularly may increase the odds of an individual becoming dependent upon alcohol and developing an alcohol use disorder (Babor et al., 1992; Jennison, 2004; Sher et al., 2005; Zucker, 1987). This would also be likely to make transitioning
into adult work and social roles more difficult, as heavy drinking is inconsistent with success as well as the values and needs of others in such roles such as employers, spouses, and children (Staff et al. 2010; Yamaguchi & Kandel, 1985).

Thus, use of the new Pregame HED indicator introduced here moves attention away from simply whether students take part in any pre-event consumption toward the amount of alcohol being consumed while pregaming. The cutoff used for the Pregame HED indicator parallels the four/five drinks cutoff used by the more general HED indicator, which represents consuming approximately the amount of alcohol required for an average individual to become legally intoxicated if consumed in a two-hour period (i.e., .08 g/dL; National Institute on Alcohol Abuse and Alcoholism, 2015). However, Pregame HED assesses whether this amount was consumed before going out, not just throughout the course of an entire day. Given the increased interest in the amount of alcohol consumption articulated here, some might suggest using a continuous measure to add precision to the assessment of pregame alcohol consumption. Although continuous measures of risky drinking may work well in daily diary studies (e.g., Russell, Almeida, & Maggs, 2017), such measures are not ideal for assessing frequency and are not conducive to use in large, nationally-representative panel studies (e.g., Schulenberg et al., 2018; Swendsen et al., 2012) or population- or campus-wide screening instruments (e.g., Heck, 1991; Saunders et al., 1993). However, much like the traditional HED indicator, the simplicity of the dichotomous Pregame HED indicator allows for its use in a wide variety of study designs. Thus, the Pregame HED indicator takes into account more than just level of drinking and whether students pregame by adding a quantity component to the currently used any pregaming indicator and adding a contextual component to the general HED indicator.
Additionally, much like HED, pregaming is very common. Estimates suggest that two-thirds of college students (and three-fourths of drinkers) report pregaming in the past two to four weeks and that pregaming occurs on one-third to one-half of all drinking days (DeJong et al., 2010; LaBrie & Pedersen, 2008; Pedersen et al., 2009; Pedersen, LaBrie, & Lac, 2008). As reported in Paper 1, in the ULS, 56% of all students and 71% of drinkers reported at least one pregaming occasion within an up to 2-week period within up to 7 semesters, and pregaming was reported on 41% of sampled drinking days. This suggests that pregaming, like HED (Hingson et al., 2017; Schulenberg et al., 2018), is statistically normative. In contrast, Pregame HED is not rare, but it is certainly not a normative behavior. Paper 1, for example, found that 33% of all students and 41% of drinkers reported Pregame HED at least once, and Pregame HED occurred on 15% of sampled drinking days. Supplemental analyses showed that although any pregaming provided greater sensitivity than Pregame HED in identifying students who reported medium-term consequences one to two years later (Table 4-17), Pregame HED provided greater specificity in doing so (Tables 4-18).

Lastly, one may wonder whether past research linking pregaming to greater alcohol consumption (Barnett, Orchowski, Read, & Kahler, 2013; Labhart et al., 2013; LaBrie et al., 2016) and negative consequences (Barry et al., 2013; Haas et al., 2012; Kenney et al., 2010; Merrill et al. 2013) has been primarily driven by more extreme Pregame HED drinkers and occasions. That is, it may be that Pregame HED drinkers and occasions explain the majority of the variance in increased alcohol consumption and negative consequences but that this is masked by the use of the broad general pregaming indicator. As Paper 1 showed at the daily level, students experienced a greater number of negative consequences on days they engaged in Pregame HED compared to days with more moderate levels of pregaming. Taken together, the
present findings strengthen and extend past work linking pregaming with greater medium-term consequences, and they demonstrate the utility of a new pregaming indicator that may be a useful complement to the existing HED and general pregaming indicators.

Why Is It Important to Differentiate Between Levels of HED?

By introducing greater differentiation in the measurement of heavy drinking, the present findings demonstrated that first-year HID drinkers were more likely than HED-only drinkers to exhibit a hazardous and harmful pattern of drinking in fourth year. HID was also positively associated with alcohol-related problems before control variables were added to the model, indicating that HID did not uniquely predict alcohol-related problems. Although there has been scant research on the association between HID and medium-term consequences, the present longitudinal findings are consistent with and extend past research testing related hypotheses. For example, in a previous analysis of these ULS data, students were more likely to experience a range of individual negative consequences (e.g., being hungover, passing out) on HID days than on HED-only days (Linden-Carmichael et al., 2018). Further, two national, cross-sectional studies, one of college freshman (White et al. 2006) and one of young adults (i.e., ages 18-26; Patrick, Terry-McElrath, Kloska, & Schulenberg, 2016), have shown that HID drinkers engage in HED (i.e., 4+/5+ drinking) more often than HED-only drinkers. Thus, to the extent that the consequences of such high levels of drinking accumulate over time due to repeated exposure, it would be expected that HID drinkers would experience more medium-term alcohol-related problems than HED-only drinkers. Further, using time-varying effect modeling (TVEM) on a national cross-sectional sample of adults aged 18 to 64, Linden-Carmichael et al. (2017) found that HID drinkers were more likely than HED-only drinkers to meet the criteria for an alcohol use disorder and that this association was strongest for those of traditional college age (i.e., ages
18 to 25, although the association was strongest for 18-year-olds). For instance, more than four-fifths of 18-year-old HID drinkers had AUD in comparison to just over two-fifths of HED-only drinkers.

But, one may ask, why does this matter? HID is a specific type of HED, so HED naturally is more prevalent and occurs on more drinking days. HED has also already been linked with an array of short- and long-term outcomes (e.g., Jennison, 2004; Presley & Pimentel, 2006; Slutske, 2005; Wechsler et al., 2002). So, why is it necessary for researchers to start using an additional heavy drinking variable that is based on HED and has a similar acronym? Given that drinking among college students often occurs well beyond the HED threshold (Naimi et al., 2010; Read et al., 2008; White et al., 2006), it is possible that much of the established links of HED with negative consequences and other risky behaviors are primarily attributable to HID drinkers and occasions. For example, the HED indicator groups together as ‘heavy drinkers’ individuals who never drink much more than a six-pack of beer (i.e., an HED-only drinker) with those who sometimes drink a twelve-pack of beer (i.e., an HID drinker). By doing this, it is difficult to distinguish between these two types of drinkers. Although the frequency of any level of drinking is certainly another variable to be considered (Courtney & Polich, 2009), it may be that HED-only drinking in college is indicative of a developmental disturbance (Schulenberg et al., 2001), that is, deviant behavior limited to a specific period of the life span that is statistically normative and culturally sanctioned. Similarly, although drinking more than four/five drinks and less than eight/ten drinks (for women/men) is still heavier than experts may recommend, this level of drinking in college may be more (but not fully) consistent with the transition catalyst model of substance identified by Schulenberg and Maggs (2002) which suggests that alcohol use
can help facilitate the formation of friendships, romantic and sexual relationships, and social bonding during the developmental transition to adulthood.

In contrast, HID in college may be more indicative of an emerging diagnosable substance use disorder, based on both the high level of episodic drinking as well as the greater frequency of HED (Patrick et al., 2016; White et al. 2006). Integrative theories that emphasize deviance proneness (i.e., Jessar and Jessor’s problem behavior theory [Donovan, Jessar, & Costa, 1991; Jessar & Jessor, 1977], peer cluster theory [Oetting & Beauvais, 1986, 1987], and Sher’s deviance proneness models [Sher, 1991]) all tend to view substance use as a form of antisocial behavior and as highly associated with other conduct problems, though not necessarily evidence of an emerging conduct problem (Chassin, Hussong, & Beltran, 2009; Petraitis, Flay, & Miller, 1995). From this perspective, although there is substantial evidence linking HED with other risky behaviors, including drinking games, illegal drug use, risky sexual behaviors, interpersonal violence, and vandalism (Miller, Naimi, Brewer, & Jones, 2007; Pedersen & LaBrie, 2006; Wechsler, Davenport, Dowdall, Moeykens, & Castillo, 1994), perhaps it is HID that is much more a part of a constellation of other risky drinking behaviors than HED-only. For instance, a previous analysis of ULS data found that approximately one in six students were likely to be in a latent class of substance use characterized by HID along with marijuana use, non-medical prescription drug use, and cigarette use (Evans-Polce, Lanza, & Maggs, 2016). Another previous analysis of ULS data found that playing drinking games predicted HID both on days drinking games were played and in general (Fairlie et al., 2015). Future work contrasting the likelihood of engaging in other risky or antisocial behaviors among HID, HED-only, and non-HED drinkers and occasions would provide substantial insight into this area.
Taken together, it is important for researchers to start to differentiate between levels of HED (e.g., Hingson et al., 2017; Linden-Carmichael et al., 2018; White et al., 2006). As shown in supplemental analyses in Tables 4-17 and 4-18, the HID indicator appears to offer less sensitivity but greater specificity than HED in identifying medium-term consequences several years later. Both indicators have their place in college drinking research. The challenge for researchers moving forward will be how to use them most effectively in identifying individuals most at risk for serious longer-term harm.

**Is Day Drinking Actually Risky?**

Day drinking in first year predicted hazardous/harmful drinking in fourth year before non-drinking control variables were added to the model, but it did not predict any of the other three outcomes. Interestingly, Paper 2 showed that day drinking was positively associated with heavy drinking using both traditional and high-intensity thresholds, as well as with risky behaviors (i.e., playing drinking games and using illegal drugs), at the daily level, but predicted fewer negative consequences when the total number of drinks consumed that day was controlled. The present findings and those of Paper 2 suggest that although day drinking may co-occur with heavy alcohol consumption and other risky behaviors, it may not be independently associated with short- or medium-term negative consequences.

Why might this be the case? Perhaps day drinking is defined too broadly here. Much like pregaming, drinking alcohol during the day time is not inherently dangerous. For example, having a single alcoholic drink with lunch likely does not confer much risk of harm that day or over time. However, Paper 2 showed that nearly three-fourths of day drinking occasions in this college student sample resulted in HED. Thus, it appears that day drinking in the college environment is most typically a heavy drinking behavior, and perhaps assessing a more specific
indicator, such as Day HED, would be more predictive of short- or medium-term consequences. Alternatively, it may be that nearly all of the risk associated with day drinking can be explained by the amount of alcohol consumption. Perhaps before further assessing the negative consequences of day drinking, researchers should agree on a conceptual definition and learn more about its characteristics and how it does or does not differ from nighttime drinking.

**Lack of Associations with Alcohol Violations and Anticipated Delay of Graduation**

It should be noted that neither Pregame HED, HID, nor day drinking predicted alcohol violations or an anticipated delay of graduation. This was not entirely surprising given that these outcomes are not as directly related to drinking as the other two outcomes, hazardous/harmful drinking and alcohol-related problems, and both have many other key determinants. Given the high rates of heavy drinking in this sample (e.g., Howard et al., 2015; Linden-Carmichael et al., 2018), there were likely high numbers of students who participated in underage drinking and/or were drunk in public on the days sampled here, especially those on the “social weekend” (Del Boca, Darkes, Greenbaum, & Goldman, 2004; Finlay, Ram, Maggs, & Caldwell, 2012). Given the low percentage of students who reported receiving any alcohol violations (less than 7%) in relation to the amount who reported heavy drinking (more than 75%), perhaps local law enforcement officials tended to only give citations to students who also engaged in antisocial behavior, such as fighting or harassing other individuals or damaging property. In that case, other non-drinking variables (e.g., peer rejection, past aggression; Patterson, DeBaryshe, & Ramsey, 1989) may better predict such additional antisocial behavior as well as why some students received an alcohol violation and others did not.

Past studies have linked HED with some short- and medium-term academic consequences (e.g., missing class, receiving lower grades overall; Engs et al. 1996; Presley et al.
1996; Wechsler et al. 2002), but results have not been entirely conclusive (Gill, 2002; Howland et al., 2010; Paschall & Freisthler, 2003; Williams, Powell, & Wechsler, 2003). Since delayed graduation is an indirect, distal effect of heavy drinking, there are certainly other variables that are more direct and substantial influences on whether a student graduates on time, most notably those in the academic domain such as standardized test scores, high school and college academic performance, time spent studying, and changes in major (Greene & Maggs, 2015; Westrick, Le, Robbins, Radunzel, & Schmidt, 2015), among others. Variables related to the types of activities students participate in also seem to be associated with delayed graduation. For instance, in the models for the first two sets of research questions, Greek participants were less likely than non-participants to anticipate a delay of graduation, despite consistent findings in the literature that Greek students drink in greater quantity and with greater frequency than non-Greek students (Borsari & Carey, 1999; McCabe et al., 2005; Turrisi, Mallett, Mastroleo, & Larimer, 2006). However, although the association between Greek involvement and academic performance (i.e., grades) appears to be less well established, there does seem to be some consistent evidence that Greek involvement is associated with higher rates of retention and greater odds of graduating in general and on time (Routon & Walker, 2014; Walker, Martin, & Hussey, 2015; Winston & Saunders, 1987). In this light, the present findings are consistent with past work, at least in terms of the association between Greek organization participation and not anticipating a delay of graduation.

**Strengths and Limitations**

**Strengths**

This paper was one of the first to prospectively assess the association of HID, pregaming, and day drinking with medium-term consequences several years later using longitudinal data and
in a college student sample. Although several papers have examined the association between HID and short-term consequences (Linden-Carmichael et al., 2018; Patrick, Cronce, Fairlie, Atkins, & Lee, 2016) or the concurrent association between HID and medium-term consequences using cross-sectional data (Hingson, Zha, & White, 2017; Linden-Carmichael et al., 2017), this paper is the first to use measurements of HID to prospectively predict consequences assessed two to three years later in an exclusively college student sample. Similarly, although a few studies have documented associations between pregaming and medium-term consequences (e.g., LaBrie et al., 2016), none have assessed academic or legal consequences prospectively and none have used the newly-introduced Pregame HED indicator. Thus, for the limited literatures on HID and pregaming, this paper extends much of the work on acute, short-term, health-related consequences by testing the associations between HID and pregaming with medium-term consequences in additional domains.

This paper also has several notable strengths related to its sample. First, the stratified random sampling procedure that was used in selecting ULS participants resulted in a sample that was fairly balanced in regard to gender and four groups of varied race/ethnicity, which should have increased the generalizability of the sample in comparison to less diverse samples (e.g., Borsari et al., 2007). The sample was also homogenous in terms of being full-time, first-time, traditionally-aged, non-visa college students, which adds precision to the generalizability of the findings. In contrast, less homogenous classroom-based samples often have unknown numbers of older, part-time, and international students (e.g., Knight et al., 2002; Wechsler et al., 2000), which makes the generalizability of the findings much less defined. Second, these ULS data were collected over students’ first four years of college. This allowed for testing associations between drinking behaviors in first year, shortly after students matriculated to college, and
outcomes in fourth year, right before many students transition into employment and post-graduate contexts. Third, the retention and completion rates were high, and there was little missing data within persons and across days (Howard et al., 2015). Lastly, this paper assessed medium-term outcomes in several domains, including health, legal, and academic outcomes. It is important to examine all the consequences of drinking behaviors in order to fully understand the motivations behind such behaviors and how they may impede or (in some cases) facilitate physical, cognitive, and social and emotional development.

Limitations

In spite of these strengths, there were also some limitations. First, the daily-level measurements of drinking were not designed to create dichotomous person-level variables assessing whether students ever engaged in these behaviors. Doing so here may have hindered the measurement reliability and validity of the risky drinking variables. For example, there may have been students who did engage in these behaviors at some points during first year but who did not do so on one of the 28 sampled days. Future studies could instead adapt existing questions of frequency of drinking from quantity/frequency measures, such as asking students how many times they engaged in each behavior in the past 6 or 12 months (Courtney & Polich, 2009; Dawson et al., 2004; Rehm, 1998). Second, although this paper did not attempt to determine causality, the temporal precedence of the variables is somewhat unclear. For example, given that many individuals initiate alcohol use in high school (Chassin et al., 2009; Miech et al., 2019), it is unclear how many students were already demonstrating a pattern of hazardous/harmful drinking or experiencing high levels of alcohol-related problems in first year or before they matriculated to university. Although measurements of alcohol-related problems (i.e., RAPI scores) were available in first year, these were not added as a control variable so as to
be consistent with models predicting other outcomes for which first-year measurements were not available. Future studies could better assess a range of medium-term consequences longitudinally in order to examine when the consequences begin to emerge. For instance, a study that collected multiple measurements of high school and college academic performance would be better able to connect changes in the level or frequency of individuals’ drinking with changes in their academic performance. Third, the findings presented here are based on students at a single university, so it is unclear the extent to which the results generalize to students at other types of universities in other regions of the United States or in other countries. It is also unclear the extent to which the results generalize to individuals in their late teens and early twenties who do not attend college (e.g., White et al., 2005) or to young adults in their late twenties or early thirties (e.g., Staff et al., 2010).

Future Directions

Future research should aim to more fully address several issues. First, subsequent investigations should assess a wider range of medium-term outcomes. The transition from adolescence to adulthood encompasses development in a number of domains such as biological, cognitive, social, and career development (Osgood, Ruth, Eccles, Jacobs, & Barber, 2005; Schulenberg & Schoon, 2012; Settersten Jr. & Ray, 2010). These domains are generally too broad to be assessed with a single indicator, such as whether someone experienced alcohol-related problems or anticipated graduating later than they had originally planned. Direct indicators of physical health, such as disease, disability, and/or weight gain, should also be examined as medium-term consequences of risky drinking given alcohol’s negative association with physical health across adulthood more generally (Berkey, Rockett, & Colditz, 2008; Lloyd-Richardson, Lucero, DiBello, Jacobson, & Wing, 2008; Murray et al., 2002; Rehm et al., 2009,
Similarly, instead of just focusing on academics, indicators of occupational success, such as acceptance into graduate programs (Arria, Allen, Caldeira, Vincent, & O’Grady, 2019) or obtaining career-track jobs (Jennison, 2004), should also be assessed using longer-term longitudinal designs (e.g., Rutledge & Sher, 2001; Bartholow, Sher, & Krull, 2003).

Second, future work should continue to distinguish between HED and HID as well as between general pregaming and Pregame HED. Most research in both of these areas has used broad indicators (i.e., HED, any pregaming; Jennison, 2004; LaBrie et al., 2016; Wechsler et al., 2000, 2002), but it is unclear whether the associations between these two behaviors and negative consequences and other risky behaviors are mostly due to extremely heavy drinking individuals and occasions (i.e., HID and Pregame HED). Although the broad HED and any pregaming indicators seem to confer greater sensitivity in identifying individuals who are at risk for negative consequences, HID and Pregame HED appear to predict such consequences with greater specificity. Thus, when used in conjunction, such indicators may be able to better distinguish between individuals at different levels of risk than using only the HED and any pregaming indicators alone.

Third, future work should continue to assess how often students engage in risky behaviors simultaneously and what the event-level consequences of doing so are (DeJong et al., 2010; Linden-Carmichael & Lau-Barraco, 2017; Read et al., 2010). For instance, HID and Pregame HED occasions likely become far more unsafe when mixed with other risky behaviors, such as illegal drug use, drinking and driving, or unprotected sex. Further, risky behaviors, such as playing drinking games, may be part of a mechanism that enables Pregame HED or HID to occur (Zamboanaga et al., 2014). Fourth, and finally, additional research is needed to more fully understand and better define day drinking. This drinking behavior appears to be somewhat
common among students, but this is only the second paper (to the author’s knowledge) to assess
day drinking in this population. Learning more about the contexts in which day drinking occurs,
what other behaviors tend to co-occur with it, and how it is or is not distinct from nighttime
drinking should be priorities for researchers before continuing to examine its medium- and long-
term consequences.
### Tables

**Table 0-1**
*Number of Participants and Days in the University Life Study By Semester*

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<th>Semester</th>
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<td>Number of students</td>
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<td>Number of daily</td>
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Table 0-2
Alcohol Use Indicators Used to Identify Different Types of Drinkers

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<tr>
<th>Type of Drinker</th>
<th>Maximum Number of Daily Drinks Ever Consumed</th>
<th>Coded As</th>
<th>Semesters Used</th>
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<td>Non-HED Drinkers</td>
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<tr>
<td>Female</td>
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<td>1-2</td>
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<tr>
<td>Male</td>
<td>5+</td>
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<tr>
<td>&lt; 4</td>
<td>&lt; 5</td>
<td>0</td>
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<tr>
<td>HED Drinkers</td>
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<td></td>
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<tr>
<td>Female</td>
<td>4+</td>
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<td>1-2 (Hypotheses 1 and 2);</td>
</tr>
<tr>
<td>Male</td>
<td>5+</td>
<td></td>
<td>4-5 (Hypothesis 3)</td>
</tr>
<tr>
<td>&lt; 4</td>
<td>&lt; 5</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>HED-Only Drinkers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>4-7</td>
<td>1</td>
<td>1-2</td>
</tr>
<tr>
<td>Male</td>
<td>5-9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 3 or ≥ 8</td>
<td>≤ 4 or ≥ 10</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>HID Drinkers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>8+</td>
<td>1</td>
<td>1-2</td>
</tr>
<tr>
<td>Male</td>
<td>10+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 7</td>
<td>≤ 9</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Pregame HED Drinkers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>4+ while pregaming</td>
<td>1</td>
<td>4-5</td>
</tr>
<tr>
<td>Male</td>
<td>5+ while pregaming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 4 while pregaming, including no pregame drinking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 5 while pregaming, including no pregame drinking</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. HED = Heavy Episodic Drinking; HID = High-Intensity Drinking; Pregaming = drinking before “going out” for the night.
Table 0-3
Univariate Descriptive Statistics of Drinking Predictor Variables, Medium-Term Consequence Outcome Variables, and Control Variables for Research Questions 1 and 2

<table>
<thead>
<tr>
<th>Drinking Predictor Variables (Semesters 1 and 2)</th>
<th>N (% of Drinkers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HED Drinkers</td>
<td>355 (75.1%)</td>
</tr>
<tr>
<td>HED-Only Drinkers</td>
<td>176 (37.2%)</td>
</tr>
<tr>
<td>HID Drinkers</td>
<td>179 (37.8%)</td>
</tr>
<tr>
<td>Day Drinkers</td>
<td>83 (17.5%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Medium-Term Consequence Outcome Variables</th>
<th>N (% of Drinkers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exhibited Hazardous/Harmful Drinking in Semester 7</td>
<td>182 (38.5%)</td>
</tr>
<tr>
<td>Received Any Alcohol Violations during College</td>
<td>27 (5.7%)</td>
</tr>
<tr>
<td>Anticipated Delay of College Graduation by Semester 6</td>
<td>93 (20.0%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Control Variables (Semesters 1 and 2)</th>
<th>N (% of Drinkers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>229 (48.4%)</td>
</tr>
<tr>
<td>Greek Organization Participants</td>
<td>143 (30.2%)</td>
</tr>
<tr>
<td>Athletes\textsuperscript{a}</td>
<td>281 (59.4%)</td>
</tr>
<tr>
<td>Honors Students</td>
<td>36 (7.6%)</td>
</tr>
</tbody>
</table>

\textit{Note.} Total $N = 473$ students who reported drinking on at least one sampled day in Semesters 1 and 2.

\textsuperscript{a} Includes intercollegiate and intramural athletic participation.
Table 0-4  
*Univariate Descriptive Statistics of Drinking Predictor Variables, Medium-Term Consequence Outcome Variables, and Control Variables for Research Question 3*

<table>
<thead>
<tr>
<th></th>
<th>N (% of Drinkers)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drinking Predictor Variables (Semesters 4 and 5)</strong></td>
<td></td>
</tr>
<tr>
<td>Heavy Episodic Drinkers</td>
<td>361 (79.3%)</td>
</tr>
<tr>
<td>Pregame HED Drinkers</td>
<td>168 (36.9%)</td>
</tr>
<tr>
<td><strong>Medium-Term Consequence Outcome Variables</strong></td>
<td></td>
</tr>
<tr>
<td>Exhibited Hazardous/Harmful Drinking in Semester 7</td>
<td>181 (39.8%)</td>
</tr>
<tr>
<td>Received Any Alcohol Violations during College</td>
<td>23 (5.1%)</td>
</tr>
<tr>
<td>Anticipated Delay of College Graduation by Semester 6</td>
<td>97 (21.3%)</td>
</tr>
<tr>
<td><strong>Control Variables (Semesters 4 and 5)</strong></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>207 (45.5%)</td>
</tr>
<tr>
<td>Greek Organization Participants</td>
<td>128 (28.1%)</td>
</tr>
<tr>
<td>Athletes(^a)</td>
<td>263 (57.8%)</td>
</tr>
<tr>
<td>Honors Students</td>
<td>38 (8.4%)</td>
</tr>
</tbody>
</table>

*Note.* Total N = 455 students who reported drinking on at least one sampled day in Semesters 4 and 5.  
\(^a\) Includes intercollegiate and intramural athletic participation.
Table 0-5

Negative Binomial Regressions Testing Whether First Year High-Intensity Drinkers Experienced More Alcohol-Related Problems in Fourth Year than Heavy Episodic Drinking Only Drinkers (Research Question 1a)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Semester 7 RAPI Sum</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IRR [95% CI]</td>
<td>IRR [95% CI]</td>
</tr>
<tr>
<td>Intercept</td>
<td>5.90 [5.17, 6.76]***</td>
<td>5.88 [5.15, 6.72]***</td>
</tr>
<tr>
<td>HID Drinkers(a)</td>
<td>1.44 [1.07, 1.96]*</td>
<td>1.31 [.96, 1.79]</td>
</tr>
<tr>
<td>Non-HED Drinkers(a)</td>
<td>.67 [.47, .95]*</td>
<td>.65 [.46, .93]*</td>
</tr>
<tr>
<td>Male</td>
<td>-</td>
<td>1.24 [.93, 1.65]</td>
</tr>
<tr>
<td>Greek Participant</td>
<td>-</td>
<td>1.29 [.96, 1.74]</td>
</tr>
<tr>
<td>Athlete(b)</td>
<td>-</td>
<td>1.07 [.80, 1.43]</td>
</tr>
<tr>
<td>Honors Student</td>
<td>-</td>
<td>.84 [.52, 1.36]</td>
</tr>
</tbody>
</table>

Note. \(N = 390\). RAPI = Rutgers Alcohol Problem Index; IRR = Incidence rate ratio; CI = Confidence interval.

\(a\) Reference group is HED-only drinkers = Students who reported at least one occasion of drinking at the HED level, but no occasion at the HID level, on sampled days in first year.

\(b\) Includes intercollegiate and intramural athletic participation.

* \(p < .05\); ** \(p < .01\); *** \(p < .001\).
Table 0-6
Logistic Regressions Testing Whether First-Year High-Intensity Drinkers Were More Likely than Heavy Episodic Drinking Only Drinkers to Exhibit Hazardous/Harmful Drinking in Fourth Year (Research Question 1b)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Semester 7 AUDIT (Cutoff ≥ 10)</th>
<th>OR [95% CI]</th>
<th>OR [95% CI]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td></td>
<td>.80 [.64, .99]</td>
<td>.80 [.64, 1.00]</td>
</tr>
<tr>
<td>HID Drinkers</td>
<td></td>
<td>4.03 [2.50, 6.48]***</td>
<td>3.65 [2.23, 5.95]***</td>
</tr>
<tr>
<td>Non-HED Drinkers</td>
<td></td>
<td>.46 [.25, .83]**</td>
<td>.47 [.26, .85]*</td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td>-</td>
<td>.98 [.61, 1.56]</td>
</tr>
<tr>
<td>Greek participant</td>
<td></td>
<td>-</td>
<td>1.49 [.92, 2.41]</td>
</tr>
<tr>
<td>Athlete (b)</td>
<td></td>
<td>-</td>
<td>1.97 [1.23, 3.17]**</td>
</tr>
<tr>
<td>Honors student</td>
<td></td>
<td>-</td>
<td>.58 [.25, 1.33]</td>
</tr>
</tbody>
</table>

*Note. N = 404. AUDIT = Alcohol Use Disorders Identification Test; OR = Odds ratio; CI = Confidence interval.

\(a\) Reference group is HED-only drinkers.

\(b\) Includes intercollegiate and intramural athletic participation.

\* \(p < .05\); \** \(p < .01\); \*** \(p < .001\).
Table 0-7
*Logistic Regressions Testing Whether First-Year High-Intensity Drinkers Were More Likely than Heavy Episodic Drinking Only Drinkers to Receiving Any Alcohol Violations during College (Research Question 1c)*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Any Alcohol Violations</th>
<th>OR [95% CI]</th>
<th>OR [95% CI]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td></td>
<td>.06 [.04, .10]***</td>
<td>.06 [.04, .09]***</td>
</tr>
<tr>
<td>HID Drinkers&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.98 [.43, 2.23]</td>
<td>.88 [.38, 2.04]</td>
<td></td>
</tr>
<tr>
<td>Non-HED Drinkers&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.24 [.05, 1.07]</td>
<td>.23 [.05, 1.05]</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>-</td>
<td>2.36 [.97, 5.71]</td>
<td></td>
</tr>
<tr>
<td>Greek Participant</td>
<td>-</td>
<td>.80 [.33, 1.96]</td>
<td></td>
</tr>
<tr>
<td>Athlete&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-</td>
<td>.88 [.36, 2.11]</td>
<td></td>
</tr>
<tr>
<td>Honors Student</td>
<td>-</td>
<td>.42 [.05, 3.28]</td>
<td></td>
</tr>
</tbody>
</table>

*Note. N = 405. OR = Odds ratio; CI = Confidence interval.*

<sup>a</sup> Reference group is HED-only drinkers.

<sup>b</sup> Includes intercollegiate and intramural athletic participation.

* p < .05; ** p < .01; *** p < .001.
Table 0-8

Logistic Regressions Testing Whether First-Year High-Intensity Drinkers Were More Likely than Heavy Episodic Drinking Only Drinkers to Anticipate a Delay of College Graduation by Third Year (Research Question 1d)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Anticipated Delay of College Graduation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR [95% CI]</td>
</tr>
<tr>
<td>Intercept</td>
<td>.31 [.25, .39]***</td>
</tr>
<tr>
<td>HID Drinkers(^a)</td>
<td>1.01 [.58, 1.74]</td>
</tr>
<tr>
<td>Non-HED Drinkers(^a)</td>
<td>1.36 [.76, 2.43]</td>
</tr>
<tr>
<td>Male</td>
<td>-</td>
</tr>
<tr>
<td>Greek Participant</td>
<td>-</td>
</tr>
<tr>
<td>Athlete(^b)</td>
<td>-</td>
</tr>
<tr>
<td>Honors Student</td>
<td>-</td>
</tr>
</tbody>
</table>

Note. \(N = 391\). OR = Odds ratio; CI = Confidence interval.

\(^a\) Reference group is HED-only drinkers.

\(^b\) Includes intercollegiate and intramural athletic participation.

\(* p < .05; ** p < .01; *** p < .001.\)
**Table 0-9**

*Negative Binomial Regressions Testing Whether Day Drinking in First Year Predicted Greater Alcohol-Related Problems in Fourth Year Above and Beyond Heavy Episodic Drinking (Research Question 2a)*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Semester 7 RAPI Sum</th>
<th>IRR [95% CI]</th>
<th>IRR [95% CI]</th>
<th>IRR [95% CI]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interception</td>
<td></td>
<td>6.16 [5.37, 7.06]***</td>
<td>5.94 [5.19, 6.80]***</td>
<td>5.90 [5.16, 6.74]***</td>
</tr>
<tr>
<td>Day Drinkers</td>
<td></td>
<td>1.16 [.81, 1.67]</td>
<td>1.11 [.78, 1.58]</td>
<td>1.00 [.70, 1.42]</td>
</tr>
<tr>
<td>HED Drinkers</td>
<td></td>
<td>-</td>
<td>1.80 [1.31, 2.49]***</td>
<td>1.76 [1.27, 2.42]***</td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td>-</td>
<td>-</td>
<td>1.27 [.95, 1.69]</td>
</tr>
<tr>
<td>Greek Participant</td>
<td></td>
<td>-</td>
<td>-</td>
<td>1.36 [1.01, 1.82]*</td>
</tr>
<tr>
<td>Athlete(a)</td>
<td></td>
<td>-</td>
<td>-</td>
<td>1.08 [.81, 1.45]</td>
</tr>
<tr>
<td>Honors Student</td>
<td></td>
<td>-</td>
<td>-</td>
<td>.80 [.49, 1.30]</td>
</tr>
</tbody>
</table>

**Note.**  
N = 390. RAPI = Rutgers Alcohol Problem Index; IRR = Incidence rate ratio; CI = Confidence interval. Reference group is student drinkers who reported not day drinking or engaging in HED in first year.  
\(a\) Includes intercollegiate and intramural athletic participation.  
* \(p < .05\); ** \(p < .01\); *** \(p < .001\).
Table 0-10

_Logistic Regressions Testing Whether Day Drinking in First Year Predicted Hazardous/Harmful Drinkers in Fourth Year Above and Beyond Heavy Episodic Drinking (Research Question 2b)_

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Semester 7 AUDIT (Cutoff of 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>OR [95% CI]</strong></td>
</tr>
<tr>
<td>Intercept</td>
<td>.82 [.67, 1.00]*</td>
</tr>
<tr>
<td>Day Drinkers</td>
<td>2.30 [1.36, 3.90]**</td>
</tr>
<tr>
<td>HED Drinkers</td>
<td>-</td>
</tr>
<tr>
<td>Male</td>
<td>-</td>
</tr>
<tr>
<td>Greek Participant</td>
<td>-</td>
</tr>
<tr>
<td>Athlete&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Honors Student</td>
<td>-</td>
</tr>
</tbody>
</table>

_Note._  _N_ = 404.  AUDIT = Alcohol Use Disorders Identification Test; _OR_ = Odds ratio; _CI_ = Confidence interval.  Reference group is student drinkers who reported not day drinking or engaging in HED in first year.

<sup>a</sup> Includes intercollegiate and intramural athletic participation.

* _p_ < .05; ** _p_ < .01; *** _p_ < .001.
Table 0-11
*Logistic Regressions Testing Whether Day Drinking in First Year Predicted Receiving Any Alcohol Violations during College Above and Beyond Heavy Episodic Drinking (Research Question 2c)*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Any Alcohol Violations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR [95% CI]</td>
</tr>
<tr>
<td>Intercept</td>
<td>.07 [.05, .11]***</td>
</tr>
<tr>
<td>Day Drinkers</td>
<td>.81 [.27, 2.41]</td>
</tr>
<tr>
<td>HED Drinkers</td>
<td>-</td>
</tr>
<tr>
<td>Male Gender</td>
<td>-</td>
</tr>
<tr>
<td>Greek Participant</td>
<td>-</td>
</tr>
<tr>
<td>Athlete&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Honors Student</td>
<td>-</td>
</tr>
</tbody>
</table>

*Note. N = 405. OR = Odds ratio; CI = Confidence interval. Reference group is student drinkers who reported not day drinking or engaging in HED in first year.

<sup>a</sup> Includes intercollegiate and intramural athletic participation.

* p < .05; ** p < .01; *** p < .001.
Table 0-12  
*Logistic Regressions Testing Whether Day Drinking in First Year Predicted an Anticipated Delay of College Graduation by Third Year Above and Beyond Heavy Episodic Drinking (Research Question 2d)*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Anticipated Delay of College Graduation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR [95% CI]</td>
</tr>
<tr>
<td>Intercept</td>
<td>.31 [.25, .39]***</td>
</tr>
<tr>
<td>Day Drinkers</td>
<td>1.24 [.69, 2.24]</td>
</tr>
<tr>
<td>HED Drinkers</td>
<td>-</td>
</tr>
<tr>
<td>Male</td>
<td>-</td>
</tr>
<tr>
<td>Greek Participant</td>
<td>-</td>
</tr>
<tr>
<td>Athlete&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Honors Student</td>
<td>-</td>
</tr>
</tbody>
</table>

*Note. N = 391. OR = Odds ratio; CI = Confidence interval. Reference group is student drinkers who reported not day drinking or engaging in HED in first year.*

<sup>a</sup> Includes intercollegiate and intramural athletic participation.

* p < .05; ** p < .01; *** p < .001.
Table 0-13

Negative Binomial Regressions Testing Whether Pregame Heavy Episodic Drinking in Semesters 4 and 5 Predicted Alcohol-Related Problems in Semester 7 Above and Beyond Heavy Episodic Drinking (Research Question 3a)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Semester 7 RAPI Sum</th>
<th>Semester 7 RAPI Sum</th>
<th>Semester 7 RAPI Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IRR [95% CI]</td>
<td>IRR [95% CI]</td>
<td>IRR [95% CI]</td>
</tr>
<tr>
<td>Intercept</td>
<td>5.80 [5.09, 6.62]***</td>
<td>5.65 [4.96, 6.43]***</td>
<td>5.62 [4.94, 6.40]***</td>
</tr>
<tr>
<td>Pregame HED Drinkers</td>
<td>1.72 [1.31, 2.24]***</td>
<td>1.49 [1.12, 1.98]**</td>
<td>1.49 [1.12, 1.99]**</td>
</tr>
<tr>
<td>HED Drinkers</td>
<td>1.76 [1.22, 2.54]**</td>
<td></td>
<td>1.67 [1.15, 2.42]**</td>
</tr>
<tr>
<td>Male</td>
<td>-</td>
<td></td>
<td>1.20 [.91, 1.59]</td>
</tr>
<tr>
<td>Greek Participant</td>
<td>-</td>
<td></td>
<td>1.31 [.98, 1.75]</td>
</tr>
<tr>
<td>Athlete&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-</td>
<td>-</td>
<td>.97 [.73, 1.29]</td>
</tr>
<tr>
<td>Honors Student</td>
<td>-</td>
<td>-</td>
<td>.73 [.46, 1.15]</td>
</tr>
</tbody>
</table>

Note. N = 401. RAPI = Rutgers Alcohol Problem Index; IRR = Incidence rate ratio; CI = Confidence interval. Reference group is Non-HED Drinkers (i.e., students reported not engaging in HED during Semesters 4 and 5).

<sup>a</sup> Includes intercollegiate and intramural athletic participation.

* p < .05; ** p < .01; *** p < .001.
Table 0-14
Logistic Regressions Testing Whether Pregame Heavy Episodic Drinking in Semesters 4 and 5 Predicted Hazardous/Harmful Drinking in Semester 7 Above and Beyond Heavy Episodic Drinking (Research Question 3b)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Semester 7 AUDIT (Cutoff of 10)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR [95% CI]</td>
<td>OR [95% CI]</td>
<td>OR [95% CI]</td>
</tr>
<tr>
<td>Intercept</td>
<td>.78 [.64, .96]*</td>
<td>.71 [.56, .89]**</td>
<td>.72 [.57, .90]**</td>
</tr>
<tr>
<td>Pregame HED Drinkers</td>
<td>3.82 [2.50, 5.82]***</td>
<td>2.60 [1.67, 4.06]***</td>
<td>2.86 [1.80, 4.56]***</td>
</tr>
<tr>
<td>HED Drinkers</td>
<td>-</td>
<td>5.20 [2.44, 11.11]***</td>
<td>4.77 [2.21, 10.30]***</td>
</tr>
<tr>
<td>Male</td>
<td>-</td>
<td>-</td>
<td>1.56 [.97, 2.50]</td>
</tr>
<tr>
<td>Greek Participant</td>
<td>-</td>
<td>-</td>
<td>1.54 [.95, 2.49]</td>
</tr>
<tr>
<td>Athlete(^a)</td>
<td>-</td>
<td>-</td>
<td>1.50 [.94, 2.40]</td>
</tr>
<tr>
<td>Honors Student</td>
<td>-</td>
<td>-</td>
<td>.32 [.14, .73]**</td>
</tr>
</tbody>
</table>

Note. \(N = 406\). AUDIT = Alcohol Use Disorders Identification Test; OR = Odds ratio; CI = Confidence Interval. Reference group is Non-HED Drinkers.

\(^a\) Includes intercollegiate and intramural athletic participation.

* \(p < .05\); ** \(p < .01\); *** \(p < .001\).
Table 0-15

*Logistic Regressions Testing Whether Pregame Heavy Episodic Drinking in Semesters 4 and 5 Predicted Receiving Any Alcohol Violations during College Above and Beyond Heavy Episodic Drinking (Research Question 3c)*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Any Alcohol Violations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR [95% CI]</td>
</tr>
<tr>
<td>Intercept</td>
<td>.06 [.04, .09]***</td>
</tr>
<tr>
<td>Pregame HED Drinkers</td>
<td>1.83 [.79, 4.25]</td>
</tr>
<tr>
<td>HED Drinkers</td>
<td>-</td>
</tr>
<tr>
<td>Male</td>
<td>-</td>
</tr>
<tr>
<td>Greek Participant</td>
<td>-</td>
</tr>
<tr>
<td>Athlete&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Honors Student</td>
<td>-</td>
</tr>
</tbody>
</table>

Note. N = 408. OR = Odds ratio; CI = Confidence Interval. Reference group is Non-HED Drinkers.

<sup>a</sup> Includes intercollegiate and intramural athletic participation.

* p < .05; ** p < .01; *** p < .001.
Table 0-16
Logistic Regressions Testing Whether Pregame Heavy Episodic Drinking in Semesters 4 and 5 Predicted an Anticipated Delay of College Graduation by Semester 6 Above and Beyond Heavy Episodic Drinking (Research Question 3d)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Anticipated Delay of College Graduation</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td><strong>OR [95% CI]</strong></td>
<td><strong>OR [95% CI]</strong></td>
<td><strong>OR [95% CI]</strong></td>
</tr>
<tr>
<td>Intercept</td>
<td>.32 [.25, .41]***</td>
<td>.32 [.26, .41]***</td>
<td>.31 [.24, .40]***</td>
</tr>
<tr>
<td>Pregame HED Drinkers</td>
<td>.61 [.37, 1.00]</td>
<td>.67 [.39, 1.14]</td>
<td>.68 [.40, 1.18]</td>
</tr>
<tr>
<td>HED Drinkers</td>
<td>-</td>
<td>.75 [.41, 1.35]</td>
<td>.79 [.43, 1.46]</td>
</tr>
<tr>
<td>Male</td>
<td>-</td>
<td>-</td>
<td>2.27 [1.37, 1.07]**</td>
</tr>
<tr>
<td>Greek Participant</td>
<td>-</td>
<td>-</td>
<td>.61 [.35, 1.07]</td>
</tr>
<tr>
<td>Athlete (a)</td>
<td>-</td>
<td>-</td>
<td>.90 [.54, 1.51]</td>
</tr>
<tr>
<td>Honors Student</td>
<td>-</td>
<td>-</td>
<td>1.89 [.86, 4.12]</td>
</tr>
</tbody>
</table>

*Note.* \(N = 395\). **OR = Odds ratio; CI = Confidence Interval.** Reference group is Non-HED Drinkers.

\(a\) Includes intercollegiate and intramural athletic participation.

* \(p < .05\); ** \(p < .01\); *** \(p < .001\).
Table 0-17
*Sensitivity of Dichotomous Risky Drinking Indicators in Predicting Dichotomous Medium-Term Consequences of Alcohol Use*

<table>
<thead>
<tr>
<th>Research Questions 1 and 2 (Semesters 1 and 2)</th>
<th>AUDIT</th>
<th>Any Alcohol Violations</th>
<th>Anticipated Delay of Graduation</th>
</tr>
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<tbody>
<tr>
<td>HED</td>
<td>.89</td>
<td>.93</td>
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</tr>
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<td>HID</td>
<td>.57</td>
<td>.44</td>
<td>.34</td>
</tr>
<tr>
<td>Day Drinking</td>
<td>.24</td>
<td>.15</td>
<td>.20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Research Question 3 (Semesters 4 and 5)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HED</td>
<td>.95</td>
<td>.96</td>
<td>.75</td>
</tr>
<tr>
<td>Any Pregaming</td>
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<td>.83</td>
<td>.63</td>
</tr>
<tr>
<td>Pregame HED</td>
<td>.55</td>
<td>.52</td>
<td>.29</td>
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</table>

*Note.* AUDIT = Alcohol Use Disorders Identification Test (cutoff of 10).
Table 0-18

*Specificity of Dichotomous Risky Drinking Indicators in Predicting Dichotomous Medium-Term Consequences of Alcohol Use*

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<th>Any Alcohol Violations</th>
<th>Anticipated Delay of Graduation</th>
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</thead>
<tbody>
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<td>.25</td>
<td>.24</td>
</tr>
<tr>
<td>HID</td>
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<td>.64</td>
<td>.63</td>
</tr>
<tr>
<td>Day Drinking</td>
<td>.88</td>
<td>.82</td>
<td>.83</td>
</tr>
</tbody>
</table>

| Research Question 3 (Semesters 4 and 5)       |       |                        |                                 |
| HED                                           | .30   | .20                    | .17                             |
| Any Pregaming                                 | .40   | .29                    | .27                             |
| Pregame HED                                   | .76   | .63                    | .60                             |

*Note.* AUDIT = Alcohol Use Disorders Identification Test (cutoff of 10).
CHAPTER 5

GENERAL DISCUSSION

Over the past several decades, heavy episodic drinking, also known as binge drinking, among college students has been studied extensively, and it has been shown to predict an array of negative consequences across samples and contexts (Jennison, 2004; Kiene et al., 2009; Patrick & Maggs, 2015; Schulenberg et al., 2018; Wechsler et al., 2000, 2002). However, the development of research on tangential aspects of heavy college drinking, such as pregaming (Borsari et al., 2007; Pedersen & LaBrie, 2007), tailgating (Glassman et al., 2010; Neal & Fromme, 2007), and playing drinking games (Borsari, 2004; Zamboanga et al., 2014), as well as the emergence of a push to consider additional thresholds of heavy drinking (i.e., high-intensity drinking; Hingson, Zha, & White, 2017; Patrick, 2016; White et al., 2006), points to the need to consider more than just whether college students engage in HED in general and on particular occasions.

What Was Learned from This Work?

It Is Important to Differentiate among Levels of Drinking

A key argument this dissertation makes is that it is important to consider the level of HED given the high variability in regular alcohol consumption that exists above this threshold (Naimi et al., 2010; Patrick & Terry-McElrath, 2017; Read et al., 2008; White et al., 2006). The work presented here extends the emerging body of research on HID by showing that HID drinkers in the first year of college were more likely to exhibit a hazardous/harmful pattern of drinking and alcohol-related problems in fourth year than students who drank at the HED level but not the HID level. Supplemental analyses demonstrated that HID was able to predict these medium-term consequences with greater specificity than HED, whereas HED did so with greater
sensitivity. Together, the current findings and other recent findings on HID (e.g., Hingson et al., 2017; Linden-Carmichael et al., 2018) emphasize the need for researchers to more clearly differentiate among drinking levels in order to effectively identify individuals and drinking occasions with the most risk for experiencing negative consequences, especially those that are most harmful (e.g., alcohol-related motor vehicle accidents, sexual victimization).

This same argument is also applied to drinking that occurs before college students go out at night. Nearly all of the research on pregame drinking has simply assessed whether or not individuals drink before going out in general or on specific occasions, despite some evidence that the amount individuals drink before going out varies from very little to enough to reach legal intoxication (Kenney et al., 2010; Labhart et al., 2013; Pedersen & LaBrie, 2008; Pedersen et al., 2009; Read et al., 2010). This dissertation showed that getting drunk before going out predicted a greater likelihood of drinking more than double the traditional heavy drinking threshold and experiencing more negative consequences than drinking at a more moderate level or not drinking at all before going out on drinking days. Although no associations between day drinking and short- and medium-term consequences were observed, it was speculated that this may have resulted from not accounting for how much students drank on day drinking days when testing these associations. Thus, alcohol consumption among college students varies greatly between students and across occasions, and this dissertation demonstrates the importance of better accounting for this variability in future research in order to more precisely identify risk associated with heavy drinking.

It Is Important to Differentiate among Heavy Drinking Contexts

A second key argument this dissertation makes is that the physical, social, and temporal contexts in which HED occurs matter. One particular context this dissertation focused on was
that of pregame drinking, which tends to occur in private residences with small groups of close friends (DeJong et al., 2010; Pedersen & LaBrie, 2007). This dissertation showed that getting drunk before going out (i.e., Pregame HED) predicted short- and medium-term negative consequences independent of and with more specificity than getting drunk in general (i.e., HED). This new finding suggests that there is unique risk associated with getting drunk before going out, in addition to established risks associated with getting drunk more generally. For instance, a student who gets drunk (i.e., drinks to the HED level) with a friend in their dorm or apartment will likely incur a somewhat milder level of risk, although the exact amount depends on a number of factors specific to the individual and the occasion. If this student then goes out to a bar or private party, as on a Pregame HED occasion, they likely incur far more risk due to the distance they must travel while intoxicated, the likelihood that they will continue to drink even more alcohol at the subsequent event, and the increased likelihood of interaction with people they do not know well which may increase their likelihood of victimization.

Another context focused on here was that of day drinking. This dissertation showed that drinking during the daytime was more characterized by heavy and very heavy drinking than evening or nighttime drinking but that daytime drinking was associated with negative consequences in different ways. Students who reported drinking during the daytime more often reported greater negative consequences in general, but students tended to report fewer negative consequences on specific days they drank during the daytime compared to evening or nighttime drinking days. Both getting drunk before going out and drinking during the daytime were associated with an increased likelihood of very heavy drinking, and each was associated with other risky behaviors. Because this dissertation introduced day drinking to the empirical literature, more research on day drinking is needed to better determine its level of risk and how it
differs from pregame drinking. Nonetheless, this work demonstrates the importance of better accounting for the contexts in which heavy drinking occurs in future research so as to better detect students and occasions at greatest risk for alcohol-related harms. Although heavy episodic drinking is generally associated with negative consequences and other risky behaviors, this dissertation highlights how the magnitude of these associations may change depending on where, when, and with whom these drinking behaviors occur.

Risky Drinking Indicators May Be Most Effective When Used Together

Third, this dissertation argues that researchers can use the growing number of risky drinking indicators (e.g., HED, HID, pregame drinking, playing drinking games, mixing alcohol with energy drinks, tailgating, etc.) most effectively by employing them in conjunction with one another. For instance, this dissertation showed that very heavy drinking predicted medium-term negative consequences independent of more general heavy drinking. Similarly, getting drunk before going out predicted greater short-term consequences than drinking more moderate amounts of alcohol before going out or not drinking before going out. Supplemental analyses demonstrated the trade-offs in sensitivity and specificity that accompany using different indicators of risky drinking. For example, the broader HED and any pregaming indicators offered higher sensitivity in identifying problem drinkers than the more specific HID and Pregame HED indicators. However, the more specific indicators offered better specificity in identifying problem drinkers than the broader indicators.

Most importantly, this work showed how such indicators can be used together to help determine whether associations with risky behaviors and negative consequences are due more to context or amount of consumption. For example, students were more likely to drink very heavily and experienced more negative consequences on days they got drunk before going out than on
days they drank more moderate amounts of alcohol before going out as well as on days they drank more moderate amounts before going out in comparison to drinking days they did not drank at all prior to going. This suggests that the amount of alcohol students drink before going out on days they drink predicts the total amount they consume throughout the night and the number of negative consequences they experience. In contrast, students were no more likely to play drinking games or mix alcohol with energy drinks on days they got drunk before going out than on days they drank more moderately before going out, although students were more likely to play drinking games and mix alcohol with energy drinks on days they drank more moderately before going out in comparison to drinking days they did not drink at all before going out. This seems to suggest that there is something about the pregaming context that is conducive to these two risky behaviors and that this association is less related to how much alcohol students consume. Thus, although broader indicators of risky drinking, such as HED or any pregaming, are useful in some circumstances, they are likely even more useful when used in conjunction with more specific indicators, such as HID and Pregame HED. Using such indicators together in future work will help researchers learn more about which correlates and consequences of drinking are more closely related to context, amount of alcohol consumption, and/or other factors.

**Strengths and Limitations**

There are at least five specific strengths of this dissertation. First, these papers address innovative research questions that address gaps in the college drinking literature, and they introduce two new concepts and ways of measuring risky drinking, that is, drinking to the heavy episodic threshold before going out and starting drinking earlier in the day. Second, each of the three main variables used here (i.e., Pregame HED, Day Drinking, HID) is very applicable to
other research across a number of contexts and designs, and these variables should be easy for respondents, stakeholders, and the general public to understand. Third, the ULS sample used throughout was a probability-based sample of a single university campus that was fairly balanced in regard to gender and four major race/ethnicity groups. The sample was also fairly homogenous as all participants were first-time, full-time, traditionally-aged college students and nearly all were residential students living in a relatively isolated environment, which likely made opportunities for social activities while at school more similar than in more age- and role-diverse samples (e.g., Barry et al., 2013; Knight et al., 2002; Wechsler et al., 2000). Additionally, the sample included daily observations collected across three-and-a-half years. Collectively, these characteristics broaden the generalizability of the present findings, especially in comparison to other studies in the college drinking literature that used non-random sampling techniques (e.g., Merrill et al., 2013; Pedersen & LaBrie, 2007), were cross-sectional or collected data in narrower time frames (e.g., Glassman et al., 2010; Wechsler et al., 2000), or predominantly consisted of White students (e.g., Borsari et al., 2007; Read et al., 2010; White et al., 2006). Fourth, the ULS had both high response rates and high retention throughout. At least 80% of participants completed 12 out of 14 daily surveys in all seven semesters, and 79% of the original sample was retained in the final semester (Howard et al., 2015). Thus, findings were likely only marginally biased by non-response or attrition. To the extent that bias did occur, estimates of the prevalence of drinking behaviors or of the associations between drinking behaviors and their correlates or consequences were likely conservative (i.e., they were underestimated). Lastly, the use of an advanced analytic technique allowed for testing within-person, daily associations that controlled for stable, between-person differences and for testing more standard between-person associations (Raudenbush & Bryk, 2002). This technique minimized the influence of person-level
confounding variables in daily associations and allowed for comparing the significance and
direction of associations across hierarchical levels.

There were several limitations nonetheless. First, students were all from a single cohort
at a single university, which restricts the generalizability of the findings to a degree. Second, the
associations described here are correlational in nature. Although causality may be suggested by
past work and/or speculated here, the design and analysis did not test, and therefore did not
provide evidence of, causality. Third, some of the variables may have been measured with
limited reliability or validity. Daily measurements of drinking behaviors across short, two-week
bursts were likely not the best method for assessing the frequency or prevalence of such
behaviors (Paper 3). Similarly, assessing the total number of negative consequences students
experienced each day, as opposed to assessing consequences individually, may have affected the
associations between Pregame HED and day drinking with negative consequences (Papers 1 and
2). It is also possible that social desirability bias contributed to students overreporting how often
or how much they drank; however, at least one study found that social desirability bias
(specifically impression management bias) was associated with the underreporting of heavy
drinking (e.g., Davis, Thake, & Vilhena, 2010). In general, studies assessing the measurement
validity of self-reported alcohol consumption have found that college students tend to
underreport alcohol consumption due to recall bias and their overestimation of what constitutes a
standard drink, among other factors (e.g., Northcote & Livingston, 2011; White et al., 2005).

Policy and Intervention Implications

So, why does any of this matter? For decades, researchers have described the high levels
of heavy drinking that occur on many college campuses nationwide (Berkowitz & Perkins, 1986;
Maggs, Williams, & Lee, 2011; O’Hare, 1990; Straus & Bacon, 1953; Wechsler et al., 2000,
Similarly, policy-makers, college administrations, health officials, and researchers have aimed to develop and test prevention programs and policies to reduce such heavy drinking and its negative consequences (e.g., Chaloupka & Wechsler, 1996; Dimeff, Baer, Kivlahan, & Marlatt, 1999; Turrisi, Jaccard, Taki, Dunnam, & Grimes, 2001; Wechsler, Lee, Nelson, & Lee, 2003). Although there have been historical decreases in rates of HED among college-aged individuals (Substance Abuse and Mental Health Services Administration [SAMHSA], 2015; Schulenberg et al., 2018), rates still remain high (≥ 30% report HED in the past month) and the rates of alcohol-overdose hospitalizations and deaths appear to have increased in recent years (Hingson, Zha, & Smyth, 2017). Thus, there is still much room for improvement in college drinking prevention.

This work informs prevention and policy research in a number of ways that may help scientists develop and test new methods or policies aimed at reducing the prevalence and consequences of heavy drinking. First, this dissertation helps point to the need for alcohol policies to be more fully evaluated and perhaps even more evidence-based (Marlatt & Witkiewitz, 2010; Toomey et al., 2007). In a paper that discussed the implications of the pregaming literature for public policy, Wells, Graham, and Purcell (2009) speculated that policies aimed at reducing heavy drinking in bars and other licensed establishments may unintentionally result in higher rates of drinking before going out and, ultimately, in more negative consequences. Research published since 2009 (e.g., Barnett et al., 2013; Merill et al., 2013; LaBrie et al., 2016), including this dissertation, has demonstrated that drinking before going out is very common among college students and has strengthened the claim that pregame drinking is associated with greater risk for short- and medium-term consequences. Thus, one policy-related strategy could be to reevaluate local policies designed to limit drinking within
licensed premises (e.g., those that prohibit drink specials or set mandatory closing times) to better understand what unintended consequences may result. A first step would be to more specifically determine whether alcohol policies actually result in less overall drinking or if some drinking is simply displaced from licensed establishments to unregulated settings (e.g., pregame parties), as postulated by Wells et al. (2009). Similarly, it is important to determine whether negative consequences in sum, as well as particular consequences (i.e., drunk driving accidents, hospitalizations) are lower when alcohol policies are enforced. Fully considering the range of consequences of alcohol-related policies, as well as their effectiveness at limiting overall levels of drinking and risk, may help policymakers refine the legal approaches they take toward prevention.

Second, Wells et al. (2009) recommended continued work on the development, implementation, and evaluation of policies and programs designed to change drinking norms, promote drinking in moderation, and encourage safer decision-making when drinking (e.g., BASICS; Dimeff et al., 1999), especially since some students report strong motivations to get drunk on particular occasions. One of the most effective college drinking programs, BASICS, is a targeted program that is often given to individuals who have received an alcohol violation and/or are currently heavy drinkers at high risk for negative consequences (Fachini, Aliane, Martinez, & Furtado, 2012). Thus, prevention scientists may be able to use some of the risky drinking indicators used here to better identify students at risk for longer-term problems. As demonstrated in Paper 3, students who report Pregame HED with any regularity early on in college are likely to be at greater risk for alcohol problems by the end of college several years later. Perhaps these items could be added to survey screening instruments to better identify students in need of intervention.
Third, the increased use of alcohol-free programs on college campuses has been identified as a promising strategy for reducing college drinking and its negative consequences by the National Institute on Alcoholism and Alcohol Abuse (NIAAA, 2015) and in the prevention literature more broadly (DeJong et al., 1998; Vicary & Karshin, 2002; Wechsler et al., 2002). These programs are designed to provide alternative social opportunities and fun activities for college students in more prosocial, alcohol-free environments on campus (DeJong & Langford, 2002; NIAAA, 2015). Layland, Calhoun, Russell, and Maggs (2019) found that students who attended alcohol-free late-night campus activities drank and used illegal drugs less in general and on days they attended. Although such programming may not appeal to all students (Wei, Barnett, & Clark, 2010), if such programs can be expanded or altered in order to attract more students, they may be successful in limiting HID and HED. However, similar to the issues related to alcohol control policies described above, Wei et al. (2010) found that students were more likely to pregame on days they attended alcohol-free events than days they attended events where alcohol was permitted, such as private parties. Given the risks associated with pregaming and Pregame HED reported here, researchers will likely need to keep this in consideration as they move forward in designing and evaluating alcohol-free programs. One strategy for improving the reach and/or effectiveness of such programs is to offer them during common pregaming or day drinking times, instead of just the more typical late-night time slots. For instance, colleges could try offering alcohol-free programming on social weekend nights starting as early as 6:00 PM in order to provide alternative activities and opportunities for socialization during times when students might otherwise be drinking at a pregame party. Similarly, perhaps alcohol-free programming could also be extended to the daytime on Saturdays, especially those
in which students may be more likely to day drink, such as football game days or those around the beginning or end of the semester/school year.

**Future Research**

These papers show the need for college drinking researchers to begin examining how drinking in different physical, social, and/or temporal contexts affects the risks associated with heavy drinking. They also demonstrate why it is important for researchers who study particular contexts (e.g., pregaming, day drinking, tailgating, special occasions) to begin assessing how much alcohol students are drinking in these contexts, not just whether they drink in them. Thus, the amount of alcohol students consume and the context and manner in which they drink need to be considered together, rather than in isolation, more frequently. For example, future work should aim to better identify who Pregame HED drinkers are and to assess what specific negative consequences are more likely on Pregame HED occasions.

Further, future research should focus more on within-day patterns or processes of drinking. Much of the extant literature on heavy college drinking has examined associations between HED and its correlates and consequences (Jennison, 2004; Kiene et al., 2009; Patrick, Maggs, & Lefkowitz, 2015; Schulenberg et al., 2018; Wechsler et al., 2000, 2002). However, far less research has focused on fully describing drinking episodes as they actually happen or examining how processes that occur throughout a drinking episode affect the consequences that will ultimately be experienced. Paper 1 showed how common it is for students to get drunk in one context before traveling to another perhaps quite different context and continuing to drink. This finding demonstrates how many drinking episodes can thought of as a dynamic series of connected, but separate, drinking events. Better understanding such episodes and the ways in which the series of events unfold may help inform prevention efforts. For instance, does getting
drunk before one goes to a private house party affect one’s likelihood of sexual victimization? Is the number of drinking venues students go to in a given episode related to the amount of alcohol they consume? Do students tend to go out with a single group of friends or peers, or is it more typical to meet up with several groups of peers in different locations throughout the course of a night? Better understanding the nuances of students’ drinking episodes and the processes that facilitate heavy consumption or harm will better allow prevention scientists to identify targets of environmental prevention approaches that would be more difficult to detect in studies using between-day or between-person associations.

Lastly, future research on heavy college drinking should continue to utilize more advanced measurement methods, such as using wearable biosensors to frequently measure individuals’ transdermal alcohol concentration (Barnett, Meade, & Glynn, 2014; Greenfield, Bond, & Kerr, 2014) or using smartphones to assess psychosocial and environmental influences on drinking behavior in real-time (i.e., ecological momentary assessment [EMA]; Piasecki et al., 2011; Shiffman, 2009; Stone & Shiffman, 1994). The use of such new measurement techniques allows for testing novel questions that would not be possible with more traditional methods. For instance, does the time at which students change drinking locations affect the amount they drink or their chances of experiencing negative consequences? Does the speed at which students reach legal intoxication (i.e., estimated blood alcohol concentration of .08 g/dL) or peak blood alcohol concentration affect the likelihood of experiencing or the severity of negative consequences? Similarly, does the amount of time in which students’ estimated blood alcohol concentration is above the level of legal intoxication predict the number of consequences students will experience or the likelihood of experiencing individual negative consequences?
In sum, heavy college drinking remains a public health concern despite historical declines in this behavior among college-aged individuals. HED has been a very useful indicator of heavy drinking that has been used extensively, but newer research, including that presented here, shows that there is much this indicator cannot tell us. These papers demonstrate how common drinking well above the HED threshold and in understudied contexts seems to be. This necessitates better differentiation among levels of heavy drinking and among the specific contexts in which heavy drinking occurs. This dissertation has contributed to the college drinking literature by demonstrating the usefulness of two new risky drinking indicators that were introduced here (i.e., Pregame HED, day drinking), as well as one which has recently emerged in the literature (i.e., HID). These papers also demonstrated how more nuanced ways of measuring risky drinking can provide greater specificity than HED in predicting medium-term consequences. Thus, this dissertation argues that these additional indicators should be used in conjunction with HED, not in place of it, in future work to better differentiate among risky drinkers and risky drinking occasions. For instance, national college drinking studies that wanted to add additional items to the NIAAA’s recommended sets of alcohol-related items (NIAAA, 2003) may also want to ask about the frequency of HID and Pregame HED in the past 12 months to complement the existing item asking about HED in the past 12 months. As researchers better understand the intricacies of college student drinking episodes, including where, when, and with whom drinking occurs, how each of these changes throughout the episode, and the within-day processes that contribute to risky drinking, it will hopefully become increasingly possible to implement policies and programs that can more effectively reduce risky drinking and its consequences.
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# VITA

## Brian H. Calhoun

### Education

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<td>2016</td>
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### Publications


