



## DSM-based problem gambling: Increasing the odds of heavy drinking in a national sample of U.S. college athletes?

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### ARTICLE INFO

#### Article history:

Received 20 March 2010

Received in revised form

8 June 2010

Accepted 1 July 2010

#### Keywords:

Gambling

Alcohol use

Heavy episodic drinking

Prevalence

College athletes

Gender

### ABSTRACT

Despite previously found co-occurrence of youth gambling and alcohol use, their relationship has not been systematically explored in a national sample using DSM-based gambling measures and multivariate modeling, adjusted for potential confounders. This study aimed to empirically examine the prevalence patterns and odds of at-least-weekly alcohol use and heavy episodic drinking (HED) in relation to various levels of gambling severity in college athletes. Multivariate logistic regression analyses were performed on data from a national sample of 20,739 U.S. college athletes from the first National Collegiate Athletic Association national survey of gambling and health-risk behaviors. Prevalence of at-least-weekly alcohol use significantly increased as DSM-IV-based gambling severity increased, from non-gambling (24.5%) to non-problem gambling (43.7%) to sub-clinical gambling (58.5%) to problem gambling (67.6%). Multivariate results indicated that all levels of gambling were associated with significantly elevated risk of at-least-weekly HED, from non-problem ( $OR = 1.25$ ) to sub-clinical ( $OR = 1.75$ ) to problem gambling ( $OR = 3.22$ ); the steep increase in the relative risk also suggested a possible quadratic relationship between gambling level and HED risk. Notably, adjusted odds ratios showed problem gambling had the strongest association with at-least-weekly HED, followed by marijuana ( $OR = 3.08$ ) and cigarette use ( $OR = 2.64$ ). Gender interactions and differences were also identified and assessed. In conclusion, attention should be paid to college athletes exhibiting gambling problems, especially considering their empirical multivariate associations with high-risk drinking; accordingly, screening for problem gambling is recommended. More research is warranted to elucidate the etiologic mechanisms of these associations.

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### 1. Introduction

As indicated by the National College Health Risk Behavior Survey, college students engage in a host of risk behaviors, including excessive alcohol use, unsafe sex, illicit drug use, etc (Douglas et al., 1997). Among them, alcohol misuse has been rated by most college administrators to be the chief concern about student life (DeJong and Langford, 2002), particularly heavy episodic drinking (HED), also known as “binge” drinking, given its pervasiveness on campus and negative consequences (Wechsler et al., 1994, 2002). For example, Hingson et al. (2002) estimated that approximately 1400 U.S. college students die each year from alcohol-related causes; nearly 80% of these deaths are due to motor-vehicle crashes. In addition, student drinking is implicated in approximately 500,000

unintentional injuries, more than 600,000 assaults, and more than 70,000 sexual assaults or date rapes (Hingson et al., 2002). Also, extensive research has been undertaken in recent decades to study college student drinking and associated problems as reviewed by O'Malley and Johnston (2002) and Baer (2002).

By contrast, this body of literature on college risk behaviors has paid relatively little attention to college student gambling, although with the widespread expansion of legalized gambling throughout North America, emerging evidence has shown that youth represent a high-risk group for gambling problems (Shaffer and Hall, 1996, 2001; National Research Council, 1999; Shaffer et al., 1999; Jacobs, 2000; Derevensky et al., 2003; Huang and Boyer, 2007). For example, a meta-analysis of existing gambling studies over the past 25 years (Shaffer and Hall, 2001) estimated that sub-clinical and clinical problem gambling among college students was more than double the rates in adults; yet, out of the 139 study samples identified, only 19 were from college students, compared with 66 adult population studies.

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Albeit relatively scarce, prior college gambling research has reported associations between gambling and other risk behaviors, including alcohol use/abuse (Lesieur et al., 1991; Winters et al., 1998; LaBrie et al., 2003; Engwall et al., 2004). As such, gambling has increasingly been recognized as an emerging health problem on campus (Stuhldreher et al., 2007) and a potential correlate of college student drinking (Martens et al., 2009). However, despite previously found co-occurrence of youth gambling and alcohol use, their relationship has not been systematically explored in a national sample using standardized DSM-based gambling measures and multivariate statistical modeling, adjusted for potential confounding factors. For example, a recent study only estimated the correlation coefficients of college gambling activities and alcohol use, without using validated gambling measures (Martens et al., 2009). An earlier and also the first national survey of gambling in the general U.S. college students ( $N = 10,765$ ) was the 2001 Harvard School of Public Health College Alcohol Study (CAS) (LaBrie et al., 2003). Unfortunately, although CAS included by far the largest sample of general college students in gambling research, it only compared gamblers vs. non-gamblers, without employing any standardized gambling measures to assess the level of gambling severity and its potential “dose-response” relationships with other correlates. Further, CAS did not report gambling prevalence separately by gender, and given the well-known gender differences in gambling (Lesieur et al., 1991; Winters et al., 1998; Engwall et al., 2004), its reported estimates could be biased in either direction.

Importantly, college athletes are a high-risk group for HED (Wechsler et al., 1995, 1997; Huang et al., 2006). Considering the aforementioned co-occurrence of gambling and drinking, there is reason to be concerned that college athletes, especially those who gamble, may be even more susceptible to heavy drinking. Moreover, college athletes have been reported to have higher prevalence of problem gambling (Engwall et al., 2004). These findings suggest the need for additional research into the relationship between gambling and drinking in college athletes. However, even fewer studies have investigated college athlete gambling, and the published ones thus far have been mostly constrained by small, convenience samples, and hence unable to provide representative prevalence estimates of gambling and associated alcohol use in the college athlete population (e.g., Cullen and Latessa, 1996; Cross and Vollano, 1999; Weinstock et al., 2007). It is worth noting that the National Collegiate Athletic Association (NCAA) has Bylaws (National Collegiate Athletic Association, 2009) pertaining to college athletes' gambling and substance use. Gambling in the form of sports wagering on any intercollegiate, amateur or professional team or contest is prohibited. Also banned are specific drugs, including stimulants, anabolic agents, alcohol, etc., but the alcohol use ban only applies to athletes in the sport of rifle. Tobacco use is also prohibited during practice and competition.

To date, research has found preliminary evidence that gambling athletes use alcohol more commonly than their non-gambling peers (Huang et al., 2007a). What remains unclear and needs to be further explored empirically, hence the primary objective of this study, is the multivariate relationship between various levels of DSM-based gambling severity and heavy drinking in college athletes, adjusted for potential confounders. Of note, our research question echoed several recently published journal commentaries. For example, Giesbrecht (2009) stated, “alcohol consumption and gambling often are concurrent activities, and it would be of interest to read more about convergence and divergence of heavy drinking and extensive gambling.” Also, in concert with Blaszczyński's (2009) comment about gambling, “deleterious effects may occur at any level of participation,” we examined the associations between heavy drinking and all levels of gambling, not just problem gambling. Finally, Petry (2009) commented, “some first steps should precede

more complex study designs,” suggesting that a better understanding of cross-sectional data regarding gambling diagnoses, classifications, and gambling-related harm should perhaps be the initial approach.

In view of these commentaries and the aforementioned methodological constraints encountered in previous college athlete gambling research, the present study analyzed data from a national sample of college athletes, including the DSM-IV Gambling Screen (Stinchfield et al., 2005) questions to assess the level of gambling severity. Illumination of the relationship between gambling severity and heavy drinking can enhance our understanding of the added risk and harm of gambling in terms of its associated high-risk alcohol use, and can inform the development of prevention programs and future research. Possible mechanisms and explanations for the relationship between problem gambling and heavy drinking were discussed. Additionally, males and females were also analyzed separately throughout this study to evaluate potential gender differences.

## 2. Materials and methods

The present study is based on survey data from the 2003 NCAA national study on gambling and associated health-risk behaviors, which, to our knowledge, is the first national assessment of problem gambling behavior among U.S. college athletes.

### 2.1. Survey procedure

The sampling plan was designed so that at least 12% of the NCAA member institutions that sponsor a given sport would be selected at random to survey their athletes in that sport. Approved by the Institutional Review Boards of NCAA and participating schools, the survey was conducted in consultation with the Director of Athletics and with the assistance of the Faculty Athletics Representative (FAR) at each participating school. The FAR was provided with a specific protocol to follow and script to read which emphasized that the study was completely voluntary, each student's responses were anonymous, and voluntary completion of this study constituted the informed consent to participate, as reiterated on the survey form. The FAR distributed the survey to all athletes of a sampled team on the same occasion. The last team member to complete the survey was asked to seal and mail the pre-addressed, pre-paid envelope containing completed surveys to NCAA.

### 2.2. Participants

A total of 20,739 surveys were received. The response rate was between 65 and 75 percent. Males (approximately 62%) were slightly overrepresented in this sample, compared with the full NCAA student-athlete population (58% males). In regard to age, 88.8% of this college athlete sample was 18–21, 10.8% was 22 or older, and 0.4% was under 18. With respect to their race/ethnicity, 75% described themselves as white, 15% as African–American, and 10% as from another racial/ethnic group. These proportions approximate those seen in the overall U.S. population of student-athletes (National Collegiate Athletic Association, 2004). Since the present study examined gambling and alcohol use behaviors among college athletes, we only included 16,030 participants with DSM-IV Gambling Screen (Stinchfield et al., 2005) information for analyses.

### 2.3. Measures

#### 2.3.1. Gambling

Problem gambling was assessed using the DSM-IV Gambling Screen (Stinchfield et al., 2005), which consists of 10 questions

(Huang et al., 2007b) corresponding with the 10 diagnostic criteria associated with gambling problems (e.g., “During the past year, have you needed to gamble with larger amounts of money or with larger bets in order to obtain the same feeling of excitement?”). Responses to the 10 items were summed to create a score, ranging from 0 to 10, with a higher score indicating more gambling problems. The 10 DSM-IV diagnostic criteria have been found to exhibit satisfactory reliability, validity, and classification accuracy (Stinchfield et al., 2005). Accordingly, gamblers were classified as: *non-problem gamblers* if they had a DSM score of 0; *sub-clinical gamblers* if they had a DSM score of 1–3; and *problem gamblers* if they had a DSM score of 4–10. Notably, in a clinical setting, a DSM score of  $\geq 5$  typically indicates pathological gambling. However, given that this was a population-based study and that there was research suggesting that lowering the cut score from 5 to 4 would improve classification accuracy (Stinchfield et al., 2005), all gamblers with a DSM score of  $\geq 4$  were classified as problem gamblers in this study.

### 2.3.2. Alcohol use

As implemented in the 2001 National Household Survey on Drug Abuse (Substance Abuse and Mental Health Services Administration, 2001), alcohol use was defined as consuming at least one drink in the past month; HED (or “binge drinking”) was defined as having five or more drinks in a row at least once in the past month. They were further dichotomized into *at-least-weekly alcohol use* and *at-least-weekly HED*, respectively, to indicate more frequent use.

### 2.3.3. Sociodemographic and drinking-related control variables

To examine the relationship between gambling and alcohol use by multivariate modeling, the following seven control variables associated with college student drinking (Wechsler et al., 1995) were included to adjust for potential confounding: male, under 21 years, white, religion not important, fraternity/sorority residence, cigarette use, and marijuana use.

## 2.4. Data analysis

SPSS 16 was used to perform all data analyses. Prevalence estimates of at-least-weekly alcohol use and HED were compared across various types of gamblers, using Pearson chi-square test. An effect size analysis was also performed for each chi-square comparison by computing phi in a  $2 \times 2$  matrix or Cramer's V in a matrix larger than  $2 \times 2$  (Cohen, 1988). To evaluate the relative strength of association between problem gambling and heavy drinking, in comparison with other drinking covariates, multivariate logistic regression modeling was conducted among college athlete drinkers, adjusted for the aforementioned seven control variables. Gender interactions were tested and included in the overall models; gender-specific models were also estimated to assess the differential effects by gender.

## 3. Results

### 3.1. Prevalence of gambling and alcohol use in college athletes

Males (57.0%) had higher prevalence of gambling than females (30.0%). Further, 16.1% of males and 3.0% of females were classified as sub-clinical gamblers; 2.2% of males and 0.2% of females were classified as problem gamblers ( $\chi^2 = 1428$ , 3df,  $P < 0.001$ ). The majority of both males (78.5%) and females (75.6%) reported alcohol use ( $\chi^2 = 19$ , 1df,  $P < 0.001$ ); similarly, more males (68.5%) reported HED than females (55.8%) ( $\chi^2 = 265$ , 1df,  $P < 0.001$ ).

### 3.2. Gambling severity and prevalence of at-least-weekly alcohol use and HED

Tables 1 and 2 present prevalence of at-least-weekly alcohol use and HED, respectively, by DSM-based gambling severity; the overall chi-square comparisons were significant ( $\chi^2 = 1124$  and 973, respectively, 3df,  $P < 0.001$ ). For example, similar to the pattern of at-least-weekly alcohol use, prevalence of at-least-weekly HED also significantly increased as gambling severity escalated, from non-gambling (16.8%) to non-problem gambling (31.6%) to sub-clinical gambling (46.2%) to problem gambling (59.5%). Similar and also statistically significant relations remained when males and females were evaluated separately. Males also had significantly higher prevalence of at-least-weekly alcohol use and HED than females, irrespective of gambling severity. Overall, effect size analyses of these prevalence comparisons indicated a small-to-medium effect pursuant to the standards proposed by Cohen (1988): 0.1 is a small effect, 0.3 is a medium effect, and 0.5 is a large effect.

### 3.3. Gambling and estimated risk of at-least-weekly alcohol use and HED

Table 3 presents three sets of univariate and multivariate logistic regression models estimating the risk of at-least-weekly alcohol use. The first multivariate model indicated that all seven socio-demographic and drinking-related control variables were significantly associated with at-least-weekly alcohol use, with fraternity residence interacting with male gender ( $OR = 2.30$ , i.e., male, rather than female, residents in Greek houses were at significantly increased risk for at-least-weekly alcohol use, which was also demonstrated in subsequent gender-specific models). Compared with non-gamblers, problem gamblers had more than three times ( $OR = 3.10$ ) and sub-clinical gamblers had approximately two times ( $OR = 1.97$ ) the risk of at-least-weekly alcohol use; non-problem gamblers also had a 20% increase in risk ( $OR = 1.20$ ). The gender interaction further indicated that male non-problem gamblers were slightly more likely ( $OR = 1.21$ ) than female non-problem gamblers to engage in at-least-weekly alcohol use, which was also corroborated in subsequent gender-specific models. Both gender-specific models revealed significantly increased risk of at-least-weekly alcohol use associated with elevated gambling, as in the overall model, but the  $OR$  for female problem gamblers was not statistically significant.

**Table 1**

Prevalence (%) of at-least-weekly alcohol use among U.S. college athletes, by type of gambler and gender.

Type of gambler	All		Male		Female	
	%	(n/N) <sup>a</sup>	%	(n/N) <sup>a</sup>	%	(n/N) <sup>a</sup>
Non-gambler	24.5	(2071/8467)	27.3	(1142/4188)	21.7	(929/4279)
Non-problem gambler	43.7	(2429/5558)	48.8	(1904/3900)	31.7	(525/1658)
Sub-clinical gambler	58.5	(1047/1789)	60.3	(969/1607)	42.9	(78/182)
Problem gambler	67.6	(146/216)	68.6	(142/207)	44.4	(4/9)
All	35.5	(5693/16,030)	42.0 <sup>b</sup>	(4157/9902)	25.1 <sup>b</sup>	(1536/6128)
$\chi^2$ (3df); P-value	1124;	$P < 0.001$	728;	$P < 0.001$	96;	$P < 0.001$
Cramer's V <sup>c</sup>	0.265		0.271		0.125	

<sup>a</sup> Prevalence (%) =  $(n/N) \times 100\%$ . N: number of participants in the corresponding cell, by type of gambler and gender; n: number of participants in the corresponding cell who reported at-least-weekly alcohol use.

<sup>b</sup> Chi-square comparison between males and females in their overall prevalence of at-least-weekly alcohol use was significant ( $\chi^2 = 473$ , 1df,  $P < 0.001$ , phi = 0.172). df: degrees of freedom; phi: effect size measure for the chi-square test involving a  $2 \times 2$  matrix.

<sup>c</sup> Cramer's V: effect size measure for the chi-square test involving a matrix larger than  $2 \times 2$ .

**Table 2**  
Prevalence (%) of at-least-weekly heavy episodic drinking among U.S. college athletes, by type of gambler and gender.

Type of gambler	All		Male		Female	
	%	(n/N) <sup>a</sup>	%	(n/N) <sup>a</sup>	%	(n/N) <sup>a</sup>
Non-gambler	16.8	(1416/8451)	20.1	(842/4182)	13.4	(574/4269)
Non-problem gambler	31.6	(1751/5539)	36.9	(1434/3884)	19.2	(317/1655)
Sub-clinical gambler	46.2	(826/1786)	48.3	(775/1604)	28.0	(51/182)
Problem gambler	59.5	(128/215)	60.9	(126/207)	25.0	(2/8)
All	25.8	(4121/15,991)	32.2 <sup>b</sup>	(3177/9877)	15.4 <sup>b</sup>	(944/6114)
$\chi^2$ (3df); P-value	973; $P < 0.001$		588; $P < 0.001$		52; $P < 0.001$	
Cramer's V <sup>c</sup>	0.247		0.244		0.092	

<sup>a</sup> Prevalence (%) = (n/N) × 100%. N: number of participants in the corresponding cell, by type of gambler and gender; n: number of participants in the corresponding cell who reported at-least-weekly heavy episodic drinking.

<sup>b</sup> Chi-square comparison between males and females in their overall prevalence of at-least-weekly heavy episodic drinking was significant ( $\chi^2 = 552$ , 1df,  $P < 0.001$ , phi = 0.186). df: degrees of freedom; phi: effect size measure for the chi-square test involving a 2 × 2 matrix.

<sup>c</sup> Cramer's V: effect size measure for the chi-square test involving a matrix larger than 2 × 2.

Table 4 presents the same three sets of models as in Table 3, except for the outcome being at-least-weekly HED. Similarly, the first multivariate model also indicated that all seven control variables were significantly associated with at-least-weekly HED, including three gender interactions. That is, male athletes under 21 years were less likely ( $OR = 0.69$ ), male whites were more likely ( $OR = 1.39$ ), and male residents in Greek houses were more likely

( $OR = 1.87$ ) than their female counterparts, respectively, to engage in at-least-weekly HED. These patterns were revealed in subsequent gender-specific models as well. The overall multivariate model also demonstrated that all levels of gambling were associated with significantly elevated risk of at-least-weekly HED, from non-problem ( $OR = 1.25$ ) to sub-clinical ( $OR = 1.75$ ) to problem gambling ( $OR = 3.22$ ). The male-only model showed similar patterns; however, the gambling variables did not remain statistically significant in the female-only multivariate model.

**4. Discussion**

The present study reports findings from the first national survey of problem gambling and other risk behaviors among U.S. college athletes. This study has established a clear, empirical relationship between elevated gambling and increased prevalence of at-least-weekly alcohol use and HED. Problem gamblers were affected the most in this college athlete population, as evidenced in gambling research among general college students (Engwall et al., 2004). Beyond prevalence comparisons, the overall multivariate logistic regression model also revealed that problem gambling was the strongest covariate of at-least-weekly HED, followed by other well-known correlates of college drinking such as marijuana and cigarette use. These findings lend support to further research into the role of problem gambling as well as its inclusion as an emerging key risk factor in future college alcohol studies. Also, the recurring gender differences underscore the importance of comparing prevalence and differential risk by gender in gambling and alcohol research.

**Table 3**  
Univariate and multivariate logistic regression estimating the risk of at-least-weekly alcohol use among college athletes who reported alcohol use in the past year.

Variable	All (N = 12,013)		Male (N = 7482)		Female (N = 4531)	
	Crude OR (95%CI)	Adj. OR (95%CI)	Crude OR (95%CI)	Adj. OR (95%CI)	Crude OR (95%CI)	Adj. OR (95%CI)
Gender						
Male	2.31 (2.14–2.50)*	1.98 (1.77–2.21)*	–	–	–	–
Female	1.00	1.00	–	–	–	–
Age						
Under 21 years	0.86 (0.80–0.93)*	0.86 (0.79–0.94)*	0.87 (0.80–0.96)*	0.82 (0.73–0.91)*	0.99 (0.86–1.14)	0.96 (0.83–1.12)
21 years or older	1.00	1.00	1.00	1.00	1.00	1.00
Race/Ethnicity						
White	2.54 (2.30–2.80)*	2.57 (2.30–2.87)*	2.96 (2.63–3.33)*	2.71 (2.37–3.08)*	2.28 (1.89–2.75)*	2.24 (1.83–2.75)*
Non-white	1.00	1.00	1.00	1.00	1.00	1.00
Religion						
Not important	1.70 (1.57–1.84)*	1.47 (1.34–1.60)*	1.75 (1.58–1.94)*	1.48 (1.32–1.65)*	1.58 (1.38–1.81)*	1.43 (1.24–1.66)*
Important	1.00	1.00	1.00	1.00	1.00	1.00
Fraternity/Sorority Residence						
Yes	2.33 (1.79–3.03)*	1.18 (0.88–1.58)	3.03 (2.17–4.24)*	2.72 (1.89–3.91)*	1.25 (0.94–1.67)	1.17 (0.88–1.57)
No	1.00	1.00	1.00	1.00	1.00	1.00
Male*Fraternity Residence	–	2.30 (1.44–3.66)*	–	–	–	–
Cigarette Use						
Yes	3.84 (3.40–4.34)*	3.34 (2.92–3.82)*	4.15 (3.50–4.93)*	3.31 (2.75–3.99)*	4.16 (3.47–5.00)*	3.38 (2.77–4.11)*
No	1.00	1.00	1.00	1.00	1.00	1.00
Marijuana Use						
Yes	4.34 (3.89–4.85)*	3.36 (2.98–3.78)*	4.17 (3.62–4.81)*	3.25 (2.79–3.79)*	4.48 (3.73–5.38)*	3.54 (2.91–4.29)*
No	1.00	1.00	1.00	1.00	1.00	1.00
Gambling Status						
Problem gambling	5.17 (3.74–7.17)*	3.10 (2.14–4.48)*	4.39 (3.12–6.20)*	3.31 (2.26–4.87)*	1.68 (0.44–6.44)	1.33 (0.30–5.92)
Sub-clinical gambling	3.14 (2.80–3.52)*	1.97 (1.73–2.25)*	2.68 (2.35–3.06)*	2.04 (1.77–2.36)*	1.98 (1.45–2.70)*	1.56 (1.10–2.23)*
Non-problem gambling	1.82 (1.69–1.97)*	1.20 (1.04–1.38)*	1.81 (1.63–2.00)*	1.46 (1.31–1.63)*	1.31 (1.15–1.49)*	1.20 (1.04–1.38)*
Non-gambling	1.00	1.00	1.00	1.00	1.00	1.00
Male*Non-problem gambling	–	1.21 (1.01–1.44)*	–	–	–	–

OR: odds ratio; CI: confidence interval; Adj. OR: adjusted OR. Crude OR was derived from univariate logistic regression analysis, whereas adjusted OR was obtained from multivariate logistic regression analysis, controlling for all other variables presented in the table. \* $p < 0.05$ .

**Table 4**  
Univariate and multivariate logistic regression estimating the risk of at-least-weekly heavy episodic drinking among college athletes who reported alcohol use in the past year.

Variable	All (N = 11,990)		Male (N = 7466)		Female (N = 4524)	
	Crude OR (95%CI)	Adj. OR (95%CI)	Crude OR (95%CI)	Adj. OR (95%CI)	Crude OR (95%CI)	Adj. OR (95%CI)
Gender						
Male	2.69 (2.48–2.93)*	2.45 (1.81–3.31)*	–	–	–	–
Female	1.00	1.00	–	–	–	–
Age						
Under 21 years	0.92 (0.85–0.99)*	1.23 (1.03–1.47)*	0.91 (0.83–1.00)	0.85 (0.77–0.95)*	1.24 (1.05–1.46)*	1.21 (1.02–1.45)*
21 years or older	1.00	1.00	1.00	1.00	1.00	1.00
Male*Under 21 years	–	0.69 (0.56–0.85)*	–	–	–	–
Race/Ethnicity						
White	2.80 (2.50–3.14)*	2.23 (1.74–2.86)*	3.33 (2.91–3.80)*	3.04 (2.63–3.52)*	2.33 (1.83–2.95)*	2.26 (1.76–2.89)*
Non-white	1.00	1.00	1.00	1.00	1.00	1.00
Male*White	–	1.39 (1.05–1.85)*	–	–	–	–
Religion						
Not important	1.56 (1.44–1.70)*	1.30 (1.19–1.43)*	1.65 (1.50–1.83)*	1.37 (1.23–1.53)*	1.32 (1.13–1.55)*	1.14 (0.97–1.36)
Important	1.00	1.00	1.00	1.00	1.00	1.00
Fraternity/Sorority Residence						
Yes	1.91 (1.50–2.44)*	1.12 (0.81–1.54)	2.39 (1.79–3.20)*	2.11 (1.53–2.89)*	1.19 (0.89–1.58)	1.11 (0.80–1.53)
No	1.00	1.00	1.00	1.00	1.00	1.00
Male*Fraternity Residence	–	1.87 (1.19–2.94)*	–	–	–	–
Cigarette Use						
Yes	3.16 (2.83–3.53)*	2.64 (2.33–3.00)*	3.45 (2.97–3.99)*	2.64 (2.25–3.11)*	3.47 (2.88–4.17)*	2.67 (2.19–3.26)*
No	1.00	1.00	1.00	1.00	1.00	1.00
Marijuana Use						
Yes	3.90 (3.52–4.31)*	3.08 (2.75–3.44)*	3.74 (3.29–4.24)*	3.00 (2.62–3.44)*	4.12 (3.43–4.94)*	3.26 (2.68–3.96)*
No	1.00	1.00	1.00	1.00	1.00	1.00
Gambling Status						
Problem gambling	5.73 (4.24–7.74)*	3.22 (2.29–4.54)*	4.56 (3.33–6.26)*	3.54 (2.48–5.05)*	1.57 (0.35–7.03)	1.32 (0.27–6.59)
Sub-clinical gambling	3.09 (2.75–3.46)*	1.75 (1.54–1.99)*	2.49 (2.18–2.83)*	1.87 (1.62–2.15)*	1.83 (1.30–2.58)*	1.35 (0.92–1.98)
Non-problem gambling	1.76 (1.62–1.91)*	1.25 (1.14–1.37)*	1.67 (1.50–1.86)*	1.34 (1.19–1.50)*	1.21 (1.04–1.41)*	1.10 (0.94–1.30)
Non-gambling	1.00	1.00	1.00	1.00	1.00	1.00

OR: odds ratio; CI: confidence interval; Adj. OR: adjusted OR. Crude OR was derived from univariate logistic regression analysis, whereas adjusted OR was obtained from multivariate logistic regression analysis, controlling for all other variables presented in the table. \* $p < 0.05$ .

#### 4.1. Gambling severity and prevalence of frequent HED in drinking athletes

This study found that the prevalence of frequent HED increased as gambling severity increased. This high-risk HED pattern became even more alarming among frequent alcohol users – e.g., almost nine in 10 problem gamblers (87.7%) who reported at-least-weekly alcohol use also reported at-least-weekly HED, compared with sub-clinical gamblers (78.9%), non-problem gamblers (72.1%), and non-gamblers (68.4%). These figures indicated that while not all alcohol users engaged in HED, an overwhelming majority of these at-least-weekly alcohol users engaged in at-least-weekly HED, and the tendency toward this form of high-risk drinking grew stronger as gambling severity increased.

Of note, unlike prior college gambling studies as reviewed earlier (e.g., LaBrie et al., 2003), which simply compared the effects of gambling vis-à-vis non-gambling, the current study evaluated the “dose-response” effects of various gambling levels using standardized DSM-based measures. Also, instead of examining HED, this study took a step further to investigate at-least-weekly HED, which included a frequency component and represented an even riskier form of HED.

#### 4.2. Gender differences and interaction effects on alcohol use

Several gender interactions were identified; accordingly, gender-specific models were fitted separately to assess the differential effects by gender. Overall, as demonstrated in the

multivariate analyses which included both males and females in the same regression models, males were almost twice as likely ( $OR = 1.98$ ) to report at-least-weekly alcohol use as were females, and males were 2.45 times as likely ( $OR = 2.45$ ) to engage in at-least-weekly HED as were females. Future research may explore the reasons for these gender differences. Of particular interest to this study was the significant gender interaction with non-problem gambling. It is also noteworthy that, while the effects of problem gambling on at-least-weekly HED appeared to be rather different in the male-only ( $OR = 3.54$ ) and female-only ( $OR = 1.32$ ) models, their gender interaction was not statistically significant and hence not included in the overall model. This result could in part be ascribed to the small number of female problem gamblers in this study and a consequent decrease in statistical power with this group.

#### 4.3. Effects of gambling vs. other drinking covariates on alcohol use

Known as covariates of drinking in the general college student population, all seven drinking-related control variables in our multivariate models have also been found significantly associated with at-least-weekly alcohol use and HED. These results provided empirical evidence that these college drinking covariates may apply to college athletes as well. More importantly, this study demonstrated that all three levels of gambling were significantly associated with increased risk of at-least-weekly alcohol use and HED among males. Further, comparisons of the adjusted odds ratios showed that problem gambling among males was associated with

the greatest risk of at-least-weekly HED, compared with all other drinking covariates in the model. In addition, the steep increase in the relative risk of at-least-weekly HED from non-problem ( $OR = 1.34$ ) to sub-clinical ( $OR = 1.87$ ) to problem gambling ( $OR = 3.54$ ) suggested a possible quadratic relationship between the level of gambling severity and risk of at-least-weekly HED among males; a similar pattern existed for at-least-weekly alcohol use. By contrast, while non-problem gambling and sub-clinical gambling among females were also significantly associated with elevated risk of at-least-weekly alcohol use, their strength of association was weaker than marijuana and cigarette use. These findings indicated that problem gambling could be an emerging risk factor for college drinking, especially among male athletes. Future research is warranted to empirically examine if these results could be replicated among general college students.

#### 4.4. Possible explanations for associations between problem gambling and heavy drinking

Qualitative investigations are also needed to enhance our understanding of the associations found between problem gambling and heavy drinking. Below, the authors suggested a few possible explanations. First, for non-problem gamblers, the slightly increased risk of frequent alcohol use and HED might reflect the social nature of their gambling, as they were likely to drink to socialize when they gambled. By contrast, problem gamblers drank more frequently and heavily with their increased gambling involvement, as they might also use alcohol, beyond socializing, to cope with gambling-related stress and to self-medicate for gambling-related problems. This line of argument also suggests a possible course of development of these two co-occurring behaviors. For example, alcohol may be used initially as a social lubricant among gamblers, who may initiate gambling for the exact same purpose – namely, to socialize, establish friendships, and “fit in.” Gradually, what starts as an innocent social activity may escalate and become a problem behavior because of the addictive nature of gambling and alcohol use.

Second, gambling by definition is taking chances, and as such, problem gamblers may be greater risk-takers. Hence, the observed heavier drinking pattern among problem gamblers may be a manifestation of their underlying risk-prone personality, which may also predispose them to other risk behaviors, as evidenced by consistently higher prevalence of tobacco, marijuana, and other drug use among problem gamblers (Huang et al., 2007a).

Third, the co-occurrence of problem gambling and heavy drinking suggests that alcohol consumption may be tied to gambling activities among these college athletes just as drinking is commonly regarded as an integral part of a fraternity party. For example, alcoholic beverages may be served or readily available where gambling takes place – e.g., at a casino, a social gathering, or a fraternity party, where drinking is common, socially acceptable, and even expected as norms. Hence, problem gamblers may be exposed to this type of social situation more frequently with their increased gambling involvement, thereby engaging in more frequent heavy drinking.

#### 4.5. Limitations and future directions

This study has some limitations that could be addressed in future research. First, its cross-sectional design constrained our ability to make causal inferences about the associations found in this study, although some variables remain constant over time (e.g., gender and race/ethnicity). Longitudinal research is required in the future to illuminate the temporal, causal relations of these correlates (including gambling) with heavy drinking. Furthermore,

additional qualitative studies are also needed to elucidate the mechanisms which can help to explain the relationships found between problem gambling and heavy drinking.

Another limitation pertains to the generalizability of these findings to the general college student population. Funding permitting, future research can recruit comparable samples of college athletes and general college students to evaluate if problem gambling has differential effects on high-risk drinking in these two groups.

Finally, the small sample size of female problem gamblers in this study, as reflected by much wider confidence intervals than those of their male counterparts, may be attributable for the statistically non-significant multivariate regression results associated with problem gambling in females. To improve the precision of such estimates, female problem gamblers need to be strategically over-sampled in future studies to ensure enough statistical power to examine the effect of problem gambling on high-risk alcohol use in females.

#### 4.6. Conclusions

This study has provided national baseline data on problem gambling and drinking behaviors in U.S. college athletes. Regardless of the specific causal relationship, the significant associations between problem gambling and high-risk drinking established in the present study corroborates the persistence of the youth problem behavior pattern (Donovan and Jessor, 1985) and underscores the importance of incorporating problem gambling as a risk factor in future investigations of college drinking. This information is particularly instrumental to health care providers, as well as to college administrators and athletics personnel in developing evidence-based school policies and initiatives to curb college drinking and gambling problems. In this light, screening for problem gambling as part of a high-risk behavior prevention framework can be a practical approach to help identify high-risk drinkers. As education programs are devised to raise awareness of problem gambling and associated risk behaviors in college students, more research is also needed to elucidate the etiologic mechanisms and to identify the individual and contextual factors that may account for the relationship between problem gambling and high-risk drinking.

#### Role of funding sources

Funding for this study was provided by the U.S. National Collegiate Athletic Association (NCAA). Preparation of this manuscript was also supported in part by grant NSC 98-2621-M-002-021- from the National Science Council, Taiwan as well as grant 97-EC-17-A-31-I2-H015 to Dr. Huang. The funding sources had no further role in study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the paper for publication.

#### Contributors

Jiun-Hau Huang conceptualized ideas, reviewed the literature and summarized previous related work, analyzed the data, interpreted findings, wrote the first draft of the manuscript, and revised subsequent drafts. Durand F. Jacobs had responsibility for designing the protocol for this study. Jeffrey L. Derevensky contributed to editing of drafts. All authors contributed to and have approved the final manuscript.

#### Conflict of interest

None declared.

## Acknowledgements

Funding for this study was provided by the U.S. National Collegiate Athletic Association (NCAA). Preparation of this manuscript was also supported in part by grant NSC 98-2621-M-002-021 from the National Science Council, Taiwan as well as grant 97-EC-17-A-31-I2-H015 to Dr. Huang.

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