Alcohol Consumption and Blood Pressure Among Students in a University Health Center

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Abstract

Objective: This study examined the prevalence of and relationships between drinking and blood pressure (BP) among University Health Center patients, since drinking in young-adulthood is very prevalent, and serves as a risk factor for elevated BP. ***Methods:*** These relationships were examined using logistic regression models, controlling for demographic and other risk factors. ***Results:*** Approximately 29% of subjects reported drinking, and 42% of BP readings were above normotensive levels. Female drinkers were more likely than male drinkers to experience elevated systolic and diastolic BPs. Drinking was unrelated to diastolic BP, but risky drinkers were less likely than abstainers to experience elevated systolic BP. ***Conclusions:*** Findings provide partial support for the alcohol-BP J-shaped curve. Findings may also have implications on the future use of alcohol screening in university health centers. Alcohol screening may be used for early intervention and to promote positive health behaviors related to alcohol use and onset of chronic diseases among college students. Further study of gender differences is also warranted.

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Introduction

Alcohol consumption among young adults on college campuses is a major concern for public health professionals, college and university administrators, health care providers, and policy makers (Dejong, Towvim, & Schneider, 2007; Mitchell, Toomey, & Erickson, 2005; Task Force of the National Advisory Council on Alcohol Abuse and Alcoholism, 2002; United States Preventive Services Task Force, 2010; Wechsler, Kelley, Weitzman, San Giovanni, & Seibring, 2000; Wechsler, Seibring, Liu, & Ahl, 2004). The concerns about college student drinking stem from epidemiological evidence that reveals a high prevalence of alcohol use within that population (O'Malley & Johnston, 2002; Turrisi, Mallett, Mastroleo, & Larimer, 2006). College student alcohol use has been found to be higher than their non-student peers; and risky and heavy patterns of drinking increase more for college students than their non-student peers (O'Malley & Johnston, 2002). Many student drinkers also exhibit symptoms that meet the diagnostic criteria for alcohol abuse or dependence (Knight et al., 2002); and college students are more likely to receive an alcohol abuse diagnosis than their non-student peers (Piasecki, Sher, Slutske, & Jackson, 2005). Further, college drinking may also place students at risk for acute and chronic problems that have serious implications for overall health.

To date, much of the focus on alcohol-related problems experienced by college students has been on school–related, psychological, interpersonal, behavioral or legal problems (Gruenewald, Johnson, Ponicki, & LaScala, 2010; Hingson, Zha, & Weitzman, 2009). The research on college student alcohol-related physiological and medical problems has been primarily limited to investigations of alcohol-related injuries (Hingson, Heeren, Winter, & Wechsler, 2005; Hingson, Heeren, Zakocs, Winter, & Wechsler, 2003; Hingson et al., 2009), hangovers (Piasecki et al., 2005) and blackouts (Mundt, Zakletskaia, Brown, & Fleming, 2011; White, Singer, Kraus, & Swartzwelder, 2004). However, the critical period for adopting health promoting or health compromising behaviors, related to chronic diseases such as hypertension, may begin in adolescence and encompass the period when many young adults are in college (Park, Mulye, Adams, Brindis, & Irwin, 2006). In relation to alcohol consumption, young adulthood is the period when use peaks (Park et al., 2006), making it a critical crossroad regarding chronic conditions known to be associated with drinking.

Alcohol Consumption, Blood Pressure, and Young Adults

Cardiovascular diseases such as hypertension are among the many chronic diseases found to be associated with alcohol use (Klatsky, 2010; Klatsky & Gunderson, 2008). Prior studies have found associations between alcohol consumption and blood pressure that span the continuum between light/low risk drinkers and heavy/high risk drinkers (Estruch, Coca, & Rodicio, 2005; Klatsky, Koplik, Gunderson, Kipp, & Friedman, 2006). The distribution of this association is typically a J- or U-shaped curve (Beilin, 2005; Sesso, Cook, Buring, Manson, & Gaziano, 2008). One biological mechanism by which alcohol consumption may negatively influence blood pressure is through the disruption of red blood cell sodium (Na^+) metabolism; it contributes to increased vascular resistance and makes conditions favorable for elevated blood pressure (Coca et al., 1992).

Much of the evidence on the association between alcohol consumption and elevations in blood pressure has been provided by studies made up of samples of middle-aged and elderly individuals (Fortmann, Haskell, Vranizan, Brown, & Farquhar, 1983; Gillman, Cook, Evans, Rosner, & Hennekens, 1995; Sesso et al., 2008). The focus on older age groups is the result of evidence from clinical studies that suggest the negative effects of elevated blood pressure are more dramatic during older adulthood than in young adulthood (Kaplan & Lieberman, 1998).

While there is sufficient evidence that establishes the importance of focusing on older adults, this evidence does not adequately probe risk factors for elevated blood pressure in young adulthood. For example, in one study of blood pressure and stroke outcomes, the absolute risk among older adults (8.4%) was much higher for blood pressure related stroke than those in middle and young adulthood (1.7%) (Prospective Studies Collaboration, 1995). However, the relative risk for young and middle aged adults was almost 10-fold for blood pressure related stroke compared to the 2-fold risk for blood pressure related stroke in older adults (Prospective Studies Collaboration, 1995).

Additionally, there are studies that provide evidence of significant associations between alcohol consumption and blood pressure in young adulthood (Dyer et al., 1990; Gillman et al., 1995). In particular, findings from the Gillman et al. (1995) study suggest that the pattern of the relationship between alcohol use and blood pressure during young adulthood is J-shaped. Non-drinkers have higher mean blood pressures than moderate drinkers of alcohol, and heavy drinkers have mean blood pressures markedly higher than those of non-drinkers. This is salient because young adulthood is the period when alcohol use peaks and binge or heavy episodic drinking ($\geq$ 5 drinks for men and $\geq$ 4 drinks for women in one sitting) is most prevalent among college students (Jennison, 2004; Wechsler, Lee, Kuo, & Lee, 2000). While there have been a few studies that explore the relationship between alcohol consumption and blood pressure among young adults, we did not find any investigations that examined the process of screening for alcohol induced elevations in blood pressure among college students. As a result, there were no investigations conducted to better understand the relationship between drinking and blood pressure among students on a college or university campus.

Alcohol Screening in University Health Centers

In general, physicians seldom ask young adults about their alcohol use and/or advise them about excessive alcohol consumption (Hingson, Heeren, Edwards, & Saitz, 2011). Findings from a recent national study on young adults and physician counseling about risk for excess drinking reveals that persons aged 18 – 25 are more likely to exceed the National Institutes on Alcohol Abuse and Alcoholism (NIAAA) guidelines for low risk drinking than persons aged 26-39 (Hingson et al., 2011). However, the 18-25 year olds were less likely to be asked about drinking and counseled about risky drinking patterns relative to persons aged 26-39 (Hingson et al., 2011). This is problematic given the relative high rates of alcohol consumption known to occur among young adults, specifically college students.

Historically, it has been difficult to routinely screen college students for problematic alcohol use in the campus setting (Foote, Wilkens, & Vavagiakis, 2004). Many campuses do not have standard procedures that include: venues for screening (medical or psychological service units), instruments for alcohol screening with college students, or procedures for intervention and treatment when alcohol problems are identified (Foote et al., 2004). Health care providers in university health centers are in a unique position to identify problems associated with alcohol or other drugs during routine medical exams (Rickman & Mackey, 1995; Task Force of the National Advisory Council on Alcohol Abuse and Alcoholism, 2002). They may also play an important role in preventing the onset and/or progression of medical problems associated with alcohol use. As a result, the Task Force of the National Advisory Council on Alcohol Abuse and Alcoholism (2002) recommends incorporating alcohol screening and intervention into standard practice in campus health centers.

This study examines data from a southern university that responded to the call for alcohol screening in university health centers. Little is known about the alcohol-blood pressure relationship among young adults on or around college campuses where, for many, heavy alcohol use occurs. The purpose of this study was: (1) to conduct preliminary examinations of the prevalence of alcohol consumption behaviors and blood pressure among young adult University Health Center (UHC) clients; and (2) to test the relationship between drinking and blood pressure adjusting for demographics and risk factors.

Methodology

Data Source

The data for this study were comprised of de-identified electronic medical records from 21,199 student encounters, at a campus-based UHC, between December 2005 and November 2006. This UHC is located on the campus of a large university in the southeastern region of the United States. The UHC is accredited by The Joint Commission. The Joint Commission, formerly The Joint Commission on Accreditation of Healthcare Organizations, is a not for profit organization that accredits over 19,000 healthcare organizations and programs in the United States, including the one referred to in this study (The Joint Commission, 2012). The UHC provides comprehensive health services to students that include: an allergy/travel clinic, vision clinic, dental clinic, medical clinic, women's clinic, sports medicine, physical therapy, counseling and psychiatric services, urgent care, laboratory, pharmacy, and radiology.

During each visit to the UHC, students were asked about their alcohol use, information about their medical history and family medical history, and had various physiological measures taken by the UHC staff. For the purposes of this study, the data provided by the UHC were restricted to students between the ages of 18 and 25 with data on blood pressure in their electronic medical record, N = 16,989; and whites and blacks made up over 80% during the study period (Allen, 2006). All other groups separately made up $\leq$ 5.5% of the student population. The study design and analysis plan were reviewed and approved by the University of Georgia Institutional Review Board.

Measures

Alcohol Consumption. During each patient encounter, UHC staff asked several questions related to drinking behaviors: Do you drink alcohol? In the last 30 days, have you had five-or-more drinks on one occasion (males only) or four-or-more drinks on one occasion (females only)? How many days per week do you drink alcohol? On a typical day how many drinks do you have? How many times per month do you drink five-or-more drinks on a single occasion?

Alcohol use was treated as the primary explanatory variables in this study. We used the aforementioned alcohol questions to create the explanatory variables. In order to determine whether or not a student was an at-risk drinker, we assessed the average drinks students had per week by developing a measure that included the number of days a student drinks per week multiplied by the number of drinks they have on a typical drinking day. They were considered at-risk if the average number of drinks per week was between seven and 10 if female, and 14 if male. They were considered risky drinkers if they reported drinking four-or-more drinks per day if they were female and five-or-more drinks if they were male. We considered using the binge drinking measure "In the last 30 days, have you had five-or-more drinks on one occasion (males only) or four-or-more drinks on one occasion (females only)?" However, we decided against examining this measure for two reasons. The first reason was that recent alcohol intake has the most influence on blood pressure (Klatsky, Gunderson, Kipp, & Udaltsova, 2006). We believed that the item asking students how many drinks they had on a typical day might have a greater sense of propinquity than an item that inquires about the past month, since that item encompasses multiple weeks. Additionally, since heavy drinking episodes are highly prevalent among college students, we believed that students who reported five-or-more drinks (male) or four-or-more drinks (female) on a typical day were likely to consume these drinks within a few hours of one another (or on one occasion).

Further, students were considered high-risk drinkers if they drank seven-or-more drinks per week and four-or-more drinks in one day if female; and males were high-risk drinkers if they had 14-or-more drinks per week and five-or-more drinks per day.

Blood Pressure. The outcome variable for this study was blood pressure. There were two measures of blood pressure: (1) systolic blood pressure; and (2) diastolic blood pressure. The two blood pressure variables were operationalized as categorical variables. Systolic blood pressure was: Normal (<120mm Hg); Pre-hypertensive (120mm Hg – 139mm Hg); Stage 1 high blood pressure (140mm Hg – 159mm Hg); and Stage 2 high blood pressure (≥160mm Hg) (National Heart Lung and Blood Institute, 2004). Diastolic blood pressure was: Normal (<80mm Hg); Pre-hypertensive (80mm Hg – 90mm Hg); Stage 1 high blood pressure (90mm Hg – 99mm Hg); and Stage 2 high blood pressure (≥100mm Hg). Both variables were also treated as dichotomous variables. Systolic blood pressure was categorized as Normal if <120mm Hg and Abnormal if ≥120mm Hg (National Heart Lung and Blood Institute, 2004). Diastolic blood pressure was categorized as Normal if <80mm Hg and Abnormal if ≥80mm Hg.

Risk Factors. The following biomedical risk factors were abstracted from medical records: body mass index (BMI) (underweight <18.5, normal ≥18.5 to <25, and overweight ≥25); smoker (yes or no); family history of alcohol abuse/dependence (yes or no); family history of hypertension (yes or no); and family history of cardiovascular disease (yes or no).

Socio-Demographic Characteristics. Demographic covariates were also included in the analyses. These variables were: age (categorized as 18-20 or 21-25); race (white or black); and sex (male or female).

Data Analysis

All analyses were conducted using SAS version 9.1. First, we conducted initial descriptive analyses of the sample to estimate the prevalence of demographic characteristics and other health behaviors among this clinical population of students. Next, we reduced the data by excluding the 1,952 patients that were not white or black and estimated the prevalence of the categorical blood pressure variable (Normal, Pre-hypertension, Stage 1 hypertension, and Stage 2 hypertension) and the dichotomous blood pressure variable (normal and abnormal). We also examined various levels of alcohol use. These analyses were conducted in order to understand on what level and to what extent whites differ from blacks and males differ from females in relation to prevalence of blood pressure elevations and risky alcohol use. We tested to determine statistically significant differences in the means between these race and gender groups. In the last group of analyses, we ran multivariate logistic regression models in order to examine the association that drinking had on systolic and diastolic blood pressure, adjusting for other risk factors and demographic characteristics.

Results

Table 1 shows descriptive statistics for all students between the ages of 18 and 25 with data on blood pressure in their electronic medical record. Most students reported being drinkers (68.1%). It also shows that most students in this sample were male (64.4%), white (82.6%), and between the ages of 21 and 25 (59.2%). Most had a BMI within the normal range (BMI 18.5 to <25) (68.7%), and reported being non-smokers (82.2%). Furthermore, most students reported the absence of a family history of alcohol abuse/dependence (99.4%), hypertension (86.2%), and cardiovascular disease (91.8%).

In Table 2, there were no significant differences between whites and blacks on the four categories of hypertension ($p = 0.41$). When the four categories were collapsed into two, the difference by race only approached significance ($p = 0.11$). In both cases, just over half of both groups were represented in the normal category (blacks: 55.4%; whites: 58.0%). By gender, males were more likely to be both pre-hypertensive and hypertensive ($p < 0.0001$). The same was true when these categories were collapsed into two. In both cases, a smaller proportion of males (32.97% vs. 71.49% females) appeared in the Normal category (Table 3).

Table 1: Demographic characteristics of UGA students (all races) who received services from the University Health Center between December 1, 2005 and November 30, 2006.

Demographic Characteristic	*n*	%
Gender		
Male	10,942	64.4
Female	6,047	35.6
Race		
White	14,046	82.6
Black	991	5.8
Other	1,961	11.5
Age (years)		
18-to-20	6,937	40.8
21-to-25	10,061	59.2
Drinker		
No	5,421	31.9
Yes	11,568	68.1
Body Mass Index		
Underweight	537	4.3
Normal	8,597	68.7
Overweight	2,443	19.5
Obese	946	7.6
Ever smoke		
No	11,904	82.2
Yes	2,574	17.8
Family history of alcohol use		
No	16,902	99.4
Yes	96	0.6
Family history of hypertension		
No	14,653	86.2
Yes	2,345	13.8
Family history of cardiovascular disease		
No	15,601	91.8
Yes	1,397	8.2

Table 2: Prevalence of hypertension and alcohol use by race.

	White	Black	Overall	*p*-Value [2]
Hypertension-1 [1] Normal Pre-hypertension Stage-1 hypertension Stage-2 hypertension	8,140 (58.0%) 5,533 (39.4%) 353 (2.5%) 20 (0.1%)	549 (55.4%) 412 (41.6%) 29 (2.9%) 1 (0.1%)	8,689 (57.8%) 5,945 (39.5%) 382 (2.5%) 21 (0.2%)	.4080
Hypertension-2 Normal Non-normal	8,140 (58.0%) 5,906 (42.1%)	549 (55.4%) 442 (44.6%)	8,689 (57.8%) 6,348 (42.2%)	.1157
Drinker No Yes	3,614 (28.7%) 8,976 (71.3%)	500 (57.1%) 376 (42.9%)	4,114 (30.6%) 9,352 (69.5%)	<.0001
Binge drinking No Yes	6,777 (75.5%) 2,199 (24.5%)	344 (91.5%) 32 (8.5%)	7,121 (76.1%) 2,231 (23.9%)	<.0001
Drinking risk None At-risk Risky High-risk	6,353 (70.8%) 423 (4.7%) 1,636 (18.2%) 563 (6.3%)	339 (90.2%) 5 (1.3%) 32 (8.5%) 0 (0.0%)	6,692 (71.6%) 428 (4.6%) 1,668 (17.8%) 563 (6.0%)	<.0001

1 Normal (Systolic: ≤120 and Diastolic: ≤80); PreHTN (Systolic: 120-139 or Diastolic: 80-89); S1HTN (Systolic: 140-159 or Diastolic: 90-99); and S2HTN (Systolic: ≥160 or Diastolic: ≥100).

2 Two-sample t-test.

We also compared mean blood pressure by race and gender (Data not shown.) When the mean systolic blood pressure for whites was compared to blacks, blacks (116.5 mm Hg) were slightly higher than whites (115.8 mm Hg) ($p = .070$). The mean diastolic blood pressure for blacks (74.1 mm Hg) was not significantly different from whites (73.7 mm Hg) ($p = .170$). However, when we compared the mean systolic blood pressure of females to males, we found that females (111.2 mm Hg) were significantly lower than males (124.0 mm Hg) ($p < .0001$). The mean diastolic blood pressure for females (71.7 mm Hg) was also significantly lower than males (77.3 mm Hg) ($p < .0001$).

Table 3: Prevalence of hypertension and alcohol use by gender.

	Female	Male	Overall	*p*-Value [2]
Hypertension-1 [1] Normal Pre-hypertension Stage-1 hypertension Stage-2 hypertension	6,925 (71.5%) 2,686 (27.7%) 75 (0.8%) 1 (0.0%)	1,763 (33.0%) 3,257 (60.9%) 307 (5.7%) 20 (0.4%)	8,688 (57.8%) 5,943 (39.5%) 382 (2.5%) 21 (0.2%)	<.0001
Hypertension-2 Normal Non-normal	6,925 (71.5%) 2,762 (28.5%)	1,763 (33.0%) 3,584 (67.0%)	8,688 (57.8%) 6,346 (42.2%)	<.0001
Drinker No Yes	2,848 (32.2%) 6,001 (67.8%)	1,266 (27.4%) 3350 (72.6%)	4,114 (30.6%) 9,351 (69.5%)	<.0001
Binge drinking No Yes	4,798 (80.0%) 1,203 (20.0%)	2,322 (69.3%) 1,028 (30.7%)	7,120 (76.1%) 2,231 (23.9%)	<.0001
Drinking risk None At-risk Risky High-risk	4,507 (75.1%) 291 (4.8%) 858 (14.3%) 345 (5.8%)	2,185 (65.2%) 137 (4.1%) 810 (24.2%) 218 (6.5%)	6,692 (71.6%) 428 (4.6%) 1,668 (17.8%) 563 (6.0%)	<.0001

1 Normal (Systolic: ≤120 and Diastolic: ≤80); PreHTN (Systolic: 120-139 or Diastolic: 80-89); S1HTN (Systolic: 140-159 or Diastolic: 90-99); and S2HTN (Systolic: ≥160 or Diastolic: ≥100).

2 Two-sample t-test.

There were significant racial and gender differences in self-reported drinking behavior. Table 2 shows that a larger proportion of blacks (57.1%) than whites (28.7%) reported they were not drinkers ($p < .0001$). Of those who drank in both groups, whites were more willing than blacks to report their quantity and frequency of drinking as evidenced by the large amount of missing data that we observed from the black drinkers (data not shown). A larger proportion of whites than blacks reported higher frequencies (i.e., two-or-more days per week) of alcohol use ($p < .0001$) (data not shown) and binge, at-risk, risky, and high-risk drinking ($p < .0001$). The differences in binge, at-risk, risky, and high-risk drinking were significant ($p < .0001$). Table 3 shows that a larger proportion of males (72.6%) than females (67.8%) reported being drinkers ($p < .0001$). Of those who drank in both groups, males were better represented in terms of higher quantities (five-or-more drinks) and higher frequencies (three-or-more days per week) of drinking than females ($p < .0001$) (data not shown.).

We also conducted analyses to examine whether or not there were differences in means between the racial and gender groups on binge drinking (data not shown). The mean number of times that whites had five-or-more drinks on one occasion (8.6) in a month was significantly higher than the mean for blacks (5.5) ($p < .0001$) (data not shown). The mean number of times that males reported having had five-or-more drinks on one occasion in the last month (11.4) was significantly higher than the number of times females had four-or-more drinks on one occasion in the last month (6.6) ($p < .0001$) (data not shown).

Table 4: Logistic regression: Association between drinking status and blood pressure.

	Odds of experiencing elevated systolic blood pressure			Odds of experiencing elevated diastolic blood pressure		
	OR	**95% CI**	***p*-Value**	**OR**	**95% CI**	***p*-Value**
Drinking risk						
None	1.00			1.00		
At-risk	1.06	0.81, 1.38	0.670	1.19	0.91, 1.56	0.210
Risky	0.70	0.60, 0.82	<.0001	0.96	0.82, 1.12	0.580
High-risk	0.99	0.77, 1.26	0.910	0.89	0.69, 1.15	0.370
Age						
18-to-20	1.00			1.00		
21-to-25	0.90	0.80, 1.01	0.080	1.26	1.08, 1.39	< 0.010
Race						
White	1.00			1.00		
Black	0.81	0.60, 1.08	0.150	0.93	0.69, 1.26	0.650
BMI						
Normal	1.00			1.00		
Underweight	0.53	0.37, 0.77	0.0009	0.87	0.60. 1.25	0.440
Overweight	1.78	1.55, 2.05	< 0.0001	1.75	1.53, 2.02	< 0.0001
Obese	3.64	2.89, 4.58	< 0.0001	4.36	3.53, 5.40	< 0.0001
Gender						
Male	1.00			1.00		
Female	6.18	5.45, 7.00	< 0.0001	2.86	2.52, 3.25	< 0.0001
Smoker						
No	1.00			1.00		
Yes	1.12	0.10, 1.26	0.100	1.16	1.01, 1.34	0.030
Family History: Hypertension						
No	1.00			1.00		
Yes	1.12	0.95, 1.33	0.170	1.06	0.88, 1.27	0.540
Family History: Alcohol Use						
No	1.00			1.00		
Yes	1.18	0.60, 2.31	0.630	1.22	0.61, 2.42	0.580
Family History: CV Disease						
No	1.00			1.00		
Yes	1.24	1.01, 1.51	0.040	0.96	0.77, 1.20	0.720

In the final set of analyses, we ran logistic regressions to assess the associations between various levels of alcohol use on systolic and diastolic blood pressure, adjusting for select risk and demographic variables. Table 4 displays results of these analyses, which indicate risky drinkers were less likely to experience elevations in systolic BP than those not engaged in any level of risky drinking (OR: 0.70; 95% CI: 0.60, 0.82). Being underweight was protective for systolic blood pressure (OR: 0.53; 95% CI: 0.37, 0.77) relative to having a BMI in the normal range. Females (OR: 6.18; 95% CI: 5.45, 7.00) or those who had BMIs classifying them as overweight (OR: 1.78; 95% CI: 1.55, 2.05), or obese (OR: 3.64: 95% CI: 2.89, 4.58) had greater odds of elevations in systolic blood pressure relative to those who were male or who had normal BMIs. No level of drinking risk presented significant risk or protection above those that did not engage in risk-prone patterns of drinking for diastolic blood pressure. Females (OR: 2.86; 95% CI: 2.52, 3.25), smokers (OR: 1.16; 95% CI: 1.01, 1.34), overweight (OR: 1.75; 95% CI: 1.53, 2.02), obese (OR: 4.36; 95% CI: 3.53, 5.40), and students 21-to-25 years-old (OR: 1.26; 95% CI: 1.08, 1.39) were significantly more likely than males, those with normal BMIs, and students 18-to-20 years of age to experience elevations in diastolic blood pressure.

Discussion

This study is one of the first investigations to examine the relationship between drinking and elevations in blood pressure among college students receiving services from a university health center. Most prior studies examining the relationship between young adult drinking and blood pressure are focused on large population samples. We believed that focusing this examination on a college-based population was important because risky patterns of drinking are prevalent on college campuses. It was also important because there is evidence that elevations in young adult blood pressure are associated with elevated blood pressure and cardiovascular disease later in life (McCarron, Davey Smith, Okasha, & McEwen, 2000; Nelson, Ragland, & Syme, 1992; Paffenbarger & Wing, 1969). Every cumulative occurrence of elevated blood pressure may contribute to increases in morbidity and potential years of life lost for young adults (Carter-Edwards, Godette, White, & Tyson, 2009). Additionally, results of this study contribute to establishing the importance of alcohol screening in university health centers and add to the growing body of literature on this topic.

As expected, the descriptive analyses indicate that most of this clinical sample had blood pressures in the normal range and that most were also drinkers. When we examined the categorical data on blood pressure more closely, we found that most young adults in the sample, with blood pressures in the abnormal range, were pre-hypertensive rather than hypertensive. This is not beyond what we would expect during this period of the life course. Additionally, we found that males made up most of the pre-hypertensive group and most males had blood pressures that were in the abnormal (pre-hypertensive) range. Alternatively, most females had blood pressures that were classified as normal. The finding related to the higher prevalence of elevated blood pressure in young adult males is consistent with prior research examining the relationship between alcohol use and blood pressure in young adulthood (Gillman, et al., 1995).

There were no significant differences in blood pressure between white and black students in this sample. The prevalence of elevated blood pressure between whites and blacks was not significantly different and only the mean systolic blood pressure for blacks was slightly higher than the mean systolic blood pressure for whites. These findings were contrary to what was expected. Prior studies have shown that, in general, blacks have more hypertension and suffer more from it than whites (Kaplan & Lieberman, 1998). There is also evidence showing that the heavier burden that blacks experience relative to whites, related to elevations in blood pressure, occur as early as young adulthood (Pletcher et al., 2008); and it continues through older adulthood (Borrell & Crawford, 2008; Glasser et al., 2011). Findings related to the higher prevalence of elevated blood pressure that blacks experience may reflect

adverse environmental, socioeconomic and/or genetic factors that are more prevalent among blacks than whites (Kaplan & Lieberman, 1998; Pletcher et al., 2008); however, examination of these determinants was beyond the aims and scope of this study. Additionally, the evidence presented here, from prior studies, was not based on data limited to college student populations different from the data in this manuscript.

Blacks that make it to college may be very different from those who do not go to college. They may be different on factors that were not measured and/or examined in this study. Further, by virtue of the fact that the blacks in this study are in college, they have achieved a certain social status, regardless of the economic backgrounds of their families of origin, that may afford them access to unknown resources that may be important to keeping blood pressure under control. Studies designed to define such resources and examine their relationship to blood pressure among college students are ripe areas of future inquiry.

Most of the students in the sample were drinkers and the alcohol consumption patterns of whites and males were significantly more prevalent and higher than the patterns of blacks and females. The finding that males had heavier patterns of drinking than females is consistent with results of other epidemiological studies of sex differences in college drinking (Gross, 1993). There was also a significant difference in the prevalence of drinkers between whites and blacks such that whites reported a higher prevalence. Black young adults have been known to have lighter patterns of drinking than many other racial groups, but they experience consequences that are equivalent to or greater than groups with riskier patterns of drinking (Godette et al., 2009). This is consistent with the findings from the current study in that we did not find highly significant differences in mean blood pressures between whites and blacks in this sample adjusting for drinking.

We also found that there was some reluctance on the part of black student drinkers to report their pattern of drinking (quantity and frequency) based on the large amount of missing data that we observed from the black drinkers. Perhaps the reluctance to report was related to social or cultural norms (e.g., church/religion or family related factors) in the black community that were not explored in this study (Godette, Headen, & Ford, 2006; Meilman, Presley, & Lyerla, 1994). It may also have been related to fear of reporting about a deviant and illegal (for those under the age of 21) behavior on a campus where blacks are such a significant minority.

When we examined whether or not the odds of experiencing elevations in blood pressure was associated with alcohol consumption, we found that none of the patterns of drinking explored was significantly associated with elevations in blood pressure. We expected high-risk drinking to be associated with elevations in blood pressure but that hypothesis was not supported in this study. In fact, the relationship that this pattern of drinking had to elevations in systolic and diastolic blood pressure was in the direction of protection, although those estimates were not significant. The only pattern of drinking that influenced elevations in both systolic and diastolic blood pressure, in the direction of risk, was the at-risk drinking pattern. However, those estimates were also not significant. Although more than half of all reported alcohol-related problems may be related to occasions where four-or-more drinks are consumed, many problems experienced by student drinkers have been associated with consuming as little as two-to-four drinks (Gruenewald et al., 2010; Hingson et al., 2009). These findings suggest there may be risk of alcohol-related problems (including elevated BP) associated with the full spectrum of alcohol consumption from low risk drinking to high-risk drinking.

The only pattern of alcohol consumption that was significantly associated with systolic blood pressure was risky drinking. Risky drinking was associated with systolic blood pressure in the direction of protection, which was contrary to what we expected. Evidence from prior research indicates that more than two alcoholic drinks per day increases the risk for elevations in blood pressure (Kaplan & Lieberman, 1998). However, there are several

reasons why results of this study may not be entirely consistent with the findings of other studies on the relationship between alcohol consumption and blood pressure.

The first reason may be differences in the way the data were collected. The data for this study were not originally collected for the purpose of research. They were collected for the purpose of treatment planning and the definition of a drink was not defined for the student patients when they were queried. As a result, it is very possible that when these students were asked about their alcohol consumption, they had diverse ideas about the definition of a drink. This may have resulted in over-reporting or under-reporting of alcohol consumption. Many of the other studies on the relationship between young adult alcohol consumption and blood pressure collected data by survey questionnaire or by interview (Dyer et al., 1990; Gillman et al., 1995). The difference in data collection method may make a difference in reporting (Klatsky, Gunderson, et al., 2006).

Further, we did not assess how many days per week these risky drinkers drank. It is possible that, in this sample, the risky drinkers never actually exceeded the weekly limits of what would keep them in the at-risk/low-risk drinking category. At-risk drinkers in this sample were the closest to what would be considered low-risk to moderate drinkers. Moderate drinkers are considered those who drink 1 to < 3 drinks per day (Gillman, et al., 1995; Klatsky, Gunderson, et al., 2006). This would work out to be the 7 to 14 drinks per week that is considered at-risk/low-risk, in this study, depending on the student's sex. There is evidence of moderate drinking having a protective effect on blood pressure (Dyer et al., 1990; Gillman et al., 1995). This represents the dip in the J or U-shaped curve. Perhaps the risky drinker group in this study is actually more like moderate drinkers over the course of a week. In addition, we did not have information on these student's drinking histories. Length of drinking history is likely to impact alcohol's effect on blood pressure.

Finally, although more males drink and have higher mean systolic and diastolic blood pressures, females had greater odds of experiencing elevations in blood pressure relative to males. There are a number of reasons why females, in this sample, were at greater risk for elevations in both systolic and diastolic blood pressure. The simplest explanation is that females in the sample may have been more susceptible to white coat hypertension or isolated clinic hypertension. White coat hypertension/isolated clinic hypertension occurs when patients experience elevated blood pressure levels when their blood pressure is taken in a physician's office or medical office setting (Kaplan & Lieberman, 1998). If the blood pressure readings decrease when blood pressure is taken in an out-of-office setting, this is known as the white coat effect (Kaplan & Lieberman, 1998). There is some evidence that female patients are more likely to have higher BP readings in the physician's office or medical clinic than males (Millar & Accioly, 1996). Females may also be more likely to experience elevations in systolic blood pressure when measured by male observers in the clinical setting; but this effect dissipates after repeated measurement (Millar & Accioly, 1996).

Young college-aged females may also be more prone to calorie-sparing eating prior to drinking than males (Nowicke, 2011). Their use of caffeine products, laxatives, diuretics, prescriptions stimulants, in order to lose weight or suppress appetite prior to weekend drinking (Nowicke, 2011), may play a role in the experience of blood pressure elevations. This is most likely to be true for females who use caffeinated or other stimulant products. This phenomenon has been referred to as drunkorexia. While drunkorexia might be a contributing factor to the observed increase in female odds of elevated blood pressure over males, it must be noted that extreme dieting has also been associated with low blood pressure (Nowicke, 2011). Future investigations designed specifically to understand this finding may provide evidence that will prove to be less equivocal than what is presented here. Additionally, it might be the case that more of the females than the males experienced some other factor that could adversely impact their BP but was not measured in this study.

There are other potential limitations to this study that must be discussed. First, this study involves a clinical sample of college students from one university. As a result, the findings of

this study cannot be generalized to the larger student population or community samples of young adults. It is also very possible that social desirability biased student responses when queried about alcohol use. All of the students in our sample were being seen at the medical clinic at the university health center. It is possible that they may have been more reluctant to report their patterns of alcohol use to staff in the medical clinic than they would have been in the counseling and psychological services clinic where substance abuse services are offered. In addition, there are other factors that may serve as confounders for which we could not or did not adjust for in these analyses (e.g., leptin levels, pulse, etc.). Further, this study was also an exploratory examination of cross-sectional data; as a result, no causal inferences could be made from the analyses conducted.

Based on these limitations and others addressed earlier in the discussion, we recommend there be additional studies of the relationship between young adult alcohol consumption and blood pressure in campus-based UHC populations. We caution strongly against making any clinical recommendations based on these early stage findings. It appears that findings from this study might support evidence from other studies that illustrate the potential protective effect of moderate drinking on blood pressure. However, we are still waiting for proof that makes this an absolute (Klatsky, 2010) although a compelling case has been made for light to moderate drinking reducing hypertension and other cardiovascular disease risk in populations older than the young adults that were our focus. The few studies that have examined the relationship between young adult alcohol consumption and blood pressure have only scratched the surface of the knowledge to be gained on this topic.

Despite these limitations, this study represents an exploratory look at the relationship between blood pressure and alcohol among college students. It adds to the small but growing literature on alcohol use and blood pressure during young adulthood; and it further establishes the utility of alcohol screening in university health centers by providing yet another example of how alcohol screening might be used in a university health center to intervene early and promote positive health behaviors related to alcohol consumption and the onset of chronic diseases among college students. Future studies should further explore sex differences related to alcohol and blood pressure by conducting analyses that are stratified by sex or that test for interactions that include student sex. Future studies could also conduct analyses on the relationship between alcohol consumption and blood pressure that adjust for: pulse, leptin, co-morbid mental health issues, student athletic involvement, involvement in greek-letter organizations, and other socio-environmental factors in addition to the other factors included in this study.

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