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Trends in incidence and risk markers of student emergency department visits with alcohol intoxication in a U.S. public university—A longitudinal data linkage study

Duc Anh Ngo[a,c,*], Saumitra V. Rege[c], Nassima Ait-Daoud[a,b], Christopher P. Holstege[a,c]

[a] Department of Student Health, Division of Student Affairs, University of Virginia, 400 Brandon Avenue, Charlottesville, VA 22908, United States
[b] Department of Psychiatry and Neurobehavioral Sciences, University of Virginia School of Medicine, PO BOX 800223, Charlottesville, VA 22908-0699, United States
[c] Department of Emergency Medicine, University of Virginia School of Medicine, PO BOX 800699, Charlottesville, VA 22908-0699, United States

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ABSTRACT

Background: To examine the trends in incidence and socio-demographic, organizational, academic, and clinical risk markers of student alcohol intoxication associated with emergency department (ED) visits.

Methods: Student admission data from 2009 to 2015 were linked to primary healthcare data and subsequent ED visits with alcohol intoxication identified using ICD-9 codes within one year following the first (index) enrollment each year. Incidence rate per 10,000 person-years was calculated. Cox proportional hazard regression provided adjusted hazard ratios (HR) (95 % CIs) for the association between student characteristics and subsequent ED visits with alcohol intoxication.

Results: Of 177,128 students aged 16–49 enrolled, 889 had at least one ED visit with alcohol intoxication, resulting in an incidence rate of 59/10,000 person-years. Incidence increased linearly from 45/10,000 person-years in 2009–10 to 71/10,000 person-years in the 2014–15 academic year ($p < 0.001$). HRs (95%CIs) of student characteristics associated with this outcome were: males (versus females): 1.38 (1.21–1.58); below 20 years of age (versus 25–30 years): 3.36 (1.99–5.65); Hispanic (versus Asian) students: 1.61 (1.16–2.25); parental tax dependency: 1.49 (1.16–1.91); Greek life member: 1.96 (1.69–2.26); member of an athletic team: 0.51 (0.36–0.72); undergraduate (versus graduate) students: 2.65 (1.88–3.74). Past year alcohol use or having been diagnosed with depression or anxiety were also significant predictors. Adjustments for campus-related factors strongly attenuated the associations between student socio-demographic characteristics with this outcome.

Conclusions: Linking student admission data with ED clinical data can help monitor student alcohol intoxication associated with ED visits and identify student groups at higher risk who subsequently can be targeted for intervention efforts.

1. Introduction

Alcohol misuse continues to be a significant health problem among college students. According to the 2015 National Survey of Drug Use and Health, 58.0% of full-time U.S. college students aged 18–22 drank alcohol in the past month compared with 48.2% of those not enrolled in college full-time of the same age (Center for Behavioral Health Statistics and Quality, 2016). Similarly, according to the Monitoring the Future Survey, the prevalence of binge drinking (32.4% vs. 28.7%) and alcohol intoxication (40.8% vs. 30.4%) was higher among U.S. college students compared to young adults not enrolled in college during 2016 (National Institute on Drug Abuse, 2017). Alcohol intoxication is a major problem in this age group that results in numerous adverse health consequences, such as injury/trauma, mental health disorder, assault, or death (Ngo et al., 2018; NIAAA, 2013). Excessive alcohol consumption also negatively impacts student academic performance and social behavior (Ansari et al., 2013).

To date, few U.S.-based published studies have examined alcohol use and related health consequences amongst college students presenting to hospital EDs (Ngo et al., 2018; Turner and Shu, 2004; Wright et al., 1998; Wright and Slovis, 1996). These studies reported that prevalence of ED visits involving alcohol use ranged from 10 to 16 per 100 ED visits and that the prevalence was higher among younger, first-year, white, and undergraduate students. Notably, the study by (Ngo et al., 2018) using data collected over an extended period documented for the first time the rising trends in the prevalence of student alcohol

* Corresponding author at: Department of Student Health, University of Virginia, 400 Brandon Avenue, Charlottesville, VA, 22903, United States.
E-mail address: dan9k@virginia.edu (D.A. Ngo).

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intoxication associated with ED visits. This study also noted that prevalence of this problem drinking was higher in the student population than in corresponding general populations.

Although student problem drinking is a serious social and public health concern, not all students are risky drinkers. There is great variability in student alcohol consumption, which is mediated by a range of personal, interpersonal, psychological, and campus-related factors. It is well-established that white, first-year students (Wechsler et al., 1995), and students enrolled in fraternities/sororities (Lo and Globetti, 1995; Presley et al., 2002) or students participating in sport-related activities (Kwan et al., 2014; Lisha and Sussman, 2010; Turrisi et al., 2006) have higher rates of episodic heavy drinking than other students. The type of residence and the college size also affect the level of binge drinking (NIAAA, 2002). Students who experienced psychiatric disorders, including psychological distress (Livingston et al., 2016) or social anxiety (Brook and Willoughby, 2016; Dawson et al., 2005) had greater odds of alcohol misuse.

Several underlying mechanisms that explain variability in student risky drinking have been documented in various studies. Student ethnicity has been implicated in influencing student drinking through genetic or familial factors (Baer, 2002). First-year students and undergraduate students drink more than upper class and graduate students due to their common misperceptions that heavy drinking is an integral part of the college experience (Sher and Rutledge, 2007; Boekeloo et al., 2009). In addition, those who drink excessively are more likely young students and less experienced drinkers, whereby they are unable to manage appropriately the amount of alcohol they consume. Parental tax dependency, which is more common among younger students (e.g., < 24 years of age) or undergraduate students, would also be associated with problem drinking. Immediate and proximal college-specific social contexts and activities that students select (e.g., athletics or fraternities) mediate student drinking behavior through the social normative process (Baer, 2002). Members of Greek organizations are more likely to believe that alcohol is a vehicle for friendship, social activity, and sexuality than comparison non-members. Student-athletes, on the other hand, experience excessive time demands, psychological pressures to live up to coaches, fans, and family expectations, and peer norms, all of which contribute to heightened risks of excessive alcohol consumption (Martens et al., 2006). Mental health disorders, including depression and anxiety, have been shown to be comorbid with alcohol use disorders among college students where alcohol use is viewed as a vehicle to self-manage those mental health conditions (Baer, 2002).

However, significant gaps in literature remain when focusing on the student population. Nearly all available studies of college alcohol use and risk factors for misuse relied on sample-based cross-sectional self-report surveys, which is subject to significant limitations: selection bias, recall bias, high rate of non-response, and inability to collect clinical data (NIAAA, 2002). Using a cross-sectional design, these studies were unable to provide incidence estimates and determine the temporal sequence in the relationships between risk factors and student harmful alcohol use. In particular, prior studies of student alcohol intoxication in hospital EDs were only based on a subset of students who already presented to EDs. This shortcoming precludes the ability to identify student characteristics at the time of enrollment that can be predictive of this harmful drinking behavior.

This study aimed to evaluate the trends in the incidence of student alcohol intoxication associated with hospital ED visits and assess the longitudinal relationships between student socio-demographic characteristics, campus-related and psychological factors with this outcome. As not all factors influence the risk of intoxication to the same extent (Baer, 2002), our study also sought to determine whether demographic gradients in the risk of alcohol intoxication were independent of and/or mediated by campus-related and clinical risk factors. Given that student socio-demographic characteristics are not modifiable, this information is essential to inform not only models of risk but also the design of preventive interventions by helping identify student subgroups at greater risk than others and to elucidate potential targeted interventions throughout student enrollment.

2. Methods

2.1. Study population, study design, and data sources

The current study was based on a cohort of 177,128 students who enrolled in a U.S. public university during six academic years from 2009–10 to 2014–15. A retrospective cohort design was used. Data was created by linking the University's Student Information System (SIS) with 3 other student datasets: Student Health Record dataset, ED's Patient Registration System, and Clinical Data Repository.

2.1.1. SIS

SIS is the university's student registry database that contains information on student demographic characteristics (e.g., age, gender, ethnicity), organizational affiliation, extracurricular activities (e.g., athletic participation), schools, academic level and academic program for each term a student is enrolled. Every student has a unique student identification number. The SIS also identifies students who are affiliated with university's Fraternity and Sorority Governing Councils and students who are members of the university-affiliated athletic team for each academic term.

2.1.2. Student Health Record dataset

Student Health Record dataset is a census of all student visits to the University Student Health Center (SHC) clinic. It records student demographics and clinical conditions associated with each visit coded according to the Ninth Revision of the International Classification of Disease (ICD-9).

2.1.3. ED's Patient Registration System

ED's Patient Registration System is a reporting system for students visiting the university hospital ED. It generates a daily report of individuals who are flagged as students in the ED (those who identify as students have "Student Health" indicated as their Primary Care Provider at the time of registration). These reports are available 48 h after the ED visit date.

2.1.4. Clinical Data Repository

Clinical Data Repository is an electronic data repository of patient admissions and visits to all clinics and departments in the university health system. It contains ICD diagnostic codes for each ED visit, unstructured clinical notes, and other key clinical variables including laboratory test results (e.g. blood alcohol values, urine drug screen tests), admission characteristics (e.g. date/time of arrival and triage, disposition, acuity), medications and procedures administered during the visit, and post-visit recommendations and referrals (e.g. primary care provider, specialist).

2.2. Data linkage

To link the above four student datasets, a three-step process was employed. In the first step, an initial subset of students who visit the ED was extracted from the Patient Registration System. Students identified from this system were matched with the SIS based on names (first and last) and date of birth. In the second step, this data was further linked to student ED clinical data for each visit within the Clinical Data Repository, using each student's unique electronic medical record (EMR) number and the specific ED visit date. After this second step, a dataset was obtained with a full record of a subset of students who had an ED visit in the university hospital. In the third step, SIS was longitudinally linked using the student university ID and academic terms with the two subsets of students: those who visited the University SHC clinic and those who visited the ED. Through this process, we obtained

Table 1
Characteristics of the study students.

Characteristic	n (%)	Incidence*	Characteristic	n (%)	Incidence*
Gender[a]			**First-time enroll**[a]		
Male	98779 (55.8)	69	No	109290 (61.7)	47
Female	78349 (44.2)	51	Yes	67838 (38.3)	80
Age[a]			**Greek life**[a]		
16–19	46559 (26.3)	129	No	155435 (87.8)	43
20–24	69045 (39.0)	52	Yes	21693 (12.2)	163
25–29	25200 (14.2)	10	**Athlete**[a]		
30–50	36324 (20.5)	1	No	169458 (95.7)	59
Ethnicity[a]			Yes	7670 (4.3)	49
Asian and HPC	15468 (8.7)	56	**Parental tax dependency**[a]		
African American	11235 (6.3)	58	No	88083 (49.7)	15
Hispanic	8240 (4.7)	89	Yes	89045 (50.3)	95
Multiracial	4525 (2.6)	88	**Past year alcohol use**[a]		
Non-resident	13492 (7.6)	60	No	176882 (99.9)	58
White	109859 (62.0)	37	Yes	246 (0.1)	274
Other**	14309 (8.1)	47	**Depression**[a]		
Academic level[a]			No	175522 (99.1)	58
Graduate	75043 (42.4)	92	Yes	1606 (0.9)	133
Undergraduate	102085 (57.6)	9	**Anxiety**[a]		
			No	175588 (98.9)	58
			Yes	2088 (1.1)	128

*Per 10,000 person-years
**American Indian (n = 289), Native Hawaiian (n = 173), and Unknown ethnicity (n = 13847).
[a] Indicate statistically significant difference in incidence between student groups ($p < 0.05$).

a comprehensive, integrated, de-identified dataset containing a full record of all students each time they enrolled linked with clinical records of those who visited the university SHC clinic and/or hospital ED.

2.3. Follow up and ascertainment of ED visits with alcohol intoxication

Follow up started at the date when the student first enrolled (index enrollment) in each academic year and ended at the earliest date of the following: the end date of the student's last semester, the date when the student was transferred to another university or withdrew, or day 365th following the index enrollment.

The outcome was the first ED visit with alcohol intoxication occurring within one year since the index enrollment, which was identified from ICD-9 diagnostic codes documented in the patient EMR. ICD-9 codes indicating alcohol intoxication included 305.0 and 303.0 as defined in the national statistics on alcohol-related ED visits (NIAAA, 2013). The physician's diagnosis of this condition was primarily based on clinical presentation and/or the patient self-report of drinking before the ED visit.

Students with acute alcohol intoxication overwhelmingly seek care at the university hospital ED which is within a mile of campus student housing, the majority of off-campus student housing, and the fraternity/sorority houses. The nearest alternate ED is at a private hospital approximately five miles from the center of campus that is not conveniently accessible to students and rarely utilized as confirmed by the student health insurance data utilization.

2.4. Ascertainment of covariate risk markers

Student socio-demographics (gender, age, ethnicity, parental tax dependency), academic levels (undergraduate, post-graduate), organizational affiliation (member of fraternities and sororities), or athletic participation associated with the index enrollment were ascertained from SIS. Clinical risk factors were extracted from the Student Health Record dataset using ICD-9 codes. In this study, we considered depression, anxiety, and alcohol-related visits recorded in this dataset within one year prior to the index enrollment as potential clinical covariates.

2.5. Data analysis

The unit of analysis is students at index enrollments in each academic year. First, descriptive statistics were used to provide a frequency distribution of students' characteristics. Incidence rate (per 10,000 person-years) of ED visits with alcohol intoxication were calculated by dividing the number of ED visits by the total years of follow up since the index enrollment. Group differences and the temporal trend in the incidence rate were evaluated using Poisson regression.

Second, three sequential Cox proportional hazard regression models were performed to provide hazard ratios (HRs), and 95% confidence intervals (CIs) for the relationships between student characteristics and first ED visits with alcohol intoxication within one year following index enrollment. Since not all students had completed follow up since the index enrollment, this form of analysis is able to take into account the time of occurrence of each event (i.e., ED visit with alcohol intoxication) as well as the time of censoring for students who were not observed for the entire follow up (Szklo and Nieto, 2012). Specifically, model 1 included students' socio-demographic characteristics (gender, age, ethnicity, and parental tax dependency) adjusted for the number of enrollments (i.e., first enrollment or otherwise). Model 2 included all variables in model 1 plus campus-related variables: student organizational affiliation (fraternities/sororities), athletic participation, and academic level (undergraduate vs. graduate). Model 3 (full model) contained all variables in model 2 plus antecedent clinical risk markers: past year alcohol use, depression, and anxiety. Changes in HRs of the relationships between student demographic characteristics and intoxication across 3 statistical models were evaluated to identify what campus-related and clinical markers mediated these relationships. Data were analyzed using SAS 9.4 Software. Ethical approval was provided by the University Institutional Review Board.

3. Results

3.1. Characteristics of the study population

There were 181,827 students aged 16–49 years (median = 21.7) at index enrollments during the study period. After excluding 4,599 students (2.6%) with missing data on covariates, 177,128 students (56% males) were available for analysis. Over 26% of students were aged

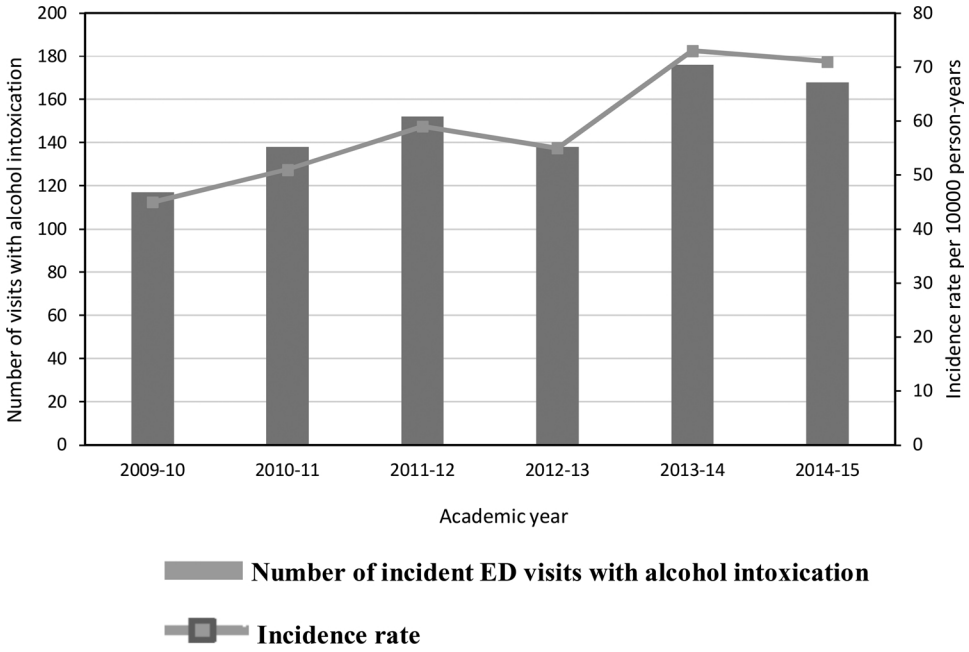

Fig. 1. Trend in incidence of ED visits with alcohol intoxication, 2009/10-2014/2015.

16–19 years, 39% aged 20–24, 14% aged 25–29, and 20.5% aged 30–49. White students accounted for 62% of the total cohort, followed by Asian and Pacific Islanders (8.7%), non-American residents (7.6%), African American (6.3%), Hispanic (4.7%), and multiracial (2.6%). Nearly 58% were undergraduate students, and 42% were graduate students, 12.2% were affiliated with a fraternity or sorority, 4.3% were members of a university-affiliated athletic team, 38% were enrolled for the first time, and over half were dependent on parents for tax (Table 1).

3.2. Trends in incidence of ED visits with alcohol intoxication

Over the study period, 889 students had at least one ED visit with alcohol intoxication within one year after the index enrollment over a total of 151,414 person-years follow-up, 59,889 students (33%) had graduated, withdrew, or were transferred. The overall incidence rate was 59/10,000 person-years. The incidence increased linearly from 45/10,000 person-years in 2009–10 to 71/10,000 person-years in the 2014-15 academic year ($p < 0.001$) (Fig. 1).

When comparing different student groups, the incidence was higher in males, students under 20 years of age, Hispanic students, first-time enrolled students, students having parental tax dependency, students affiliated with fraternities/sororities, undergraduate students, and students with past year alcohol use or having been diagnosed with depression or anxiety. The incidence, on the other hand, was lower in students who were members of an athletic team ($p < 0.001$). In particular, the incidence decreased greatly and linearly with age: 129 in students aged < 20 years, 52 in ages 20–24, 10 in ages 25–29, and 1 in ages 30–49 ($p < 0.001$) (Table 1).

3.3. Relationships between student characteristics and intoxication

In the full multivariable Cox proportional hazard regression model, HRs (95%CIs) of student characteristics associated with incident ED visits with alcohol intoxication were: males (versus females): 1.38 (1.21–1.58); below 20 years of age (versus 25–30 years): 3.36 (1.99–5.65); Hispanic (versus Asian) students: 1.61 (1.16–2.25); parental tax dependency: 1.49 (1.16–1.91); Greek life member: 1.96 (1.69–2.26); member of an athletic team: 0.51 (0.36–0.72); undergraduate versus graduate students: 2.65 (1.88–3.74), and first time enrolled students: 1.92 (1.65–2.25). Past year alcohol use (HR = 3.56 (1.58–8.0)) or having been diagnosed with depression (HR = 2.38 (1.48–3.84)) or anxiety (HR = 2.36 (1.54–3.61)) were also significantly associated with higher risk for ED visits with alcohol intoxication (Table 2).

In comparing HRs in model 1 and model 2, adjustment for campus-related factors (e.g., Greek life members, student-athletes, and academic level) significantly attenuated the magnitude of associations between alcohol intoxication and age, ethnicity, and parental tax dependency. Specifically, compared to the reference group, HR reduced from 6.75 to 3.30 for age < 20 and from 3.43 to 2.11 for ages 20–24, respectively; and HR reduced from 2.26 to 1.49 for parental tax dependency. In particular, HRs for associations with ethnicity either reduced (from 1.82 to 1.63) for Hispanic or became non-statistically significant for multiracial and white students. The subsequent analysis further controlling for clinical risk markers: past year alcohol use, depression, and anxiety (Model 3) did not fundamentally change the magnitude of these associations (Table 2, Fig. 2).

Compared to model 1, all 3 fit statistics (-2 Log likelihood, Akaike's Information Criterion, and Schwarz Bayes Criterion) decreased in model 2 and model 3, indicating that adding covariates improved the fit of the model.

4. Discussion

In this large, well-defined, and longitudinal student cohort, incident alcohol intoxication associated with student ED visits occurred in 59/10,000 person-years with a rising trend over a 6-year period. The findings have delineated for the first time that conventional campus-related factors (organizational affiliation, athletic participation, and academic level) mediated to significant extents socio-demographic gradients by age, ethnicity, and parental tax dependency in the risk of student alcohol intoxication requiring emergency interventions.

Although no available studies have documented the trends in incidence of student alcohol intoxication in hospital EDs, the observed rising trend mirrored the national increase in the prevalence of alcohol-related ED visits among college-age young people from 97 to 120 per 10,000 population during the 2006–2010 period (NIAAA, 2013). In addition, several studies of non-student populations in other Western countries (Bertholet et al., 2014; Haberkern et al., 2010; O'Farrell et al.,

Table 2
Associations between student characteristics and ED visits with alcohol intoxication.

Characteristic	Number of events	Model 1 h (95%CI)	Model 2 h (95%CI)	Model 3 h (95%CI)
Gender				
Female	430	1	1	1
Male	459	1.36 (1.19–1.55)	1.37 (1.2–1.56)	1.38 (1.21–1.58)
Age				
< 20	570	6.75 (4.19–10.85)	3.3 (1.96–5.55)	3.36 (1.99–5.65)
20–24	295	3.43 (2.15–5.47)	2.11 (1.28–3.48)	2.11 (1.28–3.47)
25–29	21	1	1	1
30–50	3	0.11 (0.03–0.38)	0.09 (0.03–0.31)	0.09 (0.03–0.31)
Ethnicity				
Asian	78	1	1	1
Black	57	1.39 (0.99–1.96)	1.39 (0.99–1.96)	1.37 (0.97–1.93)
Hispanic	64	1.82 (1.3–2.53)	1.63 (1.17–2.27)	1.61 (1.16–2.25)
Multi-racial	36	1.57 (1.05–2.32)	1.42 (0.96–2.11)	1.41 (0.95–2.1)
Non-Resident	41	1.12 (0.77–1.64)	1.11 (0.76–1.63)	1.12 (0.76–1.63)
White	564	1.43 (1.13–1.81)	1.25 (0.98–1.59)	1.23 (0.97–1.57)
Other	49	1.39 (0.97–1.99)	1.27 (0.89–1.82)	1.25 (0.87–1.8)
First time enroll				
No	451	1	1	1
Yes	438	1.63 (1.41–1.89)	1.83 (1.57–2.13)	1.92 (1.65–2.25)
Tax dependence				
No	104	1	1	1
Yes	785	2.26 (1.79–2.85)	1.49 (1.16–1.9)	1.49 (1.16–1.91)
Greek life member				
No	558	–	1	1
Yes	331	–	1.94 (1.68–2.24)	1.96 (1.69–2.26)
Athlete				
No	854	–	1	1
Yes	35	–	0.51 (0.36–0.71)	0.51 (0.36–0.72)
Academic level				
Graduate	57	–	1	1
Undergraduate	832	–	2.71 (1.92–3.82)	2.65 (1.88–3.74)
Past year alcohol use				
No	883	–	–	1
Yes	6	–	–	3.56 (1.58–8)
Depression				
No	870	–	–	1
Yes	19	–	–	2.38 (1.48–3.84)
Anxiety				
No	865	–	–	1
Yes	24	–	–	2.36 (1.54–3.61)

Model 1: Gender, age, ethnicity, and number of enrollment.
Mode 2: All variables in model 1 + campus-related factors (Greek member, athletes, and academic level).
Model 3: All variables in model 3 + clinical risk markers (past year alcohol use, depression, anxiety).

2004; Verelst et al., 2012) also reported a rising trend in the prevalence of ED visits with alcohol intoxication. Thus, although students may form a unique population with a higher frequency of alcohol intoxication associated with ED visits, they shared a common trend with other populations.

The observed rising trends may reflect either a true increase in the number of students who consumed excessive alcohol that required ED evaluation or an increase in the number of intoxicated students presenting to EDs for treatment due to outreach programs encouraging bystanders to activate emergency services where intoxicated students can utilize the ED as a confidential and safe place to sober. An earlier study demonstrated that provision of dedicated ED transports to students with alcohol intoxication on the university campus increased the number of students calling for help, resulting in a 56% increase in the number of intoxicated students transferred to the local ED (Kharasch et al., 2016; Turner and Shu, 2004; Wright et al., 1998; Wright and Slovis, 1996). Regardless of reasons accounting for this increase, greater numbers of students visiting the ED with alcohol intoxication placed a greater burden on the ED. This underscores the need for intervention strategies to modify excessive drinking behaviors in order to reduce intoxication and the need for ED services targeting risky drinking among the student population.

The study findings reinforce current knowledge on risk factors of student risky drinking. In particular, the longitudinal design supports that student socio-demographic, campus-specific, and clinical factors can predict future problematic drinking. The findings were in parallel with previous studies reporting that young (< 20 years of age) students, undergraduate students, and students affiliated with fraternities/sororities experienced a higher rate of ED visits with alcohol intoxication (Turner and Shu, 2004; Wright et al., 1998; Wright and Slovis, 1996). However, in contrast to the vast majority of available studies (Turrisi et al., 2006), this study demonstrated that students who were members of a university athletic team were less likely, not more likely, than other students to experience this harmful alcohol use. A possible explanation is that their activities are better supervised or they are required to abstain from drinking during sports seasons or risk the loss of their athletic scholarship. Also, athletic students in this particular campus might be reluctant to visit the university hospital's ED due to policies or disciplinary actions pertaining to student-athlete drinking behavior, specific athletic leadership, and/or perception of student-athletes regarding the confidential use of the ED to sober. This finding needs to be further researched. In addition, White students were consistently reported in previous studies to have the highest risk for problematic drinking (O'Malley and Johnston, 2002; Wechsler et al., 1995). In this study, Hispanic students, for an unknown reason, were at the highest risk. This might be attributed to the fact that while Hispanics are traditionally less likely to drink than non-Hispanics, the consumption volumes are higher in Hispanics who do consume alcohol (SAMHSA, 2013).

In addition to conventional socio-demographic and campus-related risk factors, this study also found that students with prior alcohol-related visits to the SHC clinic or having been diagnosed with depression and/or anxiety were at higher risk for ED visits related to alcohol intoxication. This finding complements available studies noting that for many students, excessive alcohol consumption in college represents a continuation or escalation of drinking patterns established earlier (Turrisi et al., 2006). Since excessive use of alcohol and mental health disorders may reciprocally be related, the presence of depression or anxiety might be a consequence of past risky alcohol consumption or a cause for subsequent excessive drinking (Kushner et al., 2000; Sherry, 2008), which both explained a higher risk of intoxication among students with these conditions in their prior visits to the SHC clinic.

4.1. Public health and clinical implications

Our study offers new insights into intervention efforts utilized to curb student hazardous drinking on the university campus. As the findings indicated, demographic gradients in the risk of intoxication appeared attenuated or diminished after accounting for campus-related

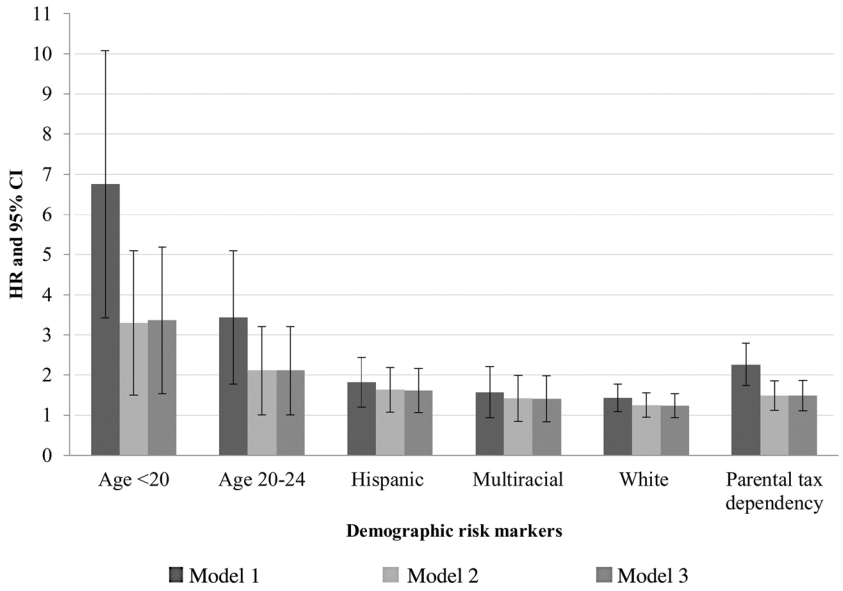

Fig. 2. Changes in HRs for associations of age, ethnicity, and parental tax dependency with the risk of ED visits for alcohol intoxication before (model 1) and after adjustment for campus-related (model 2) and clinical risk markers (model 3).

factors. In other words, the role of socio-demographic factors (i.e., age, ethnicity, parental tax dependency), which are not amenable to interventions became less prominent factors when students were members of the Greek system, undergraduate students, or student-athletes. This finding highlights the importance of modifying campus-specific environments and social contexts that shape student drinking behavior. For example, Greeks living in designated housing can provide opportunities to target interventions to change the Greek environment and drinking norms towards prohibiting dangerous drinking, which might have collective effects on students living in this environment regardless of their socio-demographic backgrounds.

Students presenting to the ED following complications associated with alcohol provides a unique opportunity for interventions to not only ameliorate the harm of the acute intoxication but also help prevent further occurrence of this risky drinking behavior. Evidence-based ED guidelines focused on a consistent approach to intervene effectively with such students need to be developed and consistently followed by ED providers. As an example, one intervention being implemented on college campuses is the Brief Alcohol Screening and Intervention for College Students (*BASICS*) after ED discharge (Ngo et al., 2018).

4.2. Strengths and limitations

The study has numerous strengths. First, the analysis was based on a complete major university student population with limited missing data. The findings were, therefore, population-representative and not affected by a selection bias that often occurs in sample-based student surveys. Second, it employed a longitudinal design and linked different student datasets to examine a wide range of risk factors associated with the incident of ED alcohol intoxication visits. The observed associations, therefore, were not affected by the influence of prevalence-incidence bias, and the potential for reverse causation. Third, measures of alcohol intoxication were based on clinical diagnosis by ED's physicians which were not subject to self-reporting bias. Our validation study found that code-based recording of alcohol intoxication was highly accurate (94% positive predictive value) and reasonably complete (66% sensitivity) (Holstege et al., 2018).

Study findings should also be interpreted in conjunction with limitations. The data did not capture alcohol-related ED visits to other health facilities when a majority of students are off campus, such as during spring or summer breaks. Furthermore, only 66% of ED visits with alcohol intoxication were captured by ICD-9 diagnostic codes. Nonetheless, it is likely that this under-ascertainment of intoxication tends to be randomly distributed across different student groups, which can lead to an underestimate, not an overestimate of the strength of the associations. The findings are specific to the ED of a public university health system, which may not be generalizable to other universities. However, the overall trend was analogous to the national trend, and the observed relationships with key student characteristics (e.g., age, gender, Greek life member) were consistent with earlier studies, indicating that our data reflect generalizable risk patterns of harmful alcohol use among student populations.

5. Conclusion

Our study further advances knowledge on determinants of problem drinking among students by elucidating the mediating roles of campus-related factors in the risk of alcohol intoxication requiring ED visits. This finding stresses the need for modifying campus-specific social contexts and environments that are associated with student harmful alcohol use. The study also highlights that linking student administrative data with subsequent ED clinical data can monitor the temporal trend in alcohol intoxication in a student population. Since not all students face the same risk of this clinical outcome, a rich account of student socio-demographic characteristics, organizational, academic, and clinical risk markers allows for development of a robust risk screening algorithm to identify a subset of students with higher risk trajectories, who should be targeted through screening, enhanced counseling, and timely referral to available education and preventive services.

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Contributors

CH conceived the dataset. AN conceived the study design, extended data linkage and performed the analyses and drafted the manuscript. All authors contributed to interpretation of the results and writing the manuscript. All authors approved the final version of the manuscript before submission.

Conflict of interest

No conflict declared.

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