



Patterns of high-intensity drinking among young adults in the United States: A repeated measures latent class analysis



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HIGHLIGHTS

- We found four latent classes of longitudinal patterns of drinking from 18 to 25/26.
- 16% had a long-term pattern of high-intensity drinking starting in high school.
- Other patterns of alcohol use did not include high-intensity drinking.
- Gender and race/ethnicity differentiate between patterns of use.

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ABSTRACT

Objective: Using a national sample of young adults, this study identified latent classes of alcohol use including high-intensity drinking (10+ drinks) from ages 18 to 25/26, and explored associations between time-invariant covariates measured at age 18 and class membership.

Method: Longitudinal data from the national Monitoring the Future study were available for 1078 individuals (51% female) first surveyed as 12th grade students in 2005–2008, and followed through modal age 25/26. Repeated measures latent class analysis was used to identify latent classes based on self-reported alcohol use: no past 30-day drinking, 1–9 drinks per occasion in the past 2 weeks, and 10+ drinks per occasion.

Results: Four latent classes of alcohol use from ages 18 to 25/26 were identified: (1) Non-Drinkers (21%); (2) Legal Non-High-Intensity Drinkers (23%); (3) Persistent Non-High-Intensity Drinkers (40%); and (4) High-Intensity Drinkers (16%). Membership in the High-Intensity Drinkers class was characterized by higher than average probabilities of high-intensity drinking at all ages, with the probability of high-intensity drinking increasing between ages 18 and 21/22. Both gender and race/ethnicity significantly differentiated class membership, whereas neither parental education (a proxy for socioeconomic status) nor college plans at 12th grade showed significant associations.

Conclusions: More than one in seven individuals who were seniors in high school experienced a long-term pattern of high-intensity drinking lasting into middle young adulthood. Young adult high-intensity drinking is often preceded by high-intensity drinking in high school, suggesting the importance of screening and prevention for high-intensity drinking during adolescence.

1. Introduction

Heavy drinking is associated with a broad range of adverse acute and long-term consequences, including fatal and non-fatal injuries, health problems, alcohol use disorders, and birth defects (National Institute on Alcohol Abuse and Alcoholism, 2016). High-quantity alcohol use has typically been defined as heavy episodic drinking,

operationalized as having 5 or more drinks on a given occasion (Johnston, O'Malley, Bachman, Schulenberg, & Miech, 2016; Wechsler & Nelson, 2001), or as gender-specific levels of 4 or more drinks for women and 5 or more drinks for men (National Institute on Alcohol Abuse and Alcoholism, 2004). However, the average number of drinks in a typical heavy episodic drinking occasion for young adults ages 18–24 has been estimated at > 9 (National Institute on Alcohol

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Abuse and Alcoholism, 2004). Recent calls in the literature suggest adding a cut-off for very high-risk drinking (Hingson & White, 2013; Patrick, 2016), referred to as high-intensity drinking and usually operationalized as having 10 or more drinks on a given occasion (i.e., twice the typical binge-drinking threshold) (Patrick, 2016). Individuals who report high-intensity drinking have been found to not only consume a larger quantity of alcohol on drinking occasions than individuals who drink below the 10+ level, but also to engage in 5+ drinking more frequently than those who do not report high-intensity drinking (Patrick, Terry-McElrath, Kloska, & Schulenberg, 2016). High-intensity drinking has been estimated to raise blood alcohol concentration (BAC) levels to at least four times the legal 0.08% limit (Hingson & White, 2013), resulting in severe and even life-threatening levels of impairment (National Institute on Alcohol Abuse and Alcoholism, 2015).

Studies have begun to provide data on both the prevalence and overall developmental trajectory of high-intensity drinking among older adolescents and young adults, largely using data from Monitoring the Future (Johnston et al., 2016). Using the same measure and similar nationally representative samples of high school seniors as used in the present study, an earlier study found that 10.5% reported high-intensity drinking (Patrick et al., 2013). A similar percentage (10.3%) of young adults aged 19/20 reported high-intensity drinking from 2006 to 2015 (Patrick & Terry-McElrath, 2016); prevalence was somewhat higher (12.4%) among young adults in their mid-20s (Terry-McElrath & Patrick, 2016). The normative developmental trajectory for high-intensity drinking was an increasing frequency from late adolescence to peak at age 21/22, and decreasing frequency thereafter (Patrick et al., 2016). However, the degree of variation in specific patterns of stability and change in high-intensity drinking across young adulthood has yet to be considered, as has been done extensively regarding heavy episodic drinking (summarized below). Understanding developmental patterns of high-intensity drinking across the transition to adulthood is important for both etiological and prevention advances, providing needed insights into the extent and predictors of, for example, persistent high-intensity drinking versus persistent drinking that is not high-intensity (Schulenberg & Maggs, 2002).

Sociodemographic differences in levels of high-risk alcohol use among high school students have been documented. Being male (vs. female), being white (vs. non-white), and having higher parental education (a proxy for family-of-origin socioeconomic status) are associated with significantly higher levels of high-risk alcohol use in 12th grade (Miech, Johnston, O'Malley, Bachman, & Schulenberg, 2016; Patrick et al., 2013, 2016). Sociodemographic differences in trajectories (or rates of change over time) in overall frequency of high-intensity drinking also have been identified. A steeper increase in frequency of high-intensity drinking from ages 18 to 21/22 was observed for males (vs. females) and individuals who attended a 4-year college full-time at age 19/20 (vs. others). A steeper rate of decrease from ages 21/22 to 25/26 was observed for college attenders (vs. others). Parental education was not significantly associated with the overall normative developmental trajectory of high-intensity drinking (Patrick et al., 2016). The above sociodemographic differences in baseline prevalence and trajectory change of high-intensity drinking are similar to those observed for overall alcohol use and for 5+ drinking in particular (Chassin, Hussong, & Beltran, 2009; Johnston et al., 2016; Maggs & Schulenberg, 2004; Park, Paul Mulye, Adams, Brindis, & Irwin, 2006; Patrick & Schulenberg, 2011; Patrick et al., 2016; Schulenberg & Maggs, 2002). The above research indicates that the risk for participation in high-intensity drinking is particularly high during early young adulthood, especially for males, whites, and those attending college. However, the extent to which these covariates may be associated with distinct within-person patterns of high-intensity drinking over time is unknown.

Use of growth mixture modeling has identified several specific sub-trajectories of alcohol use spanning adolescence and young adulthood.

The majority of such work has focused on developmental patterns of heavy episodic drinking. Results from such studies typically identify a relatively large consistently light or moderate user group, a smaller group of chronic heavy users, and then groups that evidence various patterns of either increasing or decreasing use over time (Chassin, Pitts, & Prost, 2002; Jackson, Sher, & Schulenberg, 2008; Maggs & Schulenberg, 2004; Nelson, Van Ryzin, & Dishion, 2015; Schulenberg, Wadsworth, O'Malley, Bachman, & Johnston, 1996). Gender, race/ethnicity, and college attendance have been associated with higher-risk drinking trajectories across studies. Being white and being male each increased the odds of being in a high-use or steep-escalation trajectory group (for a review see Maggs & Schulenberg, 2004; e.g., Nelson et al., 2015). In (2015), not attending college within two years of finishing high school was associated with early onset trajectories of alcohol use. These studies reveal heterogeneity in young adult drinking that is obscured by aggregate results. The importance of identifying such patterns lies in the resulting theoretical and intervention implications that emerge. Such potential benefits include estimating the probability of membership in subgroups that are at especially high risk for negative consequences and identifying risk factors that may differentiate between membership in subgroups characterized by use escalation or decline (Ellickson, Martino, & Collins, 2004). Research on heterogeneity in drinking patterns across young adulthood that include a high-intensity drinking cut-off, and the risk factors associated with membership in specific subgroups, has not been available to this point.

The current study aims to contribute to knowledge about high-risk drinking in young adulthood by identifying latent classes of early young adult alcohol use that include high-intensity drinking. Specifically, we empirically identify the number and prevalence of distinct patterns of stability and change over time within individuals using a trichotomous indicator of alcohol use (i.e., consuming no alcohol in the past 30 days, drinking but not engaging in 10+ drinking, or 10+ drinking) at each age from 18 through 25/26 using repeated measures latent class analysis (RMLCA; Lanza & Collins, 2006). Further, we explore associations between key time-invariant covariates measured at age 18 and class membership. Two research questions guided analyses: (1) How many unique latent classes of within-person alcohol use and high-intensity drinking from ages 18 to 25/26 can be empirically identified, and what percentage of the population is estimated to be in each class? (2) To what extent do gender, race/ethnicity, socioeconomic status, and college plans differentiate class membership?

2. Method

2.1. Data, setting, and study population

The study utilizes data from Monitoring the Future (MTF), a national cohort-sequential study. Detailed methodology is provided elsewhere (Bachman, Johnston, O'Malley, Schulenberg, & Miech, 2015; Johnston et al., 2016; Miech et al., 2016). Briefly, a nationally representative sample of approximately 15,000 12th graders (at modal age 18) from about 130 schools has been surveyed annually since 1975, yielding sequential cohorts. Students complete self-administered surveys, typically during a normal class period. A representative random subsample of about 2400 seniors is selected from each annual sample for longitudinal follow-up; substance users are oversampled (analyses include weights accounting for sampling procedures). Respondents are randomly divided with half of each cohort surveyed one year after graduation (modal age 19) and half surveyed two years after graduation (modal age 20). Participants are then surveyed every two years. Data from ages 18, 19/20, 21/22, 23/24, and 25/26 are included in the current analyses. Follow-up questionnaires are mailed in the spring with a modest monetary incentive. The University of Michigan Institutional Review Board approved the study.

The current analyses use an item on high-intensity drinking that was

asked from 2005 onwards on one of six randomly distributed questionnaire forms used in the MTF data collection. The current sample was limited to 12th-grade cohorts from 2005 to 2008, thereby ensuring that all respondents had the opportunity to respond to the relevant measures at modal ages 19/20, 21/22, 23/24, and 25/26 (data for the age 25/26 survey were collected during 2012–2016; see Supplemental Table 1). By design, a total of 1600 individuals from the 2005–2008 cohorts responded to the relevant questionnaire form at age 18 and were selected for longitudinal participation as described above. Of these, 1078 individuals (67.4% of the eligible sample) provided valid responses to the alcohol use measures utilized in the current study during at least two of the five data collection time points relevant to these analyses, and were included in the analytic sample. Attrition adjustments are discussed below.

2.2. Measures

2.2.1. Alcohol use

At each modal age, respondents were asked, “On how many occasions (if any) have you had any alcohol beverage to drink—more than just a few sips—during the last 30 days?” Respondents were also asked, “During the last two weeks, how many times have you had 10 or more drinks in a row?” Responses to these measures were combined to create the following three-category measure at each modal age: 1) no past 30-day alcohol use, 2) past 30-day alcohol use without 10+ drinking, any 3) 10+ drinking in the past two weeks.

2.2.2. Covariates

Covariates were limited to time-invariant measures reported at age 18. Gender was coded as male or female. Self-identified race/ethnicity was coded as White, Black, Hispanic, or Other. Preliminary analyses indicated that non-White respondents reported very low prevalence of 10+ drinking; thus, analyses used a dichotomy of White versus non-White. Parental education (used as a proxy for family-of-origin socioeconomic status) indicated whether respondents reported that at least one parent had graduated from college. College plans indicated if respondents definitely planned to graduate from a four-year college in the future (vs. other).

2.3. Analysis

To address the first research question (RQ1), RMLCA (Lanza & Collins, 2006) was used to identify unique patterns of alcohol use across ages 18 to 25/26. No functional form over time (such as quadratic growth) is assumed in RMLCA, allowing discontinuous patterns of use over time to be modeled (Lanza & Collins, 2006). For example, RMLCA has been used to model longitudinal change in past 12-month alcohol use among adolescents (Feldman, Masyn, & Conger, 2009), 6+ drinks per month among adults (Lanza & Collins, 2006), and daily smoking status among adults (McCarthy, Ebssa, Witkiewitz, & Shiffman, 2015). The methodology is highly appropriate for efforts to characterize longitudinal patterns of young adult high-intensity drinking. Analyses were conducted in Mplus v7.3

(Muthén & Muthén, 1998–2015) using full information maximum likelihood estimation with robust standard errors. Identification of maximum likelihood solutions was confirmed for all models using 500 initial stage random starts and 250 final stage optimizations.

To address RQ2, all covariates were added simultaneously to baseline-category, multinomial logistic regression models to examine whether covariates differentiated among the classes. These models were based on modal assignment of individuals to latent classes using posterior probabilities, and were corrected for classification error using an approach proposed by Vermunt (2010). This approach has been shown to be superior to traditional modal assignment without the correction (Vermunt, 2010); it is the approach currently recommended in Mplus for covariates and is implemented using the R3STEP command, wherein covariates are not allowed to affect latent class formation (Asparouhov & Muthén, 2014).

For all analyses (those addressing both RQ1 and RQ2), missing data on alcohol use indicators were assumed to be missing at random and were handled using Mplus' full information maximum likelihood estimation procedure (Muthén & Muthén, 1998–2015). Missing data on covariates were handled via mean imputation (continuous variables) or missing data indicators (categorical variables).

Follow-up participation in the MTF study has been shown to be differential with respect to the following 12th grade drug use and demographic characteristics: gender, race/ethnicity, college plans, high school grades, number of parents in the home, religiosity, parental education, alcohol use, cigarette use, marijuana use, region of the country, 12th grade cohort, and oversampling of age 18 substance users into the longitudinal follow-up. Thus, attrition weights (inverse probability weights) were calculated that adjusted for the probability of responding at age 25/26 based on the listed characteristics (Terry-McElrath & O'Malley, 2015). All analyses used the resulting attrition weights.

3. Results

3.1. Identifying latent classes of alcohol use across ages 18 to 25/26 (RQ1)

Using the five trichotomous alcohol use indicators across ages 18 to 25/26, RMLCAs with one to five classes were considered. The optimal number of classes was determined by examining model fit, interpretability, parsimony, and stability/identification. When interpreting models, item response probability values of 0.50 or higher were considered to indicate a “high” probability of endorsing the specified use level. Model fit and selection criteria are reported in Table 1. Due to the use of trichotomous indicators, it was not possible to use the bootstrap likelihood ratio test as a criterion for selecting the optimal number of latent classes. Instead, the analyses relied on a variety of fit criteria, of which the BIC and sample size-adjusted BIC (a-BIC) have been shown in simulations to perform particularly well at selecting the “correct” latent class model (Dziak, Lanza, & Tan, 2014). Values for the BIC were virtually identical for the 3- and 4-class model; all other fit criteria and interpretability indicated that the 4-class model was optimal.

Class membership and item response probability parameter

Table 1

Fit Information for RMLCAs Modeling Past Two-Week Alcohol Use from Ages 18 through 25/26 with 1–5 Latent Classes.

Classes	df	AIC	BIC	a-BIC	VLMR	a-LMR	Entropy	Loglikelihood	Stability
1	231	7167.4	7217.2	7185.5				– 3573.7	1.000
2	219	6581.2	6685.9	6619.2	0.000	0.000	0.653	– 3269.6	1.000
3	209	6426.6	6586.1	6484.4	0.006	0.006	0.637	– 3181.3	1.000
4	198	6371.9	6586.2	6449.6	0.038	0.040	0.640	– 3142.9	0.944
5	188	6377.7	6646.8	6475.3	0.805	0.806	0.648	– 3134.9	0.252

Note. Unweighted n = 1078. RMLCA = repeated measures latent class analysis; AIC = Akaike information criterion; BIC = Bayesian information criterion; a-BIC = adjusted BIC; VLMR = Vuong-Lo-Mendell-Rubin likelihood ratio test; a-LMR = Lo-Mendell-Rubin adjusted likelihood ratio test; Stability = proportion of time the maximum-likelihood solution was selected out of 250 final stage optimizations (preceded by 500 initial stage sets of random starting values). Bold font indicates selected model.

Table 2

Parameter Estimates for Four-Class Model of Past Two-Week Alcohol Use from Ages 18 through 25/26.

Modal age	Overall proportion	Non-Drinkers	Legal Non-HI Drinkers	Persistent Non-HI Drinkers	HI Drinkers
Latent class membership probabilities					
		0.21	0.23	0.40	0.16
Item response probabilities					
No past 30-day alcohol use					
18	0.51	0.81	0.85	0.28	0.19
19/20	0.44	0.77	0.89	0.15	0.07
21/22	0.28	0.80	0.42	0.01	0.03
23/24	0.25	1.00	0.07	0.08	0.03
25/26	0.22	0.69	0.11	0.15	0.03
Past 30-day alcohol use without 10+ drinking					
18	0.39	0.14	0.10	0.66	0.45
19/20	0.45	0.23	0.10	0.78	0.43
21/22	0.58	0.20	0.58	0.89	0.32
23/24	0.63	0.00	0.90	0.88	0.40
25/26	0.66	0.27	0.87	0.82	0.38
Any 10+ drinking in past 2 weeks					
18	0.10	0.04	0.04	0.05	0.36
19/20	0.11	0.00	0.01	0.07	0.50
21/22	0.15	0.00	0.00	0.10	0.64
23/24	0.12	0.00	0.04	0.04	0.57
25/26	0.11	0.04	0.02	0.03	0.59

Notes: Unweighted n = 1078. HI = high-intensity. Bold font indicates item-response probabilities of ≥ 0.50 . Latent class membership probabilities sum to 1 horizontally. Item response probabilities (reflecting the probabilities of each level of use for the sample overall, as well as within latent classes), sum to 1 vertically *within age*. For example, at age 18, the overall probability of no alcohol use in the past 30 days was 0.51, the probability of having 1–9 drinks per occasion during the past two weeks was 0.39, and was 0.10 for having 10+ drinks.

estimates for the 4-class solution are reported in Table 2. The overall probability of reporting no past 30-day alcohol use decreased from 0.51 at age 18 to 0.22 at age 25/26. In contrast, the overall probability of past 30-day alcohol use without 10+ drinking rose over time from 0.39 at age 18 to 0.66 at age 25/26. The overall probability of 10+ drinking followed the expected trajectory of increasing from ages 18 to 21/22 (from 0.10 to 0.15), and then decreasing to 0.11 by age 25/26. The four identified latent classes are labeled and described as follows:

1. Non-Drinkers (prevalence = 0.21, indicating an estimated 21% of the sample were members of this latent class). Probabilities of no past 30-day alcohol use were high at all ages for this class.
2. Legal Non-High-Intensity Drinkers (23%). Membership in this class was characterized by high probabilities of no past 30-day alcohol use at ages below the legal drinking age of 21. Thereafter, high probabilities of past 30-day alcohol use without 10+ drinking were observed from ages 21/22 through 25/26, increasing from 0.58 at age 21/22 to approximately 0.90 at ages 23/24 and 25/26.
3. Persistent Non-High-Intensity Drinkers (40%). Membership in this class was characterized by high probabilities of past 30-day alcohol use without 10+ drinking at all ages from 18 through 25/26. Developmental progression was observed, as probabilities increased from 0.66 at age 18 to 0.89 at age 21/22, and then decreased somewhat to 0.82 at age 25/26.
4. High-Intensity Drinkers (16%). Members of this class reported high probabilities of 10+ drinking from ages 19/20 through 25/26. At age 18, the probability of 10+ drinking was 0.36. Although certainly lower than the probabilities of 10+ drinking observed at later ages for members of this class, at age 18 a probability of 0.36 for 10+ drinking was > 3 times higher than the overall age 18 probability of 0.10 for 10+ drinking. This indicated that even at age 18, members of the High-Intensity Drinkers class had notably higher probabilities of 10+ drinking than average.

Table 3

Covariate descriptive statistics.

	Range	%	SE
Gender			
Female	0,1	49.5	2.01
Male	0,1	50.5	2.01
Race/ethnicity			
Non-White	0,1	43.0	2.10
White	0,1	56.1	2.09
Missing	0,1	0.9	0.30
Parental education			
Some college or less	0,1	26.9	1.86
College degree	0,1	67.0	1.98
Missing	0,1	6.1	1.14
Definitely plan to graduate from 4-year college			
Yes	0,1	54.1	2.05
No	0,1	39.8	2.07
Missing	0,1	6.1	1.02

Note. Unweighted n = 1078. Missing data modeled using missing data indicators as shown.

3.2. Associations between age 18 covariates and class membership (RQ2)

Table 3 provides descriptive statistics for covariates. Table 4 reports unadjusted and adjusted relative risk ratios (ARRs) from bivariate and multivariable multinomial logistic regression models examining the relative risk of membership in each specified class versus the High-Intensity Drinkers class.

Males were significantly less likely than females to be members of the Non-Drinkers class compared to the High-Intensity Drinkers class. Males also were significantly less likely than females to be in the Legal and Persistent Non-High-Intensity Drinkers classes compared to the High-Intensity Drinkers class. White respondents were significantly less likely than non-White respondents to be in either the Non-Drinkers or Legal Non-High-Intensity Drinkers classes compared to the High-Intensity Drinkers class. No significant racial/ethnic differences were observed in the relative risk of membership in the Persistent Non-High-Intensity vs. High-Intensity Drinkers classes. Parental education and college plans showed no significant associations with class membership.

4. Discussion

Among this national sample of young adults, four unique patterns of alcohol use between ages 18 and 25/26 were identified: non-use, use only at legal ages without high-intensity drinking, persistent use without high-intensity drinking, and high-intensity drinking. The relative risk for membership in the high-intensity drinking class was highest for male and White respondents, but did not vary based on age 18 socioeconomic status or plans to attend college.

Only one latent class was characterized by high-intensity drinking; none of the other three classes showed high probabilities of high-intensity drinking at any age. Importantly, these High-Intensity Drinkers exhibited chronic high risk across ages 18 to 26: a notably elevated proportion of them reported high-intensity drinking at age 18 and most of the rest were using some level of alcohol. These results indicate that individuals were unlikely to initiate high-intensity drinking if alcohol use initiation was delayed until after high school. This finding is supported by prior research (Patrick & Terry-McElrath, 2016) that also indicated there were very few people who were High-Intensity Drinkers at age 19/20 who did not report high-intensity drinking in high school (at age 18). Furthermore, high-intensity drinking tended to persist through young adulthood. That is, those with high-intensity drinking at the peak alcohol use years of ages 21 and 22 tended to continue with this type of alcohol use through their mid-twenties.

The chronic nature of the high-risk drinking that characterized the high-intensity drinking class raises concerns about health-related

Table 4
Associations of age 18 covariates on past two-week alcohol use classes: multinomial logistic regression.

	HI Drinkers		Non-Drinkers				Legal Non-HI Drinkers					Persistent Non-HI Drinkers				
	[Base class]	RR	p	ARR	(95% CI)	p	RR	p	ARR	(95% CI)	p	RR	p	ARR	(95% CI)	p
Gender																
Female		(ref)		(ref)			(ref)		(ref)			(ref)		(ref)		
Male		0.19	< 0.001	0.20	(0.10, 0.40)	< 0.001	0.25	< 0.001	0.26	(0.12, 0.55)	< 0.001	0.16	< 0.001	0.17	(0.08, 0.36)	< 0.001
Race/ethnicity																
Non-White		(ref)		(ref)			(ref)		(ref)			(ref)		(ref)		
White		0.29	0.003	0.35	(0.15, 0.80)	0.013	0.18	< 0.001	0.19	(0.08, 0.44)	< 0.001	0.44	0.062	0.48	(0.19, 1.18)	0.111
Parental education																
No college		(ref)		(ref)			(ref)		(ref)			(ref)		(ref)		
Some college +		0.79	0.553	1.10	(0.43, 2.84)	0.841	0.70	0.391	0.78	(0.33, 1.85)	0.569	0.91	0.826	1.10	(0.47, 2.54)	0.833
Definitely plan to graduate from 4-year college																
No		(ref)		(ref)			(ref)		(ref)			(ref)		(ref)		
Yes		1.02	0.963	0.87	(0.44, 1.72)	0.684	1.54	0.237	1.59	(0.72, 3.49)	0.247	1.71	0.138	1.36	(0.65, 2.82)	0.415

Note. Unweighted n = 1078. HI = high-intensity. RR = bivariate relative risk ratio. ARR = adjusted relative risk ratio controlling simultaneously for gender, race/ethnicity, parental education, and college plans. HI Drinkers are the base (i.e., reference) category for reported multinomial logistic regression models. CI = confidence interval.

outcomes and helps pinpoint the need for intervention efforts across the transition to adulthood for this high-risk group. In the current study, 16% of the sample engaged in persistent, high-intensity (10+) alcohol use across a span of about 8 years (from ages 18 to 25/26). The acute consequences of the BAC levels associated with high-intensity drinking include the following (National Institute on Alcohol Abuse and Alcoholism, 2015): dangerously impaired driving-related skills, judgement, and decision making; blackouts; alcohol poisoning; loss of consciousness; and significant risk of death due to suppression of vital life functions. Also, long-term health consequences of high-risk drinking can be serious (National Institute on Alcohol Abuse and Alcoholism, 2016): interference with brain function; damage to the heart, liver and pancreas; increased risk of certain cancers; and weakened immune system. Excessive alcohol consumption was estimated to cost the United States \$249 billion in 2010, including lost workplace productivity, health care expenses, law enforcement and other criminal justice expenses, and costs related to motor vehicle crashes (Sacks, Gonzales, Bouchery, Tomedi, & Brewer, 2015). Chronic High-Intensity Drinkers no doubt contribute a great deal to those personal and societal costs.

The results from the current study indicate that males may be most likely to be members of the high-intensity drinking class, but the risk of membership in this class may not be based on an individual's socio-economic status or college plans. An individual's White racial/ethnic status may be a risk factor for persistent (non-high-intensity) drinking and high-intensity drinking, but race/ethnicity did not differentiate between these two higher-risk classes. Prevention and intervention efforts may be strengthened by focusing on individuals who report any history of underage alcohol use, and particularly high-intensity drinking, during high school or the years immediately following.

4.1. Limitations

These findings must be considered within their limitations. The sample was based on 12th grade students; as a result, high school dropouts were not included (Kanny, Liu, Brewer, Garvin, & Balluz, 2012; Kanny, Liu, Brewer, & Lu, 2013; Naimi et al., 2003). Further, high-intensity drinking was assessed as self-reported behavior within the past two weeks, which may not reflect alcohol patterns over longer time periods, and with the same measure for men and women, rather than gender-specific cut-offs that may help account for differences in body size and alcohol metabolism. These limitations notwithstanding,

the current analyses provide needed information to address gaps in the literature regarding patterns of alcohol use and high-intensity drinking in a national sample of young adults.

4.2. Conclusions

More than one in seven individuals who were seniors in high school experienced a long-term pattern of high-intensity drinking lasting through their mid-20s. Young adult high-intensity drinking is often preceded by high-intensity drinking in high school, suggesting the importance of screening and prevention for high-intensity drinking among underage drinkers. This study found that high-intensity drinking during the transition to adulthood is best characterized as a relatively persistent, rather than sporadic, high risk behavior.

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Contributors

Dr. Patrick conceptualized the study and took primary responsibility for the main text. Ms. Terry-McElrath conducted data analysis and contributed to the original manuscript draft and revisions. Dr. Schulenberg reviewed the drafted manuscript. Dr. Bray consulted on data analysis and contributed to interpretation of results. All authors contributed to and have approved the final manuscript.

Conflict of interest

The authors declare that they have no conflicts of interest.

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