

# Drinking Intensity at Age 29/30 as a Predictor of Alcohol Use Disorder Symptoms at Age 35 in a National Sample

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**ABSTRACT. Objective:** The purpose of this longitudinal study was to identify associations of drinking intensity at age 29/30 with symptoms of alcohol use disorder (AUD) at age 35. **Method:** Analyses used national longitudinal data from 1,253 individuals (53.5% female) participating in the Monitoring the Future study. Age 29/30 data were collected from 2005 to 2013; age 35 data were collected from 2010 to 2018. Multivariable models regressed age 35 past-5-year AUD symptoms (vs. nondisordered drinking/abstinence) on age 29/30 past-2-week drinking intensity (no/low [0–4] drinking, binge [5–9] drinking, high-intensity [10+] drinking), with key covariates being controlled for. **Results:** At age 35, 32.6% ( $SE = 1.50$ ) of respondents reported AUD symptoms. AUD symptoms at age 35 were reported by 77.5% ( $SE = 4.79$ ) of participants who reported age 29/30 high-intensity drinking and 60.6% ( $SE = 3.95$ ) of participants who reported age 29/30 binge drinking. Age 35 past-5-year abstinence

was reported by almost no respondents reporting age 29/30 binge drinking or high-intensity drinking. AUD symptoms at age 35 were significantly more likely for those who reported binge (adjusted multivariable odds ratio [AOR] = 5.61, 95% CI [3.79, 8.30],  $p < .001$ ) or high-intensity (AOR = 12.26, 95% CI [6.70, 22.41],  $p < .001$ ) drinking versus no/low drinking at age 29/30. The likelihood of having AUD symptoms was significantly higher for high-intensity than for binge drinkers (AOR = 2.18, 95% CI [1.14, 4.19],  $p = .019$ ). **Conclusions:** Nearly 80% of those young adults who reported engaging in high-intensity drinking (10+ drinks in a row) at age 29/30 later reported AUD symptoms at age 35. High-intensity drinking appears to be a strong prospective marker of risk for AUD symptoms among adults in the United States. (*J. Stud. Alcohol Drugs*, 82, 362–367, 2021)

ALCOHOL USE DISORDER (AUD) is linked to a range of adverse outcomes, including mortality, disability, accidents, and violence (Room et al., 2005; Samokhvalov et al., 2010; Stahre et al., 2014). Worldwide, more than 2.5 million deaths are attributable to AUD on an annual basis (World Health Organization, 2014). Approximately 5.8% of the U.S. adult population age 18 and older—roughly 14.4 million adults—met criteria for AUD in 2018 (Substance Abuse and Mental Health Services Administration [SAMHSA], 2019). Annually in the United States, excessive alcohol use and AUD are responsible for 90,000 premature deaths and cost more than \$225 billion (Bouchery et al., 2011; Centers for Disease Control and Prevention, 2019). Reducing AUD risk and prevalence is a central public health priority.

The number of drinks consumed at a single occasion is a key measure of alcohol risk and has been associated with

AUD (e.g., Linden-Carmichael et al., 2017). Heavy episodic or “binge” drinking—defined as 5+ drinks using a universal threshold or 4+ drinks for women/5+ drinks for men—is associated with AUD among adolescents and young adults in cross-sectional studies and controlled experiments (Adolorato et al., 2018; Gowin et al., 2017; Grant et al., 2003). Yet, the average number of drinks consumed during a binge is significantly higher than the 4+/5+ threshold (Naimi et al., 2010). Reliance on the binge indicator alone may obscure higher-risk populations (Patrick, 2016). High-intensity drinking (HID) is defined as 10+ drinks using a universal threshold or sex-specific cutoffs of 8+ for women/10+ for men (Hingson et al., 2017; Linden-Carmichael et al., 2017; Patrick, 2016). Cross-sectionally, individuals who engage in HID report binge drinking more frequently than non-HID binge drinkers (Patrick et al., 2016), and they are at higher risk for alcohol-related problems, including AUD, compared with individuals who engage in binge but not high intensity drinking (Linden-Carmichael et al., 2017). Both binge drinking and HID are cross-sectionally associated with AUD across adulthood; however, HID is a stronger correlate of AUD than binge drinking (Linden-Carmichael et al., 2017). Prospective risk from HID to later AUD symptoms has not been previously examined.

Key gaps in longitudinal research focused on AUD remain, including long-term associations between alcohol use and AUD among national samples in the United States (King et al., 2014; McCambridge et al., 2011; Seeley et al.,

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2019; Zucker et al., 2006). In general, there is a dearth of research on AUD from young adulthood to later adulthood (35+; King et al., 2014; Newton-Howes et al., 2019). AUD typically emerges in adolescence, peaks in the mid or late 20s, and thereafter declines as alcohol misuse becomes less socially acceptable and prevalent, potentially resulting from social role changes (Evans-Polce et al., 2020a, 2020b; King et al., 2014; Newton-Howes et al., 2019; Pardini et al., 2007; SAMHSA, 2019). Yet AUD can persist into adulthood (i.e., age 30), resulting in increased risk for more severe consequences from alcohol misuse (Grant et al., 2006; Jennison, 2004; Linden-Carmichael et al., 2017).

Available longitudinal research on AUD has primarily focused on binge drinking among adolescents or young adults (King et al., 2014; Newton-Howes et al., 2019). Binge drinking in early adolescence is associated with AUD in young adulthood (Foster et al., 2015; Grant et al., 2006; Mc-Cambridge et al., 2011; Riala et al., 2004), and after age 30 (Newton-Howes, 2019; Schulenberg et al., 2003; Seeley et al., 2019; Zucker et al., 2006). To our knowledge, prospective research on associations between HID and AUD is not available. In particular, it is not known if HID is a particular marker for AUD risk above and beyond binge drinking. More detailed information on markers for future AUD risk spanning from early to later adulthood is key to identifying patterns and prevention targets to reduce later AUD onset as well as persistent and increased risk in later adulthood (King et al., 2014; Zucker et al., 2006).

### *Current study*

The current study examined prospective associations between drinking intensity and AUD symptoms using longitudinal data from a national sample aged 29/30 to 35. Specifically, analyses modeled associations between past-2-week drinking intensity level (<5 drinks per occasion, 5–9 drinks, or 10+ drinks) at age 29/30 and abstinence, nondisordered drinking, or AUD symptoms at age 35.

## **Method**

### *Sample*

Data were obtained from the Monitoring the Future study (Schulenberg et al., 2018). Monitoring the Future comprises annual, nationally representative samples of approximately 15,000 U.S. 12th grade students (modal age 18) in roughly 130 schools. Each year, a sample of 2,400 12th graders is selected for longitudinal follow-up (drug users are oversampled; analytic weights account for such oversampling). Data collection involves mailed questionnaires; a random half of the follow-up sample begins follow-up 1 year after 12th grade (modal age 19) and is surveyed biennially through modal age 29; the other half begins follow-up 2 years af-

ter 12th grade (modal age 20) and is surveyed biennially through modal age 30. Additional follow-up surveys are collected every 5 years beginning at modal age 35 (hereafter, modal age is referred to simply as “age”). A University of Michigan Behavioral Sciences Institutional Review Board approved the study.

HID measures were first introduced in 2005 on one of the six randomly distributed Monitoring the Future questionnaire forms used at ages 18 to 29/30. Age 29/30 data collection occurred from 2005 to 2013 (involving 12th grade cohorts from 1993 to 2001); age 35 data from these individuals were collected from 2010 to 2018. A total of 3,359 individuals who responded to the relevant questionnaire form were selected for follow-up; 1,314 (39.1%) responded to the age 35 survey. Sixty-one respondents (4.6% of 1,314) had missing data on AUD symptoms at age 35, leaving 1,253 cases for analysis (95.4% of 1,314). Weights were used to adjust for attrition (see *Analysis*).

### *Measures*

*Age 35 AUD symptoms.* Respondents were asked if they had used any alcohol in the past 5 years. If yes, they were asked, “Think back over the last 5 years. Did your use of alcohol cause you any of the following problems?” Items addressing all 11 of the criteria for substance use disorder according to the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (DSM-5; American Psychiatric Association, 2013), were listed (response options: “no,” “a little,” “some,” “a lot”) (see Supplemental Table 1). (Supplemental material appears as an online-only addendum to this article on the journal’s website.) Respondents were coded as exhibiting each criterion if they responded other than “no” to any item; the 11 dichotomous indicators were then summed to calculate the total number of criteria endorsed. Following recommended practice (American Psychiatric Association, 2013; Goldstein et al., 2015; Grant et al., 2015), AUD symptoms were indicated by meeting two or more criteria. Respondents were coded as past-5-year abstainers, nondisordered drinkers (endorsed 0 or 1 criteria), or having AUD symptoms (endorsed 2+ criteria) (Bray et al., 2019; Jang et al., 2018, 2019; Patrick et al., 2011; Schulenberg et al., 2016). Although the resulting measure does not reflect a clinical AUD diagnosis, the approach is fairly consistent with that used in other large surveys (Evans-Polce et al., 2020a, 2020b; Harford & Muthén, 2001; Muthén, 1996; Nelson et al., 1998) and has been used with Monitoring the Future data in prior studies examining symptoms of substance use disorder (Patrick et al., 2011, 2016; Schulenberg et al., 2016). AUD symptoms were further differentiated into mild (2–3 criteria), moderate (4–5 criteria), and severe (6+ criteria) categories.

*Age 29/30 drinking intensity.* Respondents were asked to report the number of occasions during the last 2 weeks in

which they had (a) 5 or more, and (b) 10 or more drinks in a row. Responses were combined to make a mutually exclusive three-category variable reflecting the maximum number of drinks consumed in a row in the past 2 weeks: no/low drinking (0–4 drinks), binge but not HID (5–9 drinks; hereafter referred to simply as binge drinking), and HID (10+ drinks).

*Covariates.* At age 18 (12th grade survey), respondents reported sex (male/female), race (White/non-White), and if at least one parent had obtained a college degree (yes/no, as a measure of socioeconomic status; Patrick et al., 2012). At age 29/30, respondents reported if they had graduated from a 4-year college program (yes/no), were married (yes/no), had any children (yes/no), and were employed during the first full week of March (yes [having two or more jobs/one full-time job/one part-time job] vs. no [full-time homemaker/laid off or waiting to start a job/no paid employment at all]). Age 35 data collection year was coded using dichotomous indicators comprising 3-year groupings to account for possible nonlinear time associations: 2010–2012, 2013–2015, and 2016–2018.

### Analysis

Analyses used survey procedures in SAS v.9.4 (SAS Institute Inc., Cary NC) for descriptive analyses. Logistic regression and ordinal logistic regression models were fit using Mplus v.7.4 specifying MLR and Monte Carlo integration; missing data on covariates were addressed using full information maximum likelihood. All analyses were weighted using attrition weights, calculated as the inverse of the probability of responding at age 35 based on covariates measured at age 18 (sex, race/ethnicity, college plans, high school grades, number of parents in the home, religiosity, parental education, alcohol use, cigarette use, marijuana use, region of country, cohort, and sampling weight correcting for oversampling of age 18 substance users).

## Results

### Sample description

The sample was 46.5% ( $SE = 1.63$ ) male and 70.0% (1.71) White; at age 18, 51.7% (1.61) reported having at least one parent with a college degree. At age 29/30, 56.5% (1.75) reported being a college graduate, 53.3% (1.71) were married, 46.8% (1.72) had children, and 87.3% (1.15) were employed. Past-2-week drinking intensity at age 29/30 was 75.8% (1.44) no/low drinking, 16.0% (1.21) binge drinking, and 8.2% (0.95) HID. Regarding past-5-year alcohol use at age 35, 9.9% of respondents were classified as abstainers, 57.5% as nondisordered drinkers, and 32.6% as having AUD symptoms. Almost none of those reporting binge or HID at age 29/30 were categorized as past-5-year abstainers at age 35. Therefore, to estimate associations between age

29/30 drinking intensity and past-5-year AUD symptoms at age 35, the categories of abstainer and nondisordered were combined, resulting in 67.4% (1.50) abstainer/nondisordered drinkers and 32.6% (1.50) with AUD symptoms for further analyses.

### Associations between drinking intensity and AUD symptoms

Table 1 reports bivariate and multivariable associations between age 29/30 drinking intensity and past-5-year AUD symptoms at age 35. In bivariate models using no/low drinking as the referent category, the odds of AUD symptoms were five times higher (bivariate odds ratio [OR] = 5.76) for those reporting binge drinking and more than double that (OR = 13.11) for those reporting HID. Only 21.1% ( $SE = 1.57$ ) of those who reported no/low drinking met criteria for AUD symptoms compared with 60.6% (3.95) of those reporting binge drinking and 77.5% (4.79) of those reporting HID. An additional bivariate model (not shown) indicated that the likelihood of AUD symptoms was more than twice as high for those reporting HID versus binge drinking (OR = 2.26, 95% CI [1.19, 4.30],  $p = .012$ ).

As shown in Table 1, the strength of these associations was attenuated only slightly after covariates were controlled for. In the multivariable model, the adjusted odds of past-5-year AUD symptoms at age 35 remained five times higher (adjusted multivariable OR [AOR] = 5.61) for those reporting age 29/30 binge drinking versus no/low drinking, and more than twice that (AOR = 12.26) for those reporting HID. In an additional multivariable model (not shown), the likelihood of AUD symptoms at age 35 remained more than twice as likely for those reporting HID versus binge drinking (AOR = 2.18, 95% CI [1.14, 4.19],  $p = .019$ ).

### AUD symptom severity

In additional analyses (not tabled), AUD symptoms were modeled as a five-level ordinal outcome (0 = abstainer, 1 = nondisordered, 2 = mild [2–3 criteria], 3 = moderate [4–5 criteria], or 4 = severe [6+ criteria]). In multivariable models using moderate drinking as the referent, higher AUD severity was associated with binge drinking (5–9 drinks; AOR = 5.82, 95% CI [4.13, 8.20],  $p < .001$ ) and high-intensity drinking (10+ drinks; AOR = 12.49, 95% CI [7.73, 20.19],  $p < .001$ ). In an additional model using binge drinking as the referent, high-intensity drinking was associated with significantly higher AUD symptom severity (AOR = 2.14, 95% CI [1.32, 3.49],  $p = .002$ ).

## Discussion

In this national longitudinal study, involvement in binge drinking or HID at age 29/30 was associated with a greater

TABLE 1. Associations between age 29/30 drinking intensity and past-5-year alcohol use disorder symptoms at age 35

Variable	Bivariate associations			Multivariable associations		
	OR	[95% CI]	<i>p</i>	AOR	[95% CI]	<i>p</i>
Age 29/30 alcohol use						
No/low (0–4) drinking	(ref.)			(ref.)		
Binge (5–9) drinking	5.76	[3.96, 8.38]	<.001	5.61	[3.79, 8.30]	<.001
High-intensity (10+) drinking	13.11	[7.35, 23.36]	<.001	12.26	[6.70, 22.41]	<.001
Age 18 covariates						
Male (vs. female)	1.39	[1.06, 1.82]	.016	0.98	[0.72, 1.35]	.920
White (vs. non-White)	2.01	[1.95, 2.08]	<.001	0.93	[0.63, 1.36]	.709
Parents college degree (vs. no college degree)	1.56	[1.19, 2.04]	.001	1.41	[1.03, 1.91]	.029
Age 29/30 covariates						
College graduate (vs. non)	1.37	[1.02, 1.85]	.039	1.26	[0.90, 1.76]	.185
Married (vs. not)	0.62	[0.47, 0.83]	.001	0.81	[0.57, 1.17]	.265
Any children (vs. none)	0.67	[0.50, 0.89]	.007	1.01	[0.71, 1.43]	.970
Employed <sup>a</sup>	1.53	[0.97, 2.41]	.067	1.26	[0.78, 2.04]	.338
Year of age 35 data collection						
2010–2012	(ref.)			(ref.)		
2013–2015	1.21	[0.87, 1.68]	.252	1.13	[0.79, 1.63]	.501
2016–2018	1.49	[1.07, 2.09]	.020	1.24	[0.85, 1.81]	.272

Notes: Unweighted  $n = 1,253$ . OR = bivariate odds ratio; AOR = adjusted multivariable odds ratio; CI = confidence interval; ref. = reference.

<sup>a</sup>Employed defined as having two or more jobs, one full-time job, or one part-time job versus full-time homemaker, laid off or waiting to start a job, or no paid employment at all during the first full week of March.

likelihood of AUD symptoms at age 35. Although binge drinking (5–9 drinks) was associated with higher risk of AUD symptoms than no/low drinking (0–4 drinks), those who reported HID (10+ drinks) at age 29/30 had significantly higher odds of AUD symptoms at age 35 than either those reporting binge or no/low drinking. HID at the end of young adulthood is a strong risk factor for subsequent symptoms of AUD.

The current study found that approximately one third of age 35 respondents reported AUD symptoms in the past 5 years. These estimates are in line with those obtained from other studies investigating nationally representative samples of U.S. adult alcohol users. Data from the 2012–2013 National Epidemiologic Survey on Alcohol and Related Conditions–III found that among those ages 30–44, 34.4% reported any lifetime AUD (Grant et al., 2015). Only among those ages 18–29 was lifetime AUD prevalence higher, at 37.0% (Grant et al., 2015).

It was remarkable that almost no respondents who reported binge drinking or HID at age 29/30 went on to report past-5-year abstinence from alcohol use at age 35. This finding speaks to the stability of continued alcohol use among those who engage in binge drinking and HID. Prior research found that individuals were unlikely to start HID after high school (Terry-McElrath & Patrick, 2016), and those who reported HID in 12th grade continued to have high probabilities of participating in HID in 2-year follow-ups throughout their mid-20s (Patrick et al., 2017). Findings from the current study indicate that both binge drinking and HID are markers for sustained risky alcohol use that extends across periods of years. Among adolescents who drink at high-intensity levels, alcohol appears to serve a larger number of functions (i.e., use for more reasons and

in more contexts) than for adolescents who report binge drinking or no/low drinking (Terry-McElrath et al., 2017). Such increased reliance on drinking to address daily events and situations may help to perpetuate HID across age and highlights the need for treatment evaluation and support to help reduce drinking intensity among those who engage in HID. Further longitudinal research is needed to examine the extent to which HID persists into mid- and late adulthood, and the extent to which the additional risks associated with HID continue to be observed.

The current study's results indicated that almost 80% of those who reported HID at age 29/30 also reported past-5-year AUD symptoms at age 35. Although binge drinking was associated with increased risk, HID was a clearer marker for later AUD symptoms. Given the high morbidity and mortality associated with excessive alcohol use and AUD (Bouchery et al., 2011; Centers for Disease Control and Prevention, 2019), identification of specific factors that can help health professionals quickly and effectively assess risk for symptoms of AUD is a priority. The results of the current study indicate that HID may function as one such particular risk factor. Health professionals should consider screening for this extreme drinking behavior. Quick assessments asking individuals about the maximum number of drinks they have consumed within the past 2 weeks may provide a concise and simple way for health care providers to identify individuals who may benefit from more detailed screening tools and/or treatment referrals.

#### Limitations

The current study's results are subject to limitations. The sample was based on 12th grade students; dropout before

12th grade is associated with increased alcohol use (Tice et al., 2017). Although some bias in study results may have resulted from attrition, use of attrition weights resulted in recapturing baseline sample characteristics on key measures. Monitoring the Future items on binge drinking and HID reflect recent (past-2-week) drinking intensity only and were included in the survey from 2005 onward just for those ages 18–30 (and thus not asked at age 35). Further, symptoms of AUD are first asked at age 35. These factors result in an inability to examine associations between HID and AUD before 2005 or before age 35. These limitations notwithstanding, the current analysis provides data from a national sample of adults to examine associations between drinking intensity—including HID—and later AUD symptoms during mid-adulthood.

### Conclusion

This study is one of the first to use HID (compared with binge drinking) as a prospective predictor of AUD symptoms. The majority of prior research focused on the first few years after high school (e.g., among college students); this study clarifies that HID continues throughout the late 20s and is indicative of subsequent problematic drinking. In fact, almost 80% of those reporting HID at age 29/30 later reported AUD symptoms at age 35. High-intensity (10+ drinks) drinkers had significantly greater risk than either binge (5–9 drinks) drinkers or no/low (0–4 drinks) drinkers for AUD symptoms at age 35. Future research that examines additional and longer-term mental and physical health consequences would further enhance our understanding of the impact of HID.

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