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Age of First Use, Age of Habitual Use, and Problematic Alcohol Use: a Cross-cultural Examination Among Young Adults in Seven Countries¹

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Abstract

Earlier age of alcohol use initiation has been consistently associated with later problematic alcohol use. However, it is unclear what aspect of early initiation is key for risk assessment and whether there are cultural differences. The present study examined relationships between Age of First Use (AFU) and Age of Habitual Use (AHU) on alcohol use behaviors across seven countries (USA, England, Argentina, Uruguay, Spain, Canada, South Africa). Participants were 5336 college students reporting past month alcohol consumption. Participants provided information, via online survey, on AFU, AHU, and current drinking behaviors. Results demonstrated significant direct associations between age variables and all outcomes, except for AHU to drinking frequency.

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Furthermore, AFU demonstrated stronger associations with drinking frequency, while AHU was more strongly associated with AUDIT scores and negative consequences. A moderation effect of country was discovered among several regression paths. These findings suggest AHU should receive greater focus in alcohol research.

Keywords Age of first use · Age of habitual use · Alcohol · Cross-cultural · Young adults

Introduction

Early onset of alcohol consumption has been associated with long-term problematic alcohol use, including development of an alcohol use disorder (AUD; Centers for Disease Control & Prevention, 2021). This finding has driven public policy, such as enforcing restrictions on the purchase or consumption of alcohol, with the aim of delaying initiation of drinking. Despite these efforts, many individuals take their first sip of alcohol well before the legal age of consumption in their country, with 39.7% of American individuals having their first drink between the ages of 12 and 20 (Substance Abuse & Mental Health Services Administration, 2021). In another epidemiological study, 21.7% of 8th graders (12–14 years old), 34.7% of 10th graders (15–16 years old), and 54.1% of 12th graders (17–18 years old) reported ever having tried alcohol (Johnston et al., 2022); however, recent research brings into question using Age of First Use as a standard for predicting problematic alcohol use or AUD later in life (Morean et al., 2012; Maimaris & McCambridge, 2014; Sartor et al., 2016; Vera et al., 2020). Further complicating matters is the cultural context, as early initiation to drinking is defined differently across different cultures. The purpose of the present research is to address this question of early risk factors for problematic alcohol use by analyzing, across samples of college student drinkers from seven countries, the role of a potential alternative for predicting alcohol-related problems: *Age of Habitual Use* of alcohol.

Age of First Alcohol Use and Problematic Alcohol Use

There is a cultural notion backed by an abundance of literature establishing some relationship between age of first use of alcohol, or when an individual has had their first sip of alcohol, and alcohol use later in life (Buchmann et al., 2009; DeWit et al., 2000; Pautassi et al., 2020). It is therefore no surprise that asking individuals to report their age of first use of alcohol has become standard in medical and research contexts (Levy & Kokotailo, 2011). The measure, however, comes with several caveats that have problematized its use as a primary age-based risk factor of future problematic use (Kuntsche et al., 2016). For example, Age of First Use might describe an isolated event in the drinking trajectory of an individual. That is, someone who may have had their first use of alcohol at a young age may refrain from using alcohol again for many years. Additionally, some literature has reported a weak association between Age of

First Use and subsequent problematic alcohol use (Labouvie et al., 1997; Maimaris & McCambridge, 2014), introducing concerns over the number of other factors that may influence these associations (Sarvet & Hasin, 2016). For example, some research has found minimal association between Age of First Use and future drinking outcomes once you control for other relevant constructs (e.g., conduct problems, Rossow & Kuntsche, 2013).

Age of Habitual Use and Problematic Alcohol Use

Habitual substance use is not formally defined across the substance use literature but has been examined and functionally contextualized in existing research (Hogarth, 2020; Newlin & Strubler, 2007). In the present research we will consider habitual use interchangeable with other terms (e.g., regular use) expressing reoccurring use to some degree (Puddey et al., 1987; Spoth et al., 2005; Voskoboinik et al., 2016). Though not as plentiful as research on age of first use, a relationship between early habitual use and various negative outcomes has been reported, including longitudinal associations with problematic substance use behaviors (Berchtold et al., 2011). Particularly in the context of problematic drinking, regular drinking has been theorized to contribute to an environment conducive to eventual AUD (Barker & Taylor, 2014; Davis et al., 2020). The research exploring the relationship between age of onset of habitual use and problematic substance use, let alone alcohol use, is however limited.

Cross-cultural Perspectives

There is a wide variety of legal cut-offs for drinking age and purchase age across countries. For example, legal access to alcohol purchasing begins at 18 years old in Argentina and Spain, making habitual use beginning at 17 years old seem less concerning than if such behavior is found in the USA, held to a 21 year old legal standard (See Supplemental Table 1 for a description of the various alcohol policies among all the countries assessed in the present study). Even greater is the variability, both within and between countries, for what can be considered a “socially accepted” drinking age. In the USA it is culturally accepted for individuals to engage in regular drinking at college (Merrill & Carey, 2016), but not that much during adolescence. On the other hand, in environments outside of North America, while there might not be the same emphasis on introduction to alcohol in a college-campus context, there may be more acceptance of early drinking in other contexts, such as family settings (Bravo et al., 2017; Kuntsche et al., 2006). Greater acceptance of early drinking in family settings could be related to the belief, held by some parents, that supplying small amounts of alcohol to their children in a controlled and supervised setting helps them achieve responsible drinking and reduces the risk of them exhibiting hazardous drinking patterns later in life (Gilligan & Kypri, 2012; Jackson et al., 2012). Additionally, the internal dynamics of cultural politics in different countries have proven to drive cross-cultural and cross-generational shifts between the

dichotomy of dry cultures, where attitudes and norms concerning drinking are more conservative, and wet cultures, where attitudes and norms concerning drinking are less conservative, which could reasonably contribute to variability in drinking outcomes (Room, 2010). These cultural variations provide an interesting context for understanding what it means to engage in “early” first use and “early” habitual use, and further complicates the question if these cultural differences impact the average ages at which people engage in first use or habitual use and if these cultural differences impact the relationship between Age of First Use or Age of Habitual Use on problematic alcohol use later in life.

Purpose of the Present Study

The present study examined the relationship between Age of First Use and Age of Habitual Use on alcohol use behaviors among college student drinkers from seven countries (USA, England, Argentina, Uruguay, Spain, Canada, and South Africa). We also examined possible differences in drinking behaviors, specifically use frequency/quantity and negative alcohol-related consequences across countries. Our first hypothesis was that alcohol related experiences (i.e., Age of First Use and Age of Habitual Use) and alcohol behaviors (including drinking frequency, binge drinking frequency, and drinking quantity) would differ significantly cross-culturally, particularly due to different alcohol related laws (i.e., lower age requirement would probably lead to lower Age of First and Habitual Use). The second hypothesis was that earlier Age of First Use and earlier Age of Habitual use would both be significantly associated with alcohol use and problems in young adulthood across all cultures.

More specifically, our expectation was greater predictive value of Age of Habitual Use over Age of First Use, given the findings of prior twin studies demonstrating more significant associations of AUD with Age of Habitual Use rather than Age of First Use (Davis et al., 2020). Furthermore, early exposure to alcohol is not a culturally specific phenomenon (Bonnie et al., 2004; Strunin et al., 2007; Sudhinaraset et al., 2016) and limited research exists comparing the relationship between Age of First Use or Age of Habitual Use on problematic drinking across different cultures. Therefore, we explored whether associations within our models were culturally universal or culturally specific (i.e., test of moderation).

Method

Participants and Procedures

Participants were college students ($n = 9171$) recruited from 12 universities across seven countries (USA, Canada, Spain, England, Argentina, Uruguay, and South Africa) to complete an online survey exploring risk and protective factors of substance use and addictive behaviors between February 2019 and March 2020. The analytic sample for this study was limited to students who completed questions about Age of First Use, Age of Habitual Use, and reported

consuming alcohol at least once in the past 30 days (total sample $n = 5336$, 72.5% female; USA $n = 2168$, 68.9% female; Canada $n = 972$, 69.4% female; South Africa $n = 353$, 82.1% female; Spain, $n = 566$, 72.4% female; Uruguay $n = 129$, 86.0% female; Argentina, $n = 780$, 75.8% female; England, $n = 368$, 81.3% female). Study procedures (see Bravo et al., 2021 for more information) were approved by the institutional review boards (or the international equivalent) for each participating university.

Measures

All appropriate measures exhibit at least metric invariance across the countries, a necessary requirement when examining associations between constructs across different groups (Ciecuch et al., 2019). For all constructs, items were averaged or summed such that higher scores indicate higher endorsement of that construct.

Introduction to Alcohol Use This construct was broken down into two main measures: self-reported Age of First Use and self-reported Age of Habitual Use. The former was assessed with the question “How old were you the first time you drank alcohol?”, whereas the latter was assessed with the question “At what age did you begin to consume alcohol as a habit?”. These questions were translated into Spanish for students in Argentina, Spain, and Uruguay.

Alcohol Use Single items were used to measure past 30-day alcohol use frequency and past 30-day binge drinking frequency (i.e., drinking 4 + /5 +standard drinks in a single drinking period, for women/men [in Spain it is 7 +for men, 5.5 +for women]). To measure typical quantity of alcohol use per week, participants were presented with a visual guide about typical drinks (specific to each country), to help them ascertain the concept of Standard Drink Units (SDUs). Using a grid such that each day of the week was broken down into six 4-h blocks of time (12a–4a, 4a–8a, 8a–12p, etc.), participants were asked to report at which times they consumed alcohol during a “typical week” in the past 30 days, as well as the number of drinks typically consumed during that time block. The measure was translated into Spanish for students in Argentina, Spain, and Uruguay. We calculated typical quantity of alcohol use by summing the total number of standard drinks consumed across time blocks during the typical week. To make accurate comparisons across countries, the total number SDUs consumed were transformed into grams of alcohol considering country specific SDU rates based on grams of alcohol (quantity estimates > 3SDs above the mean were Winsorized).

AUD Symptoms To assess AUD symptoms, we employed a modified version of the 10-item Alcohol Use Disorders Identification Test (i.e., Alcohol Use Disorder Identification Test– US [AUDIT-US]; Higgins-Biddle & Babor, 2018), originally created by Saunders et al. (1993). In this version, the response options for Items 1–3 are adjusted and the wording for Item 3 reflects the USA gender-specific definition of heavy episodic drinking (i.e., frequency of drinking 4 + /5 + standard drinks [14 g of alcohol] for women/men in a single drinking period).

This measure was translated into Spanish based off the original Spanish version of the AUDIT created by Rubio Valladolid et al. (1998). However, in Spain we used an open-ended response option (as opposed to Likert scale) and item 3 was adapted to reflect binge drinking definition in Spain (i.e., 7+ for men, 5.5+ for women in a single drinking period). A total score was calculated by summing the scores across all items (Total sample Cronbach's $\alpha = 0.77$, Cronbach's α by country ranged from $\alpha = 0.72$ to $\alpha = 0.81$).

Alcohol Use Consequences Negative alcohol-related problems were assessed using the Brief-Young Adult Alcohol Consequences Questionnaire (B-YAACQ; Kahler et al., 2005) or its Spanish version for students in Argentina, Spain, and Uruguay (Pilatti et al., 2014). The B-YAACQ is a 24-item questionnaire that measures alcohol-related negative experiences within the past 30 days. A composite score reflective of the total number of distinct alcohol problems experienced in the past 30 days was created by summing all endorsed experiences (total Cronbach's $\alpha = 0.86$, Cronbach's α by country range from $\alpha = 0.81$ to $\alpha = 0.88$).

Data Analysis Plan

We first conducted one-way ANOVAs, followed by post hoc Bonferroni tests, to examine country-level differences in prevalence rates of alcohol use patterns. To investigate independent associations between the variables, correlations were examined across the total sample and within each country. We then examined the direct associations between the age variables (i.e., Age of First Use and Age of Habitual Use) and each of the five alcohol outcomes (i.e., 30-Day Drinking Frequency, 30-Day Binge Drinking Frequency, Typical Quantity, AUDIT scores, and B-YAACQ scores) using separate multiple regression models (one for each outcome). Wald's test of parameter constraints was used to analyze which predictor was stronger, by determining if effect sizes were statistically significantly different (at $p < 0.05$) from each other. Parameters were estimated using maximum likelihood estimation, and missing data (< 1% in all models) were handled using full information maximum likelihood. Statistical significance was determined by 99% bias-corrected bootstrapped confidence intervals (based on 10,000 bootstrapped samples) that did not contain zero. To test for invariance of the models across gender and countries, we conducted sets of χ^2 difference tests ($p < 0.01$) comparing unconstrained models, in which regression effects were free to vary across country/gender groups, to a constrained model, in which corresponding regression effects were forced to be equivalent across countries/gender groups. All correlation, regression, and chi-square models were run in *Mplus* version 8.6 (Muthen & Muthen, 1998–2019), whereas ANOVAs were run in SPSS 27.0.

Results

Prevalence rates of distinct alcohol use patterns in the total sample and analysis

of variance results across countries are presented in Table 1. Within the total sample, on average, individuals had their first drink at around 15-years old ($M = 15.16$) and began drinking habitually at about 17-and-a-half years old ($M = 17.47$). The ANOVA revealed significant differences between countries on both age variables, Age of First Use, $F(6, 5329) = 58.34, p < 0.001$ and Age of Habitual Use, $F(6, 5329) = 70.31, p < 0.001$, as well as each of the outcome variables (see Table 1). Of note are the differences that appeared along lines of legal consumption age such that we saw significantly lower average Ages of First Use and Habitual use among countries with younger legal drinking ages (e.g., England, Argentina, Uruguay) compared to countries with older legal drinking ages (e.g., USA and Canada). Bivariate correlations between each of the study variables in the total sample are presented in Table 2. Both age variables (Age of First Use and Age of Habitual Use) were significantly negatively correlated with each of the outcome variables, such that older ages for First Use and Habitual Use were both generally associated with less alcohol use or alcohol related problems. Furthermore, the two Age variables were strongly positively correlated with each other ($r = 0.50$) although less in strength (i.e., $r < 0.80$; Young, 2017) than would indicate issues of multicollinearity (i.e., suggesting these are distinct constructs; Berry & Feldman, 1985). Bivariate correlations and descriptive statistics of all study variables in each country's sample are presented in Supplemental Tables 2-8.

Model Results: Associations with Alcohol Use Behaviors and Outcomes

Regression results from the total sample are summarized in Table 3. Within our multivariate regression model, we found statistically significant direct associations between the Age variables and all the outcome variables, apart for Age of Habitual Use predicting Drinking Frequency. Specifically, we found that earlier Age of First Use and earlier Habitual Use were weakly associated (while controlling for the other predictor) with higher scores on Drinking Frequency, Binge Drinking Frequency, Typical Drink Quantity, AUDIT scores, and BYAACQ scores in young adulthood.

Wald's test indicated that, for last 30-Day Drinking Frequency, Age of First Use was a significantly stronger predictor than Age of Habitual Use, Wald $\chi^2 = 24.04, p < 0.001$. On the other hand, Age of Habitual Use was a statistically significant stronger predictor for AUDIT scores (Wald $\chi^2 = 5.728, p = 0.02$) and a significant stronger predictor of BYAACQ scores (Wald $\chi^2 = 4.817, p = 0.03$). No significant differences between Age of First Use and Age of Habitual Use were found in predictive potential for the Binge Frequency (Wald $\chi^2 = 2.802, p = 0.09$) and Quantity (Wald $\chi^2 = 0.105, p = 0.75$) outcome variables.

Multi-group Models

In examining structural invariance across gender, chi-square analyses on our constrained multigroup models compared to the unconstrained model indicated model invariance across genders for the paths between both Age of First Use and

Age of Habitual Use and the five outcome variables and revealed no significant differences by gender (see Supplemental Table 9). In examining structural invariance across countries, our constrained multigroup models compared to the unconstrained model did not support model invariance across countries for three of the model paths (see Supplemental Table 10). Specifically, a moderation effect of country exists with respect to the regression paths in the Age of First Use \rightarrow AUDIT ($\chi^2(1, 5336) = 17.32, p < 0.01$), Age of Habitual Use \rightarrow AUDIT ($\chi^2(1, 5336) = 25.80, p < 0.001$) and Age of Habitual Use \rightarrow 30 Days Binge Drinking ($\chi^2(1, 5336) = 32.33, p < 0.001$) paths. To identify where the lack of invariance in model arose, we then freed each path comparing two specific country results at a time. See Table 4 for estimates by country and significant differences.

Table 1 General demographics and ANOVA results

Variable <i>Mean (SD)</i>	Total	USA	Canada	South Africa	Spain	Argentina	Uruguay	England	Significant differences
Total sample size	<i>n</i> = 5336	<i>n</i> = 2168	<i>n</i> = 972	<i>n</i> = 353	<i>n</i> = 566	<i>n</i> = 780	<i>n</i> = 129	<i>n</i> = 368	N/A
Age* <i>Canada > England</i> <i>South Africa > England</i> <i>Spain > USA, Canada, England</i> <i>Argentina > USA, Canada, South Africa, Spain, England</i> <i>Uruguay > USA, Canada, South Africa, Spain, Argentina, England</i>	20.45 (3.92)	19.77 (3.19)	19.97 (4.23)	20.49 (2.32)	21.01 (3.09)	22.22 (4.92)	26.36 (6.44)	18.86 (2.29)	USA > England
Age of First Use*	15.16 (2.07)	15.67 (2.11)	15.31 (2.06)	15.07 (2.13)	14.58 (1.64)	14.43 (1.65)	14.86 (2.26)	14.41 (2.23)	USA > Canada, South Africa, Spain, Argentina, Uruguay, England Canada > Spain, Argentina, England South Africa > Spain, Argentina, England
Age of Habitual Use*	17.47 (1.95)	17.94 (1.88)	17.68 (1.89)	17.41 (1.72)	16.64 (1.77)	16.64 (2.02)	17.46 (2.69)	17.18 (1.41)	USA > Canada, South Africa, Spain, Argentina, England Canada > Spain, Argentina, England South Africa > Spain, Argentina Uruguay > Spain, Argentina England > Spain, Argentina
30-Day Drinking Frequency* *	6.00 (5.00)	6.12 (5.10)	5.21 (4.81)	7.30 (5.20)	4.95 (4.11)	5.46 (4.56)	4.65 (4.48)	9.38 (5.28)	USA > Canada, Spain South Africa > USA, Canada, Spain, Argentina, Uruguay England > USA, Canada, South Africa, Spain, Argentina, Uruguay

Table 1

(continued) Variable	Total	USA	Canada	South Africa	Spain	Argentina	Uruguay	England	Significant differences
<i>Mean (SD)</i>									
30 Day Binge Drinking Frequency*	2.47 (3.37)	2.87 (3.54)		2.18 (3.16)	2.92 (3.62)		1.45 (2.31)	1.45 (2.41)	0.85 (1.46) 4.72
	(4.46)	USA > Canada, Spain, Argentina, Uruguay							
	Canada > Spain, Argentina, Uruguay								
	South Africa > Canada, Spain, Argentina, Uruguay								
	England > USA, Canada, South Africa, Spain, Argentina, Uruguay								
	USA > Canada, South Africa, Spain, Argentina, Uruguay								
	Canada > South Africa, Spain, Argentina, Uruguay								
Typical Quantity*	133.06 (118.81)	153.70 (131.19)	135.99 (118.54)	105.54 (91.72)	103.48 (94.91)	112.72 (110.41)	65.20 (64.94)	138.98 (106.22)	
	Spain > Uruguay								
	England > South Africa, Spain, Uruguay								
	USA > Canada, Spain, Argentina, Uruguay								
	Canada > Uruguay								
AUDIT*	9.93 (5.65)	10.22 (5.74)	9.47 (5.45)	10.15 (5.95)	9.84 (4.94)	8.68 (4.95)	6.95 (4.21)	13.63 (6.61)	
	South Africa > Canada, Spain, Argentina, Uruguay								
	Spain > Uruguay								
	England > USA, Canada, South Africa, Spain, Argentina, Uruguay								

Table 1

(continued) Variable	Total differences	USA	Canada	South Africa	Spain	Argentina	Uruguay	England	Significant
<i>Mean (SD)</i>									
BYAACQ*	5.12 (4.45)	5.43 (4.76)	4.53 (4.18)	6.40 (4.63)	4.37 (3.84)	4.45 (3.78)	3.06 (3.29)		
6.93 (4.48)	<i>USA > Canada, Spain, Argentina, Uruguay</i>								

Canada > Uruguay

South Africa > USA, Canada, Spain, Argentina, Uruguay

England > USA, Canada, Spain, Argentina, Uruguay

USA, United States of America. *ANOVA $p \leq .001$. Significant differences in alcohol use behavior and outcome prevalence rates across countries were determined by a Bonferroni corrected post hoc comparisons. Typical quantity of alcohol use was calculated by summing the total number of standard drinks (defined to the participant) consumed across time blocks during the typical week. To make accurate comparisons across countries, the total number SDUs consumed were transformed into grams of alcohol considering country specific SDU rates based on grams of alcohol (quantity estimates > 3SDs above the mean were Winsorized)

Table 2 Bivariate correlations among study variables in total sample ($n = 5336$)

	1	2	3	4	5	6	7	<i>M</i>	<i>SD</i>
1. Age of First Use	---							15.16	2.07
2. Age of Habitual Use	.49	---						17.47	1.95
3. Drinking Last 30 Days	-.13	-.07	---					6.00	5.00
4. Binge Drinking Last 30 Days	-.10	-.12	.58	---				2.47	3.37
5. Typical Quantity	-.11	-.12	.49	.61	---			131.55	119.07
6. BYAACQ	-.12	-.15	.31	.42	.42	---		5.12	4.44
7. AUDIT	-.16	-.19	.41	.57	.56	.66	---	9.95	5.68

Significant correlations are shown in bold for emphasis and were determined by a 99% bias-corrected stand- arized bootstrapped confidence interval (based on 10,000 bootstrapped samples) that does not contain 0

Table 3 Estimates for Age of First Use and Age of Habitual Use predicting alcohol-use outcomes

	<i>B</i>	β	<i>SE</i>	99% CI
Drinking frequency as outcome				
Age of First Use → Drinking Frequency	— 0.33	— 0.14	0.02	— 0.18 , — 0.09
Age of Habitual Use → Drinking Frequency	0.01	0.00	0.02	— 0.05, 0.06
Binge frequency as outcome				
Age of First Use → Binge Frequency	— 0.08	— 0.05	0.02	— 0.09 , — 0.01
Age of Habitual Use → Binge Frequency	— 0.16	— 0.09	0.01	— 0.13 , — 0.06
Typical quantity as outcome				
Age of First Use → Typical Quantity	— 4.39	— 0.08	0.02	— 0.12 , — 0.04
Age of Habitual Use → Typical Quantity	— 4.92	— 0.08	0.02	— 0.12 , — 0.04
AUDIT as outcome				
Age of First Use → AUDIT	— 0.24	— 0.09	0.02	— 0.13 , — 0.04
Age of Habitual Use → AUDIT	— 0.42	— 0.15	0.02	— 0.18 , — 0.10
BYAACQ as outcome				
Age of First Use → BYAAQ	— 0.13	— 0.06	0.02	— 0.11 , — 0.02
Age of Habitual Use → BYAAQ	— 0.26	— 0.12	0.02	— 0.15 , — 0.08

Significant associations are shown in bold for emphasis (determined by a 99% bias-corrected standardized bootstrapped confidence interval that does not contain 0). SE and 99% CI depicted refer to standardized effects

Table 4 Standardized estimates for Age of First Use and Age of Habitual Use predicting drinking outcomes by country

Association	USA	Canada	South Africa	Spain	Argentina	Uruguay	England	Significant difference in strength of associations
Age of First Use → Drinking Frequency	-.13	-.12	-.15	-.14	-.10	-.43	-.10	N/A
Age of Habitual Use → Drinking Frequency	.03	-.01	-.08	-.06	-.05	.06	-.18	N/A
Age of First Use → Binge Frequency	-.09	-.05	-.07	-.08	-.02	-.19	.02	N/A
Age of Habitual Use → Binge Frequency*	-.15	-.16	-.15	-.08	-.07	-.002	-.23	USA > Argentina, Uruguay
Canada > Uruguay								England > Spain, Argentina, Uruguay
Age of First Use → Typical Quantity	-.11	-.12	-.14	-.11	-.19	-.08	.04	N/A
Age of Habitual Use → Typical Quantity	-.11	-.16	-.09	-.11	-.03	-.13	-.17	N/A
Age of First Use → AUDIT*	-.11	-.08	-.22	-.17	-.09	-.10	.07	US, South Africa, Spain > England
Age of Habitual Use → AUDIT*	-.20	-.19	-.09	-.04	-.14	-.17	-.28	US > Spain
Canada > Spain								England > US, Canada, South Africa. Spain, Argentina, Uruguay
Age of First Use → BYAAQ	-.08	-.04	-.23	-.09	-.08	-.07	.07	N/A
Age of Habitual Use → BYAAQ	-.14	-.17	-.05	-.09	-.12	-.08	-.24	N/A

Significant associations are shown in bold for emphasis (determined by a 99% bias-corrected standardized bootstrapped confidence interval that does not contain zero). Estimates depicted refer to standardized effects. Significant differences in country associations are starred and direction of those differences are provided in the Significant difference column. Differences in associations between specific countries was determined using chi-square difference test ($p < .01$) when constraining associations to be equal across comparison groups

Overall, we found that in the Age of Habitual Use → 30 Days Binge Drinking model, model variance was driven by a variety of country differences including differences between the USA vs. Uruguay/Argentina, where the direct effect was stronger in the USA. Additional differences included Canada vs. Uruguay (stronger for Canada), as well as England vs Spain/Argentina/Uruguay (stronger effect for England). In the Age of First Use → AUDIT, variance was driven by differences between England vs. USA/South Africa/Spain, where the effect was weaker (and positive) for the English sample than for the other three countries (associations were stronger and negative). Finally, in the Age of Habitual Use → AUDIT model, significant differences arose between England vs. all other countries, where the effect was stronger for the English sample than for the other six countries (all associations were negative in directionality). Additionally, significant model differences were found between Spain vs. USA/Canada (associations were stronger for both the USA and Canada samples).

It is important to note that while examining associations across countries, the model estimates varied as did the differences in the patterns of statistical significance, which were likely due to sample size differences between countries. For example, the model estimates for the English sample were more extreme than the total analytic sample for a number of indicators but were not statistically significant due to the small number of participants from the English sample.

Discussion

The purpose of the present study was to examine alcohol use behaviors and the relationship between Age of First Use and Age of Habitual Use on alcohol use behaviors (including problematic alcohol use) among college students from seven countries. In line with previous research, we found significant cross-cultural differences in drinking practices and outcomes (Smart & Ogborne, 2000). Specifically, among college students that reported drinking in the past 30 days, students in countries with an older legal drinking cut off (such as the USA) had their first experiences with alcohol later in life (i.e., older first age of use) when compared to countries with younger or no legal drinking cut offs, such as England or Argentina. Similarly, students in countries with older legal alcohol purchase ages, such as the USA and Canada, reported later start of habitual drinking than countries with younger purchase ages such as Argentina and Uruguay. Furthermore, our findings demonstrated that indicators of alcohol misuse (i.e., AUDIT scores) and alcohol consequences scores are higher in countries with relatively early legal drinking cut off ages. Such findings highlight the importance of culture and policy when studying development milestones associated with problematic alcohol use. These findings also suggest the potential importance of distinguishing between legal drinking age and legal alcohol purchase age such that younger legal drinking age may introduce early opportunities to try alcohol, perhaps under supervision, while younger legal purchase age opens space for unsupervised drinking from a young age.

The regressions results provided additional support for associations between Age of First Use and Age of Habitual Use with alcohol practices later in life (Jackson et al., 2012; Sudhinaraset et al., 2016), such that earlier Age of First Use and Age of Habitual Use were associated with higher reports of drinking frequency, binge drinking frequency, alcohol typical quantity consumed, and higher AUDIT and BYAACQ scores during young adulthood. A new and unique contribution of the present study is that our findings demonstrate that Age of First Use and Age of Habitual Use do not associate with later drinking outcomes with the same intensity. Specifically, Age of First Use had stronger associations with drinking frequency, while Age of Habitual Use was more strongly associated with AUDIT scores and negative consequences, in line with the limited existing research (Davis et al., 2020).

Several mechanisms may underlie the differential associations found. One possibility takes into account the impact of early alcohol exposure on the developing brain (Dawson et al., 2008). Pre-clinical studies have revealed detrimental effects of early (e.g., adolescent) alcohol exposure, yet most of these studies have employed heavy and protracted alcohol exposure. For instance, Marszalek-Grabska et al. (2018) reported memory recognition deficits after binge-like (2.0–4.0 g/kg) and prolonged alcohol exposure in rats, akin to what we refer to here as Habitual Use. Age of First Use, as self-reported in clinical studies, might represent a first exposure to alcohol that likely involves low frequency or dose and hence with little impact on the developing brain. Furthermore, significant associations between Age of First Use and later problematic drinking may be, in fact, indicative of some genetic liability (Davis et al., 2020). On the contrary, Age of Habitual Use might entail engagement with alcohol in frequency and amount substantial enough to impact brain development, particularly in areas of the frontal lobe associated with cognitive performance and evaluation of rewards and losses (Bourque et al., 2016; Silveri, 2012). Future studies should further dissect both milestones by registering the typical dose achieved in the first contacts with alcohol and the average alcohol consumed during Habitual Use.

Another possibility is that Age of Habitual Use represents a mediator in a chain of events that ultimately lead to AUDs, so that it relates to AUDIT and BYAACQ scores more closely than Age of First Use. Under this perspective, the latter milestone would be a distal predictor, exerting a broader effect. Some studies have established that there is a large lag period, sometimes ranging from two to four years (the present sample average was about two years) between the first use of alcohol and problematic use of the drug (Behrendt et al., 2009). This lag provides a large space for other factors to develop and come into play, such as time for habitual use to develop. Studies focusing on tobacco (Conner et al., 2021) or other substances (Casanueva et al., 2014) have demonstrated a pattern of early first use associated with earlier onset of habitual use. Additional longitudinal research has shown a direct relationships between early Age of First Use, transition to habitual use, and eventually transition to misuse (Wittchen et al., 2008). Further research has expanded upon these findings, demonstrating strong relationships between first use, first intoxication, regular drinking, and

problematic use, and more specifically alcohol use disorder (Sartor et al., 2016). An alternative explanation of the limited association between Age of First Use and later drinking outcomes, along similar lines, is the marker hypothesis that suggests that early alcohol use and the later development of symptoms of problematic drinking are not causally related but instead are both manifestations of a third variable unidentified in this study (Guttmanova et al., 2011). Such variables could include genetic vulnerability or early exposure to stress.

We found several significant cross-cultural differences in the associations between age variables and outcome variables. These differences, which were driven largely by significant differences between USA and other countries or England and other countries, may be the consequence of cultural differences in perception of acceptable drinking behavior. For example, the association between Age of First Use and AUDIT scores was, among the countries tested in the present study, generally weaker in the sample from England. This could relate to Age of First Use in England being relatively culturally irrelevant, or at least not as significant as Age of Habitual Use (England had the strongest effect for Age of Habitual Use → AUDIT scores). If an early first drink, as permitted by law in England, is normalized then it would make sense that later drinking behaviors will not associate as closely with Age of First Use as something like early Habitual Drinking, which is more limited by stricter purchasing laws (Smith & Foxcroft, 2009).

Limitations and Future Directions

Some limitations of this study warrant further investigation into this area of research. First, the cross-sectional design of this study does not allow us to make temporal inferences based on this data. Since drinking law and diversion programming relies on delaying age of early use, it is important to conduct longitudinal studies beginning before drinking behaviors start to provide more foundation for understanding the causation piece of both Age of First Use and Age of Habitual Use across these countries. Additionally, participants in the present study differed in age, which may have introduced recall bias, where respondents report events closer to the time of interview than is true or the tendency to underestimate the elapsed time since an event occurred, skewing the reporting of Age of First Use and Age of Habitual Use (Johnson & Schultz, 2005). Furthermore, the samples from each respective country may not be entirely representative of the broader college-student population with regards to gender distribution. In the present study, samples were skewed towards being predominantly (between 68.9% and 86.0%) female-identifying. Previous research is mixed on the role of gender in models associating alcohol initiation and later use behaviors (Chatterjee et al., 2018; Donovan, 2004; Hawkins et al., 1997).

We did not measure the impact of drinking on cognitive and other brain function, which limits speculation on potential neurobiological mechanisms underlying the Age effects. Future studies may expand on these findings to explore brain development in the context of Age of First Use and Age of

Habitual Use. This should provide a better understanding of how each milestone relates to other factors down the line (e.g., drinking norms and problematic use). Another limitation is in the strict focus on alcohol use. Some existing literature suggests that in contexts of lifetime polysubstance use, early initiation in one substance may relate to problems in another substance (Behrendt et al., 2012). Polysubstance use is becoming more prevalent in college populations (Barrett et al., 2006; Bravo et al., 2021; Conway et al., 2018; Looby et al., 2021; Willis et al., 2019), thus future studies could enrich this area of research by studying the relationship between first use and habitual use of various substances and the corresponding outcomes.

Perhaps the most critical limitation of this research, and of this area of research more broadly, is the lack of fixed definitions and criterion for age variables, including but not limited to Age of First Use and Age of Habitual Use. The significant differences in the average Age of First Use and Age of First Habitual Use, and further the significant differences between Associations of Age of First Use and Age of First Habitual Use with various alcohol related outcomes suggests that people do not equate their Age of First Use experience to be the same as their Age of First Habitual use exposure. The way individuals interpreted the question of Age of Habitual Use could have influenced their response such that Age of Habitual Use may hold negative connotation or understood to mean age at which an individual notices dependency on alcohol which inherently would relate to problematic alcohol use more. Others may have simply understood Habitual Use to mean when regular use began; although what “regular” use means in this case could be interpreted differently as well. These terms have yet to be explicitly and consistently defined in the literature, but are constantly being used, sometimes interchangeably, with other terms like Regular Use or Age of Onset to examine age-related alcohol consumption milestones and how they relate to problematic alcohol use down the line. In the present study, Age of First Use was determined with the question, “How old were you the first time you drank alcohol?” while Habitual Use was determined with the question “At what age did you begin to consume alcohol as a habit?”. In other studies, however, Age of First Use has been addressed with different questions which can vary the answers. For instance, one study explicitly restricted Age of First Use to not include small taste or sips (Livingston et al., 2016). Future studies may investigate how individuals understand the differences between the various age milestones, and should aim to functionally define these terms such that they hold distinct psychometric properties in the context of predicting alcohol use outcomes.

Conclusions

Though drinking cultures, practices, and outcomes differ across the globe, the existence of legislation around legal drinking or alcohol purchasing in nearly every country highlights the importance of legal drinking age as a cross-cultural milestone. With that, the onus of intervening in problematic alcohol use is put on different aspects of early drinking laws cross-culturally, with some countries

focusing on delaying drinking all together, while others focus on delaying regular access to alcohol. Similarly, research on age variables and how they relate to problematic alcohol use outcomes down the line have favored Age of First Use in predicting alcohol use trends later in life (DeWit et al., 2000; Maimaris et al., 2013), but have also demonstrated that early alcohol use defined differently, such as by Age of Habitual Use, also predicts later alcohol use and more specifically problematic alcohol use (Guttmanova et al., 2011; Ohannessian et al., 2015).

The present research provides a necessary examination and comparison of the different age variables explored in the existing alcohol literature with the understanding that diverse drinking culture may be associated with different outcomes. The implications of our findings specifically provide grounds to dig deeper into alcohol use trajectories from various early drinking age milestones, including but not limited to Age of First Use and Age of Habitual Use. Moreover, this research demonstrates a need for further investigating age variables and how we define these age variables for practical application. Specifically, understanding how alcohol use practices as they relate to age at certain drinking milestones differ depending on how we define those milestones. Problematic alcohol use is a global phenomenon, but the role of varying alcohol related laws and drinking culture cannot be undermined. To reduce problematic alcohol use and derail alcohol use disorder before it begins, it is critical that research focuses not only on understanding how early experiences can relate to later outcomes, but to understand how this may vary with culture and leverage that knowledge to interrupt negative cycles of use.

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Data Availability Data and analytic outputs are available at <https://doi.org/10.17605/OSF.IO/UG6D5>.

Declarations

Conflict of Interest The authors declare no competing interests.

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