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Predictors of Adverse Alcohol Use Consequences Among Tertiary Students

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Abstract

Background: The alcohol consumption patterns of young adults are of concern. Critically, tertiary students consume greater quantities of alcohol, are at increased risk of injury/harm, and have higher rates of alcohol use disorders (AUD) as compared to their non-university enrolled peers. The Brief Young Adult Alcohol Consequences Questionnaire (BYAACQ) is one of several tools utilised to explore adverse alcohol-related outcomes among tertiary students. Alcohol intake behaviour, assessed via retrospective summary measures, has been linked to BYAACQ score. It is unclear, however, how drinking assessed in real-time, in conjunction with variables such as age of drinking onset, might predict severity of adverse alcohol consequences as captured by the BYAACQ.

Methods: The psychometric properties of the BYAACQ were explored using a large Australian sample of tertiary students (N = 893). A subsample (n = 504) provided alcohol intake information in real-time (21 days; event- and notification-contingent) via a smartphone app (CNLab-A) plus details related to age of drinking onset, drug use, parental alcohol/drug use, and anxiety/depression symptomology.

Results: Average BYAACQ score was 7.23 (SD = 5.47). Classical and item response theory analyses revealed inconsistencies related to dimensionality, progressive item severity, and male/female differential item functioning. Current drinking – namely, frequency of intake and quantity per drinking occasion – plus age of drinking onset predicted BYAACQ score after controlling for age, other drug use, and depression symptomology.

Conclusions: The BYAACQ is a sound tool for use with Australian samples. Information related to current drinking, age of drinking onset, and drug use is useful for predicting severity of alcohol use consequences. These markers might enable tertiary institutions to better target students who could benefit from prevention/intervention programs.

Key Words: Alcohol, Consequences, Tertiary students, BYAACQ, Age of drinking onset

Predictors of Adverse Alcohol Use Consequences Among Tertiary Students

Introduction

Globally, alcohol consumption patterns of young adults are of concern. Substantial proportions of young people in the United States (9.6%; 18-25 years), the United Kingdom (18%; 16-24 years), and Australia (18.5%; 18-24 years) drink at levels that exceed national daily/weekly guidelines, placing them at increased risk of injury and/or harm (Australian Institute of Health and Welfare [AIHW], 2017; NHS Digital, 2018; Substance Abuse and Mental Health Services Administration, 2017). The incidence of heavy episodic drinking is highest among individuals aged 20-24 years across all regions of the world (World Health Organisation [WHO], 2018). Worryingly, tertiary-level students have been shown to consume even greater quantities of alcohol, to be at increased risk of injury/harm, and to have higher rates of alcohol use disorders (AUD) than their non-university enrolled peers (Dawson et al., 2004; Johnston et al., 2013; Knight et al., 2002; Kypri et al., 2005; Slutske, 2005). It is therefore important ways are found to adequately assess the spectrum of adverse consequences of alcohol consumption in this population and to examine predictors of

these outcomes, so that appropriately targeted prevention and early intervention programs can be realized.

A number of well-validated and reliable self-report surveys have been used to index adverse drinking consequences among adolescents and young adults in the United States (Devos-Comby and Lange, 2008). Of these, the 24-item Brief Young Adult Alcohol Consequences Questionnaire (BYAACQ) was designed specifically to assess severity of alcohol use related consequences among tertiary students (Kahler et al., 2005). Derived from the longer 48-item Young Adult Consequences Questionnaire (YAACQ) using item response theory (IRT) analyses, the architects of the BYAACQ have shown the measure is unidimensional; taps a continuum of consequences (that is, progressive item severity is evident); demonstrates high discrimination between levels of severity; has sound internal consistency (.83); and, shows no gender bias (Kahler et al., 2005). While subsequent investigations – using samples from the United States, The Netherlands, and Argentina – have confirmed the unidimensional nature of the BYAACQ and its validity, progressive item severity has generally not been found to be consistent across these studies (Kahler et al., 2008; Pilatti et al., 2014; Verster et al., 2009). Additionally, there is evidence of gender bias, either in terms of total score or differential item functioning (Kahler et al., 2008; Pilatti et al., 2014; Verster et al., 2009).

Although several Australian-based studies have utilised the BYAACQ in recent times (Caudwell and Hagger, 2014; Lam et al., 2017; Treeby and Bruno, 2012), the psychometric properties of the measure have not been extensively explored in the Australian context. This is an important oversight as there are significant legal and cultural differences – that continue to evolve over time – between Australia and other countries where the BYAACQ has been validated. In Australia, for instance, the legal drinking age is 18, whereas in the United States it is 21, and in The Netherlands 16 year olds were, until recently, permitted to consume beer and wine (WHO, 2014). Evidence suggests greater adverse drinking consequences are associated with lower legal minimum drinking age (Carpenter and Dobkin, 2011). The legal driving age in Australia is also 18. Thus, unlike the United States, Argentina and the Netherlands, young people can commence drinking the same year they get their driver's license. While provisional drivers are subject to strict blood alcohol content restrictions in Australia, research has shown there is a significant increase in risky alcohol-related driving behaviours – such as, driving under the influence and driving when

intoxicated – among tertiary students once the legal drinking age is reached (Beck et al., 2010). Alcohol intake patterns and concomitant adverse drinking outcomes of tertiary students in any country may be a function of these (and other) legal and cultural differences. Consequently, before we can be confident the BYAACQ adequately describes the drinking consequences of Australian tertiary students, an examination of its psychometric properties when used with this group is warranted.

Various factors have been found to predict adverse drinking consequences in tertiary students. Of primary – but not sole – concern has been the link between alcohol consumption and consequences (Ham and Hope, 2003; Mallett et al., 2013; Prince et al., 2018). With regard to the BYAACQ in particular, research has shown medium to large positive correlations between total score and frequency of drinking, quantity consumed, heavy episodic drinking, and incidence of drunkenness (Kahler et al., 2008, 2005; Napper et al., 2015; Pearson and Hustad, 2017; Pilatti et al., 2014; Verster et al., 2009). In these studies, however, variables used to describe drinking have typically been derived from retrospective summary measures of drinking, such as timeline followback, the daily drinking questionnaire, and researcher-generated surveys. Such methods have generally been found to underestimate drinking when compared to real-time (or near real-time) methods of assessing intake, such as smartphone apps (Dulin et al., 2017; Monk et al., 2015; Poulton et al., 2018). Investigation into the relationship between alcohol consumption captured in real-time via an app and negative drinking consequences as measured using the BYAACQ is yet to be well examined. Given the increasing popularity of using app-based methods in the medical and allied arenas (Luxton et al., 2011; Ozdalga et al., 2012), this constitutes a gap in the literature.

Alcohol use explains, on average, less than 23% of the variance in adverse drinking consequences among tertiary students; as such, factors beyond intake must be explored in an effort to ascertain other predictors involved (Prince et al., 2018). Age of drinking onset is of particular interest. Research suggests individuals who commence drinking at younger ages are more likely to drive under the influence of alcohol, be involved in a car accident, engage in heavy episodic drinking, get involved in physical fights, injure themselves or others, and/or be diagnosed with AUD (Dawson et al., 2008; Grant et al., 2001; Hingson et al., 2001, 2002, 2006; Hingson and Zha, 2009; Liang and Chikritzhs, 2015). There is, however, some controversy regarding research in this area. Specifically, empirical definitions are

often varied and/or imprecise; various confounding variables – such as family history of AUD or substance use disorders (SUD), depression, and anxiety – are not always adequately controlled for; and, there is some suspicion age of onset interacts with other predictors (Kuntsche et al., 2016; Maimaris and McCambridge, 2014; Warner and White, 2003). Nonetheless, there is still some agreement that age of onset is a useful means of identifying risk of alcohol-related problems, especially when the period of observation is restricted to adolescence and/or young adulthood (Hingson et al., 2016; Labouvie and White, 2002; Warner and White, 2003). Moreover, both the WHO and US Department of Health and Human Services have advocated that early age of drinking onset should be considered a marker for future problems (US Department of Health and Human Services, 2007; WHO, 2014). Although Verster and colleagues (2009) reported a medium strength inverse relationship between drinking onset age and BYAACQ score, there appears to have been no investigation to date into how this variable, in conjunction with current drinking, might influence BYAACQ score.

The aims of this study were two-fold. First, we sought to investigate the psychometric properties of the BYAACQ in a large Australian sample. In particular, we used both classical and item response test theories to examine dimensionality, validity, item functioning, and gender bias. We then examined the relationship between current drinking, age of drinking onset, and alcohol-related consequences. Specifically, we sought to establish if current drinking – captured in real-time via a smartphone app – and age of drinking onset predicted severity of adverse drinking consequences – measured via the BYAACQ – in healthy tertiary students after controlling for age, gender, other drug use anxiety, depression, and parental AUD/SUD.

Materials and Methods

Participants and Procedures

The full sample consisted of 893 undergraduate and graduate university students (M_{age} = 21.59, *SD* = 4.45, range: 17-57, 70.4% female) recruited through adverts posted in and around the University of Melbourne. A sub-sample (*n* = 504, M_{age} = 21.69, *SD* = 4.81, range: 17-46, 70.2% female) provided 21 days of drinking data via an app. Participants under the age of 13 years, those who did not consume alcohol, and individuals with a history of AUD/SUD were excluded. The University

of Melbourne Human Ethics Committee approved the study in accordance with the standards for ethical research of the National Health and Medical Research Council.

After reading a plain language statement and providing informed consent, participants answered a brief online researcher-devised demographic survey and then undertook the BYAACQ. The app sub-sample also completed the following measures: Alcohol, Smoking and Substance Involvement Screen (ASSIST), Generalised Anxiety Disorder (GAD-7) scale, Patient Health Questionnaire (PHQ-9), and Alcohol Use Disorders Identification Test (AUDIT). They additionally indicated the age at which they consumed their first full standard drink of alcohol. They then downloaded and used a smartphone app to record alcohol use over 21 days. Participants were compensated via course credit or received AU$10 for time spent completing online surveys and AU$0.50 each day information about alcohol consumption was submitted via the app (regardless of whether alcohol had been consumed or not). In the latter case, participants received a bonus AU$9.50 if app data were submitted on all 21 days. The maximum participants could be reimbursed was AU$30.

Measures

GAD-7. This 7-item screener asks participants how often – and to what degree – they have experienced symptoms of anxiety over the last two weeks (Spitzer et al., 2006). Originally developed to identify anxiety in primary care settings, it has also been validated for use in the healthy population (Löwe et al., 2008). Scores range from 0-21; scores of 10 or more suggest moderate anxiety (Löwe et al., 2008; Spitzer et al., 2006).

PHQ-9. This 9-item screener asks individuals how frequently – and to what extent – they have experienced depressive symptoms over the last two weeks (Kroenke et al., 2001). Initially designed to detect depression in primary care settings, it has also been standardised for use in the healthy population (Kocalevent et al., 2013). Scores range from 0-27; scores of 10 or more are indicative of moderate depression (Kroenke et al., 2010).

AUDIT. This 10-item screening measure asks participants to respond to questions assessing alcohol intake, problems, and dependence with reference to the preceding six months (Saunders et al., 1993). Scores of eight or more indicate hazardous alcohol consumption (Babor et al., 2001).

ASSIST. Designed to identify harmful use of alcohol, tobacco and illicit drugs, the ASSIST comprises eight questions covering 10 substances; it assesses frequency of use and associated problems over the preceding three months (WHO ASSIST Working Group, 2002). Substance-specific scores can be used to differentiate between low, moderate or high risk use of that substance, while total score is indicative of global harmful drug use severity. Given other measures in this study already index alcohol use and misuse, all ASSIST responses pertaining to alcohol were excluded from analyses. ASSIST total score in this study thus reflects global harmful drug use severity excluding alcohol.

BYAACQ. A 24-item dichotomous response measure, the BYAACQ assesses adverse consequences of drinking among healthy university students over the previous 12 months (Kahler et al., 2005). Summed scores provide an indication of the severity of alcohol-related consequences.

CNLab-A. This freely available custom-built iOS/Android app can be used to record real-time (or near real-time) alcohol intake over 21 days. The app has previously been found to be a valid and reliable measure of alcohol intake (Poulton et al., 2018; Poulton et al., in press). Alcohol intake data can be submitted at any time, either in response to twice-daily notifications or while drinking. See Figure 1 for further details. Drinking indices derived from the app include percent drinking days; total standard drinks; standard drinks per drinking day; hourly rate of intake; and, number of occasions where 4/4+ (and so forth) drinks were consumed in the one episode.

Data Analyses

Average BYAACQ score was computed for the full sample. Standardised values for skewness (0.64, *SE* = .08) and kurtosis (-0.18, *SE* = .16) were $Z_{skewness}$ = 8.00 and $Z_{kurtosis}$ = 1.13, suggesting significant skew (but no significant kurtosis) at $p < .05$. However, this is common when the sample is large, as such samples give rise to small standard errors. Sample sizes greater than 200 warrant examination of the probability-probability (P-P) plot to determine normality (Tabachnick and Fidell, 2013). These plots revealed no obvious systemic deviation from the straight line, suggesting the data was normally distributed. Item percent prevalence was conceived as percentage of participants endorsing each BYAACQ question; this provided information about progressive item severity. Differences between men and women were tested using *t*-tests/chi-square as appropriate (SPSS 26). Exploratory factor

analysis (EFA) was conducted using the weighted least squares means and variance adjusted estimation method (Mplus 8.1), which is recommended when variables are categorical (Muthén and Muthén, 2010). Fit of the data to a Rasch item response theory (IRT) model was investigated using Xcalibre 4.2.2.0 (Wright and Linacre, 1994). According to this model, items are assumed to differ from one another in terms of degree of severity. Severity estimates are scaled so that average item severity is zero; values less than/greater than zero indicate less/more severe items (Bond and Fox, 2015). Mean square infit and outfit values provide a measure of item fit. As infit statistics are information-weighted, they are considered less sensitive to outlier influences; as such, they are often the focus of item fit interpretations (Bond and Fox, 2015). Infit values in the range .6 to 1.4 are considered productive for measurement (Wright and Linacre, 1994). In order to detect item response differences between men and women, the Mantel-Haenszel statistic was used for differential item functioning (DIF). Considered the gold standard for comparing the performance of two groups on dichotomously scored items, this involves splitting each group into severity levels and then comparing the probability of individuals in each group endorsing each item at each severity level (Gómez-Benito et al., 2018; Guyer and Thompson, 2014; Sireci and Rios, 2013; Tay et al., 2015). Log transformed Mantel-Haenszel coefficients (M-H D) were computed for each item – values less than/greater than 0 indicate males/females were more likely to endorse the item – and tested for significance (Guyer and Thompson, 2014).

With regard to the sub-sample that provided drinking information via the CNLab-A app, standardised values for skewness (0.65, *SE* = .11) and kurtosis (-0.10, *SE* = .22) were $Z_{\text{skewness}} = 5.91$ and $Z_{\text{kurtosis}} = 0.45$, suggesting significant skew (but no significant kurtosis) at $p < .05$. Again, examination of the probability-probability (P-P) plot revealed no obvious systemic deviation from the straight line, suggesting the data was normally distributed. Differences in BYAACQ score as a function of sex and first-degree relative AUD/SUD status were examined using *t*-tests. Correlational/chi-square analyses were conducted to examine the relationship between average BYAACQ score and other variables. Non-significant results and strong correlations between independent variables informed decisions regarding predictors to be included in the regression model (Tabachnick and Fidell, 2013). Correlational analyses revealed strong relationships between a number of app derived drinking indices: total standard drinks and percent days drinking, $r(502) = .72$, $p <$

.001; total standard drinks and standard drinks per drinking day, $r(502) = .68$, $p < .001$; total standard drinks and occasions where five or more drinks were consumed in one episode, $r(502) = .91$, $p < .001$; and, standard drinks per drinking day and occasions where five or more drinks were consumed in one episode, $r(502) = .66$, $p < .001$. To avoid problems related to multicollinearity, total standard drinks and occasions where five or more drinks were consumed in one episode were not included in the model. Differences in BYAACQ score as a function of drinking onset group were investigated using one-way analysis of variance (ANOVA); post hoc tests were Bonferroni corrected for multiple comparisons. Hierarchical multiple regression was used to explore the relative influence of current drinking variables and age of drinking onset on BYAACQ score. Age of drinking onset was dummy coded with ≥ 18 as baseline. Regression diagnostics revealed 3 cases had standardised residuals greater than |3.00|; however, as Cook's Distance had a maximum value of 0.05, these outliers were not unduly influencing the model. There was no evidence that assumptions of multicollinearity or homoscedasticity were violated.

Results

BYAACQ psychometric properties

Average BYAACQ score of the full sample was 7.53 ($SD = 5.37$) with scores ranging from 0 (7.6%; $n = 68$) to 24 (0.20%; $n = 2$); scores above 19 were relatively rare (2.6% scored ≥ 20). In terms of progressive item severity, a number of items appeared out of order. In particular, few participants indicated they had engaged in drink driving, whereas large numbers claimed they had less energy or felt tired due to drinking. There was no difference between the total scores of men and women, $t(891) = 1.30$, $p = .194$, $r = .04$. Despite this, men selected five items significantly more often than women. Compared to women, the odds of endorsing item 5 (I have taken foolish risks when drinking), 6 (I have passed out from drinking) and 7 (I have found I needed larger amounts of alcohol to feel any effect) were, respectively, 1.49 (95% CI 1.11, 2.00), 1.65 (95% CI 1.22, 2.22) and 1.34 (95% CI 1.00, 1.80) times higher for males. Likewise, the odds of selecting item 10 (I have driven a car when I knew I had too much to drink) and item 15 (I have woken up in an unexpected place after drinking) were, respectively, 1.79 (95% CI 1.10, 2.93) and 2.44 (95% CI 1.67, 3.57) times higher for males than females. Table 1 shows frequency of endorsing each BYAACQ item plus frequencies as a function of gender. For comparative purposes,

item percent prevalence reported in several key studies is provided in Supporting Table S1. Cronbach's alpha and Guttman's λ_2 were both .90.

For the EFA, both the minimum average partial procedure and parallel analysis suggested two underlying factors, but previous studies have reported one underlying factor (Kahler et al., 2005; Verster et al., 2009). We considered both one- and two-factor solutions.

With regard to the one-factor model, the comparative fit index (CFI) was 0.96, the root mean square error of approximation (RMSEA) was 0.048, and the standardized root mean square residual (SRMR) was 0.085. The two-factor model had a CFI of 0.98, an RMSEA of 0.038, and a SRMR of 0.067. CFI indices greater than 0.95, RMSEA values not more than 0.06, and SRMR indices less than 0.08 are recommended (Schmitt, 2011). Thus, fit indices for both models were fair to good. Factor loadings were all significant, though there were a number of cross-loading items in the two-factor solution (see Table 1). Inspection of the two-factor solution did not suggest item grouping reflected any particular theoretical underpinning.

We also conducted a Rasch IRT analysis. This revealed two items fell just outside the desired mean square infit range. In particular, item 21 (My drinking has created problems between myself and my boyfriend/girlfriend/spouse, etc.) and item 24 (I have felt like I needed a drink after I'd gotten up) had mean square infit indices less than .60, indicating possible item redundancy (Wright and Linacre, 1994). Item severity estimates ranged from -2.02 (low severity) to 1.83 (high severity). According to this metric, items 1 to 3 (I have said or done embarrassing things; I have had a hangover the morning after; and, I have felt very sick to my stomach or thrown up) were less severe alcohol-related consequences, while item 24 (I have felt like I needed a drink after I'd gotten up) was the most severe. The mean person-level estimate of alcohol-related consequences for this sample was -0.98 (*SD* = 1.36). Two items showed significant DIF; that is, after controlling for severity level, men endorsed item 15 (I have woken up in an unexpected place) more often, while women selected item 17 (I have had less energy or felt tired) more frequently. See Table 2 for item-level severity estimates, mean square infit and outfit indices, as well as M-H D statistics and associated *p*-values.

BYAACQ, current drinking, and age of drinking onset

Descriptive statistics – plus correlations with BYAACQ score – for the sub-sample that provided drinking information via an app are detailed in Table 3. Average

BYAACQ score of this group was 7.62 (*SD* = 5.20) with scores ranging from 0 to 23; 2.8% scored ≥ 20. There were no differences between the total BYAACQ scores of men and women, $t(502) = 0.48$, $p = .630$, $r = .02$, or between the scores of participants who reported they did ($n = 25$) or did not have a first degree relative with an AUD/SUD, $t(502) = -1.05$, $p = .294$, $r = .05$.

In terms of age of drinking onset, 39.3% of this sub-sample reported consuming their first full alcoholic beverage prior to 15, 40.3% indicated this occurred at 16 or 17, while 20.4% stated this happened at 18 years or older. There was no relationship between age of drinking onset group and sex, χ^2 (2, $N = 504$) = 5.68, $p = .059$, or between age of drinking onset group and first-degree relative AUD/SUD status, χ^2 (2, $N = 504$) = 1.78, $p = .410$.

A one-way ANOVA revealed a large significant effect of age at first drink on BYAACQ score, $F(2, 501) = 35.06$, $p < .001$, $\omega = .35$. Post hoc tests showed individuals who commenced drinking at 15 years or younger had significantly greater BYAACQ scores ($M = 9.31$, $SD = 5.10$) than those who consumed their first drink at 16 or 17 ($M = 7.62$, $SD = 4.83$; $p = .002$; 95% CI [0.53, 2.87]), and those who started drinking at 18 or older ($M = 4.35$, $SD = 4.52$; $p < .001$; 95% CI [3.54, 6.39]). There was also a significant difference between the BYAACQ scores of those who commenced drinking at 16 or 17 and those who started at 18 years or older ($p < .001$; 95% CI [1.85, 4.68]).

With regard to the hierarchical multiple regression, chronological age was entered at step 1; this variable explained 3.5% of the variance in BYAACQ score, $F(1, 502) = 18.05$, $p < .001$. At step 2, app derived indices related to current drinking – specifically, percent drinking days and total standard drinks per drinking day – were entered into the model; this explained 24.6% of the variance in BYAACQ scores, $F(3, 500) = 54.47$, $p < .001$. Current drinking explained an additional 21.2% of the variance in BYAACQ scores, after controlling for age, $\Delta R^2 = .21$, F change (2, 500) = 70.20, $p < .001$. At step 3, age of drinking onset was entered into the model; this explained 30.2% of the variance in BYAACQ scores, $F(5, 498) = 43.14$, $p < .001$. This variable explained an additional 5.6% of the variance in BYAACQ scores, after controlling for age and current drinking, $\Delta R^2 = .06$, F change (2, 498) = 19.95, $p < .001$. At step 4, ASSIST score was entered into the model; this explained 37.3% of the variance in BYAACQ scores, $F(6, 497) = 49.24$, $p < .001$. ASSIST score explained an additional 7.1% of the variance in BYAACQ scores, after controlling for age, current

drinking, and age of drinking onset, $\Delta R^2 = .07$, F change (1, 497) = 55.96, $p < .001$. At step 5, GAD-7 and PHQ-9 scores were entered into the model; this explained 39.2% of the variance in BYAACQ scores, $F(8, 495) = 39.88$, $p < .001$. GAD-7 and PHQ-9 scores explained an additional 1.9% of the variance in BYAACQ scores, after controlling for age, current drinking, age of drinking onset, and ASSIST score, $\Delta R^2 = .02$, F change (2, 495) = 7.76, $p < .001$. Finally, interaction items – each of PHQ-9 and GAD-7 by each of the drinking indices – were included in the model. These items did not significantly improve the model, $\Delta R^2 = .003$, F change (4, 491) = 0.63, $p = .644$, and so were dropped from the final model. See Table 4 for coefficient details.

Discussion

This study investigated the psychometric properties of the BYAACQ and examined if current drinking and age of drinking onset predicted severity of adverse alcohol-related consequences in Australian university students. Our results suggest the BYAACQ is suitable for use with Australian samples. Importantly, we also found both current drinking – captured in real-time using a smartphone app – and under-18 age of drinking onset categories predicted negative alcohol-related outcomes – assessed using the BYAACQ – after controlling for the effects of chronological age, other drug use, and symptoms of anxiety and depression.

BYAACQ psychometric properties

In our sample, BYAACQ mean score and range (7.53; 0-24) was consistent with those reported in the United States (7.20-8.90; 0-22; Kahler et al., 2008; Napper et al., 2015) and Australia (7.72; 0-24; Treeby and Bruno, 2012), but not Europe or South America (4.70-5.13; 0-19; Pilatti et al., 2014; Verster et al., 2009). Aside from some notable exceptions, there was rough alignment in terms of progressive item severity – expressed as item percent prevalence or as an IRT severity estimate – between this study and those conducted elsewhere (Kahler et al., 2005, 2008; Pilatti et al., 2014; Verster et al., 2009). Item 17 (I have had less energy or felt tired), however, was found to be much less severe and item 10 (I have driven a car) considerably more severe than reported in the United States. Progressive item severity differences across studies set in diverse locations may be a reflection of legal and cultural distinctions between countries that may themselves evolve over time. For instance, although young people in Victoria (the state in which this study was conducted) can obtain a driver's license at 18, if they are caught driving with any alcohol in their system their license will be cancelled and they will be disqualified from driving for up to six

months; this might disincentivise and consequently reduce the prevalence of this behaviour among young persons in this state as compared to elsewhere. Drink driving is now also considered the most dangerous and unacceptable of all driving behaviours in this state (Nieuwesteeg, 2012; Transport Accident Commission [TAC], 2016). Only 4% of Victorian drivers reported having driven when they knew or suspected they were over the legal limit in 2016, whereas 14% reported having done so in 2001 (McIntyre et al., 2011; TAC, 2016). Though the prevalence of drink driving was higher in our sample (8.1%) as compared to the general population, it was still much less than reported in BYAACQ validation studies conducted in the United States 10-15 years ago (Kahler et al., 2005, 2008).

While several studies have provided evidence supporting the unidimensional nature of the BYAACQ (Kahler et al., 2005, 2008; Pilatti et al., 2014; Verster et al., 2009), our findings showed either a one- or two-factor solution could be applied to the data. Our two-factor solution had several cross-loading items, however, and could not be interpreted according to any theoretical underpinnings. Previous psychometric investigations of alcohol problem surveys have suggested two-factor solutions may emerge when items describing very serious consequences have low endorsement rates (Hurlbut and Sher, 1992). Our IRT analysis showed items were characterised by distinct severity estimates, though our range was not as broad as reported in previous studies (Kahler et al., 2005; Pilatti et al., 2014). Two items (21 and 24) fell just outside the lower limit of the recommended infit range. As these items were at the severe end of the alcohol consequences continuum, they still may nonetheless be helpful in identifying individuals with extreme alcohol intake problems.

There was no difference between the BYAACQ total score of men and women, though both classical test and IRT analyses revealed differential item functioning. According to the former, men were more likely than women to endorse a number of items (5-7, 10, and 15). By contrast, analyses utilising the Mantel-Haenszel statistic identified biases against both women (15) and men (17). Although several studies report BYAACQ differential item functioning (Pilatti et al., 2014; Verster et al., 2009), the measure was originally developed to be free of significant gender bias (Kahler et al., 2005). Since its inception, however, there has been considerable change in the drinking habits of both men and women. In Australia, for instance, the proportion of individuals drinking daily has been declining steadily since 2004; since 2013, however, this decrease has been driven by significant reductions in the alcohol

intake of men, not women (AIHW, 2017). Worldwide, there is growing evidence the problematic alcohol use and alcohol-related harm male-female gap is converging and that this may be a function of greater and/or more consistent alcohol use among young women (Slade et al., 2016). Alcohol consequences questionnaire outcomes are, at least in part, a reflection of the alcohol use characteristics of the young persons surveyed; as the latter changes over time, so too will the former.

BYAACQ, current drinking, and age of drinking onset

We found current alcohol consumption plus age of drinking onset together accounted for 30.2% of the variance in adverse alcohol use consequences after controlling for chronological. Increases in both frequency of drinking and quantity consumed on each drinking occasion were associated with increases in BYAACQ score. This is consistent with research that has demonstrated links between various alcohol consumption indices and BYAACQ score (Kahler et al., 2005, 2008; Napper et al., 2015; Pearson and Hustad, 2017; Pilatti et al., 2014; Verster et al., 2009). However, unlike previous studies that relied on retrospective summary measures of drinking, we assessed alcohol consumption in real-time using a smartphone app. This method has been shown to elicit higher frequency and greater quantity of drinking than retrospective measures (Dulin et al., 2017; Monk et al., 2015; Poulton et al., 2018). An age of drinking onset of less than 18 years was also associated with increases in BYAACQ score. Compared to a ≥ 18 drinking onset age, an age at first drink of ≤ 15 had a stronger positive impact on BYAACQ score than did a 16/17 age of drinking onset. These findings are in keeping with a large body of evidence that suggests individuals who commence drinking at earlier ages are more likely to experience negative alcohol-related outcomes, including AUD (Dawson et al., 2008; Grant et al., 2001; Hingson et al., 2001, 2002, 2006; Hingson and Zha, 2009; Liang and Chikritzhs, 2015).

Criticism of the age of drinking onset literature has alluded to the potential confounding effects of an AUD/SUD family history, anxiety, and depression. As such, we sought to include these variables, as well as other drug use, in our regression model. Preliminary analyses revealed no BYAACQ score differences as a function of AUD/SUD family history status (or as a function of sex); these variables were therefore omitted from the model. Other drug use and symptoms of depression were both significant predictors of severity of adverse alcohol use consequences; that is, increases in each of these variables were associated with increases in BYACQ score.

Interestingly, other drug use accounted for a sizeable 7.1% of the variance in adverse alcohol use consequences after controlling for other variables. Evidence suggests tertiary students frequently combine drinking with the use of nonmedical prescription and illicit drugs (McCabe, 2005; McCabe et al., 2005, 2006). Moreover, polydrug use involving alcohol and other drugs has previously been found to significantly increase the risk of experiencing alcohol-related problems (McCabe et al., 2006). Given the contribution other drug use made to our model, this may be a useful marker – along with current alcohol use and age at first drink – for identifying tertiary students likely to experience adverse alcohol-related consequences. Interestingly, we found symptoms of depression, but not anxiety, predicted adverse alcohol-related outcomes. This is consistent with a recent study that showed a small but significant correlation between depression symptomology – in the form hopelessness – and BYAACQ score, but no such link between symptoms of anxiety – of the anxiety sensitivity type – and BYAACQ score (Pearson and Hustad, 2017). Drinking to cope has been postulated as mediating the relationship between negative affect and alcohol-related problems (Martens et al., 2008).

A limitation of this study pertains to our measurement of anxiety and depression symptomology. We used relatively brief measures that did not allow for an extensive examination of the relationship between anxiety and depression symptomology subtypes and alcohol use consequences. With regard to anxiety, for instance, our measure did not include questions related to social anxiety, yet this has been implicated in severity of alcohol use consequences (Buckner and Heimberg, 2010). It might also have been useful to consider how drinking to cope might have impacted our model. Additionally, future studies might seek to assess both adverse alcohol consequences and drinking in real-time. This might provide more detailed information about the relationship between various drinking indices and proximal negative outcomes. It might also reveal how specific consequences inform subsequent drinking.

In sum, our examination of the psychometric properties of the BYAACQ revealed it is a sound means of assessing adverse alcohol use consequences in Australian samples. Given our findings, we also believe real-time measures of alcohol intake, age of drinking onset, and other drug use together function as useful markers for identifying tertiary students at risk of experiencing more severe negative drinking

outcomes. Tertiary institutions might consider using these markers to determine provision of targeted prevention and/or early intervention programs.

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Figure 1 Legend

Screenshots from the CNLab-A app. On opening, CNLab-A asks users if alcohol has been consumed in the last 24 hours (A). Thereafter, participants are asked if they have consumed alcohol since their last submission. If they indicate – by pressing "No" – that no drinking has occurred, the app can be closed. This serves to differentiate between participants who have forgotten to upload data and those who have not been drinking. If participants indicate drinking has occurred – by pressing "Yes" – images of common alcoholic beverages (including beer, wine, cider/premix, spirit/liqueur, and cocktail) are displayed (B). Participants then select the type of beverage consumed by touching the appropriate image on the screen. They are required to indicate quantity and size consumed for each beverage via a simple scroll option menu (C). Alcohol content as a function of beverage type is prefilled. Participants are able to repeat this process by tapping "Back" in order to add as many drink types as required. Erroneously entered data can be deleted by swiping left. Prior to submitting data, participants must also specify the start and end time of their drinking, again using a scroll option menu (D). Data cannot be submitted more than 15 minutes ahead of the current time or after more than 24 hours have elapsed in order to circumvent potential forward and/or back filling. Participants are able to either report their drinking in separate sessions or they can leave the app open to the

775 'drinks' screen so as to record beverages as they are consumed. The later option
776 still allows participants to use other features on their phone. Participants can
777 access a history of their submission dates and times (but not their drinking data) via
778 the "History" button. At the conclusion of the experimental period, an automated
779 message thanks participants and gives them simple feedback regarding the number of
780 days they consumed alcohol, total standard drinks consumed, and average daily
781 consumption.

782 **Table 1**

783 *BYAACQ Item Percent Prevalence as a Function of Total Sample (N = 893) and Male/Female Groups Plus Exploratory Factor Analysis Factor Loadings*

		Prevalence					One-factor	Two-factor solution	
		Total *N* = 893	Female *n* = 629	Male *n* = 264	χ^2	*p*-value	Solution (*SE*)	Factor 1 (*SE*)	Factor 2 (*SE*)
1	While drinking, I have said or done embarrassing things	79.7	80.1	78.8	0.21	.650	.91 (.02)	.91 (.03)	
2	I have had a hangover (headache, sick stomach) the morning after I had been drinking	74.8	75.7	72.7	0.86	.354	.80 (.03)	.85 (.04)	
3	I have felt very sick to my stomach or thrown up after drinking	68.4	63.8	66.7	0.53	.465	.71 (.03)	.89 (.05)	
17	I have had less energy or felt tired because of my drinking	61.8	61.0	57.2	3.39	.066	.64 (.03)	.46 (.06)	
8	When drinking, I have done impulsive things that I regretted later	50.6	49.1	54.2	1.89	.169	.87 (.02)	.92 (.03)	
4	I often have ended up drinking on nights when I had planned not to drink	40.3	40.7	39.4	0.13	.717	.61 (.03)	.47 (.06)	
7	I have found that I needed larger amounts of alcohol to feel any effect,	37.8	35.8	42.8	3.91	.048	.62 (.03)	.50 (.06)	

	or that I could no longer get high or drunk on the amount that used to get me high or drunk								
5	I have taken foolish risks when I have been drinking	37.3	34.5	43.9	7.09	.008	.82 (.02)	.84 (.03)	
9	I've not been able to remember large stretches of time while drinking heavily	36.5	35.6	38.6	0.73	.392	.76 (.02)	.79 (.04)	
16	I have felt badly about myself because of my drinking	34.4	35.5	31.8	1.09	.297	.71 (.03)	.58 (.06)	
6	I have passed out from drinking	32.6	29.3	40.4	10.77	.001	.72 (.03)	.69 .05)	
11	I have not gone to work or missed classes at school because of drinking, a hangover, or illness caused by drinking	29.5	28.9	30.7	0.27	.601	.68 (.03)	.53 (.06)	
12	My drinking has gotten me into sexual situations I later regretted	27.7	26.7	29.9	0.96	.327	.77 (.03)	.81 (.04)	
18	The quality of my work or schoolwork has suffered because of my drinking	20.5	21.0	19.3	0.32	.573	.75 (.03)	.42 (.08)	.51 (.07)
14	I have become very rude, obnoxious	19.3	18.1	22.0	1.77	.184	.70 (.03)	.56 (.06)	

	or insulting after drinking								
13	I have often found it difficult to limit how much I drink	19.1	18.1	21.6	1.44	.230	.75 (.03)	.60 (.07)	
19	I have spent too much time drinking	16.3	15.4	18.6	1.34	.247	.78 (.03)	.49 (.08)	.45 (.07)
15	I have woken up in an unexpected place after heavy drinking	14.6	11.0	23.1	22.02	<.001	.72 (.03)	.63 (.06)	
20	I have neglected my obligations to family, work, or school because of drinking	14.4	14.0	15.5	0.36	.550	.83 (.03)	.51 (.08)	.49 (.07)
23	My physical appearance has been harmed by my drinking	10.8	10.5	11.4	0.15	.701	.66 (.04)		.74 (.08)
21	My drinking has created problems between myself and my boyfriend/girlfriend/spouse, parents, or other near relatives	8.2	7.9	8.7	0.14	.704	.73 (.04)	.59 (0.07)	
10	I have driven a car when I knew I had too much to drink to drive safely	8.1	6.7	11.4	5.51	.019	.56 (.05)	.42 (.08)	
22	I have been overweight because of drinking	7.4	7.5	7.2	0.02	.886	.63 (.05)		.90 (.05)
24	I have felt like I needed a drink after I'd gotten up (that is, before	3.2	3.2	3.4	0.03	.860	.58 (.07)		.45 (.13)

breakfast)

Table 1 Legend

Item numbers reflect original item number (Kahler et al., 2005); all factor loadings are significant at $p < .05$.

Table 2

Rasch Model Severity Estimates and Standard Errors, Mean Square Infit and Outfit Indices, and Log Transformed Mantel-Haenszel Coefficients for BYAACQ Items (N = 893)

	Mnsq	DIF

		Severity estimate	SE	I	O	M-H D	*p*-value
1	While drinking, I have said or done embarrassing things	-2.02	0.09	0.66	0.48	0.73	.283
2	I have had a hangover (headache, sick stomach) the morning after I had been drinking	-1.78	0.07	0.78	0.64	0.94	.133
3	I have felt very sick to my stomach or thrown up after drinking	-1.51	0.08	0.89	0.97	0.76	.193
17	I have had less energy or felt tired because of my drinking	-1.26	0.08	1.02	0.90	1.14	.033**
8	When drinking, I have done impulsive things that I regretted later	-0.85	0.08	0.77	0.65	-0.17	.799
4	I often have ended up drinking on nights when I had planned not to drink	-0.49	0.08	1.04	1.04	0.44	.404
7	I have found that I needed larger amounts of alcohol to feel any effect, or that I could no longer get high or drunk on the amount that used to get me high or drunk	-0.39	0.08	1.01	0.99	-0.54	.348
5	I have taken foolish risks when I have been drinking	-0.37	0.08	0.78	0.61	-0.95	.166
9	I've not been able to remember large stretches of	-0.34	0.08	0.85	0.70	-0.03	.961

	time while drinking heavily						
16	I have felt badly about myself because of my drinking	-0.26	0.08	0.90	0.81	0.93	.105
6	I have passed out from drinking	-0.19	0.07	0.88	0.76	-1.17	.067
11	I have not gone to work or missed classes at school because of drinking, a hangover, or illness caused by drinking	-0.06	0.07	0.90	0.82	0.12	.847
12	My drinking has gotten me into sexual situations I later regretted	0.01	0.07	0.82	0.66	-0.06	.925
18	The quality of my work or schoolwork has suffered because of my drinking	0.34	0.07	0.77	0.62	0.64	.323
14	I have become very rude, obnoxious or insulting after drinking	0.41	0.07	0.80	0.66	-0.35	.595
13	I have often found it difficult to limit how much I drink	0.42	0.07	0.75	0.53	-0.26	.698
19	I have spent too much time drinking	0.57	0.07	0.69	0.54	-0.27	.708
15	I have woken up in an unexpected place after heavy drinking	0.68	0.07	0.73	0.49	-2.13	.009*
20	I have neglected my obligations to family, work, or school because of drinking	0.69	0.07	0.63	0.41	-0.03	.964
23	My physical appearance has been harmed by my	0.95	0.06	0.74	0.51	0.04	.962

	drinking						
21	My drinking has created problems between myself and my boyfriend/girlfriend/spouse, parents, or other near relatives	1.18	0.06	0.59	0.35	0.04	.969
10	I have driven a car when I knew I had too much to drink to drive safely	1.19	0.06	0.70	0.69	-1.21	.196
22	I have been overweight because of drinking	1.26	0.06	0.67	0.50	0.34	.713
24	I have felt like I needed a drink after I'd gotten up (that is, before breakfast)	1.82	0.06	0.52	0.52	0.08	.954

Table 2 Legend

Item numbers reflect original item number (Kahler et al., 2005). SE = standard error. Mnsq = Mean square; I = infit; O = outfit. DIF = Differential item functioning; M-H D = Log transformed Mantel-Haenszel coefficient; *p*-values > .05 indicate no significant differences between the scores of men/women. [*]Bias against women. [**]Bias against men.

Table 3

Descriptive Statistics for the App Sub-Sample (n = 504) Plus Correlations With BYAACQ Score

	M (*SD*)	Correlation
Age	21.69 (4.81)	.19*
Years of education	14.56 (2.03)	.08
GAD-7	5.02 (5.15)	.16*
PHQ-9	6.19 (5.29)	.19*
AUDIT	8.10 (5.30)	.67*
ASSIST	8.33 (15.15)	.42*

Percent days drinking	24.93 (18.62)	.33*
Total drinks	23.13 (24.06)	.44*
Drinks per drinking day	4.04 (3.03)	.40*
Hourly rate of intake	2.34 (2.17)	.08
5/5+ intake	1.59 (2.04)	.41*

Table 4

Unstandardised and Standardised Beta Values for the Hierarchical Multiple Regression Predicting Brief Young Adult Alcohol Consequences Questionnaire Scores From Chronological Age, Depression (PHQ-9), Anxiety (GAD-7), Drug Use (ASSIST Excluding Alcohol), App-Derived Current Drinking Indices, and Age at First Drink

	Unstandardised		Standardised		
	B	*SE*	*β*	*p*	CI 95%
Model 1					
Constant	3.25	1.05			
Age	0.20	0.05	.19	< .001	[0.11, 0.29]
Model 2					
Constant	-0.65	1.01			
Age	0.19	0.04	.18	< .001	[0.11, 0.28]
Percent drinking days	0.06	0.01	.20	< .001	[0.03, 0.08]
Drinks per drinking day	0.64	0.07	.37	< .001	[0.50, 0.78]

Model 3					
Constant	-2.08	1.03			
Age	0.18	0.04	.17	< .001	[0.10, 0.27]
Percent drinking days	0.05	0.01	.16	< .001	[0.02, 0.07]
Drinks per drinking day	0.58	0.07	.33	< .001	[0.44, 0.71]
≤ 15 age at first drink (vs. 18)	3.47	0.55	.33	< .001	[2.38, 4.53]
16/17 age at first drink (vs. 18)	2.13	0.54	.20	< .001	[1.07, 3.20]
Model 4					
Constant	-1.42	0.98			
Age	0.16	0.04	.15	< .001	[0.08, 0.24]
Percent drinking days	0.04	0.01	.13	.001	[0.02, 0.06]
Drinks per drinking day	0.52	0.07	.30	< .001	[0.39, 0.64]
≤ 15 age at first drink (vs. 18)	2.64	0.53	.25	< .001	[1.59, 3.68]
16/17 age at first drink (vs. 18)	1.85	0.52	.17	< .001	[0.83, 2.86]
ASSIST	0.10	0.01	.28	< .001	[0.07, 0.12]
Model 5					
Constant	-2.69	1.02			
Age	0.18	0.04	.17	< .001	[0.10, 0.26]
Percent drinking days	0.04	0.01	.13	.001	[0.02, 0.06]
Drinks per drinking day	0.54	0.07	.31	< .001	[0.41, 0.67]
≤ 15 age at first drink (vs. 18)	2.49	0.53	.23	< .001	[1.45, 3.52]

16/17 age at first drink (vs. 18)	1.73	0.51	.16	.001	[0.72, 2.73]
ASSIST	0.09	0.01	.25	< .001	[0.06, 0.11]
PHQ-9	0.14	0.05	.14	.011	[0.03, 0.24]
GAD-7	0.01	0.05	.01	.894	[-0.10, 0.11]

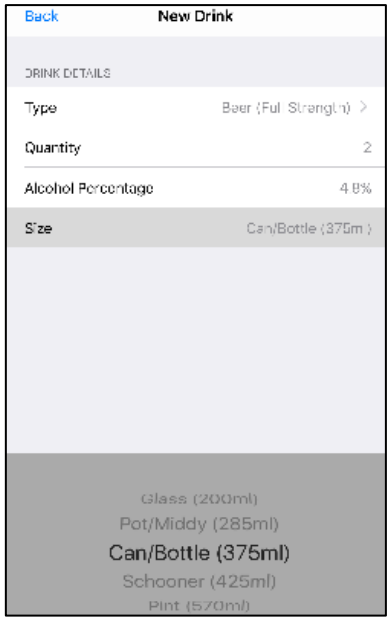
Table 4 Legend

SE = standard error; CI = confidence interval. Drinks refer to self-reported alcohol consumption in Australian standard drinks (1 drink = 10 g alcohol). Age at first drink was dummy coded with ≥ 18 as baseline. GAD-7 = Generalised Anxiety Disorder screen; PHQ-9 = Patient Health Questionnaire; ASSIST = Alcohol, Smoking and Substance Involvement Screen (excludes alcohol components).

(A)

(B)

(C)



(D)