Utility of the Brief Young Adult Alcohol Consequences Questionnaire to identify college students at-risk for alcohol related problems: Relative Operating Characteristics across Seven Countries

Abstract

The present study examined the utility of the B-YAACQ to distinguish among students at-risk for problematic alcohol use as measured by the AUDIT. A sample of 6382 students (mean age=20.28, SD=3.75, 72.2% females) from seven countries (i.e., U.S., Canada, South-Africa, Spain, Argentina, Uruguay, England) completed the B-YAACQ, the AUDIT and different measures of alcohol use. ROC analyses suggested that a cutoff score of 5 maximized the YAACQ's discrimination utility to differentiate between students at low versus moderate/high risk in the total sample and across countries (except in Canada, where the cutoff was 4). In addition, a cutoff of 7 differentiated between students at low/moderate versus high risk in the total sample, while cutoffs of 10, 9, 8 and 7 differentiate between students at low/moderate versus high risk in Uruguay, U.S and Spain (10), Argentina (9), England (8), and Canada and South-Africa (7), respectively. Students classified at the three risk levels (i.e., low, moderate and high) differed in age (i.e., a younger age was associated with higher risk) and drinking patters (i.e., higher drinking frequency, quantity, binge drinking and AUDIT and B-YAACQ scores in the higher risk groups). This study suggest that the B-YAACQ is a useful tool to identify college students at-risk for experiencing problematic patterns of alcohol use.

Keywords: college students, alcohol, ROC analyses, screening, alcohol-related problems

Introduction

Alcohol use is prevalent among college students around the world. Rates of past-month alcohol use are high: close to 70% of students sampled from several universities from Canada (American College Health Association, 2016), 81% of a sample of students from U.S., Spain and Argentina (Bravo et al., 2019), and around 90% of students sampled from one university in the U.K. ([94.5%]; Jones et al., 2014). Students exhibit a wide variety of drinking patterns, from light to more intense alcohol use (Busto Miramontes et al., 2021; Calhoun & Maggs, 2021; Patrick, 2016; Tarrant et al., 2016), including heavy episodic drinking. The latter drinking pattern is usually defined as the consumption of 56/70 (for male/female, respectively) grams of alcohol within a ≤2-hours drinking session (National Institute on Alcohol Abuse and Alcoholism, 2004) or within one drinking session (Substance Abuse and Mental Health Services Administration, 2019). Noteworthy, a substantial portion of college students around the world report patterns of problematic alcohol use (Davoren et al., 2016).

Frequency of heavy episodic drinking and problematic patterns of alcohol use are significantly positively associated with alcohol-related negative consequences that affect different areas (i.e., physical, legal, emotional, social, and cognitive) of a students' life and also of those around them (Kenney et al., 2018; Krieger et al., 2018; Merrill & Carey, 2016; Pearson et al., 2016). These consequences range from relatively mild and usually more frequent (e.g., having a hangover, saying or doing embarrassing things) to more severe and less prevalent (e.g., neglecting work or family obligations, drunk driving), the latter of which include an increased likelihood of developing an alcohol use disorder (Prince et al., 2019).

The Brief YAACQ to measure alcohol-related problems in college students

It is of utmost importance to identify students who would benefit from early

interventions to reduce harmful drinking patterns and associated consequences. Modified from the full 48-item YAACQ (Read et al., 2006), the Brief Young Adult Alcohol Consequences Questionnaire (B-YAACQ; Kahler et al., 2005) encompasses 24 items that assess alcohol-related negative consequences typically reported by college students. Studies across countries and languages, conducted in the context of Classical Test Theory or Item Response Theory (Ferreira et al., 2014; Kahler et al., 2005; Pilatti et al., 2014; Verster et al., 2009; Zhang et al., 2019; Zamboanga et al., 2021), have established the psychometric properties of this measure. Additionally, the B-YAACQ is fast to administer and easy to score. Specifically, using a dichotomous format [yes/no], participants report whether or not they experienced each consequence and, by summing the affirmative answers, the total score reflects the total number of experienced problems within a given timeframe (typically past month).

The B-YAACQ could be particularly useful in university settings, as a screening tool to identify students demonstrating problematic patterns of alcohol use. This identification is key to promote early intervention. A relevant step to accomplish this goal involves providing empirically derived cutoffs to differentiate students exhibiting different levels of problem drinking. Past research (Read et al., 2016) has empirically identified cutoffs for the full YAACQ that represent problem drinking based on the scores provided by the Alcohol Use Disorders Identification Test ([AUDIT]; Babor et al., 2001). The AUDIT was developed by the World Health Organization to screen for excessive drinking. The manual recommends that scores between 8 and 15 are indicative of hazardous drinking while scores greater than 15 are indicative of harmful use (Babor et al., 2001). Read and colleagues (2016) found that a cutoff of 8 differentiated between those at low risk (i.e., AUDIT score $\leq$7) from those at moderate/high risk (i.e., AUDIT score $\geq$8) on the full YAACQ. Moreover, those endorsing

16 alcohol-related negative consequences were efficiently identified as at high risk (i.e., AUDIT score ≥16) and differentiated from those at low/moderate risk. However, limited research has empirically established cutoffs for the B-YAACQ.

The empirical identification of the cutoffs scores for the B-YAACQ that denote problem drinking will provide a guideline to identify students at-risk based on this briefer measure. The present study aimed to extend previous findings with the full YAACQ (Read et al., 2016) by empirically identifying cutoffs for the B-YAACQ in a large, multi-national sample (U.S., Canada, England, South-Africa, Spain, Uruguay, and Argentina). We also sought to determine whether cutoffs were invariant across countries. Past research suggests that different cutoffs for the AUDIT should be used for male and female college students (Demartini & Carey, 2012). Therefore, we also calculated ROC curves within each sex.

Method

Sample and procedure

Participants were college students from 13 universities across seven countries: U.S. (5 universities across four states: Colorado, New Mexico, New York, Virginia), Canada (2 universities located in the Ontario and Manitoba provinces), Argentina (2 universities in the province of Cordoba), England, South Africa, Spain, and Uruguay. The analytical sample for the present study only included data from participants who reported drinking alcohol at least one day within the past month and completed the AUDIT measure (n=6,382). The distribution of the sample across countries and sex is presented in Table 1. Mean age significantly differed across countries ($F = 133.77$; $p \leq .001$). Specific differences across countries, as explored via Tukey's *post-hoc* test, are described in Table 1.

Students were invited to participate in a study assessing risk and protective factors associated with addictive behaviors (see Bravo et al. 2021 for more details). For the English-

speaking sites (i.e., U.S., Canada, England and South-Africa), students were recruited from Psychology Department pools and received research participation credit. In Argentina and Uruguay an invitation was disseminated through online social networks, e-mail listings, or flyers. In these two countries, different prizes were raffled among participants who completed the survey (Uruguay: 10 cash prizes [each of ≈US$ 20 at the time]; Argentina: 25 prizes each one of ≈US$ 10 at the time [10 vouchers for a bookstore and 15 cash prizes]). In Spain, all the students of the university were sent an email invitation to participate; those who completed the survey received 5 euros.

Students interested in participating completed an online survey programmed following a planned missingness design (Graham et al., 2006; Schafer, 1997). Specifically, all participants completed the sociodemographic and substance use measures which were followed by a randomly selected set of 12, out of a total of 17, measures. The study procedures were approved by the institutional review boards (or the international equivalent) for each participating university.

Measures

Reliability analyses (ω de McDonald) of each measure, estimated for the total sample and across countries, are presented in Table 1.

Alcohol Use. In this study, alcohol use frequency was assessed by asking how many days in the past month (possible range: 1-30 days) did students consume alcohol. Further, frequency of heavy episodic drinking was assessed using a similar approach but focused on heavy episodic drinking days in the past month (possible range 0-30). Participants also reported the number of Standard Drink Units (SDUs) they consumed during each of six 4-hour blocks (12a-4a, 4a-8a, 8a-12p, etc.) during a "typical week" in the past 30 days. To familiarize participants with the SDUs concept, they were presented a visual guide about

typical drinks (specific to each country). The typical quantity of alcohol use was calculated by first adding the total number of SDUs across time blocks and then transforming this value into grams of alcohol (considering country specific SDU rates based on grams of alcohol). Quantity estimates >3SDs above the mean were Winsorized.

Alcohol-related Problems. The 24-item B-YAACQ (Kahler et al., 2005) was used for measurements in U.S., Canada, South Africa and England. The Spanish version of this measure (Pilatti et al., 2014) was employed for measurements in Argentina, Spain, and Uruguay. Across countries, participants indicated whether (0=*no*, 1=*yes*) they experienced the alcohol-related problem described by each item, in the past month. Items are scored dichotomously and the total score was calculated by summing all the affirmative responses which reflects the total number of negative consequences experienced in that time period. This measure exhibits measurement invariance across countries (Chentsova et al. 2022).

Alcohol Use Disorder Identification Test. We used the Alcohol Use Disorder Identification Test - US (AUDIT-US; Higgins-Biddle & Babor, 2018) which is a modified version of the Alcohol Use Disorders Identification Test (Babor et al., 2001; Saunders et al., 1993). Participants were presented the same visual guide about SDU described in the previous section. For measurement in Spain, the wording of item 3 (i.e., How often do you have 5 or more SDU [if male] or 4 or more SDU [if female] on one occasion?) was adjusted to reflect how a standard unit is measured in that country where one standard drink contains 10 grams of alcohol (i.e., How often do you have 7 or more SDU [if male] or 5.5 or more SDU [if female] on one occasion?). For the same reason, in Spain we used an open question for item 2 (which originally has these options: 1 drink, 2 drinks, 3 drinks, 4 drinks, 5-6 drinks, 7-9 drinks, and ≥10 drinks). That is, Spanish participants reported the number of SDUs they consumed. To make accurate comparisons, we scored their written responses similar to those

reported by students in other countries (e.g., 7 drinks was coded as 6-7). Additionally, the AUDIT-US contains more response options for items 1 to 3 than the original AUDIT (e.g., the AUDIT-US includes the options "4-6 times a week" and "daily" while the original AUDIT include one option "≥4 times a week"). Therefore, for the present study, responses to items 1 and 3 were adjusted to reflect the response options of the original AUDIT. For example, item 1 of the AUDIT-US includes the options "less than monthly" and "monthly" and item 2 includes the options "1 drink", "2 drinks", "3 drinks" and "4 drinks". These options were collapsed to match the options "monthly or less" (item 1) or "1 or 2 drinks" and "3 or 4 drinks" (item 2), respectively, in the original AUDIT. The AUDIT (Babor et al., 2001; Saunders et al., 1993) is comprised of 10 items and has been used worldwide to assess harmful drinking in college students (Devos-Comby & Lange, 2008). Items are answered with an ordinal response scale across two domains: alcohol consumption (items 1 to 3) and problematic use (items 4 to 10). The first eight items are rated on a 5-point scale (range=0 to 4), whereas the two remaining items are rated on a 3-point scale (scored 0, 2, or 4). Responses are summed to generate a total score (range=0-40) where higher scores indicate more hazardous drinking patterns (Babor et al., 2001).

Data analysis plan

We examined drinking behaviors (frequency and quantity questions, binge drinking status and binge drinking frequency), alcohol-related negative consequences (B-YAACQ) and hazardous drinking patterns (AUDIT) using descriptive statistics. Then, we conducted receiver operating characteristic (ROC) analyses to determine scores of the B-YAACQ that denotes different levels of risk based on established AUDIT cutoffs. The ROC is a statistical and graphical tool broadly used to describe the diagnostic accuracy of an instrument or test against a gold standard measurement (Obuchowski & Bullen, 2018). Two key terms related

to ROC analyses are sensitivity and specificity, which respectively describe the proportion of positives that were correctly identified as exhibiting the condition (sensitivity) and the proportion of negatives that were correctly identified as not exhibiting the condition (specificity; Carter et al., 2016). Additionally, the positive predictive values (PPV) and the negative predictive values (NPV) refer to the probability that the condition is present when the test is positive (PPV) and the probability that the condition is not present when the test is negative (NPV).

More in detail, ROC curves assess the discriminative utility of a cutoff by plotting sensitivity (i.e., the true positive rate) against 1- specificity (i.e., the false positive rate) and calculating the sensitivity and specificity of the instrument at every possible cutoff point (Akobeng, 2007). The area under the curve (AUC) provides a summary metric that takes into account both sensitivity and specificity. The closer the AUC values are to 1.00 ([100% of the area], perfect discrimination), the greater the cutoff's ability to differentiate between those meeting the criteria and those not meeting the criteria (Cherpitel, 1995). Values of .80 or higher suggest good discrimination while values of .70 or lower indicate poor discrimination (Read et al., 2016). We also used a Likelihood Ratio (LR) index, a global measure of the discriminant power of the diagnostic test that does not vary with prevalence of the condition in the sample under examination (Šimundić, 2009). One method to determine optimal cutoffs points is the Youden's index (J = sensitivity + specificity – 1; Youden, 1950). Its maximum value of 1.00 indicates a perfect test in terms of its diagnostic capacity, while values close to 0 suggest the test has no diagnostic predictability (Demartini & Carey, 2012). We used this index to determine an appropriate cutoff score that can be applied to indicate different levels of at-risk drinking.

We first estimated ROC curves to determine the cutoff score for the B-YAACQ that

differentiate between individuals exhibiting low versus moderate/high risk and then we conducted another ROC analysis to identify the cutoff score for the B-YAACQ that discriminate between those with low/moderate versus high risk. In each we examined the ROC curves for the total sample and then calculated ROC curves within each country. Therefore, and following Read et al.'s (2016) reference study, we empirically determine two cutoffs' points on the B-YAACQ indicative of three different levels of risk (i.e., low, moderate, and high). We also calculated ROC curves within each sex; however, due to sample size restrictions, these analyses were conducted only with the total sample. Considering that countries differed in the age of the participants, we estimated ROC curves for the subsample of participants corresponding to the developmental stage of emerging adulthood (i.e., participants age between 18 years to 25 years of age, Sussman & Arnett, 2014). The aim was to assess if this subsample exhibited a different pattern of results, compared to the total sample. All descriptive analyses were done using SPSS Version 22 and all ROC analyses were calculated using SPSS Version 22 and *jamovi* (Version 2.2).

Results

Descriptive results

Table 1 presents descriptive results on different drinking outcomes. Across countries, the mean of drinking days within the previous month was around 5 for most of the countries, 6 days for students in South Africa and close to 9 in England. The occurrence of binge drinking within the previous 30 days was above 60% for all English-speaking countries (with more than 80% of the students in England reporting this pattern of alcohol use) and below that percentage for all Spanish-speaking countries. With the exception of England, who reported more moderate drinking risk levels, the majority of the students across countries reported AUDIT's scores ≤7, denoting low risk drinking. Across all countries but England,

the percentage of students at high-risk was close to 10% in South Africa and around 7% or less for the remaining countries. In England, close to 1 out of 5 students (18.9%) were categorized at high-risk.

ROC analyses to differentiate low versus moderate/high risk

Table 2 shows the sensitivity, specificity, PPV, NPV, AUC and Youden's index. The latter determined the cutoff score for the B-YAACQ that best differentiates low versus moderate/high risk. Results are presented for the total sample, across sex and across country.

Total sample. This first ROC analyses provided an AUC value of .823 (SE = .05) and had a 95% confidence interval (CI) from .81 to .83. Therefore, the B-YAACQ performed better than chance to differentiate those individuals with low-risk from those individuals with moderate/high risk. Based on the Youden J values, the cutoff score that provides a more adequate balance between sensitivity and specificity to discriminate between the two conditions was 5 (see Table 2). This score allowed to correctly identify 75.4% of the students in the corresponding condition (low versus moderate/high risk). At this score, the increase in odds favoring at-risk condition (LR+) is 3.12 (CI 95%, 2.91-3.31).

Female. The estimated ROC curves provided an AUC value of .824 (SE= .01; CI 95%, .81-84). Based on the Youden J values, the cutoff score that provides a more adequate balance between sensitivity and specificity to discriminate between the two conditions was 5 (see Table 2). This score allowed to correctly identify 74.6% of the female subsample in the corresponding condition (low versus moderate/high risk). At this score, the increase in odds favoring at-risk condition (LR+) is 2.94 (CI 95%, 2.75-3.15).

Male. The estimated ROC curves provided an AUC value of .829 (SE= .01; CI 95%, .81-.85). The Youden J index suggested that a score of 5 was the cutoff score that maximized the discrimination utility of the test (see Table 2). This score allowed to correctly identify

76% of the male participants in the corresponding condition (low versus moderate/high risk). At this score, the increase in odds favoring at-risk condition (LR+) is 3.65 (CI 95%, 3.18-3.4.18).

U.S., South African, Spanish, Argentinean, Uruguayan and English samples. For all these samples, the Youden J index suggested that a score of 5 was the cutoff score that maximized the discrimination utility of the test (see Table 2). ROC analyses to differentiate between low and moderate/high risk college students provided an AUC value of .81 (SE= .01; CI 95%, .79-.83) within the sample of U.S.; an AUC value of .85 (SE= .02; CI 95%, .81-.88) within the sample of South Africa; an AUC value of .79 (SE= .02; CI 95%, .75-.83) within the sample of Spain; an AUC value of .80 (SE= .02; CI 95%, .77-.83) within the sample of Argentina; an AUC value of .80 (SE= .05; CI 95%, .70-.91) within the sample of Uruguay, and an AUC value of .87 (SE = .02; CI 95%, .83-.91) within the sample of England (see Figure 1). The cutoff of 5 correctly identified in the corresponding condition 74.1% of the U.S. students (LR+ 2.95 [CI 95%, 2.69-3.23]); 75.8% of the students from South-Africa students (LR+ 2.75 [CI 95%, 2.32-3.26]); 73.9% of the students from Spain (LR+ 2.95 [CI 95%, 2.40-3.63]); 72.8% of the students from Argentina (LR+ 2.73 [CI 95%, 2.31-3.22]); 83.8% of the students from Uruguay (LR+ 5.67 [CI 95%, 3-11-10.34]), and 81.3% of the students from England (LR+ 3.63 [CI 95%, 2.67-4.95]).

Canadian sample. These ROC analyses provided an AUC value of .84 (SE= .01; CI 95%, .82-.87). The Youden J index suggested that a score of 4 maximized the discrimination utility of the test to differentiate between low versus moderate/high risk (see Table 2). This cutoff correctly identified 75.7% of the Canadian students in the corresponding condition. At this score, the increase in odds favoring at-risk condition (LR+) is 2.99 (CI 95%, 2.63-3.40).

ROC analyses to differentiate low/moderate versus high risk

Table 3 shows the sensitivity, specificity, PPV, NPV, AUC and Youden's index conducted to determine the cutoff score for the B-YAACQ that differentiate between individuals exhibiting low/moderate versus high risk. Results are presented for the total sample, across sex, and across countries.

Total sample. Using the total sample, this first ROC analyses provided an AUC value of .89 (SE= .01; CI 95%, .88-.91) which implies that the B-YAACQ performed better than chance to differentiate between students at low versus at moderate/high risk. Based on the Youden J values, the cutoff score that provided the most adequate balance between sensitivity and specificity to discriminate between the two conditions was 7. Using the score of 7 as a cutoff allowed to correctly identify 78% of the students in the corresponding condition (low/moderate versus high risk). At this score, the increase in odds favoring at-risk condition (LR+) is 3.83 (CI 95%, 3.61-4.06).

Female. The value of the estimated AUC was .91 (SE= .01; CI 95%, .89-.92) and the Youden J values suggested a score of 7 is the cutoff score that provided the most adequate balance between sensitivity and specificity to discriminate between the two conditions (see Table 3). This score allowed to correctly identify 78.2% of women in the corresponding condition (low/moderate versus high risk). At this score, the increase in odds favoring at-risk condition (LR+) is 3.99 (CI 95%, 3.73-4.27).

Male. The estimated ROC curves provided an AUC value of .86 (SE= .02; CI 95%, .83-.89) and the Youden J index identified the score of 7 as the cutoff that maximized the discrimination utility of the test (see Table 3). This score allowed to correctly identify 77.2% of male students in the corresponding condition (low versus moderate/high risk) and, at this score, the increase in odds favoring at-risk condition (LR+) is 3.51 (CI 95%, 3.13-3.94).

U.S. sample. ROC analyses provided an AUC value of .88 (SE= .01; CI 95% .85-

.91). These results and those for the other countries are presented in Figure 2. The Youden J index suggested that a score of 10 maximized the discrimination utility of the test. However, based on the same J index, a score of 9 also provided an adequate balance between sensitivity and specificity. Scores of 9 and 10 correctly identified 85.5% and 88.7% of the U.S. students, respectively. At the score of 10, the LR+ is 7.19 (CI 95%, 6.23-8.30) and at the score of 9 the LR+ is 5.51 (CI 95%, 4.87-6.23). Based on these values, the score of 10 was selected as the most adequate cutoff.

Canadian sample. ROC analyses provided an AUC value of .90 (SE= .02; CI 95%, .87-.93). Based on the Youden J index, a score of 7 maximized the discrimination utility of the test and correctly identified 81.3% of the students from Canada. The LR+ is 4.53 (CI 95%, 6.23-8.30).

South African sample. ROC analyses generated an AUC value of .88 (SE= .02; CI 95%, .84-.92). The Youden J index (0.59) indicated that a score of 6 maximized the discrimination utility of the test. Despite a reduction in sensitivity, a score of 7 (0.59) also provided an adequate balance between sensitivity and specificity. The score of 6 and the score of 7 correctly identified 66% and 72.1% of the students, respectively. At the score of 6, the LR+ is 2.58 (CI 95%, 2.27-2.93) while at the score of 7, the LR+ is 2.98 (CI 95%, 2.52-3.53). Based on these values, the score of 7 was selected as the most adequate cutoff.

Spanish sample. The analyses provided an AUC value of .89 (SE= .04; CI 95%, .81-.96). The Youden J index identified that a score of 10 maximized the discrimination utility of the test and correctly identified 91.8% of the students from Spain in the corresponding condition. At this score, the LR+ is 10.08 (CI 95%, 6.89-14.75).

Argentinean sample. The analyses generated an AUC value of .90 (SE= .03; CI 95%, .84-.96). The Youden J index indicated that 9 was the cutoff score that maximized the

discrimination of the test. This cutoff correctly identified 88.4% of the students and the increase in odds favoring at-risk condition (LR+) is 7.12 (CI 95%, 5.49-9.23).

Uruguayan sample. ROC analyses generated an AUC value of .99 (SE= .01; CI 95%, .98-1.00). Although the Youden J index indicated that a score of 11 maximized the discrimination utility of the test, all the estimated ROC curves for the range of scores from 9 to 11 provided 100% of sensitivity and ≥94% of specificity, suggesting that the three scores provided an adequate balance between sensitivity and specificity. Notably, the sensitivity and specificity values corresponding to a cutoff score of 10 or 11 were almost identical. The score of 10 as the cutoff correctly identified 97.7% of the students (LR+ 42.33 [CI 95%, 13.84-129.51]) while the score of 11 correctly identified 98.5% of the students (LR+ 63.5 [CI 95%, 16.06-251.14]). Based on these values, and also considering the values of the remaining countries, the score of 10 was selected as the most adequate cutoff.

English sample. ROC analyses generated an AUC value of .92 (SE= .02; CI 95% .86-.94). The cutoff score that provided the most adequate balance between sensitivity and specificity was 8 (based on Youden J index). This cutoff correctly identified 77.6% of the students. The LR+ is 3.55 (CI 95%, 2.89-4.36).

ROC analyses to differentiate low versus moderate/high risk and low/moderate versus high risk among the subsample of emerging adults

The ROC analyses (see Supplementary Table 1) for emerging adult participants were identical to those found for the total sample. Specifically, based on the Youden J values, the cutoff score that provides a more adequate balance between sensitivity and specificity to discriminate between low and moderate/high risk conditions was 5 and between low/moderate and high risk was 7.

Differences in sociodemographic variables and alcohol outcomes across B-YAACQ levels of risk.

We classified students in each of three different levels of risk, based on the previously presented ROC results. Specifically, a first category corresponded to scores up to five (for all countries but Canada where this level corresponded to scores up to 4) and represented a low level of risk. A second category corresponded to a moderate level of risk and included scores between 6 and 10 for U.S., Uruguay and Spain, between 5 and 7 for Canada, between 6 and 7 for South Africa, between 6 and 9 for Argentina, and between 6 and 8 for England. The third at-risk category represented a high-risk level and it corresponded to scores 10 or higher for Argentina, 8 or higher for Canada and South Africa, 11 or higher for U.S., Uruguay and Spain, and 9 or higher for England. Within the total sample, 64% of the students endorsed a number of alcohol problems indicative of low risk while 36% endorsed consequences that are indicative of moderate or high risk.

We examined differences in sociodemographic variables (age, sex) and drinking behaviors across the three at-risk levels. These results are presented in Table 4. The proportion of women and men in each of the three Levels (1, 2 or 3) was similar and there was not a significant association between these two variables. Participants classified in Levels 2 and 3 were significantly younger than students classified in Level 1. Drinking behaviors and alcohol-related problems significantly differed across levels. Specifically, students classified in Level 1 reported drinking significantly less frequently and at a lower quantity than students classified in Level 2 who, in turn, reported drinking less (in frequency and quantity) than students classified in Level 3. Among those students classified in Level 3, the percentage reporting binge drinking within the previous month almost doubled in percentage compared to those classified in Level 1. Regarding the total score in the B-

YAACQ and in the AUDIT, participants classified in Level 3 endorsed, as expected, significantly more alcohol-related problems and higher severity of hazardous drinking than students classified in Level 2 who, in turn, endorsed more problems than participants in Level 1.

A unique feature of the B-YAACQ is that items are ordered by severity (Kahler et al., 2005), which is generally consistent across countries (Pilatti et al 2014; Verster et al., 2009). Overall, we found evidence that supports this assertion. As shown in Supplementary Table 2 and as assessed via logistic regression, there were some significant associations between country membership and endorsement of each B-YAACQ item. The effect size of these significant associations was, however, negligible (ΔR^2 [$0.13 \leq 0.26$]). Subsequently we used the empirically identified cutoffs to assess, using logistic regression, if low versus moderate, and moderate versus high, participants differed in the endorsement of the B-YAACQ items. Several associations achieved significance, yet their effect size was negligible. The association between the endorsement of the item "Had less energy or felt tired because of my drinking" and membership into the moderate versus low risk was significant and the effect size was large (see Supplementary Table 3).

Discussion

In a large and diverse sample of college students from around the world, the present study identified empirically-based cutoffs for the B-YAACQ that outline different levels of problem drinking. These cutoffs were validated against the AUDIT, a measure widely used to identify hazardous drinking patterns. We also examined the performance of these cut offs across the seven countries represented in our sample, finding both convergence and divergence in the identification of risk across cultures.

We identified two empirical cutoffs for the B-YAACQ that permitted to discriminate

among three risk levels (Low, Moderate, High) that resemble categories established by the AUDIT. Specifically, in the total sample, a cutoff of 5 for the B-YAACQ discriminated between students at low versus moderate/high risk. That is, students reporting more than five affirmative responses on the 24-item B-YAACQ can be reliably used as a cutoff to identify at least a moderate level of risk. Specifically, a score of 5 correctly classified at least 72% of the participants, distinguishing low versus moderate/high risk. Notably, this cutoff was generally similar across countries, denoting at least moderate risk across six of the seven examined countries (i.e., U.S., Spain, South-Africa, Argentina, Uruguay and Argentina), with a slightly lower cutoff (i.e., 4) for Canadian students in the sample.

Our findings also provided a cutoff to differentiate between students exhibiting low or moderate risk versus those at high risk. At the total sample level, we found that a score of 7 alcohol-related consequences measured by the B-YAACQ represents an adequate balance between sensitivity and specificity. Across countries, however, results provided different cutoffs ranging between 7 and 10 affirmative responses to reliably identify students at risk. This variability could be associated with possible variations in the frequency that these problems are experienced by students across countries. Past research (Pilatti et al., 2014; Verster et al., 2009) noted that some problems of the B-YAACQ may be more common for college students from a particular region or country which might influence the type or number of alcohol-related problems experienced by these college students.

Of note, past research has shown that the item content of the B-YAACQ along the *severity* continuum (i.e., the most and least difficult [i.e., severe] at ends of the difficulty spectrum) was largely similar for college students of Argentina (Pilatti et al., 2014), Belgium (Verster et al., 2009), and the U.S. (Kahler et al., 2005), suggesting that the B-YAACQ adequately measures problems from low to high severity in students from different countries.

Despite the noted variability in the cutoffs differentiating the different levels of risk, particularly those concerning low/moderate versus high risk, some commonalities could be proposed. Specifically, it seems that a cutoff of 5 could be used across countries to differentiate between participants at low versus moderate/high risk. Additionally, a cutoff of 8 could be a reasonable cutoff to distinguish participants at low/moderate versus high risk, across countries.

At a descriptive level we found that, with one exception (England site), more than half of the sample (>60%) was classified as exhibiting low hazardous alcohol drinking patterns (as measured by the AUDIT). The higher occurrence of hazardous drinking patterns found in England is consistent with past research (Davoren et al., 2016; Tarrant et al., 2019). Using the cut-scores established for the B-YAACQ, our results showed that the majority of the sample was classified in the first level representing low risk. Again, this prevalence was around >60% for six countries but lower than 48% for students from England. Strikingly, we found that a statistically similar percentage of women and men were classified in each at-risk category. This is different from the study of Read and colleagues' (2016), where women were more likely to be classified in the lower risk categories. This seemingly contradictory result is, however, in line with recent research showing narrower differences in alcohol use between men and women (McCaul et al., 2019; White, 2020). Since the B-YAACQ measures fewer alcohol-related consequences than the full YAACQ, it is also possible that there was less room to detect sex-related variability.

Clinical Implications

These findings offer some potential implications for the facilitation of campus-based interventions. Though a number of intervention programs designed to reduce harmful drinking exist (e.g., Marlatt et al., 1998; Terlecki et al., 2015; Scott-Sheldon et al., 2014;

Skidmore et al., 2016), student-initiated engagement with these interventions tends to be low (Borsari et al., 2018; Caldiera et al., 2009; Cranford et al., 2009). An important direction for alcohol prevention efforts is to proactively identify and engage students in intervention and services to reduce risky drinking. Using cutoffs identified here, the B-YAACQ could be a part of such preventive efforts. Specifically, with the identification of three distinct zones of risk (Low, Moderate, High) the B-YAACQ could be used as part of a comprehensive process that identifies harmful drinking patterns and connects students with services that are appropriate to their level of risk (screening, brief intervention, and referral to treatment; SBIRT). For example, those identified in the "Moderate" risk category may be referred to lower-level, harm-reduction based intervention efforts geared toward reducing such consequences (e.g., Brief Motivational Interventions, Normative Feedback Interventions, peer-based intervention). In contrast, those who scored in the highest risk zones, may be better suited for more intensive interventions.

Most colleges have procedures in place to screen their students for harmful patterns of alcohol involvement. However, much of this screening takes place in indicated (once a problem already is in evidence) rather than universal (delivered to all) settings. As such, early identification is less likely (Lenk et al., 2012). The brief format of the B-YAACQ lends itself to early screening efforts, conducted on a larger (universal) scale. Indeed, some recent data suggest that students may be especially receptive to earlier and more universal efforts to intervene on harmful drinking (Meister et al., 2022).

Limitations and future research

Across countries, sample size varied by country, and our Uruguay subsample was particularly small. Additionally, the mean age of the participants from Uruguay was significantly greater than that found in students from the other countries. However, this does

not seem to be a bias of our sample, but instead an idiosyncratic feature of college students from Uruguay. It has been reported that the mean age of the college students in the largest public university in Uruguay is 26 (General Directorate of Planning, 2019), which equals that found in the present study. Thus, findings regarding Uruguay require cautious interpretation. Another limitation is that among all countries but Uruguay, the majority of the students were in their first or second year of college while almost all the students from England were first years. Students in their first or second year are most likely to still be adjusting to the college environment which may impact their alcohol consumption and/or the alcohol-related problems they experience (Merrill & Carey, 2016). It will be important to replicate our results in samples with more heterogeneity regarding years in college. An additional valuable aim to purse in future research, which also illustrates an additional limitation of the present study, is to longitudinally examine trajectories or patterns of alcohol use and alcohol-related problems for students classified at different levels of risk. As past research suggested different cutoffs should be used for male and female college students with the AUDIT (Demartini & Carey, 2012), it is a limitation that we were not able to examine, due to sample size restrictions, this possibility. Future research should examine sex differences of these cutoffs within each country.

Conclusions

Overall, we found support for the use of the B-YAACQ to classify students at different risk levels for problematic drinking. Specifically, five or more reported consequences on the B-YAACQ differentiated low to moderate/high risk (based on scores from the AUDIT) and this cutoff was fairly consistent across countries. In differentiating between low/moderate and high risk, a cutoff score of 8 seems optimal. However, cutoff scores varied across countries, suggesting cross-national specificity is needed when

identifying high-risk college student drinkers within each country. Although the cutoffs of 5 and 8 could be proposed, future research is needed to examine the clinical utility of such scores, and if supported, our findings provide a mechanism for identifying at-risk college students who may need early prevention/intervention efforts to reduce long-term negative consequences.

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Table 1.
Descriptive statistics among study variables in total sample and by country

	Total sample	U.S.	Canada	England	South-Africa	Spain	Argentina	Uruguay
Total sample size	6382	2800	1147	402	541	571	791	130
Sex								
Male	27.3%	31.0%	29.6%	18.9%	16.6%	27.5%	24.0%	13.8%
Female	72.2%	68.5%	69.3%	80.1%	82.6%	72.3%	75.7%	86.2%
Other, Missing	0.5%	0.4%	1.0%	1.0%	0.7%	0.2%	0.3%	0.0%
Age (M±SD)[1]	20.28 ±3.75	19.63 ±3.02	19.89 ±4.10	18.97 ±2.56	20.39 ±2.12	21.00 ±3.09	22.21 ±4.90	26.32 ±6.43
Year in college								
First Year	-	52.6%	67%	97.8%	36.9%	26.3%	31.4%	9.2%
Second Year	-	23.8%	22.2%	1.2%	25.9%	31.5%	25.9%	19.2%
Third Year	-	14.6%	6.6%	0.7%	27.8%	16.8%	17.1%	29.2%
Four Year	-	8.8%	2.2%	-	8.0%	16.3%	10.5%	23.1%
Fifth-Seventh Year	-	-	1.5%	-	1.1%	3.2%	15.1%	10.1%
Other, Missing	-	0.2%	0.5%	0.2	0.4%	6.0%	0.1%	9.3%
Alcohol Use (M±SD)								
Frequency	5.59 ±4.97	5.47 ±5.02	4.91 ±4.81	8.93 ±5.35	6.38 ±5.30	4.92 ±4.11	5.42 ±4.55	4.63 ±4.47
TQ	124.42±115.55	138.64±126.74	128.40±114.95	131.47±105.85	90.58±84.78	105.09±94.78	114.60±110.00	64.91±64.75
Binge								
Occurrence	64.6%	65.3%	65.8%	81.5%	68%	56.9%	58.5%	42.3%
Frequency (M±SD)	2.25 ±3.32	2.45 ±3.41	2.00 ±3.10	4.40 ±4.42	2.44 ±3.59	1.44 ±2.30	1.47 ±2.60	0.85 ±1.46
B-YAACQ	4.73 ±4.36	4.77±4.58	4.18±4.07	6.56±4.64	5.59±4.47	4.36±3.83	4.43±3.79	3.04±3.29
Audit	7.15 ±5.15	6.98±5.13	6.77±4.85	10.56±6.32	7.71±5.46	7.07±4.61	6.65±4.53	5.01±3.76
Low	61.9%	62.6%	65.3%	34.6%	59.5%	63.2%	65.7%	80%
Moderate	30.8%	30.6%	27.8%	46.5%	30.9%	31.3%	29.8%	17.7%
High	7.3%	6.8%	6.9%	18.9%	9.6	5.4%	4.4%	2.3%
Reliability (ω)								
B-YAACQ	0.868	0.888	0.859	0.868	0.852	0.841	0.823	0.823
AUDIT	0.812	0.822	0.809	0.832	0.821	0.766	0.757	0.769

Note. Frequency of Alcohol Use = number of days with alcohol use within the previous month (possible range: 1-30 days). Binge frequency = number of days with heavy episodic drinking within the previous month (possible range 0-30). TQ = Typical quantity (in grams) of alcohol use within a typical week. B-YAACQ = Brief Young Adult Alcohol Consequences Questionnaire; AUDIT = Alcohol Use Disorders Identification Test. Audit categories: Low = scores ≤7; Moderate = scores 8-15; High = ≥16. [1]An Analysis of Variance, and subsequent *post-hoc* tests (all $p \leq 0.05$), indicated that participants from England were younger than participants from all countries, and those from Uruguay were the oldest. Participants from U.S. were younger than students from South Africa, Argentina and Spain. Participants from Canada were younger than participants from Spain and Argentina. Participants from South Africa and Spain were younger than participants from Argentina.

Table 2.
Summary statistics for Receiver Operating Characteristic analyses determining cutoff values for the Brief Young Adult Alcohol Consequences Questionnaire (B-YAACQ) for the identification of students at-risk for problem alcohol use (AUDIT cutoff value ≤7; differentiating low from moderate/high risk).

Sample	Score	Sensitivity	Specificity	PPV	NPV	Youden's index	AUC	Metric Score
Total	4	81.51%	66.59%	60.05%	85.38%	0.481	0.823	1.48
	5	**73.87%**	**76.29%**	**65.76%**	**82.56%**	**0.502**	**0.823**	**1.50**
	6	64.09%	83.66%	70.75%	79.07%	0.478	0.823	1.48
Female	4	83.14%	64.91%	56.36%	87.60%	0.480	0.824	1.48
	5	**75.57%**	**74.87%**	**62.11%**	**84.90%**	**0.504**	**0.824**	**1.50**
	6	65.60%	82.93%	67.68%	81.56%	0.485	0.824	1.49
Male	4	78.32%	71.87%	70.22%	79.65%	0.502	0.829	1.50
	5	**70.43%**	**80.68%**	**75.54%**	**76.31%**	**0.511**	**0.829**	**1.51**
	6	60.90%	85.99%	78.64%	72.19%	0.469	0.829	1.47
U.S.	4	79.66%	66.04%	58.36%	84.45%	0.457	0.809	1.46
	5	**71.35%**	**75.8%**	**63.79%**	**81.57%**	**0.471**	**0.809**	**1.47**
	6	62.37%	82.65%	68.23%	78.61%	0.450	0.809	1.45
Canada	3	87.44%	60.75%	54.21%	90.1%	0.482	0.844	1.48
	4	**80.65%**	**73.03%**	**61.38%**	**87.66%**	**0.537**	**0.844**	**1.54**
	5	72.86%	80.11%	66.06%	84.75%	0.530	0.844	1.53
South-Africa	**5**	**86.3%**	**68.63%**	**65.17%**	**88.05%**	**0.549**	**0.846**	**1.55**
	6	75.34%	79.19%	71.12%	82.52%	0.545	0.846	1.55
	7	66.21%	85.71%	75.92%	78.86%	0.519	0.846	1.52
Spain	4	77.62%	65.10%	56.40%	83.33%	0.427	0.792	1.43
	5	**69.52%**	**76.45%**	**63.2%**	**81.18%**	**0.460**	**0.792**	**1.46**
	6	59.52%	82.27%	66.14%	77.75%	0.418	0.792	1.42
Argentina	4	77.86%	63.27%	52.49%	84.58%	0.411	0.802	1.41
	5	**69.74%**	**74.42%**	**58.70%**	**82.52%**	**0.442**	**0.802**	**1.44**
	6	59.78%	83.46%	65.32%	79.93%	0.432	0.802	1.43
Uruguay	4	65.38%	80.77%	45.95%	90.32%	0.462	0.802	1.46
	5	**65.38%**	**88.46%**	**58.62%**	**91.09%**	**0.539**	**0.802**	**1.54**
	6	53.85%	93.27%	66.67%	88.99%	0.471	0.802	1.47
England	4	92.02%	64.75%	83.16%	81.08%	0.568	0.869	1.57
	5	**83.65%**	**76.98%**	**87.3%**	**71.33%**	**0.606**	**0.869**	**1.61**

6	71.86%	84.89%	90.00%	61.46%	0.568	0.869	1.57

Sensitivity = proportion of positives correctly identified; Specificity = proportion of negatives correctly identified; PPV = positive predictive values; NPV = negative predictive values; AUC = area under the curve. For parsimony, we only present the ROC values generated for the selected and neighboring scores.

Table 3.

Summary statistics for Receiver Operating Characteristic analyses determining cutoff values for the Brief Young Adult Alcohol Consequences Questionnaire (B-YAACQ) for the identification of students at-risk for problem alcohol use (AUDIT cutoff value ≤15; differentiating low/moderate from high risk).

Sample	Score	Sensitivity	Specificity	PPV	NPV	Youden's index	AUC	Metric Score
Total	6	90.15%	69.83%	19.09%	98.9%	0.600	0.891	1.60
	7	**87.15%**	**77.22%**	**23.2%**	**98.7%**	**0.644**	**0.891**	**1.64**
	8	80.94%	82.13%	26.34%	98.2%	0.631	0.891	1.63
	9	75.37%	86.74%	30.99%	97.81%	0.621	0.891	1.62
	10	70.24%	90.7%	37.36%	97.47%	0.609	0.891	1.61
Female	6	93.4%	69.75%	17.08%	99.37%	0.632	0.906	1.632
	7	**90.28%**	**77.37%**	**21.02%**	**99.17%**	**0.677**	**0.906**	1.677
	8	84.03%	82.12%	23.87%	98.72%	0.661	0.906	1.661
Male	6	84.57%	69.97%	23.95%	97.59%	0.545	0.862	1.545
	7	**81.71%**	**76.74%**	**28.21%**	**97.40%**	**0.585**	**0.862**	**1.585**
	8	75.43%	82.04%	31.96%	96.76%	0.575	0.862	1.575
U.S.	6	87.96%	69.75%	17.55%	98.75%	0.577	0.877	1.58
	7	85.34%	76.73%	21.17%	98.62%	0.621	0.877	1.62
	8	80.1%	81.56%	24.13%	98.24%	0.617	0.877	1.62
	9	76.44%	86.12%	28.74%	98.04%	0.626	0.877	1.63
	10	**72.77%**	**89.88%**	**34.49%**	**97.83%**	**0.627**	**0.877**	**1.63**
Canada	6	89.87%	74.06%	20.4%	99%	0.639	0.898	1.64
	7	**86.08%**	**80.99%**	**25.09%**	**98.74%**	**0.671**	**0.898**	**1.67**
	8	77.22%	85.02%	27.6%	98.06%	0.622	0.898	1.62
South-Africa	6	96.15%	62.78%	21.55%	99.35%	0.589	0.879	1.59
	7	**88.46%**	**70.35%**	**24.08%**	**98.29%**	**0.588**	**0.879**	**1.59**
	8	78.85%	76.07%	25.95%	97.13%	0.549	0.879	1.55
Spain	7	83.87%	76.67%	17.11%	98.81%	0.605	0.885	1.61
	8	77.42%	83.52%	21.24%	98.47%	0.609	0.885	1.61
	9	74.19%	88.70%	27.38%	98.36%	0.629	0.885	1.63
	10	**70.97%**	**92.96%**	**36.67%**	**98.24%**	**0.639**	**0.885**	**1.64**
Argentina	7	85.71%	79.89%	16.48%	99.18%	0.652	0.896	1.66
	8	82.86%	84.26%	19.59%	99.07%	0.671	0.896	1.67
	9	**80.00%**	**88.76%**	**24.78%**	**98.97%**	**0.688**	**0.896**	**1.69**
	10	74.29%	91.67%	29.21%	98.72%	0.660	0.896	1.68
Uruguay	9	100%	94.49%	30.00%	100%	0.945	0.992	1.94
	10	**100%**	**97.64%**	**50.00%**	**100%**	**0.976**	**0.992**	**1.98**

	11	100%	98.43%	60.00%	100%	0.984	0.992	1.98
England	7	93.42%	69.02%	41.28%	97.83%	0.624	0.897	1.62
	8	**88.16%**	**75.15%**	**45.27%**	**96.46%**	**0.633**	**0.897**	**1.63**
	9	78.95%	81.9%	50.42%	94.35%	0.608	0.897	1.61

Sensitivity = proportion of positives correctly identified; Specificity = proportion of negatives correctly identified; PPV = positive predictive values; NPV = negative predictive values; AUC = area under the curve. For parsimony, we only presented between 3 and 5 generated ROC values including the selected and neighboring scores.

Table 4.
Sociodemographic variables and alcohol consumption as a function of the brief YAACQ risk levels.

	Level 1: Low	Level 2: Moderate	Level 3: High	F/χ^2	*Post hoc*
Total sample	64%	19.7%	16.3%		
Sex				5.63 ns	
Men	63%	20.2%	16.7%		
Women	64.4%	21.3%	14.4%		
Other, Missing	65.7%	11.4%	22.9%		
Age (M±SD)	20.54±4.23	19.83±2.76	19.81 ±2.52	26.76^{***}	1 > 2, 3
Country					
U.S.	65.8%	19.8%	14.4%		
Canada	61.7%	19.0%	19.3%		
South-Africa	57.1%	13.7%	29.2%		
Spain	66.9%	25.4%	7.7%		
Argentina	68.6%	20.1%	11.3%		
Uruguay	83.8%	12.3%	3.8%		
England	47.8%	22.6%	29.6%		
Alcohol Use(M±SD)					
Frequency	4.59±4.27	6.50±5.09	8.42±6.01	295.91^{***}	1< 2< 3
TQ	92.90±88.58	156.08±118.57	204.44±147.77	484.26^{***}	1< 2< 3
Binge					
Occurrence	52.2%	82.5%	91.4%		
Frequency	1.38±2.46	2.95±3.22	4.80±4.58	560.78^{***}	1< 2< 3
B-YAACQ	2.09±1.69	6.96±1.20	12.40±3.35	12167.54^{***}	1< 2< 3
AUDIT	5.08±3.43	8.69±4.13	13.44±6.02	1837.95^{***}	1< 2< 3

Note. Frequency of Alcohol Use = number of days with alcohol use within the previous month (possible range: 1-30 days). Binge frequency = number of days with heavy episodic drinking within the previous month (possible range 0-30). TQ = Typical quantity (in grams) of alcohol use within a typical week. B-YAACQ = Brief Young Adult Alcohol Consequences Questionnaire; AUDIT = Alcohol Use Disorders Identification Test.

Figure caption

Figure 1. Receiver operating characteristic curve (ROC) for prediction of cutoffs for the Brief Young Adult Alcohol Consequences Questionnaire (B-YAACQ) that differentiate low versus moderate/high risk alcohol drinking, based on the Alcohol Use Disorders Identification Test (AUDIT) scores. ROC curves are separated by country (i.e., U.S., Canada, South-Africa, Spain, Argentina, Uruguay and England).

Figure 2. Receiver operating characteristic curve (ROC) for prediction of cutoffs for the Brief Young Adult Alcohol Consequences Questionnaire (B-YAACQ) that differentiate low/moderate versus high risk alcohol drinking, based on the Alcohol Use Disorders Identification Test (AUDIT) scores. ROC curves are separated by country (i.e., U.S., Canada, South-Africa, Spain, Argentina, Uruguay and England).