



Published in final edited form as:

J Am Coll Health. 2018 ; 66(8): 774–782. doi:10.1080/07448481.2018.1453514.

Validity of the AUDIT-C Screen for At-Risk Drinking Among Students Utilizing University Primary Care

Clare E. Campbell and

Department of Psychology, Syracuse University, Syracuse, NY, United States

Stephen A. Maisto

Department of Psychology, Syracuse University, Syracuse, NY, United States

Abstract

Objective: Research is needed to establish the psychometric properties of brief screens in university primary care settings. This study aimed to assess the construct validity of one such screen, the Alcohol Use Disorders Identification Test-Consumption (AUDIT-C), for detecting at-risk drinking among students who have utilized on-campus primary care.

Participants: 389 students recently seen in university primary care completed a confidential online survey in December 2014.

Methods: Bivariate correlations between the AUDIT-C and measures of alcohol consumption and negative drinking consequences provided concurrent evidence for construct validity. Receiver Operating Characteristic curve analyses determined optimal cut-off scores for at-risk drinking.

Results: The AUDIT-C significantly correlated with measures of alcohol consumption and negative drinking consequences ($p < .001$). Analyses support optimal AUDIT-C cut-off scores of 5 for females and 7 for males.

Conclusions: The AUDIT-C is a valid screen for at-risk drinking among students who utilize university primary care.

Keywords

alcohol; AUDIT-C; college students; primary care; screening

Problematic drinking among college students is a persistent and pervasive public health concern.^{1–3} Among college-aged adults, over a third (38.8%) endorse recent heavy-episodic drinking,⁴ which is associated with a variety of negative consequences including physical injury, assault, risky sex, interpersonal problems, and impaired academic performance.⁵ There is ample evidence for the efficacy⁶ and feasibility⁷ of brief interventions to reduce at-risk drinking among college students, as well as the need for preventive screening and brief interventions (SBI) for at-risk drinkers in primary care.^{8,9} Despite this evidence, little research has been conducted on SBI among students presenting for primary care at university health centers. In fact, the majority of research on SBI in college students has

been conducted with students in introductory psychology courses or otherwise recruited from settings outside the bounds of primary care.^{10–15} As these studies' findings may not generalize to university primary care, externally valid research is needed to establish the psychometric properties of brief alcohol screens among students utilizing university primary care. Likewise, SBI implementation efforts could benefit from the use of an evidence-based screening measure that is brief, standardized, and validated in primary care.¹⁶

A review of screening measures for detecting problematic alcohol use in college students identified screens that have been validated in a college sample and can be recommended based on their psychometric properties.¹⁷ These screening measures include the Rapid Alcohol Problem Screen (RAPS4),¹⁸ College Alcohol Problem Scale (CAPS),¹⁹ CUGE (Cut down, Under influence, Guilty, Eye opener),²⁰ Alcohol Use Disorders Identification Test (AUDIT),^{21,22} and the AUDIT-C,²³ a 3-item measure derived from the first three items on the AUDIT. A more recent study²⁴ also supports the use of a modified version of the CAGE (Cut down, Annoyed, Guilty, Eye opener) screen among college students. Of these recommended screens, only the AUDIT and AUDIT-C were developed for use in primary care settings.^{21–23}

The AUDIT-C was originally implemented by the Veterans Health Administration as a brief screen for problematic alcohol use among veterans presenting to primary care.²⁵ Accordingly, its validity has been primarily researched among veterans.^{25–28} The AUDIT-C has also been validated among large samples of non-veteran adults.^{29,30} In addition, a meta-analysis³¹ concluded that the 3-item AUDIT-C is as effective as the original 10-item AUDIT in screening for at-risk drinking and alcohol use disorder in most settings, including primary care. However, research on the AUDIT-C is limited among college student populations, particularly in the context of university primary care.

Only two prior studies have identified AUDIT-C cut-off scores among college students in the United States,^{32,33} both of which utilized samples of non-treatment-seeking undergraduates. Neither of these studies^{32,33} validated the AUDIT-C as a screen for all facets of at-risk drinking. At-risk drinking is defined by two related but distinct criteria: at-risk consumption (i.e., consumption levels above recommended limits, thereby placing the drinker at risk for problems related to their alcohol use), and/or the experience of negative drinking consequences.³⁴ Research validating the AUDIT-C among college students has used at-risk consumption levels³² or alcohol use disorder diagnosis,³³ but not negative drinking consequences per se, as validity criteria. Accordingly, to validate the AUDIT-C as a screen for at-risk drinking in college students, research is needed to determine optimal cut-off scores for negative drinking consequences as well as at-risk consumption. Further, the limited research with non-clinical samples of college students cannot be assumed to generalize to students who present to university primary care and would complete the AUDIT-C as part of usual clinical procedures.

Given these gaps in the literature, the purpose of this study was to examine the construct validity of the AUDIT-C as a brief screen for at-risk drinking among college students recently seen in university primary care. This was accomplished through empirically estimating the correlation of the AUDIT-C with measures of negative drinking consequences

and consumption. It was hypothesized that the AUDIT-C would be positively correlated with past-year negative drinking consequences as well as measures of alcohol consumption (i.e., drinks per drinking day, drinks per week, and heavy drinking days over the past three months).

This study also aimed to determine optimal cut-off scores for the criteria of negative drinking consequences and at-risk consumption. As AUDIT-C thresholds are differentially associated with at-risk consumption and alcohol use disorder according to gender,^{32,33,35} optimal AUDIT-C cut-off scores were expected to differ for males and females. Accordingly, analyses determined optimal gender-based cut-off scores for both at-risk consumption and negative drinking consequences.

Methods

Setting

Contact information for potential participants was pulled from a database of all students who had recently been seen in university primary care at a private university in the northeastern United States. This clinic provides general medical care to full-time undergraduate and graduate students. Medical care is provided by physicians, physician assistants, nurse practitioners, and nurses, as well as a registered dietician and a psychiatric nurse practitioner. Services include health maintenance, screening, and preventive services (e.g., physical exams, pap smears, STD testing, tobacco cessation), treatment of acute illness, management of uncomplicated conditions (e.g., asthma, acne), psychiatric medication management, and nutrition counseling. Integrated behavioral health providers³⁶ offer triage, evaluation, and brief intervention for mental health concerns. Students who require specialty care are referred to nearby hospitals or outpatient providers in the community. The university's primary care clinic is separate in both purpose and location from the university's Counseling Center, which provides crisis services and short-term individual and group mental health counseling. Longer-term mental health treatment is offered at the university's Psychological Services Center, which is the training clinic for the university's clinical psychology doctoral program.

Procedures

A random selection of 2000 students seen in university primary care during the fall 2014 semester were contacted twice by email in December 2014 and invited to participate in an online survey. Only students who consumed alcohol in the past year were eligible to participate. Students were fully informed of their rights as research participants via an online informed consent. After consenting to participate, participants were directed to an online survey. Participants were compensated via entry into a prize drawing for one of six tablet computers. All procedures were approved by the university's institutional review board.

Participants

A total of 415 participants consented to participate, corresponding with a 20.8% response rate. This response rate is similar to previous studies^{37,38} recruiting from a general student population via email. Of the 415 who consented, 389 eligible participants completed at least

one item of the survey. Two additional participants were missing one of the AUDIT-C items, for a total of 387 completing the AUDIT-C in its entirety. Among eligible participants, the median time to complete the survey was 6 minutes 40 seconds; the 5% trimmed mean for completion time was 7 minutes 41 seconds. Participants were predominantly undergraduates (78.8%), female (64.1%), White (69.9%), non-Hispanic (88.8%), and spoke English as their first language (84.4%). The mean age was 20.97 years old ($SD = 3.22$). See Table 1 for complete participant demographics. Demographics of the sample resembled those of the university undergraduate population as a whole.³⁹ In comparison to the university's undergraduate population, this study had somewhat greater representation of females (64.1% vs. 55% at the university) and Asian students (12.3% vs. 6.4% at the university).

Measures

Alcohol Use Disorders Identification Test-Consumption (AUDIT-C)—The AUDIT-C²³ is a 3-item measure derived from the first three items on the AUDIT.²² The AUDIT-C items are each rated on a scale from 0 to 4 and address drinking frequency, typical quantity, and frequency of heavy drinking (i.e., “five or more drinks on one occasion”) over the past year. In the current sample, internal consistency among the three items of the AUDIT-C was acceptable, with Cronbach's alpha equal to 0.80.

Quick Drinking Screen (QDS)—The Quick Drinking Screen (QDS),⁴⁰ a 3-item measure of alcohol consumption, was administered to provide evidence in support of the construct validity of the AUDIT-C. The QDS has been found to assess past 90-day alcohol use as a reliable alternative to the Timeline Followback (TLFB) calendar.^{40–42} Variables derived from the QDS include: drinking days per week, drinks per week, drinks per drinking day, number of heavy drinking days (5 or 4 standard drinks on one occasion for men and women, respectively), and maximum number of drinks on one occasion. Although the QDS has not been validated within college samples, recent research suggests that the QDS provides specific and accurate quantitative data regarding alcohol consumption,⁴³ thereby supporting its use as a reference standard for the criterion of at-risk alcohol consumption.

The at-risk consumption criterion was defined as exceeding average weekly consumption limits on the QDS: 14 or more drinks per week for males; 7 or more drinks per week for females.⁴⁴ This operationalization of at-risk consumption was used because average weekly consumption provides a more representative picture of drinking patterns and is consistent with prior research.³² In contrast, heavy drinking is more sensitive to outlier days; specifically, in the current study design one heavy drinking day in the past three months would classify an individual as an at-risk drinker but may not be representative of their typical behavior.

Brief Young Adult Alcohol Consequences Questionnaire (BYAACQ)—The 24-item Brief Young Adult Alcohol Consequences Questionnaire (BYAACQ)⁴⁵ assessed past-year negative drinking consequences. Items were dichotomously scored according to whether the individual experienced each particular consequence during the past year; endorsed consequences were then summed, resulting in a total score ranging from 0 to 24. Cronbach's alpha was 0.87 in the current sample.

The negative drinking consequences criteria were derived by the authors according to the relative number of negative consequences endorsed on the BYAACQ. Specifically, BYAACQ summary scores were dichotomized according to the overall number of consequences endorsed, with dichotomization occurring at the 50th, 75th, and 90th percentiles. This was based on the assumption that higher total scores on the BYAACQ correspond with more severe experiences of consequences overall, as the BYAACQ was designed to be a unidimensional representation of negative alcohol-related consequences in college students.⁴⁵ Thus, the criteria of interest were: BYAACQ upper half, BYAACQ upper quartile, and BYAACQ upper decile. In the current sample, the total numbers of consequences corresponding to the 50th, 75th, and 90th percentiles were 6, 10, and 15, respectively. Thus, those who endorsed 6 or more consequences were in the upper half, those with 10 or more consequences were in the upper quartile, and those with 15 or more consequences were in the upper decile.

Data analyses

Data analyses were completed using SPSS.⁴⁶ Preliminary analyses included descriptive statistics and gender-based comparisons. Males and females were compared on all continuous alcohol use variables (i.e., AUDIT-C, BYAACQ, QDS) using independent samples t-tests. Chi-square tests compared the proportion of males and females meeting at-risk consumption status (according to number of drinks per week), meeting negative drinking consequences criteria (i.e., upper half, upper quartile, and upper decile), and endorsing individual BYAACQ items. Participants who identified as transgender ($n = 2$) could not be categorized as male or female because the demographics survey presented transgender as a separate category and did not otherwise assess self-identified gender or biological sex. Accordingly, those two participants were excluded from gender-based comparisons.

Concurrent evidence for construct validity was examined through computation of bivariate correlations between the AUDIT-C and measures of consumption and negative drinking consequences. Cut-off scores were identified via Receiver Operating Characteristic (ROC) curve analyses.⁴⁷ The purpose of an ROC curve is to plot the false positive fraction (1 - specificity) against the true positive fraction (sensitivity) at various cut-offs. Analyses were conducted with the sample separated by gender.

Specifically, ROC curves were plotted for each gender to determine their corresponding AUC values (viz., area under the curve); the AUC values were then compared to determine whether the AUDIT-C performed differently for males and females according to a chi-square test,^{48,49} where

$$\text{ChiSq} = (AUC_1 - AUC_2)^2 / (s_1^2 + s_2^2).$$

Separate ROC curves were generated for the comparison standards of negative drinking consequences on the BYAACQ (upper half, upper quartile, and upper decile), as well as at-risk weekly consumption according to National Institute on Alcohol Abuse and Alcoholism (NIAAA) guidelines.⁴⁴ Optimal cut-off scores were identified based on the AUDIT-C score

that maximized the combined sensitivity and specificity, as indicated by Youden's Index⁵⁰ (J), where

$$J = \text{sensitivity} + \text{specificity} - 1.$$

Youden's Index suggests diagnostic ability of each possible cut-off score by equally weighing specificity and sensitivity. A cut-off score with no diagnostic ability would have a $J = 0$; a diagnostically perfect cut-off score would have a $J = 1$.

Data preparation

Missing data were not replaced and were excluded pairwise so that one instance of missing data would not preclude the inclusion of the participant's data in other analyses for which the participant had complete data. Classifying participants into categories of negative drinking consequences on the BYAACQ was conducted using only those without any missing BYAACQ items due to the use of summary scores for categorization. One outlier was identified in the QDS data (one participant reporting 50 drinks daily); that participant's QDS data were removed. An examination of variable distributions revealed that the following QDS derived variables were positively skewed (above 1.0) and leptokurtic: drinks per week, drinks per drinking day, heavy drinking days, and maximum number of drinks.

Therefore, skewed QDS variables were log-transformed before testing for gender differences and computing bivariate correlations.

Results

Descriptive data and gender comparisons

Alcohol use variables were summarized for the whole sample (Table 2) and by gender (Table 3). The mean AUDIT-C score was 5.28 ($SD = 2.55$). As measured by the QDS, the mean number of drinks per week was 9.23 ($SD = 10.34$), with a mean of 3.95 drinks per drinking day ($SD = 2.48$) and a mean of 2.05 drinking days per week ($SD = 1.53$). The mean number of heavy drinking days in the past three months was 6.76 ($SD = 10.73$), and the mean for maximum number of drinks in one day was 7.14 ($SD = 5.00$). Among participants reporting gender and consumption on the QDS ($n = 356$), 39.6% ($n = 141$) met criteria for at-risk consumption. The mean number of past-year consequences was 7.08 ($SD = 5.14$). Among participants with complete BYAACQ data ($n = 340$), 94.1% endorsed at least one consequence.

See Table 3 for gender-specific descriptive data and comparisons. AUDIT-C total and all alcohol consumption variables derived from the QDS were significantly greater for males than for females ($p < .001$). The proportion of males and females meeting at-risk consumption status did not differ statistically, $\chi^2(1) = 0.12, p = .73$; 38.4% of males and 40.3% of females met at-risk consumption status. Likewise, males and females were equally likely to be at or above the 50th, 75th, and 90th percentiles for total number of negative drinking consequences, and there were no gender differences in the mean number of drinking consequences endorsed on the BYAACQ ($p = .27$). The majority of the individual

BYAACQ items were endorsed at similar rates for males and females. However, males were more likely to endorse waking up in an unexpected place after drinking, spending too much time drinking, wanting/needing a drink before breakfast, and passing out from drinking ($p < .05$). Females were more likely to endorse feeling sick or vomiting after drinking ($p < .05$).

Establishing construct validity

As expected, the AUDIT-C was significantly correlated ($p < .001$) with total number of consequences on the BYAACQ, as well as with all consumption variables derived from the QDS, supporting the construct validity of the AUDIT-C as a brief screen for at-risk drinking. The magnitude of these correlations ranged from $r = .60$ (between AUDIT-C and BYAACQ total) to $r = .84$ (between AUDIT-C and log-transformed heavy drinking days).

Identifying cut-off scores

Cut-off scores were identified via ROC curve analyses, with the sample separated by gender due to significant gender differences in alcohol consumption and AUDIT-C scores. All AUC values were significantly greater than 0.50 ($p < .001$), indicating that the AUDIT-C performed better than chance at categorizing participants according to at-risk consumption and level of consequences (i.e., BYAACQ criteria). For example, among females, the AUC value for the criterion of being in the upper half for total BYAACQ was 0.779 ($SE = .03$; $p < .001$), indicating a 77.9% probability that a female who was positive for the BYAACQ upper half criterion had a higher AUDIT-C score than a female who was negative for that criterion (i.e., in the lower half).

A comparison of male and female AUC values indicated that the AUDIT-C did not perform differently according to gender for any of the criteria ($p < .001$). However, an examination of sensitivity, specificity, and Youden's index indicated that optimal cut-off scores did differ by gender. Cut-off scores maximizing combined sensitivity and specificity for females and males, respectively, were 5 and 7 for at-risk consumption, 5 and 6 for upper half of consequences, 5 and 7 for upper quartile of consequences, and 5 and 7 for upper decile of consequences. See Table 4 and Table 5 for gender-specific AUC values for each criterion, as well as optimal cut-off scores and their corresponding diagnostic indices (i.e., sensitivity, specificity, and Youden's index).

Comment

This sample of past-year drinkers who had recently utilized university primary care averaged two heavy drinking days per month and consumed an average of approximately nine drinks per week.

Approximately 40% of both males and females met criteria for at-risk consumption, defined as exceeding NIAAA-defined weekly limits.⁴⁴ As recommended weekly limits are higher for males relative to females (i.e., 14 vs. 7), it is unsurprising that males reported more frequent and greater quantities of alcohol consumption, as reflected on the AUDIT-C and QDS. This gender difference is consistent with prior research regarding sex-based differences in metabolizing alcohol.^{51,52} The similarity in number of negative drinking consequences across genders is also consistent with prior research among college students.⁵³

The results of this study support the validity of the AUDIT-C among college students recently seen in university primary care. Specifically, results support the construct validity of the AUDIT-C as a brief screen for at-risk drinking, defined as at-risk levels of alcohol consumption and/or experiencing negative drinking consequences. This study expands upon prior research³² that focused primarily on at-risk consumption levels as the validity comparison and reference standard for determining AUDIT-C cut-off scores.

Results also indicate optimal cut-off scores of 5 for females and 7 for males. These cut-off scores are substantially higher than those recommended based on research with veterans^{23,54} and community samples⁵⁵ of adults, which recommended cut-off scores of 3 for women and 4 for men. These differences may be due to characteristics of the population as well as differences in comparison criteria used to determine cut-off scores. The current study's cut-off scores more closely resemble those suggested for detecting alcohol use disorder among young adults presenting for emergency care (i.e., 5 for females, 6 for males).⁵⁶ The current study's recommended cut-off scores also resemble those suggested in a study³⁵ of Korean students recruited from a university health service, which suggested slightly higher cut-off scores for detecting alcohol use disorder (i.e., 6 for females, 7 for males) than for at-risk drinking (i.e., 4 for females, 6 for males).

Interestingly, this study's recommended cut-off scores are higher than those suggested by a study that used a DSM-5 (Diagnostic and Statistical Manual of Mental Disorders, 5th edition) alcohol use disorder diagnosis as the criterion of interest among a large sample of undergraduates.³³ This may be due to the relatively low threshold required for a DSM-5 alcohol use disorder diagnosis (i.e., endorsement of two symptoms during the past year) in comparison to the number of negative drinking consequences required for students to be classified as experiencing alcohol-related problems in the current study. Specifically, students in this study at or above the 50th percentile for drinking consequences endorsed at least six consequences in the last year; those in the upper quartile had ten or more consequences and those in the upper decile had 15 or more consequences. Although negative drinking consequences on the BYAACQ are distinct from alcohol use disorder symptoms, there is enough overlap that it would be possible for an individual to meet diagnostic criteria for alcohol use disorder and yet be below the 50th percentile for number of consequences.

Higher recommended cut-off scores from this study in comparison to previous research could also be due to a difference in the wording of the third AUDIT-C item, which asks about heavy drinking. The current study worded the item to reflect standard drink sizes in the United States (i.e., 5 or more beverages containing 0.60 ounces of ethanol on one occasion), which was based on World Health Organization (WHO)²¹ and NIAAA⁴⁴ recommendations. However, the original AUDIT, published by the WHO in Switzerland, used "six or more drinks on one occasion" for the third item.²¹ This wording was used in an early Veterans Health Administration study²³ of the AUDIT-C, as well as subsequent validity studies.⁵⁴⁻⁵⁶ Other AUDIT-C validity studies^{33,57} did not fully describe the measure, so it is unclear which wording was used for item three. Therefore, in addition to differences in recruitment settings and comparison criteria for determining cut-off scores, discrepant wording may partly account for differences in cut-off scores. As a lower threshold (5 or more drinks) may be endorsed more readily than the higher threshold (6 or more), this

study's wording of the third AUDIT-C item may have inflated AUDIT-C total scores. It would thus be expected that the current study would have higher AUDIT-C scores overall, which may partially explain the higher cut-off scores in this study in comparison to previous research. Accordingly, when applying the findings from this study, it will be important to consider which version of the AUDIT-C is used, particularly in regard to the wording of the heavy drinking item.

Despite discrepancies with much of the previous research using veteran, community, and student samples, these findings replicate and extend a recent study³² that recommended cut-off scores of 5 for females and 7 for males in predicting at-risk consumption among college students recruited from introductory psychology courses. The current study extends this prior research on the validity of the AUDIT-C among college students due to its recruitment of students presenting to on-campus primary care, thereby providing data that for the first time may be generalized to that setting.

Directions for future research

This study represents an important step toward validating the use of the AUDIT-C in university primary care settings. The next step in advancing this research might include replication within the usual bounds of primary care, given that the current study used an online survey rather than in-person recruitment. Furthermore, future research could advance knowledge and clinical practice via longitudinal investigations to establish the predictive validity of the AUDIT-C. This would help providers understand how current AUDIT-C scores predict health-related outcomes, including alcohol-related consequences.

Further research is also needed on the feasibility of integrating the AUDIT-C into university health centers. A validated screening measure using empirically determined cut-off scores may be less effective if administered inconsistently. Qualitative research in VA clinics suggests common problems to screening implementation include non-standardized administration due to verbal screening, provider assumptions about patient alcohol use, and patient discomfort.⁵⁸ Therefore, next steps should assure that dissemination efforts emphasize standardized screening procedures and the use of empirically supported cut-off scores.

In addition to feasibility, research is also needed on the utility of integrating the AUDIT-C into university primary care settings. Although it may seem likely that utilizing the screen would increase the likelihood of discussing alcohol use during primary care visits, that assumption should be tested empirically. A recent study⁵⁹ showed that a comprehensive electronic screener increased discussion of mental health concerns (i.e., depression and anxiety) but did not influence discussion of substance use or somatic symptoms among adolescents presenting to pediatric primary care. It is unclear as to whether research conducted in a pediatric setting would be replicated in a university primary care setting. Thus, additional research is needed to determine the impact of screening for at-risk drinking among university students in primary care.

Limitations

This study's results should be interpreted in light of its limitations. The study's recruitment through email and completion of the study through an online survey may limit the generalizability of its findings to university primary care. Although all participants had recently presented to primary care, it is unknown as to whether those who self-selected to participate were representative of all patients seen in that setting in terms of demographic variables, alcohol consumption, and negative drinking consequences.

One methodological limitation of the study is that the time frame referenced by the QDS (e.g., past 3 months) differed from the time frame referenced by the AUDIT-C and BYAACQ (i.e., past 12 months). This limitation may be mitigated by evidence suggesting that average drinking patterns during the past 3 months tend to adequately represent past-year drinking.⁶⁰ However, future replications of this research could benefit from ensuring all time frames are consistent.

An additional limitation relates to the potential influence of social desirability. The validity of AUDIT-C reports may have been affected by social desirability, as previous research⁶¹ indicates that college students' concerns with impression management are inversely related to disclosure of alcohol consumption and negative consequences. The influence of social desirability on ratings of alcohol consumption may be particularly salient among students who are underage and for whom accurate screening would require them to admit to doing something illegal. Therefore, it is possible that reports of alcohol consumption and prevalence of negative alcohol-related consequences may be underestimated due to under-reporting.

In contrast, the use of online data collection may have encouraged more truthful reports in comparison to in-person screening, as participants' reports were confidential and were not shared with their medical providers. Accordingly, external validity of these findings may be attenuated by differences in the study's data collection procedures in comparison to in-person screening that still is typical in primary care. This is supported by research suggesting that computer-based administration of the AUDIT-C is more likely to result in a positive screen and is less affected by social desirability bias in comparison to paper-based AUDIT-C administration.⁶² Therefore, this study may overstate the construct validity of the AUDIT-C in primary care due to problems with generalizing from online data collection to paper-based screening in primary care settings.

Conclusion

This study provides evidence for the construct validity of the AUDIT-C as a brief screen for at-risk drinking among college students presenting to primary care. It also supports the use of separate cut-off scores for males and females. Additional research is needed to establish the generalizability of this study's findings to other university healthcare settings and ultimately to everyday clinical practice. Consistent screening with the AUDIT-C has the potential to improve recognition of at-risk drinking and subsequently reduce the individual and public health impact of problematic alcohol use.

Acknowledgements

Thank you to Dr. Jennifer Funderburk for guidance in the development and execution of this project, and to Susan Sperry, Shannon Sweeney, and Emily Zale, who assisted with recruitment. Special thanks to Ryan Garver, who volunteered his time and programming talents to assist with online data collection.

Reference

1. Hingson R, Heeren T, Winter M, Wechsler H. Magnitude of alcohol-related mortality and morbidity among U.S. college students ages 18–24: Changes from 1998 to 2001. *Annu Rev Public Health* 2005;26:259–279. doi:10.1146/annurev.publhealth.26.021304.144652 [PubMed: 15760289]
2. Task Force of the National Advisory Council on Alcohol Abuse and Alcoholism. A call to action: Changing the culture of drinking at U.S. colleges, NIH Pub. No. 02–5010 2002 <http://www.collegedrinkingprevention.gov/media/taskforcereport.pdf>.
3. Hingson RW, Zha W, Weitzman ER. Magnitude of and trends in alcohol-related mortality and morbidity among U.S. college students ages 18–24, 1998–2005. *J Stud Alcohol Drugs Suppl* 2009;(s16):12–20. [PubMed: 19538908]
4. Hingson R, Zha W, Smyth D. Magnitude and trends in heavy episodic drinking, alcohol-impaired driving, and alcohol-related mortality and overdose hospitalizations among emerging adults of college ages 18–24 in the United States, 1998–2014. *J Stud Alcohol Drugs* 2017;78(4):540–548. [PubMed: 28728636]
5. Merrill JE, Carey KB. Drinking over the lifespan. *Alcohol Res Curr Rev* 2016;38(1):103–114.
6. Carey KB, Scott-Sheldon LAJ, Carey MP, DeMartini KS. Individual-level interventions to reduce college student drinking: A meta-analytic review. *Addict Behav* 2007;32(11):2469–2494. doi:10.1016/j.addbeh.2007.05.004 [PubMed: 17590277]
7. Ehrlich PF, Haque A, Swisher-McClure S, Helmkamp J. Screening and brief intervention for alcohol problems in a university student health clinic. *J Am Coll Health* 2006;54(5):279–287. doi:10.3200/JACH.54.5.279-288 [PubMed: 16539220]
8. Solberg LI, Maciosek MV, Edwards NM. Primary care intervention to reduce alcohol misuse ranking its health impact and cost effectiveness. *Am J Prev Med*. 2008;34(2):143–152. doi:10.1016/j.amepre.2007.09.035
9. Zakletskaia L, Wilson E, Fleming MF. Alcohol use in students seeking primary care treatment at university health services. *J Am Coll Health* 2010;59(3):217–223. doi:10.1080/07448481.2010.502413 [PubMed: 21186453]
10. Baer JS, Kivlahan DR, Blume AW, McKnight P, Marlatt GA. Brief intervention for heavy-drinking college students: 4-year follow-up and natural history. *Am J Public Health* 2001;91(8):1310–1316. [PubMed: 11499124]
11. Borsari B, Carey KB. Effects of a brief motivational intervention with college student drinkers. *J Consult Clin Psychol* 2000;68(4):728–733. [PubMed: 10965648]
12. Larimer ME, Turner AP, Anderson BK, et al. Evaluating a brief alcohol intervention with fraternities. *J Stud Alcohol* 2001;62(3):370–380. [PubMed: 11414347]
13. Marlatt GA, Baer JS, Kivlahan DR, et al. Screening and brief intervention for high-risk college student drinkers: Results from a 2-year follow-up assessment. *J Consult Clin Psychol* 1998;66(4):604–615. [PubMed: 9735576]
14. Murphy JG, Duchnick JJ, Vuchinich RE, et al. Relative efficacy of a brief motivational intervention for college student drinkers. *Psychol Addict Behav* 2001;15(4):373–379. doi:10.1037/0893-164X.15.4.373 [PubMed: 11767271]
15. Tomaka J, Palacios R, Morales-Monks S, Davis SE. An evaluation of the BASICS alcohol risk reduction model among predominantly hispanic college students. *Subst Use Misuse* 2012;47(12):1260–1270. doi:10.3109/10826084.2012.692754 [PubMed: 22709440]
16. Seigers DKL, Carey KB. Screening and brief interventions for alcohol use in college health centers: A review. *J Am Coll Health* 2010;59(3):151–158. doi:10.1080/07448481.2010.502199 [PubMed: 21186444]

17. Winters KC, Toomey T, Nelson TF, Erickson D, Lenk K, Miazga M. Screening for alcohol problems among 4-year colleges and universities. *J Am Coll Health* 2011;59(5):350–357. doi: 10.1080/07448481.2010.509380 [PubMed: 21500052]
18. Cherpitel CJ. A brief screening instrument for problem drinking in the emergency room: The RAPS4, Rapid Alcohol Problems Screen. *J Stud Alcohol* 2000;61(3):447–449. doi:10.15288/jsa.2000.61.447 [PubMed: 10807217]
19. O'Hare T Measuring problem drinking in first time offenders: Development and validation of the College Alcohol Problem Scale (CAPS). *J Subst Abuse Treat* 1997;14(4):383–387. doi:10.1016/S0740-5472(97)00033-0 [PubMed: 9368216]
20. Aertgeerts B, Buntinx F, Bande-Knops J, et al. The value of CAGE, CUGE, and AUDIT in screening for alcohol abuse and dependence among college freshmen. *Alcohol Clin Exp Res* 2000;24(1):53–57. [PubMed: 10656193]
21. Babor TF, Higgins-Biddle J, Saunders J, Monteiro M. *The Alcohol Use Disorders Identification Test: Guidelines for Use in Primary Care* 2nd ed. Geneva, Switzerland: World Health Organization; 2001.
22. Saunders JB, Aasland OG, Babor TF, de la Fuente JR, Grant M. Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO collaborative project on early detection of persons with harmful alcohol consumption-II. *Addict Abingdon Engl* 1993;88(6):791–804.
23. Bush K, Kivlahan DR, McDonell MB, Fihn SD, Bradley KA. The AUDIT alcohol consumption questions (AUDIT-C): An effective brief screening test for problem drinking. *Arch Intern Med* 1998;158(16):1789–1795. [PubMed: 9738608]
24. Taylor P, El-Sabawi T, Cangin C. Improving alcohol screening for college students: Screening for alcohol misuse amongst college students with a simple modification to the CAGE questionnaire. *J Am Coll Health* 2016;64(5):397–403. doi:10.1080/07448481.2016.1168429 [PubMed: 27007953]
25. Bradley KA, Williams EC, Achtmeyer CE, Volpp B, Collins BJ, Kivlahan DR. Implementation of evidence-based alcohol screening in the Veterans Health Administration. *Am J Manag Care* 2006;12(10):597–606. [PubMed: 17026414]
26. Crawford EF, Fulton JJ, Swinkels CM, Beckham JC, VA Mid-Atlantic MIRECC OEF/OIF Registry Workgroup, Calhoun PS. Diagnostic efficiency of the AUDIT-C in U.S. veterans with military service since September 11, 2001. *Drug Alcohol Depend* 2013;132(1–2):101–106. doi: 10.1016/j.drugalcdep.2013.01.012 [PubMed: 23465735]
27. Hawkins EJ, Lapham GT, Kivlahan DR, Bradley KA. Recognition and management of alcohol misuse in OEF/OIF and other veterans in the VA: A cross-sectional study. *Drug Alcohol Depend* 2010;109(1–3):147–153. doi:10.1016/j.drugalcdep.2009.12.025 [PubMed: 20167440]
28. McDevitt-Murphy ME, Williams JL, Bracken KL, Fields JA, Monahan CJ, Murphy JG. PTSD symptoms, hazardous drinking, and health functioning among U.S. OEF and OIF veterans presenting to primary care. *J Trauma Stress* 2010;21(1):108–111. doi:10.1002/jts.20482
29. Dawson DA, Grant BF, Stinson FS, Zhou Y. Effectiveness of the derived Alcohol Use Disorders Identification Test (AUDIT-C) in screening for alcohol use disorders and risk drinking in the US general population. *Alcohol Clin Exp Res* 2005;29(5):844–854. [PubMed: 15897730]
30. Rubinsky AD, Dawson DA, Williams EC, Kivlahan DR, Bradley KA. AUDIT-C scores as a scaled marker of mean daily drinking, alcohol use disorder severity, and probability of alcohol dependence in a U.S. general population sample of drinkers. *Alcohol Clin Exp Res* 2013;37(8):1380–1390. doi:10.1111/acer.12092 [PubMed: 23906469]
31. Kriston L, Hölzel L, Weiser A- K, Berner MM, Härter M. Meta-analysis: Are 3 questions enough to detect unhealthy alcohol use? *Ann Intern Med* 2008;149(12):879–888. [PubMed: 19075207]
32. DeMartini KS, Carey KB. Optimizing the use of the AUDIT for alcohol screening in college students. *Psychol Assess* 2012;24(4):954–963. doi:10.1037/a0028519 [PubMed: 22612646]
33. Hagman BT. Toward efficient screening for DSM-5 alcohol use disorders in college students: Performance of the AUDIT-C. *Addict Disord Their Treat* 2015;14(1):1–15. doi:10.1097/ADT.0000000000000038
34. Funderburk JS, Maisto SA, Sugarman DE. Brief alcohol interventions and multiple risk factors in primary care. *Subst Abuse* 2007;28(4):93–105. doi:10.1300/J465v28n04_02

35. Kwon US, Kim JS, Kim SS, Jung JG, Yoon S- J, Kim SG. Utility of the alcohol consumption questions in the Alcohol Use Disorders Identification Test for screening at-risk drinking and alcohol use disorders among Korean college students. *Korean J Fam Med* 2013;34(4):272–280. doi:10.4082/kjfm.2013.34.4.272 [PubMed: 23904957]
36. Funderburk JS, Fielder RL, DeMartini KS, Flynn CA. Integrating behavioral health services into a university health center: Patient and provider satisfaction. *Fam Syst Health J Collab Fam Health* 2012;30(2):130–140. doi:10.1037/a0028378
37. Kaplowitz MD, Hadlock TD, Levine R. A comparison of web and mail survey response rates. *Public Opin Q* 2004;68(1):94–101. doi:10.1093/poq/nfh006
38. Sheehan KB. E-mail survey response rates: A review. *J Comput-Mediat Commun* 2006;6(2):0-0. doi:10.1111/j.1083-6101.2001.tb00117.x
39. Syracuse University. Facts [Brochure] 2017 2016. <https://www.syracuse.edu/wp-content/uploads/quick-facts.pdf>.
40. Sobell LC, Agrawal S, Sobell MB, et al. Comparison of a quick drinking screen with the timeline followback for individuals with alcohol problems. *J Stud Alcohol* 2003;64(6):858–861. [PubMed: 14743950]
41. Dum M, Sobell LC, Sobell MB, Heinecke N, Voluse A, Johnson K. A Quick Drinking Screen for identifying women at risk for an alcohol-exposed pregnancy. *Addict Behav* 2009;34(9):714–716. doi:10.1016/j.addbeh.2009.04.001 [PubMed: 19406583]
42. Roy M, Dum M, Sobell LC, et al. Comparison of the Quick Drinking Screen and the alcohol timeline followback with outpatient alcohol abusers. *Subst Use Misuse* 2008;43(14):2116–2123. doi:10.1080/10826080802347586 [PubMed: 18825590]
43. Letourneau B, Sobell LC, Sobell MB, Agrawal S, Gioia CJ. Two brief measures of alcohol use produce different results: AUDIT-C and Quick Drinking Screen. *Alcohol Clin Exp Res* 2017;41(5):1035–1043. doi:10.1111/acer.13364 [PubMed: 28247424]
44. National Institute on Alcohol Abuse and Alcoholism. *Helping Patients Who Drink Too Much: A Clinician's Guide* Baltimore, MD: National Institute of Health; 2005.
45. Kahler CW, Strong DR, Read JP. Toward efficient and comprehensive measurement of the alcohol problems continuum in college students: The Brief Young Adult Alcohol Consequences Questionnaire. *Alcohol Clin Exp Res* 2005;29(7):1180–1189. doi:10.1097/01.ALC.0000171940.95813.A5 [PubMed: 16046873]
46. IBM Corp. *IBM SPSS Statistics for Macintosh* Armonk, NY: IBM Corp.; 2012.
47. Metz CE. Basic principles of ROC analysis. *Semin Nucl Med* 1978;8(4):283–298. [PubMed: 112681]
48. Metz CE, Kronman HB. Statistical significance tests for binormal ROC curves. *J Math Psychol* 1980;22(3):218–243. doi:10.1016/0022-2496(80)90020-6
49. Gonen M *Analyzing Receiver Operating Characteristic Curves with SAS* Cary, NC: SAS Institute Inc.; 2007.
50. Youden WJ. Index for rating diagnostic tests. *Cancer* 1950;3(1):32–35. [PubMed: 15405679]
51. Baraona E, Abittan CS, Dohmen K, et al. Gender differences in pharmacokinetics of alcohol. *Alcohol Clin Exp Res* 2001;25(4):502–507. [PubMed: 11329488]
52. Kypri K, Langley J, Stephenson S. Episode-centred analysis of drinking to intoxication in university students. *Alcohol Alcohol* 2005;40(5):447–452. doi:10.1093/alcalc/agh178 [PubMed: 15996969]
53. Read JP, Haas AL, Radomski S, Wickham RE, Borish SE. Identification of hazardous drinking with the young adult alcohol consequences questionnaire: Relative operating characteristics as a function of gender. *Psychol Assess* 2016;28(10):1276–1289. doi:10.1037/pas0000251 [PubMed: 26691503]
54. Bradley KA, Bush KR, Epler AJ, et al. Two brief alcohol-screening tests from the Alcohol Use Disorders Identification Test (AUDIT): Validation in a female Veterans Affairs patient population. *Arch Intern Med* 2003;163(7):821–829. doi:10.1001/archinte.163.7.821 [PubMed: 12695273]
55. Bradley KA, DeBenedetti AF, Volk RJ, Williams EC, Frank D, Kivlahan DR. AUDIT-C as a brief screen for alcohol misuse in primary care. *Alcohol Clin Exp Res* 2007;31(7):1208–1217. doi:10.1111/j.1530-0277.2007.00403.x [PubMed: 17451397]

56. Kelly TM, Donovan JE, Chung T, Bukstein OG, Cornelius JR. Brief screens for detecting alcohol use disorder among 18–20 year old young adults in emergency departments: Comparing AUDIT-C, CRAFFT, RAPS4-QF, FAST, RUFT-Cut, and DSM-IV 2-item scale. *Addict Behav* 2009;34(8): 668–674. doi:10.1016/j.addbeh.2009.03.038 [PubMed: 19398161]
57. Aertgeerts B, Buntinx F, Ansoms S, Fevery J. Screening properties of questionnaires and laboratory tests for the detection of alcohol abuse or dependence in a general practice population. *Br J Gen Pract J R Coll Gen Pract* 2001;51(464):206–217.
58. Williams EC, Achtmeyer CE, Thomas RM, et al. Factors underlying quality problems with alcohol screening prompted by a clinical reminder in primary care: A multi-site qualitative study. *J Gen Intern Med* 2015;30(8):1125–1132. doi:10.1007/s11606-015-3248-z [PubMed: 25731916]
59. Gadowski AM, Fothergill KE, Larson S, et al. Integrating mental health into adolescent annual visits: Impact of previsit comprehensive screening on within-visit processes. *J Adolesc Health* 2015;56(3):267–273. doi:10.1016/j.jadohealth.2014.11.011 [PubMed: 25586231]
60. Vakili S, Sobell LC, Sobell MB, Simco ER, Agrawal S. Using the Timeline Followback to determine time windows representative of annual alcohol consumption with problem drinkers. *Addict Behav* 2008;33(9):1123–1130. doi:10.1016/j.addbeh.2008.03.009 [PubMed: 18562125]
61. Davis CG, Thake J, Vilhena N. Social desirability biases in self-reported alcohol consumption and harms. *Addict Behav* 2010;35(4):302–311. doi:10.1016/j.addbeh.2009.11.001 [PubMed: 19932936]
62. Graham A, Goss C, Xu S, Magid DJ, Diguseppi C. Effect of using different modes to administer the AUDIT-C on identification of hazardous drinking and acquiescence to trial participation among injured patients. *Alcohol Alcohol* 2007;42(5):423–429. doi:10.1093/alcalc/agl123 [PubMed: 17341515]

Table 1.

Participant demographic characteristics.

	<i>% / m (SD)</i>	<i>n</i>
Gender		368
Female	64.1%	
Male	35.3%	
Transgender	0.5%	
Age	20.97 (3.22)	366
Race		366
White	69.9%	
Black	5.7%	
Asian	12.3%	
Native American	0.3%	
Pacific Islander	0.0%	
Mixed Race	7.4%	
Other	4.4%	
Ethnicity		366
Hispanic	11.2%	
Non-Hispanic	88.8%	
English as first language?		366
Yes	84.4%	
No	15.6%	
GPA	3.36 (0.48)	358
Year in school		368
Freshman	23.1%	
Sophomore	13.6%	
Junior	20.1%	
Senior	20.4%	
5 th -year Senior	1.6%	
Graduate student	21.2%	
Greek Life		366
No	72.7%	
Yes- Pledge	1.1%	
Yes- Member	26.2%	

Table 2.

Alcohol use information for the full sample.

Variable	Mean	Mdn	SD	Min-Max	<i>n</i>
AUDIT-C	5.28	5.00	2.55	1–12	387
BYAACQ	7.08	6.00	5.14	0–24	340
Drinks per week	9.23	6.00	10.34	0–90	363
Drinks per drinking day	3.95	3.00	2.48	0–20	364
Heavy drinking days	6.76	3.00	10.73	0–90	361
Drinking days per week	2.05	2.00	1.53	0–7	367
Max drinks in 1 day	7.14	6.00	5.00	0–50	359

Note. Descriptive statistics are reported on original data prior to transformations. AUDIT-C and BYAACQ reports were based on the past year; remaining alcohol consumption variables were based on the past 90 days.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 3.

Alcohol use information and independent samples t-tests by gender

Variable	Males				Females				t	p		
	Mean	Mdn	SD	Min-Max	n	Mean	Mdn	SD			Min-Max	
AUDIT-C	6.33	6.00	2.68	1-12	130	4.69	4.00	2.27	1-10	235	5.93	.00
BYAACQ	7.50	6.50	5.72	0-24	118	6.81	6.00	4.81	0-20	211	1.12	.27
Drinks per week*	13.25	9.00	13.80	0-90	125	7.13	5.00	7.19	0-40	231	4.57	.00
Drinks per drinking day*	4.81	4.00	2.95	0-18	125	3.50	3.00	2.09	0-20	232	4.46	.00
Heavy drinking days*	10.47	4.00	14.78	0-90	124	4.88	3.00	7.20	0-40	231	3.86	.00
Drinking days per week	2.53	2.00	1.69	.01-7	127	1.80	2.00	1.38	0-6	232	4.17	.00
Max drinks in 1 day*	9.76	9.00	6.77	1-50	124	5.77	6.00	2.94	0-20	231	6.13	.00

* Note: Indicates variable was log-transformed prior to independent samples t-tests. Descriptive statistics are reported on original data prior to transformations. AUDIT-C and BYAACQ reports were based on the past year; remaining alcohol consumption variables were based on the past 90 days.

Table 4.

AUC, cut-off scores, sensitivity, specificity, & Youden's index for each criterion (females).

Criteria	AUC	Optimal Cut-off	Sensitivity	Specificity	Youden's Index
At-risk consumption	.910	5	.903	.774	.677
BYAACQ upper half	.779	5	.696	.704	.400
BYAACQ upper quartile	.774	5	.824	.591	.415
BYAACQ upper decile	.749	5	.850	.526	.376

Note. AUC is the Area Under the Curve value for each criteria's ROC curve as a whole; values for sensitivity, specificity, and Youden's index are specific to the optimal cut-off score for each criterion.

Table 5.

AUC, cut-off scores, sensitivity, specificity, & Youden's index for each criterion (males).

Criteria	AUC	Optimal Cut-off	Sensitivity	Specificity	Youden's Index
At-risk consumption	.937	7	0.958	.805	.764
BYAACQ upper half	.835	6	.838	.720	.558
BYAACQ upper quartile	.822	7	.838	.679	.517
BYAACQ upper decile	.825	7	.923	.571	.494

Note. AUC is the Area Under the Curve value for each criteria's ROC curve as a whole; values for sensitivity, specificity, and Youden's index are specific to the optimal cut-off score for each criterion.