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# Detecting At-Risk Drinking in University Primary Care: Validity of the AUDIT-C

Clare Elizabeth Campbell
*Syracuse University*

Abstract

Research has shown that primary care physicians are more likely to discuss alcohol use with their patients when brief screens are routinely administered. One such screen, the Alcohol Use Disorder Identification Test-Consumption (AUDIT-C; Bush, Kivlahan, McDonnell, Fihn, & Bradley, 1998), has yet to be validated for detecting at-risk alcohol consumption and negative drinking consequences among students presenting to a university student health service for primary care. Accordingly, the proposed study aimed to assess the construct validity of the AUDIT-C among students ($N$ = 387) recruited from Syracuse University's University Health Service (UHS). Receiver Operating Characteristic curve analyses were used to determine optimal cut-off scores for at-risk consumption and negative drinking consequences. Optimal cut-off scores were also examined separately by gender. Results support the construct validity and utility of the AUDIT-C as a screen for at-risk levels of alcohol consumption and alcohol-related problems among students presenting to UHS. Results also indicate optimal cut-off scores of 5 for females and 7 for males as indicators of at-risk consumption levels as well as likelihood of experiencing an elevated number of negative drinking consequences. These results support the use of the AUDIT-C in university primary care settings and have implications for screening and brief interventions for at-risk drinking.

# DETECTING AT-RISK DRINKING IN UNIVERSITY PRIMARY CARE: VALIDITY OF THE AUDIT-C

by

Clare E. Campbell

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Table of Contents

List of Tables

List of Figures

Figure Page

List of Appendices

Detecting At-Risk Drinking in University Primary Care: Validity of the AUDIT-C

College students frequently have mental and behavioral health concerns (ACHA, 2010) but tend not to use available on-campus mental health services (Garlow et al., 2008; Rosenthal & Wilson, 2008; Yorgason, Linville, & Zitzman, 2008), often resulting in those concerns not being addressed (Cranford, Eisenberg, & Serras, 2009). One way to help to solve this problem of not accessing available services is through integration of behavioral health into on-campus primary care services. This would allow for mental and behavioral health needs to be addressed when students present for physical health concerns in primary care. This approach is referred to as integrated primary care, or primary care-mental health integration (PC-MHI; Pomerantz & Sayers, 2010; Strosahl, 1998). Behavioral health screening in primary care provides an opportunity to identify mental and behavioral health concerns as a part of routine medical treatment that may otherwise go untreated. This is in part because fewer barriers exist for students seeking treatment for physical health in comparison to mental health (Eisenberg, Golberstein, & Gollust, 2007). Integrated primary care also allows for more collaboration between health professionals and ultimately treatment that is more efficient, comprehensive, and person-centered (deGruy & Etz, 2010).

Although integrated primary care provides unique opportunities for early assessment and intervention, the primary care setting also presents unique constraints. In particular, primary care providers (PCPs) are expected to assess for multiple physical and behavioral problems within the span of an appointment averaging approximately fifteen minutes (Blumenthal et al., 1999; Gottschalk & Flocke, 2005; Tai-Seale & McGuire, 2012). Thus, thorough assessments of multiple behavioral health concerns are not practical or feasible and priority areas must be determined in practice. Brief screens help to address this constraint by quickly identifying

potentially problematic behaviors and drawing the provider's attention to the need for further assessment or referral. It is particularly important to keep screens brief within primary care settings so that the screens can be completed, scored, and reviewed within an appointment without taking too much time away from addressing the presenting problem (Funderburk, Fielder, DeMartini, & Flynn, 2012). In fact, it is not uncommon for PCPs to be apprehensive about the amount of time required for screening and referring patients for behavioral health concerns, especially in light of their already busy and fast-paced schedules (Thomas, Waxmonsky, McGinnis, & Barry, 2006). In contrast to PCPs' concerns, patients appear to appreciate the need to screen for hazardous alcohol use in primary care, with one study reporting 90% patient agreement with statements regarding the importance and usefulness of alcohol screening as part of their healthcare (Miller, Thomas, & Mallin, 2006).

## Brief Screens in Primary Care

Although even the briefest of screens adds to the length of a primary care visit, behavioral health screens are important in that they function as an alert and call to action for further assessment. In fact, a recent study of students' experiences with integrated behavioral health providers in university health services (UHS) showed that the majority (86%) of students who remember completing a screening measure also talked to their medical provider about at least one of the behavioral health concerns addressed in the screen (Funderburk et al., 2012). Screening measures also systematically call patients' and providers' attention to potential behavioral health concerns that may be unrelated to the presenting problem and may not otherwise be addressed due to time constraints and the decreased likelihood of addressing additional topics as time "runs out" during the appointment (Tai-Seale & McGuire, 2012). This is consistent with other preliminary research on patients' and providers' perceptions of

behavioral health screens in university primary care, which revealed that using the screens led to an increased recognition and discussion of behavioral health concerns (Alschuler, Hoodin, & Byrd, 2008).

Regarding alcohol use in particular, research has shown that clinicians discuss alcohol use with more patients when brief screens are routinely implemented than when they identify patients with problematic alcohol use based on clinical presentation alone (Reinholdz, Fornazar, Bendtsen, & Spak, 2013). Furthermore, clinicians demonstrate poor sensitivity when it comes to identifying patients based solely on suspicions of alcohol problems (Vinson, Turner, Manning, & Galliber, 2013). For example, a study of general practitioners in Belgium reported that the clinicians relying on clinical judgment alone identified only 33.5% of patients that met diagnostic criteria for an alcohol use disorder; in contrast, a variety of alcohol use screens were able to identify between 68% and 93% of those same patients (Aertgeerts, Buntinx, Ansoms, & Fevery, 2001).

**Defining At-Risk Drinking**

At-risk drinking is defined by consumption levels above recommended limits (i.e., placing the drinker at risk for problems related to their alcohol use) and/or by the experience of negative drinking consequences (Funderburk, Maisto, & Sugarman, 2007). Recommended limits typically refer to those recommended by the National Institute on Alcohol Abuse and Alcoholism (NIAAA), which defines at-risk alcohol consumption as exceeding daily or weekly limits (NIAAA, 2005). For the purposes of the current study, at-risk consumption levels will refer to exceeding weekly limits (i.e., 7 or more drinks per week for females and 14 or more drinks per week for males), rather than a heavy or “binge” drinking occasion (i.e., 4 or more drinks on one occasion for females, 5 or more for males). This is because heavy drinking is more

sensitive to outlier days, as one heavy drinking day would classify an individual as an at-risk drinker. In contrast, average weekly consumption provides a more representative picture of drinking patterns and is less affected by outliers.

**Screening and Brief Intervention in College Students**

A large proportion of college students consume amounts of alcohol that are associated with the experiencing of negative alcohol-related consequences (Hingson, Heeren, Winter, & Wechsler, 2005; Task Force, 2002). Research supports the need for preventive screening and brief interventions (SBI) for at-risk drinkers (e.g., Solberg, Maciosek, & Edwards, 2008; Zakletskaia, Wilson, & Fleming, 2010). There is ample evidence for the efficacy and feasibility of brief interventions to reduce drinking among college students (Carey, Scott-Sheldon, Carey, & DeMartini, 2007; Ehrlich, Haque, Swisher-McClure, & Helmkamp, 2006). Despite this evidence, little research has been conducted on systematic screening and brief intervention among students actually presenting for primary care at university health centers.

College student populations could benefit from healthcare models that implement regular screening for at-risk alcohol use. This includes screening that identifies lower but potentially problematic levels of alcohol use, as the experience of mild to moderate alcohol-related problems is common among college students (Hingson et al., 2005). Over two decades ago, the Institute of Medicine made official recommendations regarding widespread implementation of a SBI model to address the broad spectrum of problematic alcohol use (Institute of Medicine, 1990). Since then, the majority of research on SBI in students has been conducted with students in introductory psychology courses or otherwise recruited from settings outside the bounds of primary care (e.g., Baer, Kivlahan, Blume, McKnight, & Marlatt, 2001; Borsari & Carey, 2000; Larimer et al., 2001; Marlatt et al., 1998; Murphy et al., 2001; Tomaka, Palacios, Morales-

Monks, & Davis, 2012). Thus, these studies findings may have limited generalizability to the context in which SBI would actually take place (viz., primary care). Externally valid research is needed to establish the psychometric properties of brief alcohol assessments in university primary care settings.

Even among the few studies recruiting students from primary care (e.g., Amaro et al., 2010; Ehrlich et al., 2006), screening procedures have been inconsistent and not completed within the bounds of primary care. For example, Ehrlich and colleagues recruited past-year drinkers from university primary care but completed screening separately from the primary care appointment. This resulted in resources being used outside of the usual primary care appointment for 325 students, with only 129 ultimately receiving any intervention. A SBI study conducted by Amaro et al. (2010) aimed to establish the feasibility of screening students in primary care; however, the study sample was not completely drawn from university primary care. In fact, the majority of students (67%) were recruited via advertisements that facilitated "self-referral" to the SBI program. Screening procedures were also inconsistent, as screening differed depending on whether the participant was referred through UHS or self-referred. Thus, the SBI research could benefit from the use of an evidence-based screening measure that is brief, standardized, and used consistently within primary care settings (see review by Seigers & Carey, 2011).

## The AUDIT and AUDIT-C as Validated Screening Measures

It is essential that clinicians use screening measures that are validated for the population in which they are used. One such measure is the Alcohol Use Disorders Identification Test (AUDIT; Babor, Higgins-Biddle, Saunders, & Monteiro, 2001; Saunders, Aasland, Babor, de la Fuente, & Grant, 1993), which was developed for use in primary care settings. The AUDIT has been validated in numerous primary care settings as an indicator of at-risk drinking as well as

possible alcohol use disorders (AUD; see review by Reinert & Allen, 2007). While research on screening and brief intervention in university primary care has used the AUDIT as the screening measure (Ehrlich et al., 2006; Martens et al., 2007), even a 10-item assessment may place unnecessary burden on primary care providers and be beyond the scope of what is needed for an initial screening measure in primary care settings.

The AUDIT-C (Bush, Kivlahan, McDonnell, Fihn, & Bradley, 1998) is a 3-item measure derived from the first three items on the AUDIT. The AUDIT-C was originally implemented by the Veterans Health Administration as a brief screen for harmful alcohol use among veterans presenting to primary care (Bradley et al., 2006). Accordingly, the validity of the AUDIT-C has been primarily researched among veterans (e.g., Bradley et al., 2006; Crawford et al., 2013; Hawkins, Lapham, Kivlahan, & Bradley, 2010; McDevitt-Murphy et al., 2010). However, the AUDIT-C has also been validated among large samples of non-veteran adults. Specifically, among a representative sample of U.S. adults, the AUDIT-C performed well as a screen for both at-risk consumption and the likelihood and severity of AUD (Dawson, Grant, Stinson, & Zhou, 2005; Rubinsky, Dawson, Williams, Kivlahan, & Bradley, 2013). In addition, a meta-analysis concluded that the AUDIT-C was as effective as the AUDIT in screening for at-risk drinking and AUD in most settings (Kriston, Hölzel, Weiser, Berner, & Härter, 2008), including primary care. However, research on the AUDIT-C among college student populations is limited in the context of university primary care.

**Review of AUDIT-C Cut-Off Scores**

For any criterion of interest, scoring at or above a specific cut-off score indicates a reasonable likelihood of meeting that criterion. For the AUDIT-C, an empirically derived cut-off score functions as an indicator of the point at which an individual likely meets the criterion of at-

risk drinking, thus warranting further assessment. Previously established evidence-based cut-off scores on the AUDIT-C are not ideal for detecting all facets of at-risk drinking among college students presenting to primary care, particularly with regards to negative drinking consequences. This is primarily due to varied study samples and the use of criterion measures with a focus on alcohol consumption and/or AUD but not negative drinking consequences (further described later). However, a brief review of studies establishing AUDIT-C cut-off scores is necessary in order to appreciate the potential contribution of the proposed study.

An early study identified a cut-off score of 3 for detecting at-risk consumption of alcohol (Gordon et al., 2001). This study defined at-risk consumption as 16 or more drinks per week for men and 12 or more drinks per week for women. The Gordon et al. study sample included over 13,000 current drinkers from a dozen different primary care sites, including community and university health clinics and a Veterans Affairs Medical Center.

Dawson et al. (2005) reported cut-off scores for the AUDIT-C in detecting at-risk alcohol consumption and alcohol dependence among a large sample representative of the U.S. adult population. The Dawson et al. study is unique in that it reported cut-offs for past-year drinkers as well as a representative sample of the U.S. adult population (i.e., including non-drinkers). Interestingly, at-risk consumption was best detected by a cut-off score of 4 among past-year drinkers as well as the total population. However, a slightly higher cut-off score of 5 was best for detecting alcohol dependence in past-year drinkers, while a cut-off score of 4 best balanced sensitivity and specificity in detecting dependence among the population as a whole.

A subsequent study validated the AUDIT-C in a large sample of adults presenting to community (i.e., non-veteran) primary care (Bradley et al., 2007). Cut-off scores were established based on their ability to detect any past-year “alcohol misuse,” which the authors

defined as drinking above NIAAA recommended limits (NIAAA, 2005) or meeting past-year criteria for an AUD according to the *Diagnostic and Statistical Manual of Mental Disorders*, 4th edition (DSM-IV; American Psychiatric Association, 1994). The AUDIT-C performed well in identifying the authors' definition of alcohol misuse. Specifically, the AUDIT-C was more effective than the full AUDIT, the third AUDIT item on its own, an augmented version of the CAGE questionnaire (Ewing, 1984), and self-reports of drinking above recommended weekly limits. In this community sample, cut-off scores were similar to those identified by Dawson et al. (2005), but differed as a function of gender. The recommended cut-off scores were identified as $\geq 4$ for men and $\geq 3$ for women, which are the same as those previously identified in research with veteran populations (Bush et al., 1998; Bradley et al., 2003).

In contrast to the studies cited thus far, which used samples from community primary care clinics, a study of young adult patients from emergency departments suggested higher AUDIT-C cut-off scores (Kelly, Donovan, Chung, Bukstein, & Cornelius, 2009). Kelly and colleagues compared multiple brief screens in their ability to detect the presence of a current AUD among adults aged 18-20 presenting for emergency care. Optimal sensitivity and specificity for the AUDIT-C in detecting AUD was obtained at or above a score of 6. Gender-specific cut-off scores were 6 for males and 5 for females. Although the sample from the Kelly et al. study was similar to the current study's sample in that it consisted of young adults, it is plausible that individuals presenting to emergency departments represent a different population than students presenting to UHS for routine care, possibly with more severe alcohol use symptomatology related to their need for emergency services. Accordingly, the current study focused on the validity of the AUDIT-C in detecting negative drinking consequences as opposed to the presence of AUD.

**Screening via the AUDIT-C with college students.** Research on AUDIT-C cut-offs among college students in the United States is limited to two studies (DeMartini & Carey, 2012; Hagman, 2015). The first was a study conducted by DeMartini and Carey (2012), which examined the utility of the full AUDIT and the AUDIT-C in detecting at-risk drinking among college students recruited from introductory psychology courses. At-risk drinking was defined as weekly alcohol consumption above NIAAA recommended thresholds (NIAAA, 2005). Area under the curve (AUC) analyses demonstrated that the AUDIT-C performed significantly better than the AUDIT in the detection of at-risk levels of alcohol consumption, thus validating the AUDIT-C as a measure of consumption. DeMartini and Carey recommended overall as well as gender-based cut-off scores, suggesting an overall cut-off score of 6, with optimal cut-offs of 7 for males and 5 for females.

Accordingly, although the study by DeMartini and Carey (2012) provides information on the construct validity of the AUDIT-C as a measure of consumption, it does not provide information beyond what could be obtained through a measure of past-week alcohol consumption. In other words, the AUDIT-C cut-off scores proposed by DeMartini and Carey relate to establishing the criterion of consumption above the “at-risk” threshold but do not establish the criterion of harmful drinking as indicated by negative drinking consequences, thereby addressing only one of two criteria for at-risk drinking. Although individuals with higher levels of alcohol consumption tend to have a higher number of negative drinking consequences, consumption and consequences are two distinct constructs. Furthermore, latent class analyses of college student drinkers revealed that similar consumption patterns occurred across different classes of drinkers (defined by number of AUD symptoms and alcohol-related problems), suggesting that consumption patterns, while informative, are not fully indicative of level of

negative drinking consequences (Beseler, Taylor, Kraemer, & Leeman, 2012). Accordingly, research is needed to determine whether AUDIT-C scores indicating at-risk consumption may differ from those associated with negative drinking consequences, and to determine cut-off scores associated with the criterion of negative drinking consequences in addition to at-risk consumption levels.

In DeMartini's unpublished dissertation (2011), the AUDIT and AUDIT-C were also compared in their ability to detect the presence of an alcohol use disorder (DSM-IV abuse or dependence) among the same sample of college students from an introductory psychology course. An alcohol abuse diagnosis is conceptually related to the construct of negative drinking consequences as experiencing multiple instances of specific negative drinking consequences could warrant a diagnosis of alcohol abuse. However, DiMartini ultimately did not establish AUDIT-C cut-off scores in predicting AUD. This was because, as hypothesized by DeMartini (2011), Receiver Operating Characteristic (ROC) curve analyses indicated that the AUDIT performed significantly better than the AUDIT-C in predicting the presence of any AUD, so only cut-off scores on the AUDIT were established for detecting AUD. However, although the AUDIT performed significantly better at detecting AUD with a total area under the curve (AUC) of .77 ($p < .001$), the AUDIT-C was still better than chance with a total AUC of .72.

A recent study (Hagman, 2015) examined the utility of the AUDIT-C in predicting mild, moderate, and severe AUD, as defined by the latest (fifth) edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013). The sample consisted of non-treatment seeking undergraduates from three public universities who completed an online questionnaire battery as part of the Core Alcohol and Drug Use survey. Hagman used ROC analyses that suggested cut-off scores of 3, 4, and 5 for mild, moderate, and

severe DSM-5 AUD, respectively. For the reference standard of a DSM-5 AUD, regardless of severity, Hagman's results indicated an optimal cut-off score of 4, as well as separate cut-off scores of 5 and 3 for males and females, respectively.

In sum, previous research has been limited by its use of at-risk consumption or AUD, but not negative drinking consequences, as validity criteria. The present study addressed this gap in previous research by examining whether the AUDIT-C is associated with negative drinking consequences in order to establish criterion-related evidence for the construct validity of the AUDIT-C.

The limited research with college students described above cannot be assumed to generalize to students who present to a UHS for a medical concern and who would complete the AUDIT-C as part of usual clinical procedures. There appears to be only one published study examining the AUDIT-C among college students recruited from a UHS (Kwon et al., 2013). Like the studies reviewed earlier, Kwon et al. used at-risk drinking (i.e., NIAAA-defined heavy or binge drinking; NIAAA, 2005) and AUD (DSM-IV abuse or dependence) as comparison standards. For males and females respectively, cut-off scores were identified as 6 and 4 for at-risk drinking and as 7 and 6 for AUD. However, this study was conducted in South Korea, where alcohol consumption is legal at a younger age than in the United States. Furthermore, Kwon et al. modified the AUDIT-C quantity and binge-drinking items in order to reference the number of standard drinks in a bottle of "soju, the most popular type of alcohol in Korea" (p. 274). Accordingly, results may not generalize to the AUDIT-C among college students in the United States.

**Study Aims**

This review has shown that the utility of the AUDIT-C as a screen for hazardous or harmful alcohol use does not have empirically demonstrated utility among college students in the United States presenting to a UHS. Furthermore, no study has provided empirically determined cut-off scores on the AUDIT-C based on the criterion of negative drinking consequences. Previous research (e.g., DeMartini & Carey, 2012; Kwon et al., 2013) has established criterion-related evidence for construct validity of the AUDIT-C as a sensitive and specific screen for at-risk levels of alcohol consumption, subsequently implying that it can then by extension be used to screen for alcohol-related problems. However, it is important to establish empirically whether the AUDIT-C has utility in screening for potentially problematic drinking among college students presenting to UHS and, if so, to determine optimal cut-off scores for this purpose.

**Aim 1.** The primary aim of this study was to examine the utility of the AUDIT-C as a brief screen for at-risk drinking among college students presenting to UHS 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 binge days over the past three months).

**Aim 2.** The second aim was to determine optimal cut-off scores for the criteria of negative drinking consequences and at-risk consumption. As research has demonstrated that AUDIT-C thresholds are differentially associated with at-risk consumption and alcohol use disorders according to gender (DeMartini & Carey, 2012; Kwon et al., 2013), optimal AUDIT-C cut-off scores were expected to differ for males and females. Accordingly, analyses determined

optimal gender-based and overall cut-off scores for both at-risk consumption and negative drinking consequences.

## Methods

The study was initiated during the Spring 2014 semester. At the end of the Spring 2014 semester (April-May 2014), 1500 students were contacted via an initial email and two follow-up emails, of whom 16% ($n$ = 240) initiated the survey. Among those who initiated the survey, 97% completed the AUDIT-C, but only 57% completed the Brief Young Adult Alcohol Consequences Questionnaire (BYAACQ; Kahler, Strong, & Read, 2005), and only 51% completed the Online Timeline Followback (TLFB; Pedersen, Grow, Duncan, Neighbors, & Larimer, 2012). Lower than expected rates of participation (i.e., 16%), as well as the poor completion rates just described, led to a need to continue recruitment into the following semester. As the greatest participant drop-out occurred during the Online TLFB, that measure was replaced with a simpler questionnaire to capture quantity and frequency of alcohol consumption; namely, the Quick Drinking Screen (QDS; Sobell et al., 2003). Use of the QDS was expected to reduce participant burden and thereby improve consent and completion rates. In fact, average study completion time was reduced from approximately 20 minutes to 8 minutes. The order of the questionnaires was also changed so that data essential to the study aims were collected first. After making these changes to the study procedures, recruitment was continued the following semester (Fall 2014).

As methods differed by semester, data were compared using t-tests and chi-square tests to determine whether it would be justifiable to combine data from the two semesters. Demographics were not significantly different by semester, with the exception of gender, as the percentage of male students was significantly lower in the Spring semester (19.9%) in comparison to the Fall

semester (35.3%). The AUDIT-C and BYAACQ total scores did not differ significantly by semester ($p > .10$). However, alcohol consumption summary variables derived from the TLFB (semester 1) and the QDS (semester 2) were significantly different ($p < .05$). Specifically, there were significant differences in drinks per drinking day, drinks per week, and drinking days per week, with greater overall consumption reported in the Fall (semester 2) in comparison to the Spring (semester 1). As the measurement instruments varied systematically with time, as well as with changes in methods, these differences could be due to time, measurement confounds, or both. Therefore, only semester 2 data were included in analyses.

**Survey Procedures**

The online survey was conducted using an open-source survey application, LimeSurvey, which allowed for custom formatting for a variety of question types. After consenting to participate, students were directed to the survey to complete the AUDIT-C, the Quick Drinking Screen (QDS), and report past-year experiences of negative drinking consequences. The survey also collected demographic information. Various brief behavioral health screens were also included in the online battery for use in a separate study.

**Measures (see Appendix for full copies of measures used)**

**Alcohol use screen.** The Alcohol Use Disorders Identification Test – Consumption (AUDIT-C; Bush et al., 1998) is a 3-item measure derived from the first three items on the AUDIT (Saunders et al., 1993). 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.[1] Instructions for the AUDIT-C include the definition of a "standard drink" (i.e., a 12 oz. beer, 5 oz. glass of wine, or 1.5 oz. of hard liquor/distilled spirits; NIAAA, 2005). Internal consistency among the three items of the AUDIT-C was acceptable, with Cronbach's alpha equal to 0.80.

**Alcohol consumption.** The Quick Drinking Screen (QDS; Sobell et al., 2003) was administered to provide evidence of concurrent validity in support of the construct validity of the AUDIT-C, as the AUDIT-C and QDS are both measures of alcohol consumption. The QDS has been found to assess past 90-day alcohol use as a reliable alternative to the Timeline Followback (TLFB) calendar, the original measure proposed for the current study (see Sobell et al., 2003; Dum et al., 2009; Roy et al., 2008). Additionally, because the QDS has only four questions, it is simpler to complete than the TLFB. As the study was conducted online, the benefits of simplifying data collection procedures in order to minimize missing data outweighed the potential benefits from gathering more detailed information via the TLFB. Variables derived from the QDS include: drinking days per week, drinks per week, drinks per drinking day, number of binge days, and maximum number of drinks on one occasion.

**Negative drinking consequences.** The Brief Young Adult Alcohol Consequences Questionnaire (BYAACQ; Kahler, Strong, & Read, 2005) was used to assess negative drinking consequences over the past year. The BYAACQ was developed by starting with a 48-item scale (Read, Kahler, Strong, & Colder, 2006) and using item response analyses to select the final set of

[1] The third AUDIT-C item was modified based on the AUDIT manual's recommendation that items be adjusted "in order to fit the most common drink sizes and alcohol strength in your country" (Babor et al., 2001, p. 32). This is consistent with AUDIT published by the NIAAA (2005), which uses "5 or more drinks on one occasion" in item three. The original AUDIT, published by the World Health Organization in Switzerland, used "six or more drinks on one occasion" for the third item (Babor et al., 2001), which reflects the European definition of a standard drink as 10 grams of alcohol. In the United States, a standard drink is defined as approximately 14 grams of alcohol (NIAAA, 2005). Thus, six European standard drinks and five American standard drinks are equivalent (i.e., 60 grams of alcohol).

24 items, which reduced redundancy and gender bias in the scale. 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 for the 24 items of the BYAACQ was 0.87 in the current sample.

Although scores on the BYAACQ represent number of consequences experienced over the past year, the total score needed to be dichotomized for the current study in order to identify cut-off scores according to the experience of negative drinking consequences. Therefore, participants were first categorized as positive for "any" negative drinking consequences according to whether they endorsed any of the negative consequences on the BYAACQ. The BYAACQ was also dichotomized according to the overall number of consequences endorsed, with dichotomization occurring at the $50^{th}$, $75^{th}$, and $90^{th}$ percentiles. This was based on the assumption that higher total scores on the BYAACQ correspond with more severe experience of consequences overall, as the BYAACQ was designed to be a unidimensional representation of negative alcohol-related consequences in college students (Kahler et al., 2005). Thus, the criteria of interest were: any consequences, BYAACQ upper half, BYAACQ upper quartile, and BYAACQ upper decile.

**Demographics.** As part of the online survey, participants reported age, gender, year in school, GPA, race/ethnicity, and fraternity/sorority membership. They also indicated whether they spoke English as their first language.

**Behavioral health screens.** Additional data were collected for behavioral health screens commonly implemented in primary care settings (e.g., marijuana use, smoking, insomnia, depression, and posttraumatic stress). These included: the 8-item Cannabis Use Disorder Identification Test – Revised (Adamson et al., 2010); a 2-item Smoking Screener to assess

frequency and amount of cigarette/cigar use; the 7-item Insomnia Severity Index (Bastien, Vallieres, & Morin, 2001); the 2-item Patient Health Questionnaire screen for depression (Arroll, Crengle, Kerse, & Falloon, 2010; Kroenke, Spitzer, & Williams, 2003); and the 4-item Primary Care PTSD screen (Prins et al., 2003). These data were for purposes of a later study and were not analyzed for the current study.

**Eligibility and Recruitment**

Only students with any past-year alcohol consumption were eligible to participate. According to Dawson and colleagues (2005), including nondrinkers in the AUC analyses "inflates the estimated rates of specificity beyond those that would be observed in the population at risk of alcohol problems, i.e., among current drinkers" (p. 845). Furthermore, a response of "never" on the first AUDIT-C item ("How often have you had a drink containing alcohol in the last year?") would automatically receive a score of zero and classify the individual as a past-year nondrinker. Accordingly, this study only included students presenting to UHS who reported alcohol consumption in the past year.

A list of email addresses compiled by UHS staff was randomized such that 2000 random UHS patients were contacted via email and invited to participate in an online survey. The email introduced the study by offering students the option to participate in a research study about students' health behaviors, specifying that only students who consumed alcohol in the past year were eligible to participate. Students were fully informed of their rights as research participants via the online informed consent. Each participant was assigned an individual survey identification "token," embedded in the link emailed to each potential participant using a custom email program housed on a secure university server. The subsequent data they provided were identified via that token so that the data were kept separate from participant's email address

(which was the only personally identifiable information collected for the study). A separate password-protected database maintained the email addresses so that participants could be compensated via entrance into a prize drawing.

## Participants

**Response rates and missing data.** At the end of the Fall 2014 semester (November-December 2014), 2000 students were contacted via an initial email and one follow-up email. Students were not contacted in Fall 2014 if they had completed the survey during the previous semester. A total of 415 participants consented to participate in the survey, corresponding with a 20.8% response rate. This response rate is similar to previous studies recruiting from a general student population via email (e.g., Kaplowitz, Hadlock, & Levine, 2004; Sheehan, 2001). Of the 415 who consented, 13 did not complete any of the survey and 13 were ineligible (due to indicating no alcohol consumption in the past year on the first item of the AUDIT-C). Thus, a total of 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. Sample sizes varied by analysis due to sporadic missing data throughout. Among eligible participants, the median time to complete the survey was 6 minutes 40 seconds; due to outliers, the average time to complete the survey was 27 minutes 17 seconds. The 5% trimmed mean was 7 minutes 41 seconds. There were 37 extreme values for completion time (above 950 seconds, which was the 75$^{th}$ percentile plus 1.5x the interquartile range). Extreme values ranged from 16 minutes 13 seconds to the maximum of 39 hours 18 minutes 23 seconds. Participants were not removed from the data set based on survey completion time, as it is unknown as to why certain participants took longer to respond.

**Demographics.** Demographics were reported by 95% of the 389 participants (see Table 1). Excluding those who did not report demographics, participants were 64.1% female, 35.3% male, and 0.5% transgender. The mean age was 20.97 years old (*SD* = 3.22). The majority of participants was White (69.9%), non-Hispanic (88.8%), and spoke English as their first language (84.4%).

It should be noted that demographics of the sample resemble those of the university undergraduate population as a whole (Syracuse University, 2014-2015). In comparison to the university's undergraduate population, this study had somewhat greater representation of females (64.1% vs. 55% at Syracuse University), racial minority students (30.1% vs. 25.6% at Syracuse University), Asian students (12.3% vs. 6.4% at Syracuse University), and Hispanic students (11.2% vs. 8.6% at Syracuse University).

**Compensation.** Participants were entered into a prize drawing for one of six iPad Minis (valued at $299.99). The prize drawing occurred upon the study's completion. Each participant was given up to five entrances into the drawing, depending upon how many sections of the survey he/she completed. A prize drawing was used in order to maximize available resources. For the same cost as six iPad Minis, direct compensation would have been less than ten dollars per participant. Research indicates that prize drawings or lotteries do not differentially attract participants with greater risk-taking or financial motives (Sauermann & Roach, 2013).

Although only participants from the Fall 2014 semester were included in analyses, the prize drawing also included participants from the previous semester (i.e., Spring 2014). Of the 642 that initiated the survey, 3.3% (*n* = 22) received zero entrances into the drawing, including 20 participants that were ineligible due to endorsing "never" on the first item of the AUDIT-C (i.e., never consuming alcohol in the past year). A slight majority (56.9%) completed all items

from all parts of the survey and received 5 entrances into the drawing. The mean number of drawing entrances was 3.96.

**Data Analyses**

**Establishing construct validity.** Concurrent validity was examined through bivariate correlations between the AUDIT-C and measures of consumption and negative drinking consequences.

**Identifying cut-off scores.** Cut-off scores were identified via Receiver Operating Characteristic (ROC) curve analyses (Metz, 1978). 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. Separate ROC curves were generated for the comparison standards of negative drinking consequences on the BYAACQ (any, upper half, upper quartile, and upper decile), as well as at-risk consumption according to NIAAA guidelines (NIAAA, 2005). Optimal cut-offs were identified based on the AUDIT-C score that maximized the combined sensitivity and specificity, as indicated by Youden's Index (J), where

$$J = \text{sensitivity} + \text{specificity} - 1; \text{ (Youden, 1950).}$$

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.

Additional analyses were also conducted with the sample separated by gender. Specifically, ROC curves were plotted for each gender to determine their corresponding AUC values; the AUC values were then compared to determine whether the AUDIT-C performed differently for males and females according to a chi-square test, where

$$\text{ChiSq} = (AUC_1 - AUC_2)^2 / (s_1^2 + s_2^2); \text{ (Metz \& Kronman, 1980; Gonen, 2007).}$$

Specificity and sensitivity values were also examined to determine optimal cut-off scores for each gender.

**A priori power analyses.** The vast majority of research utilizing ROC/AUC analyses does not include power analyses or a priori estimates of sample size (Bachmann, Puhan, ter Riet, & Bossuyt, 2006). However, formulas for estimating sample size have been presented by Hanley and McNeil (1982). For the current analyses, the primary power-related concern was having sufficient sample size to accurately discriminate between individuals meeting vs. not meeting the criteria of interest, assessed one at a time (i.e., one criterion per ROC curve).

AUC estimates from previous research range from .89 to .93 for the criterion of at-risk consumption (Bradley et al., 2003; DeMartini, 2011; Kwon et al., 2013). Previous research also suggests that half of the participants could be expected to meet the criterion of at-risk consumption (207 at-risk and 194 not at-risk; DeMartini, 2011).

Because the AUC describes the probability of the AUDIT-C correctly classifying individuals according to whether or not they meet the criterion of interest (i.e., at-risk consumption), the null hypothesis was that the AUDIT-C would perform no better than chance, as indicated by an AUC = .50. Accordingly, a sample size of approximately 400 would allow for excellent power to detect the difference between the anticipated AUC (.90) and chance (.50), power = 1.00 [calculated using Power Analysis and Sample Size software (PASS; Hintze, 2012), based on formulas presented by Hanley & McNeil, 1982]. A conservative (i.e., large) sample size was desirable due to the potential for unanticipated variability, particularly for the criterion of negative drinking consequences. There was no precedent for calculating the AUC for the AUDIT-C in detecting the presence of negative drinking consequences, so expected AUC was unknown and therefore expected power could not be calculated for that criterion.

**Data cleaning.** Prior to analyses, data distributions were examined for outliers and checked for missing data. Variable distributions were also examined for skewness and kurtosis so that skewed or kurtotic distributions could be transformed prior to statistical analyses, when appropriate.

## Results

### Data Preparation

**Missing data and outliers.** One outlier was identified in the QDS data (one participant reporting 50 drinks daily); that participant's QDS data was removed. Missing data were not replaced and were excluded pairwise (not listwise). Classifying participants into categories of negative drinking consequences on the BYAACQ was conducted using only those without any missing BYAACQ items (viz., complete data) due to the use of summary scores for categorization.

**Skewness and kurtosis**. 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, binge days, and maximum number of drinks (see Table 2). Therefore, skewed QDS variables were log-transformed before testing for gender differences or correlating with AUDIT-C scores.

**Criterion variables.** Classifying participants into categories of negative drinking consequences on the BYAACQ was conducted using only those without any missing BYAACQ items (viz., complete data). Participants were classified according to whether they endorsed any negative drinking consequences, as well as using percentile-based categories. For percentile-based categories, the total numbers of consequences corresponding to the $50^{th}$, $75^{th}$, and $90^{th}$ percentiles were 6, 10, and 15, respectively. Thus, those that 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.

At-risk consumption categories were calculated by determining average weekly consumption (as reported on the QDS). Males were classified as at-risk if they consumed an average of 14 or more drinks per week; females were classified as at-risk if they consumed an average of 7 or more drinks per week (NIAAA, 2005).

**Descriptive Data**

**Alcohol use.** Alcohol use variables were summarized for the whole sample (see Table 2) and by gender (see gender comparisons, below). 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 binge 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).

***At-risk drinking criteria.*** Among participants reporting gender and consumption on the QDS (*n* = 356), 39.6% (*n* = 141) met criteria for at-risk consumption (i.e., 7 or more drinks per week for females, 14 or more drinks per week for males). Among the participants with complete BYAACQ data (*n* = 340), 94.1% endorsed at least one consequence. After categorizing participants according to BYAACQ percentiles, 55% were in the upper half, 26.8% were in the upper quartile, and 10.3% were in the upper decile.

***Gender comparisons.*** Males and females were compared on all continuous alcohol use variables (i.e., AUDIT-C total, BYAACQ total, and alcohol use variables derived from the QDS) using independent samples t-tests (see Table 3). AUDIT-C total and all alcohol consumption variables derived from the QDS were significantly greater for males than for females ($p < .001$).

In contrast, males and females did not differ in the mean number of drinking consequences endorsed on the BYAACQ.

The proportion of males and females meeting NIAAA at-risk consumption status (according to number of drinks per week) was compared. Males and females were not significantly different in their likelihood of at-risk status, $\chi^2$ (1) = 0.12, $p$ = .73; 38.4% of males and 40.3% of females met at-risk consumption status.

BYAACQ items and categories were also compared by gender. The majority of the individual consequences were endorsed at similar rates for males and females (see Table 4). 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 ($p < .05$). Among the subsample of only those with complete BYAACQ data who endorsed male or female gender ($n$ = 329), males and females were equally likely to be at or above the 50$^{th}$, 75$^{th}$, and 90$^{th}$ percentiles for total number of negative drinking consequences (see Table 5).

**Aim 1: Establishing Construct Validity**

In order to examine the utility of the AUDIT-C as a brief screen for at-risk drinking among college students presenting to UHS primary care, correlations of the AUDIT-C with measures of negative drinking consequences and consumption were empirically estimated. As expected, the AUDIT-C was significantly correlated with total number of consequences on the BYAACQ, as well as well as with all consumption variables derived from the QDS (see Table 6). The correlation between the AUDIT-C and the BYAACQ ($r$ = .60) provides criterion-related evidence of the construct validity of the AUDIT-C as an indicator of negative drinking

consequences. Significant correlations between the AUDIT-C and consumption variables derived from the QDS provide evidence of concurrent validity, as the AUDIT-C and QDS are both measures of alcohol consumption.

**Aim 2: Identifying Cut-Off Scores**

Cut-off scores were identified via ROC curve analyses (Metz, 1978). See Figures 1 through 5 for ROC curves plotting the false positive fraction (1 - specificity) against the true positive fraction (sensitivity) at various cut-off scores. All AUC values were significantly greater than .50, 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, the AUC value for the criterion of being in the upper half for total BYAACQ was 0.797 (*SE* = .024; $p < .001$), indicating a 79.7% probability that an individual who was positive for the BYAACQ upper half criterion had a higher AUDIT-C score than an individual that was negative for that criterion (viz., below the $50^{th}$ percentile on the BYAACQ). See Table 7 for AUC values for all criteria and statistical comparisons to the null hypothesis that AUC = .50. Youden's index indicated that cut-offs maximizing combined sensitivity and specificity were 6 for at-risk consumption, 3 for any consequences, 5 for upper half of consequences, 5 for upper quartile of consequences, and 7 for upper decile of consequences (see Tables 8-12).

ROC curve analyses were also conducted with the sample separated by gender. 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 (see Table 13). However, an examination of sensitivity, specificity, and Youden's index indicated that optimal cut-offs did differ by gender. Cut-offs for males and females, respectively, were 7 and 5 for at-risk consumption, 5 and 3 for any consequences, 6 and 5 for upper half of consequences, 7 and 5 for upper quartile of

consequences, and 7 and 5 for upper decile of consequences (see Tables 14-23). See Table 24 for a summary of recommended cut-offs for each criterion based on the whole sample and separated by gender.

## Discussion

This study sought to: 1) assess the construct validity of the AUDIT-C among students recruited from Syracuse University's University Health Service (UHS) and 2) determine optimal cut-off scores for at-risk consumption and negative drinking consequences. Results support the utility of the AUDIT-C as a screen for at-risk alcohol consumption and alcohol-related problems among students presenting to a UHS. 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. Results also indicate optimal cut-off scores of 5 for females and 7 for males as indicators of at-risk consumption levels as well as an increased likelihood of experiencing an elevated number of negative drinking consequences.

The current study expands upon prior research that focused primarily on at-risk consumption levels as the validity comparison and reference standard for determining cut-off scores (DeMartini & Carey, 2012). It also extends research on 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.

This study's second aim was to identify cut-off scores for at-risk consumption levels as well as negative drinking consequences. The cut-off scores identified are substantially higher than those recommended based on research with veterans and community samples of adults, which recommended cut-off scores of 3 for women and 4 for men (Bush et al., 1998; Bradley et al., 2003; Bradley et al., 2007). 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 by Kelly et al. (2009) for detecting AUD among young adults presenting for emergency care (i.e., 5 for females, 6 for males). The current study's recommended cut-off scores also resemble those suggested by Kwon et al. (2013) for Korean students recruited from UHS. Kwon et al. suggested slightly higher cut-off scores for detecting AUD (i.e., 6 for females, 7 for males) than for at-risk drinking (i.e., 4 for females and 6 for males).

Interestingly, this study's recommended cut-off scores are higher than those suggested by a study that used a DSM-5 AUD diagnosis as the criterion of interest among a large sample of undergraduates (Hagman, 2015). This may be due to the relatively low threshold required for a DSM-5 AUD 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 50$^{th}$ 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 AUD symptoms, there is enough overlap that it would be possible for an individual to meet diagnostic criteria for AUD and be below the 50$^{th}$ percentile for number of consequences. For example, if an individual endorsed "I have felt like I needed a drink after I'd gotten up (that is, before breakfast)" and "I've not been able to remember large stretches of time while drinking heavily" but no other consequences, he/she would likely meet DSM-5 diagnostic criteria for an AUD but would fall well below the BYAACQ mean number of consequences ($m$ = 7.08).

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 drinks on one occasion), which was based on WHO and NIAAA recommendations (Babor et al., 2001; NIAAA, 2005). However, the original AUDIT, published by the WHO in Switzerland, used "six or more drinks on one occasion" for the third item (Babor et al., 2001). This wording was used in an early Veterans Health Administration (VA) study of the AUDIT-C (Bush et al., 1998), subsequent studies conducted in the VA and adult outpatient clinics (e.g., Bradley et al., 2003; Bradley et al., 2007), as well as a study of young adults presenting to an emergency department (Kelly et al., 2009). Other AUDIT-C validity studies did not fully describe the measure, so it is unclear which wording was used for item three (e.g., Hagman, 2015; Aertgeerts et al., 2001). 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 regards 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 those of DeMartini and Carey (2012), who recommended an overall cut-off score of 6, with optimal cut-offs of 7 for males and 5 for

females. This study extends those findings to university students presenting to primary care and supports the validity of the AUDIT-C as an indicator of negative drinking consequences in addition to at-risk consumption levels.

**Study Limitations**

This study's recruitment through email and completion of the study through an online survey may limit the generalizability of study 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 patients typically seen in primary care in terms of their alcohol consumption and negative alcohol-related consequences.

Response rates also limit the ability to generalize these findings to all students completing screens in primary care, as only one-fifth of those contacted initiated the survey. Adjustments were made halfway through the study that successfully improved the response rate (from 16% in May 2014 to 21% in December 2014). Completion rates also improved from approximately 10% of those contacted in May 2014 to 21% in December 2014. Previous research (Kennedy et al., 2014) utilized mailed postcards and telephone calls to supplement email recruitment and subsequently had 44.8% of those invited complete the survey. This suggests that response rates for the present study may have been improved given additional financial resources and more intensive multi-modal recruitment. Personalizing recruitment emails may have also improved response rates (see Kypri, Gallagher, & Cashell-Smith, 2004). Unfortunately, this was not feasible, because the initial recruitment emails were compiled and sent in bulk by UHS staff due to privacy regulations. Another study on alcohol use (Reed, Prado, Matsumoto, & Amaro, 2010) provided $10 to all participants and had a 40% response rate; no additional details were provided on recruitment procedures. However, lower response rates have

also been reported with recruitment done solely through email (e.g., 5-10%; McAlaney & McMahon, 2007; Burke et al., 2012). Thus, the current study's response rate falls within the range of response rates for prior web-based alcohol surveys (i.e., from 5% to 45%). However, it is not known as to whether individuals who self-selected to complete the survey were representative of UHS patients as a whole.

An additional limitation relates to the potential impact of social desirability. The validity of AUDIT-C reports may have been influenced by social desirability, as previous research indicates that college students' concerns with impression management are inversely related to disclosure of alcohol consumption and negative consequences (Davis, Thake, & Vilhena, 2010). 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. Furthermore, external validity of these findings may be attenuated by differences in the study's data collection procedures in comparison to in-person screening that occurs in primary care. This is supported by research that suggests that computer-based administration of the AUDIT-C is more likely to result in a positive screen and is less impacted by social desirability bias in comparison to paper-based AUDIT-C administration (Graham, Goss, Xu, Magid, & Diguiseppi, 2007). 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 screening in primary care settings.

**Directions for Future Research**

This study represents an important step in validating the use of the AUDIT-C in university primary care settings. However, with access to additional time and resources, future research could add to the field via longitudinal investigations to establish the predictive validity of the AUDIT-C. This study focused on concurrent past-year alcohol consumption and alcohol-related consequences and accordingly does not inform health care providers as to what to expect regarding patients' future behaviors. It would be helpful for providers to understand how current AUDIT-C scores predict health-related outcomes, including alcohol-related consequences, and whether certain groups of students would benefit from more intensive intervention in comparison to other students who may be more likely to decrease their alcohol consumption on their own.

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 would not be expected to be as 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 (Williams et al., 2015). A review of the literature indicates that even when behavioral health providers are integrated in primary care settings, they are often not utilized effectively (Miller, Brown Levey, Payne-Murphy, & Kwan, 2014). Therefore, next steps should include dissemination efforts to ensure screening is conducted consistently and with appropriate 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. It is possible that the normativity of at-risk drinking in college student alcohol use may bias UHS providers against discussing alcohol with their patients; in other words, at-risk drinking may be seen as normative to the college experience and therefore not worth addressing during the primary care appointment. However, the present study suggests that elevated AUDIT-C scores are associated with more negative alcohol-related consequences and are thus an important indicator of the students' health as a whole. A recent study found 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 (Gadomski et al., 2015). 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.

Overall, as university health centers see a wide range of individuals, it may be useful to examine whether the AUDIT-C functions differently for sub-groups of students. The current study did not examine demographic differences other than gender in the utility of the AUDIT-C. Therefore, a direction for future research would be to test whether these findings generalize to critical populations, including racial and ethnic minorities, non-native English speakers, and non-traditional students. For example, it may be informative to examine whether older students or non-native English speakers respond differently to the AUDIT-C and/or experience different negative drinking consequences. For non-native English speakers, future research could examine

whether less familiarity with the English language limits the validity of the AUDIT-C; if so, alternative methods of administration might be considered (e.g., oral instead of written administration; translating the AUDIT-C to the individual's native language). Prior research suggests that undergraduate students consume more alcohol and experience more alcohol-related consequences in comparison to post-college young adults (Perkins, 1999), and that perceived drinking norms vary such that heavy drinking among young, female, full-time students is viewed more favorably than heavy drinking among older, male, employed individuals (Colby, Swanton, & Colby, 2012). As this study's sample consisted of 21.2% graduate students, and graduate students also utilize on-campus primary care, it may be informative to examine whether differences exist in the predictive validity and utility of the AUDIT-C among graduate students or older undergraduates in comparison to age-typical undergraduate students.

This study highlights the contribution of negative alcohol-related consequences toward our understanding of the construct of at-risk drinking. Including consequences in addition to consumption to define at-risk drinking has implications for brief interventions targeting the broad spectrum of problematic alcohol use. Defining at-risk drinking solely according to alcohol consumption may limit the scope of interventions, whereas including alcohol-related consequences may inspire novel interventions to target at-risk drinking. For example, normative feedback interventions typically provide college students information on how their alcohol consumption compares to typical consumption among their peers, with the goal of correcting students' perceptions regarding normative alcohol use and subsequently altering their drinking behavior (e.g., Agostinelli, Brown, & Miller, 1995; Neighbors, Dillard, Lewis, Bergstrom, & Neil, 2006). Another direction for brief intervention could provide normative feedback on the experience of negative drinking consequences. For example, if an individual believes that all

college students regularly pass out from drinking alcohol, data from this study could be used to demonstrate that, among students with past-year alcohol use, only 19% of females and 29% of males report experiencing that consequence in the last year.

The current study is unique in that it identified different cut-off scores according to increasingly severe number of alcohol-related consequences. For example, for males and females combined, an AUDIT-C cut-off score of 3 suggests at least one negative drinking consequence; a cut-off score of 5 suggests the individual is experiencing more negative drinking consequences than 50% of their peers; and a cut-off score of 7 suggests the individual is experiencing more negative drinking consequences than 90% of their peers. This could be extended to further research on treatment matching according to severity of negative drinking consequences, as suggested by scoring at different cut-offs. Specifically, the AUDIT-C screen could be integrated into stepped care interventions such that different cut-offs suggest differential next steps for treatment, such as watchful waiting, brief intervention, or referral to specialty care (Drummond et al., 2009; Seekles, van Straten, Beekman, van Marwijk, & Cuijpers, 2011).

**Conclusions and Clinical Implications**

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, with 7 for males and 5 for females suggesting likelihood of at-risk consumption and an elevated number of alcohol-related consequences. Additional research is needed to establish the clinical utility of integrating the AUDIT-C into university primary care settings.

This study's findings are relevant to screening and brief intervention models for at-risk drinking, particularly among students presenting for primary care at universities like Syracuse

University (i.e., large, private, secular, coeducational institutions). It is not known whether results would generalize to primary care patients at universities with different characteristics (e.g., small, public, rural, religious), since the AUDIT-C has not yet been validated for that population. Clinical practice would likely be improved through consistent use of the AUDIT-C in university primary care, using separate cut-off scores for males and females to indicate the need for further assessment and brief intervention. This would require that providers consistently use the screening instrument, take the time to calculate total scores, know what cut-off scores are meaningful, and use that information to inform their clinical practice. Consistent implementation of these results may require ongoing education for primary care staff and medical providers, particularly among those who are new to university primary care and are therefore accustomed to working with different patient populations. With adequate training and proper implementation, 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 harmful alcohol use.

Table 1

*Participant Demographic Characteristics*

| | % / *m* (*SD*) | *n* |
|---|---|---|
| Gender | | 368 |
| Female | 64.1% | |
| Male | 35.3% | |
| Transgender | 0.5% | |
| Year in school | | 368 |
| Freshman | 23.1% | |
| Sophomore | 13.6% | |
| Junior | 20.1% | |
| Senior | 20.4% | |
| 5th-year Senior | 1.6% | |
| Graduate student | 21.2% | |
| 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 |
| 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 | Median | *SD* | Min – Max | Skewness | Kurtosis | *n* |
|---|---|---|---|---|---|---|---|
| AUDIT-C | 5.28 | 5.00 | 2.55 | 1-12 | 0.22 | -0.67 | 387 |
| BYAACQ | 7.08 | 6.00 | 5.14 | 0-24 | 0.86 | 0.35 | 340 |
| Drinks per week | 9.23 | 6.00 | 10.34 | 0-90 | 2.74 | 13.67 | 363 |
| Drinks per drinking day | 3.95 | 3.00 | 2.48 | 0-20 | 1.85 | 7.14 | 364 |
| Binge days (past 90 days) | 6.76 | 3.00 | 10.73 | 0-90 | 3.28 | 15.05 | 361 |
| Drinking days per week | 2.05 | 2.00 | 1.53 | 0-7 | 0.73 | 0.64 | 367 |
| Max drinks in 1 day | 7.14 | 6.00 | 5.00 | 0-50 | 2.73 | 16.31 | 359 |

*Note*. AUDIT-C and BYAACQ based on past year; remaining alcohol consumption variable were calculated based on the prior 90 days.

Table 3

*Alcohol Use Information and Independent Samples t-tests by Gender*

| | Males | | | | Females | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Variable | Mean | Mdn | *SD* | Min-Max | Mean | Mdn | *SD* | Min-Max | *t* | *p* |
| AUDIT-C | 6.33 | 6.00 | 2.68 | 1-12 | 4.69 | 4.00 | 2.27 | 1-10 | 5.93 | .00 |
| BYAACQ | 7.50 | 6.50 | 5.72 | 0-24 | 6.81 | 6.00 | 4.81 | 0-20 | 1.12 | .27 |
| Drinks per week* | 13.25 | 9.00 | 13.80 | 0-90 | 7.13 | 5.00 | 7.19 | 0-40 | 4.57 | .00 |
| Drinks per drinking day* | 4.81 | 4.00 | 2.95 | 0-18 | 3.50 | 3.00 | 2.09 | 0-20 | 4.46 | .00 |
| Binge days (past 90 days)* | 10.47 | 4.00 | 14.78 | 0-90 | 4.88 | 3.00 | 7.20 | 0-40 | 3.86 | .00 |
| Drinking days per week | 2.53 | 2.00 | 1.69 | .01-7 | 1.80 | 2.00 | 1.38 | 0-6 | 4.17 | .00 |
| Max number of drinks in 1 day* | 9.76 | 9.00 | 6.77 | 1-50 | 5.77 | 6.00 | 2.94 | 0-20 | 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. Due to sporadic missing data, samples sizes ranged from 118-130 for males and 211-235 for females. AUDIT-C and BYAACQ reports were based on the past year; remaining alcohol consumption variables were based on the past 90 days.

Table 4

*BYAACQ Consequences Endorsed by Gender (All Available Data; N = 366)*

| Item text | Percent Endorsed "Yes" | | Chi-square | *p* |
|---|---|---|---|---|
| | Males | Females | | |
| I have had a hangover (headache, sick stomach) the morning after I had been drinking. | 74.6 | 73.3 | .07 | .79 |
| I have taken foolish risks when I have been drinking. | 48.5 | 50.2 | .10 | .75 |
| I've not been able to remember large stretches of time while drinking heavily. | 39.2 | 39.8 | .013 | .91 |
| The quality of my work or school work has suffered because of my drinking. | 15.4 | 11.4 | 1.17 | .28 |
| I have had less energy or felt tired because of my drinking. | 54.6 | 61.5 | 1.66 | .20 |
| My drinking has gotten me into sexual situations I later regretted. | 26.9 | 24.3 | 0.32 | .57 |
| I often have ended up drinking on nights when I had planned not to drink. | 43.1 | 38.0 | 0.89 | .35 |
| My physical appearance has been harmed by my drinking. | 11.7 | 9.8 | 0.31 | .58 |
| While drinking, I have said or done embarrassing things. | 69.3 | 66.5 | 0.29 | .59 |
| **I have felt very sick to my stomach or thrown up after drinking.** | **60.0** | **70.3** | **4.03** | **.045** |
| I have not gone to work or missed classes at school because of drinking, a hangover, or illness caused by drinking. | 29.5 | 22.0 | 2.47 | .17 |
| When drinking, I have done impulsive things I regretted later. | 39.5 | 33.9 | 1.15 | .28 |
| I have been overweight because of drinking. | 8.5 | 9.8 | 0.16 | .69 |

| | | | | |
|---|---|---|---|---|
| **I have woken up in an unexpected place after heavy drinking.** | **25.6** | **12.8** | **9.44** | **.00** |
| **I have spent too much time drinking.** | **17.7** | **8.1** | **7.67** | **.01** |
| I have felt badly about myself because of my drinking. | 19.2 | 22.6 | 0.55 | .46 |
| My drinking has created problems between myself and my boyfriend/girlfriend/spouse, parents, or other near relatives. | 12.3 | 13.7 | 0.14 | .71 |
| **I have felt like I needed a drink after I'd gotten up (that is, before breakfast).** | **7.8** | **1.7** | **8.08** | **.00** |
| I have driven a car when I knew I had too much to drink to drive safely. | 12.5 | 8.1 | 1.85 | .17 |
| I have neglected my obligations to family, work, or school because of drinking. | 13.2 | 11.1 | 0.34 | .56 |
| I have often found it difficult to limit how much I drink. | 19.2 | 15.4 | 0.89 | .35 |
| **I have passed out from drinking.** | **28.9** | **19.2** | **4.42** | **.04** |
| I have become very rude, obnoxious, or insulting after drinking. | 29.2 | 23.5 | 1.44 | .23 |
| I have found that I needed larger amounts of alcohol to feel any effect, or that I could no longer get high or drunk on the same amount that used to get me high or drunk. | 32.3 | 25.4 | 1.98 | .16 |

*Note*. Items in bold were endorsed at significantly different rates by gender ($p > .05$).

Table 5

*BYAACQ Categories by Gender (N=329)*

| Category | Percent Endorsed "Yes" | | Chi-square | *p* |
|---|---|---|---|---|
| | Males (*n* = 118) | Females (*n* = 211) | | |
| ≥ 50th percentile | 57.6 | 53.1 | 0.63 | 0.43 |
| ≥ 75th percentile | 31.4 | 24.2 | 1.99 | 0.16 |
| ≥ 90th percentile | 11.0 | 9.5 | 0.20 | 0.66 |

Table 6

*Bivariate Correlations among Alcohol Use Variables*

| | AUDIT-C | BYAACQ | Drinks per Drinking Day* | Drinks per Week* | Binge Days* | Max Drinks* | Drinking Days per Week |
|---|---|---|---|---|---|---|---|
| AUDIT-C | 1.00 | -- | -- | -- | -- | -- | -- |
| BYAACQ | .597 | 1.00 | -- | -- | -- | -- | -- |
| Drinks per Drinking Day* | .757 | .433 | 1.00 | -- | -- | -- | -- |
| Drinks per Week* | .798 | .501 | .726 | 1.00 | -- | -- | -- |
| Binge Days* | .841 | .554 | .765 | .756 | 1.00 | -- | -- |
| Max Drinks* | .760 | .489 | .770 | .706 | .787 | 1.00 | -- |
| Drinking Days per Week | .595 | .416 | .339 | .824 | .517 | .470 | 1.00 |

*Note.* * Indicates variable was log-transformed prior to analyses. All correlations are statistically significant at $p < .001$.

Table 7

*AUC Values for All Criteria*

| Criterion | AUC | *SE* | *p* | 95% CI lower bound | 95% CI upper bound |
|---|---|---|---|---|---|
| At-risk consumption | .892 | .017 | <.001 | .858 | .925 |
| BYAACQ criteria | | | | | |
| Upper half | .797 | .024 | <.001 | .750 | .844 |
| Upper quartile | .796 | .026 | <.001 | .746 | .847 |
| Upper decile | .771 | .038 | <.001 | .697 | .846 |
| Any consequences | .861 | .048 | <.001 | .767 | .954 |

Table 8

*Sensitivity, Specificity, & Youden's Index for NIAAA At-Risk Consumption Criterion*

| Cut-off | Sensitivity | 1-Specificity | Specificity | Youden's Index |
|---|---|---|---|---|
| 1 | 1.000 | 1.000 | .000 | .000 |
| 2 | 1.000 | .879 | .121 | .121 |
| 3 | .993 | .748 | .252 | .245 |
| 4 | .979 | .603 | .397 | .376 |
| 5 | .936 | .346 | .654 | .590 |
| **6** | **.830** | **.196** | **.804** | **.634** |
| 7 | .674 | .089 | .911 | .585 |
| 8 | .518 | .056 | .944 | .462 |
| 9 | .305 | .014 | .986 | .291 |
| 10 | .092 | .009 | .991 | .083 |
| 11 | .021 | .000 | 1.000 | .021 |
| 12 | .007 | .000 | 1.000 | .007 |

Table 9

*Sensitivity, Specificity, & Youden's Index for BYAACQ "Any" Criterion*

| Cut-off | Sensitivity | 1-Specificity | Specificity | Youden's Index |
|---|---|---|---|---|
| 1 | 1.000 | 1.000 | .000 | .000 |
| 2 | .953 | .500 | .500 | .453 |
| **3** | **.890** | **.250** | **.750** | **.640** |
| 4 | .790 | .200 | .800 | .590 |
| 5 | .614 | .100 | .900 | .514 |
| 6 | .476 | .100 | .900 | .376 |
| 7 | .335 | .050 | .950 | .285 |
| 8 | .238 | .050 | .950 | .188 |
| 9 | .141 | .000 | 1.000 | .141 |
| 10 | .053 | .000 | 1.000 | .053 |
| 11 | .016 | .000 | 1.000 | .016 |
| 12 | .006 | .000 | 1.000 | .006 |

Table 10

*Sensitivity, Specificity, & Youden's Index for BYAACQ Upper Half Criterion*

| Cut-off | Sensitivity | 1-Specificity | Specificity | Youden's Index |
|---|---|---|---|---|
| 1 | 1.000 | 1.000 | .000 | .000 |
| 2 | .984 | .855 | .145 | .129 |
| 3 | .963 | .717 | .283 | .246 |
| 4 | .914 | .559 | .441 | .355 |
| **5** | **.781** | **.342** | **.658** | **.439** |
| 6 | .647 | .217 | .783 | .430 |
| 7 | .503 | .092 | .908 | .411 |
| 8 | .364 | .059 | .941 | .305 |
| 9 | .214 | .033 | .967 | .181 |
| 10 | .080 | .013 | .987 | .067 |
| 11 | .027 | .000 | 1.000 | .027 |
| 12 | .011 | .000 | 1.000 | .011 |

Table 11

*Sensitivity, Specificity, & Youden's Index for BYAACQ Upper Quartile Criterion*

| Cut-off | Sensitivity | 1-Specificity | Specificity | Youden's Index |
|---|---|---|---|---|
| 1 | 1.000 | 1.000 | 0.000 | 0.000 |
| 2 | 1.000 | 0.899 | 0.101 | 0.101 |
| 3 | 1.000 | 0.798 | 0.202 | 0.202 |
| 4 | 0.956 | 0.681 | 0.319 | 0.275 |
| **5** | **0.901** | **0.468** | **0.532** | **0.433** |
| 6 | 0.769 | 0.339 | 0.661 | 0.430 |
| 7 | 0.626 | 0.206 | 0.794 | 0.420 |
| 8 | 0.473 | 0.137 | 0.863 | 0.336 |
| 9 | 0.352 | 0.052 | 0.948 | 0.300 |
| 10 | 0.121 | 0.024 | 0.976 | 0.097 |
| 11 | 0.055 | 0.000 | 1.000 | 0.055 |
| 12 | 0.022 | 0.000 | 1.000 | 0.022 |

Table 12

*Sensitivity, Specificity, & Youden's Index for BYAACQ Upper Decile Criterion*

| Cut-off | Sensitivity | 1-Specificity | Specificity | Youden's Index |
|---|---|---|---|---|
| 1 | 1.000 | 1.000 | 0.000 | .000 |
| 2 | 1.000 | .918 | .082 | .082 |
| 3 | 1.000 | .836 | .164 | .164 |
| 4 | .971 | .73 | .270 | .241 |
| 5 | .914 | .546 | .454 | .368 |
| 6 | .800 | .414 | .586 | .386 |
| **7** | **.686** | **.276** | **.724** | **.410** |
| 8 | .486 | .197 | .803 | .289 |
| 9 | .400 | .102 | .898 | .298 |
| 10 | .200 | .033 | .967 | .167 |
| 11 | .114 | .003 | .997 | .111 |
| 12 | .057 | .000 | 1.000 | .057 |

Table 13

*Comparison of AUC Values by Gender for All Criteria*

| Criterion | AUC | *SE* | *p* for null hypothesis (AUC=.50) | 95% CI | | Chi-square | Chi-square *p* |
|---|---|---|---|---|---|---|---|
| | | | | lower bound | upper bound | | |
| At-risk consumption | | | | | | 0.91 | 0.34 |
| Males | .937 | .021 | .000 | .895 | .978 | | |
| Females | .910 | .019 | .000 | .872 | .948 | | |
| BYAACQ upper-half | | | | | | 1.26 | 0.26 |
| Males | .835 | .039 | .000 | .758 | .912 | | |
| Females | .779 | .031 | .000 | .718 | .84 | | |
| BYAACQ upper-quartile | | | | | | 0.87 | 0.35 |
| Males | .822 | .037 | .000 | .749 | 0.895 | | |
| Females | .774 | .036 | .000 | .704 | 0.844 | | |
| BYAACQ upper-decile | | | | | | 1.11 | 0.29 |
| Males | .825 | .051 | .000 | .725 | 0.925 | | |
| Females | .749 | .051 | .000 | .648 | 0.850 | | |
| BYAACQ any consequences | | | | | | 0.25 | 0.61 |
| Males | .846 | .073 | .001 | .702 | .990 | | |
| Females | .893 | .058 | .000 | .779 | 1.00 | | |

Table 14

*Sensitivity, Specificity, & Youden's Index for NIAAA At-Risk Consumption Criterion (Males)*

| Cut-off | Sensitivity | 1-Specificity | Specificity | Youden's Index |
|---|---|---|---|---|
| 1 | 1.000 | 1.000 | 0.000 | .000 |
| 2 | 1.000 | .922 | .078 | .078 |
| 3 | 1.000 | .857 | .143 | .143 |
| 4 | 1.000 | .753 | .247 | .247 |
| 5 | 1.000 | .558 | .442 | .442 |
| 6 | 1.000 | .377 | .623 | .623 |
| **7** | **0.958** | **.195** | **.805** | **.764** |
| 8 | .854 | .130 | .870 | .724 |
| 9 | .625 | .039 | .961 | .586 |
| 10 | .229 | .026 | .974 | .203 |
| 11 | .063 | .000 | 1.000 | .063 |
| 12 | .021 | .000 | 1.000 | .021 |

Table 15

*Sensitivity, Specificity, & Youden's Index for NIAAA At-Risk Consumption Criterion (Females)*

| Cut-off | Sensitivity | 1-Specificity | Specificity | Youden's Index |
|---|---|---|---|---|
| 1 | 1.000 | 1.000 | 0.000 | 0.000 |
| 2 | 1.000 | .854 | .146 | .146 |
| 3 | .989 | .686 | .314 | .303 |
| 4 | .968 | .518 | .482 | .449 |
| **5** | **.903** | **.226** | **.774** | **.677** |
| 6 | .742 | .095 | .905 | .647 |
| 7 | .527 | .029 | .971 | .498 |
| 8 | .344 | .015 | .985 | .329 |
| 9 | .140 | .000 | 1.000 | .140 |
| 10 | .022 | .000 | 1.000 | .022 |

Table 16

*Sensitivity, Specificity, & Youden's Index for BYAACQ "Any" Criterion (Males)*

| Cut-off | Sensitivity | 1-Specificity | Specificity | Youden's Index |
|---|---|---|---|---|
| 1 | 1.000 | 1.000 | .000 | .000 |
| 2 | .973 | .625 | .375 | .348 |
| 3 | .936 | .500 | .500 | .436 |
| 4 | .855 | .375 | .625 | .480 |
| **5** | **.745** | **.125** | **.875** | **.620** |
| 6 | .636 | .125 | .875 | .511 |
| 7 | .509 | .125 | .875 | .384 |
| 8 | .427 | .125 | .875 | .302 |
| 9 | .291 | .000 | 1.000 | .291 |
| 10 | .127 | .000 | 1.000 | .127 |
| 11 | .036 | .000 | 1.000 | .036 |
| 12 | .018 | .000 | 1.000 | .018 |

Table 17

*Sensitivity, Specificity, & Youden's Index for BYAACQ "Any" Criterion (Females)*

| Cut-off | Sensitivity | 1-Specificity | Specificity | Youden's Index |
|---|---|---|---|---|
| 1 | 1.000 | 1.000 | .000 | .000 |
| 2 | .945 | .364 | .636 | .581 |
| **3** | **.864** | **.091** | **.909** | **.773** |
| 4 | .749 | .091 | .909 | .658 |
| 5 | .533 | .091 | .909 | .442 |
| 6 | .372 | .091 | .909 | .281 |
| 7 | .236 | .000 | 1.000 | .236 |
| 8 | .141 | .000 | 1.000 | .141 |
| 9 | .060 | .000 | 1.000 | .060 |
| 10 | .010 | .000 | 1.000 | .010 |

Table 18

*Sensitivity, Specificity, & Youden's Index for BYAACQ Upper Half Criterion (Males)*

| Cut-off | Sensitivity | 1-Specificity | Specificity | Youden's Index |
|---|---|---|---|---|
| 1 | 1 | 1 | .000 | .000 |
| 2 | 1 | .880 | .120 | .120 |
| 3 | .985 | .80 | .200 | .185 |
| 4 | .985 | .60 | .400 | .385 |
| 5 | .912 | .420 | .580 | .492 |
| **6** | **.838** | **.280** | **.720** | **.558** |
| 7 | .706 | .180 | .820 | .526 |
| 8 | .603 | .140 | .860 | .463 |
| 9 | .397 | .100 | .900 | .297 |
| 10 | .176 | .040 | .960 | .136 |
| 11 | .059 | .000 | 1.000 | .059 |
| 12 | .029 | .000 | 1.000 | .029 |

Table 19

*Sensitivity, Specificity, & Youden's Index for BYAACQ Upper Half Criterion (Females)*

| Cut-off | Sensitivity | 1-Specificity | Specificity | Youden's Index |
|---|---|---|---|---|
| 1 | 1 | 1 | .000 | .000 |
| 2 | .982 | .837 | .163 | .145 |
| 3 | .955 | .673 | .327 | .282 |
| 4 | .875 | .531 | .469 | .344 |
| **5** | **.696** | **.296** | **.704** | **.400** |
| 6 | .518 | .173 | .827 | .345 |
| 7 | .384 | .041 | .959 | .343 |
| 8 | .232 | .020 | .980 | .212 |
| 9 | .107 | .000 | 1.000 | .107 |
| 10 | .018 | .000 | 1.000 | .018 |

Table 20

*Sensitivity, Specificity, & Youden's Index for BYAACQ Upper Quartile Criterion (Males)*

| Cut-off | Sensitivity | 1-Specificity | Specificity | Youden's Index |
|---|---|---|---|---|
| 1 | 1.000 | 1.000 | .000 | .000 |
| 2 | 1.000 | .926 | .074 | .074 |
| 3 | 1.000 | .864 | .136 | .136 |
| 4 | 1.000 | .741 | .259 | .259 |
| 5 | 1.000 | .568 | .432 | .432 |
| 6 | .946 | .444 | .556 | .502 |
| **7** | **.838** | **.321** | **.679** | **.517** |
| 8 | .703 | .272 | .728 | .431 |
| 9 | .541 | .148 | .852 | .393 |
| 10 | .243 | .062 | .938 | .181 |
| 11 | .108 | .000 | 1.000 | .108 |
| 12 | .054 | .000 | 1.000 | .054 |

Table 21

*Sensitivity, Specificity, & Youden's Index for BYAACQ Upper Quartile Criterion (Females)*

| Cut-off | Sensitivity | 1-Specificity | Specificity | Youden's Index |
|---|---|---|---|---|
| 1 | 1.000 | 1.000 | .000 | .000 |
| 2 | 1.000 | .887 | .113 | .113 |
| 3 | 1.000 | .767 | .233 | .233 |
| 4 | .922 | .648 | .352 | .274 |
| **5** | **.824** | **.409** | **.591** | **.415** |
| 6 | .627 | .270 | .730 | .357 |
| 7 | .490 | .138 | .862 | .352 |
| 8 | .314 | .075 | .925 | .239 |
| 9 | .216 | .006 | .994 | .210 |
| 10 | .020 | .006 | .994 | .014 |

Table 22

*Sensitivity, Specificity, & Youden's Index for BYAACQ Upper Decile Criterion (Males)*

| Cut-off | Sensitivity | 1-Specificity | Specificity | Youden's Index |
|---|---|---|---|---|
| 1 | 1.000 | 1.000 | .000 | .000 |
| 2 | 1.000 | .943 | .057 | .057 |
| 3 | 1.000 | .895 | .105 | .105 |
| 4 | 1.000 | .800 | .200 | .200 |
| 5 | 1.000 | .667 | .333 | .333 |
| 6 | 1.000 | .552 | .448 | .448 |
| **7** | **.923** | **.429** | **.571** | **.494** |
| 8 | .769 | .362 | .638 | .407 |
| 9 | .692 | .219 | .781 | .473 |
| 10 | .385 | .086 | .914 | .299 |
| 11 | .231 | .010 | .990 | .221 |
| 12 | .154 | .000 | 1.000 | .154 |

Table 23

*Sensitivity, Specificity, & Youden's Index for BYAACQ Upper Decile Criterion (Females)*

| Cut-off | Sensitivity | 1-Specificity | Specificity | Youden's Index |
|---|---|---|---|---|
| 1 | 1.000 | 1.000 | .000 | .000 |
| 2 | 1.000 | .905 | .095 | .095 |
| 3 | 1.000 | .805 | .195 | .195 |
| 4 | .950 | .689 | .311 | .261 |
| **5** | **.850** | **.474** | **.526** | **.376** |
| 6 | .650 | .326 | .674 | .324 |
| 7 | .550 | .189 | .811 | .361 |
| 8 | .300 | .116 | .884 | .184 |
| 9 | .200 | .042 | .958 | .158 |
| 10 | .050 | .005 | .995 | .045 |

Table 24

*Summary of Recommended Cut-Off Scores Balancing Sensitivity and Specificity*

| Criteria | Females and Males | Females Only | Males Only |
|---|---|---|---|
| At-risk consumption | 6 | 5 | 7 |
| Any consequences | 3 | 3 | 5 |
| BYAACQ upper half | 5 | 5 | 6 |
| BYAACQ upper quartile | 5 | 5 | 7 |
| BYAACQ upper decile | 7 | 5 | 7 |

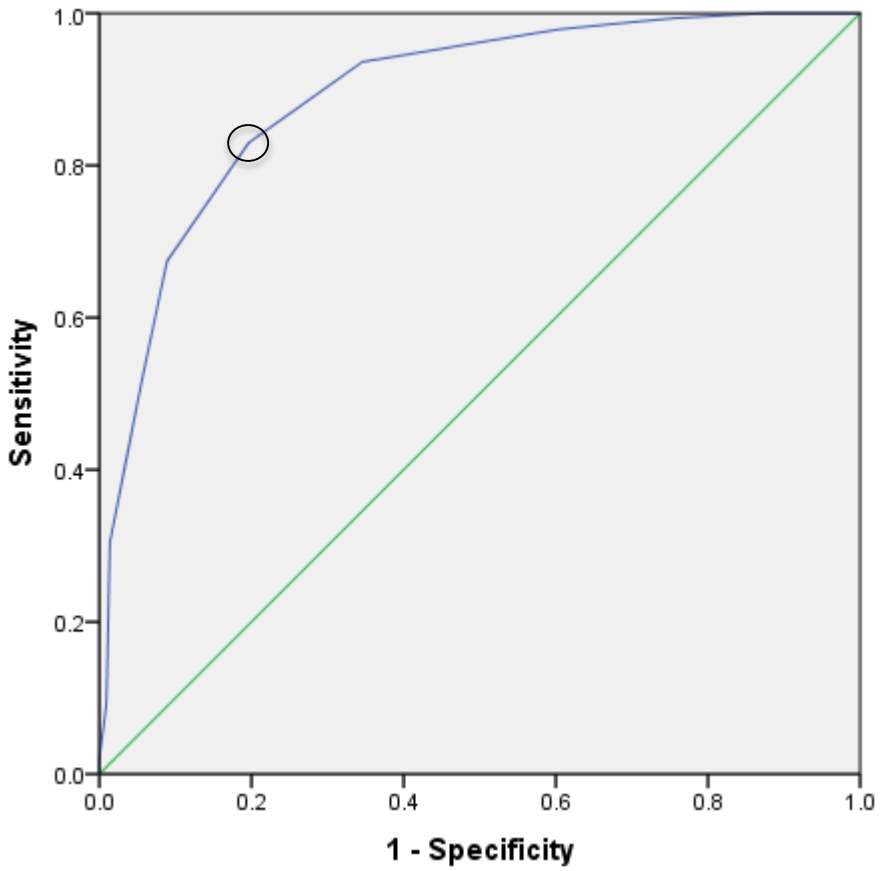


*Figure 1*. ROC curve for AUDIT-C predicting NIAAA at-risk consumption. Optimal cut-off score of 6 is indicated by a circle. The diagonal line indicates the theoretical ROC curve for AUC = .50.

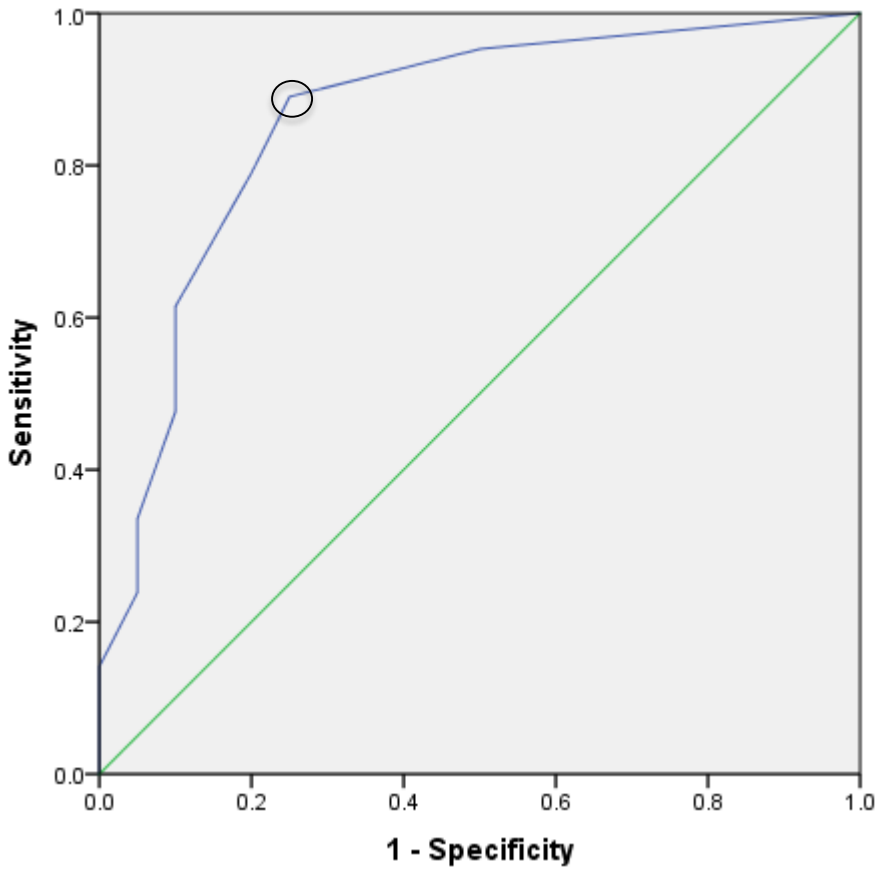


*Figure 2.* ROC curve for AUDIT-C predicting any BYAACQ consequences. Optimal cut-off score of 3 is indicated by a circle. The diagonal line indicates the theoretical ROC curve for AUC = .50.

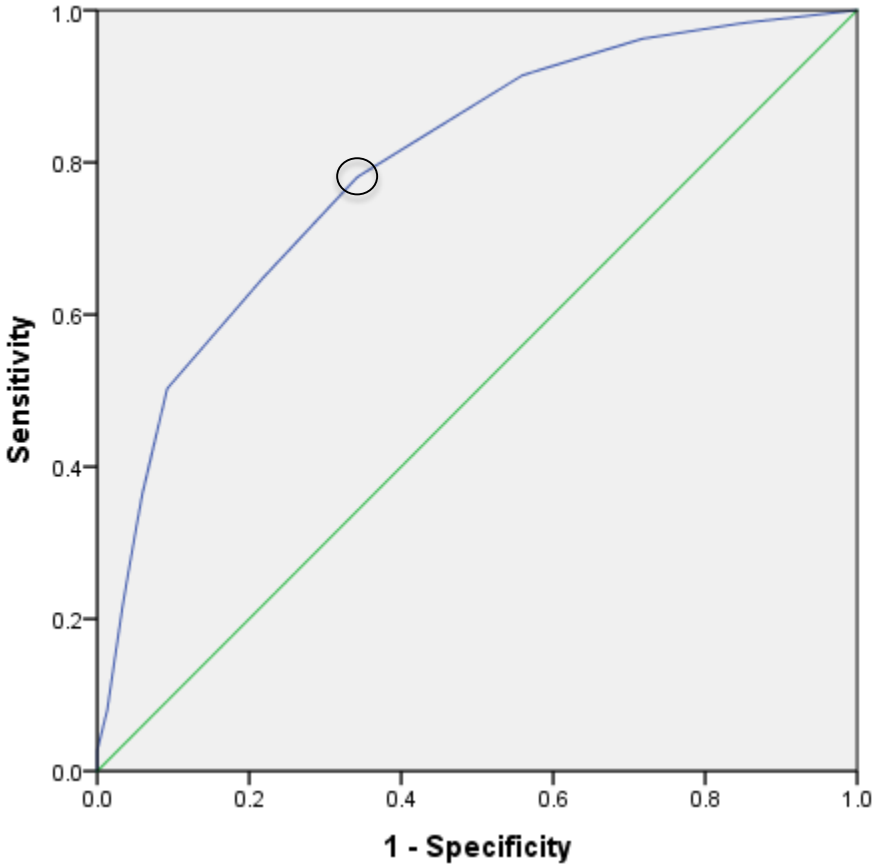


*Figure 3.* ROC curve for AUDIT-C predicting upper half BYAACQ consequences. Optimal cut-off score of 5 is indicated by a circle. The diagonal line indicates the theoretical ROC curve for AUC = .50.

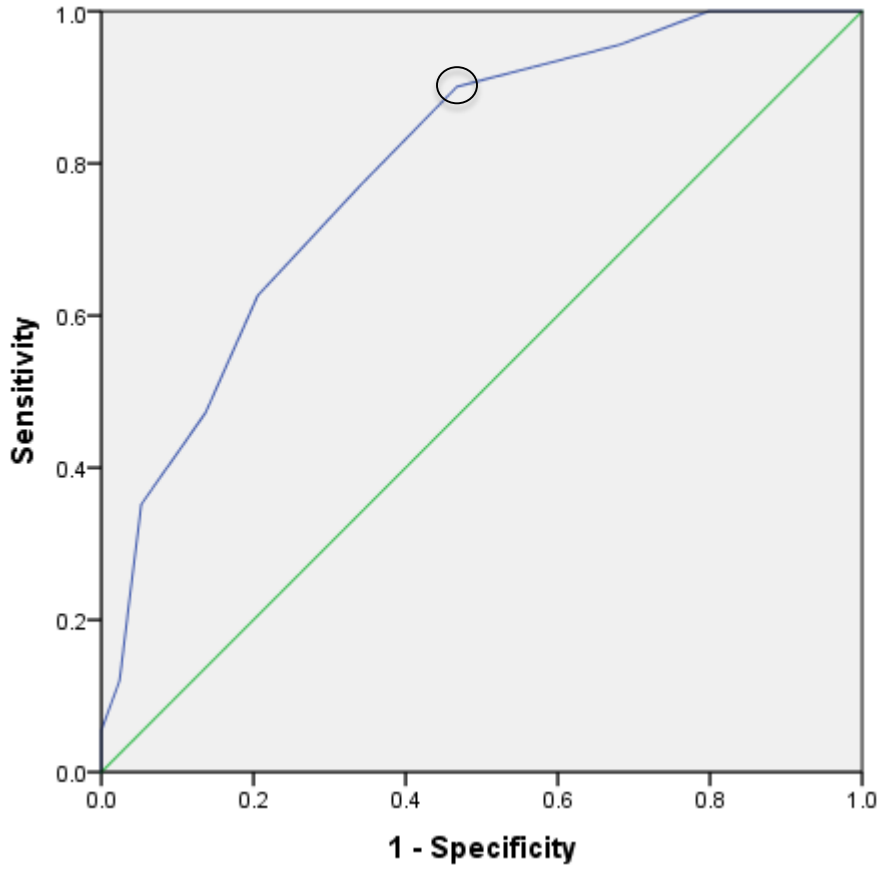


*Figure 4.* ROC curve for AUDIT-C predicting upper quartile BYAACQ consequences. Optimal cut-off score of 5 is indicated by a circle. The diagonal line indicates the theoretical ROC curve for AUC = .50.

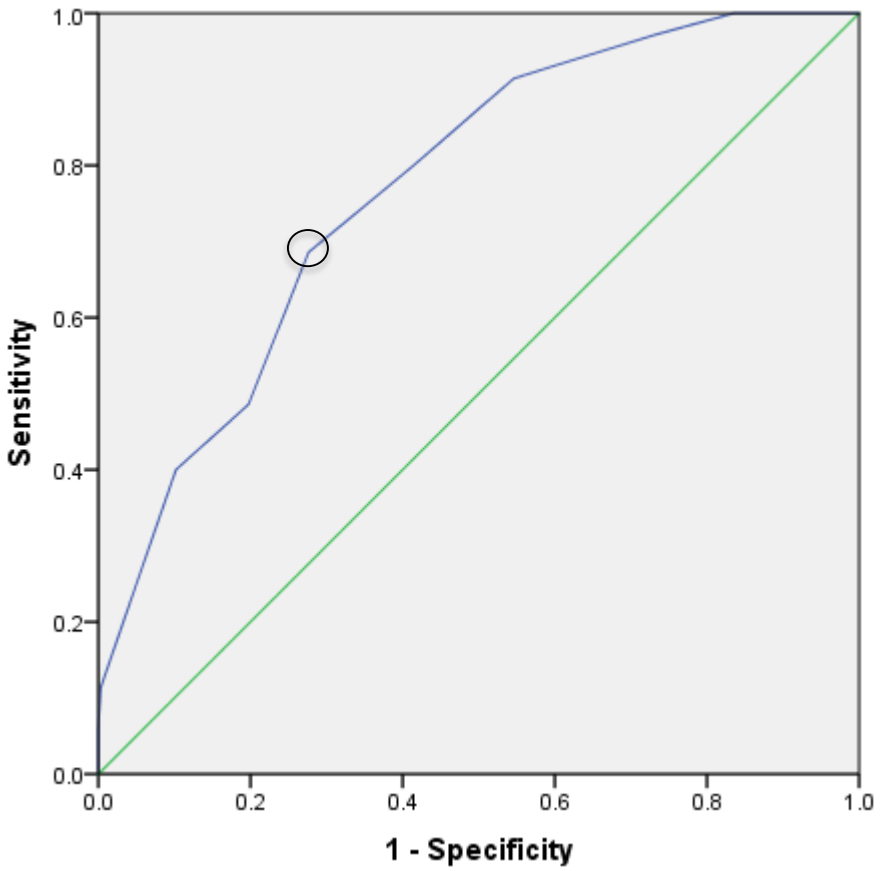


*Figure 5.* ROC curve for AUDIT-C predicting upper decile BYAACQ consequences. Optimal cut-off score of 7 is indicated by a circle. The diagonal line indicates the theoretical ROC curve for AUC = .50.

Appendix A.
Recruitment Email Script

Subject: Online Survey Opportunity (with valuable prize drawing)

Syracuse University (SU) Health Services is collaborating with Clare Campbell to learn more about the health behaviors of students who visit us. Therefore, we are inviting you to participate in a research study that will ask about your health behaviors, including sleep habits, mood, and substance use.

The study involves you filling out a survey that takes approximately 10 minutes to complete.

As a token of our appreciation for completing the study, you will be enrolled in a drawing for one of six iPad minis.

Your information will be kept completely confidential, and your health providers will **not** have access to the information you provide as part of the survey. In fact, all identifying information will be destroyed once the drawing is complete. **Since this study asks about your use of alcohol over the past year, please participate only if you have consumed alcohol at least once during the past year.**

If you are interested and would like more details about the study, please visit [INSERT LINK HERE].

If you would like to ask any questions about the study, please contact Clare Campbell at cecamp01@syr.edu.

Sincerely,
Syracuse University Health Services Staff

Appendix B.
Follow-up Recruitment Email Script

Subject: Reminder – Research Study Opportunity (with valuable prize drawing)

This is a reminder that you are invited to participate in an online survey of Syracuse University (SU) Health Services patients. The survey asks about health behaviors, including sleep habits, mood, and substance use. If you have already completed the survey, please disregard this email – and THANK YOU for your participation!

The study involves you filling out a survey that takes approximately 10 minutes to complete. If you have not completed the survey, please consider clicking the link below to learn more about it.

As a token of our appreciation for completing the study, you will be enrolled in a drawing for one of six iPad minis.

Your information will be kept completely confidential, and your health providers will **not** have access to the information you provide as part of the survey. In fact, all identifying information will be destroyed once the drawing is complete. **Since this study asks about your use of alcohol over the past year, please participate only if you have consumed alcohol at least once during the past year.**

If you are interested and would like more details about the study, please visit [INSERT LINK HERE].

If you would like to ask any questions about the study, please contact Clare Campbell at cecamp01@syr.edu.

Sincerely,
Syracuse University Health Services Staff

Appendix C.
Online Consent Script

DEPARTMENT OF PSYCHOLOGY
*430 Huntington Hall (315) 443-2354*

***University Health Services Patients' Health Behaviors***

My name is Clare Campbell, and I am a graduate student at Syracuse University (SU) under the supervision of Dr. Stephen Maisto. I am inviting you to participate in a research study. Involvement in the study is voluntary, so it is your choice whether or not you want to participate.

This page will explain the study to you and please feel free to email me at cecamp01@syr.edu if you would like to ask any questions about the study before you participate. I will be happy to explain anything in detail if you wish.

I am interested in learning more about alcohol use and health behaviors of students who visit SU Health Services. **Since this study asks about use of alcohol over the past year, please participate only if you have consumed alcohol at least once during the past year.** Participation in this study will involve completing several questionnaires about your alcohol use, including how much and how often you drink alcohol, and the effects of alcohol that you may or may not have experienced. You will also be asked to complete brief questionnaires about your mood, sleep, smoking, marijuana use, and demographics (like age, race, ethnicity, and involvement in Greek life).

The survey will take approximately 10 minutes to complete. All information will be kept confidential.

**Confidentiality*:***
You will have a number assigned to your responses, and only the research team will have the key to indicate which number belongs to which participant. Your health care providers at SU Health Services will **not** have access to any of the information you provide as part of this research study.

**Compensation:**
In appreciation for your time, you will be entered into a drawing to win one of six iPad Minis. Compensation will be pro-rated based on how much of the survey you complete so that you can earn up to five entrances into the prize drawing. Your odds of winning will be approximately 1.5 out of 100. (Your odds may be better or worse, depending on how many people complete all parts of the survey. In other words, if fewer participants complete the entire survey, your likelihood of winning will be improved.)

**Benefits and Risks:**
There is no direct benefit to you for participating in this study. However, you will be contributing to science by helping us to understand alcohol use and health behaviors of patients who use University Health Services. In addition, you may benefit by reflecting on your health behaviors and gaining a better understanding of your own health.

The risks to you of participating in this study are minimal. However, it is possible that responding to questions about health behaviors and mood may cause some mild emotional discomfort. If you would like to contact a professional to discuss any concerns you might have, you can contact the following on-campus services: the University Counseling Center at 315-443-4715, or the Psychological Services Center at 315-443-3595.

Whenever one works with email or the internet, there is always the risk of compromising privacy, confidentiality, and/or anonymity. Your confidentiality will be maintained to the degree permitted by the technology used. It is important for you to understand that no guarantees can be made regarding the interception of data sent via the internet by third parties.

The researchers are not immune to legal subpoena about illegal activities. Although a very rare occurrence, if law enforcement officials request access to these data, we would have to provide them.

**Right to Withdraw:**
If you do not want to take part, you have the right to refuse to take part, without penalty. If you decide to take part and later no longer wish to continue, you have the right to withdraw from the study at any time, without penalty.

**Contact Information:**
If you have any questions, concerns, or complaints about the research, contact Clare Campbell at cecamp01@syr.edu or Dr. Stephen Maisto at 315-443-2334. If you have any questions about your rights as a research participant, you have questions, concerns, or complaints that you wish to address to someone other than the investigators, or if you cannot reach the investigators, contact the Syracuse University Institutional Review Board at 315-443-3013.

If you do NOT wish to participate in the study, please decline participation by closing the window.

By continuing, you are agreeing that:

1) All of your questions have been answered;
2) You have consumed alcohol at least once during the past year;
3) You are 18 years of age or older; and
4) You wish to participate in this research study.

If you would like a copy of this consent, please feel free to print this page.

By clicking “Next” below, you agree to participate in this research study.

Appendix D.

Alcohol Use Disorders Identification Test – Consumption (AUDIT-C)

*Think about your drinking over **the past year**. Please circle the response that represents the best answer for you.*

| **1 standard drink is equal to:** | | |
|---|---|---|
| **Beer or wine coolers:** | **Wine:** | **Hard Liquor (shot):** |
| **12 oz.** | **5 oz.** | **1.5 oz.** |

1. How often do you have a drink containing alcohol?
    0) Never
    1) Monthly or less
    2) 2-4 times a month
    3) 2-3 times a week
    4) 4 or more times a week

2. How many drinks containing alcohol do you have on a typical day when you are drinking?
    0) 1 or 2
    1) 3 or 4
    2) 5 or 6
    3) 7 to 9
    4) 10 or more

3. How often do you have five or more drinks on one occasion?
    0) Never
    1) Less than monthly
    2) Monthly
    3) Weekly
    4) Daily or almost daily

Appendix E.

Brief Young Adult Alcohol Consequences Questionnaire (BYAACQ)

*Below is a list of things that sometimes happen to people either during or after they have been drinking alcohol. Please select either NO or YES to indicate whether or not that item describes something that has happened to you* ***IN THE PAST YEAR.***

In the past year…

1. I have had a hangover (headache, sick stomach) the morning after I had been drinking.
2. I have taken foolish risks when I have been drinking.
3. I've not been able to remember large stretches of time while drinking heavily.
4. The quality of my work or school work has suffered because of my drinking.
5. I have had less energy or felt tired because of my drinking.
6. My drinking has gotten me into sexual situations I later regretted.
7. I often have ended up drinking on nights when I had planned not to drink.
8. My physical appearance has been harmed by my drinking.
9. While drinking, I have said or done embarrassing things.
10. I have felt very sick to my stomach or thrown up after drinking.
11. I have not gone to work or missed classes at school because of drinking, a hangover, or illness caused by drinking.
12. When drinking, I have done impulsive things I regretted later.
13. I have been overweight because of drinking.
14. I have woken up in an unexpected place after heavy drinking.
15. I have spent too much time drinking.
16. I have felt badly about myself because of my drinking.
17. My drinking has created problems between myself and my boyfriend/girlfriend/spouse, parents, or other near relatives.
18. I have felt like I needed a drink after I'd gotten up (that is, before breakfast).
19. I have driven a car when I knew I had too much to drink to drive safely.
20. I have neglected my obligations to family, work, or school because of drinking.
21. I have often found it difficult to limit how much I drink.
22. I have passed out from drinking.
23. I have become very rude, obnoxious, or insulting after drinking.
24. I have found that I needed larger amounts of alcohol to feel any effect, or that I could no longer get high or drunk on the same amount that used to get me high or drunk.

# Appendix F.

## Demographics Questionnaire

Please provide the following information to help us learn more about you.

1. What is your current age? _____ years
2. What is your gender?
   - Male (1)
   - Female (2)
   - Transgender (3)
3. What year are you in your undergraduate career? (If you are a graduate student, select last option.)
   - 1st (1)
   - 2nd (2)
   - 3rd (3)
   - 4th (4)
   - 5th or higher (5)
   - graduate student (6)
4. What is your current/approximate GPA? _____
5. What racial group best describes you?
   - White (1)
   - Black or African-American (2)
   - Asian (3)
   - Native American or Native Alaskan (4)
   - Native Hawaiian or other Pacific Islander (5)
   - Mixed Race (6)
   - Other (7)
6. Do you consider yourself Hispanic or Latino?
   - Yes (1)
   - No (0)
7. Is English your first language?
   - Yes (1)
   - No (0)
8. Are you a member or pledge of a fraternity or sorority?
   - _____ Not a member (0)
   - _____ Pledge (1)
   - _____ Member (2)

Appendix G.

Quick Drinking Screen (QDS)

The next questions are about your alcohol use in the past 3 months (90 days). For these questions, please report your drinking in terms of STANDARD DRINKS.

One standard drink is defined as:

- **12 oz. of beer** (8 oz. malt liquor or 10 oz. of microbrew or craft beer)
  - Beers may come in 12 oz., 16oz. or 22 oz. cans. Consider the container you typically drink from. A pint glass is 16 oz., so 3 pints = 48 oz. = 4 standard drinks.
  - 40 oz. of malt liquor is 5 drinks. 40 oz. of regular beer is about 3 drinks.
- 10 oz. of wine cooler (e.g., Mike's Hard Lemonade, Smirnoff Ice)
- **5 oz. of wine**
  - About one half of a glass is 5 oz. One bottle of wine is about 5 drinks.
- 1.5 oz. (one shot) of liquor
- **1 cocktail with 1.5 oz. of liquor**
  - A mixed drink with three shots is considered 3 drinks.

(1) On average, in the past 3 months, how many **days per week** did you drink any alcohol? (Note: Fewer than 12 days <u>total</u> out of the past 3 months averages < 1 day per week; 12 or more days <u>total</u> averages at least 1 day per week)

Response options: < 1, 1, 2, 3, 4, 5, 6, 7

(1a) If < 1: How many days out of the past 3 months did you drink any alcohol?
(Note: < 1 day per week on average means fewer than 12 drinking days during the past 3 months)

(2) On average, on days when you did drink, how many standard drinks did you have in a day?

(3) How many times in the past 3 months have you had 5 or more (for men) or 4 or more (for women) standard drinks on one occasion?

(4) In the past 3 months, what was the greatest number of standard drinks you consumed in one day?

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# VITA

NAME OF AUTHOR: Clare Elizabeth Campbell

GRADUATE AND UNDERGRADUATE SCHOOLS ATTENDED:
Scripps College, Claremont, CA
State University of New York at Geneseo, Geneseo, NY
Syracuse University, Syracuse, NY

DEGREES AWARDED:
Bachelor of Arts in Psychology, 2010, State University of New York at Geneseo

PUBLICATIONS:

Funderburk, J. S., Maisto, S. A., Wade, M. J., Kenneson, A., & **Campbell, C. E.** (2014). Clinical course of alcohol use in Veterans following an AUDIT-C positive screen. *Military Medicine, 179,* 1198-1206.

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