

Article

# The Alcohol Use Disorders Identification Test (AUDIT): Exploring the Factor Structure and Cutoff Thresholds in a Representative Post-Conflict Population in Northern Uganda

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## Abstract

**Aims:** Despite increased use of the Alcohol Use Disorders Identification Test (AUDIT) in sub-Saharan Africa, few studies have assessed its underlying conceptual framework, and none have done so in post-conflict settings. Further, significant inconsistencies exist between definitions used for problematic consumption. Such is the case in Uganda, facing one of the highest per-capita alcohol consumption levels regionally, which is thought to be hindering rebuilding in the North after two decades of civil war. This study explores the impact of varying designation cutoff thresholds in the AUDIT as well as its conceptual factor structure in a representative sample of the population.

**Methods:** In all, 1720 Congo Lye Project participants completed socio-economic and mental health questionnaires, provided blood samples and took the AUDIT. Participant characteristics and consumption designations were compared at AUDIT summary score thresholds of  $\geq 3$ ,  $\geq 5$  and  $\geq 8$ . Confirmatory factor analyses (CFA) explored one-, two- and three-factor level models overall and by sex with relative and absolute fit indicators.

**Results:** There were no significant differences in participant demographic characteristics between thresholds. At higher cutoffs, the test increased in specificity to identify those with hazardous drinking, disordered drinking and suffering from alcohol-related harms. All conceptual models indicated good fit, with three-factor models superior overall and within both sexes.

**Conclusion:** In Northern Uganda, a three-factor AUDIT model best explores alcohol use in the population and is appropriate for use in both sexes. Lower cutoff thresholds are recommended to identify those with potentially disordered drinking to best plan effective interventions and treatments.

**Short summary:** A CFA of the AUDIT showed good fit for one-, two-, and three-factor models overall and by sex in a representative sample in post-conflict Northern Uganda. A three-plus total AUDIT cutoff score is suggested to screen for hazardous drinking in this or similar populations.

## INTRODUCTION

As Northern Uganda reemerges from over two decades of civil war between the Government Forces and the Lord's Resistance Army (LRA), the region is rapidly changing. Since the cessation of conflict in 2006, NGOs and community leaders have expressed concerns regarding significant increases in substance use, yet there remains a paucity of data on problematic substance use in the region (Johnson, 1996; Weaver and Roberts, 2010). Indeed, little is known regarding the pervasiveness and health impacts of alcohol consumption during post-conflict transition periods as populations move from periods of conflict toward relative stability and reconstruction, a problem exacerbated as the majority of alcohol-related harms globally remain under- or unreported (Reinert and Allen, 2007; WHO, 2014). This is particularly worrisome as Northern Uganda already faces high rates of post-traumatic stress disorder (PTSD), depression and human immunodeficiency virus (HIV) (Spittal *et al.*, 2008; Patel *et al.*, 2014; Mugisha *et al.*, 2015), all of which can be exacerbated by problematic drinking behaviors (Babor *et al.*, 2001; Brief *et al.*, 2004; Woolf-King and Maisto, 2011; WHO, 2014). As Uganda already experiences one of the highest per-capita alcohol consumption levels in sub-Saharan Africa, it is critical to identify an appropriate tool to accurately assess alcohol use and misuse in the region (Babor *et al.*, 2001; WHO, 2014).

Since its first publication in 1989 and subsequent updates in 1992 and 2001, the Alcohol Use Disorder Identification Test (AUDIT) has become one of the most widely used tools measuring drinking patterns globally (Reinert and Allen, 2007). The AUDIT is a 10-question scale comprises three domains. Questions 1–3 focus on hazardous consumption, indicators of patterns that may indicate future harm or dependence. Questions 4–6 explore alcohol dependency, the behavioral, mental and physical results of continued alcohol use including withdrawal symptoms and impaired judgment. Questions 7–10 detail alcohol-related physical, mental and social harms that result from problematic alcohol usage both in the present and in the past. The first eight questions are scored on a five level (0–4) ordinal scale of increased severity of use and/or impact, and the last two questions at three levels each (0–2). The full wording of each question and possible responses for participants in this study are listed as part of Table 1. More recently, a shortened version, the AUDIT-C, has been introduced (Bush *et al.*, 1998). Comprising only the first three questions of the test, it provides a more rapid assessment tool for identifying hazardous drinking only and has been found applicable in multiple settings (Reinert and Allen, 2007).

The expanded use of the AUDIT in global epidemiological research has brought increased scrutiny into its performance in different languages, cultures and demographic groupings. Concerns that concepts within the AUDIT such as 'standard drink,' 'typical day' or 'heavy drinking session' may vary significantly in different groups as well as the recognition that biological factors may influence individual level psychological impacts of alcohol have led researchers to adjusted cutoff thresholds (Reinert and Allen, 2007). Recent meta-analyses have found significant discrepancies in cutoffs used with thresholds as low as summation score of two or greater

(Babor *et al.*, 2001; Reinert and Allen, 2007). Similar questions have emerged regarding the underlying conceptual framework of the AUDIT and the merits of applying a single summation score in defining alcohol disorders. Test guidelines suggest comparing a summation score of all 10 of a respondent's questions with a cutoff threshold of 8 or more to define the presence of an alcohol-related disorder. Amalgamating the conceptual domains of hazardous use, alcohol dependence and related harms within single composite score is suggestive of a uni-dimensional model. Explanatory and confirmatory factor analyses (EFA/CFA) assessing the construct validity of the underlying structure of the AUDIT have provided mixed results, with evidence toward one-, two-, three- and even four-factor frameworks (Reinert and Allen, 2007; Rist *et al.*, 2009; Peng *et al.*, 2012). Though most recent evidence now points toward a two-factor approach for the AUDIT, with Questions 1–3 focusing on the concept of 'alcohol consumption' and the remaining Questions 4–10 unified into 'alcohol-related problems' (Reinert and Allen, 2007; Peng *et al.*, 2012). The lack of overall uniformity of the EFA/CFA findings may be partially due to differences in the analytical approaches used, but clearly more research is needed to assess the impact different languages, ethnicities and cultural settings have on the underlying conceptual framework of the AUDIT.

Amidst the myriad of other health concerns, alcohol use and misuse remains an often-understudied subject in populations in sub-Saharan Africa, limiting the evidence base from which to plan effective interventions. While this is beginning to change, many studies are limited due to small and often non-representative samples of the population and a lack of standardization in assessment metrics. Though use of the AUDIT and AUDIT-C has increased in recent years there has been little consistency in the cutoffs used to define hazardous drinking (Tumwesigye and Kasirye, 2005; Kalichman *et al.*, 2007; Woolf-King and Maisto, 2011). Such is the case in Uganda, where despite high levels of alcohol use present in the population, studies of alcohol use have tended to focus on specific non-representative segments of the population. Two studies used a score of  $\geq 3$  to denote alcohol misuse and  $\geq 8$  for hazardous drinking (Wandera *et al.*, 2015, 2016). Others varied cutoffs based on participant sex, defining hazardous use as  $\geq 3$  and  $\geq 4$  for women and men respectively in Kampala (Hahn *et al.*, 2014) and another using  $\geq 5$  for women and  $\geq 8$  for men in Mbarara (Santos *et al.*, 2014). Only one study has applied the AUDIT in Northern Uganda, focusing on internally displaced persons (IDP) immediately after the cessation of the conflict in 2006, using the standard cutoff of  $\geq 8$  to denote hazardous drinking (Roberts *et al.*, 2011). No studies have since explored alcohol use patterns in the North despite drastic shifts in population dynamics after decades of conflict as people return to their ancestral villages amidst rapid modernization. Promisingly, all of these studies reported high Cronbach's Alpha scores, but none to our knowledge have specifically examined the underlying conceptual framework of the test. This study seeks to address these issues and assess the conceptual categories of the AUDIT and applicability of the various cutoff points for disordered drinking in post-conflict Northern Uganda.

**Table 1.** AUDIT results and drinking classifications by participant sex and overall with UORs and 95% CI for differences by sex

	Female <i>n</i> (%)	Male <i>n</i> (%)	Total <i>n</i> (%)	UOR (95% CI)
Total number	963 (55.9%)	757 (44.1%)	1720 (100%)	
How often do you have a drink containing alcohol				
Never	915 (95.0%)	561 (74.1%)	1476 (85.8%)	ref.
Monthly or less	26 (2.7%)	56 (7.4%)	82 (4.8%)	3.51 (2.20–5.74)
2–4 Times a month	14 (1.5%)	40 (5.3%)	54 (3.1%)	4.66 (2.57–8.94)
2–3 Times a week	5 (0.5%)	28 (3.7%)	33 (1.9%)	9.13 (3.82–27.02)
4+ Times a week	3 (0.3%)	72 (9.5%)	75 (4.4%)	39.14 (14.51–160.38)
How many drinks containing alcohol do you have on a typical day when you are drinking				
Never	945 (98.1%)	703 (92.9%)	1648 (95.8%)	ref.
Less than monthly	16 (1.7%)	42 (5.5%)	58 (3.4%)	3.53 (2.01–6.51)
Monthly	1 (0.1%)	7 (0.9%)	8 (0.5%)	9.41 (1.67–176.09)
Weekly	1 (0.1%)	3 (0.4%)	4 (0.2%)	4.03 (0.52–81.62)
Daily or almost daily	0 (0.0%)	2 (0.3%)	2 (0.1%)	
How often do you have six or more drinks on one occasion				
Never	942 (97.8%)	672 (88.8%)	1614 (93.8%)	ref.
Less than monthly	13 (1.3%)	37 (4.9%)	50 (2.9%)	3.99 (2.16–7.85)
Monthly	6 (0.6%)	19 (2.5%)	25 (1.5%)	4.44 (1.87–12.24)
Weekly	2 (0.2%)	12 (1.6%)	14 (0.8%)	8.41 (2.28–54.17)
Daily or almost daily	0 (0.0%)	17 (2.2%)	17 (1.0%)	
How often during the last year have you found that you were not able to stop drinking once you had started				
Never	948 (98.4%)	696 (91.9%)	1644 (95.6%)	ref.
Less than monthly	8 (0.8%)	24 (3.2%)	32 (1.9%)	4.08 (1.90–9.76)
Monthly	5 (0.5%)	15 (2.0%)	20 (1.2%)	4.09 (1.58–12.61)
Weekly	0 (0.0%)	7 (0.9%)	7 (0.4%)	
Daily or almost daily	2 (0.2%)	15 (2.0%)	17 (1.0%)	10.22 (2.87–64.96)
How often during the last year have you failed to do what was normally expected from you because of drinking				
Never	952 (98.9%)	712 (94.1%)	1664 (96.7%)	ref.
Less than monthly	6 (0.6%)	17 (2.2%)	23 (1.3%)	3.79 (1.57–10.54)
Monthly	3 (0.3%)	17 (2.2%)	20 (1.2%)	7.58 (2.53–32.54)
Weekly	1 (0.1%)	7 (0.9%)	8 (0.5%)	9.36 (1.66–175.15)
Daily or almost daily	1 (0.1%)	4 (0.5%)	5 (0.3%)	5.35 (0.79–104.75)
How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session				
Never	954 (99.1%)	737 (97.4%)	1691 (98.3%)	ref.
Less than monthly	6 (0.6%)	7 (0.9%)	13 (0.8%)	1.51 (0.50–4.71)
Monthly	2 (0.2%)	3 (0.4%)	5 (0.3%)	1.94 (0.32–14.77)
Weekly	1 (0.1%)	4 (0.5%)	5 (0.3%)	5.18 (0.76–101.40)
Daily or almost daily	0 (0.0%)	6 (0.8%)	6 (0.3%)	
How often during the last year have you had a feeling of guilt or remorse after drinking				
Never	954 (99.1%)	720 (95.1%)	1674 (97.3%)	ref.
Less than monthly	5 (0.5%)	16 (2.1%)	21 (1.2%)	4.24 (1.65–13.01)
Monthly	2 (0.2%)	9 (1.2%)	11 (0.6%)	5.96 (1.53–39.19)
Weekly	0 (0.0%)	5 (0.7%)	5 (0.3%)	
Daily or almost daily	2 (0.2%)	7 (0.9%)	9 (0.5%)	4.64 (1.12–31.19)
How often during the last year have you been unable to remember what happened the night before because you had been drinking				
Never	954 (99.1%)	720 (95.1%)	1674 (97.3%)	ref.
Less than monthly	3 (0.3%)	15 (2.0%)	18 (1.0%)	6.63 (2.18–28.68)
Monthly	4 (0.4%)	10 (1.3%)	14 (0.8%)	3.31 (1.10–12.11)
Weekly	0 (0.0%)	7 (0.9%)	7 (0.4%)	
Daily or almost daily	2 (0.2%)	5 (0.7%)	7 (0.4%)	3.31 (7.12–23.18)
Have you or someone else been injured as a result of your drinking				
No	959 (99.6%)	735 (97.1%)	1694 (98.5%)	ref.
Yes but not in last year	3 (0.3%)	11 (1.5%)	14 (0.8%)	4.78 (1.49–21.21)
Yes in the last year	1 (0.1%)	11 (1.5%)	12 (0.7%)	14.35 (2.78–262.66)
Has a relative or friend or a doctor or another health worker been concerned about your drinking or suggested you cut down				
No	958 (99.5%)	717 (94.7%)	1675 (97.4%)	ref.

Yes but not in last year	3 (0.3%)	16 (2.1%)	19 (1.1%)	7.13 (2.26–30.72)
Yes in the last year	2 (0.2%)	24 (3.2%)	26 (1.5%)	16.03 (4.74–99.98)
Categorizations based on the AUDIT answers				
AUDIT score				
Mean (SD)	0.2 ( $\pm$ 1.6)	1.7 ( $\pm$ 4.1)	0.9 ( $\pm$ 3.1)	
Score of 3 or more				
No	932 (97.4%)	611 (80.8%)	1543 (90.1%)	ref.
Yes	25 (2.6%)	145 (19.2%)	170 (9.9%)	8.85 (5.82–13.99)
Score of 5 or more				
No	940 (98.2%)	668 (88.4%)	1608 (93.9%)	ref.
Yes	17 (1.8%)	88 (11.6%)	105 (6.1%)	7.28 (4.41–12.77)
Score of 8 or more				
No	946 (98.9%)	693 (91.7%)	1639 (95.7%)	ref.
Yes	11 (1.1%)	63 (8.3%)	74 (4.3%)	7.82 (4.26–15.77)
Suggested treatment by total AUDIT score <sup>a</sup>				
0: non drinker	915 (95.0%)	561 (74.1%)	1476 (85.8%)	ref.
1–7: brief interventions	37 (3.8%)	133 (17.6%)	170 (9.9%)	5.86 (4.06–8.68)
8–15: targeted interventions	8 (0.8%)	47 (6.2%)	55 (3.2%)	9.58 (4.65–22.04)
16–19: direct counseling and monitoring	2 (0.2%)	6 (0.8%)	8 (0.5%)	4.89 (1.22–33.47)
20+: diagnostic evaluation, referral to a specialist, and treatment	1 (0.1%)	10 (1.3%)	11 (0.6%)	16.31 (3.1–299.75)
Hazardous use <sup>a</sup>				
No	935 (97.7%)	658 (87.0%)	1593 (93.0%)	ref.
Yes	22 (2.3%)	98 (13.0%)	120 (7.0%)	6.60 (3.73–12.63)
Alcohol dependency <sup>a</sup>				
No	940 (98.2%)	681 (90.1%)	1621 (94.6%)	ref.
Yes	17 (1.8%)	75 (9.9%)	92 (5.4%)	6.09 (3.65–10.74)
Harmful drinking <sup>a</sup>				
No	944 (98.6%)	693 (91.7%)	1637 (95.6%)	ref.
Yes	13 (1.4%)	63 (8.3%)	76 (4.4%)	6.33 (4.02–10.40)

<sup>a</sup>Based on 2001 guidelines.

## MATERIALS AND METHODS

### Ethics

This study received ethical approval in both Canada and Uganda from the University of British Columbia-Providence Healthcare Research Ethics Board, Makerere College of Health Sciences School of Public Health-Science Ethical Committee and the Ugandan National Council of Science and Technology. Approval to conduct research in each district was received from the Office of the President of Uganda and each Resident District Commissioner.

### Sample

This paper reports findings from the Cango Lyec Project, a large 5-year prospective cohort exploring health vulnerability in post-conflict Northern Uganda. Briefly, an in-depth census, mapping and enumeration of randomly selected communities in the districts most affected by the conflict, was completed. Three communities in each district were then selected for a multi-stage stratified sampling of the entire population aged 13–49 years. Consent and assent were obtained by trained local interviewers prior to the administration of questionnaires and blood sampling. The AUDIT scale was introduced in the second year of the cohort and was administered as part of the follow-up questionnaire for all 1720 returning participants.

### Measurements

Participant questionnaires contain questions on socio-demographic characteristics, conflict-related experiences, sexual vulnerabilities, knowledge of HIV and other sexually transmitted infections (STIs) and access to healthcare. Screening for depression and PTSD was conducted *via* the Hopkins Symptom Checklist-25 (HSCL-25) (American Psychiatric Association, 2000) and the Harvard Trauma Questionnaire (HTQ) Parts I and IV, respectively (Mollica *et al.*, 2004). Screening cutoffs were based on instrumental standards of having personally experienced 12 or more events listed in the HTQ Part I, scoring an average of 2 or greater in Part IV and an average score of 1.75 or more on the HSCL-25 (American Psychiatric Association, 2000; Palmieri *et al.*, 2007; Silove *et al.*, 2007). Both scales have been demonstrated to be reliable in a number of contexts and have been previously used in the region (Scholte *et al.*, 2004; Shoeb *et al.*, 2007; Roberts *et al.*, 2008). HIV and Syphilis status was determined from annually collected blood samples. HIV testing utilized parallel enzyme-linked immunosorbent assay (ELISA) tests and the addition of a confirmatory western blot test for discordant results. Syphilis was determined by rapid plasma reagin tests with confirmatory *T. pallidum* hemagglutination assay tests. Trained HIV counselors returned test results to all participants who requested them. Participants with positive tests for syphilis are immediately treated using single-dose antibiotics and participants

with HIV, above cutoff trauma or depression scores, who have any mention of suicidal ideation or who met criteria for hazardous drinking are immediately referred to the closest comprehensive health center.

Alcohol use was measured using the 2001 Second Edition of the AUDIT. As with all scales used in the study, the questions were first translated and back translated into the local language, Acholi Luo, by experienced Acholi researchers and tested in a pilot community. Standard units of alcohol were defined as a single beer, a standard shot or a sachet of Waragi (a generic name for distilled spirits), or large glass of traditionally brewed alcohol. The presence of an alcohol-related disorder was defined at three separate cutoff threshold levels for summation scores of  $\geq 3$ ,  $\geq 5$  and the standard  $\geq 8$ . As the lower cutoff points could lead to the inclusion of individuals consuming alcoholic beverages regularly but who do not otherwise fit criteria for disordered drinking, participants were assessed based on the test's three conceptual levels of 'hazardous drinking', 'alcohol dependence' and 'alcohol-related harm'. These were defined by test guidelines noted for giving greater detail in consumption measurements (Babor *et al.*, 2001); potentially hazardous drinking was defined as any positive score on Questions 2 and 3 in the AUDIT tool dealing with the number of drinks normally consumed in one sitting and the frequency of having six or more drinks. Alcohol dependency likewise was defined as a score of one or more on any of questions four to six in the AUDIT tool. Finally, alcohol-related harm was defined as any score greater than one on the last four questions in the AUDIT tool, which includes inquiry into historical drinking patterns.

### Analysis

Descriptive univariate statistics were calculated to assess characteristics of the population overall and within each cutoff threshold used to define hazardous drinking. Bivariate analyses compared distributions between each level to assess whether there were significant differences present in population demographics at the different cutoff points. Due to the natural inclusion of lower level hazardous drinkers at each increased cutoff point and thus lack of independence, Fishers exact test was used to assess the relationship between participant characteristics and cutoff thresholds.

The construct validity of the AUDIT scale was examined using CFA at one-, two- and three-factor levels based on the conceptual frameworks listed prior for all participants and stratified by sex. In holding with best practice, multiple indices are presented reporting model goodness-of-fit including both absolute and relative fit models (Hoyle and Panther, 1995; Hu and Bentler, 1999); root mean square error of approximation (RMSEA), Tucker-Lewis non-normed-fit index (NNFI), Bentler comparative fit index (CFI) and Bentler and Bonnett normed-fit index (NFI). All models utilized a weighted least squares means and variance adjusted estimator (WLSMV) to account for the floor and ceiling effects of the categorical AUDIT data (Brown, 2006; Peng *et al.*, 2012). Good fit was indicated by common guidelines for each index: RMSEA of  $< 0.06$  with  $< 0.03$  indicating 'excellent' fit, CFI  $\geq 0.95$ , TLI  $\geq 0.90$ , NNFI  $\geq 0.95$ , NFI  $\geq 0.90$ . Chi-square test results are also reported with a 0.05 significance threshold, with recognition of the potential limitations as an indicator for CFA (Bentler and Bonett, 1980; Kenny *et al.*, 2003; Barrett, 2007). Cronbach's alpha was also calculated to assess the internal reliability of the test and for each subscale.

All analyses were conducted using the R statistical package version 3.2.4 (R Foundation for Statistical Computing, Vienna, Austria). CFA were run in R using the Lavaan package 0.5-20.

## RESULTS

All 1720 returning participants in Round 2 of the Cango Lyeec Project received the AUDIT and are included in analyses. Table 1 breaks down participant responses to the AUDIT questions overall, and by sex, as well as test results. A summary of their characteristics overall and at each of the  $\geq 3$ ,  $\geq 5$  and  $\geq 8$  cutoff scores is presented in Table 2. A majority of participants were female (55.9%), and ages ranged from 13 to 52 years old with a median age of 27 years. HIV prevalence in the population was 12.2%, with screening criteria for PTSD and depression were met for 5.3% and 8.3% of the participants, respectively.

Responses to the individual questions of the AUDIT are presented at the top of Table 1, with unadjusted odds ratios (UORs) and 95% confidence intervals (95% CIs) showing differences by participant sex. Categorization of drinking status and treatment recommendations based on the AUDIT guidelines are also listed including adjusted cut-offs for total scores  $\geq 3$ ,  $\geq 5$  and the standard  $\geq 8$ . A majority of all participants (85.8%) abstained from alcohol use, with women (95%) significantly more likely to do so than men (74.1%). Men continually reported significantly greater levels of alcohol use, dependency criteria and alcohol-related harms, with the exception of those needing a drink first thing in the morning, with no difference between men and women (UOR: 1.51; 95% CI: 0.50–4.71).

The mean total AUDIT score for men of 1.7 (SD: 4.1) was significantly higher than the mean score of 0.2 for women (SD: 1.6,  $P < 0.0001$ ). Based on test guidelines (Babor *et al.*, 2001) of total score  $\geq 8$ , 4.3% of participants fit classifications for disordered drinking. Men were 7.82 times more likely than women to fit this criteria (95% CI: 4.26–15.77). When the cutoff point for inclusion was relaxed to a score of  $\geq 5$ , the total percent of the population fitting categorization rose to 6.1% with the odds of men being included remaining seven times higher than women (OR: 7.28, 95% CI: 4.41–12.77). The most lenient inclusion cutoff of  $\geq 3$  more than doubled the number of participants deemed hazardous compared with the standard guidelines overall and for each sex (9.9% total, 19.2% males, 2.6% females). It also showed an increase in the discrepancy between males and females with the former 8.85 times more likely to be classified as hazardous drinkers (95% CI: 5.82–13.99).

When participants were classified within each distinct level of the AUDIT, 7.0% fit criteria for hazardous drinking, 5.4% for alcohol dependency and 4.4% reported alcohol-related harms. Men were over six times more likely than women to be classified in each category (Hazard UOR: 6.06, 95% CI: 3.72–12.63; Dependence UOR: 6.09, 95% CI: 3.65–10.74; Harm UOR: 6.33, 95% CI: 4.02–10.40). The results for hazardous drinking as a distinct level defined by a score greater than zero on Questions 2 or 3 were similar among women to when a total AUDIT score of  $\geq 3$  was used (2.3% vs. 2.6%). Among men, and overall, more participants would fit classification for hazardous drinking than if a total score of  $\geq 5$  was used but fewer than if the score was decreased to  $\geq 3$ .

At the AUDIT standard cutoff threshold of a summation score  $\geq 8$ , only 4.3% of study participants fit designation for the presence of disordered drinking. When the cutoff was lowered to  $\geq 5$  the percent included rose to 6.1%. At the least stringent  $\geq 3$  threshold, 10% of the study population was included, more than doubling the original number with potentially disordered drinking behaviors. There were no significant differences in socio-demographic characteristics defining participants, their mental health screening status or test results between the cutoff levels. Clear distinctions emerged between cutoff thresholds within the AUDIT subcategories.

**Table 2.** Study population characteristics overall and by AUDIT score cutoff threshold

	Total n (%)	AUDIT score cutoff for hazardous drinking			P-value
		3+ n (%)	5+ n (%)	8+ n (%)	
Total participants	1713 (100%)	170 (10.0%)	105 (6.1%)	74 (4.3%)	
Sex					
F	957 (55.9%)	25 (14.7%)	17 (16.2%)	11 (14.9%)	0.943
M	756 (44.1%)	145 (85.3%)	88 (83.8%)	63 (85.1%)	
Age group					
13–19	399 (23.3%)	2 (1.2%)	2 (1.9%)	2 (2.7%)	0.998
20–24	288 (16.8%)	21 (12.4%)	12 (11.4%)	10 (13.5%)	
25–29	316 (18.4%)	34 (20.0%)	21 (20.0%)	13 (17.6%)	
30–34	239 (14.0%)	25 (14.7%)	15 (14.3%)	9 (12.2%)	
35–39	189 (11.0%)	34 (20.0%)	25 (23.8%)	17 (23.0%)	
40–44	157 (9.2%)	25 (14.7%)	14 (13.3%)	12 (16.2%)	
45–49	110 (6.4%)	25 (14.7%)	13 (12.4%)	8 (10.8%)	
50+	15 (0.9%)	4 (2.4%)	3 (2.9%)	3 (4.1%)	
District					
Amuru	499 (29.1%)	60 (35.3%)	39 (37.1%)	28 (37.8%)	0.989
Gulu	831 (48.5%)	79 (46.5%)	46 (43.8%)	32 (43.2%)	
Nwoya	383 (22.4%)	31 (18.2%)	20 (19.0%)	14 (18.9%)	
Community type					
Transient	695 (40.6%)	72 (42.4%)	48 (45.7%)	37 (50.0%)	0.854
Displaced	269 (15.7%)	41 (24.1%)	22 (21.0%)	15 (20.3%)	
Permanent	749 (43.7%)	57 (33.5%)	35 (33.3%)	22 (29.7%)	
Ever abducted					
No	1269 (74.1%)	110 (64.7%)	71 (67.6%)	50 (67.6%)	0.881
Yes	444 (25.9%)	60 (35.3%)	34 (32.4%)	24 (32.4%)	
Marital status					
0. Never married	575 (33.6%)	20 (11.8%)	17 (16.2%)	13 (17.6%)	0.669
1. Married	1062 (62.0%)	143 (84.1%)	83 (79.0%)	59 (79.7%)	
2. Wid/sep/div	76 (4.4%)	7 (4.1%)	5 (4.8%)	2 (2.7%)	
Highest education level attained					
0. Primary	1018 (59.4%)	96 (56.5%)	62 (59.0%)	42 (56.8%)	0.998
1. Secondary	386 (22.5%)	40 (23.5%)	22 (21.0%)	16 (21.6%)	
2. Tertiary/university	98 (5.7%)	12 (7.1%)	8 (7.6%)	7 (9.5%)	
3. Others	63 (3.7%)	12 (7.1%)	6 (5.7%)	4 (5.4%)	
4. No schooling	148 (8.6%)	10 (5.9%)	7 (6.7%)	5 (6.8%)	
Ever tested for HIV					
No	181 (10.6%)	22 (12.9%)	12 (11.4%)	9 (12.2%)	0.977
Yes	1532 (89.4%)	148 (87.1%)	93 (88.6%)	65 (87.8%)	
HIV positive					
Negative	1499 (87.5%)	138 (81.2%)	83 (79.0%)	63 (85.1%)	0.622
Positive	209 (12.2%)	32 (18.8%)	22 (21.0%)	11 (14.9%)	
Missing	5 (0.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Active Syphilis					
Negative	1639 (95.7%)	158 (92.9%)	100 (95.2%)	70 (94.6%)	0.767
Positive	69 (4.0%)	12 (7.1%)	5 (4.8%)	4 (5.4%)	
Missing	5 (0.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Screened for PTSD					
No	1617 (94.4%)	161 (94.7%)	98 (93.3%)	68 (91.9%)	0.655
Yes	91 (5.3%)	9 (5.3%)	7 (6.7%)	6 (8.1%)	
Missing	5 (0.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
12 or more trauma experiences					
No	1570 (91.7%)	151 (88.8%)	92 (87.6%)	65 (87.8%)	0.929
Yes	143 (8.3%)	19 (11.2%)	13 (12.4%)	9 (12.2%)	
Screened for depression					
No	1565 (91.4%)	154 (90.6%)	95 (90.5%)	66 (89.2%)	0.918
Yes	143 (8.3%)	16 (9.4%)	10 (9.5%)	8 (10.8%)	
Missing	5 (0.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Ever attempted suicide					
No	1619 (94.5%)	159 (93.5%)	95 (90.5%)	67 (90.5%)	0.519
Yes	94 (5.5%)	11 (6.5%)	10 (9.5%)	7 (9.5%)	

Continued

Table 2. Continued

	Total n (%)	AUDIT score cutoff for hazardous drinking			P-value
		3+ n (%)	5+ n (%)	8+ n (%)	
Physically abused by a recent partner in last 6 months					
No	1422 (83.0%)	115 (67.6%)	72 (68.6%)	50 (67.6%)	0.988
Yes	291 (17.0%)	55 (32.4%)	33 (31.4%)	24 (32.4%)	
Forced into a sexual act by a recent partner in last 6 months					
No	1677 (97.9%)	164 (96.5%)	100 (95.2%)	71 (95.9%)	0.936
Yes	36 (2.1%)	6 (3.5%)	5 (4.8%)	3 (4.1%)	
Ever sexually abused or raped					
No	1563 (91.2%)	165 (97.1%)	103 (98.1%)	72 (97.3%)	0.911
Yes	150 (8.8%)	5 (2.9%)	2 (1.9%)	2 (2.7%)	
Ever had sex					
No	281 (16.4%)	1 (0.6%)	1 (1.0%)	1 (1.4%)	0.785
Yes	1432 (83.6%)	169 (99.4%)	104 (99.0%)	73 (98.6%)	
Total sexual partners <sup>a</sup>					
1–2	649 (45.3%)	24 (14.2%)	16 (15.4%)	9 (12.3%)	0.978
3+	752 (52.5%)	143 (84.6%)	87 (83.7%)	63 (86.3%)	
Missing	31 (2.2%)	2 (1.2%)	1 (1.0%)	1 (1.4%)	
Had any STI in the last 6 months <sup>a</sup>					
No	1031 (72.0%)	127 (75.1%)	75 (72.1%)	49 (67.1%)	0.428
Yes	401 (28.0%)	42 (24.9%)	29 (27.9%)	24 (32.9%)	
Any STI currently <sup>a</sup>					
No	1241 (86.7%)	149 (88.2%)	91 (87.5%)	61 (83.6%)	0.579
Yes	191 (13.3%)	20 (11.8%)	13 (12.5%)	12 (16.4%)	
Always used a condom with ALL recent partners <sup>a</sup>					
No	1272 (88.8%)	159 (94.1%)	98 (94.2%)	69 (94.5%)	1.000
Yes	160 (11.2%)	10 (5.9%)	6 (5.8%)	4 (5.5%)	
Do you know your partner (s) HIV status <sup>a</sup>					
Yes for all partners	867 (60.5%)	109 (64.5%)	69 (66.3%)	50 (68.5%)	0.997
Yes for some	46 (3.2%)	13 (7.7%)	8 (7.7%)	5 (6.8%)	
Dont know for any	477 (33.3%)	43 (25.4%)	25 (24.0%)	16 (21.9%)	
Missing	42 (2.9%)	4 (2.4%)	2 (1.9%)	2 (2.7%)	
How many children do you have <sup>a</sup>					
0	744 (52.0%)	35 (20.7%)	25 (24.0%)	19 (26.0%)	0.632
1–2	235 (16.4%)	38 (22.5%)	18 (17.3%)	13 (17.8%)	
3–4	189 (13.2%)	31 (18.3%)	21 (20.2%)	16 (21.9%)	
5–6	147 (10.3%)	33 (19.5%)	19 (18.3%)	11 (15.1%)	
7+	117 (8.2%)	32 (18.9%)	21 (20.2%)	14 (19.2%)	
Hazardous drinking ( $\geq 1$ on Q2 or Q3)					
No	1593 (92.8%)	52 (30.6%)	11 (10.5%)	2 (2.7%)	<0.0001
Yes	120 (7.2%)	118 (69.4%)	94 (89.5%)	74 (97.3%)	
Alcohol dependency ( $\geq 1$ on Q4–6)					
No	1621 (94.6%)	78 (45.9%)	21 (20.0%)	7 (9.5%)	<0.0001
Yes	92 (6.4%)	92 (54.1%)	84 (80.0%)	67 (90.5%)	
Alcohol-related harm ( $\geq 1$ on Q7–10)					
No	1637 (95.6%)	94 (55.3%)	34 (32.4%)	14 (18.9%)	<0.0001
Yes	76 (4.4%)	76 (44.7%)	71 (67.6%)	60 (81.1%)	

<sup>a</sup>Restricted to those who report having ever had sex.

Hazardous drinking, an affirmative answer for Questions 2 or 3, included 69.4% of the participants with a  $\geq 3$  total score. This increased to 89.5% at the  $\geq 5$  cutoff level and 97.3% at the  $\geq 8$  level. This continued within both the alcohol dependence and harmful consumption designations. The percentage of participants within each  $\geq 3$ ,  $\geq 5$  and  $\geq 8$  cutoff group characterized as alcohol dependent

increased from 54.1% to 80.0% to 90.5%. Those experiencing alcohol-related harms also rose from 44.7% to 67.6% to 81.1%, respectively. All of these differences were statistically significant at the  $P < 0.0001$  level.

Results from the CFA are reported in Table 3, showing one-, two- and three-factor models overall and stratified by sex, of each of

**Table 3.** CFA for the AUDIT by structure and participant sex including Cronbach's  $\alpha$  scores

Indices of model fit	All participants			Males			Females		
	1 Factor	2 Factor	3 Factor	1 Factor	2 Factor	3 Factor	1 Factor	2 Factor	3 Factor
	63.39 (35)	60.41 (34)	47.34 (32)	56.16 (35)	54.84 (34)	40.72 (32)	23.06 (35)	22.32 (34)	20.39 (32)
Chi-square (df)	$P < 0.0001$	$P = 0.002$	$P = 0.262$	$P = 0.276$	$P = 0.212$				
Chi-square $P$ -value	0.032 (0.024–0.039)	0.031 (0.024–0.039)	0.028 (0.020–0.036)	0.040 (0.028–0.052)	0.040 (0.028–0.052)	0.033 (0.020–0.047)	0.012 (0.000–0.027)	0.012 (0.000–0.027)	0.014 (0.000–0.029)
RMSEA	0.995	0.995	0.996	0.992	0.992	0.995	1.000	1.000	1.000
Tucker-Lewis NNFI	0.998	0.997	0.997	0.994	0.994	0.996	1.000	1.000	1.000
Bentler CFI	0.998	0.998	0.999	0.996	0.996	0.997	1.000	1.000	0.999
NFI	0.998	0.998	0.999	0.996	0.996	0.997	1.000	1.000	0.999
Cronbach's $\alpha$ and subscales overall and for each subscale <sup>a</sup>	0.85	0.68, 0.83	0.68, 0.74, 0.76	0.84	0.66, 0.82	0.66, 0.71, 0.76	0.90	0.75, 0.90	0.75, 0.86, 0.75

<sup>a</sup>The order of the listed  $\alpha$  corresponds to the subscale grouping order within the AUDIT.

the 10 AUDIT questions. Chi-square tests were statistically significant ( $P$ -values  $< 0.0001$ ) at each factor level overall and for men in contrast to those for women. All other CFA indicators of both absolute and relative model fit returned 'good' to 'excellent' results within every iteration of the models overall and when sex-stratified. All RMSEAs were well below the 0.06 cutoff, and NNFI, NFI and CFI indicators were similarly good, ranging from 0.992 for one- and two-level models involving males up to 1.000 in all models involving females. In every case, the fit indicators for the three-level models were superior to those of the one- and two-level ones.

Cronbach's alpha scores detailing the overall internal reliability for the AUDIT for overall, by sex, and for each subscale at two- and three-factor levels are reported at the bottom of Table 3. For all participants, the Cronbach's  $\alpha$  showed relatively good internal reliability. Scores within subscales decreased inversely to increased number of conceptual levels, with lower  $\alpha$  consistently for the first three questions examining hazardous drinking. Internal reliability remained good in all two-factor models for the broad concept of 'alcohol-related consequences'. In three-factor models, only the middle alcohol dependency level among women showed reasonable internal reliability with an  $\alpha = 0.86$ .

### DISCUSSION

This study explored the use of the AUDIT in post-conflict Northern Uganda, assessing implications of adjusted cutoff scores to denote hazardous drinking as well as the conceptual factor structure of the test. It sought to further current epidemiological evidence as to the applicability of the test in lesser studied settings, cultures and languages. Overall, men consumed significantly more alcohol and suffered from more associated consequences than women, consistent with findings from and around the world (WHO, 2014). However, the percentage fitting criteria for drinking disorders within the study population even at the lowest threshold (9.9%) were much lower than in other non-post-conflict regions of Uganda where levels range from 17.4% to 34.8%. Likewise, the mean AUDIT scores for both sexes and overall were lower than previously seen in Northern Uganda in IDP camp settings (Roberts *et al.*, 2011). These differences are likely reflective of the distinct characteristics of a post-conflict region. As individuals and families return to ancestral villages to rebuild their homes in a region with limited infrastructure and economic opportunity, the acquisition and consumption opportunities for alcohol are much more limited.

Cronbach's  $\alpha$  scores are consistent with those from 15 other countries showing high internal consistency both for the entire AUDIT and for the 'alcohol-related consequences' subscale Questions 4–10. The weaker Cronbach's  $\alpha$  scores seen at each of the domains within the three-factor models are also consistent with the other studies (Peng *et al.*, 2012).

The CFA showed good fit in every iteration of the sex and conceptual level approaches possible within AUDIT. The only exception was significant Chi-square test statistics, suggesting poor fit, seen for men and both sexes combined. However, the Chi-square test is known to favor rejection in large samples as well as when distributions are not normal and/or suffer from floor and ceiling effects, as the case with this study (Bentler and Bonett, 1980; Doyle *et al.*, 2007; Hooper *et al.*, 2008). The strength of the two- and three-factor models over a one-factor approach is consistent with most current research, implying that the first three questions of the AUDIT do measure a distinct aspect of alcohol consumption compared with the latter questions (Selin, 2006; Doyle *et al.*, 2007; Reinert and

Allen, 2007). While this supports the applicability of the abbreviated AUDIT-C to capture information on hazardous drinking, it also highlights the limitations of this test to informing on consumption-related consequences. The superiority of the three-level model for both sexes and overall differs from the larger supporting the two-factor approach with Questions 4–10 unified into a single concept of ‘adverse consequences’ (Bergman and Källmén, 2002; Chung *et al.*, 2002; Reinert and Allen, 2007; Peng *et al.*, 2012). This is not necessarily cause for concern as while two-level frameworks may be applicable in many settings, the emergence of one- and three-level frameworks demonstrates the ability for population characteristics to affect the test’s underlying structure. As few studies have conducted CFA of the AUDIT within sub-Saharan Africa, and fewer still in post-conflict settings, these findings lend weight to calls for further research into the cultural, ethnic and linguistic impacts on the factor structure of the test (Rumpf *et al.*, 2002; Reinert and Allen, 2007).

The CFA continues to build on evidence showing that the AUDIT factor structure is not dependent on participant sex, and this study reaffirms that non sex-stratified approaches do not bias toward one-factor models (Rist *et al.*, 2009; Peng *et al.*, 2012). The superior scores of the indicators of fit for all female-only models at every conceptual factor level over to those of men and both sexes combined, especially the appearance of perfect NNFI, NFI and CFI scores, should be treated with some caution. The extreme imbalance between those who do and do not drink (5.0% vs. 95.0%) and resulting small sample size ( $n = 48$ ) may have skewed results.

The challenges of approaching the AUDIT as a single level, 10-question scale with a globally uniform cutoff score are shown in Table 2. For those meeting the instrument standard cutoff of a total score of  $\geq 8$ , almost all (97.3%) met the subscale criteria for hazardous drinking. Likewise at this cutoff point, significant majorities were both classified as potentially dependent consumers and suffering from alcohol-related harms (90.5% and 81.1%, respectively). Even at the  $\geq 5$  and  $\geq 3$  thresholds, a majority of included participants fit criteria for all three sub-designations, with the only exception being the 44.7% suffering from alcohol-related harms in the  $\geq 3$  group. The higher thresholds clearly increase the specificity of capturing those with problematic drinking behaviors. In doing so it lowers the sensitivity of the test, and the use of the higher  $\geq 5$  and  $\geq 8$  cutoffs limits exploration of the test subcategories. As an assessment tool, the AUDIT is especially useful to indicate early stage potentially disordered drinking where interventions can be less invasive and costly. Within this population therefore, the use of a  $\geq 3$  cutoff point to denote the potential presence of an alcohol disorder is more useful than higher levels.

### Limitations

The Congo Lyec Project includes self-reported behavioral data that are potentially subject to both selection and recall biases. Measuring standard units of alcohol remains elusive globally, as percentages per unit vary significantly within types as do volumes per unit (Kerr and Stockwell, 2012). In rural Uganda especially problematic as consumption often occurs *via* communal containers, with the percent alcohol in traditionally brewed beverage difficult to measure.

Caution should also be given around the extrapolation of the  $\geq 3$  summation score denoting hazardous drinking, as this study lacked biological testing or the use of another scale to verify the designations of alcohol misuse. Despite these concerns, we are confident that the biases were minimized due to the rigorous staff training, participant

recruitment and community engagement, an explanation around definitions of alcohol use that characterized the study.

### CONCLUSIONS

The strikingly high alcohol consumption present in Uganda and the relatively low use currently by peoples in the North creates a unique opportunity for use of pro-active targeted interventions to delay and perhaps interrupt national trends from taking hold in the region. This study clearly demonstrated the AUDIT as an appropriate tool not only to assess potential hazardous drinking behaviors but also the ensuing consequences within this culturally, linguistically and developmentally unique setting.

Given the benefits of identifying problematic consumers early to stem the potential for increased risk, the use of a low threshold cutoff that increases sensitivity would best be used, thus capturing and offering brief treatments as described to drinkers before hazard, dependence and harm take hold.

### CONFLICT OF INTEREST STATEMENT

None declared.

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