



## Comparing Alcohol Use Disorders Identification Test (AUDIT) with Timeline Follow Back (TLFB), DSM-5 and Phosphatidylethanol (PEth) for the assessment of alcohol misuse among young people in Ugandan fishing communities

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### ABSTRACT

**Background:** Validated tools for assessing alcohol use among young people in low-income countries are needed to estimate prevalence and evaluate alcohol-reduction interventions. We validated Alcohol Use Disorders Identification Test (AUDIT) against Timeline Follow Back (TLFB), Diagnostic and Statistical Manual of Mental Disorders (DSM-5) and phosphatidylethanol (PEth); and the 30-day-AUDIT against the 12-months-AUDIT among young Ugandans.

**Methods:** In 2018, we collected retrospective data on 30-day and 12-month AUDIT, TLFB and DSM-5 in a cross-sectional study of 15–24 year old residents of Ugandan fishing communities. AUDIT was administered by Audio Computer Assisted Self-Interviewing (ACASI) and DSM-5 and TLFB by psychiatric nurses. We determined PEth16:0/18:1 levels from dried blood spots using liquid chromatography tandem-mass spectrometry (heavy usage,  $\geq 210$  ng/mL) and calculated sensitivity and specificity of AUDIT against the other measures.

**Results:** Among 1281 participants (52.7% male, mean age 20 years), half ( $n = 659$ ; 51.4%) reported ever drinking alcohol, 19.4% had 12-month-AUDIT  $\geq 8$  (21.5% men; 17.0% women), and 24.2% had 30-day-AUDIT  $\geq 8$  (29.0% men; 18.9% women). Twenty percent of participants had detectable PEth with 55 (4.3%) classified as heavy drinkers; 50.7% reported  $\geq 2$  symptoms on DSM-5 and 6.3% reported binge drinking in the previous month based on TLFB (8.9% men, 3.5% women). The 30-day-AUDIT  $\geq 8$  had sensitivity 86.7%, 95%CI: 81.8%–90.7% and specificity 90.9%, 95%CI:89.0%–92.6% versus 12-month-AUDIT  $\geq 8$ . Both 30-day and 12-month-AUDIT  $\geq 8$  were sensitive and specific markers of heavy drinking by PEth (12-month-AUDIT sensitivity = 80.0%; 95%CI:67.0%–89.6%; specificity = 83.3%; 95%CI:81.1%–85.3%). The 30-day-AUDIT was a sensitive and specific marker of binge drinking based on TLFB (sensitivity = 82.7%; 95%CI:72.7%–90.2%, specificity = 79.8%; 95%CI:77.4%–82.1%); 12-month-AUDIT had lower sensitivity. Both 30-day and 12-month AUDIT  $\geq 8$  were highly specific but insensitive markers of having DSM-5  $\geq 2$  symptoms.

**Conclusion:** Among young people in Uganda, ACASI-administered 30-day and 12-month-AUDIT have good diagnostic properties compared to PEth, DSM-5 and TLFB. Self-reported AUDIT provides a quick and valid means of assessing alcohol misuse in these communities.

### 1. Introduction

The global burden of disease attributable to harmful alcohol use is high, estimated at 5.3% of all deaths worldwide (3 million) and 5.1% of all disability-adjusted life years (132.6 DALYs). The burden attributable to alcohol misuse and illicit drug use among adolescents and young

adults is high, with 14% of all deaths among 20–39 year olds attributed to alcohol use (Degenhardt, Stockings, Patton, Hall, & Lynskey, 2016; Vos et al., 2015). Young people in so called “key populations” (populations recognised as being at increased risk of acquiring HIV compared to the general population) in sub-Saharan Africa may be at a heightened risk for both HIV and alcohol misuse (Kiwanuka et al., 2017; Kuteesa

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et al., 2019) especially in countries with high per-capita alcohol consumption levels, such as Uganda (World Health Organisation, 2018). However, there are limited data on alcohol misuse among young people from these settings. It is imperative to understand alcohol use in adolescence because that is a time when substance use and substance use disorders are most likely to be initiated. In addition, interventions at this stage in life are more likely to be successful in prevention of future harms because habits have not yet formed.

Locally validated tools are needed to (i) accurately monitor problem drinking in young key population groups, (ii) assess the impact of any potential interventions and (iii) address methodological challenges in the accurate evaluation and full characterization of individual-level alcohol use patterns, alcohol use disorders, and alcohol treatment in surveys (Greenfield & Kerr, 2008; Kuteesa et al., 2019). A key challenge is the lack of a gold standard for measuring alcohol consumption or consumption patterns, or alcohol misuse. Each of the available tools has a unique profile of advantages, disadvantages, and threats to validity and reliability (T. F. Babor, Higgins-Biddle, Saunders, & Monteiro, 2001; Piasecki, 2019). For instance, while the Timeline Follow Back (TLFB) calendar method is used to identify heavy episodic drinking or bingeing, the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) assesses symptoms of alcohol use disorder, both alcohol measurement tools and the framing of questions themselves are likely to influence the adequacy of survey measures of alcohol use (Francis, Helander, Kapiga, Weiss, & Grosskurth, 2015; Greenfield & Kerr, 2008).

Phosphatidylethanol (PEth) is a recently developed direct alcohol biomarker that has been used in different settings for detection of any alcohol consumption, and to distinguish between heavy and moderate drinking (Francis, Weiss, et al., 2015; Greenfield & Kerr, 2008; Schrock, Wurst, Thon, & Weinmann, 2017). In Uganda, PEth  $\geq 10$  ng/mL has been shown to be highly sensitive (88%) and specific (89%) for any alcohol consumption among adults in the prior 21 days (Hahn et al., 2012). Compared with self-reported measures, newer objective alcohol consumption measures such as PEth, ecological momentary assessments (Morgenstern, Kuerbis, & Muench, 2014) and trans-dermal alcohol sensors, remain inaccessible because of cost, weak laboratory infrastructure particularly in sub-Saharan Africa and need for advanced data management and analysis expertise (Greenfield & Kerr, 2008; Morgenstern et al., 2014).

The 10 item Alcohol Use Disorder Test (AUDIT) has three domains, quantity-frequency, symptoms of dependency, and consequences of consumption. Use of both AUDIT and AUDIT-C (a shortened version of AUDIT focusing on consumption) has been increasingly popular in recent years but cut-offs for hazardous use remain inconsistent. (T. F. Babor et al., 2001; Higgins-Biddle & Babor, 2018; Kuteesa et al., 2019; Reinert & Allen, 2007; Wandera et al., 2015; Woolf-King & Maisto, 2011). A total AUDIT score of  $\geq 8$  is recommended by WHO as an indicator of hazardous and harmful alcohol use, as well as possible alcohol dependence (Thomas F Babor & Robaina, 2016). One study in Uganda used cut-off scores of  $\geq 8$  and  $\geq 5$  for men and women, respectively (Santos et al., 2014) following guidance from a population-based study in Finland which suggested that these cut-offs had the most optimal sensitivity and specificity for hazardous drinking (Aalto, Alho, Halme, & Seppa, 2009).

Standard alcohol consumption measures such as AUDIT were not designed for use in young people (Reinert & Allen, 2002, 2007). Two recent studies, both among young people in Tanzania were the first to validate AUDIT, TLFB and MINI-DSM-4 against PEth (Francis, Helander, et al., 2015; Francis, Weiss, et al., 2015), although the performance of the alcohol dependence section of DSM-4 when compared to PEth for detecting alcohol dependence was unsatisfactory (sensitivity 69%, specificity 85%) (Francis, Helander, et al., 2015). However, both the TLFB and the 12-months-AUDIT were strongly correlated with PEth and were sensitive markers to detect alcohol misuse based on PEth in the same population (sensitivity TLFB 96.0%; AUDIT 100%) (Francis, Weiss, et al., 2015).

Quantifying alcohol consumption by self-report is particularly difficult in sub-Saharan Africa because of the ubiquitous availability of homebrews served in non-standard drink volumes with widely varying alcohol concentrations (World Health Organisation, 2018). Self-report methodologies may also be subject to recall, retrospective and social desirability biases and misunderstanding of alcohol use questions (Bajunirwe et al., 2014; Greenfield & Kerr, 2008), making alcohol use measurement even more challenging. In Uganda, social desirability has been shown to be a particular challenge because identification of alcohol-related problems may be culturally dependent, and spiritual or religious (Adong et al., 2018; Tumwesigye et al., 2013) expectations from peers and family members may influence young people's reporting of alcohol consumption (Gardner & Steinberg, 2005; Steinberg & Monahan, 2007).

To our knowledge, no studies have attempted to validate alcohol use assessment tools in young key population sub-populations in sub-Saharan Africa. Fishing communities in Uganda are at high risk of HIV infection. Estimates suggest an overall prevalence of HIV among young people aged 15–24 years in these communities of 19.7%, higher among females (26%) than males (12%) (Mafigiri et al., 2017). The high rates of HIV in this sub-population have been attributed to risky sexual behaviour, high mobility, inadequate access to prevention services, and excessive alcohol consumption leading to risky sexual behaviour (Kiene, Lule, Sileo, Silmi, & Wanyenze, 2017; Kiwanuka et al., 2017; Seeley et al., 2012). However, due to a lack of validated diagnostic tools, the diagnosis of harmful use and alcohol dependence among young people in these settings remains challenging. Locally validated tools are essential to identify people who may benefit from alcohol focused interventions.

We hypothesized that the 30-days-AUDIT would more accurately measure alcohol consumption compared to 12-months-AUDIT due to the shorter recall period; and that AUDIT, a relatively cheaper and quicker tool to administer compared to TLFB, DSM-5 and PEth, would accurately measure alcohol consumption. Our study had two primary aims: first, to validate the 30-day-AUDIT with the 12-months-AUDIT, and second, to validate AUDIT against TLFB, DSM-5 and PEth.

## 2. Materials and methods

### 2.1. Study design, setting and population

From December 2017 to July 2018 we conducted a cross-sectional survey among young people aged 15–24 years, resident in fishing communities in Uganda. The study setting comprised 27 island fishing villages in Mukono district, on Lake Victoria, Uganda; located about two to three hours away from Entebbe by motorised canoe, with a total population of  $\sim 12,300$  people, and 7,741 households (Uganda Bureau of Statistics, 2016). The fishing communities consist of well-defined, geographically separated villages. Each village is located on the lake-shore, and governed by a single administrative committee (Nampijja et al., 2015). We collaborated with village health teams and local leaders who had extensive connections throughout the communities. These groups supported community engagement and mobilisation.

A two-stage sampling procedure was used. In stage one, 20 villages were selected at random from the full list of 27 villages on the islands using simple random sampling. In stage two, we updated a pre-existing village lists of households from a pre-existing census (a household was defined as people who sleep in the same house and share meals), and then households were sampled from each selected village, with probability proportional to the number of households in the village. This yielded a self-weighted sample. Participants were eligible if they were aged 15–24 years and resided in a fishing community. Potentially eligible participants were screened for eligibility and provided with information about the study. Emancipated minors and study participants aged 18 years and older were asked for written informed consent prior to any protocol-specified procedures being conducted. For non-

emancipated minors, we sought their assent and their parents/guardians' consent to participate. Impartial witnesses documented the consent for illiterate study participants.

The survey protocol and consent procedures were approved by the Uganda Virus Research Institute's Research Ethics Committee, Uganda National Council for Science and Technology, and the London School of Hygiene and Tropical Medicine, UK.

Participants were asked to complete the 30-days AUDIT first and thereafter the 12-months AUDIT. The DSM-5 and the TLFB were administered soon after. To minimise social desirability and misreporting bias, self-reported measures were 30-days and 12-months AUDIT administered by Audio Computer Assisted Self-Interviewing (ACASI). Those who could not complete the ACASI were interviewed face-to-face.

The DSM-5 was used to assess alcohol use disorder (AUD) and was administered clinically by psychiatric nurses who also administered the timeline follow back (TLFB). All these data were captured by a tablet computer. Prior to the survey, we piloted the full interview including ACASI, and back-translated it from English to *Luganda*, reviewing for comprehension and cultural relevance. We conducted interviews in private, interviewers were young, age matched and trained on interviewing young people. For all self-reported measures (AUDIT, TLFB and DSM-5) we used an alcohol pictorial display to demonstrate volumes of standard drinks (10gm of alcohol) to ensure accurate measures of actual type and amount of alcohol consumed (Francis, Weiss, et al., 2015).

## 2.2. Measurement and classification of alcohol use

For AUDIT, we used a reference period of 30 days in addition to the standard 12-month period for two reasons (i) to determine whether a shorter recall period might alter psychometric properties of the tool potentially resulting in less misclassification of alcohol mis(usage) (ii) to facilitate more meaningful comparison of AUDIT, TLFB and PEth because, whilst standard AUDIT questions refer to a 12 months reporting period, both the one-month TLFB and PEth detect recent alcohol intake. Therefore, individuals reporting heavy alcohol use based on the 12-months-AUDIT could be erroneously expected to show high levels of PEth also at present, even when they may have markedly reduced their alcohol intake. AUDIT scores were classified into standard groupings as follows: < 7 low risk or non-drinking; 8–15 excess of low risk; 16–19 harmful drinking;  $\geq 20$  alcohol dependence. Alcohol misuse was defined as AUDIT score of  $\geq 8$ , binge drinking was defined as an average consumption of  $\geq 6$  drinks per drinking occasion based on TLFB. Under DSM-5, participants reporting at least two of the 11 criteria during the same 12-month period received a diagnosis of alcohol use disorder (AUD) (Thomas F Babor & Robaina, 2016), with the severity of AUD classified based on the number of criteria met—mild (presence of 2–3 symptoms), moderate (4 to 5 symptoms), or severe (6 or more symptoms).

## 2.3. Laboratory measurements

To collect dried blood samples (DBS), we used ethanol free swabs for disinfection of the venous puncture site. The DBS samples were allowed to dry at room temperature, without any direct sun for three hours and then stored in an air tight mini-grip bag with a drying agent in a fridge at  $< 8^\circ\text{C}$  for a maximum of 4 days. The samples were then transported to the MRC/UVRI and LSHTM Uganda Research Unit reference laboratory in Entebbe where they were kept at  $-20^\circ\text{C}$  prior to express delivery on dry ice to the University of Bern, Switzerland, for analysis. DBS samples were kept at  $-20^\circ\text{C}$  in the Bern laboratory and analysed within five to seven days of arrival to avoid degradation of PEth. Assays of the main PEth homologues (16:0/18:1 and 16:0/18:2), in human blood (Hill-Kapturczak et al., 2019) were conducted using high-performance liquid chromatography-tandem mass spectrometry (LC-MS/MS) as described elsewhere (Luginbühl, Weinmann, Butzke, &

Pfeifer, 2019). Detection of PEth is associated with active excessive drinking in the previous 3–4 weeks. Cut-offs were set at  $< 20$  ng/mL (light or no consumption), 20–209 ng/mL (significant consumption) and  $\geq 210$  ng/mL (heavy consumption) (Helander & Hansson, 2013).

## 2.4. Data management and analysis

PEth concentration data were merged with the questionnaire data and exported to Stata version 13.1 for analysis (StataCorp, 2013). We summarised the characteristics of survey participants disaggregated by gender using means, standard deviations, and frequencies. We calculated Spearman's correlation coefficients to assess the relationship between AUDIT and TLFB, DSM-5 and PEth.

We calculated sensitivity and specificity for 30-day AUDIT versus 12-months AUDIT and for the two AUDIT measures versus TLFB, DSM and PEth respectively using the pre-defined cut-offs, and calculated area under the receiver operating characteristics (ROC) curve. To investigate the optimal cut-off values and utility of the AUDIT for this population, we graphed the ROC curve and calculated sensitivity and specificity for alternative AUDIT cut-offs, comparing against each of TLFB, DSM and PEth.

## 3. Results

A total of 4521 households in the 20 villages were randomly selected for inclusion in the survey. Of these, 1115 (25.0%) were occupied by at least one young person, with a total of 1621 young people. Among these, there were 340 (31.0%) refusals to take part in the study. Thus, a total of 1281 young people aged 15–24 years from 969 households were included in the study. Of these, 675 were male (52.7%) and 606 female (47.3%) (Table 1). The mean age was 20 years (SD 2.7), and the majority (61.3%) had attained primary education or less. Among all participants, 558 (43.6%) were single, with more women (253, 41.8%) reporting being married than men (158, 23.4%), and 42.9% of the study participants had lived in the fishing community for less than six months. Administration of ACASI questionnaires was acceptable and feasible, only two participants had difficulty completing the ACASI and were interviewed face-to-face.

Overall, 51.4% of participants reported ever using any alcohol (53.8% men, 48.8% women), 24.2% had a 30-day-AUDIT score of  $\geq 8$  (29.0% in men vs 18.9% in women) and 19.4% had a 12 months-AUDIT score of  $\geq 8$  (21.5% in men vs 17.0% in women). Among all participants, 261 (20.4%) had PEth 16:0/18:1 concentrations  $> 20$  ng/mL with a mean concentration of 42.5 (SD 168.5); 55 (4.3% of all participants) had PEth 16:0/18:1 concentration of  $> 210$  ng/mL, indicating heavy chronic drinking (5.5% men, 2.0% women) (Table 2). Overall, 50.7% of all participants reported symptoms of alcohol use disorder ( $\geq 2$  symptoms on DSM-5) (52.6% men, 47.3% women), representing 98.5% of those reporting ever using any alcohol. Of the 11 DSM-5 symptom prevalence ranged from 37.3% to 89.8%, with the most commonly reported symptoms being craving a drink of alcohol (prevalence 88.0%), giving up or cutting back on recreational activities because of alcohol use (89.8%), and continuing to drink even though it was making one feel depressed or anxious or adding to another health problem or after having had a memory blackout (86.2%). Internal consistency was high for DSM-5, AUDIT-30 and AUDIT-12 months (Cronbach's alpha 0.86, 0.84 and 0.86, respectively). Based on TLFB, 6.3% engaged in binge drinking in the previous month (8.9% men, 3.5% women). There were higher levels of alcohol dependence (AUDIT score  $\geq 20$ ) than harmful drinking (AUDIT score 16–19) with both versions of AUDIT, and the majority ( $n = 556$ , 86.0%) of those classified as having AUD based on DSM-5 were categorised as severe ( $\geq 6$  symptoms). Both men and women reported similar levels (44%) of severe AUD (Table 2).

The 12-months and 30-day AUDIT scores were strongly correlated (Spearman's correlation coefficient 0.91). Compared with 12-months-

**Table 1**  
General characteristics of study sample.

Characteristics	Categories	Men (n = 675)		Women (n = 606)		Overall (n = 1281)	
		n	%	N	%	N	(%)
Age	15–19 years	261	38.7	226	37.3	487	38
	20–24 years	414	61.3	380	62.7	794	62
Religion	Christian	505	74.8	461	76.1	966	75.4
	Muslim	156	23.1	145	23.9	301	23.5
	Traditional/Other	14	2.1	0	0	14	1.1
Marital status	Married	158	23.4	253	41.8	411	32.1
	Cohabiting	106	15.7	118	19.5	224	17.5
	Single	378	56.0	180	29.7	558	43.6
	Separated/divorced/ widowed	33	4.9	55	9.1	88	6.9
Education attainment	None	22	3.3	15	2.5	37	2.9
	Incomplete primary	338	50.1	262	43.2	600	46.8
	Complete primary	76	11.3	73	12.1	149	11.6
	Secondary junior	210	31.1	230	38	440	34.4
	Secondary senior and above	29	4.3	26	4.3	55	4.3
Time resident in fishing community	< 6 months	254	37.6	296	48.8	550	42.9
	7 to 11 months	114	16.9	100	16.5	214	16.7
	1 to 5 years	221	32.7	170	28.1	391	30.5
	6 to 10 years	37	5.5	16	2.6	53	4.1
	> 11 years	49	7.3	24	4	73	5.7

AUDIT ≥ 8, the 30-day AUDIT ≥ 8 had sensitivity 86.7%, 95%CI: 81.8%–90.7% and specificity 90.9%, 95%CI: 89.0–92.6% (Table 3).

There was strong evidence of a positive correlation between AUDIT and the other three measures of alcohol use/misuse (Table 3). The 30-day-AUDIT ≥ 8 and 12-months-AUDIT ≥ 8 were both sensitive and specific markers of heavy chronic drinking (PEth ≥ 210 ng/mL): sensitivity for both 30-day and 12-month AUDIT 80% (95% CI: 67.0%–89.6%); specificity 78.3% (95% CI: 75.9%–80.6%) and 83.3% (95%CI 81.1%–85.3%) respectively. In contrast, both AUDIT tools had low sensitivity against a positive PEth of any value (≥20 ng/mL): sensitivity 55.2% and 56.3% respectively, although specificity was high

(91.0% and 89.8% respectively, Table 3).

The 30-day-AUDIT ≥ 8 was a sensitive and specific markers of binge drinking based on TLFB (sensitivity 82.7%, 95%CI: 72.7%–90.2%; specificity 79.8%, 95%CI: 77.4%–82.1%). Sensitivity to detect binge drinking was lower for 12-months-AUDIT (69.1%, 95%CI: 57.9%–78.9%; specificity 84.0%, 95%CI: 81.8%–86.0%) (Table 3). When compared to AUD assessed by DSM-5, both AUDIT scores had high specificity (98.4%, 95%CI: 97.1%–99.2%) but low sensitivity (30-day AUDIT: 46.1%, 95%CI: 42.2%–50.0%; 12 month AUDIT: 36.7%, 95%CI: 33.0%–40.5%; Table 3), reflecting the fact that nearly all participants reporting any alcohol use were classified as having AUD based

**Table 2**  
Alcohol misuse patterns.

Characteristics	Categories	Men (n = 675)	Women (n = 606)	Overall (n = 1281)			
				296	48.8	659	51.4
Ever used alcohol	Yes	363	53.8	296	48.8	659	51.4
	No	312	46.2	310	51.2	622	48.6
30-day-AUDIT	Mean (SD)	5.5	8	3.7	6.3	4.7	7.3
	< 7 Low risk or non-drinker	480	71.1	492	81.2	972	75.9
	8–15 Excess of low risk	105	15.6	70	11.6	175	13.7
	16–19 Harmful drinking	28	4.2	18	3.0	46	3.6
	≥20 Alcohol dependence	62	9.2	26	4.3	88	6.9
12-months-AUDIT	Mean (SD)	4.7	7.7	3.3	6.2	4.0	7.0
	< 7 Low risk or non-drinker	530	78.5	503	83	1033	80.6
	8–15 Excess of low risk	72	10.7	60	9.9	132	10.3
	16–19 Harmful drinking	19	2.8	24	4	43	3.4
	≥20 Alcohol dependence	54	8	19	3.1	73	5.7
PEth cut-off for heavy alcohol use (PEth 16:0/18:1)	Not detected	505	75.4	510	84.2	1015	79.5
	Low drinking (≥20 ng/mL)	128	19.1	78	12.9	206	16.1
	Heavy drinking (≥210 ng/mL)	37	5.5	18	3.0	55	4.3
	Missing	5					
TLFB: Mean (SD) No. of alcohol drinking days, past month		4.9	(5.8)	3.6	(4.8)	4.4	(5.5)
	TLFB: Mean (SD) No. of standard units per drinking day*	3.4	(4.6)	2.6	(2.4)	3.1	(3.9)
TLFB: heavy episodic intake (≥6 standard drinks on one occasion, in previous month)	Yes	60	8.9	21	3.5	81	6.3
	No	615	91.1	585	96.5	1200	93.7
DSM-5	None	320	47.4	312	51.5	632	49.3
	Mild (2–3 symptoms)	23	3.4	11	1.8	34	2.7
	Moderate (4–5 symptoms)	37	5.5	22	3.6	59	4.6
	Severe (≥6 symptoms)	295	43.7	261	43.1	556	43.4

\*Among people who drank in the past 30 days.

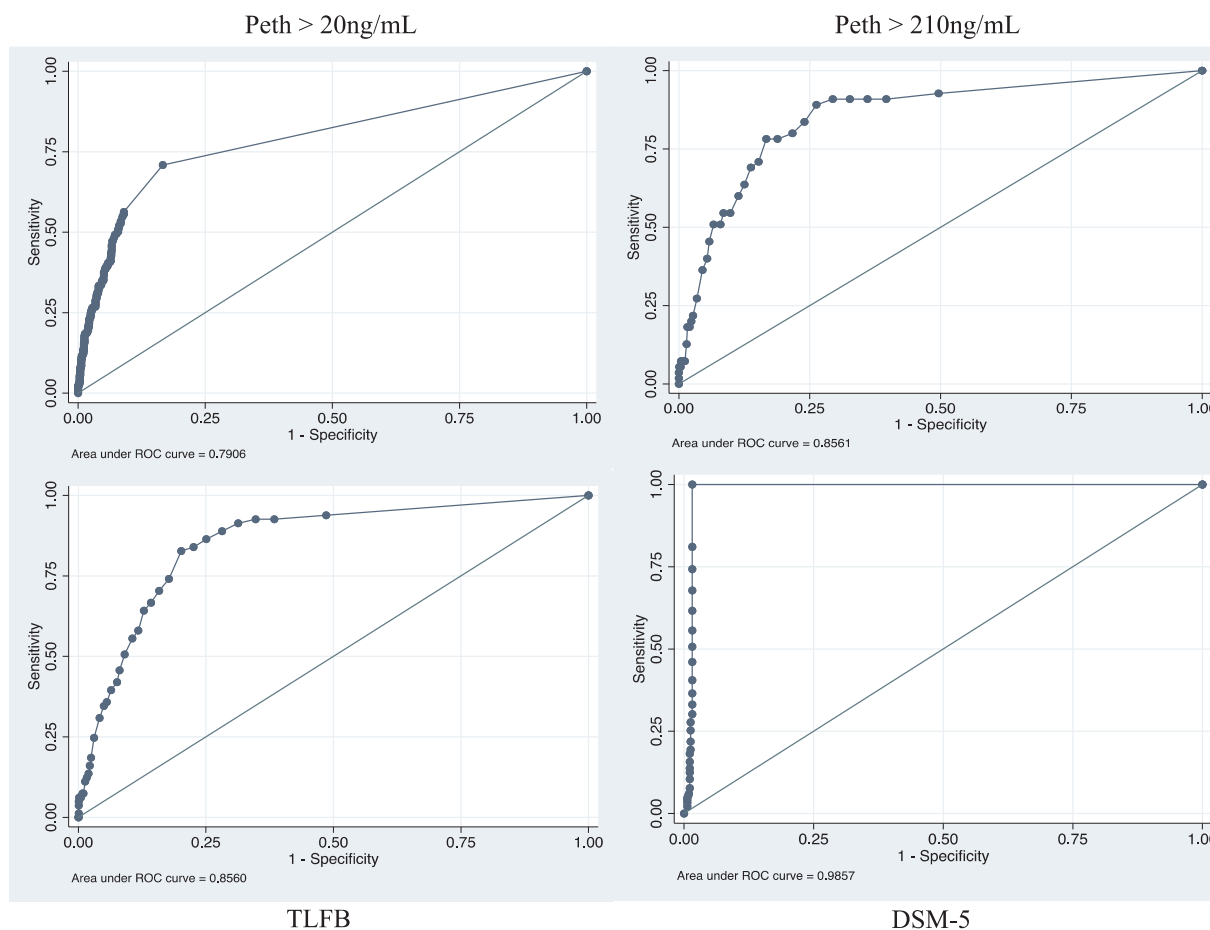
**Table 3**  
Comparing AUDIT against TLFB, DSM-5 and PEth.

Gold standard measure	Comparator	AUROC	ROC sensitivity (95%CI)	ROC specificity (95%CI)	Spearman's correlation	Positive predictive value	Negative predictive value
PEth ≥ 20ng/mL	30-days-AUDIT ≥ 8	0.74 (0.71–0.77)	56.3 (50.6–61.9)	91.0 (89.0–92.7)	0.59	66.7 (60.6–72.4)	86.7 (84.5–88.7)
	12-months-AUDIT ≥ 8	0.72 (0.69–0.76)	55.2 (48.9–61.3)	89.8 (87.7–91.6)	0.58	58.1 (51.7–64.3)	88.6 (86.5–90.5)
PEth ≥ 210 ng/mL	30-days-AUDIT ≥ 8	0.79 (0.74–0.85)	80.0 (67.0–89.6)	78.3 (75.9–80.6)	0.59	14.2 (10.5–18.6)	98.9 (98.0–99.4)
	12-months-AUDIT ≥ 8	0.82 (0.76–0.87)	80.0 (67–89.6)	83.3 (81.1–85.3)	0.58	17.7 (13.2–23.1)	98.9 (98.1–99.5)
DSM-5(AUD)	30-days-AUDIT ≥ 8	0.72 (0.7–0.74)	46.1 (42.2–50)	98.4 (97.1–99.2)	0.77	96.8 (94.1–98.4)	64.0 (60.9–67.0)
	12-months-AUDIT ≥ 8	0.68 (0.66–0.69)	36.7 (33.0–40.5)	98.4 (97.1–99.0)	0.65	96.0 (92.7–98.0)	60.2 (57.2–63.2)
TLFB (Heavy episodic intake; ≥6 standard drinks on at least one occasion, in previous month)	30-days-AUDIT ≥ 8	0.81 (0.77–0.86)	82.7 (72.7–90.2)	79.8 (77.4–82.1)	0.17	21.7 (17.2–26.7)	98.6 (97.6–99.2)
	12-months-AUDIT ≥ 8	0.77 (0.71–0.82)	69.1 (57.9–78.9)	84.0 (81.8–86.0)	0.19	22.6 (17.5–28.3)	97.6 (96.4–98.4)
12-months-AUDIT ≥ 8	30-days-AUDIT ≥ 8	0.89 (0.87–0.91)	86.7 (81.8–90.7)	90.9 (89–92.6)	0.91	69.6 (64.1–74.7)	96.6 (95.3–97.7)
12-months-10 item AUDIT ≥ 8	12-months-AUDIT -C	0.90 (0.87–0.92)	58.5 (52.1–64.7)	98.3 (97.3–99.0)	0.67	89.0 (83.1–93.3)	90.8 (88.9–92.4)
3-months-10 item AUDIT ≥ 8	3-months-AUDIT -C	0.89 (0.87–0.91)	58.3 (52.5–63.8)	97.9 (96.8–98.7)	0.66	90.0 (85.0–93.8)	88.1 (86.0–89.9)

on DSM-5.

ROC curves for 30-day-AUDIT and 12-month AUDIT against each of PEth > 20 ng/mL, PEth > 210 ng/mL, binge drinking (from TLFB) and AUD (from DSM-5) are shown in Figs. 1 and 2. These suggest that a

much lower AUDIT cut-off (≥1 or 2) would be required to give good diagnostic performance against PEth > 20 ng/mL or AUD (from DSM-5). Compared to PEth > 210 ng/mL, a 30-day-AUDIT cut-off of ≥6 and a 12-months-AUDIT cut-off of ≥7 appear to have marginally better



**Fig. 1.** ROC curves for 30-day-AUDIT against PEth, TLFB, DSM-5.

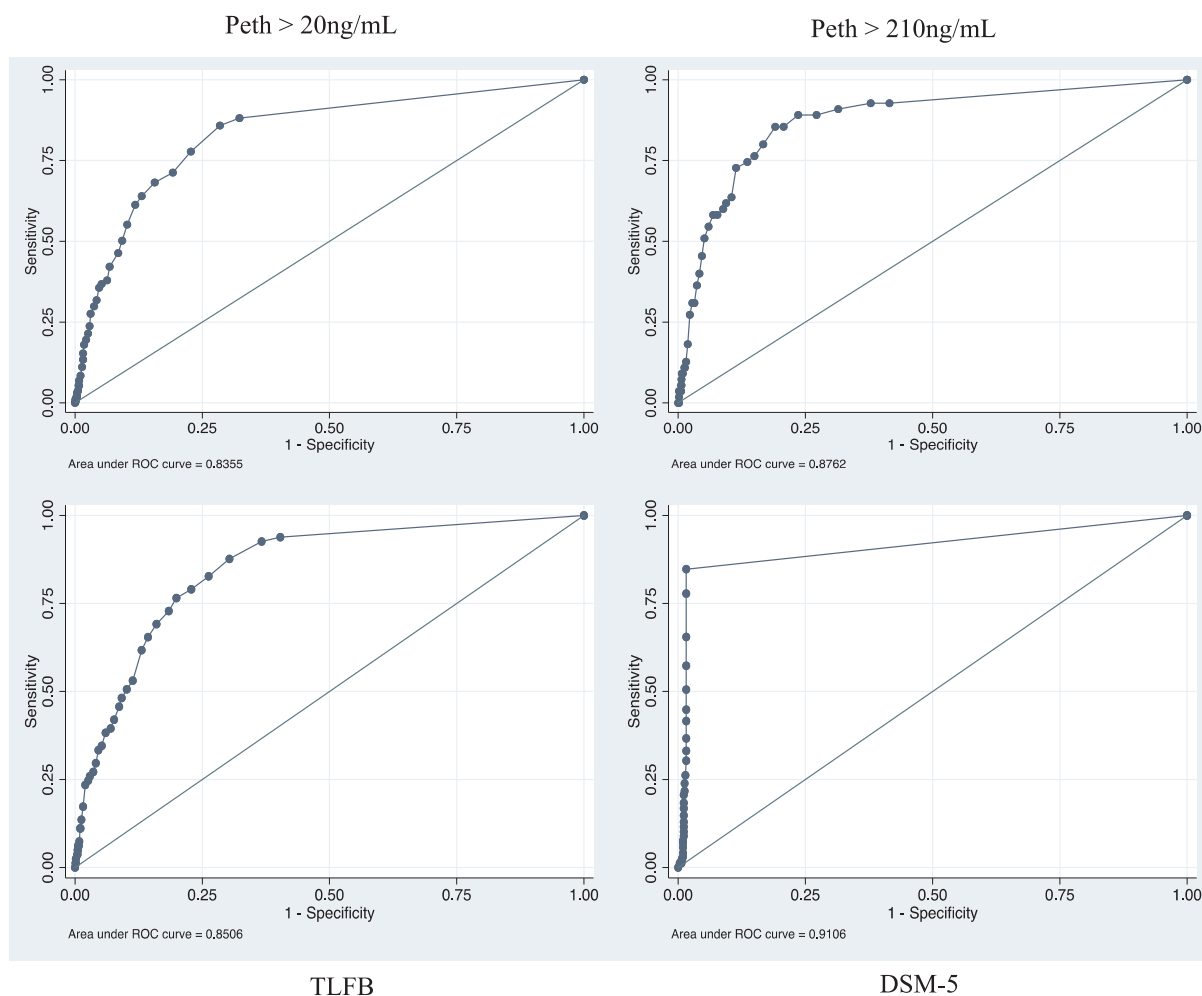


Fig. 2. ROC curves for 12-months-AUDIT against PETH, TLFB and DSM-5.

diagnostic properties than the standard cut-offs of  $\geq 8$ . When compared to binge drinking based on TLFB, AUDIT cut-offs of between  $\geq 6$  and  $\geq 8$  have the best diagnostic properties.

#### 4. Discussion

This study is the first in sub-Saharan Africa to evaluate the validity of ACASI-administered 30-day-AUDIT and 12-month-AUDIT against TLFB, DSM-5, and PETH tools among young people in a key population setting, at high risk for HIV. The primary findings of our study were: (i) a high prevalence of alcohol use with 51% (53.8% men, 48.8% women) reporting ever having used alcohol, 19% a 12-month-AUDIT  $\geq 8$ , 4.3% with PETH 16:0/18:1 concentrations of  $> 210$  ng/mL indicating recent chronic drinking and 50% with AUD according to DSM-5; (ii) both the 30-day-AUDIT and 12-months-AUDIT can be validly used to assess alcohol misuse in this young key population setting, showing good agreement with TLFB and PETH  $> 210$  ng/mL; (iii) the DSM-5 tool may not be a suitable tool for assessment of alcohol misuse in this setting, classifying nearly all drinkers as having AUD, and (iv) somewhat lower AUDIT cut-offs than the standard of  $\geq 8$  might improve the diagnostic properties of AUDIT when compared to TLFB and PETH.

Our findings of high levels of alcohol misuse among young people in this setting highlights the need for early alcohol reduction interventions since the risk for the onset of an alcohol use disorder peaks during adolescence and the transition to young adulthood (Degenhardt et al., 2016; Vos et al., 2015). It appears that among youth in fishing communities, gender differences regarding ever-use of alcohol may be negligible. It might be that the influence of environmental factors for

alcohol use in this setting do not differentially impact males and females in early adolescence. More research is needed to explore this further. Previous studies in Ugandan fishing communities have suggested a substantial population attributable fraction of new HIV infections due to alcohol consumption (Kiwunuka et al., 2017). This further highlights the need for integration of alcohol reduction in HIV prevention interventions among young people, particularly for key population settings.

The 30-day-AUDIT and 12-months-AUDIT tools are sensitive tools for screening and monitoring for problem drinking among young people in fishing communities and will be useful for evaluation of tailored interventions in this sub-population, as well as in general population settings (Francis, Helander, et al., 2015). Furthermore, the AUC for 30-day-AUDIT and 12-months-AUDIT when compared to each of the other tools are all high with the lower bound of the 95% CIs generally greater than 0.7, indicating that both self-reported AUDIT scales had good discriminatory properties.

The new DSM-5 which was administered by trained psychiatric nurses classified nearly all participants who self-reported any alcohol use as having AUD when applying the  $\geq 2$  symptoms criteria. Previous literature suggests that the low specificity compared to other tools may result from the two questions on alcohol tolerance and compulsion to drink (Francis, Helander, et al., 2015). These same concerns have been raised previously as a limitation to the use of the MINI/DSM-4, especially when administered to young people who may over-report problem drinking (Chung & Martin, 2005; Chung, Martin, & Winters, 2005). In our study, although two symptoms in particular, specifically craving/a strong desire or urge to use alcohol, and giving up of

important social, occupational, or recreational activities because of alcohol use, were almost universally reported among ever-drinkers, these alone did not drive the high prevalence. This is demonstrated by the fact that the vast majority (86%) of those with AUD based on DSM-5 were further categorised as having severe AUD ( $\geq 6$  symptoms). As a consequence of our observed high prevalence of AUD, sensitivity of AUDIT versus DSM-5 was low. Qualitative work is needed to elucidate the reasons for the differences between DSM-5 and the other tools.

A growing body of literature has demonstrated strong correlation between AUDIT and PEth (Francis, Weiss, et al., 2015). Our findings similarly suggest that ACASI administered AUDIT is an appropriate method for evaluating young people's alcohol use. Indeed, there was a strong and significant correlation between the AUDIT and PEth. When we explored alternative PEth cut offs levels for harmful drinking (e.g.  $\geq 200$  ng/mL) (Ulwellington & Smith, 2018), we obtained similar results for prevalence of alcohol misuse, and this did not markedly impact sensitivity or specificity of AUDIT compared to PEth. In addition to correlating highly with PEth, ROC curve analyses suggested that both the 30-day-AUDIT and 12-month-AUDIT performed very well in discriminating high risk and low risk drinkers (high sensitivity and specificity). Therefore, both scales are recommended for measuring alcohol use among young people in fishing communities and are potentially low cost compared to PEth. The 30-day-AUDIT may be useful in minimising under-reporting of alcohol consumption particularly in situations where current use of alcohol may compromise recall of alcohol use over longer periods of time such as 12 months. In addition, the high migration patterns in fishing community settings (Olawore et al., 2018) may influence behaviour (Sileo, Kintu, Chanes-Mora, & Kiene, 2016) and compromise recall of alcohol consumption over long periods of time. Therefore, the 30-day AUDIT might better capture information on alcohol use and AUD. It is worth noting that while the 30-days-AUDIT may yield better recall, it may lead to misrepresentation of seasonal variation in drinking (Greenfield & Kerr, 2008). Yet these variations in drinking may otherwise be critical for understanding alcohol related problems. As such, augmenting the 30-day-AUDIT with other methods capable of describing longer-term alcohol drinking patterns such as the 12-months-AUDIT/TLFB might be useful in representing respondents' overall drinking patterns.

AUDIT cut-offs for heavy drinking may vary by population. We found that a lower cut off of 6 or 7 might be have marginally better diagnostic properties than 8 in this setting. Other studies have suggested lower cut-offs for use in women (Reinert & Allen, 2002, 2007); and in post-conflict northern Uganda (Pearce et al., 2016) although they have not validated AUDIT against any other alcohol measures.

#### 4.1. Strengths and limitations

Our study had several strengths. First, we selected a large and representative sample which enhances the generalisability of our findings to fishing community settings in the eastern and southern Africa. Second, we compared the different types of alcohol consumption measures (i.e. tools that report alcohol consumption status, average volume alcohol consumption, and frequency and volume of binge drinking and PEth alcohol biomarker against each other. The assessment timeframe over which the measures obtained data ranged of drinking in the past month and or year. These tools are essential for monitoring public health and evaluating alcohol control policies and other interventions. Third, ACASI administration was acceptable and feasible suggesting that the results might be less prone to social desirability bias/misreporting. Previous literature suggests that ACASI allows more accurate reporting of sensitive behaviours including alcohol mis(usage) (Kane, Murray, Bass, Johnson, & Bolton, 2016). We did not have an interviewer-administered comparison group to test this hypothesis in our study. Therefore, our findings might not be generalizable to AUDIT being administered face-to-face. Another limitation was that we did not counter balance the order in which AUDIT-30 and

AUDIT-12 were administered so that some respondents were asked about the last 30 days first, and others the last year (all completed AUDIT-30 first, followed by AUDIT-12). As such, we could not examine order effects.

## 5. Conclusions

Among young people aged 15–24 years in fishing communities in Uganda, the DSM-5 may not be an adequate tool to detect alcohol misuse. The 30-day-AUDIT and 12-month AUDIT are both sensitive tools for the detection of alcohol misuse among young people, and may be used to augment treatment and to improve monitoring of alcohol-reduction interventions. The levels of alcohol misuse are high and may have implications for future harms. In addition, our future work will focus on association of alcohol misuse with HSV2/HIV as markers of risky sexual behaviour in these communities.

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## Contributors

MKO and EW had full access to all the data in the study and take responsibility for the integrity of the data and accuracy of the data analysis.

Study concept and design: MKO, EW, SC, HW, JS.

Acquisition, analysis or interpretation of data: MKO, EW, JS, JSN, FN, TK, HW, SC.

Drafting of the manuscript: MKO, EW.

Critical revision of the manuscript for important intellectual content: MKO, EW, SC, HW, WW.

Statistical analysis: MKO, EW.

Obtained funding: MKO, AK, EW, HW, JS.

Administrative, technical, or material support: JSN, KT, FN, DN, WW.

Study supervision: EW, JS.

Final approval of the article: MKO, EW, SC, HW, JS, WW.

## Declaration of Competing Interest

For all authors, none declared

## Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.abrep.2019.100233>.

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