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Article

# Cross-Cultural Adaptation and Psychometric Properties of the AUDIT and CAGE Questionnaires in Tanzanian Swahili for a Traumatic Brain Injury Population

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## ABSTRACT

**Aims:** To develop Swahili versions of the Alcohol Use Disorders Identification Test (AUDIT) and CAGE questionnaires and evaluate their psychometric properties in a traumatic brain injury (TBI) population in Tanzania.

**Methods:** Swahili versions of the AUDIT and CAGE were developed through translation and back-translation by a panel of native speakers of both English and Swahili. The translated instruments were administered to a sample of Tanzanian adults from a TBI registry. The validity and reliability were analyzed using standard statistical methods.

**Results:** The translated versions of both the AUDIT and CAGE questionnaires were found to have excellent language clarity and domain coherence. Reliability was acceptable (>0.85) for all tested versions. Confirmatory factor analysis of one, two and three factor solution for the AUDIT and one factor solution for the CAGE showed adequate results. AUDIT and CAGE scores were strongly correlated to each other ( $R > 0.80$ ), and AUDIT scores were significantly lower in non-drinkers compared to drinkers.

**Conclusions:** This article presents the first Swahili and Tanzanian adaptations of the AUDIT and CAGE instruments as well as the first validation of these questionnaires with TBI patients. Both instruments were found to have acceptable psychometric properties, resulting in two new useful tools for medical and social research in this setting.

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## INTRODUCTION

Excessive alcohol use, both binge drinking and chronic use, has been associated with many high risk behaviors for injuries such as crime, aggressive driving, interpersonal violence, unintentional injuries and self-inflicted injury (Organization, 2015). Alcohol use is an important contributor to morbidity and mortality for many diseases worldwide, accounting for 6% of all deaths and 9.6% of disability adjusted life years (DALYs) (Whiteford *et al.*, 2013; Molina *et al.*, 2015; World Health Organization, 2017; Ogeil *et al.*, 2016; Lhachimi *et al.*, 2016; Praud *et al.*, 2016; Nadkarni *et al.*, 2016; Popova *et al.*, 2016; Younossi and Henry, 2016; Unsworth and Mathias, 2017). In sub-Saharan Africa, research estimates that ~40% of all alcohol-attributable deaths and 40% of DALYs in men are due to injury; for women, estimates are ~10% deaths and more than 14% of DALYs. (Ferreira-Borges *et al.*, 2016).

Of all injuries, traumatic brain injuries (TBIs) are responsible for the most death and disability globally (Hyder *et al.*, 2007; Staton *et al.*, 2017); TBIs are also the leading cause of disability in people <40 years of age (Bruns and Hauser, 2003; Fleming and Ponsford, 2005). In Tanzania, the estimated burden of TBI at a regional referral hospital is ~6% of all emergency department visits, or ~1000 patients annually (Staton *et al.*, 2017). Of acute TBI patients seen at this hospital, almost 30% of them presenting for care to the emergency department had alcohol use prior to their injury (Staton *et al.*, 2017). Both globally and in Tanzania, of those who survive their debilitating injury, many (nearly 30%) either continue to suffer from or have a new substance use disorder (Zatzick *et al.*, 2002; Vissoci *et al.*, 2016).

Given the important role alcohol plays in many health outcomes, especially for injury and TBI patients, developing tools to screen for alcohol misuse has become essential in both clinical practice and public health research. Two of the most frequently used tools are the Alcohol Use Disorders Identification Test (AUDIT) and CAGE questionnaires, but neither have been cross-culturally validated to Swahili nor have been psychometrically evaluated with a TBI population. As the leading cause of the most socially and functionally disabling injuries (Schultheis and Whipple, 2014; von Steinbuechel *et al.*, 2016), TBI patients are the most likely to need alcohol use disorder assessments, yet the validity of these instruments for this population is unknown.

AUDIT was originally developed by the WHO and consists of 10 questions assessing alcohol use, dependence and harmful behavior (Saunders *et al.*, 1993). Since its publication, the AUDIT tool has been translated into numerous languages and validated among many different populations. The tool has been shown to have acceptable validity and reliability across a wide range of settings, including Sweden (Bergman and Kallmen, 2002), Korea (Kim *et al.*, 1999), Nepal (Pradhan *et al.*, 2012), Brazil (Moretti-Pires and Corradi-Webster, 2011), Japan (Kawada *et al.*, 2011), Chile (Alvarado *et al.*, 2009), the United Arab Emirates (AlMarri *et al.*, 2009), Spain (de Torres *et al.*, 2009), Germany (Dybek *et al.*, 2006), France (Gache *et al.*, 2005), India (Pal *et al.*, 2004) and Hong Kong (Leung and Arthur, 2000), among others. Specifically for TBI populations, studies have looked into the criterion validity (Bryce *et al.*, 2015), but not other measures of validity.

Although Kenya was one of the six international sites where the English language AUDIT tool was originally developed and validated (Saunders *et al.*, 1993), there is limited rigorous evaluation of the psychometric properties of the AUDIT tool elsewhere on the continent. The AUDIT questionnaire has been used to assess prevalence of

alcohol use disorders in various sub-Saharan African populations, but the majority has occurred without formal cultural cross-validation of the translated instrument in the local setting (Zetola *et al.*, 2012; Soboka *et al.*, 2014; Francis *et al.*, 2015; Schwitters *et al.*, 2015; Seth *et al.*, 2015; Wandera *et al.*, 2015; Fekadu *et al.*, 2016; Lancaster *et al.*, 2016; Thakarar *et al.*, 2016; Weiss *et al.*, 2016). Preliminary studies assessing usage of the AUDIT in Nigeria, South Africa and Zambia found the tool to be a valid screening instrument when compared to ICD-10 or Mini International Neuropsychiatric Interview questionnaire (MINI) criteria for alcohol misuse, with areas under the curve ranging from 0.75 to 0.98 (Adewuya, 2005; Myer *et al.*, 2008; Chishinga *et al.*, 2011). The reliability of AUDIT has also been assessed among subpopulations in South Africa (Young and Mayson, 2010; Peltzer *et al.*, 2011; Pengpid *et al.*, 2011), Zambia (Chishinga *et al.*, 2011) and Rwanda (Kanyoni *et al.*, 2015), where the tool was found to have excellent reliability, with Cronbach's alpha ranging from 0.83 to 0.98. However, beyond criterion validity and reliability, the broader spectrum of psychometric properties of AUDIT across sub-Saharan Africa, including Tanzania, have not been fully explored; furthermore, validated translations of the questionnaire in widely used local languages such as Swahili are sorely lacking. Although the AUDIT has consistently shown good reliability across cultures and good validity for screening for alcohol-use disorder, its internal structure, specifically the ability to differentiate an alcohol use disorder (i.e. unidimensional, two dimensions) displays diverse results in different cultures and populations and has not been tested in Swahili or TBI patients.

Similar to the AUDIT, the CAGE survey is designed to screen for alcohol dependence and abuse (Ewing, 1984). The CAGE questionnaire has also been translated into many different languages and validated in settings across the globe such as Korea (So and Sung, 2013), Brazil (Meneses-Gaya *et al.*, 2010), Taiwan (Wu *et al.*, 2008) and France (Gache *et al.*, 2005). As with AUDIT, few studies have investigated the psychometric properties of the CAGE tool in sub-Saharan Africa, and none have been conducted among TBI patients. The CAGE questionnaire has been used in several studies to assess prevalence of alcohol abuse in various sub-Saharan African populations, but frequently without prior validation of the translated instrument for the local setting (Alem *et al.*, 1999; Kebede and Alem, 1999; Siegfried *et al.*, 2001; Okulate and Odunaike, 2005; Mitsunaga and Larsen, 2008; Ghebremichael *et al.*, 2009; Kullgren *et al.*, 2009; Namagembe *et al.*, 2010; Ao *et al.*, 2011; Mongi *et al.*, 2013; Opio *et al.*, 2013; Weiss *et al.*, 2016). To our knowledge, only one study has formally assessed the validity of CAGE in the sub-Saharan region. This was conducted in a single rural South African community, where CAGE was found to have acceptable sensitivity and specificity when compared to the DSM-IV definition of alcohol dependence (100 and 78%, respectively) with adequate reliability (Cronbach's alpha = 0.7) (Claassen, 1999). The psychometric properties of CAGE elsewhere in the sub-Saharan continent are otherwise unknown, and validated translations of the tool in local languages such as Swahili for TBI patients are utterly absent.

Despite the recognized importance of the relationship between alcohol use disorders and injury in sub-Saharan Africa, validated tools for measuring alcohol misuse such as the CAGE and AUDIT are unavailable in most African communities (de Meneses-Gaya *et al.*, 2009; Francis *et al.*, 2014). Thus, there is a pressing need to develop such reliable objective measures to inform practice and policy, particularly among TBI patients among whom alcohol use has been shown to be a significant contributor to morbidity and mortality (Molina *et al.*, 2015). There are no validated versions of these

tools in Swahili, a common language spoken across East Africa, and no formal validation studies have been performed in Tanzania, where Swahili is the primary language. Therefore, the aims of this study were to (a) develop the first translation and adaptation of both AUDIT and CAGE in Swahili and (b) to perform the analysis of their psychometric properties in Tanzanian TBI patients, including evidence of reliability, internal structure and external validity.

## METHODS

### Participants

The study sample was composed of 190 adults who were part of a TBI patient registry and post-hospitalization cohort study in northern Tanzania. Participants were included if they sought acute care for a TBI of any severity, as long as they were admitted for continued care, were at least 18 years of age, spoke Swahili, were able to understand and respond to questions appropriately and consented to participate prior to hospital discharge.

### Instrument

The original scales used were the AUDIT (Saunders *et al.*, 1993) and CAGE (Ewing, 1984) questionnaires. The AUDIT tool consists of 10 questions across three domains (alcohol use, alcohol abuse and harmful behavior) and an overall score ranging from 0 to 40. The answer to each question is scored on a 5-point Likert-type scale, with assigned point values ranging from 0 to 4. The CAGE questionnaire consists of four dichotomous questions, each of which is scored as 1 for 'yes' and 0 for 'no'. Higher scores on both scales are correlated with increasing probability of alcohol misuse and dependence. Alcohol use questions covered alcohol consumption over the past 12 months; non-drinkers were defined as those who had consumed no alcohol over the preceding year. In terms of quantifying the number of drinks consumed, the National Institute on Alcohol Abuse and Alcoholism recommended guidelines for standard drinks was used (2017).

### Ethical statement

The study was approved by the Institutional Review Board of the Duke University (IRB #Pro000061652), the Ethics Committee of the Kilimanjaro Christian Medical Center, Moshi, Tanzania.

### Translation and adaptation

A translation and cross-cultural adaptation committee of five judges (physicians, nurses and researchers) oversaw the translation, adaptation and content validation process. After finalizing content validation, a pilot study was conducted with a convenience sample of 20 Tanzanian adults to assess the quality of instrument questions and coherence of language and content.

The instrument was translated through independent back translation methods, as suggested by the WHO for health outcomes translation (Erkut, 2010). Initially, a Swahili translator was hired to translate AUDIT and CAGE questionnaires into Swahili. Subsequently, another bilingual translator converted the Swahili version back into English. English translated versions were compared with the original version of the instrument and checked for inconsistencies by four independent bilingual research nurses. Issues with semantics were discussed and adjustments made by the researchers and the judges committee.

To perform theoretical and content evaluation of the translated instrument, we employed a five-point Likert scale with the aim of

verifying: (a) practical relevance, (b) language clarity of the translated instrument and (c) theoretical coherence of the item, as determined by the judges. These scales allowed for an evaluation of the consistency of the judges' opinions in relation to the items of the instrument. The experts' opinions were initially collected individually with the scale and later discussed collectively in focus group sessions to improve the quality of the translations and discuss any discordances.

### Data collection

Patients in the Kilimanjaro Christian Medical Center TBI registry were screened for inclusion in a follow-up cohort project. They were offered enrollment after informed consent and subsequently enrolled prior to hospital discharge. The patient had the AUDIT and CAGE questions administered at the bedside as a part of a 45-min interview that served as a baseline for future follow-up evaluations. All responses were collected by hand and entered into an Internet based dataset (REDCAPS); additionally, the principal investigator (C.A.S.) conducted a quality control evaluation for all data entered.

### Data analysis

Sociodemographic data were presented as means with standard deviations, medians with interquartile range, or absolute and relative frequencies. All analyses were conducted with R Language for Statistical Computing (R foundation, Vienna).

### Evidence of validity

Content validity was evaluated by a content validity coefficient for each item of the instrument (CVCi) and for the questionnaire as a whole (CVCt) (Hernandez-Nieto, 2002), with a cutoff of 0.80 deemed to be acceptable. To analyze the concordance index between judges for the theoretical dimensions of the items, the Kappa coefficient was used.

Confirmatory factor analysis (CFA) was used to test the internal structure of the AUDIT and the CAGE based on the previous literature looking at the factor structure in different populations. Although the AUDIT was originally conceived to be a three dimensions tool that evaluated alcohol use, dependence and harmful behavior (Babor *et al.*, 2001; de Menezes-Gaya *et al.*, 2009), several reports suggested that a two dimension structure (aggregating the dependence and harmful subscales) would perform better (Doyle *et al.*, 2007; Von Der Pahlen *et al.*, 2008; Rist *et al.*, 2009; Nayak *et al.*, 2015; Tuliao *et al.*, 2016). However, the most common use of the AUDIT is a sum score of all items as a unidimensional scale (Carey *et al.*, 2003; English *et al.*, 2011), from which cutoff points have been established. Therefore, we tested the three existing models based on previous evidence, to verify which structure would best be represented in a TBI population. Our hypothesis was that the unidimensional model would perform better considering the high association between alcohol use and alcohol dependence in the sub-Saharan Africa, making it harder to differentiate the subscales. For the CAGE, we tested for the unidimensional model (Table 1).

CFA model adequacy was tested using Weighted Least Square Means and Variance Adjusted (WLSMV). Model adjustment was tested through the fit indices (reference of expected values for each index): Chi-square ( $X^2$  and  $P$ -value), Root Mean Square Error of Approximation (RMSEA < 0.08, I.C. 90%), Tucker-Lewis index (TLI > 0.90) and comparative fit index (CFI > 0.95). These indices aim to assess whether the model shows a good fit to the data, as

proposed in the literature (Hu and Bentler, 1999; Kline, 2012). Average variance extracted (AVE) was calculated and values >0.50 were considered acceptable indicators of convergent validity (Hair *et al.*, 2005).

Both measures (AUDIT and CAGE) have been shown to be highly correlated in previous literature (Cremonte *et al.*, 2010). Thus, we tested external validity by correlating both scores. Our hypothesis was that the translated and adapted versions of the AUDIT and CAGE questionnaires to Swahili would also correlate positively, confirming the instrument's ability to behave as expected in relation to the theoretical concept. We also tested external validity by comparing AUDIT scores between injury patients reporting use of alcohol in the past 12 months and injury patients who abstained from alcohol in the past 12 months. Our hypothesis was that AUDIT would be able to differentiate groups by group comparison using Mann–Whitney with a significance of 5%.

### Reliability

Reliability is the capacity of an instrument to produce consistent results in different situations. We measured reliability with internal consistency to assess the degree to which all of the items in the

instrument refer to the same subject (Devellis, 2003). To measure internal consistency we used the Cronbach's alpha for the AUDIT and the Kuder-Richardson-20 (KR20) for the CAGE, given it is a dichotomous scale. (Kuder and Richardson, 1937) Similarly, composite reliability (CR) and McDonald's Omega coefficient were calculated using CFA results. Each coefficient has its strengths and limitations (Padilla and Divers, 2016); thus, we choose to compare indicators.

## RESULTS

### Sample characteristics

Most of the participants were male (83%), married (55%) and had some primary education (59%). The average age was 33.87 years old (SD = 13.32), with an average household size of 4.43 (SD = 2.48) individuals. Average personal monthly income among participants was 104.42 USD (Table 1). Most patients (91%) showed mild injury severity, measured by Glasgow Coma Score.

Regarding the alcohol use behavior, 55% of the participants reported having used alcohol in the past 12 months, with ~25% reporting using alcohol on a weekly basis. The majority (78%) of the sample reported consuming one or two units of drinks per drinking day, while almost all (96.3) of the participants reported using a maximum of four drinks per drinking day. Only 4%, approximately, used more than five drinks per drinking day. Relating to alcohol use prior to the injury, 26% of the patients showed positive alcohol use, assessed by the healthcare professionals at arrival to the hospital.

### Translation and adaptation

All items obtained language clarity and domain coherence coefficients above 0.80 for both questionnaires (Table 2). These findings indicate that the translated and adapted versions of the AUDIT and CAGE questionnaires are clearly understandable within Tanzanian culture, in addition to being relevant and pertinent. AUDIT and CAGE item classification agreement among judges was also above 0.80, indicating that the evaluators found the items to be consistent with the underlying theoretical conceptualization (Table 2).

**Table 1.** Sociodemographic profile of the validation sample

Variables	
Age (years), mean (SD)	33.87 (13.32)
Household size, mean (SD)	4.43 (2.48)
Monthly personal income, USD, mean (SD)	\$104.42 (100.08)
Monthly family income, USD, mean (SD)	\$155.20 (235.52)
Male, N (%)	159 (82.8)
Married, N (%)	104 (54.7)
Occupation, N (%)	
Business	44 (21.7)
Farming	41 (22.3)
Skilled worker	23 (12.5)
Salaried worker	67 (36.4)
Other	13 (7.1)
Education, N (%)	
Some primary education	112 (59.3)
Some secondary education	44 (23.3)
Some university education	33 (17.5)

**Table 2.** Reliability and confirmatory factor analysis model fit indicators

	AUDIT 1 factor model	AUDIT 2 factor model <sup>a</sup>	AUDIT 3 factor model <sup>a</sup>	CAGE
Reliability				
Cronbach's alpha (CI 95%)	0.85 (0.83;0.88)	0.64 (0.57;0.72)/0.79 (0.75;0.83)	0.64 (0.57;0.72)/ 0.64 (0.56/0.71)/ 0.65 (0.58;0.73)	0.76 (0.71;0.81)
Omega 6	0.88	0.67/0.79	0.67/0.58/0.61	0.73
Composite reliability	0.95	0.87/0.93	0.87/0.85/0.88	0.77
CFA				
$\chi^2$ (Df)/P-value	33.74 (35)/0.529	33.35 (34)/0.499	36.72 (34)/0.499	3.02 (2)/0.221
RMSEA (CI 95%)	0.00 (0.00;0.05)	0.00 (0.00;0.05)	0.00 (0.00;0.06)	0.05 (0.00;0.06)
TLI	0.99	0.99	0.99	0.98
CFI	0.99	0.99	0.99	0.99
Average extracted variance	0.66	0.69/0.66	0.69/0.66/0.64	0.47
Item thresholds range (Item #)	0.57 (1)–2.01 (8)			

<sup>a</sup>All paths significant

CFA = confirmatory factor analysis;  $\chi^2$  = chi-square; Df = degree of freedom; RMSEA = root mean square error of approximation; TLI = Tucker–Lewis index; CFI = comparative fit index.



### Internal structure

All AUDIT CFA models (one, two and three factor models) performed well, showing all items with factor loadings ranging from 0.41 to 0.71 (Fig. 1). All AUDIT models showed adequate fit indicators (Table 2). CAGE's CFA model showed adequate fit indicators and individual item reliability (Table 2 and Fig. 1).

### Reliability

Reliability were considered adequate with values above 0.80 for the unidimensional AUDIT and above 0.70 for CAGE in all reliability measurements, indicating strong internal consistency for both questionnaires (Table 2). When looking at the possible two and three dimensions structures for the AUDIT, both showed acceptable reliability values (~0.70) in all dimensions. However, reliability performance was worse than the AUDIT 1D model.

### Validity evidences

AUDIT and CAGE scores showed a strong positive correlation ( $R = 0.78$ ,  $P = 0.01$ ), showing that both tools agreed and performed as expected. Both scales also behaved as anticipated when comparing groups of drinkers and non-drinkers (Fig. 2). Group comparison showed significantly lower AUDIT scores ( $P < 0.05$ ) for participants reporting not having used alcohol in the past 12 months than those who reported alcohol use (Fig. 2).

## DISCUSSION

To our knowledge, current validation studies of AUDIT and CAGE performed elsewhere in sub-Saharan Africa have only assessed the diagnostic ability of the scales, comparing these instruments to either MINI criteria, the DSM-IV criteria or ICD-10 criteria for alcohol misuse or dependence (Claassen, 1999; Adewuya, 2005; Myer *et al.*, 2008; Chishinga *et al.*, 2011). This study incorporated an analysis of several other measures of validity and reliability relevant to provide evidence on the psychometric properties of AUDIT and CAGE. This is the first study to conduct a cross-cultural adaptation of the AUDIT and CAGE questionnaires in Swahili in Tanzania, and is also the first study to assess the validity of AUDIT and CAGE in a TBI population in sub-Saharan Africa. Both questionnaires, in their translated versions, performed as expected in unidimensional models and showed similar psychometric properties in relation to other languages and other populations. No specific modifications were needed for our TBI population, suggesting that the Swahili version of the AUDIT and CAGE can be used to evaluate alcohol use in this specific injury population.

The AUDIT questionnaire was originally designed to have three dimensions: one dealing with frequency of alcohol use, one with alcohol dependence, and one with risky behavior related to alcohol use (Saunders *et al.*, 1993). However, multiple previous psychometric analyses have shown that AUDIT's internal structure is most consistent with a 2D model (Bergman and Kallmen, 2002; Cook *et al.*, 2011). Functionally, however, the AUDIT is typically used in a unidimensional fashion, where a single total score is used to provide a global assessment of alcohol misuse. In our analysis of the internal structure of the Swahili version of AUDIT, an analysis of one, two and three dimensions models all demonstrated excellent fit, suggesting that any of these three models are acceptable. The apparent equivalence of the one, two and three dimensions models in this study may be a reflection of the close correlation between frequency of alcohol use, alcohol dependence, and risky behavior in this patient population

(Kallmen *et al.*, 2014). The CAGE questionnaire was found to have a unidimensional internal structure in our analysis, consistent with its original design (Ewing, 1984).

The AUDIT was found to have excellent internal consistency in our study (Table 1), similar to the findings of studies performed in South Africa, Zambia and Rwanda. (Young and Mayson, 2010; Chishinga *et al.*, 2011; Peltzer *et al.*, 2011; Pengpid *et al.*, 2011; Kanyoni *et al.*, 2015) CAGE also had acceptable internal reliability in our study (Table 1), similar to the value reported by in South Africa (Claassen, 1999). However, Cronbach's alpha has been repeatedly criticized in the specialized literature (Padilla and Divers, 2016); thus, results for the CR and Omega coefficients, which have shown less bias, were also calculated. Interestingly, all reliability coefficients (Alpha, CR and Omega) were consistent for both the AUDIT and the CAGE, which confirms a good reliability of the Swahili translated versions considering item-item correlation, factor loading distribution (Padilla and Divers, 2016). However, the reliability of the AUDIT's two and three factor models was not as good as the one factor model (Table 1).

In this study, AUDIT and CAGE scores were noted to be significantly higher among drinkers than non-drinker as expected, suggesting that these instruments are able to discriminate the population exposed to alcohol use. Additional research will likely be needed to compare the performance of the validated Swahili versions of AUDIT and CAGE presented here to other measures of alcohol abuse. Validation studies of AUDIT and CAGE elsewhere have assessed external validity by comparing the performance of these tools to other instruments such as the MINI criteria for alcohol abuse of the DSM-IV criteria for alcohol dependence (Claassen, 1999; Myer *et al.*, 2008; Chishinga *et al.*, 2011). No such comparison was performed in this study, partly because there is no clear gold standard tool for measuring alcohol misuse and so any such analyses of areas under the curve would be difficult to interpret.

Results of this study should be taken in context of its limitations. One limitation is related to our sample. The participants in this study were drawn from a sample of patients participating in a TBI registry and longitudinal cohort who were able to respond to survey questions. Such sampling allowed for validation of the AUDIT and CAGE questionnaires in a TBI population; since TBI is the leading cause of death and disability due injury at our hospital, this is an important first step in understanding the interplay between alcohol use and traumatic injury in Tanzania. While our population is composed of mostly mild TBI patients, this represents the majority of patients treated at our hospital, and those who will survive with good function; this resource limited setting with extensive access to care issues is typical for other low and middle income referral hospital settings (Staton *et al.*, 2017). However, the TBI population is unlikely to be representative of the entire adult Tanzanian population; therefore, additional research will be needed to validate AUDIT and CAGE in a more diverse patient population before using these tools in other Tanzanian groups.

Similarly, in Tanzania and globally, both alcohol use as well as TBI in Tanzania disproportionately affects males which is reflected in our unbalanced sample. Therefore, although it has been previously reported that gender influences the performance of the AUDIT and CAGE (de Meneses-Gaya *et al.*, 2009; Staton *et al.*, 2017 Tanzania: challenges and the way forward), we were not able to gather enough patients to compare across gender. Generalization in the usage of the scale should be considered carefully when applying to gender based comparisons. Further studies should look into the influence of gender in the performance of Swahili translated AUDIT and CAGE. A second limitation of this study is the absence of

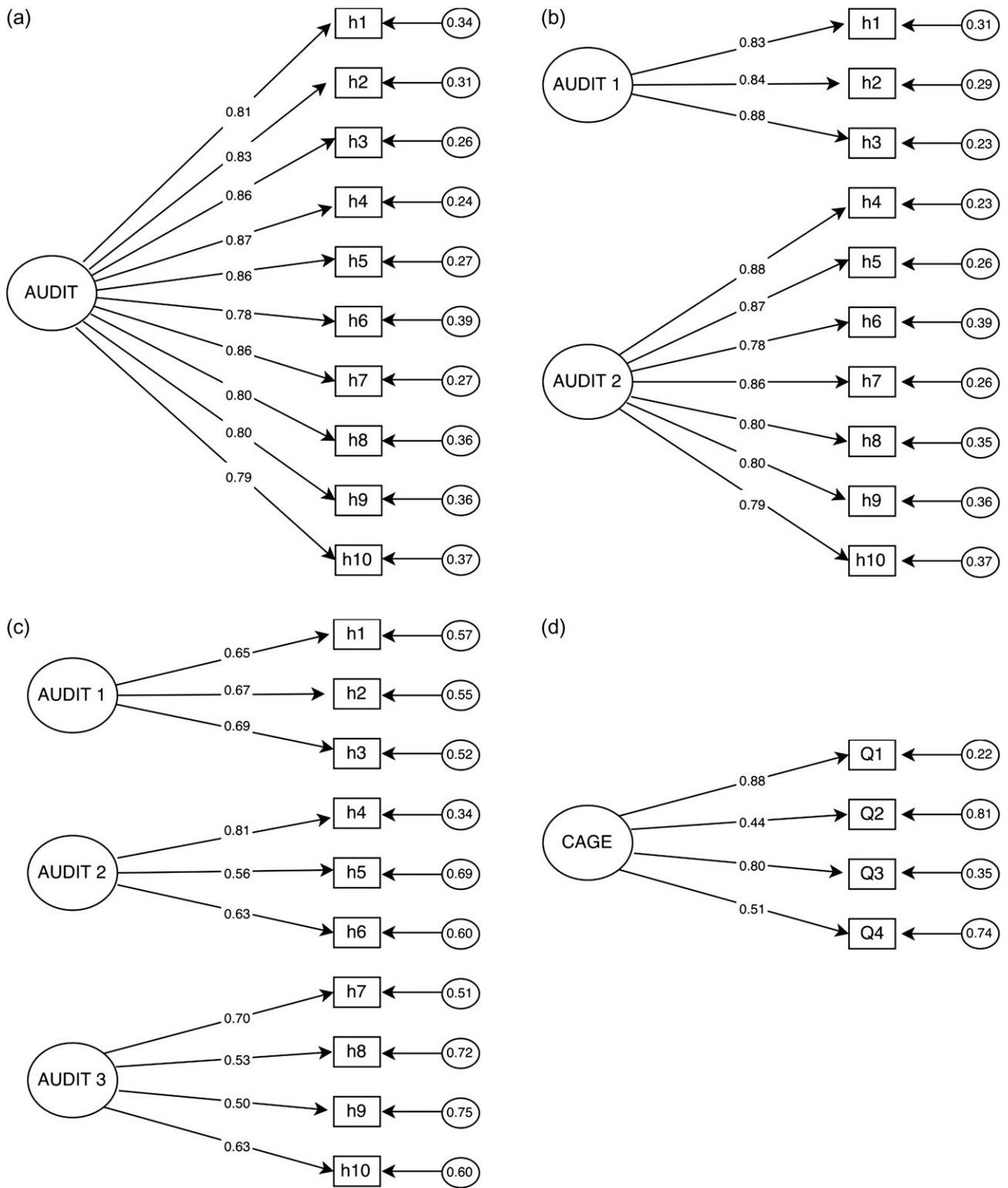


Fig. 1. Confirmatory factor analysis diagram, factor loadings for the AUDIT's (a) one factor model, (b) two factor model, (c) three factor model and CAGE (d) one factor model.

criterion validity analysis in our study, which would have allowed for a calculation of sensitivity and specificity and cutoff points of the validated instruments presented here. Tanzania, currently, has no psychiatric human resources available to support an adequate DSM-IV

screening, or to train healthcare providers to do so. As a step to a broader project about the psychiatric assessment of substance use, this project aimed specifically at evaluating the translation and adaptation of the AUDIT and CAGE to Swahili. Assuring that the

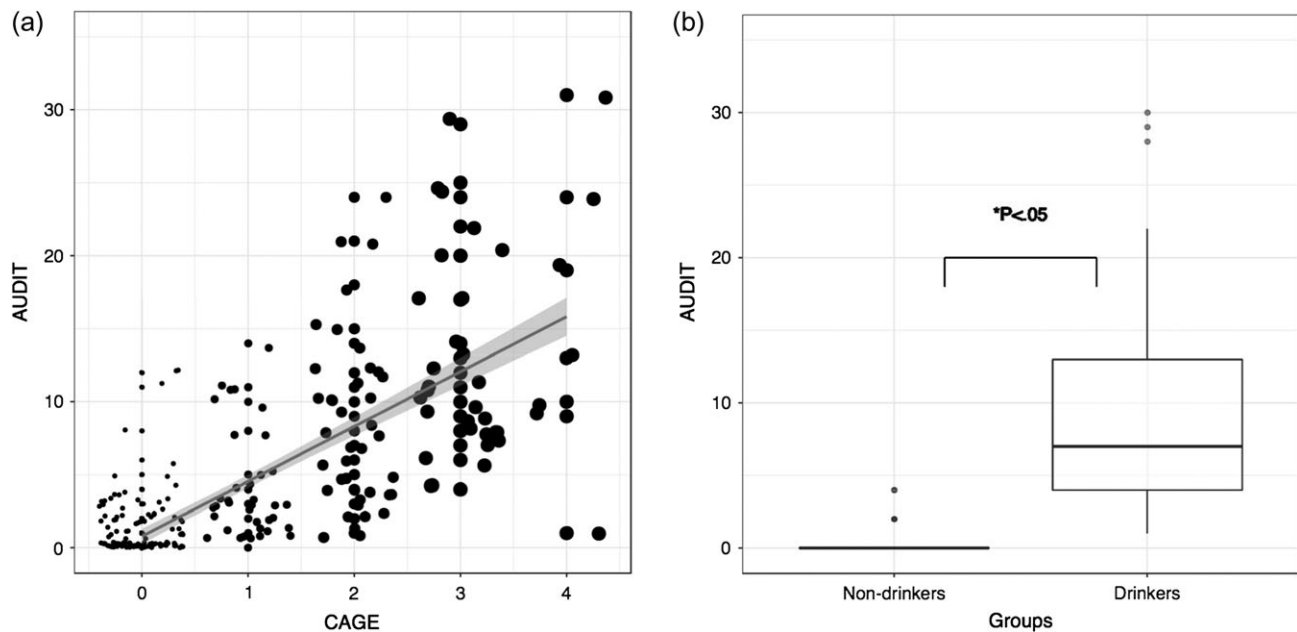


Fig. 2. Correlation between AUDIT score and CAGE and known group comparison.

current version of the instruments are psychometric adequate, we suggest that the criterion validity should be the subject of future work. A third limitation refers to our sample's post injury cognitive functioning. We could not find a validated measurement of cognitive functioning to Swahili and Tanzania, which would be a full project on its own. Our sample was enrolled with informed consent, therefore requiring decision making capacity and cognitive functioning. While for some patients we used legal authorized representative's consent, those patients ultimately regained capacity to consent as determined by their healthcare provider and were enrolled. Therefore, our sample represents mostly mild injury patients (Table 1). But, this pattern is also representative of those who survive an injury in a limited resource setting, as well as those who would be most likely to have persistent harmful alcohol use behavior (Staton *et al.*, 2017).

In conclusion, this article presents the first validation of Swahili versions of AUDIT and CAGE for TBI patients in Tanzania. These instruments provide clinicians, researchers and public health officials with a rigorously validated tool to evaluate the prevalence of alcohol misuse in Tanzania and measure its effects on health outcomes. Such data could help drive evidence-based interventions to reduce alcohol-related morbidity and mortality and shape policy. Additional research is needed to validate the AUDIT and CAGE tools in a wider Tanzanian population as well as to establish specific cutoff values for defining alcohol misuse for both instruments in Tanzania. Although this study addressed the need for Swahili versions of AUDIT and CAGE in Tanzania, there are many other languages and communities in which validated versions of these questionnaires are still lacking. Clearly, more research is needed to develop validated translations of these tools in other languages and in other settings across sub-Saharan Africa.

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## CONFLICT OF INTEREST STATEMENT

None declared.

## AUTHOR CONTRIBUTIONS

J.R.N.V. and C.A.S. thought of the scientific basis and rationale for this project. J.R.N.V., J.H. and D.E. were responsible for the writing, literature review and article preparation. C.A.S. and M.M. supervised the manuscript preparation. B.T.M. and M.M. were responsible for data collection. J.R.N.V., J.R.A., L.P.O. and J.F.C. contributed to the data analysis interpretation of the results. All authors critically reviewed the contents and approved the final version of the article.

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