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Auditing the AUDIT: A systematic review of cut-off scores for the Alcohol Use Disorders Identification Test (AUDIT) in low- and middle-income countries*

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Highlights

- Several studies in LMICs use non-recommended AUDIT cut-off scores
- Most such cut-off scores have not undergone psychometric validation
- A range of AUDIT cut-off scores appear to be suitable based on cultural context

Abstract

Introduction: The World Health Organization's (WHO) Alcohol Use Disorders Identification Test (AUDIT) is used extensively across the world, with cut-off scores recommended by the WHO. We reviewed the use and validity of AUDIT cut-off scores in low- and middle-income countries as cultural contexts are expected to influence the detection of alcohol use disorders.

Materials and Methods: The systematic review was guided by an a priori defined protocol consistent with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement. We searched Cochrane library, Medline, EMBASE, PsycINFO, CINAHL, Indmed, LILACS, and AJOL databases using appropriate search terms. We conducted a narrative synthesis of the data.

Results: We identified 54 distinct studies that used AUDIT cut-off scores which were not in alignment with those recommended by the WHO. India (n=10), Nigeria (n=9), and Brazil (n=9) produced most of these included studies. Most of the studies (n=42) did not conduct psychometric evaluations of AUDIT cut-off scores. Of the twelve studies which did report psychometric results, a wide range of cut-off scores performed well. In these studies the cut-off

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scores to detect hazardous drinking ranged from >3 to >5, for harmful drinking from >5 to >16, and for dependent drinking from >7 to >24.

Discussion: AUDIT is being widely used in LMICs and non-recommended cut-off scores are considered to be appropriate in these countries. It is important to systematically evaluate the psychometric properties of those cut-off scores to ensure the internal validity of the studies in which they are used.

Keywords: Alcohol Use Disorders Identification Test (AUDIT), Alcohol Use Disorders, Psychometrics, Low- and Middle-Income Countries, Systematic review

1. Introduction

The Alcohol Use Disorders Identification Test (AUDIT) was developed by the World Health Organization (WHO) as a tool to screen for alcohol use disorders (AUD) in various populations (Saunders et al., 1993). It is used to detect both AUD (harmful and dependent drinking) and at-risk alcohol consumption (hazardous drinking). This capability is one of its major advantages in comparison to other screening instruments, which generally focus only on harmful and dependent drinking (Gordon, 2006). Since it was first published, the AUDIT has been translated into many different languages and has been validated in different settings (Meneses-Gaya et al., 2009a). Over the years, the AUDIT has also been used extensively in clinical and epidemiological research across the world (Berner et al., 2007).

The 10-item AUDIT assesses three conceptual domains: alcohol intake (items 1–3), dependence (items 4–6), and adverse consequences (items 7–10). The AUDIT is scored by summing the values associated with the various response options, and scores can range from 0 to

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40. A range of cut-off scores for the AUDIT have been proposed to identify AUD. The generally accepted cut-off score of >8 provides good sensitivity to detect AUD, but a cut-off score of >10 offers better specificity (Babor et al., 2001). Furthermore, lower cut-off scores have been recommended for special populations or for when the focus of the screening is on at-risk alcohol consumption (Reinert and Allen, 2007). The WHO recommends the following scores for categorization of AUD: hazardous drinking (8-15), harmful drinking (16-19), and dependent drinking (>20) (Babor et al., 2001). The AUDIT is intended to assist clinicians to make decisions about management of AUD and any non-validated changes to the recommended cut-off scores could potentially affect the ability of the tool to accurately identify people with AUD. Any resultant changes in the sensitivity or specificity of the AUDIT has the potential of reducing the efficiency and utility of the tool in routine clinical care

Studies from high income countries (HICs) have recommended a range of AUDIT cut-off scores for their settings: >13 for alcohol dependence in France (Gache et al., 2005), >5 for AUD in Germany (Dybek et al., 2006), >3 and >10 for hazardous drinking and AUD respectively in Republic of Korea (Kim et al., 2014), and >10 and >17 respectively for harmful use and dependence in Australia (Degenhardt et al., 2001). The AUDIT has been translated into several languages, but only a few of these translations (e.g. Korean, Chinese, Tibetan) have been adapted to take into account local variations in standard drink sizes or national recommendations regarding safe drinking levels (Babor and Robaina, 2016). An example of such an adaptation is the U.S. AUDIT, in which the first three questions have been adjusted for the standard U.S. drink size (14 grams), the number of response alternatives in questions 1 to 3 have been expanded, and the wording of question 3 has been modified (Higgins-Biddle and Babor, 2018).

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There are a number of issues regarding the use of AUDIT which require further examination. The cultural views of AUD are influenced by prevailing norms in the society and hence there could be a cross-cultural difference in the threshold for the identification of disorders relating to the use of alcohol. A number of core concepts underpinning the diagnosis of AUD have no equivalents in the local languages of various cultures, while other aspects lack cultural applicability because they do not reflect cultural and ethnic norms of drinking (Gureje et al., 1997). An example of the latter is item 10 of the AUDIT questionnaire, which asks about other people expressing concern about one's drinking. In some cultures, comments on others' drinking behavior are very common and are not considered an adequate indicator of pathological drinking behavior (Smit et al., 2006). Furthermore, populations may also vary genetically, resulting in different alcohol tolerances and hence different trajectories to development of AUD (Edenberg, 2007).

Standardized instruments, such as the AUDIT, allow for comparison of findings across cultures and countries. However, standardized instruments that reflect a mainstream culture, when used in disparate cultural groups, also run the risk of measurement errors if the instruments lack cultural relevance. This issue raises several questions about the appropriateness in low- and middle- income countries (LMICs) of the cut-off scores recommended by the WHO, especially considering that these scores are not appropriate even in some HICs, as described above. The aim of this review is to examine the use of non-WHO-recommended AUDIT cut-off scores in LMICs, including the psychometric properties of these cut-off scores.

2. Materials and Methods

This systematic review was guided by an a priori defined protocol consistent with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement

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(Moher et al., 2009) and registered on PROSPERO (CRD42016042757). The following electronic databases were searched: Cochrane library, Medline, EMBASE, PsycINFO, Global Health, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Indmed (database of peer reviewed medical journals published from India), Literatura Latino Americana em Ciências da Saúde (LILACS-index of scientific and technical literature of Latin America and the Caribbean), and African Journals OnLine (AJOL- online library of peer-reviewed, African-published scholarly journals).

The search was conducted using appropriate search terms under the following concepts: AUDIT (e.g. AUDIT, Alcohol Use Disorder Identification Test), alcohol use and alcohol use disorders (e.g. alcohol drinking, hazardous drinking), psychometrics and context of use (e.g. validity, reliability, screening), and LMICs (e.g. developing countries, names of all LMICs as classified by the World Bank). The search strategy that we used for Medline is presented in Supplementary Material*, and it was adapted as needed to meet the unique requirements of the other databases.

NM conducted the search in June 2016, and NM and MI piloted the eligibility criteria and data extraction tool by applying them to the search returns. Subsequently, SK and AN independently assessed the titles and abstracts of the studies identified through the search of the electronic databases. If the title and abstract did not offer enough information to determine inclusion, the full paper was retrieved to ascertain whether it was eligible for inclusion. SK and AN then discussed their independent selections and arrived at a final list of eligible papers. AN inspected the reference lists of eligible papers and relevant reviews to include additional eligible

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papers that were not retrieved by the search of the electronic databases. AN also conducted a forward search on Web of Science using the eligible papers to identify studies which might have been missed in the original electronic database search and to identify eligible studies which cited any of the included papers. Finally, AG repeated the search in July 2018 to identify any studies that were published after the original search in 2016.

2.1 Eligibility Criteria

There were no restrictions on year of publication, gender, and age of the participants. Only English language publications and studies conducted in LMICs were included. Randomized control trials (RCTs), observational studies, case reports, and case series were included. Qualitative studies and any study which used a non-validated adaptation (i.e. changes made to the original tool but not psychometrically tested) of the AUDIT questionnaire were excluded. Only studies which used AUDIT cut-off scores which were different from those recommended by the WHO, and/or tested the psychometrics of AUDIT cut-off scores which were different from those recommended by the WHO were included.

2.2 Data Extraction and Analysis

Following PRISMA guidelines, a record was made of the number of papers retrieved, the number of papers excluded and the reasons for their exclusion, and the number of papers included. A data extraction form was designed for the papers, and included information such as the AUDIT cut-off scores, psychometrics of the cut off score, setting, sample description, study design, control, and results of the included studies. SC and SW independently extracted the data and any disagreements about extracted data were discussed and resolved. AN supervised the data extraction process. Lastly, AG conducted a narrative synthesis of the data by examining the extracted data and identifying common as well as deviant themes across studies.

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3. Results

Fifty-seven papers (Table 1) were included in this review by using a multi-step process to identify eligible studies (Figure 1). We identified 722 papers at the end of the electronic database search. After excluding 157 duplicates we were left with 565 unique papers. We screened the abstracts of all these papers and excluded 301 which were not relevant to the aims of our review. We reviewed the full-texts of the remaining 264 papers and excluded 207 for the following reasons: non-English papers (n = 92), used WHO recommended cut-off scores (n = 71), full text was inaccessible (n = 23), and cut-off scores were not mentioned (n = 21). Five papers (Meneses-Gaya et al., 2010a; Meneses-Gaya et al., 2010b; Nadkarni et al., 2017a; Nadkarni et al., 2017b; Patel et al., 2014) were derived from only two studies, and as such will be considered as only two studies for the remainder of the analysis i.e. 54 distinct studies were included in this review. Most of these 54 studies were conducted in Africa (n=21), followed by Asia (n=17) and South America (n=13); the remainder were conducted in Europe (n=2) and Mexico (n=1). India (n=10), Nigeria (n=9), and Brazil (n=9) produced most of the included studies.

Most studies were conducted in community settings (n=26), followed by tertiary care facilities (n=12). Communities included, but were not limited to, schools/colleges (e.g. Domingues and Domingues, 2011; Strunin et al., 2013), urban areas (e.g. Ansoleaga et al., 2013; Chen et al., 2013), households (e.g. Kanyoni et al., 2015), slums (e.g. Ghosh et al., 2012), and villages (e.g. Jonas et al., 2014). Tertiary care facilities included, among others, infectious disease hospital units (e.g. Goar et al., 2011) and specialized HIV clinics (Farley et al., 2010; Luna et al., 2014; Parry et al., 2014). The rest were conducted in primary care (n=7) or secondary care (n=12) facilities such as primary health care clinics (e.g. Luitel et al., 2018) and outpatient clinics (e.g. Yee et al., 2014), respectively. Some studies combined settings, as in the case of one

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study which recruited participants from both the community (throughout St. Petersburg) and tertiary care facilities (i.e. addiction care sites) (e.g. Lasser et al., 2018). The majority of studies were cross-sectional (n=48); the remainder were cohort studies (n=3) and randomized controlled trials (n=3).

Sample sizes in the studies ranged from 52 participants (Yee et al., 2014) to 12,781 (Ansoleaga et al., 2013). The median sample size was 337 participants. Most studies had samples of both men and women (n=38), but 12 studies investigated only one gender: four with all-female samples (Chen et al., 2013; May et al., 2018; Nöthling et al., 2013; Vythilingum et al., 2012) and eight with all-male samples (Dasgupta et al., 2013; Endsley et al., 2017; Ghosh et al., 2012; Ludford et al., 2013; Martins et al., 2012; Nadkarni et al., 2017a; Nadkarni et al., 2017b; Nayak et al., 2009; Pal et al., 2007; Patel et al., 2014). Four studies did not describe the gender distribution of their samples (Farley et al., 2010; Guo et al., 2008; Parry et al., 2014; Pinheiro et al., 2006).

The majority of the included studies did not measure psychometric properties of the AUDIT cut-off scores that were used (n=42 studies, 77.8%) (Table 2). All of these studies used at least one cut-off score that did not align with the WHO's recommendations, but these modified cut-off scores were not tested for psychometric properties. However, some studies modified their specified cut-off scores according to prior validation studies. For example, one study used cut-off scores of >8 to detect "probable drinking problems" and of >13 to detect "probable alcohol dependence" (Chen et al., 2013). These scores were consistent with a prior validation study (Saunders et al., 1993). As demonstrated here, many studies—both those that did and did not use the WHO's recommended cut-off scores—revised the WHO's terminology of AUD categories (hazardous, harmful, and dependent) it was measuring such that it was

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impossible to verify if the scores were used consistently across studies (n=8, e.g. "alcohol use in excess of low risk" (Sau, 2017)). Without psychometric validation and because the included research used such widely different terminology, the AUDIT cut-off scores that these 42 non-validation studies used could not be readily evaluated.

Of the 54 distinct studies, 12 were validation studies (Table 3). These 12 studies used a wide range of AUDIT cut-off scores to detect different levels of drinking. Cut-off scores to detect hazardous drinking ranged from >3 to >5, for harmful drinking from >5 to >16, and for dependent drinking from >7 to >24. Nearly all of these studies used at least one cut-off score lower than those recommended by the WHO (n=10). Additionally, one-third of these validation studies recommended different cut-off scores based on gender (n=4). Many of these validation studies (n=8), much like the studies that did not conduct validation of the cut-off scores they used, replaced the WHO's terminology for AUD categories with other terminology (e.g. "alcohol abuse," "alcohol use disorder," "potential alcohol abuse," and "binge drinking"). This non-standard terminology again precluded subsequent synthesis of these results. Only some of the validation studies clearly defined what a "standard drink" was for their study. This varied greatly- 10 grams ethanol (Pradhan et al., 2012; Guo et al., 2008), 13 grams ethanol (Santis et al., 2009), and 13.5 grams ethanol (Adewuya, 2005). Few studies explicitly described a standard drink in terms of local alcohol beverages (e.g. one standard drink as 300-330 ml of self-brewed highland barley wine, Guo et al., 2008; Endsley et al., 2017).

Of the four studies which included both psychometric data and standard terminology, no cut-off scores clearly outperformed the rest. For hazardous drinking, all of the included cut-off scores (>3 to >5 yielded psychometric results which ranged from 93.5% to 96.2% for sensitivity, from 63.3% to 91.5% for specificity, from 58.1% to 89.3% for Positive Predictive Value [PPV],

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and from 94.8% to 96.9% for Negative Predictive Value [NPV]). For harmful drinking, a cut-off score of >7 or >8 in two studies-Adewuya (2005) and Tsai et al. (2005), respectively- displayed better psychometric properties (90.0% sensitivity, 86.2% specificity, 47.4% PPV, 98.4% NPV in Adewuya (2005); 96% sensitivity, 85% specificity, 85% PPV, 96% NPV in Tsai et al., (2005)) than a lower cut-off score of >5 (75% sensitivity, 64.5% specificity, 45% PPV, 87% NPV; Santis et al. (2009)). One study from India found that an even higher score of >16 for harmful drinking yielded the highest psychometric results within the study (85.3% sensitivity, 89.4% specificity; Pal et al. (2004)). Dependent drinking was measured with the widest range of cut-off scores (>7 to >24), and all but a cut-off score of >7 (with sensitivity 63.6%, specificity 75%, PPV 46.7%, NPV 85.7%; Santis et al. (2009)) yielded generally high psychometric properties (sensitivity ranged from 81 to 100%, specificity from 28.6 to 94.1%, PPV from 20 to 89.3%, and NPV from 85.7 to 100%). Overall, a wide range of AUDIT cut-off scores performed well across studies. Notably, many of these included cut-off scores were lower than those recommended by the WHO. Although the validation studies used a wide variety of assessment instruments to generate reference diagnoses for the studies, almost all of those were standardized tools. This was a particular strength of those studies as accurate identification of the reference diagnosis is of critical importance in validation studies. For more details on the psychometric properties associated with different AUDIT cut-off scores, please refer to Table 3.

4. Discussion

Our review aimed to examine the ways in which the AUDIT has been used in LMICs, specifically the use of contextualized cut-off scores. Our search yielded 57 relevant results with heterogenous study designs, samples, and contexts.

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One major finding was the lack of psychometric data on the AUDIT cut-off scores used in most of the studies. Even though many of these studies cited past studies which validated these cut-off scores, they rarely cited studies that took place in the same socioeconomic and cultural contexts. For example, a study of female sex workers in Guangxi, China (Chen et al., 2013) cited a validation study that took place across many countries (Australia, Bulgaria, Kenya, Mexico, Norway, and the US), but did not include China or even any other Asian country (Saunders et al., 1993). The geographical and cultural diversity of these settings renders such comparisons weak, as prior research has suggested that the same cut-off scores on the AUDIT do not function equally well across cultures or populations (Berner et al., 2007; Cherpitel et al., 2005). Therefore, these cut-off scores, even when previously validated in prior studies, could not be properly evaluated for their applicability and validity in the studies at hand.

One major barrier to synthesizing the data about AUDIT cut-off scores was the diversity of terminology used to describe different categories of AUD. This inconsistent terminology, something that has historically plagued AUD research, was common across many studies, regardless of whether these studies measured psychometrics. Although the WHO recommends cut-off scores that will detect hazardous, harmful, and dependent drinking, many research studies replaced these terms with others such as “low risk” use or “binge drinking”. Without the use of standard terminology, it is impossible to determine whether the AUDIT cut-off scores are measuring the same constructs across studies, thereby limiting their cross-comparability.

Our most critical finding is that nearly all the AUDIT cut-off scores reported in these validation studies were lower than those recommended by the WHO. This finding suggests that the original recommendations maximized specificity at the price of sensitivity, and that dropping these cut-off scores further will tend to identify more people at risk of AUD. Only 10 studies

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included in our review used WHO's standardized terminology and examined psychometric data about AUDIT cut-off scores. There was a range of cut-off scores with relatively adequate psychometric properties across these studies, and the variability is most likely a product of the different cultural contexts in which these studies took place. Past research has suggested that the AUDIT must be culturally adapted because of the varying definitions across cultures of standard drinks, hazardous or heavy drinking, genetic differences between cultural groups, and so on (Edenberg, 2007; Smit et al., 2006). One reason for this could be that a tool like the AUDIT cannot be assumed to work in the same way across cultures, given that substance use varies due to varying social expectations and prevailing laws (Gureje et al., 1996). For example, one study included in this review (May et al., 2018) identifies binge drinking on Friday and Saturday nights among women of childbearing age as a drinking pattern common in South Africa, but not necessarily universally. Hence, screening tools might not function in a similar manner given varying drinking patterns. Another example of contextual differences in the constructs around alcohol use is the definition of a standard drink. For example, 8 grams of pure ethanol in the United Kingdom is a standard drink, while it is 14 grams in the United States. These varying definitions likely contribute to the diversity of cut-off scores. The WHO AUDIT handbook itself recommends that the tool's cut-off scores be adjusted according to "national or cultural standards," albeit without further exploring these standards (Meneses-Gaya et al., 2009b) or recommending processes for making the adjustments. Furthermore, this recommendation is not particularly helpful in countries which do not have standard drink measurements or indeed have poorly established cultural norms around drinking behaviours. Thus, our finding that different cut-off scores work well in different cultural contexts is consistent with past literature on the AUDIT.

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Finally, several studies included in this review (n=9) used different AUDIT cut-off scores based on gender. Although WHO recommendations do not explicitly encourage gender-based cut-off scores, addictions literature emphasizes the importance of making these distinctions when using the AUDIT (Aalto et al., 2006). Much as drinking patterns vary across cultures, so too can drinking patterns and their impact vary across genders (Holmila and Raitasalo, 2005). Thus, future studies should continue to examine differences in psychometrics of the AUDIT based on gender. Existing studies which examine psychometrics but without mixed samples (e.g. Endsley et al. (2017); Nayak et al. (2009)) should be interpreted carefully, as cut-off scores which yield robust psychometric data in samples of only men may not be generalizable to women and vice versa.

Our review was limited by our inclusion criteria. We excluded non-English-language studies and grey literature, which could mean that we did not cover all relevant data. The former limitation may be particularly significant considering that our review focuses on LMICs, which likely produce research in non-English languages.

Our review's major strength lies in its originality: to date, no systematic review has been conducted to comprehensively investigate the way in which the AUDIT has been used and adapted in LMICs. Although such studies exist in high-income countries, these findings cannot be generalized to the LMIC context. LMICs experience a different set of health-related problems and a dearth of health-related resources with which to tackle these problems. Thus, reviews such as this one, which focus exclusively on LMICs, are imperative in supporting contextually informed research.

Our review underscores the large gap in psychometric data regarding AUDIT cut-off scores in LMICs. It highlights the clear need for more rigorous testing of the AUDIT tool across

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cultural contexts and in mixed-gender samples, given how sensitive the tool is to demographic differences. Thus, the AUDIT should preferably be adapted if needed and validated every time it is used in a new context that is not comparable to any previous applications of the tool. These cultural adaptations of the tool are hugely important because without them, alcohol-related issues could be under-reported or mis-reported in LMICs—where these issues are becoming increasingly common and debilitating (Caetano and Laranjeira, 2006). It is only with rigorously validated screening measures that we can develop a fuller picture of the nature of alcohol-related problems in LMICs and begin to help those suffering from these problems. Furthermore, the AUDIT must be evaluated separately by gender and age (e.g. adolescents, elderly), as both these conditions will most likely affect the psychometric properties of the tool.

Our review has highlighted the large gap in research regarding the psychometrics and application of the AUDIT in LMICs. This gap points us to two vital next steps: first, more research must be conducted in LMICs to test the psychometrics of AUDIT cut-off scores in different cultural contexts, as the wide range of results found in this study suggest that the recommended AUDIT cut-off scores are not universally generalizable. Second, standard terminology must be used to describe different levels of drinking (i.e. the WHO's suggestions of hazardous, harmful, and dependent) such that psychometric studies can be more readily compared.

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Contributors

Each author of the manuscript has contributed to one or more of the following: design, leadership, conceptualization of the paper, drafting the search strategy, running the search, screening the search returns, data extraction, synthesis of data, and writing up of the findings; and commenting on the drafts of the manuscript. All authors have read and approved the final manuscript.

Contributors

This is to declare that each author of the mar1uscript has contributed as outlined below. Abhijil Nadknrni conceived and led the study, conceived the paper, screened the search returns and wrote the introduction and methods, and commented on the first draft and subsequent revisions. Alison Garter synthesized the data and wrote the first draft and subsequent revisions of the results and discussion, Shaina Costa and Sheena Wood extracted the data and commented on the draft manuscript. Sonali Kumar screened the search returns in parallel with Abhij Nadkami, and commented on the draft manuscript. Natahalie MacKinnon and Mariam Ibrahim piloted the search strategy, eligibility criteria and data extract on tool. Both commented on the draft manuscript. Richard Velleman, Godwin Fernandes, Urvita Bhatia, Benedict Weobong, and Anil Rane contributed to the review protocol, and commented on the draft of the manuscript. All authors read and approved the final manuscript.

Conflict of Interest

No conflict declared

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Figure Legend

Fig 1: Flow diagram of process leading to selection of papers for the review.

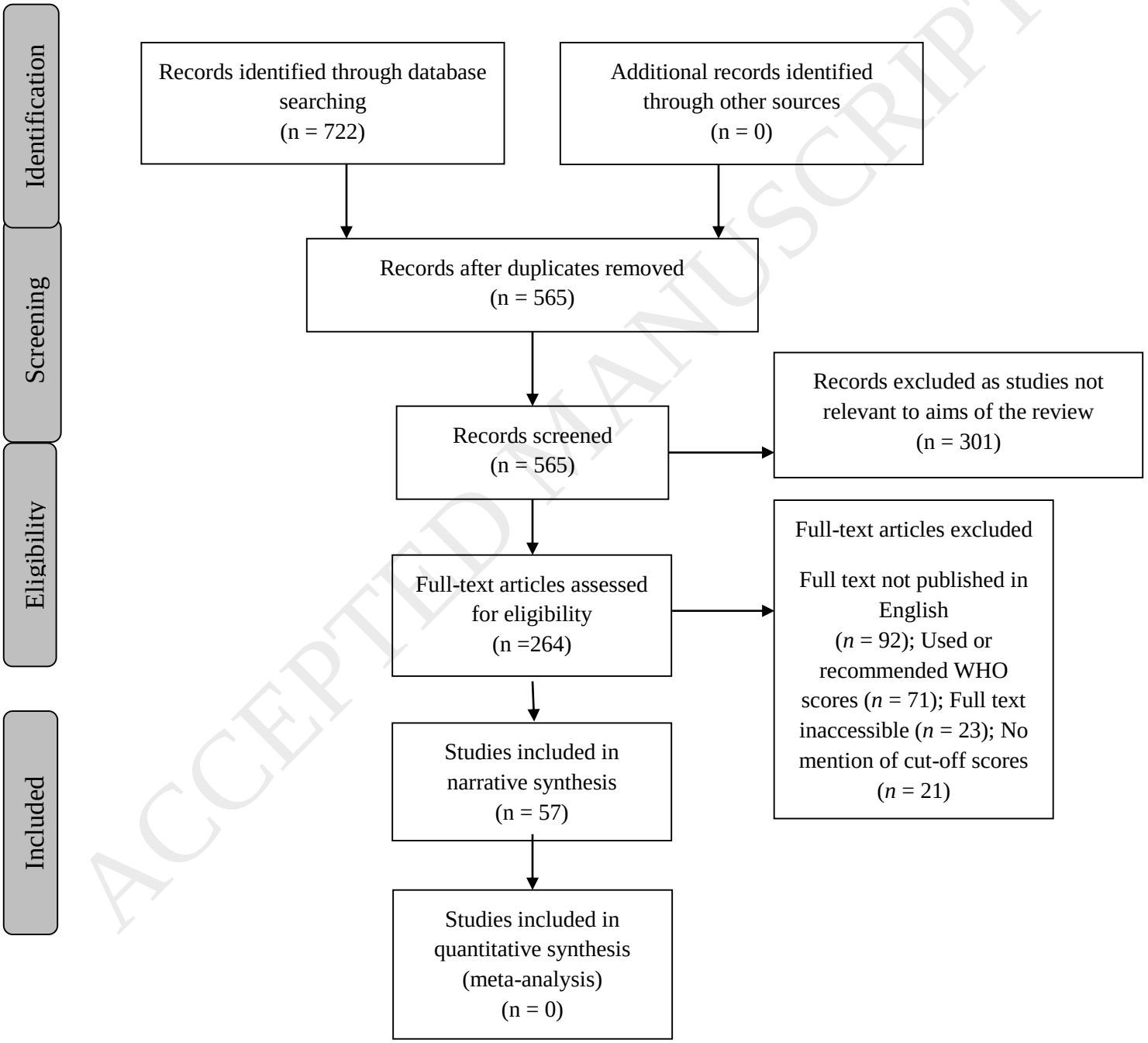

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Table 1: Studies included in the systematic review

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Author (Year)	Country	N	Sample	Setting	Study design
Blair (2017)	Uganda	1720	M 756 (44.1%); F 957; age range 13-52, median age 27	Community	Cohort
Kanyoni (2015)	Rwanda	2479	Youth (14-35 years); M 1388 (56.0%); F 1091; A 23.2 years	Community	Cross-sectional
Abayomi (2013)	Nigeria	443	Male (M) 291 (65.7%); Female (F) 152; Mean age (A) 21 (Range 14-28) years	Community (University)	Cross-sectional
Adewuya (2005)	Nigeria	248	M 181 (73.0%); F 67; A 22.5 years	Community (University)	Cross-sectional
Brisibe (2011)	Nigeria	322	M 166 (51.6%); F 156; A 41.4	Community	Cross-sectional
Farley (2010)	Nigeria	399	HIV-infected adults in a HIV care program	Tertiary care	Cross-sectional
Goar (2011)	Nigeria	160	Patients being treated for HIV/AIDS at an infectious disease unit of hospital in a major city; M 57 (35.6%); F 103; A 35.6 years	Tertiary care	Cross-sectional
Gureje (1992)	Nigeria	787 (Stage 1); 214 (Stage 2)	Patients at outpatient clinic, Stage 1: M 386 (49%); F 401; Stage 2: M 107 (50%); F 107	Secondary care	Cross-sectional
Issa (2012)	Nigeria	241	Doctors at a teaching hospital; M 182 (75.5%); F 59	Tertiary care	Cross-sectional
Obadeji (2015)	Nigeria	122	Doctors at a teaching hospital; M 97 (79.5%); F 25; A 35.65 years	Tertiary care	Cross-sectional
Olisah (2009)	Nigeria	120	Patients with HIV/AIDS attending an outpatient virology clinic; M 78 (65%); F 42; A 32.4 years	Secondary care	Cross-sectional

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Chishinga (2011)	Zambia	649	Patients attending Tuberculosis (TB) or Anti Retroviral Treatment (ART) clinic; M 363 (55.9%); F 286; median age 33 years	Primary care	Cross-sectional
Ndetei (2009)	Kenya	2770	Patients admitted in general medical facilities; M 1186 (42.8%); F 1584; age range 18 - 90 years	Primary, secondary and tertiary care	Cross-sectional
Nakhli (2011)	Tunisia	266	University students; M 152 (57.1%); F 114; A 21.2 years	Community	Longitudinal
Adams (2013)	South Africa	143	M 70 (49.0%); F 73; A 21.6 (18-25) years	Community	Cross-sectional
May (2018)	South Africa	193	Pregnant women	Primary care	Cross-sectional
Nothling (2013)	South Africa	70	70 mother-child dyads infected with HIV; A 28.8 (range 16–64) years	Primary care	Cohort
Parry (2014)	South Africa	260	HIV positive patients on ART in ART clinics; hazardous/harmful drinkers	Tertiary care	RCT
Simbayi (2004)	South Africa	257	Patients receiving services at STI clinic; M 149 (58.0%); F 78; A 27.5 years	Secondary care	Cross-sectional
Simbayi (2006)	South Africa	226	Patients receiving services at STI clinic; M 134 (59.3%); F 92; Median age 26 years	Secondary care	Cross-sectional
Vythilingum (2012)	South Africa	323	Adult women presenting to their first antenatal visit at midwife obstetric units; A 24.6 years	Tertiary care	Cross-sectional

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Luitel (2017)	Nepal	1983	M 703 (39.9%); F 1280; A 39.8 years	Community	Cross-sectional
Luitel (2018)	Nepal	1474	M 504 (34.2%); F 970; A 39.4 years	Primary care	Cross-sectional
Pradhan (2012)	Nepal	1068	Patients attending outpatient department of a university hospital; M 587 (55%); F 481; A 47.9 years in males and 47.5 years in females	Secondary care	Cross-sectional
Dasgupta (2013)	India	105	M 105 (100%); A 30-39 years (85.7%)	Community	Cross-sectional
D'Costa (2007)	India	1567	Private general practice attendees; M 338 (41%); F 597	Primary care	Cross-sectional
Endsley (2017)	India	600	Adult males, A 32.7	Community	Cross-sectional
Ghosh (2012)	India	228	Males living in slums; A 31.4 years	Community	Cross-sectional
Jonas (2014)	India	4711	Villagers in rural area; M 2191 (46.5%); F 2520; A 49.5 (30–95) years	Community	Cross-sectional
Nadkarni (2017a, 2017b); Patel (2014)	India	377	Adult males (18-65 years), A 42 years	Primary care	RCT
Nayak (2009)	India	1043	Urban and rural males	Community	Cross-sectional
Pal (2004)	India	297	Patients at either a de-addiction center or a community outreach clinic who had used alcohol in the past year, M 294 (99%); F 3; A 38.1 years	Secondary and tertiary care	Cross-sectional
Pal (2007)	India	90	Males with problematic alcohol use; A 29.7 years	Community	Randomised controlled trial (RCT)
Sau (2017)	India	99	M 54 (54.5%); F 45; A 38.62 years	Community	Cross-sectional
Chen (2013)	China	983	Urban female sex workers; A 24.42	Community	Cross-sectional

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Guo (2008)	China	3171	A 43.8 years	Community	Cross-sectional
Tsai (2005)	China	112	Inpatients from gastro-enterology wards at a medical research center; M 78 (69.9%); F 34; A 49.9 years	Tertiary care	Cross-sectional
Yee (2014)	Malaysia	52	Psychiatric patients who consume alcohol, at psychiatric outpatient clinics; M 51 (98.1%); F 1; A= 40.1 years	Secondary care	Cross-sectional
Sekulic (2012)	Bosnia and Herzegovina	1032	M 435 (42.2%); F 597	Community	Cross-sectional
Lasser (2018)	Russia	351	M 219 (70.9%); F 132; A 33.5 years	Community and tertiary care	Cross-sectional
Domingues (2011)	Brazil	398	Medical students; M 174 (43.7%); F 224; A 20.7 years	Community	Cross-sectional
Luna (2014)	Brazil	200	HIV-infected patients in a specialized clinic for HIV care; M 133 (66.5%); F (67); A 37.4 years	Tertiary care	Cross-sectional
Machado (2014)	Brazil	82	Hepatitis C-infected patients in outpatient clinic for viral hepatitis, M 52 (63.4%); F 30; A 45.1 years	Secondary care	Cross-sectional
Malbergier (2015)	Brazil	438	HIV-positive patients on ART in a HIV treatment center; M 236(52%); F 213; A 41.38 years	Secondary care	Cross-sectional
Martins (2012)	Brazil	123	Male patients with liver disease in a liver disease outpatient unit; A 42.64 years	Secondary care	Cross-sectional

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Meneses-Gaya (2010a, 2010b)	Brazil	530	Patients from a 'Psychosocial Care Center for Alcohol and Drugs (PCC-AD)' and emergency department; M 351(66%); F 179; A 36 years	Tertiary care	Cross-sectional
Morilha (2015)	Brazil	146	Patients with acute coronary syndrome (ACS) admitted to the hospital; M 95 (65.1%); F 51	Tertiary care	Cohort
Pinheiro (2006)	Brazil	386 couples	Couples living in an urban area; A 30.3 years	Community	Cross-sectional
Zucoloto (2013)	Brazil	284	Undergraduate students; M 83 (29.2%); F 201; A 21.18	Community	Cross-sectional
Herrera (2015)	Peru	399	MSM and transgender women in sexually transmitted infection (STI) clinics; M 310 (77.7%); F 89; median age 30 years	Secondary care	Cross-sectional
Ludford (2013)	Peru	5148	Sexually active men who have sex with men (MSM); A 29.5 years	Community	Cross-sectional
Strunin (2013)	Mexico	27,046 (high school) 22,417 (university)	Public high school and university students; M 24,237 (49%); F 25,226; In high school 67.5% were age 15 and in university 56% were 18 years old	Community	Cross-sectional
Ansoleaga (2013)	Chile	12781	M 5653 (44.4%); F 7128; A 18–25 (15.9%), 26–34 (20.5%), 35–44 (25.1%), 45–54 (21.3%), 55–65 (17.2%)	Community	Cross-sectional

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Santis (2009)	Chile	95	Adolescent students attending public school; M 53 (55.8%); F 42; A 15.9 years	Community	Cross-sectional

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Table 2: Studies that did not examine the psychometric properties of AUDIT cut-off scores used

Author (Year)	Country	Cut-off score(s) used or recommended
Blair (2017)	Uganda	>3 (hazardous use)
Kanyoni (2015)	Rwanda	8-15 (medium level of alcohol dependence) ≥16 (high level of alcohol dependence)
Abayomi (2013)	Nigeria	≥5 (hazardous use)
Brisibe (2011)	Nigeria	≥8 (abuse/harmful use) ≥20 (alcohol dependence)
Farley (2010)	Nigeria	≥8 or ≥10 (hazardous use)
Goar (2011)	Nigeria	4-7 (harmful use) ≥8 (hazardous use [alcohol abuse])
Issa (2012)	Nigeria	0–4 (moderate alcohol use) ≥5 (hazardous use)
Obadeji (2015)	Nigeria	0-4 (moderate use) ≥5 (hazardous use)
Olisah (2009)	Nigeria	5 to 6 (hazardous use) 7 to 8 (alcohol abuse) ≥9 (alcohol dependence)
Ndetei (2009)	Kenya	4-12 (normal) 13-18 (harmful use) ≥19 (alcohol dependence)
Nakhli (2011)	Tunisia	>13 (alcohol dependence)
Adams (2013)	South Africa	≥8 (harmful or hazardous use) ≥13 in women, ≥15 in men (alcohol dependence)
May (2018)	South Africa	>4 (current alcohol use at the light to moderate range and above) ≥8 (problem or heavy drinking)
Nothling (2013)	South Africa	≥8 (alcohol abuse) ≥13 (alcohol dependence)
Parry (2014)	South Africa	Men:

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		Six or more drinks on one occasion at least weekly, and score no more than 22 on the AUDIT (harmful/hazardous use) Women: Four or more drinks on one occasion at least weekly, and score no more than 22 on the AUDIT (harmful/hazardous use)
Simbayi (2004)	South Africa	≥9 (may be at risk or who are experiencing alcohol problems) ≥13 (likely alcohol use problems)
Simbayi (2006)	South Africa	≥9 (possible risk for alcohol problems) ≥13 (probable alcohol use problems)
Vythilingum (2012)	South Africa	>6 (risky drinking) >20 (alcohol dependence)
Luitel (2017)	Nepal	>9 (alcohol abuse or alcohol dependence)
Luitel (2018)	Nepal	>9 (alcohol abuse or alcohol dependence)
Dasgupta (2013)	India	≥8 (hazardous and harmful use) ≥12 (alcohol dependence)
D'Costa (2007)	India	≥8 (harmful use or dependent drinking)
Ghosh (2012)	India	≥8 (hazardous or harmful use) ≥13 (alcohol dependence)
Jonas (2014)	India	≥8 (hazardous use) Women: ≥13 (alcohol dependence) Men: ≥15 (alcohol dependence)
Nadkarni (2017a, 2017b); Patel (2014)	India	12-19 (harmful use)
Pal (2007)	India	8 or 9 (hazardous use) ≥10 (alcohol dependence)
Sau (2017)	India	≥8 (alcohol use in excess of low risk) ≥16 (harmful and hazardous use) ≥20 (alcohol dependence)
Chen (2013)	China	≥8 (probable drinking problem) ≥13 (probable alcohol dependence)

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		0-7 (low risk drinking) 8-15 (risk drinking) 16-19 (heavy drinking) 20-40 (hazardous drinking)
Yee (2014)	Malaysia	≥5 (potential alcohol abuse)
Sekulic (2012)	Bosnia and Herzegovina	≥11 (harmful drinking) ≤10 (non-harmful drinking)
Lasser (2018)	Russia	Women: ≥13 (alcohol dependence) Men: ≥15 (alcohol dependence)
Domingues (2011)	Brazil	<8 (not diagnosable alcohol problem) 8 to 11 (concerning consumption of alcohol) 12-15 (serious indication of a drinking problem) >15 (drinking problem)
Luna (2014)	Brazil	≥8 (harmful or hazardous drinking) Women: ≥13 (alcohol dependence) Men: ≥15 (alcohol dependence)
Machado (2014)	Brazil	≥8 (harmful use) 8-15 (mild cases) ≥16 9 (severe cases--high risk consumption)
Malbergier (2015)	Brazil	≥8 (harmful use)
Martins (2012)	Brazil	8-15 (average-risk user) ≥16 (high-risk user or with likely diagnosis of mental disorder related to the use of alcohol)
Morilha (2015)	Brazil	≤7 (hazardous use) ≥8 (harmful use) ≥20 (alcohol dependence) ≤7 (low-risk drinking) ≥8 (high-risk alcohol abuse) ≥20 (alcohol dependence)
Pinheiro (2006)	Brazil	≥10 (alcohol related disorder/alcohol misuse)
Herrera (2015)	Peru	≥17 (severe alcohol use disorder)
Ludford (2013)	Peru	≥20 (alcohol dependence) 17-19 (harmful use) 8-16 (hazardous use)

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Strunin (2013)	Mexico	≥3 (hazardous or harmful use) for high school students ≥6 (hazardous or harmful use) for university students
Ansoleaga (2013)	Chile	≥6 (hazardous use)

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Table 3: AUDIT Validation Studies

Author (Year)	Country	Cut-off score(s) used or recommended	Sensitivity	Specificity	Positive Predictive Value (PPV)	Negative Predictive Value (NPV)	Assessment Instrument	Reference Diagnosis
Adewuya (2005)	Nigeria	≥5 (hazardous use) ≥7 (harmful use) ≥9 (alcohol dependence)	93.5% 90.0% 100.0%	91.5% 86.2% 94.1%	89.3% 47.4% 20.0%	94.8% 98.4% 100.0%	Composite International Diagnostic Interview (CIDI)	Alcohol dependence and harmful use Hazardous use (determined based on WHO recommendations)
Gureje (1992)	Nigeria	≥1 (alcohol abuse or dependence)	32%	93%			CIDI	Alcohol abuse or dependence
Chishinga (2011)	Zambia	Men: ≥20 (alcohol use disorder) Women: ≥24 (alcohol use disorder)	55% 60%		50% 60%		Mini-International Neuropsychiatric Interview (MINI)	Alcohol use disorder
Pradhan (2012)	Nepal	Women: ≥4 (hazardous use) Men: ≥5 (hazardous use) ≥9 (alcohol dependence or abuse)	91.5% 93.7% 96.7% 94.3% 92.7%	91.7% 91.4% 84.4%	90.3% 80.1% 76.3%	97.2% 97.8% 95.5%	Structured clinical interview diagnosis for DSM-IV Axis I Disorders (SCID-IV)	Alcohol abuse and dependence

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		Men: Women: ≥11 (alcohol dependence) Men: Women:	89.4%	90.5%	72.1%	96.9%		
Endsley (2017)	India	≥6 (alcohol abuse) ≥13 (alcohol dependence)	87% 77%	63% 91%			MINI	Alcohol abuse and dependence
Nayak (2009)	India	≥9 (any alcohol use disorder) (alcohol dependence) ≥10 (any alcohol use disorder) (alcohol dependence)	81.15% 81.82% 77.87% 79.55%	80.03% 76.60% 82.45% 79.25%	43.39% 32.43% 46.57% 34.48%	95.58% 96.84% 94.99% 96.58%	Diagnostic questions from U.S. national alcohol surveys (informed by DSM-IV definitions)	Alcohol abuse and dependence
Pal (2004)	India	≥8 (harmful use) ≥16 (harmful use) ≥8 (alcohol dependence) ≥10 (alcohol dependence) ≥24 (alcohol dependence)	93.9% 85.3% 96.2% 95.2% 81.0%	66.7% 89.4% 28.6% 42.9% 85.7%			Composite International Diagnostic Interview, Substance Abuse Module, Version 10 (CIDI-SAM)	Harmful use and dependence
Guo (2008)	China	≥10 (alcohol abuse/dependence) ≥13 (alcohol dependence)	87.7% 85.7%	88.1% 84.6%	91% 75%	83.9% 91.7%	Severity of Alcohol Dependence Questionnaire (SADQ)	Alcohol abuse and dependence
Tsai (2005)	China	≥8 (harmful use) ≥11 (alcohol dependence)	96% 94%	85% 63%	85% 31%	96% 98%	Diagnostic Interview Schedule of the ICD-10	Harmful use and alcohol

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								dependence
Meneses-Gaya (2010a, 2010b)	Brazil	≥9 (alcohol abuse) Women: ≥12 (alcohol dependence) Men: ≥13 (alcohol dependence)	88% 82% 90%	87% 97% 92%	81% 87% 88%	91% 99% 94%	SCID-IV	Alcohol abuse and dependence
Zucoloto (2013)	Brazil	Women: >3 (binge drinking) Men: >5 (binge drinking)	90.74% 90.74%	73.68% 75.0%			Binge Drinking Detection Question (Goudriaan et al., 2007)	Binge drinking
Santis (2009)	Chile	≥3 (hazardous use) ≥5 (harmful use) ≥7 (alcohol dependence)	96.2% 75% 63.6%	63.3% 64.5% 75%	58.1% 45% 46.7%	96.9% 87% 85.7%	CIDI-SAM	Harmful and dependent drinking Hazardous use (determined based on WHO recommendations)

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