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Accuracy of the Audio Computer Assisted Self Interview Version of the Alcohol, Smoking and Substance Involvement Screening Test (ACASI ASSIST) for identifying unhealthy substance use and substance use disorders in primary care patients

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Abstract

Background—An audio computer-assisted self interview (ACASI) version of the Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST) could reduce barriers to substance use screening and assessment in primary care settings. This study evaluated the diagnostic accuracy of an ACASI ASSIST for identification of unhealthy substance use and substance use disorders (SUD).

Methods—399 adult patients were consecutively recruited from an urban safety-net primary care clinic. ACASI ASSIST scores for tobacco, alcohol, marijuana, and cocaine were compared against reference standard measures to assess the instrument's diagnostic accuracy for identifying unhealthy use and SUD, first using empirically-derived optimal cutoffs, and second using the currently recommended ASSIST cutoffs.

Results—For identifying any unhealthy use, at the empirically-derived cutoffs the ACASI ASSIST had 93.6% sensitivity and 85.8% specificity (AUC=0.90) for tobacco, 85.9% sensitivity and 60.3% specificity (AUC=0.73), for alcohol in men, 100% sensitivity and 62.4% specificity (AUC=0.81) for alcohol in women, 94.6% sensitivity and 81.6% specificity (AUC=0.88) for marijuana, and 86.1% sensitivity, 84.0% specificity (AUC=0.85) for cocaine. For SUD, sensitivity ranged from 79% (for alcohol in males), to 100% (for tobacco), and specificity was 83% or higher (AUCs ranged 0.83–0.91). For substances other than tobacco, empirically-derived cutoff scores were lower than the standard cutoffs, and resulted in higher sensitivity and lower specificity for identifying unhealthy substance use.

Conclusions—The ACASI ASSIST is a valid measure of unhealthy use and SUD for substances that are commonly used by primary care patients, and could facilitate effective and efficient screening for substance use in medical settings.

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Keywords

Drugs; alcohol; tobacco; ACASI; ASSIST; cannabis/marijuana; cocaine; alcohol; substance use; screening; unhealthy use; substance use disorder (SUD) validation

1. Introduction

Substance use is a significant public health burden worldwide (WHO, 2002; Compton, 2007; Humeniuk et al., 2008), and in the U.S., tobacco, alcohol, and drug use are among the top ten causes of preventable death (Mokdad et al., 2004). Despite the severe consequences on health and social functioning, according to the substance use estimates from the 2013 report of the National Survey on Drug Use and Health, of the estimated 22.7 million individuals aged 12 or older in 2013 who needed treatment for an illicit drug or alcohol use problem, only 2.5 million received care in specialty addiction treatment settings (SAMHSA, 2014)). Health care settings, such as primary care clinics, have the potential to identify, initially intervene, and facilitate treatment for patients with unhealthy (i.e., risky or hazardous) substance use, and substance use disorders.

Preventive care guidelines for adult patients in primary care settings recommend screening, coupled with brief office-based interventions for tobacco and alcohol use (Fiore et al., 2008, Moyer, 2013). With respect to other drugs, although recent clinical trials have not proven the efficacy of “Screening, Brief Intervention, and Referral to Treatment (SBIRT)” for reducing drug use in primary care patients (Humeniuk et al., 2012, Roy-Byrne et al., 2014; Saitz et al., 2014), SBIRT has been widely promoted by government health authorities, supported by insurance billing codes, and increasingly tracked as a health care quality measure (Buck 2011; Ghitza and Tai 2014; Rieckmann et al., 2015; SAMHSA, 2014). Yet, while tobacco screening has become standard practice, alcohol and drug screening have proven challenging to integrate into care (Babor and Higgins-Biddle 2000; Nilsen et al., 2006; Kaner 2010).

One of the primary barriers to screening for alcohol and drug use in health care settings has been the lack of a paradigm for conducting routine, high-quality screening and assessment with limited time and staff resources (Friedmann et al. 2001; Anderson et al., 2004; Johnson et al., 2011; Sterling et al., 2012). Very brief screening approaches have been developed to address this need (e.g. the Substance Use Brief Screen (SUBS), and single item screening questions for alcohol and drugs) (Smith et al., 2009; Smith et al., 2010; McNeely et al., 2015; McNeely et al., 2015b). Studies indicate that up to one-third of primary care patients will screen positive for unhealthy drug use with these brief screening approaches (Smith et al., 2010; McNeely et al., 2015a), and will thus require a brief assessment to gather essential clinical information about the types of substances used and the level of risk in order to guide clinical care.

One instrument that can provide this type of brief assessment is the Alcohol, Smoking and Substance Involvement Screening Test (ASSIST), a structured interview developed by the World Health Organization (WHO) for use in healthcare settings, and validated in a large multi-site international study (Mdege et al., 2011; Humeniuk et al., 2008; Humeniuk et al., 2012). However, the ASSIST has proven difficult to incorporate into routine care (Babor, T.,

2007; NIDA, 2010), in part because it takes approximately 5–15 minutes of in-person interaction with the patient, includes complex skip patterns, and has a scoring system that must be computed by the interviewer (Humeniuk 2010).

With the goal of making the ASSIST more feasible in busy primary care settings, we developed a self-administered audio computer assisted self-interview (ACASI) version of this instrument (McNeely et al., 2014). To facilitate screening and assessment in busy health care settings, the ACASI ASSIST could be completed prior to the medical encounter using a tablet or kiosk computer. ACASI is a valid and reliable interview mode (Butler, S.F., et al., 2001; Harris, S.K., et al., 2012) that is frequently used to limit response and social desirability bias when gathering sensitive information (O'Reilly, J., et al., 1994). Individuals are guided through the questionnaire by text and voice, and provide answers directly on the computer. ACASI technology makes it possible to support patients with limited reading ability because all relevant text is read aloud in real time, and response options are clearly indicated using both text and symbols. ACASI questionnaires are feasible in medical settings (Harris et al., 2012; Murphy et al., 2013; Satre et al., 2008; Rogers et al., 2005) and well accepted by participants (Kissinger et al., 1999; Van de Wijgert et al., 2000; Hewett et al., 2004).

Our previous study demonstrated that the ACASI ASSIST generates comparable results to the traditional interviewer-administered ASSIST (McNeely, J. et al., 2015a) and has good test-retest reliability (McNeely, J., et al., 2014). The objective of this analysis is to examine the diagnostic accuracy of the ACASI ASSIST in comparison to other 'gold standard' measures for identifying unhealthy use and substance use disorders in primary care patients.

2. Method

2.1 Setting

The study was conducted in the adult primary care clinic of a large municipal safety-net hospital in New York City from July 2012 to June 2013. Using procedures that have been previously described (McNeely et al., 2015a), a convenience sample of 399 participants was consecutively recruited from the clinic waiting area. Individuals were eligible to participate if they were current clinic patients, fluent in English, and age 18–65 years.

2.2 Study Procedures

Interviews were conducted in a private room, and participants were informed that their responses were anonymous and would be kept confidential. Participants self-administered the ACASI ASSIST in the private room, using a touch-screen tablet computer. A research assistant then administered a series of instruments that collected detailed information on substance use and served as reference standard measures. The institutional review board of the NYU School of Medicine reviewed and approved all study procedures.

2.3 Measures

A standard demographic form was administered.

2.3.1 ACASI ASSIST—The ACASI ASSIST is based on the World Health Organization ASSIST V3.0 (Humeniuk et al., 2006). It is a brief structured interview that covers nine substances (tobacco, alcohol, marijuana, cocaine, stimulants, inhalants, sedatives, hallucinogens, opioids) and assesses lifetime and current use, problems related to use, and failure to stop or cut down. The ACASI ASSIST retained all items from the ASSIST V3.0 and added two additional substance classes: prescription opioids and prescription stimulants (McNeely et al., 2015a). Using QDS Software (Nova Research Co), the ACASI ASSIST presented text of each ASSIST item and its response options on the computer screen, accompanied by a female voice that read the written text in its entirety, and allowed participants to select their responses using the computer touchscreen. We followed the standard approach to scoring the ASSIST, in which the substance specific involvement scores (SSIS) are the sum of responses to ASSIST Questions 2–7 for each substance, with a potential range of 0 to 39 (Humeniuk et al., 2006).

2.3.2 Reference Standard Measures to define unhealthy use and substance use disorder—**Unhealthy tobacco use** was defined as any tobacco use in the past 12 months and **tobacco use disorder** was defined as a score of 4 or more on the Fagerström Test for Nicotine Dependence (FTND) (Heatherton et al., 1991). **Unhealthy alcohol use** was defined as a positive response to MINI Plus Version 6.0, Question I1, which asks “*In the past 12 months, have you had 3 or more alcoholic drinks within a 3-hour period, on 3 or more occasions?*” (Lecrubier et al., 1997; Sheehan et al., 1998). Alcohol use disorder was defined as a Diagnostic and Statistical Manual of Mental Disorders (DSM), 4th edition (DSM IV) diagnosis of abuse or dependence, based on responses to the MINI Plus. **Unhealthy drug use** was defined as a positive response to QJ1 on the MINI, “*In the past 12 months, did you take any of these drugs more than once, to get high, to feel elated, to get a “buzz” or to change your mood?*” and **drug use disorder** was defined as diagnosis of DSM IV abuse or dependence on the MINI Plus.

2.4 Statistical Analyses

We calculated descriptive statistics for the sample, including prevalence of substance use reported on the reference standard measures. For the validation analyses, we excluded any substance classes for which a prevalence of the disease condition (unhealthy use or substance use disorder) was less than 10%, because estimates of diagnostic accuracy lack sufficient precision under conditions of very low prevalence (Alberg et al., 2004). Statistical analyses were conducted to (1) ascertain the accuracy of the ACASI ASSIST in classifying unhealthy substance use and substance use disorder in comparison to reference standard measures; and (2) compare the diagnostic accuracy of the ACASI ASSIST using our empirically derived cutoffs versus standard WHO ASSIST cutoffs for unhealthy use. There were no missing data for the substances included in this study.

2.4.1 Diagnostic accuracy in comparison to reference standard measures—We calculated a range of cutoffs and associated sensitivities, specificities, areas under the receiver operating characteristics curves (AUCs), positive predictive values (PPVs), and negative predictive values (NPVs), of each substance in comparison to the reference standard measure. Because previous studies found that using gender-based cutoffs for men

and women improves the diagnostic accuracy of alcohol screening instruments (Bradley et al., 2003, 2007), we performed calculations for alcohol separately for men and women. We used different criteria to select cutoffs for unhealthy use and SUD based on the clinical actions that would be triggered by the screening result. In the case of unhealthy use, it is important that clinicians do not miss cases that require further clinical assessment and counseling, (such as review of medication interactions, screening for comorbid conditions, and brief intervention), and so we chose scores that maximized sensitivity while maintaining adequate specificity (above 0.60). For identifying SUD, the costs of false positive results (such as resources required to refer patients to specialty treatment, stigma of a SUD diagnosis) must be more carefully balanced against the potential benefits of intervention for true cases of SUD, and so we selected cutoffs that generated sensitivity and specificity greater than 75%, while still maintaining good discrimination with an AUC greater than 0.80 (Hanley and McNeil 1982). We used the `roctab` and `diagt` command in STATA for these analyses (StataCorp, LP, 2013).

2.4.2 Application of WHO ASSIST CUTOFFS for unhealthy use—The standard WHO ASSIST cutoffs classify unhealthy use (defined as moderate- or high-risk use) at a cutoff of 11 or higher for alcohol, and 4 or higher for all other substances (Humenuik et al., 2010). We evaluated the diagnostic accuracy of the ACASI ASSIST using these standard cutoffs. In a second step, we compared the diagnostic accuracy of the ACASI ASSIST applying the standard WHO cutoffs versus our empirically derived cutoffs. The McNemar χ^2 two-sided test compared sensitivity and specificity (Trajman et al., 2008), and the `roccomp` analysis in STATA (Cleves and Rock 2002) compared areas under the curve. Because the WHO ASSIST risk categories (low-, moderate-, and high-risk) do not map to our definition of substance use disorder (Humenuik et al., 2008), a similar comparison of empirically derived versus WHO cutoffs was not conducted for the SUD condition.

3. Results

3.1 Sample characteristics

The 399 participants were ethnically and racially diverse, and 42% had a high school education or less (Table 1). Table 2 shows the prevalence of lifetime and current (past 3 months) substance use reported on the ACASI ASSIST.

3.2 Diagnostic accuracy for detecting unhealthy substance use

Table 3 presents the empirically derived optimal cutoffs, and the diagnostic accuracy of the ACASI ASSIST at these cutoffs, in comparison to the reference standard measures. For detection of any unhealthy tobacco use, we identified an optimal cutoff score of 4. At this cutoff, the ACASI ASSIST had 93.6% sensitivity, 85.8% specificity, and an AUC=0.90 for identifying unhealthy tobacco use. The cutoff for unhealthy alcohol use was 5 for men (sensitivity= 85.9%, specificity= 60.3%, AUC=0.73), and 3 for women (sensitivity= 100.0%, specificity= 62.4%, AUC=0.81). At a cutoff of 2, the sensitivity and specificity of the ACASI ASSIST for detecting unhealthy marijuana use were 94.6% and 81.6%, respectively, and the AUC was 0.89. For cocaine, a cutoff of 2 was 86.1% sensitive and 84.0% specific, with AUC of 0.85. Individuals with ACASI ASSIST scores at or above the

cutoffs were at least twice as likely as those with scores below the cutoffs to have unhealthy use, with positive likelihood ratios ranging from 2.16 to 6.58. Conversely, those with scores below the cutoff were less than a quarter as likely to have unhealthy use, with negative likelihood ratios ranging from 0.07–0.23.

3.3 Diagnostic accuracy for detecting substance use disorder

For identifying a tobacco use disorder, the optimal cutoff on the ACASI ASSIST was 12 (Table 3). The optimal cutoff for alcohol use disorder (AUD) differed by gender, and was 13 for men and 7 for women. The optimal cutoff score for marijuana and cocaine use disorder was 4. At these recommended cutoffs, the sensitivity of the ACASI ASSIST for identifying SUD ranged from 79% (for alcohol in men), to 100% (for tobacco), and specificity was at least 83%. Discrimination was good for all substances, with AUCs of 0.83 or greater.

3.4 Comparison of diagnostic accuracy for detecting unhealthy use with application of empirically derived versus standard ASSIST cutoffs

Table 4 shows the diagnostic accuracy of the ACASI ASSIST using the standard WHO ASSIST cutoffs (Humeniuk 2008) and the empirically derived ACASI ASSIST cutoffs for unhealthy use. Diagnostic accuracy was unchanged with respect to tobacco, as the cutoffs are the same (4). Applying the WHO cutoffs resulted in lower sensitivity, and increased specificity, for identifying unhealthy use of alcohol, marijuana, and cocaine. Differences in sensitivity and specificity were statistically significant, with the exception of sensitivity for cocaine use ($p=.317$). The comparisons of AUC were statistically significant (at the $p<0.05$ level) only in the case of unhealthy alcohol use in females.

4. Discussion

We found that the ACASI ASSIST has good diagnostic accuracy for detecting unhealthy substance use and substance use disorder for tobacco, alcohol, marijuana, and cocaine use in this sample of primary care patients. The optimal cutoffs for identifying unhealthy use were 4 for tobacco (same as the recommended cutoffs for the WHO ASSIST), 5 for alcohol in males, 3 for alcohol in females, and 2 for marijuana and cocaine. The optimal cutoffs for SUD were 12 for tobacco, 13 for alcohol in males, 7 for alcohol in females, and 4 for marijuana and cocaine.

We chose the diagnostic conditions “unhealthy use” and “SUD” to correspond to the clinical application of the ASSIST. In practice, medical providers need to be aware of *any* unhealthy substance use because of its impact on health, including attendant comorbidities and risk behaviors.

Our empirically derived cutoffs for identifying unhealthy use are lower than the standard cutoffs for the WHO ASSIST, and had better sensitivity, and acceptable levels of specificity and AUC values, for identifying unhealthy use. This is congruent with the findings of a recent study of the interviewer-administered ASSIST, which found that sensitivity and specificity for detecting unhealthy alcohol use were optimized at lower ASSIST scores than those recommended by WHO (Johnson et al., 2015). We did not find a statistically

significant difference in the AUCs of the two instruments for unhealthy use on any of the substances except for unhealthy alcohol use in females. However, given the importance of maximizing sensitivity for a screening test that seeks to identify any unhealthy substance use, we recommend use of the empirically-derived cutoffs for the ACASI ASSIST.

In the WHO ASSIST validation study, the moderate risk category was based on a DSM-IV diagnosis of substance abuse, while the high-risk category was based on a DSM-IV diagnosis of dependence (Humeniuk et al., 2008). To validate the ACASI ASSIST, we instead used the diagnostic conditions ‘unhealthy use’ and ‘SUD’ (which includes DSM-IV abuse and dependence), which are better suited to how the ASSIST would be clinically applied in a primary care setting. In primary care, identification of any use of drugs or alcohol beyond guideline-recommended levels is essential for proper diagnosis and treatment of medical and mental health conditions, for avoiding medication interactions, and for appropriately addressing common comorbidities and risk behaviors (McNeely and Saitz, 2015c; Lindsey et al., 2012; Malta et al., 2008; CDC, 2007). Using a consumption-based definition of unhealthy use, as is the case in our approach, is consistent with the validation approach used for other alcohol and drug screening tools (Bradley 1998; Bradley et al., 2003; Seale et al., 2006; Smith et al., 2009; Smith et al., 2010), and reduces the likelihood of missing cases in which substance use is clinically significant but does not progress to the level of severity of a SUD. It is also important to identify patients with SUD, (abuse or dependence), which typically require treatment interventions that are more intensive than what can be delivered in primary care settings to meaningfully impact use (Saitz 2010).

The selection of cutoffs for a screening tool needs to be guided by factors such as population, prevalence of the condition, and the cost of treatment versus failure to treat (Gryczynski et al., 2014). Typically, cutoffs for a screening test are chosen based on maximizing the AUC, which identifies the score that optimally balances sensitivity and specificity and therefore includes a certain amount of trade-off (Alberg et al., 2004; Cantor et al., 1999). However, the AUC does not take into account the clinical application of the test. Ideally, balancing the trade-offs between sensitivity and specificity should factor in such criteria as the case fatality rate of the disease, the likelihood that screening will occur on a regular basis, and the physical, psychological, and economic costs associated with false positive or false negative tests (Chang 2001; Martin et al., 2006). Thus in selecting cutoffs in our study, we used different criteria for identifying the condition of unhealthy substance use, versus SUD. For unhealthy use, we laid emphasis on increasing sensitivity (>80%), while maintaining adequate discrimination ($AUC > 0.70$), because the cost of following up a positive screen is relatively low. Patients with unhealthy use that does not rise to the level of a SUD should be educated on the health risks of their substance use, and in the case of tobacco and alcohol, guideline-recommended care consists of brief motivational counseling that can be delivered by their medical providers (Fiore et al., 2008; Moyer., 2013). For SUDs, we chose cutoffs that best balanced sensitivity and specificity, given the relatively higher costs of false positive diagnoses. A patient identified as having a SUD requires more intensive assessment and treatment, possibly including pharmacotherapy, and may be more stigmatized by the diagnosis. The costs of false positive tests for SUD are thus more significant.

4.1 Limitations

Our study has several limitations. We selected cutoffs for the ACASI ASSIST that maximized its diagnostic accuracy in the entire sample, and did not have enough participants with unhealthy use or SUD to split it into ‘development’ and ‘validation’ samples. Despite the high overall prevalence of substance use in our sample, due to the low prevalence of many drug classes, we only had adequate precision for assessments of alcohol, tobacco, marijuana and cocaine. Although these are the substances that are most likely to be encountered in primary care patients (Gryczynski et al., 2014; Manwell et al., 1998; Madras et al., 2009), other drugs (including opioids and stimulants) also pose significant health risks. A larger study, or a different study population, would be required to evaluate the ACASI ASSIST for other drugs. However, a strength of our study is that it was conducted in the population (i.e. primary care patients) in which the ACASI ASSIST is intended to be used, and established the validity of the instrument for the most prevalent substances.

Both the WHO and ACASI versions of the ASSIST rely on self-reported information. However, self-report measures of substance use have consistently shown good accuracy in the research context (Del Boca et al., 2003; Hser, 1997; Tourangeau and Smith, 1996). To increase the accuracy of reporting of drug use, subjects were informed that their responses were anonymous and would be kept confidential. Exactly how the performance of the ACASI ASSIST would change if it were introduced into routine care is not known, and would likely vary depending on specifics of the practice site and implementation approach.

Because our study was conducted in a single urban safety-net primary care clinic, and enrolled only English-speaking patients between the ages of 18–65, the generalizability of our study findings is limited. Further studies of the ACASI ASSIST should be conducted in other languages, with different age groups, and in non-urban settings. The diversity of our sample, which had good representation of individuals with low levels of formal education, can be considered strength, because a computer self-administered approach may be more challenging in populations with limited literacy and computer skills.(Butler et al., 2001; Satre et al., 2008; Reichmann et al., 2010) . Finally, our reference standard measure for SUD uses DSM IV criteria, and performance of the ACASI ASSIST may need to be re-evaluated using DSM V criteria for SUD.

5. Conclusions and Implications

The ACASI ASSIST has good diagnostic accuracy when compared to reference standard measures for identifying unhealthy use and substance use disorders for tobacco, alcohol, marijuana and cocaine in primary care patients. With increasing use of hand held devices, tablets and smart phones in health care (Kuziemy et al., 2005; Baumgart 2005; Lu et al., 2005; Garritty et al., 2006), and of web-based patient portals into the electronic health record, the use of electronic self-administered questionnaires could greatly increase the efficiency and accuracy of screening for these behaviors in health care settings. The self-administered approach may be particularly important for identifying stigmatized behaviors such as substance use, which patients are less likely to report in a face-to-face interview with clinical staff (Tourangeau and Smith 1996, Rogers et al. 1998; Des Jarlais et al., 1999; Wight et al., 2000; Kim et al., 2008). While we were able to establish recommended cutoffs for the

substances that are most frequently used by primary care patients, additional studies are needed to evaluate the diagnostic performance of the ACASI ASSIST for other drugs, and in other populations.

References

1. Abuse, N.I.o.D. [accessed on June 25, 2015] Nationwide Trends. 2015. Retrieved from <http://www.drugabuse.gov/publications/drugfacts/nationwide-trends>
2. Administration, S.A.a.M.H.S.. Results from the 2013 National Survey on Drug Use and Health: Summary of National Findings. NSDUH Series H-48. Substance Abuse and Mental Health Services Administration; Rockville, MD: 2014.
3. Alberg AJ, Park JW, Hager BW, Brock MV, Diener-West M. The use of “overall accuracy” to evaluate the validity of screening or diagnostic tests. *Journal of general internal medicine*. 2004; 19:460–465. [PubMed: 15109345]
4. Anderson P, Kaner E, Wutzke S, Funk M, Heather N, Wensing M, Grol R, Gual A, Pas L. Attitudes and managing alcohol problems in general practice: an interaction analysis based on findings from a WHO collaborative study. *Alcohol and Alcoholism*. 2004; 39:351–356. [PubMed: 15208170]
5. Babor TF, Higgins-Biddle JC. Alcohol screening and brief intervention: dissemination strategies for medical practice and public health. *Addiction*. 2000; 95:677–686. [PubMed: 10885042]
6. Babor TF, McRee BG, Kassebaum PA, Grimaldi PL, Ahmed K, Bray J. Screening, Brief Intervention, and Referral to Treatment (SBIRT) toward a public health approach to the management of substance abuse. *Substance abuse*. 2007; 28:7–30. [PubMed: 18077300]
7. Baumgart DC. Personal digital assistants in health care: experienced clinicians in the palm of your hand? *Lancet* (London, England). 2005; 366:1210–1222.
8. Bradley KA, Boyd-Wickizer J, Powell SH, Burman ML. Alcohol screening questionnaires in women: a critical review. *Jama*. 1998; 280:166–171. [PubMed: 9669791]
9. Bradley KA, Bush KR, Epler AJ, Dobie DJ, Davis TM, Sporleder JL, Maynard C, Burman ML, Kivlahan DR. Two brief alcohol-screening tests From the Alcohol Use Disorders Identification Test (AUDIT): validation in a female Veterans Affairs patient population. *Archives of Internal Medicine*. 2003; 163:821–829. [PubMed: 12695273]
10. Bradley KA, DeBenedetti AF, Volk RJ, Williams EC, Frank D, Kivlahan DR. AUDIT-C as a Brief Screen for Alcohol Misuse in Primary Care. *Alcoholism: Clinical and Experimental Research*. 2007; 31:1208–1217.
11. Buck JA. The looming expansion and transformation of public substance abuse treatment under the Affordable Care Act. *Health Affairs*. 2011; 30:1402–1410. [PubMed: 21821557]
12. Bultler SF, Budman SH, Goldman RJ, Newman FJ, Beckley KE, Trottier D, Cacciola JS. Initial validation of a computer-administered Addiction Severity Index: The ASI–MV. *Psychology of Addictive Behaviors*. 2001; 15:4. [PubMed: 11255937]
13. Cantor SB, Sun CC, Tortolero-Luna G, Richards-Kortum R, Follen M. A comparison of C/B ratios from studies using receiver operating characteristic curve analysis. *J Clin Epidemiol*. 1999; 52:885–892. [PubMed: 10529029]
14. Chang G. Alcohol screening instruments for pregnant women. *Alcohol research and health*. 2001; 25:204–209. [PubMed: 11810959]
15. Cleves MA, Rock L. From the help desk: Comparing areas under receiver operating characteristic curves from two or more probit or logit models. *The Stata Journal*. 2002; 2:301–313.
16. Compton WM, Thomas YF, Stinson FS, Grant BF. Prevalence, correlates, disability, and comorbidity of DSM-IV drug abuse and dependence in the United States: results from the national epidemiologic survey on alcohol and related conditions. *Archives of general psychiatry*. 2007; 64:566–576. [PubMed: 17485608]
17. Control, CfD. Prevention. Unintentional poisoning deaths--United States, 1999–2004. *MMWR: Morbidity and mortality weekly report*. 2007; 56:93–96. [PubMed: 17287712]
18. Del Boca FK, Darkes J. The validity of self-reports of alcohol consumption: state of the science and challenges for research. *Addiction*. 2003; 98:1–12. [PubMed: 14984237]

19. Des Jarlais DC, Paone D, Milliken J, Turner CF, Miller H, Gribble J, Shi Q, Hagan H, Friedman SR. Audio-computer interviewing to measure risk behaviour for HIV among injecting drug users: a quasi-randomised trial. *The Lancet*. 1999; 353:1657–1661.
20. Fiore MC, Jaen CR, Baker TB, Bailey WC, Benowitz N, Curry SJ. Treating tobacco use and dependence: 2008 update US Public Health Service Clinical Practice Guideline executive summary. *Respiratory care*. 2008; 53:1217–1222. [PubMed: 18807274]
21. Friedmann PD, Saitz R, Gogineni A, Zhang JX, Stein MD. Validation of the screening strategy in the NIAAA "Physicians' Guide to Helping Patients with Alcohol Problems". *Journal of studies on alcohol*. 2001; 62:234–238. [PubMed: 11332444]
22. Garritty C, El Emam K. Who's using PDAs? Estimates of PDA use by health care providers: a systematic review of surveys. *Journal of medical Internet research*. 2006; 8:e7. [PubMed: 16867970]
23. Ghitza UE, Tai B. Challenges and opportunities for integrating preventive substance-use-care services in primary care through the Affordable Care Act. *Journal of health care for the poor and underserved*. 2014; 25:36. [PubMed: 24583486]
24. Gryczynski J, Schwartz RP, Mitchell SG, O'Grady KE, Ondersma SJ. Hair drug testing results and self-reported drug use among primary care patients with moderate-risk illicit drug use. *Drug and alcohol dependence*. 2014; 141:44–50. [PubMed: 24932945]
25. Hanley JA, McNeil BJ. The meaning and use of the area under a receiver operating characteristic (ROC) curve. *Radiology*. 1982; 143:29–36. [PubMed: 7063747]
26. Harris SK, Csémy L, Sherritt L, Starostova O, Van Hook S, Johnson J, Boulter S, Brooks T, Carey P, Kossack R. Computer-facilitated substance use screening and brief advice for teens in primary care: an international trial. *Pediatrics*. 2012; 129:1072–1082. [PubMed: 22566420]
27. Heatherton TF, Kozlowski LT, Frecker RC, Fagerstrom KO. The Fagerström test for nicotine dependence: a revision of the Fagerstrom Tolerance Questionnaire. *British journal of addiction*. 1991; 86:1119–1127. [PubMed: 1932883]
28. Hewett PC, Erulkar AS, Mensch BS. The Feasibility of Computer-Assisted Survey Interviewing in Africa Experience from Two Rural Districts in Kenya. *Social Science Computer Review*. 2004; 22:319–334.
29. Hser Y-I. Self-reported drug use: results of selected empirical investigations of validity. *NIDA Res Monogr*. 1997; 167:320–343. [PubMed: 9243568]
30. Humeniuk R, Ali R, Babor T, Souza-Formigoni MLO, de Lacerda RB, Ling W, McRee B, Newcombe D, Pal H, Poznyak V. A randomized controlled trial of a brief intervention for illicit drugs linked to the Alcohol, Smoking and Substance Involvement Screening Test (ASSIST) in clients recruited from primary health-care settings in four countries. *Addiction*. 2012; 107:957–966. [PubMed: 22126102]
31. Humeniuk R, Ali R. Group, A.P.I.S. Validation of the Alcohol, Smoking and Substance Involvement Screening Test (ASSIST) and pilot brief intervention [electronic resource]: a technical report of phase II findings of the WHO ASSIST Project/prepared by Rachel Humeniuk & Robert Ali, on behalf of the WHO ASSIST Phase II Study Group. 2006
32. Humeniuk, R.; Dennington, V.; Ali, R. The effectiveness of a brief intervention for illicit drugs linked to the alcohol, smoking and substance involvement screening test (ASSIST) in primary health care settings: a technical report of phase III findings of the WHO ASSIST randomized controlled trial. Geneva: World Health Organization; 2008.
33. Humeniuk R, Henry-Edwards S, Ali R, Poznyak V, Monteiro MG. The Alcohol, Smoking and Substance Involvement Screening Test (ASSIST): manual for use in primary care. 2010
34. Johnson JA, Bembry W, Peterson J, Lee A, Seale JP. Validation of the ASSIST for Detecting Unhealthy Alcohol Use and Alcohol Use Disorders in Urgent Care Patients. *Alcoholism: Clinical and Experimental Research*. 2015
35. Johnson M, Jackson R, Guillaume L, Meier P, Goyder E. Barriers and facilitators to implementing screening and brief intervention for alcohol misuse: a systematic review of qualitative evidence. *Journal of Public Health*. 2011; 33:412–421. [PubMed: 21169370]
36. Kaner E. Brief alcohol intervention: time for translational research. *Addiction*. 2010; 105:960–961. [PubMed: 20659054]

37. Kim J, Dubowitz H, Hudson-Martin E, Lane W. Comparison of 3 data collection methods for gathering sensitive and less sensitive information. *Ambulatory pediatrics : the official journal of the Ambulatory Pediatric Association*. 2008; 8:255–260. [PubMed: 18644548]
38. Kissinger P, Rice J, Farley T, Trim S, Jewitt K, Margavio V, Martin DH. Application of computer-assisted interviews to sexual behavior research. *American Journal of Epidemiology*. 1999; 149:950–954. [PubMed: 10342804]
39. Kuziemsky CE, Laul F, Leung RC. A review on diffusion of personal digital assistants in healthcare. *Journal of medical systems*. 2005; 29:335–342. [PubMed: 16178332]
40. Lecrubier Y, Sheehan D, Weiller E, Amorim P, Bonora I, Sheehan KH, Janavs J, Dunbar G. The Mini International Neuropsychiatric Interview (MINI). A short diagnostic structured interview: reliability and validity according to the CIDI. *European psychiatry*. 1997; 12:224–231.
41. Lindsey WT, Stewart D, Childress D. Drug interactions between common illicit drugs and prescription therapies. *The American journal of drug and alcohol abuse*. 2012; 38:334–343. [PubMed: 22221229]
42. Lu YC, Xiao Y, Sears A, Jacko JA. A review and a framework of handheld computer adoption in healthcare. *International journal of medical informatics*. 2005; 74:409–422. [PubMed: 15893264]
43. Madras BK, Compton WM, Avula D, Stegbauer T, Stein JB, Clark HW. Screening, brief interventions, referral to treatment (SBIRT) for illicit drug and alcohol use at multiple healthcare sites: comparison at intake and 6 months later. *Drug and alcohol dependence*. 2009; 99:280–295. [PubMed: 18929451]
44. Malta M, Strathdee SA, Magnanini MM, Bastos FI. Adherence to antiretroviral therapy for human immunodeficiency virus/acquired immune deficiency syndrome among drug users: a systematic review. *Addiction*. 2008; 103:1242–1257. [PubMed: 18855813]
45. Manwell LB, Fleming MF, Johnson K, Barry KL. Tobacco, alcohol, and drug use in a primary care sample, 90-day prevalence and associated factors. *Journal of addictive diseases*. 1998; 17:67–81. [PubMed: 9549604]
46. Martin G, Copeland J, Gates P, Gilmour S. The Severity of Dependence Scale (SDS) in an adolescent population of cannabis users: reliability, validity and diagnostic cut-off. *Drug and Alcohol Dependence*. 2006; 83:90–93. [PubMed: 16310973]
47. McNeely J, Strauss SM, Rotrosen J, Ramautar A, Gourevitch MN. Validation of an audio computer assisted self-interview (ACASI) version of the Alcohol, Smoking and Substance Involvement Screening Test (ASSIST) in primary care patients. *Addiction*. 2015a
48. McNeely J, Strauss SM, Saitz R, Cleland CM, Palamar JJ, Rotrosen J, Gourevitch MN. A brief patient self-administered substance use screening tool for primary care: two-site validation study of the Substance Use Brief Screen (SUBS). *The American journal of medicine*. 2015b; 128:784, e789–e784, e719. [PubMed: 25770031]
49. McNeely J, Saitz R. Appropriate Screening for Substance Use vs Disorder. *JAMA internal medicine*. 2015c; 175:1997–1998. [PubMed: 26641355]
50. McNeely J, Strauss SM, Wright S, Rotrosen J, Khan R, Lee JD, Gourevitch MN. Test–retest reliability of a self-administered Alcohol, Smoking and Substance Involvement Screening Test (ASSIST) in primary care patients. *Journal of substance abuse treatment*. 2014; 47:93–101. [PubMed: 24629887]
51. Mdege ND, Lang J. Screening instruments for detecting illicit drug use/abuse that could be useful in general hospital wards: a systematic review. *Addictive behaviors*. 2011; 36:1111–1119. [PubMed: 21821364]
52. Mokdad AH, Marks JS, Stroup DF, Gerberding JL. Actual causes of death in the United States, 2000. *Jama*. 2004; 291:1238–1245. [PubMed: 15010446]
53. Moyer VA. Screening and behavioral counseling interventions in primary care to reduce alcohol misuse: US Preventive Services Task Force recommendation statement. *Annals of internal medicine*. 2013; 159:210–218. [PubMed: 23698791]
54. Murphy MK, Bijur PE, Rosenbloom D, Bernstein SL, Gallagher EJ. Feasibility of a computer-assisted alcohol SBIRT program in an urban emergency department: patient and research staff perspectives. *Addiction science & clinical practice*. 2013; 8:1–10. [PubMed: 23294846]

55. Nilsen P, Aalto M, Bendtsen P, Seppä K. Effectiveness of strategies to implement brief alcohol intervention in primary healthcare: a systematic review. *Scandinavian journal of primary health care*. 2006; 24:5–15. [PubMed: 16464809]
56. O'Reilly JM, Hubbard ML, Lessler JT, Biemer PP, Turner CF. Audio and video computer-assisted self interviewing: Preliminary tests of new technologies for data collection. *Journal of Official Statistics*. 1994; 10:197. [PubMed: 22347766]
57. Organization, WH. The world health report 2002: reducing risks, promoting healthy life. World Health Organization; 2002.
58. Reichmann WM, Losina E, Seage GR, Arbelaez C, Safren SA, Katz JN, Hetland A, Walensky RP. Does modality of survey administration impact data quality: audio computer assisted self interview (ACASI) versus self-administered pen and paper? *PloS one*. 2010; 5:e8728. [PubMed: 20090953]
59. Rieckmann T, Abraham A, Zwick J, Rasplia C, McCarty D. A Longitudinal Study of State Strategies and Policies to Accelerate Evidence-Based Practices in the Context of Systems Transformation. *Health services research*. 2015; 50:1125–1145. [PubMed: 25532616]
60. Rogers SM, Willis G, Al-Tayyib A, Villarroel M, Turner C, Ganapathi L, Zenilman J, Jadack R. Audio computer assisted interviewing to measure HIV risk behaviours in a clinic population. *Sexually Transmitted Infections*. 2005; 81:501–507. [PubMed: 16326855]
61. Roy-Byrne P, Bumgardner K, Krupski A, Dunn C, Ries R, Donovan D, West II, Maynard C, Atkins DC, Graves MC. Brief intervention for problem drug use in safety-net primary care settings: a randomized clinical trial. *Jama*. 2014; 312:492–501. [PubMed: 25096689]
62. Saitz R. Alcohol screening and brief intervention in primary care: absence of evidence for efficacy in people with dependence or very heavy drinking. *Drug and alcohol review*. 2010; 29:631–640. [PubMed: 20973848]
63. Saitz R, Palfai TP, Cheng DM, Alford DP, Bernstein JA, Lloyd-Travaglini CA, Meli SM, Chaisson CE, Samet JH. Screening and brief intervention for drug use in primary care: the ASPIRE randomized clinical trial. *JAMA*. 2014; 312:502–513. [PubMed: 25096690]
64. Satre D, Wolfe W, Eisendrath S, Weisner C. Computerized screening for alcohol and drug use among adults seeking outpatient psychiatric services. *Psychiatric Services*. 2008
65. Seale JP, Boltri JM, Shellenberger S, Velasquez MM, Cornelius M, Guyinn M, Okosun I, Sumner H. Primary care validation of a single screening question for drinkers. *J Stud Alcohol*. 2006; 67:778–784. [PubMed: 16847548]
66. Sheehan DV, Lecrubier Y, Sheehan KH, Amorim P, Janavs J, Weiller E, Hergueta T, Baker R, Dunbar GC. The Mini-International Neuropsychiatric Interview (MINI): the development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *Journal of clinical psychiatry*. 1998; 59:22–33. [PubMed: 9881538]
67. Smith PC, Schmidt SM, Allensworth-Davies D, Saitz R. Primary care validation of a single-question alcohol screening test. *Journal of general internal medicine*. 2009; 24:783–788. [PubMed: 19247718]
68. Smith PC, Schmidt SM, Allensworth-Davies D, Saitz R. A single-question screening test for drug use in primary care. *Archives of internal medicine*. 2010; 170:1155–1160. [PubMed: 20625025]
69. StataCorp, L. Stata 13. College Station, Texas, United States: StataCorp LP; 2013. <http://www.stata.com>
70. Sterling S, Kline-Simon AH, Wibbelsman C, Wong A, Weisner C. Screening for adolescent alcohol and drug use in pediatric health-care settings: predictors and implications for practice and policy. *Addict Sci Clin Pract*. 2012; 7:13. [PubMed: 23186254]
71. Tourangeau R, Smith TW. Asking sensitive questions the impact of data collection mode, question format, and question context. *Public opinion quarterly*. 1996; 60:275–304.
72. Trajman A, Luiz RR. McNemar chi2 test revisited: comparing sensitivity and specificity of diagnostic examinations. *Scand J Clin Lab Invest*. 2008; 68:77–80. [PubMed: 18224558]
73. Van de Wijgert J, Padian N, Shiboski S, Turner C. Is audio computer-assisted self-interviewing a feasible method of surveying in Zimbabwe? *International Journal of Epidemiology*. 2000; 29:885–890. [PubMed: 11034973]
74. Wight RG, Rotheram-Borus MJ, Klosinski L, Ramos B, Calabro M, Smith R. Screening for transmission behaviors among HIV-infected adults. *AIDS education and prevention: official*

publication of the International Society for AIDS Education. 2000; 12:431–441. [PubMed: 11063062]

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Table 1

Participant characteristics

Variable meaning	Category values	N (%)
Sample size		399
Gender		
	Male	206 (51.63)
	Female	193 (48.37)
	Transgender	1 (0.30)
Age	Mean= 46.75; S.D.=12.08	
	18–29	50 (12.53)
	30–39	53 (13.28)
	40–49	96 (24.06)
	50–59	150 (37.59)
	60–65	50 (12.53)
Race/Ethnicity		
	African-American	191 (47.87)
	White	79 (19.80)
	Other	129 (32.33)
Education		
	<High school	70 (17.54)
	High school graduate or GED	99 (24.81)
	Some college or trade/vocational school	119 (29.82)
	College degree	91(22.81)
	Graduate degree	17 (4.26)
	Other	3 (0.75)
Employment status		
	Employed, regular full-time	80 (20.05)
	Employed, regular part-time	37 (9.27)
	Occasional work/odd jobs	21 (5.26)
	Unemployed	104 (26.07)
	Student	23 (5.76)
	Disability	94 (23.56)
	Other	40 (10.02)
Annual Income		
	<\$5,000	92 (23.06)
	\$5,000–14,999	92 (23.06)
	\$15,000–24,999	61 (15.29)
	\$25,000–49,999	72 (18.05)
	\$50,000–74,999	23 (5.76)
	Other	59 (14.79)

Table 2

Lifetime and current (past 3 month) substance use, based on responses to the ACASI ASSIST

Substance	Lifetime use [n(%)]	Current use [n (%)]
Tobacco	251 (62.91)	132 (33.08)
Alcohol	334 (83.71)	224 (56.14)
Marijuana	233 (58.40)	69 (17.29)
Cocaine	157 (39.35)	39 (9.77)
Prescription Stimulants *	48 (12.03)	11 (2.76)
Methamphetamine	38 (9.52)	0
Inhalants	43 (10.78)	5 (1.25)
Sedatives *	97 (24.31)	35 (8.77)
Hallucinogens	90 (22.56)	11 (2.76)
Heroin	66 (16.54)	16 (4.01)
Prescription opioids *	83 (20.80)	37 (9.27)

* Only non-medical use of these substances is recorded by the ACASI ASSIST

Prevalence, sensitivity, specificity, likelihood ratios (LR), and area under the curve of the ACASI ASSIST for detecting unhealthy use and substance use disorders

Table 3

Substance class	Positive on reference standards n (%)	Positive on ACASI N (%)	Optimal cutoff	Sensitivity % (95% CI)	Specificity % (95% CI)	AUC (95% CI)	Positive LR ¹	Negative LR ¹
Unhealthy Use								
Tobacco	125 (31.33)	156 (38.1)	>= 4	93.6 (87.8, 97.2)	85.8 (81.1, 89.7)	0.90 (0.87, 0.93)	6.58	0.07
Alcohol—Men	64 (31.22)	111 (54.15)	>= 5	85.9 (75.0, 93.4)	60.3 (51.7, 68.4)	0.73 (0.67, 0.79)	2.16	0.23
Alcohol—Women	20 (10.36)	85 (44.04)	>= 3	100.0 (83.2, 100.0)	62.4 (54.8, 69.7)	0.81 (0.78, 0.85)	2.66	0.00
Marijuana	56 (14.04)	116 (29.07)	>= 2	94.6 (85.1, 98.9)	81.6 (77.1, 85.6)	0.88 (0.85, 0.92)	5.15	0.66
Cocaine	36 (9.02)	94 (23.56)	>= 2	86.1 (70.5, 95.3)	84.0 (79.8, 87.6)	0.85 (0.79, 0.91)	4.97	0.17
Substance Use Disorder								
Tobacco	49 (12.28)	114 (28.57)	>= 12	100 (92.7, 100)	82.9 (78.5, 86.7)	0.91 (0.89, 0.93)	5.38	0.00
Alcohol - Men	39 (19.02)	40 (19.51)	>= 13	79.49 (63.5, 90.7)	94.58 (90.0, 97.5)	0.87 (0.80, 0.94)	14.7	0.22
Alcohol—Women	7 (3.63)	38 (19.69)	>= 7	85.71 (42.1, 99.6)	82.80 (76.6, 87.9)	0.84 (0.70, 0.99)	4.98	0.17
Marijuana	29 (7.27)	86 (21.55)	>= 4	82.8 (64.2, 94.2)	83.2 (79.0, 87.4)	0.83 (0.76, 0.90)	4.94	0.21
Cocaine	29 (7.27)	75 (18.8)	>= 4	89.7 (72.6, 97.8)	86.8 (82.9, 90.0)	0.88 (0.82, 0.94)	6.77	0.12

¹LR = likelihood ratio

Table 4

Comparison of the diagnostic accuracy of the ACASI ASSIST for detecting unhealthy substance use at WHO-ASSIST recommended cutoffs and at empirically derived optimal ACASI-ASSIST cutoffs

Substance Class	WHO CUT OFF	ACASI CUT OFF	Diagnostic accuracy of ACASI ASSIST using WHO cutoffs					Comparison of differences in diagnostic accuracy			
			Sensitivity with WHO Cutoff % (95% CI)	Sensitivity with ACASI Cutoff % (95% CI)	Specificity with WHO Cutoff % (95% CI)	Specificity with ACASI Cutoff % (95% CI)	AUC with WHO Cutoff (95% CI)	AUC with ACASI Cutoff	Comparison of Sensitivity	Comparison of Specificity	Comparison of AUC
Tobacco	>= 4	>= 4	93.6 (87.8, 97.2)	93.6 (87.8, 97.2)	85.8 (81.1, 89.7)	85.8 (81.1, 89.7)	0.90 (0.87, 0.93)	0.90 (0.87, 0.93)	N/A	N/A	N/A
Alcohol											
Male	>= 11	>= 5	65.6 (52.7, 77.1)	85.9 (75.0, 93.4)	90.8 (84.7, 95.0)	60.3 (51.7, 68.4)	0.78 (0.72, 0.85)	0.73 (0.67, 0.79)	p=0.003 *	p=0.000 *	p=0.111
Female	>= 11	>= 3	45.0 (23.1, 68.5)	100.0 (83.2, 100.0)	91.9 (86.8, 95.5)	62.4 (54.8, 69.7)	0.68 (0.57, 0.80)	0.81 (0.78, 0.85)	p=0.001 *	p=0.000 *	p=0.032 *
Marijuana	>= 4	>= 2	78.6 (65.6, 88.4)	94.6 (85.1, 98.9)	87.8 (83.8, 91.0)	81.6 (77.1, 85.6)	0.83 (0.77, 0.89)	0.88 (0.85, 0.92)	p=0.004 *	p=0.000 *	p=0.05
Cocaine	>= 4	>= 2	83.3 (67.2, 93.6)	86.1 (70.5, 95.3)	87.6 (83.8, 90.8)	84.0 (79.8, 87.6)	0.85 (0.79, 0.92)	0.85 (0.79, 0.91)	p=0.317	p=0.000 *	p=0.468

*
p<0.05

Comparison of sensitivity and comparison of specificity using McNemar's chi-sq test

Comparison of AUC using roccomp command in STATA