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BRIEF REPORT

Criterion Validity of Self-Reports of Alcohol, Cannabis, and Methamphetamine Use Among Young Men in Cape Town, South Africa

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Abstract Valid measurement of substance use is necessary to evaluate preventive and treatment interventions. Self-report is fast and inexpensive, but its accuracy can be hampered by social desirability bias and imperfect recall. We examined the agreement between self-report of recent use and rapid diagnostic tests for three substances (alcohol, cannabis, and methamphetamine) among 904 young men living in Cape Town, South Africa. Rapid diagnostic tests detected the respective substances in 32, 52, and 22% of men. Among those who tested positive, 61% (95% CI [56%, 66%]), 70% ([67%, 74%]), and 48% ([42%, 54%]) admitted use. Men were moderately more willing to admit use of cannabis than alcohol (log OR 0.42) or admit use of alcohol than methamphetamine (log OR 0.53). Our findings show that self-report has reasonable criterion validity in this population, but criterion validity can vary substantially depending on the substance.

Keywords Criterion validity · Self-report · Alcohol · Cannabis · Methamphetamine · South Africa

Accurate screening for substance use is important for research, public health, and clinical work. This study examines how well self-reports of usage of three substances—alcoholic beverages, cannabis (known locally as "dagga"), and methamphetamine (known locally as

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"tik")—predict physiological tests of substance use among young men living in Cape Town, South Africa. The study was conducted in advance of a community-level intervention for substance use and other risky behaviors. In this setting, as in any program to treat or prevent substance use, it is important to have valid measures of substance use in order to evaluate individual outcomes and the overall intervention. Self-report is an attractive and widely used option because it is inexpensive, non-invasive, quick, and convenient, but self-report is not guaranteed to be valid. In particular, stigmatized behavior such as substance use may be underreported due to social desirability bias: people can be understandably reluctant to admit stigmatized behavior. What's more, people may simply misremember their behavior, especially if their memory has been adversely affected by substance use, as by an alcohol-induced blackout (White 2003). To this end, we estimated the criterion validity of self-report by comparing it to physiological tests.

Previous research of this kind suggests that self-report is often accurate, but accuracy can vary by population and by the substance being examined. We will focus on "honesty rates," the proportion of people who admit use among all people for whom a physiological test detected use. (In the language of binary classification, the honesty rate is called the "hit rate," "sensitivity," "recall," or "true positive rate"; it is equal to 1 minus the false negative rate. Despite our use of the word "honesty," honesty rates can of course be influenced by memory errors as well as deliberate misrepresentation.) Honesty for alcohol has received the most research attention, albeit only in clinical or treatment settings. High honesty rates (≥83%) have been found when using breath, urine, or hair tests in Sweden (Dahl et al. 2011), Australia (Bonevski et al. 2010), and Cape Town (Cherpitel et al. 2007; Peden et al. 2000; Kader et al. 2012). An exception is a urine-based study of Swedish opioid addicts in methadone maintenance treatment, who were only 65% honest about alcohol (Helander et al. 1999).

For cannabis, urine tests have found a broader range of honesty rates, perhaps partly due to the use of arrestee populations. American adolescents in cannabis dependence treatment were 77% honest (Buchan et al. 2002), American arrestees were 64% honest (Lu et al. 2001), South African arrestees were 54% honest (Plüddemann and Parry 2003), and Cape Town trauma center patients were 40% honest (Peden et al. 2000). The lowest honesty rate, 22%, was observed in a roadside survey of Belgian drivers that used a saliva test (Van der Linden et al. 2014).

We know of two previous studies reporting honesty rates for methamphetamine. The previously mentioned sample of American arrestees (Lu et al. 2001) obtained an honesty rate of 56% for a urine test. A study of admissions to a California emergency room (Lee et al. 2009) for chest pain (which is associated with methamphetamine use) found an honesty rate of 50% for a urine test.

Why might honesty differ by substance? One might speculate that honesty is affected by perceptions of the stigma and potential harm associated with a substance. Panels of experts (Nutt et al. 2007, 2010) have rated alcohol as more harmful overall than amphetamines, and amphetamine more harmful than cannabis. A survey of young adults in Manhattan (Palamar et al. 2012) found that they stigmatized cannabis (mean rating 2.11 on a five-point scale) slightly less than amphetamine (mean rating 2.71). A survey of American college students (Spigner et al. 1993) found that 78% saw regular use of amphetamines as a "great risk," while 75% said the same of daily drinking, 60% said the same of cannabis use, and 43% said the same of weekend drinking. Overall, it seems likely that people will be less honest about their amphetamine use than their cannabis or alcohol use. The relative stigma of cannabis and alcohol is less clear. As for memory, chronic use of any of alcohol (Kopelman 1995), cannabis

(Solowij and Battisti 2008), or methamphetamine (Nordahl et al. 2003) is associated with memory impairment. However, acute methamphetamine use can improve memory in at least some cases (Soetens et al. 1995), so methamphetamine reports may be less prone to memory errors than alcohol or cannabis reports.

In South Africa, as in many other jurisdictions, alcohol is legal to produce and to sell to any person who is at least 18 years old (South Africa 2004), whereas cannabis and methamphetamine are illegal to possess or use (South Africa 2003). People in Cape Town asked for their attitudes about a hypothetical addict described in a vignette (Sorsdahl et al. 2012) gave mostly the same responses regardless of the substance the character was addicted to, including 64% agreeing that the addict's problems betrayed a weak character. In fact, they seemed to stigmatize addiction more than schizophrenia or panic disorder. However, they saw alcoholics as slightly more dangerous (mean rating 6.5 on a nine-point scale) than cannabis (6.0), methamphetamine (6.0), and even heroin (6.1) addicts. They also described a male alcoholic as needing to be coerced into treatment (6.6) more than a female alcoholic (5.8). Among workers in 11 South African mines, 97% agreed that alcohol use can lead to mining accidents, and 86% said the same for cannabis (Pick et al. 2003). A survey of methamphetamine users in a township near Cape Town (Meade et al. 2015) found that 90% were interested in getting treatment, but only 10% had ever received treatment. Cannabis seems to rarely be used as an alternative treatment for HIV: among HIV-positive people in KwaZulu-Natal, elsewhere in South Africa, just 4% said they used cannabis (Peltzer et al. 2008). Overall, South Africans appear to regard all three substances with caution, with no strong tendency to see them as differentially dangerous or stigmatizing, even though the law favors alcohol.

This study has two novel features that are useful for advancing the study of substance self-report validity. One, it considers a vulnerable population in need of intervention for substance use (young men in Cape Town) in a less formal setting than clinics or police stations, where honesty may well be different. Two, it examines alcohol, cannabis, and methamphetamine use all in one sample, allowing for direct comparisons of honesty rates. Kader et al. (2012) also considered all three substances in one sample, but due to their sample sizes (around 30), only alcohol had more than one positive test.

Method

Men were recruited from 24 neighborhoods of Cape Town (the protocol is described in detail in Rotheram-Borus et al. 2017). The institutional review boards of the University of California, Los Angeles (IRB#14-001587) and Stellenbosch University (N14/08/116) approved the study protocol. In each neighborhood, a recruiter flipped a coin onto a map of the neighborhood to decide what dwelling to start with and then went from one dwelling to the next in concentric circles. People were invited to participate in the study if they were male, were aged 18 to 29 years, had slept in the dwelling in question on at least four nights a week over the past 2 months, spoke Xhosa or English, did not appear to be intoxicated, and were able to understand the recruiter. The recruiter continued until 50 men in the neighborhood had agreed to participate. The refusal rate was below 5%. Men completed consent forms before any assessment.

Homes in these areas are typically too small to allow for confidential interviewing. Hence, men were transported to a local storefront research study space for interviewing. Trained study personnel conducted a 1-h interview with each man, recording responses on mobile phones.

The interviews began in October 2015 and are currently ongoing. The interviews covered a variety of topics including basic demographic information, substance use, and contact with the criminal justice system. In this paper, we analyze the responses to three interview questions: "How many drinks containing alcohol have you had in the last three days?" (with responses dichotomized as zero vs. non-zero), "Have you used dagga [i.e., cannabis] in the last two days?", and "Have you used tik [i.e., methamphetamine] in the last two days?". We use the data up to but not including February 2017.

Men also completed urine-based rapid diagnostic tests (RDT) sold by CLIAwaived Inc. (San Diego, CA), one for each substance. The alcohol RDT (ETG-1000) detects ethyl glucuronide as low as 500 ng/mL. The cannabis RDT (CLIA-SDDT-10) detects 11-nor-Δ^9-tetrahydrocannabinol-9-carboxylic acid as low as 50 ng/mL. The methamphetamine RDT (CLIA-SDDT-16) detects methamphetamine as low as 500 ng/mL. Hence, these RDTs could detect alcohol use in the last 80 h (over 3 days), cannabis use in the last 3 days (possibly up to 7 days, or 30 days in chronic users), and methamphetamine use in the last 3 days.

Some men have received the baseline assessment (including the interview and the RDTs) more than once, because delays in beginning the intervention led to the need to update the baseline information. In this paper, we use only the first assessment of each subject.

In a pilot study of this population (Rotheram-Borus et al. 2016), only 17% of men reported ever using methaqualone (Mandrax) and 16% reported ever using cocaine, compared to 23% for methamphetamine; given these low rates, methaqualone and cocaine were not considered in this study.

Data Analysis

The data analysis concentrated on proportions, such as honesty rates and the proportion of men whose self-reports agreed with the corresponding RDT. We computed 95% confidence intervals using the percentile bootstrap or the Jeffreys method for a binomial proportion (i.e., taking the 0.025 and 0.975 quantiles of a beta distribution with parameters $a + 0.5$ and $n - a + 0.5$, where n is the number of trials and a is the number of successes), as indicated. We also calculated confusion matrices (i.e., contingency tables of use according to self-report vs. use according to RDTs). We conducted all analyses with Python 3.5 and statsmodels 0.8.0. Analysis code can be found at http://arfer.net/projects/soccer.

Results

Table 1 reviews the sample. We obtained data for 1155 men. The men were generally young (median age 22 years) and poor (52% earned R500 or less per month). Substantial minorities had been arrested (34%) or joined a gang (22%) at least once. Most of the men said they drank (76%) or had used cannabis at least once (75%), whereas a minority said they had used methamphetamine at least once (27%).

Table 2 shows the confusion matrices of self-report used to predict RDTs. Overall, RDTs detected the respective substances (alcohol, cannabis, and methamphetamine) in 32, 52, and 22% of men. (Multiple substance use was common, with 26% of men having two RDTs positive and 5% having all three positive.) By contrast, 29, 37, and 11% of men reported use. The accuracies (i.e., proportions agreement, or consistencies) were 77, 83, and 88%. These compare favorably to the base rates of the modal class (i.e., for each substance, either the

Table 1 Properties of the sample. Except for sample size, these variables are all self-reported

Sample size	1155
Age (years) median	22
Years of schooling, <9	13%
Years of schooling, 9–12	87%
Years of schooling, >12	1%
Monthly income ≤R500 (US$32)	52%
Ever held a job	70%
Ever been arrested	34%
Ever been jailed	6%
Ever joined a gang	22%
Drinks alcohol	76%
Ever used cannabis	75%
Ever used methamphetamine	27%

proportion of men with positive RDTs or the proportion with negative RDTs, whichever is larger), which are 68, 52, and 78%. Recall, however, that the time horizons asked about by the self-report questions did not exactly match the temporal thresholds of the RDTs.

We see that among men who denied use, only 18, 25, and 13% actually did use according to the RDTs. Contrapositively, among men for whom RDTs detected use, only 61, 70, and 48% admitted use. These last three figures are what we described in the introduction as "honesty rates." Jeffreys 95% confidence intervals for the honesty rates are [56%, 66%], [67%, 74%], and [42%, 54%].

To compare honesty between the three substances, we can examine the log odds ratios of each pair of honesty rates, and compute 95% confidence intervals with the percentile bootstrap. We find that men were 0.42 ([0.15, 0.69]) more honest for cannabis than alcohol, 0.53 ([0.21, 0.86]) more honest for alcohol than methamphetamine, and 0.95 ([0.67, 1.23]) more honest for cannabis than methamphetamine.

It is also useful to examine RDT results for men who stated that they did not drink or that they had never used cannabis or methamphetamine. Among alleged teetotalers, 6% tested positive for alcohol. Among those who stated they had never used cannabis or methamphetamine, 4 and 6% tested positive, respectively.

Discussion

Treating RDTs as the gold standard of whether men actually used a substance, we found that self-report was generally accurate. For each of the three substances, self-report matched biomarkers in at least 75% of men, and the accuracy was substantively higher than the base

Table 2 Confusion matrices for each of the three substances, comparing self-report to rapid diagnostic tests. Percentages are out of the column totals

	Rapid diagnostic test					
	Alcohol		Cannabis		Methamphetamine	
	Negative	Positive	Negative	Positive	Negative	Positive
Self-report: no	671 (85%)	144 (39%)	545 (97%)	177 (30%)	897 (100%)	133 (52%)
Self-report: yes	116 (15%)	224 (61%)	14 (3%)	419 (70%)	3 (0%)	122 (48%)

rate (i.e., the proportion of the RDT's modal outcome). At the same time, self-report missed many positive cases: honesty rates were 61% for alcohol, 70% for cannabis, and 48% for methamphetamine. The men were moderately more honest about cannabis than alcohol, and in turn moderately more honest about alcohol than methamphetamine.

These results are roughly comparable to those of previous studies. Compared to the previous samples discussed in the introduction (Bonevski et al. 2010; Buchan et al. 2002; Cherpitel et al. 2007; Dahl et al. 2011; Helander et al. 1999; Kader et al. 2012; Lee et al. 2009; Lu et al. 2001; Peden et al. 2000; Plüddemann and Parry 2003; Van der Linden et al. 2014), our sample was especially honest about cannabis, especially dishonest about alcohol, and typical about methamphetamine. It may be surprising that the men were more honest about cannabis than about alcohol, since in South Africa, as in most of the world, alcohol is legal whereas cannabis is not. But as discussed in the introduction (Nutt et al. 2007; Nutt et al. 2010; Spigner et al. 1993; Sorsdahl et al. 2012), attitudes, among experts and laypeople alike, may hold drinking to be as bad as cannabis or worse. Recent successes by movements to legalize cannabis, such as Colorado Amendment 64 (Healy 2014) and California Proposition 64 (McGreevy 2016) in the USA, suggest that law is beginning to change in order to conform to these attitudes. As for methamphetamine, while the honesty rate we obtained was typical of that of previous studies, its low value compared to that of the other substances is odd in light of its possible memory-boosting effects (Soetens et al. 1995) and how the respondents of Sorsdahl et al. (2012) perceived it as no more dangerous than alcohol. This said, Sorsdahl et al. asked for opinions about addicts specifically; one might imagine that without the qualification of addiction, methamphetamine use is stigmatized more than drinking.

A limitation of our study, as with most studies that seek to validate substance self-report, is that physiological tests are not (and cannot be) perfectly accurate. Hence, some of the men with a positive RDT who denied use may have been telling the truth. Another limitation is that the time horizons of the self-report questions and the RDTs were not equal. In particular, our RDT for cannabis could detect use as long ago as 30 days, whereas we asked about use in the past 2 days. This might be expected to produce a negatively biased estimate of the honesty rate for cannabis, but the fact that cannabis had the highest honesty rate of the three substances suggests that the mismatch was not a serious problem in practice. Finally, because of the consent process for the study, the men knew while they were answering self-report questions that they would later undergo physiological drug tests, if they had not already. Thus, they may have been more honest than they would have been in a study without physiological drug tests.

Future research of substance use in this population should be cognizant of the honesty rates obtained here. Most drinkers and users of cannabis can be expected to admit their use, but far from all of them: 61 and 70%, respectively. The case for methamphetamine is worse: self-report will be able to detect only a minority of users (48%) and thus is unlikely to be sufficient, especially for small samples.

One possibly striking characteristic of our sample is its poverty. Most of the men had an income of R500 or below, well under the R779 upper-bound poverty line estimated for 2014 in South Africa (Statistics South Africa 2015), which is the amount required to purchase both enough food for good health and essential non-food items, without having to sacrifice either. However, the same poverty criterion is met by 54% of South Africans (Statistics South Africa 2015), so our sample's poverty is not unusual.

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Compliance with Ethical Standards All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 (5).

Informed Consent Informed consent was obtained from all patients for being included in the study.

Conflict of Interest The authors declare that they have no conflict of interest.

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