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Predictive validity of the AUDIT for hazardous alcohol consumption in recently released prisoners*

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ABSTRACT

Background: This study aimed to assess the predictive validity of the Alcohol Use Disorders Identification Test (AUDIT) among adult prisoners with respect to hazardous drinking following release, and identify predictors of post-release hazardous drinking among prisoners screening positive for risk of alcohol-related harm on the AUDIT. **Methods:** Data came from a survey-based longitudinal study of 1,325 sentenced adult prisoners in Queensland, Australia. Baseline interviews were conducted pre-release with follow-up at 3 and 6 months post-release. We calculated sensitivity, specificity and area under the receiver operating characteristic (AUROC) to quantify the predictive validity of the AUDIT administered at baseline with respect to post-release hazardous drinking. Other potential predictors of hazardous drinking were measured by self-report and their association with the outcome was examined using logistic regression. **Results:** At a cut-point of 8 or above, sensitivity of the AUDIT with respect to hazardous drinking at 3-month follow-up was 81.0% (95%CI:77.9%-84.6%) and specificity was 65.6% (95%CI:60.6%-70.3%). The AUROC was 0.78 (95%CI:0.75-0.81), indicating moderate accuracy. Among those scoring 8 or above, high expectations to drink post-release (AOR: 2.49; 95%CI:1.57-3.94) and past amphetamine-type stimulant (ATS) use (AOR: 1.64; 95%CI:1.06-2.56) were significantly associated with hazardous drinking at 3 months post-release. Results were similar at 6 months. **Conclusions:** Among adult prisoners in our sample, pre-release AUDIT scores predicted hazardous drinking six months after release with acceptable accuracy, sensitivity and specificity. Among prisoners screening positive on the AUDIT, expectations of post-release drinking and ATS use are potential targets for intervention to reduce future hazardous drinking.

KEYWORDS: Alcohol Use Disorders Identification Test; predictive validity; prisoners; ex-prisoners; alcohol

1. INTRODUCTION

Among prisoners in developed countries, the prevalence of diagnosed alcohol use disorders ranges from 18% to 30% (Fazel et al., 2006). Clinical diagnoses, however, may under-represent the extent of alcohol misuse among prisoners; in Australia, as many as 58% of prisoners are at risk of alcohol-related harm (Australian Institute of Health and Welfare, 2011). Alcohol misuse has been linked to numerous poor health outcomes including liver disease, cardiovascular disease, diabetes, cancer, neuropsychiatric disorders and injury, and accounts for an estimated 4% of global mortality (Rehm et al., 2009). Alcohol consumption is thus likely to contribute to elevated rates of mortality (Kinner et al., 2013b) and morbidity (Fazel and Baillargeon, 2011) in ex-prisoners in the months following release, and is an important driver of recidivism (MacAskill et al., 2011).

The period of incarceration represents a unique opportunity to improve the health of this highly disadvantaged group, yet without efforts to sustain health improvements post-release, these health gains are often rapidly lost (Kinner, 2006). Identifying prisoners likely to drink hazardously after release and intervening to reduce future alcohol-related harms is hence of public health importance. To achieve this aim, two initial steps are necessary. First, the validity of tools used to identify prisoners most at risk must be established. Second, for those most at risk, points of intervention to reduce post-release hazardous drinking must be identified.

Screening tests for alcohol misuse may provide a means of identifying prisoners likely to drink hazardously post-release. The Alcohol Use Disorders Identification Test (AUDIT) was developed by the World Health Organization (WHO) to screen for risk of alcohol-related harm among adults in a primary care setting (Saunders et al., 1993). It is widely used in community populations and has exhibited excellent reliability and validity in cross-sectional studies (Reinert and Allen, 2002, 2007). Longitudinal research has established the predictive value of the AUDIT in community populations, where it has been shown to predict future alcohol-related social and medical problems (Conigrave et al., 1995), mortality (Bradley et al., 2001), medication non-adherence (Bryson et al., 2008) and recurrence and persistence of

alcohol dependence (Boschloo et al., 2012). In prisons, cross-sectional research has found that between 57% and 81% of prisoners screen positive for harmful alcohol consumption on the AUDIT (Australian Institute of Health and Welfare, 2012; Borrill et al., 2003; Butler et al., 2003; Coulton et al., 2012; Fotiadou et al., 2004; MacAskill et al., 2011; McMurrin, 2005; Newbury-Birch et al., 2009; Plant and Taylor, 2012).

Community-validated screening tools cannot, however, be assumed to be equally valid in prisons, and cross-sectional studies in prison cannot determine whether the AUDIT predicts post-release drinking patterns. Only three studies of the psychometric properties of the AUDIT among prisoners have been published. Of these, two were cross-sectional (Almarri et al., 2009; El-Bassel et al., 1998); the third was longitudinal but examined only test-retest reliability over a short timeframe without post-release follow-up (Maggia et al., 2004). We are unaware of any studies investigating the predictive validity of the AUDIT among prisoners or ex-prisoners.

Likewise, little is known about what factors might influence drinking in ex-prisoners. Among male inmates, pre-release expectations of future difficulty with alcohol use have been found to predict post-release drinking (Lösel et al., 2012). Cross-sectionally, alcohol consumption and social support are negatively associated among male ex-prisoners (Seal et al., 2007). In Australian prisoners, younger age, Indigenous ethnicity, intellectual disability, mental illness, unstable housing, young age at drinking initiation, tobacco smoking and illicit drug use are risk factors for AUDIT scores indicative of alcohol dependence (Kinner et al., 2012b). In the general community, longitudinal predictors of high alcohol consumption include male gender, white ethnicity and higher educational level (Moore et al., 2005); being unmarried (Prescott and Kendler, 2001); and mood and anxiety disorders (Wolitzky-Taylor et al., 2012). The potential of these factors as targets for intervention to reduce hazardous drinking in ex-prisoners remains to be investigated.

This paper uses data from a longitudinal study of adult prisoners and ex-prisoners to address the following aims: 1) To assess the predictive validity of the AUDIT administered to prisoners with respect

to hazardous drinking in the six months following release; 2) among ex-prisoners who screened positive on the AUDIT prior to release, to identify additional longitudinal predictors of hazardous drinking.

2. METHODS

2.1 Study design

Data for this study came from a randomised controlled trial of a low-intensity intervention aiming to facilitate health care utilisation for recently released adult ex-prisoners in Queensland, Australia. The intervention and study protocol are described in detail elsewhere (Kinner et al., 2013c); in brief, participants in the intervention group received a personalised booklet summarising their health status and identifying appropriate community health services, and were telephoned by trained workers in each of the first four weeks post-release to identify their health needs and facilitate health care utilisation.

Baseline interviews were conducted within six weeks of expected release date, and before randomisation. Baseline data were collected using a structured paper questionnaire in confidential interviews typically lasting 60–90 minutes and were subsequently entered into a computer database. Follow-up interviews were conducted approximately 1, 3 and 6 months post-release. Hazardous drinking was measured at 3 and 6 months. For those in the community, post-release interviews were conducted via telephone and data were entered directly into the database. Prison interviews were typically face-to-face, with some via telephone. The study was designed to minimise attrition (Kinner et al., 2009). Ethical clearance was granted by the University of Queensland's Behavioural and Social Sciences Ethical Review Committee.

2.2 Participants

Participants were sentenced adult prisoners from seven Queensland prisons, recruited August 2008 – July 2010. Eligible participants were within six weeks of expected release (full-time or parole) and able to provide informed, written consent. Remand (pre-trial) prisoners were excluded due to

uncertainty regarding release dates. Women were oversampled to ensure sufficient numbers for sex-stratified analyses.

Recruitment occurred via consecutive sampling. Potential participants were identified from prison records and were seen by trained interviewers in a private location. The interviewers explained the study and provided an information sheet in plain-language. Eligible prisoners were invited to sign a consent form. Participants received AU\$10 remuneration.

2.3 Measures

The AUDIT was administered at baseline interview. It consists of 10 items scored from 0–4 addressing frequency and quantity of alcohol consumption and its adverse consequences (Babor et al., 2001). AUDIT scores can be categorised into four levels of risk of alcohol-related harm: low (total scores 0–7), moderate (8–15), high (16–19) and possible alcohol dependence (20–40; Babor et al., 2001). Post-release hazardous drinking was measured via the AUDIT-Consumption (AUDIT-C), a short version of the AUDIT consisting of the first three questions on quantity and frequency of alcohol consumption. AUDIT-C scores of 3 for women and 4 for men indicate hazardous alcohol consumption (Reinert and Allen, 2007). The AUDIT and AUDIT-C were modified for use with prisoners and ex-prisoners respectively (Table 1).

Potential predictors of post-release hazardous alcohol consumption were measured at baseline interview and dichotomised for ease of assessment and interpretation in clinical settings. Demographic variables included age (<25 vs. ≥25 years), sex (female vs. male), Indigenous status (Aboriginal and/or Torres Strait Islander vs. neither), educational attainment (<10 years schooling vs. ≥10 years), employment status in the 6 months prior to incarceration (unemployed vs. any employment), housing status in the 6 months prior to incarceration (unstable vs. stable) and current relationship status (stable relationship vs. not). Subjective social support was measured using the ENRICH Social Support Inventory (ESSI; Mitchell et al., 2003) dichotomised at the median. High psychological distress was defined as a score ≥22 on the Kessler Psychological Distress Scale (K10; Andrews and Slade, 2001).

Current depressive or anxiety disorders, cannabis and amphetamine-type stimulant (ATS) use in the year prior to incarceration and early initiation into alcohol consumption (≤ 14 years; Grant and Dawson, 1997) were determined by self-report. Those reporting that they were 'likely' or 'very likely' to drink within four weeks of release were classed as expecting to drink post-release.

2.4 Statistical analyses

Those without valid AUDIT scores at baseline were excluded from all analyses. We first compared the baseline characteristics of participants scoring ≥ 8 on the AUDIT with those scoring < 8 using chi-square tests. We computed Cronbach's alpha as a measure of internal consistency of the AUDIT at baseline. To investigate the possibility of biased attrition according to baseline AUDIT score, we calculated percentage attrition by AUDIT risk category, and odds ratios (ORs) for attrition compared to the low risk category. We investigated whether loss to follow-up was likely to bias our effect estimates for predictors of hazardous drinking by fitting a multivariable logistic regression model to identify baseline predictors of attrition at 3 and 6-month follow-ups in those scoring ≥ 8 on the AUDIT. To address Aim 1 we calculated the sensitivity, specificity and positive predictive value (PPV) of the AUDIT with respect to hazardous drinking at each possible cut-off for each post-release time point. The optimal cut-off was defined as the score that yielded (sensitivity, specificity) closest to (1,1) on a Cartesian plane (Akobeng, 2007). To assess predictive accuracy, we computed areas under the receiver operating characteristic curve (AUROCs).

To address Aim 2, we selected factors with an empirical or theoretical association with risky drinking according to the literature. After restricting the sample to participants who scored ≥ 8 on the AUDIT, we computed univariable ORs for hazardous drinking at 3 and 6 months post-release. Variables having $p < 0.2$ at one or both time points were considered for inclusion in a predictive multivariable logistic regression model; age, sex and Indigenous status were considered likely to be confounders and were thus forced into the final model regardless of significance. Model building for each time point was based on an approach that aims to maximise predictive accuracy (Vittinghoff et al., 2012). First, we

constructed multivariable models with every possible combination of candidate predictors plus age, sex and Indigenous status, and then calculated 10-fold cross-validated AUROCs averaged over 20 iterations and ranked the models by AUROC in descending order. The AUROC is commonly used as a measure of predictive accuracy in logistic regression models (D'Agostino and Nam, 2004); cross-validation employs repeated data-splitting to reduce bias in measures of predictive accuracy due to over-fitting (Harrell et al., 1996). We then applied 200 iterations of the cross-validation procedure to the top 30 models and re-ranked them to identify the 10 most predictive. Finally, given the expectation that these 10 models would yield similar AUROC estimates and that the AUROC is not sensitive to small differences in the discriminative power of models (Harrell et al., 1996), we selected the most inclusive final models with the largest number of common variables between the waves of follow-up.

We conducted three sets of sensitivity analyses to investigate possible biases caused by participants who had returned to prison at follow-up, the effect of receiving the health-care utilization intervention and the effect of serving a longer sentence (≥ 1 year). We excluded participants belonging to each of these three groups in turn and re-ran our ROC analyses and multivariate logistic regression model to investigate any changes in our point estimates.

3. RESULTS

3.1 Baseline characteristics

Of 1,325 participants recruited, 1,296 had valid responses on the AUDIT and were included in analyses. Details of recruitment and participation rates are describe elsewhere (Kinner et al., 2009). Participants were predominantly male (78.9%) and over the age of 25 (74.1%); a high proportion were Indigenous (25.1%), poorly educated (43.6% had <10 years of schooling), unemployed in the year prior to incarceration (48.7%), reported high psychological distress (25.8%) and used cannabis (52.6%) or ATS (47.1%) in the year prior to incarceration.

Table 2 reports the baseline characteristics of participants who scored <8 ($n=499$, 38.5%) and ≥ 8 ($n=797$, 61.5%) on the AUDIT. A significantly greater proportion of those who scored ≥ 8 were young,

male, Indigenous, had <10 years of schooling, were not in a stable relationship, reported below average social support, used cannabis or ATS in the year prior to incarceration, initiated alcohol consumption by age 14 and reported a high likelihood of drinking in the four weeks after release (all $p < 0.05$). Cronbach's alpha for the AUDIT at baseline was 0.90, indicating excellent internal consistency.

3.2 Loss to follow-up

The follow-up fraction in our sample was 63% at 3 months and 65% at 6 months. Attrition at both follow-ups was positively associated with abstinence or AUDIT scores ≥ 8 compared to the low risk category (with those who were abstinent excluded; see Table S1)¹. Among participants scoring ≥ 8 on the AUDIT, the follow-up fraction was 60% at 3 months and 62% at 6 months post-release. Those lost to follow-up at 3 months were significantly more likely to be Indigenous, <25 years old, have below average social support and have been unemployed and unstably housed before incarceration. At 6 months, those lost to follow-up were significantly more likely to be Indigenous, not in a stable relationship and unstably housed prior to incarceration (see Table S2²).

3.3 Predictive validity of the AUDIT

We examined the psychometric properties of the AUDIT in the whole sample at all possible cut-points; the standard cut-point of ≥ 8 was optimal at 6 months and close to optimal at 3 months (Table S3³). Table 3 reports sensitivity, specificity and PPV for the AUDIT. Among participants drinking hazardously at 3 months, 81.0% (95%CI: 77.9%, 84.6%) had scored ≥ 8 on the AUDIT at baseline (sensitivity). Among those not drinking hazardously at 3 months, 65.6% (60.6%, 70.3%) had scored below 8 on the AUDIT at baseline (specificity). Among those scoring ≥ 8 on the AUDIT at baseline, 71.6% (67.3%, 75.6%) were drinking hazardously at 3 months (PPV). At higher AUDIT cut-offs, sensitivity

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decreased markedly while specificity increased; PPV was similar at all evaluated cut-offs. Results were similar for the 6-month follow-up.

Figure 1 shows the ROC curve for each follow-up. Our analysis yielded AUROCs (95%CI) of 0.78 (0.75, 0.81) at 3 months and 0.77 (0.74, 0.79) at 6 months, indicating that the AUDIT administered prior to release predicts hazardous alcohol consumption at both post-release time points with moderate accuracy.

3.4 Predictors of hazardous drinking in those scoring ≥ 8 on the AUDIT

Among prisoners scoring ≥ 8 on the AUDIT at baseline, significant, independent predictors of hazardous drinking at 3 months post-release included expectations of drinking post-release (AOR=2.49, 95%CI 1.57-3.94) and ATS use in the year prior to incarceration (AOR=1.64, 95%CI 1.06-2.56), adjusted for age, sex, Indigenous status, unstable housing, not being in a stable relationship and below average social support. At 6 months post-release, significant predictors of post-release hazardous drinking were again expectations to drink (AOR=2.31, 95%CI 1.46-3.64) and ATS use (AOR=1.59, 95%CI 1.03-2.44), adjusted for age, sex, Indigenous status, unstable housing and below average social support.

3.5 Sensitivity analyses

We conducted three sets of sensitivity analyses. First, we excluded all those who were incarcerated at each follow-up point; of those participants interviewed at 3 and 6 month follow-ups, 12% (104) and 23% (209) respectively were incarcerated at the time of interview. Second, we excluded all participants who were randomised to receive the intervention at baseline (50.2%). Third, we excluded all participants who had been incarcerated for more than 1 year (20.1%).

After excluding participants re-incarcerated at follow-up interview, our point estimates of AUROC, sensitivity and specificity consistently decreased by a small amount (<3%), with slightly larger changes observed in PPV (<5%) estimates due to a lower prevalence of hazardous drinking among those not re-incarcerated. After excluding those randomized to receive the intervention, these estimates

generally increased by a small amount (<4%). After excluding participants who had been incarcerated for >1 year, the estimates changed by a small amount (<3%).

In our multivariable model restricted to those scoring ≥ 8 on the AUDIT, effects significant in the whole sample remained of the same direction and similar magnitude (decreases of <17% and increases of <27% as a proportion of the original ORs) in all sensitivity analyses. Our key conclusions from the model were thus unchanged. Some larger changes were observed for odds ratios originally not significant, but as these results are effectively a series of subgroup analyses they were not considered to be of interest.

4. DISCUSSION

We aimed to evaluate the predictive validity of the AUDIT administered in prison and, among those screening positive on the AUDIT, identify other predictors of hazardous drinking post-release that might act as points of intervention to reduce alcohol-related harm. We found that the AUDIT was a moderate predictor of hazardous drinking in the first six months post-release and identified expectations of post-release drinking and pre-incarceration ATS use as predictors of hazardous drinking. This is one of the first and largest studies to longitudinally predict hazardous drinking in ex-prisoners. Although the AUDIT was originally developed to screen for current alcohol use disorders (Saunders et al., 1993), access to alcohol is limited during incarceration, and ex-prisoners are exposed to substantial health risk after release (Fazel and Baillargeon, 2011). As such, their post-release risk behaviours should be a primary concern for correctional authorities, particularly as prisoners approach their release date. Screening instruments that identify those most at risk of poor post-release outcomes can help inform and target re-entry interventions.

Previous research on the test-retest reliability of the AUDIT in prisons demonstrates the importance of the timing of screening due to variability in prisoners' responses (Maggia et al., 2004); we found that the AUDIT administered within six weeks of release effectively predicted future hazardous drinking. Given the very high prevalence of alcohol disorders among prisoners in Australia (Kinner et al.,

2012b) and internationally (Fazel et al., 2006), routinely administering the AUDIT at the point of release would be a valid and valuable way of screening for risk of future alcohol-related harm. However, prisoners often have complex health needs (Fazel and Baillargeon, 2011) and thus screening for and treatment of alcohol use disorders should not occur in isolation. A co-ordinated system of transitional support for ex-prisoners is needed to ensure that their alcohol-related and other health needs are effectively met (Kinner et al., 2013a).

Among participants scoring 8 or above on the AUDIT, we recorded strong associations between drinking expectations prior to release and observed post-release hazardous drinking. Expectations of drinking post-release are likely to be influenced by expectancies (beliefs and values) and perceived social norms surrounding drinking, cognitive factors which have previously been shown to predict future alcohol misuse (Wood et al., 1992). Substance treatment programs in prison typically target alcohol-related cognitions (Wilson et al., 2005). Our results are consistent with the hypothesis that alcohol-related cognitions predict future hazardous drinking. However, despite the provision of evidence-based substance treatment programs in Queensland prisons, in our sample those with high expectations to drink post-release and a history of hazardous drinking had significantly increased odds of reporting continued hazardous drinking post-release. Overall, three quarters of those whose AUDIT scores indicated risky drinking before prison reported continued hazardous drinking after release. This is consistent with evidence from recent reviews (Mitchell et al., 2007; Wilson et al., 2005) which suggests that the effects of prison-based substance treatment programs are typically modest. Such programs might be strengthened by continued support after release from custody.

We also observed moderately strong associations between pre-incarceration ATS use and post-release hazardous drinking. The association between ATS use and risky drinking has been widely documented in community settings (Furr et al., 2000; Kinner et al., 2012a) and our findings suggest the same association among recently released prisoners. Although we were unable to formally assess the causal pathway, there is good evidence that patterns of substance use before prison are strongly

predictive of substance use post-release (Kinner, 2006), such that those with a history of ATS use before prison may have been at increased risk of ATS use post-release, which may in turn have increased the risk of hazardous drinking. Concurrent risky drinking and ATS use leads to an even greater risk of harm (Degenhardt et al., 2008; Kinner et al., 2012a), further highlighting the need for co-ordinated responses to co-morbid substance use issues in this population.

4.1 Limitations

This study was limited by several factors. First, we relied on self-report measures, which may be subject to recall or social desirability bias. For some baseline variables, this was appropriate as we sought to identify potential targets for intervention in settings where ease of assessment is key. Further, other variables could only be measured by self-report (e.g., future expectations of drinking) and no clear alternatives are available for stigmatised behaviours such as illicit drug use, where self-report can be reliable (Darke, 1998). Post-release hazardous drinking was measured by self-report using the AUDIT-C. Although an objective measure (e.g., blood alcohol content) would have been a useful complement to this it was not feasible to collect at regular intervals over a six-month period, and the AUDIT-C has been shown to be a reliable and valid measure of hazardous drinking (Bush et al., 1998; Reinert and Allen, 2007). A useful approach for future studies would be to undertake prospective data linkage, for example with community drug and alcohol treatment service records, ideally in parallel with longitudinal data. Second, our follow-up period ended at six months post-release, although there is evidence that many forms of health disadvantage among ex-prisoners continue well beyond this time (Kinner, 2010). Further study is needed to establish the generalizability of our results to hazardous drinking in ex-prisoners beyond six months post-release. However, many prisoners return to risky behaviours in the immediate post-release period when the risk of morbidity and mortality is highest, making this an appropriate time frame for our study to focus on.

Third, we expect that our results on the predictive validity of the AUDIT will generalise well to ex-prisoners in other English-speaking, developed countries, but their applicability in other settings is

uncertain. Although we considered a wide range of baseline covariates, the significant associations observed in our analysis of predictors of post-release hazardous drinking may be due to unmeasured confounders. Further study is needed to understand the causal pathways to hazardous drinking in ex-prisoners.

Fourth, we were unable to obtain data on exposure to alcohol treatment services during the period of incarceration. Participants with a history of hazardous drinking may have been more likely to access these services, thereby reducing their risk of hazardous drinking following release. This unmeasured effect could have attenuated the apparent predictive accuracy of the AUDIT. Future studies should account for this effect where possible.

Finally, attrition at each follow-up was around 35%, which could bias our results. Our estimates of sensitivity, specificity and AUROC would be biased only if attrition was independently associated with baseline AUDIT score after adjustment for the outcome (post-release hazardous drinking), as can be shown through an algebraic examination similar to that of Kristman et al. (2004). This would cause sensitivity to be overestimated and specificity underestimated, and any bias in the AUROC would likely be small, with stronger associations between baseline AUDIT score and attrition leading to larger bias. In our study, attrition was positively but not strongly associated with baseline AUDIT score in a univariable analysis (see Table S1⁴). The association between attrition and the outcome was necessarily unmeasured but was likely to be positive and to explain much of the observed association between attrition and baseline AUDIT score. Thus we do not expect significant bias in our results for the predictive validity of the AUDIT. In participants scoring ≥ 8 on the AUDIT (Table S2⁵), most baseline characteristics were weakly associated with loss to follow-up, including the strongest predictors of post-

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release hazardous drinking (AOR=0.90 for high drinking expectations and AOR=1.11 for ATS use); these key findings are hence unlikely to be biased by attrition.

4.2 Conclusions

Among soon-to-be-released prisoners, the AUDIT predicts future hazardous drinking with acceptable accuracy, sensitivity and specificity, and is thus a suitable a tool for identifying prisoners at risk of hazardous drinking post-release. Among those identified as at risk using the AUDIT, our findings suggest that expectations regarding future drinking are important in determining patterns of alcohol consumption post-release. Those with a history of ATS use are also at increased risk, suggesting a potentiating effect of stimulant use on drinking behaviour. In addition to evidence-based substance treatment programs in prison, targeted post-release support is required to reduce high levels of hazardous drinking in recently released prisoners.

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FIGURE LEGEND

Figure 1: ROC curves and AUROCs (95% CI) for the AUDIT when predicting hazardous drinking at (a) 3 and (b) 6 month follow-up.

Caption: The 45° line represents values of sensitivity and specificity from a hypothetical screening test that classifies hazardous drinkers (cases) and non-hazardous drinkers (controls) as positive with equal probability; the area under this line is 0.5. Points that lie above this line classify cases as positive more frequently than controls, meaning that the screening test has better-than-random power to predict future hazardous drinking (AUROC > 0.5). An AUROC of 1 represents a screening test that predicts future hazardous drinking with 100% accuracy. Values of 0.5 to 0.7 indicate low accuracy, 0.7 to 0.9 indicates moderate accuracy and 0.9 to 1 indicates high accuracy (Akobeng, 2007).

Table 1: Modified versions of the AUDIT and AUDIT-C as administered at baseline and 3 and 6 month follow-up.

Question		Score				
		0	1	2	3	4
AUDIT-C Questions	In the <i>[specified time period]</i> ¹ , how often did you have a drink containing alcohol?	Never	Monthly or less	2-4 times a month	2-3 times a week	4+ times a week
	In the <i>[specified time period]</i> ¹ , how many drinks containing alcohol ² did you have on a typical day ³ when you were drinking?	1 or 2	3 or 4	5 or 6	7 to 9	10 or more
	In the <i>[specified time period]</i> ¹ , how often did you have 6 or more standard drinks on one occasion?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
Full AUDIT Questionnaire	In the <i>year before you came to prison</i> , how often did you find that were not able to stop drinking once you had started?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
	In the <i>year before you came to prison</i> , how often did you fail to do what was normally expected of you because of drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
	In the <i>year before you came to prison</i> , how often did you need a first drink in the morning to get you going after a heavy drinking session?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
	In the <i>year before you came to prison</i> , how often did you have a feeling of guilt or remorse after drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
	In the <i>year before you came to prison</i> , how often were you unable to remember what happened the night before because you had been drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
	Have you or someone else <i>ever</i> been injured as a result of your drinking?	No	-	Yes, but not recently ⁴	-	Yes, recently ⁴
	Has a relative, friend, doctor of other health worker <i>ever</i> been concerned about your drinking or suggested you cut down?	No	-	Yes, but not recently ⁴	-	Yes, recently ⁴

¹ At baseline interview, the specified time period was *the year before you came to prison*. At follow-up interviews, participants residing in the community were asked to consider the period *since their last interview*. Re-incarcerated participants were asked to consider the period *whilst they were in the community since their last interview*. If the participant had not been in the community since their last interview, they did not complete the AUDIT at that follow-up.

² Participants were asked to report the type and quantity of drinks consumed; these responses were subsequently coded into numbers of standard drinks.

³ Drinking *day* was interpreted as drinking *occasion* to accommodate the possibility of drinking sessions lasting more than one day (most relevant for those drinking heavily whilst using amphetamines in extended binges).

⁴ 'Recently' refers to *the year before you came to prison*.

Table 2: Baseline characteristics of participants according to AUDIT score category.

Baseline characteristics	AUDIT score < 8	AUDIT score ≥ 8	p
	n = 499 Number (Percent)	n = 797 Number (Percent)	
Age < 25 years	66 (13.2%)	270 (33.9%)	< 0.001
Female	124 (24.9%)	150 (18.8%)	0.010
Indigenous	66 (13.3%)	259 (32.5%)	< 0.001
< 10 years schooling	180 (36.1%)	385 (48.3%)	< 0.001
Unemployed prior to incarceration	241 (48.3%)	390 (48.9%)	0.823
Unstable housing prior to incarceration	103 (20.6%)	197 (24.7%)	0.090
Not in a stable relationship	274 (54.9%)	503 (63.1%)	0.003
ESSI score < 25	216 (43.3%)	398 (50.1%)	0.017
High/ very high psychological distress	128 (25.7%)	205 (25.9%)	0.926
Current depression/anxiety	79 (15.9%)	136 (17.3%)	0.524
Cannabis use in year prior to incarceration	176 (35.3%)	506 (63.5%)	< 0.001
ATS use in year prior to incarceration	202 (40.5%)	408 (51.2%)	< 0.001
Self-reported high likelihood of post-release drinking	209 (42.0%)	583 (73.2%)	< 0.001
Started drinking ≤14 years	191 (38.3%)	466 (58.5%)	< 0.001

Table 3: Positive predictive value, sensitivity and specificity for each standard AUDIT cut-off score at baseline with respect to hazardous alcohol consumption at 3 and 6 months post-release.

AUDIT score	3 month follow-up n = 812			6 month follow-up n = 840		
	PPV % (95% CI)	Sensitivity % (95% CI)	Specificity % (95% CI)	PPV % (95% CI)	Sensitivity % (95% CI)	Specificity % (95% CI)
> 8	71.6 (67.3, 75.6)	81.0 (77.9, 84.6)	65.6 (60.6, 70.3)	74.7 (70.7, 78.5)	78.9 (74.9, 82.5)	65.7 (60.6, 70.5)
> 16	77.4 (72.1, 82.2)	51.4 (46.5, 56.3)	83.9 (80.0, 87.4)	78.2 (73.0, 82.8)	48.4 (43.8, 53.0)	82.6 (78.3, 86.3)
> 20	76.2 (69.9, 81.7)	38.8 (34.1, 43.7)	87.0 (83.3, 90.2)	77.0 (70.9, 82.3)	36.8 (32.4, 41.3)	85.8 (81.8, 89.2)

Table 4: Unadjusted and adjusted odds ratios for hazardous drinking at 3 and 6 months post-release as a function of baseline characteristics among those score ≥ 8 on the AUDIT pre-release.

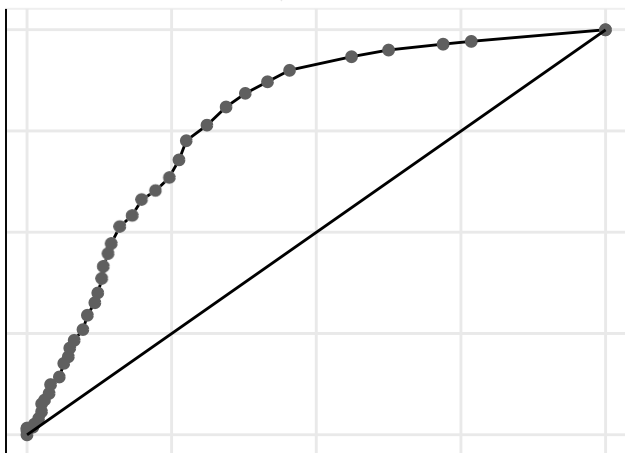
Baseline characteristics	3 months post-release n = 475		6 months post-release n = 498	
	OR (95% CI)	AOR (95% CI)	OR (95% CI)	AOR (95% CI)
Age < 25 years ^a	1.30 (0.83, 2.02)	1.02 (0.64, 1.64)	1.46 (0.94, 2.29)	1.25 (0.79, 2.00)
Female ^a	1.43 (0.85, 2.41)	1.56 (0.89, 2.72)	1.18 (0.69, 2.01)	1.29 (0.73, 2.26)
Indigenous ^a	1.17 (0.73, 1.87)	1.30 (0.79, 2.15)	0.81 (0.52, 1.27)	0.95 (0.59, 1.52)
Unemployed prior to incarceration	1.56* (1.03, 2.37)	-	1.15 (0.77, 1.73)	-
Unstable housing prior to incarceration	1.29 (0.77, 2.14)	1.15 (0.67, 1.98)	1.54 (0.90, 2.63)	1.46 (0.84, 2.55)
Not in a stable relationship	1.58* (1.05, 2.36)	1.48 (0.96, 2.29)	1.50 (1.00, 2.25)	-
ESSI score below median	1.20 (0.80, 1.80)	0.97 (0.62, 1.52)	1.55* (1.03, 2.35)	1.53 (1.00, 2.34)
Current depression/anxiety	0.67 (0.41, 1.11)	-	0.74 (0.44, 1.23)	-
Cannabis use in year prior to incarceration	1.82** (1.21, 2.73)	1.40 (0.90, 2.17)	1.03 (0.67, 1.56)	-
ATS use in year prior to incarceration	1.90** (1.27, 2.85)	1.64* (1.06, 2.56)	1.83** (1.22, 2.76)	1.59* (1.03, 2.44)
High expectations to drink post-release	2.49*** (1.62, 3.85)	2.49*** (1.57, 3.94)	2.41*** (1.56, 3.72)	2.31*** (1.46, 3.64)
High/very high psychological distress	1.06 (0.67, 1.68)	-	1.23 (0.76, 1.98)	-
< 10 years schooling	1.03 (0.69, 1.55)	-	1.23 (0.82, 1.85)	-
Started drinking at young age	0.81 (0.54, 1.22)	-	0.92 (0.61, 1.38)	-

*p < 0.05, **p < 0.01, ***p < 0.001

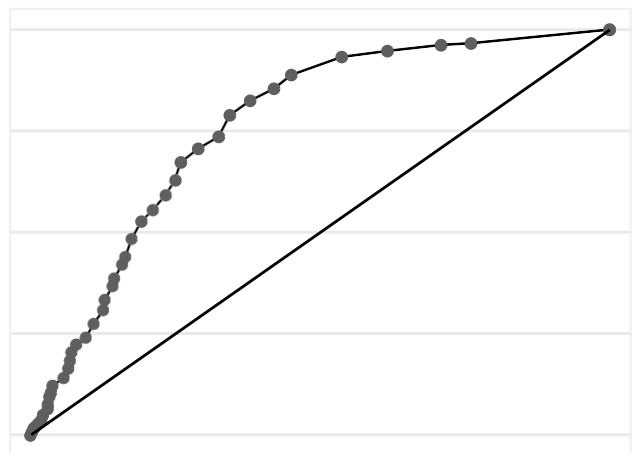
^aVariables forcibly included in the multivariable model.

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(a)



(b)



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Contributors

ET was the primary data analyst and wrote the first draft. SK and LD conceived the paper's aims, assisted data analysis and contributed to drafts. RA directed the analysis of loss to follow-up in this study and contributed to drafts. All authors approved the final version of the manuscript. SK is the principle investigator for the Passports Study; he designed the study protocol and managed data collection.

Conflict of Interest

None to declare.

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