



## Short communication

# Discriminative validity of a substance use symptom checklist for moderate-severe DSM-5 cannabis use disorder (CUD) in primary care settings

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## HIGHLIGHTS

- Assessment of moderate-severe Cannabis Use Disorder (CUD) needs improvement with growing rates of cannabis use
- We report the discriminative validity of a Substance Use Checklist for primary care patients reporting daily cannabis use
- The Checklist's overall performance was good with high specificity
- The Checklist is clinically useful to assess the probability of a diagnosis
- It is particularly useful among patient populations with average prevalence prior to screening

## ARTICLE INFO

## Keywords:

Cannabis  
Cannabis use disorder  
Clinical assessment  
Primary care  
Discriminative, validity

## ABSTRACT

**Background:** The prevalence of cannabis use disorder (CUD) is increasing in the US and primary care providers need tools to identify patients with moderate-severe CUD to facilitate treatment. A single-item screen for cannabis (SIS-C) has outstanding discriminative validity for CUD. However, because the prevalence of moderate-severe CUD is typically low, the probability that an average patient who screens positive for daily cannabis has moderate-severe cannabis use disorder is low, making follow-up assessment important.

**Methods:** This study reports the discriminative validity of a DSM-5 Substance Use Symptom Checklist ("Checklist") for moderate-severe CUD among 498 primary care patients who reported daily cannabis use on the SIS-C. We evaluated the performance of the Checklist (score 0–11) completed during routine care, compared to  $\geq 4$  DSM-5 CUD symptoms (moderate-severe CUD) on the Composite International Diagnostic Interview *Substance Abuse Module* from a confidential survey (reference standard). We estimated areas under receiver operating curve (AUROC), sensitivities, specificities, and post-test probabilities.

**Results:** Of 498 eligible patients, 17 % met diagnostic criteria for moderate-severe CUD. The Checklist's AUROC for moderate-severe CUD was 0.77 (95 % CI: 0.71–0.83), and Checklist scores of 1–2 balanced sensitivity and specificity. Among patients from a population with average prevalence of CUD before screening (~6 % prevalence) and daily use on the SIS-C, a Checklist score of 3 indicated a post-test probability of 82.1 %.

**Conclusion:** Overall performance of the Checklist was good and the high specificity made it useful for identifying patients likely to have moderate-severe CUD among those at average risk.

## 1. Introduction

The prevalence of cannabis use is increasing in the United States

(Patrick et al., 2023). As cannabis use has increased, the prevalence of cannabis use disorder (CUD) has also increased with estimates of 6.9 % of US adults meeting criteria for CUD (Cerdá et al., 2020; Hasin et al.,

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<https://doi.org/10.1016/j.dadr.2024.100260>

Received 12 March 2024; Received in revised form 20 May 2024; Accepted 12 July 2024

Available online 15 July 2024

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2017; SAMHSA, 2023). In primary care, 22 % of patients indicated cannabis use and 6.5 % of them met criteria for moderate-severe CUD (Lapham et al., 2023; Matson et al., 2022). Patients with mild CUD may not be interested in treatment, but as the severity of their CUD increases, patients may more often want treatment (Matson et al., 2023). Primary care providers are in a unique position to offer patients with moderate-severe CUD symptoms treatment, but they need tools to identify those with CUD.

Since 2015, Kaiser Permanente (KP) Washington has conducted annual screening for cannabis with the single-item screen for cannabis (SIS-C) as a part of routine primary care. Because patients who use cannabis daily are at greatest risk of CUD (Volkow et al., 2014), those who report 'daily or almost daily' (hereafter 'daily') cannabis use on the SIS-C are asked to complete an 11-item Substance Use Symptom Checklist (hereafter "Checklist") to assess Diagnostic and Statistical Manual, 5th edition (DSM-5) symptoms of Substance Use Disorder (SUD) to help engage patients in discussions of their CUD symptoms and offer treatment as appropriate (Sayre et al., 2020). While the Checklist has been evaluated psychometrically (Matson et al., 2022), the discriminative validity has not been evaluated.

This report evaluates the discriminative validity of the Checklist for past-year moderate-severe DSM-5 CUD in a sample of primary care patients who reported daily cannabis use. Specifically, this study evaluated the performance of the Checklist when used as part of routine care and documented in the electronic health record (EHR), compared to a confidential reference standard of moderate-severe past-year DSM-5 CUD from a survey.

## 2. Methods

### 2.1. Study setting and data sources

This study was conducted using EHR data and a confidential cannabis survey conducted in KP Washington primary care patients (Lapham et al., 2022). As previously described (Lapham et al., 2022), adult primary care patients ( $\geq 18$  years) were eligible for the survey if they had EHR documentation of a cannabis screen completed as part of routine primary care between January 2019 – September 2019 ( $n=108,950$ ) and were randomly sampled to receive the survey ( $n=5000$ ), including stratified oversampling for patients reporting higher frequency of cannabis use as well as Black, Indigenous, and other patients of color. This random sample was mailed survey invitation letters, followed by phone reminders, and received \$20 for completing the survey online or by phone, resulting in 1688 survey respondents (34 % response rate). Respondents' demographics, cannabis screening and Checklist scores, and diagnoses were extracted from the EHR. The study was approved by KP Washington's Institutional Review Board, and supported by the National Drug Abuse Treatment Clinical Trials Network (CTN) (2UG1DA04031406).

### 2.2. Sample

The sample for the present study includes a subset of the 1688 patients who responded to the confidential survey. Patients were included in this study of discriminative validity if: (1) they reported daily cannabis use but no other drug use, during screening in primary care (Richards et al., 2019; Sayre et al., 2020); (2) reported cannabis use and completed the reference measure for DSM-5 CUD, both on the confidential survey, and (3) completed the Checklist in primary care within 180 days of the survey. This resulted in a sample of 498 eligible patients.

### 2.3. Measures

*Single Item Screen for Cannabis (SIS-C)*. The SIS-C, a validated screen for moderate-severe CUD that asks about the frequency of cannabis use (response options: never, less than monthly, monthly, weekly, daily or

almost daily) (Matson et al., 2022), was completed by patients during routine primary care and extracted from the EHR. Patients who reported daily cannabis use on the SIS-C had post-screening probabilities ranging from 5 % to 80 % (Matson et al., 2022) based on estimated pre-screening probabilities ranging from 0.5 % to 30 % (e.g., older women versus patients with mental health or other substance use disorder conditions) (Browne et al., 2022; Compton et al., 2019; Hasin et al., 2016; Kerridge et al., 2018).

*Substance Use Symptom Checklist (Checklist)*: This Checklist was developed to assess past-year DSM-5 SUD symptoms and implemented as a part of routine primary care to support clinician-patient engagement regarding CUD and other SUD care (Glass et al., 2018; Richards et al., 2019; Sayre et al., 2020). The Checklist consists of 11 items (Supplement 1), each asking about one of the 11 DSM-5 criteria for SUD (yes/no), with the "yes" responses summed (score 0–11). Checklist data were also extracted from the EHR.

*Reference standard for DSM-5 CUD*: The Composite International Diagnostic Interview *Substance Abuse Module* (CIDI-SAM) module for CUD, modified for DSM-5 as in previous studies (Gryczynski et al., 2017; Hasin et al., 2013; McNeely et al., 2016), was collected on the confidential cannabis survey, and served as the reference standard. Scoring for the CIDI-SAM matches DSM-5 criteria for past-year mild (2–3 symptoms), moderate (4–5 symptoms) and severe ( $\geq 6$  symptoms) CUD (Hasin et al., 2013). The reference standard for this study was moderate-severe CUD in the past year on the CIDI-SAM ( $\geq 4$  symptoms) because patients with mild CUD are less likely to want treatment.

### 2.4. Data analysis

Demographic and clinical characteristics of the patient sample were analyzed with descriptive statistics. Checklist scores (0–11) were compared to the binary reference standard for moderate-severe CUD on the CIDI-SAM. Sensitivity, the true positive rate, and specificity, the true negative rate, were calculated for each score on the Substance Use Symptom Checklist (Trevethan, 2017). The area under the ROC curve (AUROC) and 95 % confidence intervals for the AUROC calculated. The AUROC reflects the Checklist's overall performance as a diagnostic test across the full scale of scores (0–11). AUROC curves with a value closer to 1 indicate better performance and a value of 0.5 indicates performance no better than chance (Hosmer and Lemeshow, 2013; Mandrekar, 2010). The optimal threshold for a diagnostic test is sometimes determined by assessing which threshold maximizes both sensitivity and specificity (Trevethan, 2017). As the Checklist is used after the SIS-C to assist clinicians in diagnosis of CUD, greater specificity may be preferable to avoid misdiagnosing patients with a potentially stigmatizing condition. Because the post-test probability of CUD depends on the pre-test probability, which can vary widely, we use Bayes' theorem (Bours, 2021) to estimate post-test probabilities for positive Checklists (positive predictive value: PPV) in subgroups of primary care patients with low (0.5 %), average (6 %) and high (30 %) prevalence of CUD, in whom a SIS-C response of daily cannabis use increases the approximate probability to 5 %, 38 % and 80 % (Supplement 2 for additional information) (Matson et al., 2022).

All analyses were performed in Stata version 16 (Stata Statistical Software, 2019), and Excel (Microsoft Corporation, 2022).

## 3. Results

### 3.1. Demographic characteristics

Table 1 presents the demographic characteristics of the study sample of 498 patients who used cannabis daily, with no other drug use reported, and completed a Checklist as part of routine care (mean days=75, SD=29). Most patients were 18–44 years old (58 %) and male (50 %), predominantly white (72.9 %), non-Hispanic (90.4 %), and commercially insured (62.9 %). Based on CIDI SAM diagnostic criteria,

**Table 1**  
Sampled Patient Demographics.

	Study Sample**	
	N	(%)
<b>Age</b>		
18–29	152	(30.5)
30–44	137	(27.5)
45–64	120	(24.1)
65+	89	(17.9)
<b>Race</b>		
Asian	19	(3.8)
Black		(10.2)
Hawaiian/Pac Isl.	51	(1.8)
Indigenous	9	(2.4)
White	12	(72.9)
Other	363	(4.4)
Unknown	22	(4.4)
	22	
<b>Hispanic (Yes)</b>	48	(9.6)
<b>Gender</b>		
Male	250	(50.2)
Female	248	(49.8)
<b>Insurance Type</b>		
Medicaid/Subsidized	71	(14.3)
Medicare	95	(19.1)
Commercial	313	(62.9)
Unknown	19	(3.8)
<b>Level of CUD based on CIDI SAM for Cannabis</b>		
No CUD	286	(57.4)
Mild CUD	127	(25.5)
Moderate CUD	54	(10.9)
Severe CUD	31	(6.2)

Notes: Patient age, race, ethnicity, and gender are derived from their EHR documentation. Patient insurance type and CUD level were questions asked in the survey.

42.6 % (95 % CI: 38.2 %-47.0 %) of these patients who reported daily cannabis use met DSM-5 criteria for any CUD and 17 % (95 % CI: 13.9 %-20.7 %) met criteria for moderate-severe CUD. The checklist items and prevalence are available in supplement 2.

3.2. Performance of the checklist

The AUROC curve for the Checklist compared to past-year moderate-severe CUD on the CIDI SAM was 0.77 (95 % CI: 0.71–0.83). Table 2 presents the sensitivity and specificity for each cut-point on the Checklist (scores of ≥6 are not reported due to cell values below 5 patients). A cut-point of 1 or 2 on the Checklist best balanced sensitivity and specificity for moderate-severe CUD (Table 2).

Table 2 also shows the estimated post-test probability of moderate-severe CUD in patients with low, average and high population prevalence (i.e., pre-test probability) of moderate CUD prior to the Checklist. The first row shows pre-test probabilities of moderate-severe CUD before the SIS-C, the second row shows pre-test probabilities before the Checklist in those who reported daily cannabis use, across the 3 levels of population prevalence. Results demonstrate the post-Checklist prevalence varied dramatically based on the pre-Checklist probability of CUD. In populations where the underlying prevalence of moderate-severe CUD is average (6 %), the probability the Checklist identified moderate-severe CUD varied from 38 % to 91 % across Checklist scores, with a post-test probability over 80 % at Checklist scores ≥3. In contrast, in populations where the underlying prevalence is low (0.5 %), the post-Checklist probability was less than 50 % even with a Checklist score of ≥5, whereas in populations where the underlying prevalence was high, the post-Checklist probability was 97 % at a Checklist score of ≥3.

**Table 2**

Discriminative validity of the DSM-5 Substance Use Symptom Checklist (“Checklist”) for Moderate-severe Cannabis Use Disorder (CUD) at each cut-point, and in populations with low, average, and high prevalence of CUD.

Score on the Checklist	Sensitivity (%)	Specificity (%)	Range of Pre-test Probabilities of Moderate-Severe CUD		
			0.5 %	6 %	30 %
			<b>Range of Pre-Checklist Probabilities of Moderate-Severe CUD after Screen indicates Daily Cannabis Use (%)</b>		
			5 %	38 %	80 %
			<b>PPV: Post-test Probability of Moderate-Severe CUD on Scores 0–5 of the Checklist (%)</b>		
0	100	0	5	38	80
1	78	63	10	56	89
2	59	85	17	70	94
3	41	94	27	81	97
4	28	97	34	86	98
5	19	99	45	91	98

Notes: Only scores of 0–5 out of a possible score of 11 on the Checklist are presented in the above table as only 5 or fewer patients had each Checklist score of 6–11. AUROC = 0.769 (95 % CI: 0.711–0.828); N = 498. Pre-test probabilities of Mod-Severe CUD and Pre-Checklist probabilities derived from Matson et al., (2022). Formula to calculate post-test probability at each score: PPV = sensitivity x prevalence / sensitivity x prevalence + (1-specificity)x(1-prevalence)

4. Discussion

4.1. Key findings

This study demonstrates that the overall performance of the DSM-5 Substance Use Symptom Checklist, collected during routine care, is acceptable (AUROC=0.77) (Hosmer and Lemeshow, 2013) when compared to a confidential diagnosis of moderate-severe DSM-5 CUD among patients who report daily cannabis use. Checklist cut-points of 1 or 2 balance sensitivity and specificity, with the maximum sensitivity 78 % at 1 or more symptoms, but excellent specificity at scores of 2–5 (85–99 %). The high specificity results in meaningful increases in the probability of identifying CUD for patients at average risk as Checklist scores increase. Checklist scores of ≥3 increase the probability of moderate-severe CUD to 82 %, from an average pre-test probability of about 40 % among those reporting daily cannabis use.

The fact that the Checklist modified probabilities of identifying CUD for patient populations whose prevalence of CUD is average (40–82 %), but minimally for subgroups of patients with the lowest (0.5 %) and highest prevalence of CUD (30 %), highlights the importance of prevalence when interpreting diagnostic tests (Sox 1986). Given that the prevalence of CUD varies by age, sex, and presence of mental health conditions or other SUD (Browne et al., 2022; Hasin et al., 2016; Kerridge et al., 2018), these factors must be taken into account in interpreting Checklist results for any patient. Therefore, for patients in populations with the lowest prevalence—e.g. an 80-year old woman—in whom the probability of moderate-severe CUD was only 5 % even with daily use(Matson et al., 2022), and for patients with the highest prevalence—e.g. a person with another mental health or SUD—in whom the probability of moderate-severe CUD is ~80 % with daily use, this study shows that Checklist score does not add meaningful information about the probability of moderate-severe CUD to that provided by the SIS-C alone. For average risk patients, however, findings indicate that Checklist scores markedly impact the probability of moderate-severe CUD. For all patients reporting symptoms of CUD, the Checklist can be used for engaging patients in discussing their symptoms, eliciting motivation to change, and offering shared decision-making, so that an acceptable treatment can be provided when desired by the patient (e.g.

counseling for cognitive behavioral therapy regarding CUD, specialty treatment, etc.).

This study has several limitations. All patients reported daily cannabis use; additional research is needed on the Checklist in other populations (e.g. those who use cannabis less often, those who report other drug use, and those who use medically vs. recreationally). The Checklist and the reference standard were administered up to 6 months apart (on average 75 days apart) and symptoms may have changed during that time. The reference standard was administered online or by phone rather than by clinical interview. Results may not generalize to other patients, settings or states with different cannabis laws. Finally, the survey response rate, although consistent with other survey studies, may limit generalizability (Guo et al., 2016; Lallukka et al., 2020).

#### 4.2. Conclusions

A DSM-5 Substance Use Symptom Checklist meaningfully increases the probability of correctly identifying moderate-severe CUD in patients at average risk for CUD who report daily cannabis use. Further research is needed to determine the Checklist's discriminative validity among other populations.

#### Funding statement

Research reported in this publication was supported by the National Institute On Drug Abuse of the National Institutes of Health under Award Number UG1DA040314. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health

#### CRedit authorship contribution statement

**Gwen T. Lapham:** Writing – review & editing, Supervision, Investigation, Funding acquisition, Conceptualization. **Katharine A. Bradley:** Writing – review & editing, Supervision, Investigation, Funding acquisition, Conceptualization. **Theresa E. Matson:** Writing – review & editing, Investigation. **Leah K. Hamilton:** Writing – original draft, Formal analysis, Conceptualization.

#### Declaration of Competing Interest

none

#### Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.dadr.2024.100260](https://doi.org/10.1016/j.dadr.2024.100260).

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