Evaluation of Screening, Assessment, Diagnosis and Treatment for Cannabis Use Disorder in Primary Care

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Abstract

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Nearly 50 million people use cannabis in the past year, and of those, 23% use cannabis daily. Frequent cannabis use increases risk of developing a cannabis use disorder (CUD), a problematic pattern of cannabis use leading to clinically significant impairment and distress. Primary care providers are ideally positioned to identify cannabis use and use disorders, provide brief interventions, and guide patients to treatment. However, CUD is under-recognized and undertreated in primary care settings. One key barrier is a lack of validated screening and assessment tools that are feasible and appropriate to use routinely in primary care. Specific aims of this dissertation were to: 1) test the performance of a single-item screening measure of patient-reported cannabis use compared to a gold-standard diagnostic criterion of Diagnostic and Statistical Manual of Mental Disorders-5th Edition (DSM-5) CUD; 2) test the psychometric properties of a Substance Use Symptom Checklist; and 3) test whether the probability of clinically recognized CUD and treatment increases with greater symptom severity and whether this relationship is moderated by age, gender, race, or ethnicity. **Aim 1** used EHR-linked data from a confidential 2019 survey of 1688 Kaiser Permanente Washington (KPWA) primary care

patients. We compared the Single-Item Screen for Cannabis (SIS-C) used routinely in primary care with results documented in the EHR to a confidential reference standard of DSM-5 CUD administered on the survey. The SIS-C demonstrated strong validity for identifying CUD (area under receiver operating characteristic curves (AUC) 0.89 [95% CI: 0.78-0.96]). A threshold of "less than monthly" cannabis use had the best balance of sensitivity (0.88) and specificity (0.83). **Aim 2** used data exclusively from the EHR. Substance Use Symptom Checklists ("Symptom Checklists") were completed 3/1/2015-3/1/2020 as part of systematic follow-up assessment for CUD by 16,140 KPWA patients reporting daily cannabis use, 4,791 patients reporting other drug use, and 2,373 reporting both. We used item response theory to evaluate the psychometric performance of the Symptom Checklist, finding it unidimensional, discriminative, and performing equally well across demographic subgroups. **Aim 3** used EHR and claims data from 13,947 KPWA patients reporting daily cannabis use who completed a Symptom Checklist 3/1/2015-3/1/2021, were continuously enrolled at KPWA, and had not received CUD care in the year prior to completing the Symptom Checklist. Using logistic regression with cluster-robust standard errors, we found that symptom severity, as reported on the Symptom Checklist, was positively associated with subsequent CUD diagnosis, initiation of CUD treatment, and ongoing engagement in CUD treatment although probability of all three care elements was generally low. Gender moderated the association between severity and CUD diagnosis such that women were more likely than men to be diagnosed but less likely than men to initiate treatment at the highest levels of severity. Overall, findings support the validity of brief, practical tools to identify and evaluate the spectrum of cannabis use and use disorder. This work lays a foundation for advancing measurement-based care for CUD in primary care.

Table of Contents

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Dedication

To those struggling with substance use and those who love someone struggling.

CHAPTER 1

Introduction

Cannabis use is common and associated with significant health risks

Cannabis is the third most commonly used drug in the United States, after alcohol and tobacco.[1] More than 16% of U.S. adults—nearly 50 million people—reported past year cannabis use, and of those, 23%—over 11 million people—used cannabis daily.[1] The prevalence of cannabis use and the perception that cannabis use is safe is increasing as states legalize its use.[1,2]

Risk of developing cannabis use disorder (CUD) increases with the frequency of use.[3,4] CUD is a problematic pattern of cannabis use leading to clinically significant impairment or distress, as manifested by ≥2 Diagnostic and Statistical Manual of Mental Disorders-5th edition (DSM-5) symptoms.[5] Although not all patients who use cannabis experience health risks, 25-50% of people who use cannabis daily develop CUD.[6] CUDs are the single most important cause of cannabis-attributable disease burden.[4] The burden of disease may be exacerbated for certain sociodemographic subgroups, including young adults, women, and people of color, who experience overlapping vulnerabilities due to their cannabis use and social identity.[7–11]

CUD is under-recognized and undertreated

Although evidence-based treatments are available (e.g., cognitive behavioral therapy, motivational enhancement therapy, and contingency management),[12] CUD is underdiagnosed[13] and largely untreated.[14,15] Only 7% of U.S. adults who report criteria consistent with past-year CUD on a national survey receive cannabis-specific treatment.[15]

The low rate of treatment may reflect trickle-down influences from macro- (political and economic context, social and cultural values), exo- (broad social networks and community

influence), meso- (health systems and other institutions), and micro- (interpersonal relationships and individual characteristics) levels. Determinants to cannabis-related care can be represented using the socioecological model (Figure 1.1).[16,17] At the macro-level, societal-level stigma about substance use and substance use treatment, as well as economic policies resulting in legal and social consequences, may prevent patients from seeking care.[18,19] Moreover, these policies and practices are rooted in agist, sexist and racist ideology that disproportionately impacts discriminated groups,[20–24] resulting in too little treatment or too much inappropriate treatment.[25–30] At the exo-level, social networks may promote unhealthy cannabis use[31,32] and community norms may discourage treatment[31,33] or discussion of treatment options.[34] At the meso-level, a lack of systematic and standardized procedures for screening and assessing patients for cannabis use and CUD symptoms may result in under-recognition of patients whose cannabis use may be causing harm.[13] Additionally, health systems tend to rely on specialty addiction or mental health settings to manage care for CUD although these settings may be less accessible, less acceptable,[14,15] and sometimes unnecessary for patients to make changes to their cannabis use.[35–37] At the micro-level, providers are often uncomfortable discussing cannabis use with patients and lack knowledge about how to treat patients with CUD.[38,39] Consequently, providers may consciously or unconsciously rely on other factors, such as patients' age, sex and gender, race and ethnicity, when considering cannabis use severity and making treatment recommendations.[26,27,40,41] Patients, in turn, report fear of specialty settings—specifically, of being put into a hospital, concern about ability to pay for treatment, treatment stigma or fear of social consequences, lack of knowledge about other treatment options, and the belief that treatment isn't needed.[18,19] The impact of barriers at each level may be augmented or reduced depending on patients' lived experiences.

Primary care is ideally suited to manage cannabis-related care

Health systems have the potential to address barriers to cannabis-related care at multiple levels. Specifically, primary care settings are well positioned to identify cannabis use and use disorders, and guide patients to treatment.[42,43] For many patients, primary care is their only contact with the healthcare system, and they may have an established long-term, on-going relationship with a primary care provider.[44] Patients may feel more comfortable disclosing and discussing their cannabis use and cannabis-related problems to their primary care providers.[45] Primary care providers can frame the benefits and risk of cannabis use in terms of the patient's overall health goals,[46] as they would other behavioral health conditions,[47] thereby minimizing potential stigma associated with seeking specialty addictions treatment.[19] However, few health systems currently screen primary care patients for cannabis use[43,48,49] and almost none systematically assess primary care patients for CUD symptoms.[48,49] Key barriers include time and resource constraints as well as a lack of systematic and standardized measurement.[50]

Measurement is foundational for improving cannabis-related care

The ability to measure cannabis use can inform prevention, symptom management, and treatment planning for primary care patients.[50] Validated cannabis use screens and CUD symptom assessments are superior to relying on clinical impressions[51] and are recommended by the U.S. Preventive Services Task Force.[52] On the one hand, they may improve equity in identifying, assessing, and treating CUD if measurement tools demonstrate measurement equivalence for patient subgroups.[53] On the other hand, they may produce disparities in identification and allocation of resources if they perform differently for some groups.[54] Understanding how screening and assessment tools perform when used as part of routine care

among minoritized groups who are often underrepresented in research is essential to ensuring measures do not perpetuate implicit biases held by the researchers or clinicians who use them.[54]

Measures must also be feasible for general medical settings. While there are many validated substance use screens, few are validated in primary care samples,[50,55–57] and none from routine practice. Few validated screens ask about cannabis use, separate from alcohol and other drug use.[50,55–57] Validation studies of screens aggregating substances may not accurately reflect cannabis-related risk.[46,50] Finally, most of these screens are too long for use in routine primary care.[50] Research on alcohol screening shows that brevity is essential if clinicians are to adopt screens.[58] Experts suggest that optimal screening instruments for use in busy primary care settings should be ≤4 items,[42,50,59] and single-item screens are preferred.[59,60] Currently, no single-item cannabis-specific screen has been validated in primary care.

Screening alone does not improve outcomes; however, screening can trigger additional assessments for symptoms of CUD, and symptom assessment can inform treatment plans or monitoring.[42,48] Standardized assessment tools are frequently used in primary care to help diagnose, provide information about appropriate level of intervention, and monitor chronic conditions.[61] However, the development and evaluation of equivalent assessment tools for CUD has lagged. There exists no validated means of assessing presence and severity of DSM-5 CUD in medical settings, although one health system proposed using a substance use disorder (SUD) symptom checklist that mirrors the 11 DSM-5 criteria for SUD.[48,62]

An integrated healthcare system that routinely screens for cannabis offers a natural laboratory for evaluating measures of cannabis-related care

In an effort to integrate behavioral health and primary care, Kaiser-Permanente Washington (KPWA) implemented annual population-based cannabis screening and

standardized follow-up assessment for patients reporting daily cannabis use[48,62] beginning in 2015 in a state where medical and non-medical cannabis use is legal. KPWA is one of the few primary care systems to systematically screen all adult primary care patients for cannabis use and possibly the only primary care system to conduct standardized assessments of symptoms using a symptom checklist measure based on DSM-5 criteria with results documented in electronic health records (EHRs).[48,62,63]

Summary and specific aims

Collectively this work aims to advance measurement-based care for CUD in primary care. The dissertation addresses the need for validated cannabis measures that perform equally well across subgroups. It examines current CUD diagnosing and treatment practices for potential bias and proposes tools to support clinicians managing cannabis-related care. The proposal is responsive to National Academies of Science (NAS) recommendations to use standardized EHR measures to improve cannabis-related care,[64] has direct implications for clinical decision-makers, and will serve as a foundation for future studies that use EHR-based cannabis measures for research in routine care settings. The specific aims are:

1. **Test the performance of a brief screening measure of patient-reported cannabis use compared to a reference standard diagnostic criterion of DSM-5 CUD** among KPWA primary care patients who responded to a confidential survey. Specifically, we compare the Single-Item Screen for Cannabis (SIS-C) routinely completed in KPWA primary care with results documented in the EHR to the reference standard completed on a confidential survey as part of a research study. We examine differences in the performance across age, gender, race, and ethnicity.

2. **Test the psychometric properties of a Substance Use Symptom Checklist** completed by KPWA primary care patients who report daily cannabis use in the past year, stratified by whether or not they report other drug use. Specifically, we use EHR data to determine whether the performance of the clinical DSM-5 Substance Use Symptom Checklist (on which patients report 0-11 symptoms) is unidimensional, discriminative, reflects a continuum of CUD severity, and functions similarly across age, sex, race, and ethnicity.
3. **Test whether the probability of clinically recognized CUD and treatment increases with greater symptom severity, and whether this association is moderated by patient sociodemographic characteristics representing lived experiences.** Specifically, we estimate the probability of three CUD care outcomes (EHR-documented CUD, initiation of CUD treatment among those diagnosed, and ongoing engagement in CUD treatment among those who initiated treatment) across levels of the Substance Use Symptom Checklist corresponding to no, mild, moderate, and severe CUD. We test the interaction between symptom severity and age, gender, race, and ethnicity, respectively.

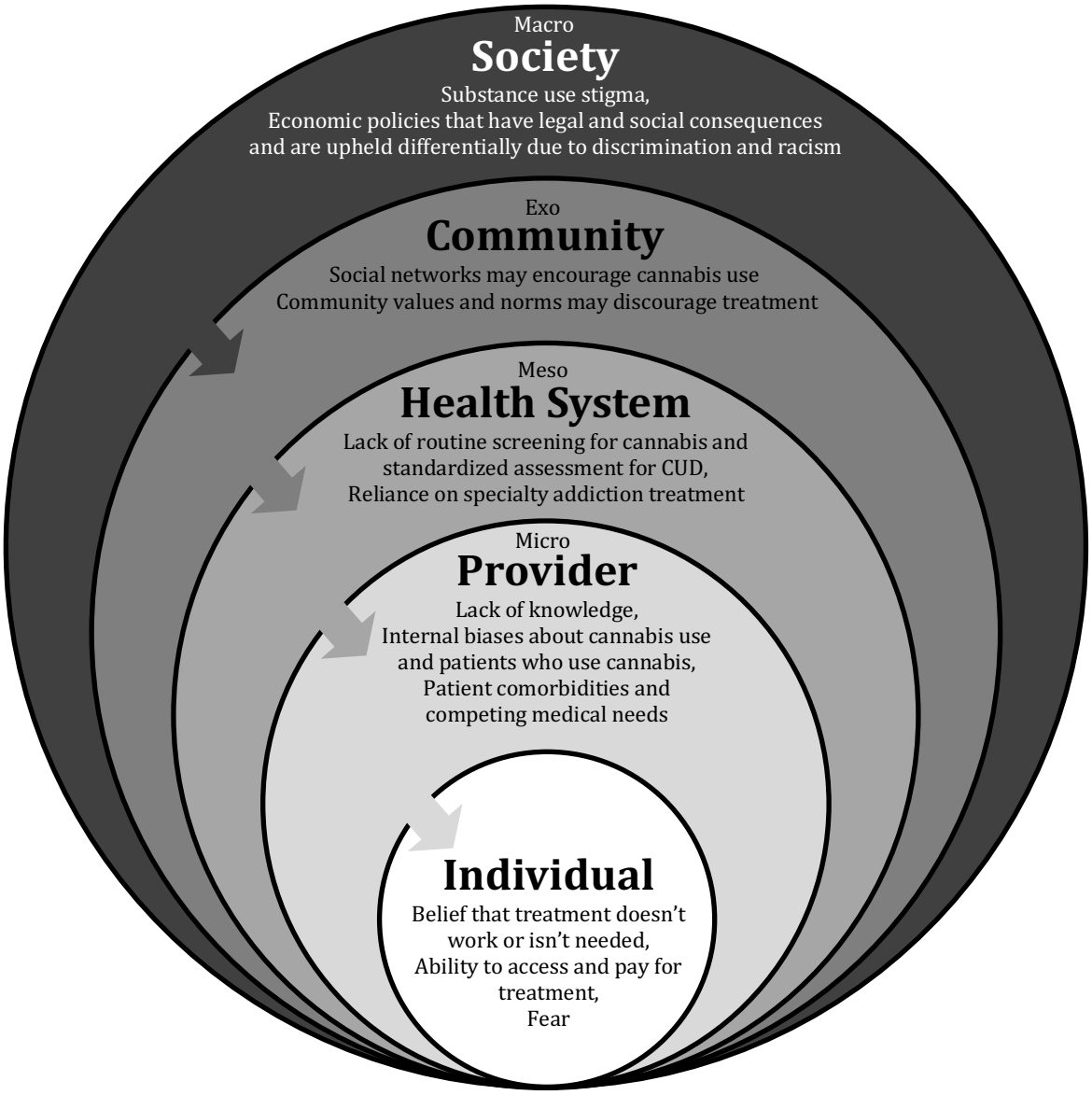


Figure 1.1 Socioecological Model of Determinants to Cannabis-Related Care

REFERENCES FOR CHAPTER 1

1. Substance Abuse and Mental Health Services Administration. Key substance use and mental health indicators in the United States: Results from the 2018 National Survey on Drug Use and Health. *HHS Publication No PEP19-5068, NSDUH Series H-54*. Published online 2019. doi:10.1016/j.drugalcdep.2016.10.042

2. Compton WM, Han B, Jones CM, Blanco C, Hughes A. Marijuana use and use disorders in adults in the USA, 2002–14: analysis of annual cross-sectional surveys. *The Lancet Psychiatry*. Published online 2016. doi:10.1016/S2215-0366(16)30208-5

3. Hasin DS. US Epidemiology of Cannabis Use and Associated Problems. *Neuropsychopharmacology*. Published online 2018. doi:10.1038/npp.2017.198

4. Volkow ND, Baler RD, Compton WM, Weiss SRB. Adverse health effects of marijuana use. *New England Journal of Medicine*. Published online 2014. doi:10.1056/NEJMra1402309

5. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 5th ed. American Psychiatric Association; 2013.

6. Hall W, Degenhardt L. Adverse health effects of non-medical cannabis use. *The Lancet*. Published online 2009. doi:10.1016/S0140-6736(09)61037-0

7. Iguchi MY, London JA, Forge NG, Hickman L, Fain T, Riehman K. Elements of well-being affected by criminalizing the drug user. *Public Health Reports*. Published online 2002.

8. Karriker-Jaffe KJ, Zemore SE, Mulia N, Jones-Webb R, Bond J, Greenfield TK. Neighborhood disadvantage and adult alcohol outcomes: Differential risk by race and gender. *Journal of Studies on Alcohol and Drugs*. Published online 2012. doi:10.15288/jsad.2012.73.865

9. Kulesza M, Matsuda M, Ramirez JJ, Wentz AJ, Teachman BA, Lindgren KP. Towards greater understanding of addiction stigma: Intersectionality with race/ethnicity and gender. *Drug and Alcohol Dependence*. Published online 2016. doi:10.1016/j.drugalcdep.2016.10.020

10. Rubinsky AD, Dawson DA, Williams EC, Kivlahan DR, Bradley KA. AUDIT-C scores as a scaled marker of mean daily drinking, alcohol use disorder severity, and probability of alcohol dependence in a U.S. general population sample of drinkers. *Alcoholism: Clinical and Experimental Research*. Published online 2013. doi:10.1111/acer.12092

11. Cooper ZD, Haney M. Investigation of sex-dependent effects of cannabis in daily cannabis smokers. *Drug and Alcohol Dependence*. Published online 2014. doi:10.1016/j.drugalcdep.2013.12.013

12. Copeland J, Clement N, Swift W. Cannabis use, harms and the management of cannabis use disorder. *Neuropsychiatry*. Published online 2014. doi:10.2217/npy.13.90

13. Bonn-Miller MO, Bucossi MM, Trafton JA. The Underdiagnosis of Cannabis Use Disorders and Other Axis-I Disorders Among Military Veterans Within VHA. *Military Medicine*. Published online 2012. doi:10.7205/milmed-d-12-00052

14. Lapham GT, Campbell CI, Yarborough BJH, et al. The prevalence of Healthcare Effectiveness Data and Information Set (HEDIS) initiation and engagement in treatment among patients with cannabis use disorders in 7 US health systems. *Substance Abuse*. Published online 2019. doi:10.1080/08897077.2018.1544964

15. Hasin DS, Kerridge BT, Saha TD, et al. Prevalence and correlates of DSM-5 cannabis use disorder, 2012-2013: Findings from the national epidemiologic survey on alcohol and related conditions-III. *American Journal of Psychiatry*. Published online 2016. doi:10.1176/appi.ajp.2015.15070907

16. Bronfenbrenner U. Toward an experimental ecology of human development. *American Psychologist*. Published online 1977. doi:10.1037/0003-066x.32.7.513

17. Sudhinaraset M, Wigglesworth C, Takeuchi DT. Social and cultural contexts of alcohol use: Influences in a social–ecological framework. *Alcohol Research: Current Reviews*. Published online 2016.

18. Gates P, Copeland J, Swift W, Martin G. Barriers and facilitators to cannabis treatment. *Drug and Alcohol Review*. Published online 2012. doi:10.1111/j.1465-3362.2011.00313.x

19. Kerridge BT, Mauro PM, Chou SP, et al. Predictors of treatment utilization and barriers to treatment utilization among individuals with lifetime cannabis use disorder in the United States. *Drug and Alcohol Dependence*. Published online 2017. doi:10.1016/j.drugalcdep.2017.09.032

20. Solomon R. Racism and Its Effect on Cannabis Research. *Cannabis and Cannabinoid Research*. Published online 2020. doi:10.1089/can.2019.0063

21. Carliner H, Sarvet AL, Gordon AR, Hasin DS. Gender discrimination, educational attainment, and illicit drug use among U.S. women. *Social Psychiatry and Psychiatric Epidemiology*. Published online 2017. doi:10.1007/s00127-016-1329-x

22. Carliner H, Delker E, Fink DS, Keyes KM, Hasin DS. Racial discrimination, socioeconomic position, and illicit drug use among US Blacks. *Social Psychiatry and Psychiatric Epidemiology*. Published online 2016. doi:10.1007/s00127-016-1174-y

23. Hemsing N, Greaves L. Gender Norms, Roles and Relations and Cannabis-Use Patterns: A Scoping Review. *Int J Environ Res Public Health*. Published online 2020. doi:10.3390/ijerph17030947

24. Earleywine M. *Understanding Marijuana: A New Look at the Scientific Evidence*.; 2010. doi:10.1093/acprof:oso/9780195138931.001.0001

25. Matsuzaka S, Knapp M. Anti-racism and substance use treatment: Addiction does not discriminate, but do we? *Journal of Ethnicity in Substance Abuse*. Published online 2019. doi:10.1080/15332640.2018.1548323

26. Wallander L, Blomqvist J. Modeling ideal treatment recommendations: A factorial survey of swedish social workers' ideal recommendations of inpatient or outpatient treatment for problem substance users. *Journal of Social Service Research*. Published online 2009. doi:10.1080/01488370802477436

27. Samuelsson E, Wallander L. Disentangling practitioners' perceptions of substance use severity: A factorial survey. *Addiction Research and Theory*. Published online 2014. doi:10.3109/16066359.2013.856887

28. Bensley KM, Harris AHS, Gupta S, et al. Racial/Ethnic Differences in Initiation of and Engagement With Addictions Treatment Among Patients With Alcohol Use Disorders in the Veterans Health Administration. *Journal of Substance Abuse Treatment*. Published online 2017. doi:10.1016/j.jsat.2016.11.001

29. Williams EC, Lapham GT, Hawkins EJ, et al. Variation in Documented Care for Unhealthy Alcohol Consumption Across Race/Ethnicity in the Department of Veterans Affairs Healthcare System. *Alcoholism: Clinical and Experimental Research*. Published online 2012. doi:10.1111/j.1530-0277.2012.01761.x

30. Williams EC, Gupta S, Rubinsky AD, et al. Variation in receipt of pharmacotherapy for alcohol use disorders across racial/ethnic groups: A national study in the U.S. Veterans Health Administration. *Drug and Alcohol Dependence*. Published online 2017. doi:10.1016/j.drugalcdep.2017.06.011

31. Brook JS, Brook DW, Rosen Z, Rabbitt CR. Earlier Marijuana Use and Later Problem Behavior in Colombian Youths. *Journal of the American Academy of Child & Adolescent Psychiatry*. 2003;42(4):485-492. doi:10.1097/01.CHI.0000037050.04952.49

32. Phillips KT, Phillips MM, Lalonde TL, Prince MA. Does social context matter? An ecological momentary assessment study of marijuana use among college students. *Addictive Behaviors*. 2018;83:154-159. doi:10.1016/J.ADDBEH.2018.01.004

33. Chen AT, Johnny S, Conway M. Examining stigma relating to substance use and contextual factors in a social media discussions. *Drug and Alcohol Dependence Reports*. 2022;3:100061. doi:10.1016/J.DADR.2022.100061

34. Rhidenour KB, Blackburn K, Barrett AK, Taylor S. Mediating Medical Marijuana: Exploring How Veterans Discuss Their Stigmatized Substance Use on Reddit. *Health Communication*. Published online February 18, 2021:1-11. doi:10.1080/10410236.2021.1886411

35. Sobell LC, Sobell MB, Wagner EF, Agrawal S, Ellingstad TP. Guided self-change: A brief motivational intervention for cannabis abuse. In: *Cannabis Dependence: Its Nature, Consequences, and Treatment*. ; 2006. doi:10.1017/CBO9780511544248.011

36. Ellingstad TP, Sobell LC, Sobell MB, Eickleberry L, Golden CJ. Self-change: A pathway to cannabis abuse resolution. *Addictive Behaviors*. Published online 2006. doi:10.1016/j.addbeh.2005.05.033

37. Sobell MB, Sobell LC. Guided self-change model of treatment for substance use disorders. *Journal of Cognitive Psychotherapy*. Published online 2005. doi:10.1891/jcop.2005.19.3.199

38. Carlini BH, Garrett SB, Carter GT. Medicinal Cannabis: A Survey Among Health Care Providers in Washington State. *American Journal of Hospice and Palliative Medicine*. Published online 2017. doi:10.1177/1049909115604669

39. Brooks E, Gundersen DC, Flynn E, Brooks-Russell A, Bull S. The clinical implications of legalizing marijuana: Are physician and non-physician providers prepared? *Addictive Behaviors*. Published online 2017. doi:10.1016/j.addbeh.2017.03.007

40. Fitzgerald C, Hurst S. Implicit bias in healthcare professionals: A systematic review. *BMC Medical Ethics*. Published online 2017. doi:10.1186/s12910-017-0179-8

41. Hairston DR, Gibbs TA, Wong SS, Jordan A. Clinician Bias in Diagnosis and Treatment. In: *Racism and Psychiatry*. ; 2019. doi:10.1007/978-3-319-90197-8_7

42. Lanier D KS. Screening in Primary Care Settings for Illicit Drug Use: Assessment of Screening Instruments — A Supplemental Evidence Update for the U.S. Preventive Services Task Force. *US Preventive Services Task Force*. Published online 2008.

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*. Published online 2009. doi:10.1016/j.drugalcdep.2008.08.003

44. 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*. Published online 2014. doi:10.1353/hpu.2014.0067

45. Kansagara D, Becker WC, Ayers C, Tetrault JM. Priming primary care providers to engage in evidence-based discussions about cannabis with patients. *Addiction Science and Clinical Practice*. Published online 2019. doi:10.1186/s13722-019-0171-3

46. Tiet QQ, Leyva YE, Browne K, Moos RH. Screen of drug use: Diagnostic accuracy for cannabis use disorder. *Addictive Behaviors*. Published online 2019. doi:10.1016/j.addbeh.2019.02.010

47. Miller WR. Sacred Cows and Greener Pastures: Reflections from 40 Years in Addiction Research. *Alcoholism Treatment Quarterly*. 2016;34(1):92-115. doi:10.1080/07347324.2015.1077637

48. Glass JE, Bobb JF, Lee AK, et al. Study protocol: a cluster-randomized trial implementing Sustained Patient-centered Alcohol-related Care (SPARC trial). *Implementation Science*. 2018;13(1):108.

49. Lapham GT, Lee AK, Caldeiro RM, et al. Frequency of cannabis use among primary care patients in Washington state. *Journal of the American Board of Family Medicine*. Published online 2017. doi:10.3122/jabfm.2017.06.170062

50. Tiet QQ, Finney JW, Moos RH. Screening psychiatric patients for illicit drug use disorders and problems. *Clinical Psychology Review*. Published online 2008. doi:10.1016/j.cpr.2007.08.002

51. Wilson CR, Sherritt L, Gates E, Knight JR. Are clinical impressions of adolescent substance use accurate? *Pediatrics*. Published online 2004. doi:10.1542/peds.2004-0098

52. Krist AH, Davidson KW, Mangione CM, et al. Screening for Unhealthy Drug Use. *JAMA*. Published online 2020. doi:10.1001/jama.2020.8020

53. Burlew AK, Feaster D, Brecht ML, Hubbard R. Measurement and data analysis in research addressing health disparities in substance abuse. *Journal of Substance Abuse Treatment*. Published online 2009. doi:10.1016/j.jsat.2008.04.003

54. Benjamin R. *Race after Technology : Abolitionist Tools for the New Jim Code*. Polity; 2019.

55. 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*. Published online 2011. doi:10.1016/j.addbeh.2011.07.007

56. Mulvaney-Day N, Marshall T, Downey Piscopo K, et al. Screening for Behavioral Health Conditions in Primary Care Settings: A Systematic Review of the Literature. *Journal of General Internal Medicine*. Published online 2018. doi:10.1007/s11606-017-4181-0

57. López-Pelayo H, Batalla A, Balcells MM, Colom J, Gual A. Assessment of cannabis use disorders: A systematic review of screening and diagnostic instruments. *Psychological Medicine*. Published online 2015. doi:10.1017/S0033291714002463

58. Bradley KA, Williams EC, Achtmeyer CE, Volpp B, Collins BJ, Kivlahan DR. Implementation of evidence-based alcohol screening in the Veterans Health Administration. *American Journal of Managed Care*. Published online 2006. doi:3204 [pii]

59. Smith PC, Schmidt SM, Allensworth-Davies D, Saitz R. A single-question screening test for drug use in primary care. *Archives of Internal Medicine*. Published online 2010. doi:10.1001/archinternmed.2010.140

60. National Institute on Alcohol Abuse and Alcoholism. Helping Patients Who Drink Too Much: A Clinician's Guide. *Family Practice News*. Published online 2005. doi:10.1016/S0300-7073(05)72194-0

61. Scott K, Lewis CC. Using measurement-based care to enhance any treatment. *Cognitive and Behavioral Practice*. Published online 2015. doi:10.1016/j.cbpra.2014.01.010

62. J.E. R, J.F. B, A.K. L, et al. Integration of screening, assessment, and treatment for cannabis and other drug use disorders in primary care: An evaluation in three pilot sites. *Drug and Alcohol Dependence*. Published online 2019. doi:10.1016/j.drugalcdep.2019.04.015

63. Bobb J, Lee A, Lapham G, et al. Evaluation of a Pilot Implementation to Integrate Alcohol-Related Care within Primary Care. *International Journal of Environmental Research and Public Health*. 2017;14(9):1030. doi:10.3390/ijerph14091030

64. National Academies of Sciences T. *Committee on the Health Effects of Marijuana: An Evidence Review and Research Agenda Board on Population Health and Public Health Practice Health and Medicine Division A Report Of.*; 2017. doi:10.17226/24625

CHAPTER 2

Validity of the Single-Item Screen – Cannabis (SIS-C) for cannabis use disorder screening in routine care

INTRODUCTION

Nearly 50 million people in the U.S. use cannabis[1], reflecting a trend toward increasing use and decreasing perception of risk.[2] A recent study of primary care patients in Washington state, which has legalized medical and adult nonmedical use, found that more than 20% reported using cannabis in the past year.[3] Findings were similar for Veterans attending primary care in the same state.[4]

Frequent cannabis use increases the risk of developing a cannabis use disorder (CUD).[5] The prevalence of CUD ranges from 2-5% in the general population,[6-9] 5-14% in young adults,[7, 9] and 8-23% among those with mental health or other substance use disorders.[8, 10] Over half of patients with past-year CUD have moderate-severe CUD, with increasing severity associated with increasing disability across cognitive, social, and emotional domains.[8] CUD is the largest contributor to cannabis-attributable disease burden.[11] Despite evidence-based treatment (e.g., behaviorally-based therapies),[12-15] CUD remains underrecognized and largely untreated.[1, 8, 16]

A valid, single-item screen could increase the feasibility of routine screening for CUD in medical settings. Single-item screens have been validated for identifying substance use disorders generally (Table 2.1) but not specifically for CUD.[17-20] Increasing cannabis use and legalization underscore the need to screen for cannabis separately from other substances—as is usually done for alcohol.[21] One health system integrated a question about the frequency of past-year cannabis use into routine care at the request of frontline clinicians.[21] To our knowledge, no study has

tested the validity of cannabis screens administered in routine care and documented in the electronic health record (EHR). This study evaluated the performance of the Single-Item Screen–Cannabis (SIS-C) when documented in the EHR as part of routine care.

METHODS

Setting

This prospective study took place at Kaiser Permanente Washington (KPWA), an integrated healthcare system providing health insurance and medical care to over 700,000 patients in Washington state, where adult cannabis use is legal. KPWA conducts annual population-based screening for cannabis use in primary care using a single item, the SIS-C (described below), with results stored in the EHR. Responses to the SIS-C can trigger additional assessment for CUD, guiding clinical decision-making.

Sample

KPWA adult patients (≥18 years old) who completed the SIS-C in primary care between January 28, 2019 and September 12, 2019 (N=108,950) were eligible to be sampled for a confidential survey about cannabis use. Patients were excluded if they were current or recent KPWA employees (~4%), needed an interpreter (2.6%), lived outside Washington State (<1%), were recently deceased (<1%), or opted out of research (<1%). Using EHR data, patients were randomly sampled for the survey (n=5,000). Persons of color and those reporting higher frequency of use were oversampled to ensure representation of important smaller subgroups of patients.[22]

Procedures

Patients were recruited between March 28, 2019 and September 12, 2019, within 60 days of completing the SIS-C to ensure proximity between screen and survey response. Patients were mailed invitations to participate, including information about the study, confidentiality, unique identifiers linking survey responses to participants' EHRs, and a $2 incentive. Reminders to complete the survey were offered by email and by phone. The survey took approximately 20 minutes and could be completed online (63%) or by phone (34%). Participants acknowledged informed consent prior to completing the survey and received $20 as compensation for survey participation.

A total of 1,688 primary care patients completed the confidential survey and constitute the sample for this study—a 34% response rate, comparable to other patient surveys.[23, 24] The KPWA Health Research Institute Institutional Review Board approved this study with waivers of consent (to identify eligible sample), consent documentation (for survey respondents), and HIPAA authorization.

Measures

Reference standard for past-year CUD

The Composite International Diagnostic Interview (CIDI) Substance Abuse Module was selected as the reference standard (i.e., "gold" standard) measure for Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5) CUD, as it is feasible to administer via web-based survey.[25, 26] The 15-item CIDI provides a diagnosis and a scaled score of CUD severity (0-11), reflecting the number of DSM-5 CUD criteria met. Any past-year CUD (i.e., mild-severe) was defined as ≥2 CUD criteria endorsed on the CIDI; moderate-severe past-year CUD was defined as ≥4 CUD criteria endorsed on the CIDI, consistent with DSM-5.[27] The first two questions of the survey asked about frequency and recency of cannabis use. Patients who

reported no past-year use on both questions were not asked to complete the CIDI to minimize assessment burden (n=94) and were assigned zero CUD criteria given their lack of cannabis use. Among the CIDI respondents, 96% completed all items and 99% completed all but one item. Incomplete CIDIs were scored based on available responses. No patient was missing a CIDI score.

EHR-documented Single-Item Screen–Cannabis (SIS-C)

The SIS-C, offered as part of routine primary care, asked about frequency of past-year cannabis use (i.e., "*How often in the past year did you use marijuana?*") with response options ("*never*," "*less than monthly*," "*monthly*," "*weekly*," and "*daily or almost daily*"), adapted from the third question of the World Health Organization's AUDIT[28] and scored 0-4 points. The term 'marijuana' is not defined on the screen and can include medical and nonmedical use. This SIS-C is part of a 7-item behavioral health screen,[29, 30] self-administered on paper during the study period. An electronic flag prompts administration of the screen after check-in if a patient has not been screened in the past year, and a Medical Assistant enters responses into the EHR before their provider visit.

Sociodemographic characteristics and comorbidities

Demographic information documented in the EHR at the time of sampling was used to approximate the social conditions that shape the health of patients at different developmental stages[34] and with different lived experiences (e.g., sexism,[35-37] racism[38-40] other social determinants of health[41]). This included age (18-29, 30-49, 50-64, or ≥65), gender (woman or man), race (American Indian/Alaska Native, Asian, Black, Native Hawaiian/Pacific Islander, or White), and ethnicity (Hispanic or non-Hispanic). Due to small sample sizes and/or low prevalence of CUD in certain subgroups, we combined age groups (18-29, 30-49, ≥50) and race

and ethnicity (non-Hispanic Black, non-Hispanic White, Hispanic) for stratified subgroup analyses. Socioeconomic status was approximated using insurance status from enrollment records, marital status, education, employment, and type of residence reported on survey. Mental health (anxiety disorder, bipolar disorder, depressive disorder, schizophrenia disorder, and other psychosis) and substance use disorder diagnoses (alcohol use disorder, CUD, opioid use disorder, stimulant use disorder, and other drug use disorder) were based on International Classification of Disease, Tenth Revision (ICD-10) codes documented in the EHR or insurance claims in the year prior to completing the survey.

Analyses

Survey weighting

All analyses were weighted to account for oversampling and nonresponse. Specifically, we estimated *sampling weights* equal to the inverse proportion of eligible patients sampled within ten sampling strata.[42, 43] We estimated *nonresponse weights* using logistic regression to predict probability of survey nonresponse based on demographic characteristics [44]. We multiplied sampling weights and nonresponse weights to obtain estimates representative of the KPWA primary care population.[45]

Descriptive

We described characteristics of the sample, including the frequency of each response option on the SIS-C.

Screening performance

We compared the SIS-C to the reference standard of any CUD (CIDI≥2) and moderate-severe CUD (CIDI≥4). To assess screening performance, we estimated sensitivity (true positive rate) and specificity (true negative rate) for each possible cut-point on the SIS-C.[46, 47] We

depicted receiver operator characteristic (ROC) curves graphically and estimated area under the curves (AUC). ROC curves provide a useful summary of the overall discriminatory power of a screen.[46] AUC can range 0-1; AUC of 0.7-0.8 indicates acceptable discrimination, 0.8-0.9 indicates excellent discrimination, >0.9 indicates outstanding discrimination.[48, 49] We estimated 95% confidence intervals (CI) for weighted AUC estimates using nonparametric bootstrapping with 10,000 replications.[50]

Differences across sociodemographic subgroups

To determine whether the SIS-C performs differently across sociodemographic subgroups, we plotted ROC curves stratified by age, gender, and race/ethnicity. Confidence intervals for the difference in AUCs between pairs of subgroups were estimated via bootstrapping.[50] Bootstrapped 95% CIs that did not contain zero indicated a significant between-group difference.

Predictive value of SIS-C for CUD

Although positive and negative predictive values (indicating the probability of a condition given a positive or negative screen) are often reported in validation studies, these post-screening probabilities are highly dependent on the prevalence of the condition in the screened population.[52] Using Bayes' theorem,[52] we estimated the probability a patient has CUD if the SIS-C is positive and the probability a patient has CUD if the SIS-C is negative across a range of prevalence estimates for CUD (i.e., <0.5%-30%).[6-10]

Analyses were conducted using STATA[53, 54], R[55, 56], and Excel.

RESULTS

Table 2.2 describes sociodemographic and clinical characteristics of the sample, which was weighted to reflect the eligible primary care population screened for cannabis use. The weighted sample was predominantly middle-aged (mean age=50.7, SD=18.1), female (55.9%), non-Hispanic (96.7%), white (74.2%), married or living with a partner (62.8%) with indicators of higher socioeconomic status. More than a quarter of patients had a past-year mental health diagnosis and 5% had a past-year substance use disorder diagnosis documented in their EHR. Based on the survey-administered CIDI reference standard, 6.6% percent of primary care patients met criteria for any past-year DSM-5 CUD, with 1.9% meeting criteria for moderate-severe CUD.

Identification of any past-year CUD

The SIS-C demonstrated excellent discriminative ability for any past-year CUD based on the reference standard: AUC 0.89 (95% CI: 0.78-0.96; Figure 2.1). Report of cannabis use "less than monthly" or more often on the SIS-C maximized sensitivity (88%) and specificity (83%), with trade-offs between sensitivity and specificity at higher screening thresholds (Table 2.3).

Performance of the SIS-C differed significantly across age (Appendix Figure 2.1). Compared to patients ≥50 years old (AUC 0.97), AUC was significantly lower for patients 30-49 (AUC 0.80; difference=0.17 [95% CI: 0.02-0.40]) and 18-29 (AUC 0.91; difference=0.06 [95% CI: 0.02-0.13]). There was no significant difference between patients 30-49 and 18-29. Performance of the SIS-C did not differ significantly by gender or race and ethnicity (Appendix Table 2.2).

The probability of any past-year CUD based on the SIS-C (positive predictive value) varied across the range of population-based prevalence estimates and screening thresholds (Table 2.4). When the underlying prevalence of CUD is 4% in the screened population, the probability

of CUD in patients with positive SIS-C screens ranges 12%-26% across screen thresholds (i.e., "less than monthly" to "daily or almost daily"), and the probability of CUD in patients with negative SIS-C screens ranges 0-2%. When the population prevalence of CUD is 8% (e.g., young men), the probability of CUD in patients with positive SIS-C screens ranges 22%-42%, and the probability of CUD for patients with negative SIS-C screens ranges 0-5%. When the prevalence of CUD is 20-30% (e.g., patients with mental health or substance use disorders), the probability of CUD in patients with positive SIS-C screens ranges 45-78%, and the probability of CUD in patients with negative SIS-C screens ranges 0-19%.

Identification of moderate-severe CUD

The SIS-C demonstrated outstanding discriminative ability for past-year moderate-severe CUD: AUC 0.95 (95% CI: 0.94-0.96; Figure 2.1). Report of "monthly" or more frequent cannabis use maximized sensitivity (96%) and specificity (89%). Report of "daily or almost daily" cannabis use had high specificity (96%) but lower sensitivity (57%; Table 2.3).

Performance of the SIS-C for identifying moderate-severe CUD differed significantly across age, race and ethnicity (Appendix Figure 2.1). Compared to patients ≥50 years old (AUC 0.98), AUC was significantly lower for patients 30-49 (AUC 0.95; difference=0.03 [95% CI: 0.01-0.5]) and 18-29 (AUC 0.91; difference=0.06 [95% CI: 0.03-0.13]). There was no significant difference between patients 30-49 and 18-29. Performance of the SIS-C was significantly lower for Hispanic patients (AUC 0.91) compared to non-Hispanic White patients (AUC 0.96; difference=0.05 [95% CI: 0.01-0.16]) but did not differ between non-Hispanic White and non-Hispanic Black patients (Appendix Table 2.2).

The probability of past-year moderate-severe CUD based on the SIS-C varied across the range of population-based prevalence estimates and screening thresholds (Table 2.3).

Probabilities were slightly higher than those reported above for any CUD (mild-severe) given the stronger performance characteristics for identifying moderate-severe CUD.

DISCUSSION

This study evaluated the screening performance of the SIS-C, a single-item cannabis screen administered and documented in the EHR as part of routine primary care. Almost 7% of primary care patients met criteria for DSM-5 CUD based on the confidential CIDI reference standard, slightly higher than national survey estimates.[6-9] The performance of the SIS-C was excellent for any past-year CUD and outstanding for moderate-severe CUD. Report of any past-year cannabis use maximized sensitivity and specificity for any CUD, whereas report of cannabis use monthly or more often maximized sensitivity and specificity for moderate-severe CUD.

While there are several substance use screens validated in general adult patient populations,[17-20, 26, 57-62] few are single-item,[17-20] no single-item screens are specific to cannabis use, and none have been validated when administered during routine care and documented in the medical record (Table 2.4). Existing single-item screens[17-20] group cannabis with other illegal drugs. In the context of legalization and increasing prevalence, clinicians may want to screen for cannabis separately from other drugs, as for alcohol.[30] One screen includes cannabis-specific items, but only in the second stage of a two-step screening process [26]. Other previously validated cannabis-specific screens may not be practical for use in routine care due to their length (>4 items)[63, 64] or appropriate due to validation only in people who use cannabis.[65, 66]

Patients may respond differently to substance use screens when they are administered in clinical settings—where providers will see results in the medical record—compared to when they are administered in confidential research settings. It is promising, therefore, that the screening

performance of the EHR-documented SIS-C for any CUD was comparable to the performance of single-item drug screens validated in research settings ,[17-20] and its performance for identifying moderate-severe CUD was stronger.[17]

The SIS-C performed well across all groups based on age, gender, and race/ethnicity, but discriminative ability was slightly less strong for younger- and middle-aged adults relative to older adults. A lower threshold may be appropriate for identifying CUD in young adults—due to the higher prevalence of CUD and because younger patients may be more susceptible to risks of CUD.[67] Discriminative ability was also less strong for Hispanic patients relative to non-Hispanic White patients. Hispanic patients may underreport their cannabis use to avoid repercussions[68] stemming from intersecting cannabis and anti-immigration stigma.[40]

Selection of a SIS-C screening threshold for detecting CUD will depend on the setting and resources for follow-up assessment and care. Although any use and monthly use were the optimal screening thresholds for identifying any CUD and moderate-severe CUD, respectively, the probability that a patient with a positive screen has a CUD is still relatively low when the underlying prevalence of CUD in the screened population is less than 8%. A lower threshold may be appropriate for some settings (e.g., mental health) and populations (e.g., young men) expected to have a higher prevalence of CUD;[7-10] whereas a higher threshold may be appropriate for general medical settings.[6-8] Threshold selection also depends on how a positive screen will be used, and the resulting cost and benefits of positive and negative screens.[69, 70] Prioritizing a sensitive threshold may be appropriate as part of behavioral health screening in primary care settings when the screen is followed by low-cost, non-stigmatizing symptom assessment and discussion of symptoms.[30, 71] Prioritizing a specific threshold that minimizes false positive

screens might be more appropriate in resource-constrained settings, or those in which assessment results in referral.[47]

The SIS-C is not a replacement for assessment of CUD symptoms or for making a diagnosis. Many–or most–patients with positive SIS-C screens will not meet criteria for CUD, depending on the prevalence of CUD in the screened population. However, the SIS-C provides a starting point for asking patients about cannabis use, which in turn can support providers in exploring reasons for use[3, 72] and discussing risks and benefits of use, including CUD.[72] Additionally, the SIS-C can identify patients for targeted administration of longer assessments for symptoms of CUD.[73]

Limitations

This study has limitations. We used the entire survey sample, assuming no CUD symptoms among respondents who indicated no past-year use on two different questions, to increase representation across the spectrum of cannabis use and to minimize spectrum bias.[74] While this approach could introduce measurement error, we expected bias to be minimal since survey participants indicated no past-year cannabis use twice. Responses from a small number of patients may have contributed disproportionately to analyses due to weighting for oversampling design and nonresponse.[75] These weights were estimated using measured factors and cannot account for unmeasured factors; however, we found that patient characteristics of the weighted sample were similar to other KPWA primary care patient samples.[3, 22] We were unable to conduct subgroup analyses for all age and race subgroups due to small sample sizes. Although comparable to other surveys,[23, 24] this survey had a relatively low response rate. Finally, this study was conducted in a health system with integrated mental healthcare in a U.S. state where

adult cannabis is legal and among patients who were largely white, married, and with high SES; potentially limiting generalizability.

CONCLUSION

This study demonstrates the validity of a self-administered, single-item cannabis screen when used in routine primary care. The SIS-C had excellent-to-outstanding screening performance for CUD, and screen thresholds can be tailored to patient populations and the needs and preferences of health settings. The SIS-C can be easily integrated with screening for alcohol, other drugs, and depression,[30, 71] thereby making screening for CUD feasible in primary care.

REFERENCES FOR CHAPTER 2

1. Substance Abuse and Mental Health Services Administration. *Key substance use and mental health indicators in the United States: Results from the 2020 National Survey on Drug Use and Health*. 2021. *HHS Publication No PEP21-07-01-003, NSDUH Series H-56*. https://www.samhsa.gov/data/

2. Compton WM, Han B, Jones CM, Blanco C, Hughes A. Marijuana use and use disorders in adults in the USA, 2002-14: analysis of annual cross-sectional surveys. *Lancet Psychiatry*. Oct 2016;3(10):954-964. doi:10.1016/S2215-0366(16)30208-5

3. Matson TE, Carrell DS, Bobb JF, et al. Prevalence of Medical Cannabis Use and Associated Health Conditions Documented in Electronic Health Records Among Primary Care Patients in Washington State. *JAMA Netw Open*. 05 03 2021;4(5):e219375. doi:10.1001/jamanetworkopen.2021.9375

4. Browne K, Leyva Y, Malte CA, Lapham GT, Tiet QQ. Prevalence of medical and nonmedical cannabis use among veterans in primary care. *Psychol Addict Behav*. Aug 26 2021;doi:10.1037/adb0000725

5. Hall W, Degenhardt L. Adverse health effects of non-medical cannabis use. *Lancet*. Oct 17 2009;374(9698):1383-91. doi:10.1016/S0140-6736(09)61037-0

6. Compton WM, Han B, Jones CM, Blanco C. Cannabis use disorders among adults in the United States during a time of increasing use of cannabis. *Drug and alcohol dependence*. 2019;204:107468-107468. doi:10.1016/j.drugalcdep.2019.05.008

7. Kerridge BT, Pickering R, Chou P, Saha TD, Hasin DS. DSM-5 cannabis use disorder in the National Epidemiologic Survey on Alcohol and Related Conditions-III: Gender-specific profiles. *Addict Behav*. Jan 2018;76:52-60. doi:10.1016/j.addbeh.2017.07.012

8. Hasin DS, Kerridge BT, Saha TD, et al. Prevalence and Correlates of DSM-5 Cannabis Use Disorder, 2012-2013: Findings from the National Epidemiologic Survey on Alcohol and Related Conditions-III. *Am J Psychiatry*. 06 01 2016;173(6):588-99. doi:10.1176/appi.ajp.2015.15070907

9. Substance Abuse and Mental Health Services Administration. *Results from the 2020 National Survey on Drug Use and Health: Detailed tables*. 2021. https://www.samhsa.gov/data/

10. Browne KC, Stohl M, Bohnert KM, et al. Prevalence and Correlates of Cannabis Use and Cannabis Use Disorder Among U.S. Veterans: Results From the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC-III). *Am J Psychiatry*. Jan 2022;179(1):26-35. doi:10.1176/appi.ajp.2021.20081202

11. Degenhardt L, Hall W. Extent of illicit drug use and dependence, and their contribution to the global burden of disease. *The Lancet*. 2012/01/07/ 2012;379(9810):55-70. doi:https://doi.org/10.1016/S0140-6736(11)61138-0

12. Chou R, Dana T, Blazina I, Grusing S, Fu R, Bougatsos C. *Interventions for Unhealthy Drug Use—Supplemental Report: A Systematic Review for the U.S. Preventive Services Task Force*. Vol. Evidence Synthesis, No. 187. 2020. 19-05255-EF-2. https://www.ncbi.nlm.nih.gov/books/NBK558205/

13. Sherman BJ, McRae-Clark AL. Treatment of Cannabis Use Disorder: Current Science and Future Outlook. *Pharmacotherapy*. 05 2016;36(5):511-35. doi:10.1002/phar.1747

14. Kansagara D, Becker WC, Ayers C, Tetrault JM. Priming primary care providers to engage in evidence-based discussions about cannabis with patients. *Addict Sci Clin Pract*. 12 02 2019;14(1):42. doi:10.1186/s13722-019-0171-3

15. Patnode CD, Perdue LA, Rushkin M, O'Connor EA. *Screening for Unhealthy Drug Use in Primary Care in Adolescents and Adults, Including Pregnant Persons: Updated Systematic Review for the U.S. Preventive Services Task Force*. Vol. Evidence Synthesis, No. 186. 2020. 19-05255-EF-1. https://www.ncbi.nlm.nih.gov/books/NBK558174/

16. Lapham GT, Campbell CI, Yarborough BJH, et al. The prevalence of Healthcare Effectiveness Data and Information Set (HEDIS) initiation and engagement in treatment among patients with cannabis use disorders in 7 US health systems. *Subst Abus*. 2019;40(3):268-277. doi:10.1080/08897077.2018.1544964

17. Gryczynski J, McNeely J, Wu LT, et al. Validation of the TAPS-1: A Four-Item Screening Tool to Identify Unhealthy Substance Use in Primary Care. *J Gen Intern Med*. Sep 2017;32(9):990-996. doi:10.1007/s11606-017-4079-x

18. McNeely J, Cleland CM, Strauss SM, Palamar JJ, Rotrosen J, Saitz R. Validation of Self-Administered Single-Item Screening Questions (SISQs) for Unhealthy Alcohol and Drug Use in Primary Care Patients. *J Gen Intern Med*. Dec 2015;30(12):1757-64. doi:10.1007/s11606-015-3391-6

19. McNeely J, Strauss SM, Saitz R, et al. A Brief Patient Self-administered Substance Use Screening Tool for Primary Care: Two-site Validation Study of the Substance Use Brief Screen (SUBS). *Am J Med*. Jul 2015;128(7):784.e9-19. doi:10.1016/j.amjmed.2015.02.007

20. Smith PC, Schmidt SM, Allensworth-Davies D, Saitz R. A single-question screening test for drug use in primary care. *Arch Intern Med*. Jul 12 2010;170(13):1155-60. doi:10.1001/archinternmed.2010.140

21. Bradley KA, Lapham GT, Lee AK. Screening for Drug Use in Primary Care: Practical Implications of the New USPSTF Recommendation. *JAMA Intern Med*. 08 01 2020;180(8):1050-1051. doi:10.1001/jamainternmed.2019.7335

22. Lapham GT, Matson TE, Carrell DS, et al. Comparison of Medical Cannabis use Reported on a Confidential Survey vs Documented in the Electronic Health Record among Primary Care Patients. *JAMA Netw Open*. Under review;

23. Guo Y, Kopec JA, Cibere J, Li LC, Goldsmith CH. Population Survey Features and Response Rates: A Randomized Experiment. *Am J Public Health*. Aug 2016;106(8):1422-6. doi:10.2105/AJPH.2016.303198

24. Lallukka T, Pietilainen O, Jappinen S, Laaksonen M, Lahti J, Rahkonen O. Factors associated with health survey response among young employees: a register-based study using online, mailed and telephone interview data collection methods. *BMC Public Health*. Feb 5 2020;20(1):184. doi:10.1186/s12889-020-8241-8

25. Compton WM, Cottler LB, Dorsey KB, Spitznagel EL, Mager DE. Comparing assessments of DSM-IV substance dependence disorders using CIDI-SAM and SCAN. *Drug Alcohol Depend*. Jul 1996;41(3):179-87. doi:10.1016/0376-8716(96)01249-5

26. McNeely J, Wu LT, Subramaniam G, et al. Performance of the Tobacco, Alcohol, Prescription Medication, and Other Substance Use (TAPS) Tool for Substance Use Screening in Primary Care Patients. *Ann Intern Med*. Nov 15 2016;165(10):690-699. doi:10.7326/M16-0317

27. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders (5th ed.)*. 2013.

28. Babor TF, Higgins-Biddle JC, Saunders JB, Monteiro MG. AUDIT: The Alcohol Use Disorders Identification Test: Guidelines for use in primary care. 2nd ed. *World Health Organization*. 2001;

29. Yeung K, Richards J, Goemer E, et al. Costs of using evidence-based implementation strategies for behavioral health integration in a large primary care system. *Health Serv Res*. Dec 2020;55(6):913-923. doi:10.1111/1475-6773.13592

30. Sayre M, Lapham GT, Lee AK, et al. Routine Assessment of Symptoms of Substance Use Disorders in Primary Care: Prevalence and Severity of Reported Symptoms. *J Gen Intern Med*. Apr 2020;35(4):1111-1119. doi:10.1007/s11606-020-05650-3

31. Spindle TR, Bonn-Miller MO, Vandrey R. Changing landscape of cannabis: novel products, formulations, and methods of administration. *Curr Opin Psychol*. Dec 2019;30:98-102. doi:10.1016/j.copsyc.2019.04.002

32. MacCallum CA, de Freitas L, Lo LA, Eadie L, Brubacher JR. Cannabinoid-Related Adverse Events and Impairment. In: Narouze SN, ed. *Cannabinoids and Pain*. Springer International Publishing; 2021:293-306.

33. Walden N, Earleywine M. How high: quantity as a predictor of cannabis-related problems. *Harm Reduct J*. May 29 2008;5:20. doi:10.1186/1477-7517-5-20

34. Ben-Shlomo Y, Kuh D. A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives. *Int J Epidemiol*. Apr 2002;31(2):285-93.

35. Greaves L, Hemsing N. Sex and Gender Interactions on the Use and Impact of Recreational Cannabis. *Int J Environ Res Public Health*. Jan 14 2020;17(2)doi:10.3390/ijerph17020509

36. Hemsing N, Greaves L. Gender Norms, Roles and Relations and Cannabis-Use Patterns: A Scoping Review. *Int J Environ Res Public Health*. Feb 4 2020;17(3)doi:10.3390/ijerph17030947

37. Krieger N. Genders, sexes, and health: what are the connections--and why does it matter? *Int J Epidemiol*. Aug 2003;32(4):652-7. doi:10.1093/ije/dyg156

38. Boyd RW, Lindo E, G., Weeks LD, McLemore MR. On Racism: A New Standard For Publishing On Racial Health Inequities. *Health Affairs Blog*. 2020;

39. Ford CL, Airhihenbuwa CO. Critical Race Theory, race equity, and public health: toward antiracism praxis. *Am J Public Health*. Apr 01 2010;100 Suppl 1:S30-5. doi:10.2105/AJPH.2009.171058

40. Bender S. The Colors of Cannabis: Race and Marijuana. *UC Davis L Rev*. 2016;50(689)

41. Keyes KM, Galea S. *Population Health Science*. Oxford University Press; 2016.

42. Kish L. *Survey sampling*. John Wiley & Sons; 1965.

43. Horvitz DG, Thompson DJ. A Generalization of Sampling Without Replacement from a Finite Universe. *Journal of the American Statistical Association*. 1952;47:663-685.

44. Hofler M, Pfister H, Lieb R, Wittchen HU. The use of weights to account for non-response and drop-out. *Soc Psychiatry Psychiatr Epidemiol*. Apr 2005;40(4):291-9. doi:10.1007/s00127-005-0882-5

45. Brick JM, Kalton G. Handling missing data in survey research. *Stat Methods Med Res*. Sep 1996;5(3):215-38. doi:10.1177/096228029600500302

46. Hulley SB. *Designing clinical research*. Lippincott Williams & Wilkins; 2007.

47. Trevethan R. Sensitivity, Specificity, and Predictive Values: Foundations, Pliabilities, and Pitfalls in Research and Practice. *Front Public Health*. 2017;5:307. doi:10.3389/fpubh.2017.00307

48. Mandrekar JN. Receiver operating characteristic curve in diagnostic test assessment. *J Thorac Oncol*. Sep 2010;5(9):1315-6. doi:10.1097/JTO.0b013e3181ec173d

49. Hosmer DW, Lemeshow S. Applied Logistic Regression. 2nd Ed. ed. John Wiley and Sons; 2000:160-164:chap Chapter 5.

50. Qin G, Hotilovac L. Comparison of non-parametric confidence intervals for the area under the ROC curve of a continuous-scale diagnostic test. *Statistical Methods in Medical Research*. 2008;17(2):207-221. doi:10.1177/0962280207087173

51. Rutter CM. Bootstrap estimation of diagnostic accuracy with patient-clustered data. *Acad Radiol*. Jun 2000;7(6):413-9. doi:10.1016/s1076-6332(00)80381-5

52. Sox HC, Jr. Probability theory in the use of diagnostic tests. An introduction to critical study of the literature. *Ann Intern Med*. Jan 1986;104(1):60-6. doi:10.7326/0003-4819-104-1-60

53. *Stata Statistical Software: Release 15*. StataCorp LP; 2017.

54. *SENSPEC: Stata module to compute sensitivity and specificity results saved in generated variables*. 2017. https://EconPapers.repec.org/RePEc:boc:bocode:s439801

55. *R: A Language and environment for statistical computing*. R Foundation for Statistical Computing; 2021. https://www.R-project.org/

56. *Package 'Weighted ROC'*. Version R package version 2020.1.31. 2020. https://github.com/tdhock/WeightedROC

57. Tiet QQ, Leyva YE, Browne K, Moos RH. Screen of drug use: Diagnostic accuracy for cannabis use disorder. *Addict Behav*. Aug 2019;95:184-188. doi:10.1016/j.addbeh.2019.02.010

58. Tiet QQ, Leyva YE, Moos RH, Frayne SM, Osterberg L, Smith B. Screen of Drug Use: Diagnostic Accuracy of a New Brief Tool for Primary Care. *JAMA Intern Med*. Aug 2015;175(8):1371-7. doi:10.1001/jamainternmed.2015.2438

59. Tiet QQ, Leyva YE, Moos RH, Smith B. Diagnostic accuracy of a two-item Drug Abuse Screening Test (DAST-2). *Addict Behav*. Nov 2017;74:112-117. doi:10.1016/j.addbeh.2017.06.008

60. Tiet QQ, Leyva Y, Moos RH, Smith B. Diagnostic accuracy of a two-item screen for drug use developed from the alcohol, smoking and substance involvement screening test (ASSIST). *Drug Alcohol Depend*. Jul 1 2016;164:22-27. doi:10.1016/j.drugalcdep.2016.03.029

61. Brown RL, Leonard T, Saunders LA, Papasouliotis O. A two-item conjoint screen for alcohol and other drug problems. *J Am Board Fam Pract*. Mar-Apr 2001;14(2):95-106.

62. Cherpitel CJ, Borges G. Screening for drug use disorders in the emergency department: performance of the rapid drug problems screen (RDPS). *Drug Alcohol Depend*. May 10 2004;74(2):171-5. doi:10.1016/j.drugalcdep.2003.12.010

63. Adamson SJ, Kay-Lambkin FJ, Baker AL, et al. An improved brief measure of cannabis misuse: the Cannabis Use Disorders Identification Test-Revised (CUDIT-R). *Drug Alcohol Depend*. Jul 1 2010;110(1-2):137-43. doi:10.1016/j.drugalcdep.2010.02.017

64. Bashford J, Flett R, Copeland J. The Cannabis Use Problems Identification Test (CUPIT): development, reliability, concurrent and predictive validity among adolescents and adults. *Addiction*. Apr 2010;105(4):615-25. doi:10.1111/j.1360-0443.2009.02859.x

65. Bonn-Miller MO, Heinz AJ, Smith EV, Bruno R, Adamson S. Preliminary Development of a Brief Cannabis Use Disorder Screening Tool: The Cannabis Use Disorder Identification Test Short-Form. *Cannabis Cannabinoid Res*. 2016;1(1):252-261. doi:10.1089/can.2016.0022

66. Steiner S, Sebastian E, Kraus L. Severity of Dependence Scale: Establishing a cut-off point for cannabis dependence in the German adult population. *Sucht*. 02/01 2008;54:S57–S63. doi:10.1024/2008.07.07

67. Volkow ND, Compton WM, Weiss SR. Adverse health effects of marijuana use. *N Engl J Med*. Aug 28 2014;371(9):879. doi:10.1056/NEJMc1407928

68. Golub A, Johnson BD, Dunlap E. The Race/Ethnicity Disparity in Misdemeanor Marijuana Arrests in New York City. *Criminol Public Policy*. 2007;6(1):131-164. doi:10.1111/j.1745-9133.2007.00426.x

69. Bradley KA, Williams EC, Achtmeyer CE, Volpp B, Collins BJ, Kivlahan DR. Implementation of evidence-based alcohol screening in the Veterans Health Administration. *Am J Manag Care*. Oct 2006;12(10):597-606.

70. Metz CE. Basic principles of ROC analysis. *Semin Nucl Med*. Oct 1978;8(4):283-98. doi:10.1016/s0001-2998(78)80014-2

71. Yeung K, Richards J, Goemer E, et al. Costs of using evidence-based implementation strategies for behavioral health integration in a large primary care system. *Health Serv Res*. 2020;55(6):913-923. doi:10.1111/1475-6773.13592

72. Matson TE, Bradley KA, Lapham GT. Self-reported Practices of Frontline Cannabis Dispensary Workers and the Implications for Clinicians. *JAMA Netw Open*. Sep 01 2021;4(9):e2125262. doi:10.1001/jamanetworkopen.2021.25262

73. Saxon AJ. Screening for unhealthy use of alcohol and other drugs in primary care. In: Stein MB, Friedman M, eds. *UpToDate*. 2022.

74. Willis BH. Spectrum bias--why clinicians need to be cautious when applying diagnostic test studies. *Fam Pract*. Oct 2008;25(5):390-6. doi:10.1093/fampra/cmn051

75. Seaman SR, White IR. Review of inverse probability weighting for dealing with missing data. *Stat Methods Med Res*. Jun 2013;22(3):278-95. doi:10.1177/0962280210395740

FIGURES FOR CHAPTER 2

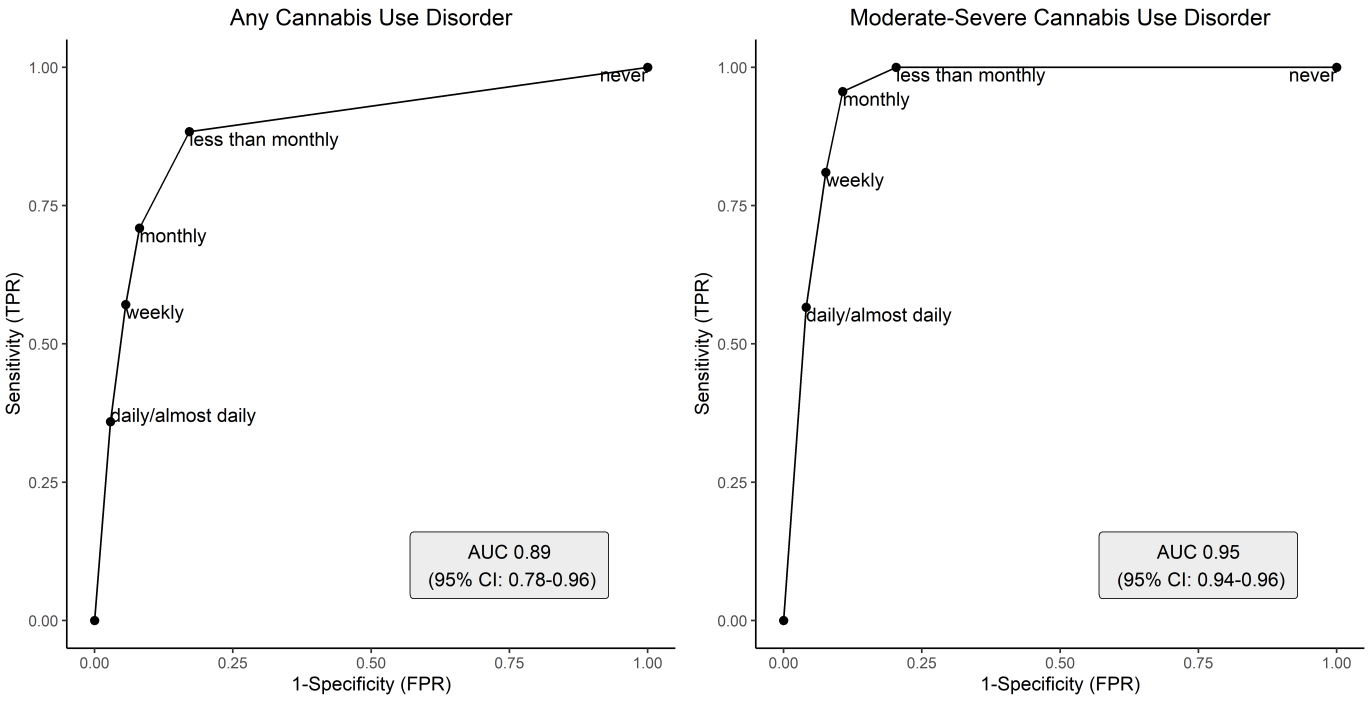


Figure 2.1. Receiver Operating Characteristic (ROC) curves for the Single-Item Screen – Cannabis (SIS-C) compared to the reference standard for past-year cannabis use disorder (CUD).

Figure 2.1 caption: The SIS-C is administered annually to primary care patients and asks about the frequency of past-year cannabis use (never, less than monthly, monthly, weekly, daily or almost daily). The Composite International Diagnostic Interview (CIDI) was used as the reference standard for past year DSM-5 CUD and was administered to survey participants on a confidential survey. The SIS-C was compared to any CUD (CIDI≥2) and moderate-severe CUD (CIDI≥4). For any CUD, the SIS-C had an area under the curve (AUC) 0.89 (95% CI: 0.78-0.96). For moderate-severe CUD, the SIS-C had AUC 0.95 (95% CI: 0.94-0.96).

TABLES FOR CHAPTER 2

(below)

Table 2.1. Review of brief validated substance use screens (≤ 4 items) for current cannabis or other drug use disorder in adults in a general medical setting

Screen	# Items	2-Step Screen (Y/N)	# Cannabis Specific Items	Validated for CUD (Y/N)	Validated for SUD (Y/N)	Administered (Self/Interview)	Offered as research or routine care	Optimal cut-point (Range)	Sens	Spec	AUC
SIS-C (this study)	1	No	1	Yes (CIDI)	No	Self	Routine care	**Any CUD:** ≥ Less than monthly (never-daily)	88	83	0.89
								Moderate-Severe CUD: ≥ Monthly (never-daily)	96	89	0.95
SoDU[57, 58]	1-2 (+1 to ascertain cannabis use)	Yes	0	Yes (MINI)	Yes (MINI)	Interview	Research	**SUD:** Item #1 ≥ 7 (0-365 days) or Item #2 ≥ 2 (0-365 days)	92	93	0.93
								CUD: Same as above	100	88	0.94
TAPS[26]	4-30	Yes	3	No	Yes (CIDI)	Interview	Research	**SUD in cannabis use sample:** Positive TAPS-1 and TAPS-2 ≥ 2 (0-3)	71	95	-
TAPS-1[17]	4 (1 item for illegal drugs)	No	0	No	Yes (WMH-CIDI)	Self and Interview	Research	**Any SUD:** ≥ Less than monthly (never-daily)	93	85	0.89
								Moderate-Severe SUD: Same as above	95	83	0.89
ASSIST-Drug[60]	1-2	Yes	0	No	Yes (MINI)	Interview	Research	**DUD:** Item #1 ≥ 2 (0-365 days) or Item #2 ≥ 5 (0-365 days)	95	88	0.92
DAST-2[59]	2	No	0	No	Yes (MINI)	Interview	Research	**DUD:** ≥ 1 (0-365 days)	94	89	0.92
RDPS[62]	4 (+1 to ascertain cannabis use)	Yes	0	No	Yes (CIDI and ICD-10)	Interview	Research	**Drug Abuse/Dependence:** ≥ 1 (0-4)	81	98	0.90
								Drug Dependence: Same as above	83	97	0.91
SSIQ[18]	1	No	0	No	Yes (MINI-Plus)	Self	Research	**SUD:** ≥ 1 (0-∞ times)	85	89	0.87
SQST[20]	1	No	0	No	Yes (CIDI)	Interview	Research	**DUD:** ≥ 1 (0-∞ times)	100	74	-
SUBS[19]	4 (1 item for illegal drugs)	No	0	No	Yes (MINI-Plus)	Self	Research	**SUD:** ≥ 1 or 2 days (never-3 or more days)	82	89	0.85

TICS[61]	2	No	0	No	Yes (CIDI-SAM)	Interview	Research	**SUD:** Any reported use (never-often)	79	78	-

Abbreviations: CUD=cannabis use disorder; DUD=drug use disorder; SUD=substance use disorder; Sens=sensitivity; Spec=specificity; AUC=area under receiver operating characteristic curves; Single-Item Screen – Cannabis (SIS-C); SoDU=Screen of Drug Use; TAPS=Tobacco, Alcohol, Prescription medication, and other Substance use; ASSIT-Drug=Alcohol, Smoking and Substance Involvement screening Test-Drug; DAST=Drug Abuse Screening Test; RDPS=Rapid Drug Problem Screen; SSIQ=Sigle-Item Screening Questions ; SQST=Single-Question Screening Test; SUBS=Substance Use Brief Screen; TICS=Two-Item Conjoint Screen; DHQ/PDHQ=Drug History Questionnaire or Psychoactive Drug History Questionnaire; CUDIT-R=Cannabis Use Disorder Identification Test-Revised; CUPIT=Cannabis Abuse Problems Identification Test; CAST=Cannabis Abuse Screening Test; CAGE-AID=Cut Down, annoyed, Guilty, Eye-opener-Adapted to Include Drugs; CUDIT-SF= Cannabis Use Disorder Identification Test-Short Form; SDS=Severity of Dependence Scale; S2BI=Screen to Brief Intervention; BSTAD=Brief Screener for Tobacco, Alcohol and other Drugs; SURP-P=Substance Use Risk Profile-Pregnancy
Note: Screens were excluded if they were not validated (e.g., NIDA Quick Screen, DHQ/PDHQ), had more than 4 items (e.g., CUDIT-R, CUPIT, CAST), did not assess current use (e.g., CAGE-AID), validated only among people who use cannabis (e.g., CUDIT-SF, SDS), adolescents (e.g., S2BI, BSTAD), or in a specialty population such as pregnant women (e.g., SURP-P, 5Ps).

Table 2.2. Characteristics of the eligible primary care population (N=1688)

	Unweighted	*Weighted*	
	No.	*%*	*(SE)*
Age[a]			
18-29	459	14.9	(2.8)
30-49	582	31.0	(3.9)
50-64	329	26.3	(3.8)
65+	318	27.7	(3.4)
Gender[a]			
Women	861	55.9	(4.1)
Men	827	44.1	(4.1)
Race[a]			
American Indian/Alaska Native	40	0.4	(0.0)
Asian	99	9.7	(2.4)
Black	163	4.8	(1.7)
Native Hawaiian/Pacific Islander	36	2.4	(0.1)
White	1,192	74.3	(3.7)
Other/Unknown race	158	8.4	(2.5)
Hispanic Ethnicity[a]	174	3.3	(1.0)
Insurance[a]			
Medicaid/Subsidized	210	6.0	(1.8)
Medicare	323	27.1	(3.4)
Commercial	1,072	64.9	(3.7)
Unknown	83	2.0	(0.8)
Marital Status[b,c]			
Married/Living with partner	966	62.8	(4.0)
Widowed	43	3.0	(1.3)
Divorced/Separated	166	9.2	(2.4)
Single/Never married	505	24.1	(3.5)
Education[b,c]			
≤ High school	319	12.7	(2.7)
Some college	665	38.6	(4.0)
≥ 4 years of college	694	47.8	(4.1)
Employment[b,c]			
Employed full time	988	55.4	(4.1)
Employed part time	152	12.6	(2.9)
Retired	298	22.0	(3.1)
Other	186	8.3	(2.3)
Unemployed	58	0.8	(0.2)
EHR-Documented Past-Year Diagnoses[a]			
Mental health diagnosis	612	26.5	(3.6)
SUD diagnosis	106	5.2	(2.0)
Mental health or SUD diagnosis	662	28.7	(3.7)
CIDI Criteria for Cannabis Use Disorder (CUD)[b]			
< 2 (no CUD)	1,070	93.3	(1.0)
2-3 (mild CUD)	364	4.7	(0.9)
≥ 4 (moderate-severe CUD)	254	1.9	(0.2)

Abbreviations: CUD = cannabis use disorder; CIDI = Composite International Diagnostic Interview; SUD = substance use disorder

[a] Data collected from electronic health records

[b] Data collected from confidential survey

[c] Subgroups do not sum to total N due to missing responses

Table 2.3. Prevalence and performance characteristics of the Single-Item Screen – Cannabis (SIS-C) for identification of past-year cannabis use disorder (CUD)

	Prevalence of scores			**Screening performance for past-year CUD**							
	Unweighted	*Weighted*		Any CUD[a]				Moderate-Severe CUD[b]			
Potential cut-points for the Single-Item Screen-Cannabis[c]	*No.*	*%*	*(SE)*	*Sens (%)*	*Spec (%)*	*AUC*	*(95% CI)*[d]	*Sens (%)*	*Spec (%)*	*AUC*	*(95% CI)*[d]
Never	99	78.1	(2.0)	--	--			--	--		
≥ Less than monthly	99	9.6	(1.2)	88	83			100	80		
≥ Monthly	118	3.3	(0.4)	71	92	0.89	(0.78-0.96)	96	89	0.95	(0.94-0.96)
≥ Weekly	376	4.0	(0.4)	57	94			81	92		
Daily or almost daily	996	5.1	(0.4)	36	97			57	96		

Abbreviations: SIS-C = Single-Item Screen – Cannabis; CUD = cannabis use disorder; Sens = sensitivity; Spec = specificity; AUC = area under the receiver operating characteristic curve; CI = confidence interval

[a] Endorsed ≥2 criteria on the Composite International Diagnostic Interview (CIDI)

[b] Endorsed ≥4 criteria on the Composite International Diagnostic Interview (CIDI)

[c] SIS-C asked, "*How often in the past year did you use marijuana?*" with responses documented in the EHR as part of routine care

[d] 95% CI obtained using nonparametric bootstrapping of weighted AUC estimates.

Table 2.4. Probability of past-year cannabis use disorder (CUD) if SIS-C is positive (or negative) across a range of population-based prevalence estimates for CUD

	Population Prevalence of Any CUD* (%)							
	0.5	**2**	**4**	**6**	**8**	**10**	**20**	**30**
Threshold for positive SIS-C	Probability Patient has CUD if SIS-C is Positive (%)							
≥ Less than monthly	1.6	6.3	12.1	17.4	22.4	26.9	45.3	58.7
≥ Monthly	2.6	9.9	18.4	25.7	32.0	37.5	57.5	69.9
≥ Weekly	2.8	10.3	19.0	26.5	32.9	38.5	58.5	70.7
Daily or almost daily	4.0	14.4	25.5	34.4	41.7	47.7	67.3	77.9
Threshold for positive SIS-C	Probability Patient has CUD if SIS-C is Negative (%)							
≥ Less than monthly	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
≥ Monthly	0.1	0.3	0.6	0.9	1.2	1.6	3.4	5.8
≥ Weekly	0.2	0.8	1.6	2.4	3.2	4.1	8.7	14.1
Daily or almost daily	0.3	1.1	2.2	3.3	4.5	5.6	11.9	18.8

	Population Prevalence of Moderate-Severe CUD* (%)							
	0.5	**2**	**4**	**6**	**8**	**10**	**20**	**30**
Threshold for positive SIS-C	Probability Patient has CUD if SIS-C is Positive (%)							
≥ Less than monthly	1.5	5.7	11.1	16.0	20.6	24.9	42.7	56.1
≥ Monthly	2.4	9.1	16.9	23.7	29.8	35.2	55.0	67.7
≥ Weekly	3.0	11.1	20.4	28.2	34.8	40.6	60.6	72.5
Daily or almost daily	4.5	16.1	28.2	37.5	45.0	51.1	70.2	80.1
Threshold for positive SIS-C	Probability Patient has CUD if SIS-C is Negative (%)							
≥ Less than monthly	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
≥ Monthly	0.0	0.1	0.2	0.3	0.5	0.6	1.3	3.5
≥ Weekly	0.1	0.3	0.7	1.0	1.4	1.8	3.9	9.8
Daily or almost daily	0.2	0.6	1.2	1.9	2.6	3.3	7.0	16.8

Abbreviations: CUD = cannabis use disorder; SIS-C = Single-Item Screen – Cannabis; DSM-5 = Diagnostic and Statistical Manual for Mental Disorders, 5th edition

* Range of prevalence estimates for past-year DSM-5 CUD was based on prior literature finding the overall prevalence of any CUD to be 2-4% and the overall prevalence of moderate-severe CUD to be 1-2%, with higher prevalence estimates for some subgroups (e.g., men, young adults, patients with mental health and substance use disorder, etc.) and lower prevalence estimates for some subgroups (e.g., women, older adults).

CHAPTER 3

Psychometric performance of a Substance Use Symptom Checklist to help clinicians assess substance use disorder in primary care

INTRODUCTION

Over 55 million adults in the United States (U.S.) use cannabis or other drugs, with cannabis being most common.[1] The health risks and addictive potential vary by substance but generally increase with the frequency and quantity of use and can result in symptoms of a substance use disorder (SUD).[2] Seven percent of U.S. adults meet diagnostic criteria for SUD,[3] defined as having two or more of 11 criteria by the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5).[4] However, the proportion of patients who receive a SUD diagnosis is much lower (0.8-1.3%).[5-8] Low rates of diagnosis decrease the opportunity for patients to receive treatment[9, 10] despite evidence-based options (e.g., pharmacotherapy for opioid use disorder, behavioral treatments for cannabis and stimulant use disorders).[11-13]

Brief, validated substance use screens, recommended by the U.S. Preventive Services Task Force,[14] typically ask about the frequency of cannabis and other drug use and are useful for screening for SUD. While brief primary care screening programs have been validated for SUDs generally,[15] they do not provide information on DSM-5 SUD symptoms. Following screening, primary care providers need to assess consequences or symptoms resulting from substance use, in order to identify the presence and severity of SUD. Brief, standardized assessments are preferable to full diagnostic interviews in general medical settings[16] and may help providers diagnose SUDs and assess patient treatment needs.[17, 18] While brief SUD assessments have been validated in research and specialty settings,[19, 20] their performance when used in general medical

settings, with responses documented in electronic health records (EHR), has not been psychometrically evaluated.

As part of behavioral health integration, Kaiser Permanente Washington began routinely screening patients for past-year cannabis and other drug use followed by Substance Use Symptom Checklist assessment when patients reported daily cannabis or any other drug use on screens.[5, 21-26] The Substance Use Symptom Checklist mirrors DSM-5 criteria for SUD, has been used to engage patients in discussions of problems they are experiencing due to cannabis or other drug use, and has been recommended for evaluating the presence and severity of SUD.[18] Although it is clinically informative and practical for use in primary care,[5, 25] its psychometric performance as a diagnostic tool is untested. The objective of this study was to evaluate the psychometric properties of the Substance Use Symptom Checklist (i.e., "Symptom Checklist") used routinely among primary care patients reporting daily cannabis use, other drug use, or both to support its use as a diagnostic tool in general medical settings.

METHODS

Setting

This cross-sectional study included patients seen in Kaiser Permanente Washington, a large integrated healthcare system providing health insurance and medical care to over 700,000 patients across 32 clinics in Washington State (2015-2020).

Behavioral health screening procedures. Adult patients (≥18 years) are asked to complete a 7-item behavioral health screen (on paper or via the patient EHR portal; Appendix Figure 3.1) as part of routine care, prompted annually with EHR reminders. The screen includes separate questions for cannabis ("*How often in the past year have you used marijuana?"*) and

other drug use ("*How often in the past year have you used an illegal drug (not marijuana) or used a prescription medication for non-medical reasons?"*).[26] For both cannabis and other drug use questions, response options are: *"never," "less than monthly," "monthly," "weekly,"* and *"daily or almost daily"* use.[27] Staff enter screen results into the EHR prior to the provider visit. More than 90% of primary care patients complete annual cannabis and/or other drug screening.

Substance Use Symptom Checklist procedures. The Symptom Checklist (Appendix Figure 3.2) was developed based on the 11 DSM-5 criteria[4] to elicit symptoms of SUD in primary care and implemented with behavioral health screening as a tool to facilitate conversations between primary care providers and their patients who reported high-risk substance use.[5] Specifically, the EHR prompts staff to administer the Symptom Checklist on paper when patients report cannabis use *"daily or almost daily"* or any drug use (i.e., response other than "never") and enter responses into the EHR. Approximately 73-78% of patients who report high-risk substance use complete the Symptom Checklist.[26]

Data

This study used EHR data from all Kaiser Permanente Washington clinics. This study received approval and waivers of consent and Health Insurance Portability and Accountability Act authorization from the Kaiser Permanente Washington Health Research Institute Institutional Review Board.

Sample

Adult patients (≥18 years) were included in the study if they had at least one primary care visit from March 1, 2015 to March 1, 2020 and completed one or more eligible Symptom Checklists. Symptom Checklists (n=42,650) were eligible if prompted by daily cannabis use and/or any other drug use screens (92%; n=39,135) and completed on the same day as screening

(84%; n=32,872). We excluded incomplete Symptom Checklists (5%; n=1,667) and those linked to a virtual encounter due to differences in workflow (<1%; n=199). Each Symptom Checklist fell into one of three mutually-exclusive subsamples, those triggered by: 1) daily cannabis only (n= 22,497); 2) other drug use only (n=5,706); or 3) both daily cannabis and other drug use (n=2,803) reported on the same day. However, patients could complete more than one Symptom Checklist over the study period and thereby be included in more than one Symptom Checklist subsample or in one subsample multiple times. Within each Symptom Checklist subsample, we randomly selected one Symptom Checklist per patient (Figure 3.1).

Measures

Substance Use Symptom Checklist. Patients self-report the presence or absence of 11 DSM-5 symptoms on the Symptom Checklist. The Symptom Checklist has a past-year timeframe consistent with diagnostic standards.[4] Summed symptom counts range from 0-11; ≥2 criteria is typically consistent with an SUD diagnosis[4] and the number of criteria endorsed reflect SUD severity (mild: 2-3 criteria; moderate: 4-5 criteria; severe: 6-11 criteria).

Demographic Characteristics. Demographic characteristics documented in the EHR were used to approximate patients' lived identities and experiences. This included age (18-24, 25-44, 45-64, and ≥65), sex (female or male), race (American Indian/Alaska Native, Asian, Black, Native Hawaiian/Pacific Islander, or White), and ethnicity (Hispanic or non-Hispanic). Participants reporting other/unknown race, or unknown ethnicity were included in descriptive tables and full sample analyses but excluded from analyses of differences in performance of the Symptom Checklist across race and ethnicity.

Analyses

Patient characteristics were described across the three Symptom Checklist subsamples: daily cannabis use only, other drug use only, and both daily cannabis and other drug use.

Current conceptions of SUD are based on evidence that there is a single spectrum reflecting underlying severity of a brain disorder[28, 29] that is not directly observable but can be measured by observable criteria, which according to the DSM-5 are cognitive, behavioral, and physiological symptoms indicating continued substance use despite significant substance-related problems.[4] Therefore, psychometric analyses of the Symptom Checklist were conducted using item response theory (IRT) in each of the Symptom Checklist subsamples. IRT was selected as the analytical approach because it aims to model the relationships that an observable set of measures (e.g., SUD criteria reported on Symptom Checklists) have with an unobservable or latent trait (e.g., SUD severity).[30] This relationship was characterized using two parameters: discrimination and severity (detailed below). A two-parameter logistic IRT model using maximum likelihood was fit with the *mirt* package in R.[31, 32] We performed three IRT analyses—one for each Symptom Checklist subsample.

Unidimensionality. IRT assumes that the latent variable (SUD severity) exists along a unidimensional continuum. The IRT concept of unidimensionality is consistent with current diagnosing standards characterizing SUD as a single brain disorder with varying severity from mild to severe.[4] We examined the fit of unidimensional IRT models by comparing model fit indices (ranging 0-1) to standard cutoffs for acceptable fit: comparative fit index (CFI) >0.95, root mean square error of approximation (RMSEA) <0.05, standardized root mean square residual (SRMSR) <0.05.[33, 34]

Item Characteristics. IRT models used two parameters, discrimination (*a*) and severity (*b*) to characterize the relationship between how patients responded to items on the Symptom

Checklist and their latent SUD severity. Discrimination characterizes how well an item differentiates patients with higher versus lower SUD severity; values can range -∞ to ∞ (but typically range 0 to 2)[35] with higher values indicative of better discrimination. Severity characterizes the value along the continuum of latent SUD severity at which an item best discriminates, which is also the level of latent SUD severity needed for patients to have a 50% chance of endorsing the item; values can range -∞ to ∞ (but typically range -3 to +3) with higher values endorsed at higher levels of SUD severity.[36] IRT parameters were plotted graphically as item characteristic curves (with discrimination and severity corresponding to an item's slope and location, respectively) to illustrate how the probability of endorsing each of the 11 items (y-axis) depends on one's latent SUD severity (x-axis).[35, 36]

Differential Item Functioning and Expected Clinical Impact. Differential item functioning can occur if the probabilities of endorsing specific Symptom Checklist items are influenced by a patient's broader lived experiences rather than their latent level of SUD severity.[35, 37] A high degree of differential item functioning could be clinically problematic, suggesting, for example, that some items measure SUD differently for different demographic subgroups. For each demographic subgroup (age, sex, race, and ethnicity) within each Symptom Checklist subsample, we used a likelihood ratio test to statistically test for differential item functioning by comparing a more complex IRT model where item parameters can vary by demographic subgroup to a simpler model that constrains item parameters to be the same for subgroups (detailed in Appendix).[37, 38]

However, differential item functioning may be present without having a meaningful clinical impact.[37] Because SUD diagnosis and severity are determined by the number of SUD criteria present (0-11), knowing whether differential item functioning leads to differences in the

total number of criteria endorsed may be more clinically meaningful than knowing whether differential item functioning is present for individual items.[38] We examined differences—across age, sex, race, and ethnicity—in the total expected number of criteria (0-11) endorsed by patients with the same level of latent SUD severity to understand whether the test as a whole performed differently across demographic subgroups. We also examined differences in comparative fit indices between models with and without correction for differential item functioning for each demographic subgroup (detailed in Appendix).[39]

RESULTS

Descriptive

Symptom Checklist subsamples included 16,140 patients who reported daily cannabis use only, 4,791 patients who reported other drug use only, and 2,373 patients who reported both daily cannabis and other drug use (Figure 3.1). All three subsamples were predominantly male (52-62%), age 25-44 (47-53%), non-Hispanic (86-88%), and White (71-76%; Table 3.1).

Prevalence of SUD Criteria

Among patients with daily cannabis use only, other drug use only, or both daily cannabis and other drug use, 26% (n=4,242), 30% (n=1,446), and 52% (n=1,229), respectively, reported symptoms consistent with SUD (≥2 criteria; Table 3.2).[4] Prevalence of each SUD criterion varied from 4% (neglect roles) to 22% (tolerance) for patients with daily cannabis use only, from 12% (hazardous use) to 25% (physical/psychological problems) for patients with other drug use only, and from 19% (neglect roles) to 42% (tolerance) for patients with both daily cannabis and other drug use (Table 3.2).

Unidimensionality

Unidimensional factor models demonstrated excellent fit to the Symptom Checklist's 11 items (CFI>0.95; RMSEA<0.05; SRMSR<0.05; Table 3.3), indicating that the 11 items measured latent SUD severity along a unidimensional continuum.

Item Characteristics

For all Symptom Checklist subsamples, Symptom Checklist items discriminated higher versus lower SUD severity as expected (discrimination parameters all positive and significant) with the probability of endorsing each item increasing as SUD severity increased. While discrimination was higher than typical[30] (illustrated by steep slopes in Figure 3.2), one item (tolerance) consistently did not discriminate as strongly as the other items. Across subsamples, some items had lower severity parameters (e.g., tolerance, physical/psychological problems, craving) and discriminated best when SUD severity was mild (illustrated by curves shifted further to the left in Figure 3.2). Other items had higher severity parameters (e.g., hazardous use, time spent, neglect roles) and discriminated best when SUD was severe (illustrated by curves shifted further to the right in Figure 3.2).

Differential Item Functioning and Clinical Impact

Several items had significant differential item functioning by age and sex for all three Symptom Checklist subsamples. Additionally, there was significant differential item functioning by race for patients who reported daily cannabis use only and by ethnicity for patients who reported other drug use only (Appendix Tables 3.1-3.8). However, correcting for item-level differential item functioning changed expected SUD criteria counts by <0.5 criteria for patients with daily cannabis use only and <1 criterion for patients with other drug use or both daily cannabis and other drug use (Appendix Figures 3.3-3.5; Appendix Table 3.9), indicating it was unlikely to significantly alter criteria counts that form the basis of SUD diagnosis. Differences in

comparative fit indices from models with and without correction for differential item functioning suggested minimal impact (ΔCFI<0.01; Appendix Table 3.10).

DISCUSSION

This study evaluated the psychometric performance of a Substance Use Symptom Checklist used routinely among primary care patients reporting daily cannabis use, other drug use, or both. Consistent with DSM-5 conceptualization of SUD, we found that the Symptom Checklist measured SUD along a unidimensional continuum and that all items discriminated SUD severity in each subsample. Differential item functioning analyses indicated that the age, sex, race, and ethnicity of the patient did not meaningfully affect total criteria counts, suggesting minimal impact of differential item functioning on accurately diagnosing SUD. Findings support use of the Symptom Checklist as a tool to aid providers in eliciting patient symptoms, identifying a spectrum of SUD severity, and making diagnoses based on DSM-5 criteria.

This is the first study to evaluate a Substance Use Symptom Checklist of DSM-5 criteria that is used routinely in primary care; however, findings are consistent with psychometric studies of SUD criteria in epidemiology studies[29, 40-51] and clinical trials.[29, 52-64] Psychometric studies were instrumental in the decision to revise DSM-4 criteria, for abuse and dependence, to DSM-5 criteria that consider SUD to be a single disorder represented on a continuum of severity.[4, 29] Our findings build upon this work to support use of the Symptom Checklist as a tool for assessing the spectrum of DSM-5 SUD in primary care

Understanding the specific symptoms patients endorse can help providers tailor conversations about substance use to the needs of their patients. Consistent with prior studies, tolerance was less discriminating than other criteria,[29] particularly for patients who use cannabis

only. This may reflect physiological adaptation to regular but not necessarily harmful use, and in the absence of two additional criteria, experts consider tolerance less likely to indicate SUD.[29] Consistent with a previous study evaluating the psychometric performance of an Alcohol Symptom Checklist used in routine care,[38] more discriminating items include neglect roles, time spent, and activities given up, which may reflect life domains that are important to patients. SUD symptoms represent negative consequences of use, which can be used in clinical conversations to help patients identify reasons for reducing their substance use.

Measurement is essential for improving care for patients using cannabis and other drugs.[23] The ability to measure SUD symptoms can help with SUD identification, symptom management, and treatment planning for patients.[65] However, few health systems routinely screen patients for cannabis and other drug use, and almost none systematically assess patients at risk for SUD symptoms. Key barriers include time and resource constraints as well as a lack of systematic and standardized measurement.[65] This study supports the Symptom Checklist's construct validity as a scaled measure of SUD severity that may help clinicians diagnose SUD and, in turn, offer medications, counseling, and/or referral to treatment. A lack of clinically meaningful difference between expected total scores on the Symptom Checklist for patients of different ages, sexes, races, and ethnicities supports its use in diverse patient populations. Prior research has shown that implementation of Symptom Checklists for patients who self-report daily cannabis and/or other drug use, can be affordable,[25] feasible in primary care,[21, 22, 24] and acceptable to patients.[5, 23]

Limitations

The use of routinely-collected assessment data documented in EHRs is a unique strength of this study; it also introduced important limitations. For patients who reported daily cannabis

and other drug use, it is unclear which substance predominantly contributed to symptoms. Similarly, among patients who reported other drug use, it is unknown what class of drugs (e.g., opioids, stimulants, etc.) contributed to symptoms. However, for the Symptom Checklist to be practical in primary care, it was not possible to develop different checklists for specific substances. Some patients may have underestimated or underreported the frequency of substance use on behavioral health screens and/or symptoms on Symptom Checklists. Also, the Symptom Checklist does not assess the frequency of symptoms. Despite psychometric validity, clinicians must still confirm that symptoms are recurrent to make a SUD diagnosis. The Symptom Checklist can prompt a patient-provider conversation to identify specific substances and symptom frequency. About 5% of Checklists had missing or skipped responses and were excluded from analyses. Analyses may have been underpowered to detect differential item functioning by race.[66] Further, the use of EHR data to categorically define age, sex, race, and ethnicity for DIF analyses does not well-approximate the multi-dimensional and intersectional experiences of sexism,[67-69] racism,[70-73] stigma,[74] and other social determinants of health that accumulate across the life course,[75] nor does it fully account for metabolic or developmental factors that may vary between patients of different sexes and ages, both of which influence substance use and SUD symptoms. Finally, this study was conducted in a health system with integrated behavioral health in a U.S. state where adult cannabis use is legal; findings may not generalize to other health systems and settings.

CONCLUSION

This study supports the Substance Use Symptom Checklist as a measure of SUD severity when used routinely in primary care. Specifically, the 11-item Symptom Checklist provides

scaled, unidimensional information to help clinicians identify SUD and gauge severity when assessing SUD among patients with high-risk cannabis and other drug use. The Symptom Checklist is brief, feasible to administer in primary care, and performs equitably across age, sex, race, and ethnicity. These findings support the clinical utility of the Symptom Checklist as a tool for identifying the spectrum of SUD in diverse populations.

REFERENCES FOR CHAPTER 3

1. Substance Abuse and Mental Health Services Administration. *Key substance use and mental health indicators in the United States: Results from the 2020 National Survey on Drug Use and Health*. 2021. *HHS Publication No PEP21-07-01-003, NSDUH Series H-56*. https://www.samhsa.gov/data/

2. Degenhardt L, Hall W. Extent of illicit drug use and dependence, and their contribution to the global burden of disease. *The Lancet*. 2012/01/07/ 2012;379(9810):55-70. doi:https://doi.org/10.1016/S0140-6736(11)61138-0

3. Substance Abuse and Mental Health Services Administration. *Results from the 2020 National Survey on Drug Use and Health: Detailed tables*. 2021. https://www.samhsa.gov/data/

4. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders (5th ed.)*. 2013.

5. Sayre M, Lapham GT, Lee AK, et al. Routine Assessment of Symptoms of Substance Use Disorders in Primary Care: Prevalence and Severity of Reported Symptoms. *J Gen Intern Med*. Apr 2020;35(4):1111-1119. doi:10.1007/s11606-020-05650-3

6. Bonn-Miller MO, Bucossi MM, Trafton JA. The underdiagnosis of cannabis use disorders and other Axis-I disorders among military veterans within VHA. *Mil Med*. Jul 2012;177(7):786-8. doi:10.7205/milmed-d-12-00052

7. Bonn-Miller MO, Harris AHS, Trafton JA. Prevalence of cannabis use disorder diagnoses among veterans in 2002, 2008, and 2009. *Psychol Serv*. Nov 2012;9(4):404-416. doi:10.1037/a0027622

8. Hallgren KA, Witwer E, West I, et al. Prevalence of documented alcohol and opioid use disorder diagnoses and treatments in a regional primary care practice-based research network. *J Subst Abuse Treat*. Mar 2020;110:18-27. doi:10.1016/j.jsat.2019.11.008

9. Grant BF, Saha TD, Ruan WJ, et al. Epidemiology of DSM-5 Drug Use Disorder: Results From the National Epidemiologic Survey on Alcohol and Related Conditions–III. *JAMA Psychiatry*. 2016;73(1):39-47. doi:10.1001/jamapsychiatry.2015.2132

10. Hasin DS, Kerridge BT, Saha TD, et al. Prevalence and Correlates of DSM-5 Cannabis Use Disorder, 2012-2013: Findings from the National Epidemiologic Survey on Alcohol and Related Conditions-III. *Am J Psychiatry*. 06 01 2016;173(6):588-99. doi:10.1176/appi.ajp.2015.15070907

11. Sherman BJ, McRae-Clark AL. Treatment of Cannabis Use Disorder: Current Science and Future Outlook. *Pharmacotherapy*. 05 2016;36(5):511-35. doi:10.1002/phar.1747

12. Ronsley C, Nolan S, Knight R, et al. Treatment of stimulant use disorder: A systematic review of reviews. *PLOS ONE*. 2020;15(6):e0234809. doi:10.1371/journal.pone.0234809

13. Korthuis PT, McCarty D, Weimer M, et al. Primary Care–Based Models for the Treatment of Opioid Use Disorder. *Annals of Internal Medicine*. 2017;166(4):268-278. doi:10.7326/m16-2149 %m 27919103

14. Krist AH, Davidson KW, Mangione CM, et al. Screening for Unhealthy Drug Use: US Preventive Services Task Force Recommendation Statement. *JAMA*. Jun 9 2020;323(22):2301-2309. doi:10.1001/jama.2020.8020

15. McNeely J, Wu LT, Subramaniam G, et al. Performance of the Tobacco, Alcohol, Prescription Medication, and Other Substance Use (TAPS) Tool for Substance Use Screening in Primary Care Patients. *Ann Intern Med*. Nov 15 2016;165(10):690-699. doi:10.7326/M16-0317

16. Saxon AJ. Screening for unhealthy use of alcohol and other drugs in primary care. In: Stein MB, Friedman M, eds. *UpToDate*. 2022.

17. Scott K, Lewis CC. Using Measurement-Based Care to Enhance Any Treatment. *Cogn Behav Pract*. Feb 2015;22(1):49-59. doi:10.1016/j.cbpra.2014.01.010

18. Marsden J, Tai B, Ali R, Hu L, Rush AJ, Volkow N. Measurement-based care using DSM-5 for opioid use disorder: can we make opioid medication treatment more effective? *Addiction*. Aug 2019;114(8):1346-1353. doi:10.1111/add.14546

19. Hildebrand M. The Psychometric Properties of the Drug Use Disorders Identification Test (DUDIT): A Review of Recent Research. *Journal of Substance Abuse Treatment*. 2015/06/01/ 2015;53:52-59. doi:https://doi.org/10.1016/j.jsat.2015.01.008

20. Yudko E, Lozhkina O, Fouts A. A comprehensive review of the psychometric properties of the Drug Abuse Screening Test. *Journal of Substance Abuse Treatment*. 2007/03/01/ 2007;32(2):189-198. doi:https://doi.org/10.1016/j.jsat.2006.08.002

21. Richards JE, Bobb JF, Lee AK, et al. Integration of screening, assessment, and treatment for cannabis and other drug use disorders in primary care: An evaluation in three pilot sites. *Drug Alcohol Depend*. Aug 1 2019;201:134-141. doi:10.1016/j.drugalcdep.2019.04.015

22. Glass JE, Bobb JF, Lee AK, et al. Study protocol: a cluster-randomized trial implementing Sustained Patient-centered Alcohol-related Care (SPARC trial). *Implement Sci*. Aug 6 2018;13(1):108. doi:10.1186/s13012-018-0795-9

23. Bradley KA, Caldeiro RM, Hallgren KA, Kivlahan DR. Making measurement-based care for addictions a reality in primary care. *Addiction (Abingdon, England)*. 2019;114(8):1355-1356. doi:10.1111/add.14605

24. Bobb JF, Lee AK, Lapham GT, et al. Evaluation of a Pilot Implementation to Integrate Alcohol-Related Care within Primary Care. *Int J Environ Res Public Health*. Sep 8 2017;14(9)doi:10.3390/ijerph14091030

25. Yeung K, Richards J, Goemer E, et al. Costs of using evidence-based implementation strategies for behavioral health integration in a large primary care system. *Health Serv Res*. 2020;55(6):913-923. doi:10.1111/1475-6773.13592

26. Bradley KA, Lapham GT, Lee AK. Screening for Drug Use in Primary Care: Practical Implications of the New USPSTF Recommendation. *JAMA Intern Med*. 08 01 2020;180(8):1050-1051. doi:10.1001/jamainternmed.2019.7335

27. WHO ASSIST Working Group. The Alcohol, Smoking and Substance Involvement Screening Test (ASSIST): development, reliability and feasibility. *Addiction*. Sep 2002;97(9):1183-94. doi:10.1046/j.1360-0443.2002.00185.x

28. Heilig M, MacKillop J, Martinez D, Rehm J, Leggio L, Vanderschuren L. Addiction as a brain disease revised: why it still matters, and the need for consilience. *Neuropsychopharmacology*. Sep 2021;46(10):1715-1723. doi:10.1038/s41386-020-00950-y

29. Hasin DS, O'Brien CP, Auriacombe M, et al. DSM-5 criteria for substance use disorders: recommendations and rationale. *The American journal of psychiatry*. 2013;170(8):834-851. doi:10.1176/appi.ajp.2013.12060782

30. Baker FB. *The Basics of Item Response Theory*. ERIC Clearinghouse on Assessment and Evaluation; 2001.

31. Chalmers R. mirt: A Multidimensional Item Response Theory Package for the R Environment. *Journal of Statistical Software*. 2012;48(6):1-29. doi:10.18637/jss.v048.i06

32. *R: A Language and environment for statistical computing*. R Foundation for Statistical Computing; 2021. https://www.R-project.org/

33. Iacobucci D. Structural equations modeling: Fit Indices, sample size, and advanced topics. *Journal of Consumer Psychology*. 2010/01/01/ 2010;20(1):90-98. doi:https://doi.org/10.1016/j.jcps.2009.09.003

34. Joreskog KG, Moustaki I. Factor Analysis of Ordinal Variables: A Comparison of Three Approaches. *Multivariate Behav Res*. Jul 1 2001;36(3):347-87. doi:10.1207/S15327906347-387

35. Hays RD, Morales LS, Reise SP. Item response theory and health outcomes measurement in the 21st century. *Med Care*. Sep 2000;38(9 Suppl):II28-42. doi:10.1097/00005650-200009002-00007

36. Nguyen TH, Han HR, Kim MT, Chan KS. An introduction to item response theory for patient-reported outcome measurement. *Patient*. 2014;7(1):23-35. doi:10.1007/s40271-013-0041-0

37. Chalmers RP, Counsell A, Flora DB. It Might Not Make a Big DIF: Improved Differential Test Functioning Statistics That Account for Sampling Variability. *Educ Psychol Meas*. Feb 2016;76(1):114-140. doi:10.1177/0013164415584576

38. Hallgren KA, Matson TE, Oliver M, et al. Practical Assessment of Alcohol Use Disorder in Routine Primary Care: Performance of an Alcohol Symptom Checklist. *J Gen Intern Med*. Aug 16 2021;doi:10.1007/s11606-021-07038-3

39. Cheung GW, Rensvold RB. Evaluating Goodness-of-Fit Indexes for Testing Measurement Invariance. *Structural Equation Modeling: A Multidisciplinary Journal*. 2002/04/01 2002;9(2):233-255. doi:10.1207/S15328007SEM0902_5

40. Clark SL, Gillespie NA, Adkins DE, Kendler KS, Neale MC. Psychometric modeling of abuse and dependence symptoms across six illicit substances indicates novel dimensions of misuse. *Addict Behav*. Feb 2016;53:132-40. doi:10.1016/j.addbeh.2015.10.015

41. Compton WM, Saha TD, Conway KP, Grant BF. The role of cannabis use within a dimensional approach to cannabis use disorders. *Drug Alcohol Depend*. Mar 1 2009;100(3):221-7. doi:10.1016/j.drugalcdep.2008.10.009

42. Derringer J, Krueger RF, Dick DM, et al. Measurement invariance of DSM-IV alcohol, marijuana and cocaine dependence between community-sampled and clinically overselected studies. *Addiction*. Oct 2013;108(10):1767-76. doi:10.1111/add.12187

43. Gillespie NA, Neale MC, Prescott CA, Aggen SH, Kendler KS. Factor and item-response analysis DSM-IV criteria for abuse of and dependence on cannabis, cocaine, hallucinogens, sedatives, stimulants and opioids. *Addiction*. Jun 2007;102(6):920-30. doi:10.1111/j.1360-0443.2007.01804.x

44. Lynskey MT, Agrawal A. Psychometric properties of DSM assessments of illicit drug abuse and dependence: results from the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC). *Psychol Med*. Sep 2007;37(9):1345-55. doi:10.1017/S0033291707000396

45. Piontek D, Kraus L, Legleye S, Buhringer G. The validity of DSM-IV cannabis abuse and dependence criteria in adolescents and the value of additional cannabis use indicators. *Addiction*. Jun 2011;106(6):1137-45. doi:10.1111/j.1360-0443.2010.03359.x

46. Saha TD, Compton WM, Chou SP, et al. Analyses related to the development of DSM-5 criteria for substance use related disorders: 1. Toward amphetamine, cocaine and prescription drug use disorder continua using Item Response Theory. *Drug Alcohol Depend*. Apr 1 2012;122(1-2):38-46. doi:10.1016/j.drugalcdep.2011.09.004

47. Wu LT, Woody GE, Yang C, Pan JJ, Reeve BB, Blazer DG. A dimensional approach to understanding severity estimates and risk correlates of marijuana abuse and dependence in adults. *Int J Methods Psychiatr Res*. Jun 2012;21(2):117-33. doi:10.1002/mpr.1354

48. Castaldelli-Maia JM, Andrade LH, Keyes KM, Cerda M, Pilowsky DJ, Martins SS. Exploring the latent trait of opioid use disorder criteria among frequent nonmedical prescription opioid users. *J Psychiatr Res*. Sep 2016;80:79-86. doi:10.1016/j.jpsychires.2016.05.007

49. Tarrahi MJ, Rahimi-Movaghar A, Zeraati H, et al. Latent class analysis of DSM-5 criteria for opioid use disorders: results from the Iranian National Survey on Mental Health. *Eur Addict Res*. 2015;21(3):144-52. doi:10.1159/000369338

50. Wu LT, Pan JJ, Yang C, Reeve BB, Blazer DG. An item response theory analysis of DSM-IV criteria for hallucinogen abuse and dependence in adolescents. *Addict Behav*. Mar 2010;35(3):273-7. doi:10.1016/j.addbeh.2009.10.009

51. Kerridge BT, Saha TD, Smith S, et al. Dimensionality of hallucinogen and inhalant/solvent abuse and dependence criteria: implications for the Diagnostic and Statistical Manual of Mental Disorders-Fifth Edition. *Addict Behav*. Sep 2011;36(9):912-8. doi:10.1016/j.addbeh.2011.04.006

52. Kirisci L, Tarter RE, Reynolds M, Vanyukov MM. Item Response Theory Analysis to Assess Dimensionality of Substance Use Disorder Abuse and Dependence Symptoms. *Int J Pers Cent Med*. 2016;6(4):260-273.

53. Perron BE, Vaughn MG, Howard MO, Bohnert A, Guerrero E. Item response theory analysis of DSM-IV criteria for inhalant-use disorders in adolescents. *J Stud Alcohol Drugs*. Jul 2010;71(4):607-14. doi:10.15288/jsad.2010.71.607

54. Yang H, Chen F, Liu X, Xin T. An Item Response Theory Analysis of DSM-5 Heroin Use Disorder in a Clinical Sample of Chinese Adolescents. *Front Psychol*. 2019;10:2209. doi:10.3389/fpsyg.2019.02209

55. Hartman CA, Gelhorn H, Crowley TJ, et al. Item response theory analysis of DSM-IV cannabis abuse and dependence criteria in adolescents. *J Am Acad Child Adolesc Psychiatry*. Feb 2008;47(2):165-173. doi:10.1097/chi.0b013e31815cd9f2

56. Martin CS, Chung T, Kirisci L, Langenbucher JW. Item response theory analysis of diagnostic criteria for alcohol and cannabis use disorders in adolescents: implications for DSM-V. *J Abnorm Psychol*. Nov 2006;115(4):807-14. doi:10.1037/0021-843X.115.4.807

57. Duresso SW, Matthews AJ, Ferguson SG, Bruno R. Is khat use disorder a valid diagnostic entity? *Addiction*. Sep 2016;111(9):1666-76. doi:10.1111/add.13421

58. Gilder DA, Gizer IR, Lau P, Ehlers CL. Item response theory analyses of DSM-IV and DSM-5 stimulant use disorder criteria in an American Indian community sample. *Drug Alcohol Depend*. Feb 1 2014;135:29-36. doi:10.1016/j.drugalcdep.2013.10.010

59. Kervran C, Shmulewitz D, Serre F, et al. Item Response Theory analyses of DSM-5 substance use disorder criteria in French outpatient addiction clinic participants. How

much is craving special? *Drug Alcohol Depend*. Jul 1 2020;212:108036. doi:10.1016/j.drugalcdep.2020.108036

60. Wu LT, Blazer DG, Woody GE, et al. Alcohol and drug dependence symptom items as brief screeners for substance use disorders: results from the Clinical Trials Network. *J Psychiatr Res*. Mar 2012;46(3):360-9. doi:10.1016/j.jpsychires.2011.12.002

61. Wu LT, Pan JJ, Blazer DG, et al. An item response theory modeling of alcohol and marijuana dependences: a National Drug Abuse Treatment Clinical Trials Network study. *J Stud Alcohol Drugs*. May 2009;70(3):414-25. doi:10.15288/jsad.2009.70.414

62. Wu LT, Pan JJ, Blazer DG, et al. The construct and measurement equivalence of cocaine and opioid dependences: a National Drug Abuse Treatment Clinical Trials Network (CTN) study. *Drug Alcohol Depend*. Aug 1 2009;103(3):114-23. doi:10.1016/j.drugalcdep.2009.01.018

63. Langenbucher JW, Labouvie E, Martin CS, et al. An application of item response theory analysis to alcohol, cannabis, and cocaine criteria in DSM-IV. *J Abnorm Psychol*. Feb 2004;113(1):72-80. doi:10.1037/0021-843X.113.1.72

64. Hasin DS, Fenton MC, Beseler C, Park JY, Wall MM. Analyses related to the development of DSM-5 criteria for substance use related disorders: 2. Proposed DSM-5 criteria for alcohol, cannabis, cocaine and heroin disorders in 663 substance abuse patients. *Drug Alcohol Depend*. Apr 1 2012;122(1-2):28-37. doi:10.1016/j.drugalcdep.2011.09.005

65. Tiet QQ, Finney JW, Moos RH. Screening psychiatric patients for illicit drug use disorders and problems. *Clin Psychol Rev*. Apr 2008;28(4):578-91. doi:10.1016/j.cpr.2007.08.002

66. Flora DB, Curran PJ. An empirical evaluation of alternative methods of estimation for confirmatory factor analysis with ordinal data. *Psychol Methods*. Dec 2004;9(4):466-91. doi:10.1037/1082-989X.9.4.466

67. Hemsing N, Greaves L. Gender Norms, Roles and Relations and Cannabis-Use Patterns: A Scoping Review. *Int J Environ Res Public Health*. Feb 4 2020;17(3)doi:10.3390/ijerph17030947

68. Greaves L, Hemsing N. Sex and Gender Interactions on the Use and Impact of Recreational Cannabis. *Int J Environ Res Public Health*. Jan 14 2020;17(2)doi:10.3390/ijerph17020509

69. Carliner H, Sarvet AL, Gordon AR, Hasin DS. Gender discrimination, educational attainment, and illicit drug use among U.S. women. *Soc Psychiatry Psychiatr Epidemiol*. Mar 2017;52(3):279-289. doi:10.1007/s00127-016-1329-x

70. Carliner H, Delker E, Fink DS, Keyes KM, Hasin DS. Racial discrimination, socioeconomic position, and illicit drug use among US Blacks. *Soc Psychiatry Psychiatr Epidemiol*. Apr 2016;51(4):551-60. doi:10.1007/s00127-016-1174-y

71. Matsuzaka S, Knapp M. Anti-racism and substance use treatment: Addiction does not discriminate, but do we? *J Ethn Subst Abuse*. Oct-Dec 2020;19(4):567-593. doi:10.1080/15332640.2018.1548323

72. Golub A, Johnson BD, Dunlap E. The Race/Ethnicity Disparity in Misdemeanor Marijuana Arrests in New York City. *Criminol Public Policy*. 2007;6(1):131-164. doi:10.1111/j.1745-9133.2007.00426.x

73. Medicine Io. *Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care*. The National Academies Press; 2003:780.

74. Hatzenbuehler ML, Phelan JC, Link BG. Stigma as a fundamental cause of population health inequalities. *Am J Public Health*. May 2013;103(5):813-21. doi:10.2105/AJPH.2012.301069

75. Ben-Shlomo Y, Kuh D. A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives. *Int J Epidemiol*. Apr 2002;31(2):285-93.

FIGURES FOR CHAPTER 3

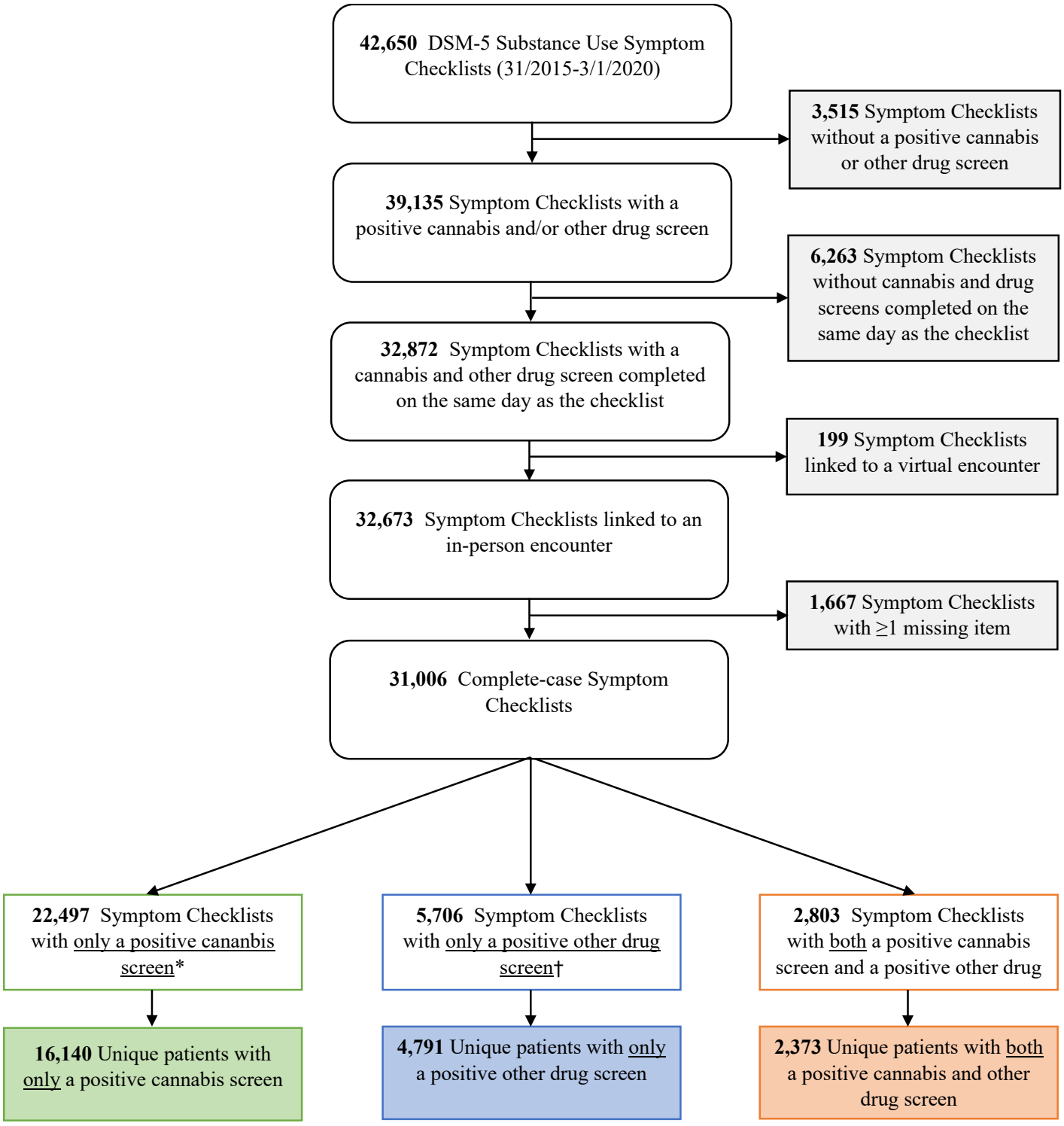


Figure 3.1. Process of selecting DSM-5 Substance Use Symptom Checklists ("Symptom Checklists") for inclusion in analyses

Figure 3.1 Caption: DSM-5 Substance Use Symptom Checklists are typically administered after a positive cannabis and/or other drug use screen, as part of routine primary care. Positive cannabis and/or other drug use screens were used to define subsamples in which to test the psychometrics properties of the checklist. A single, random checklist for each subsample was selected.

Abbreviations: DSM-5=Diagnostic and Statistical Manual, 5th Edition

* Cannabis screens were considered positive if a patient indicated daily/almost daily cannabis use in the past year

† Other drug screens were considered positive if a patient indicated any other drug use in the past year.

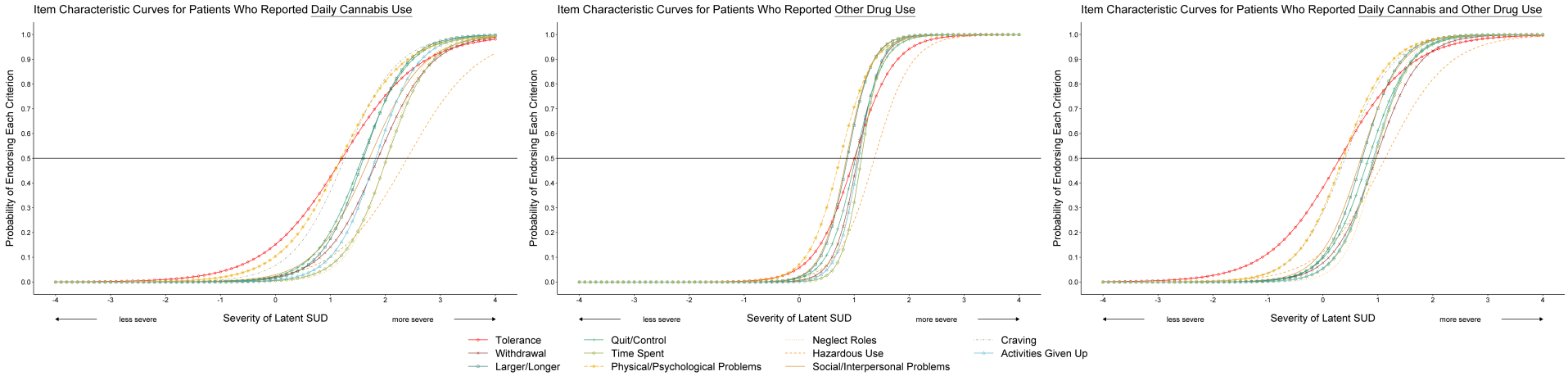


Figure 3.2. Item characteristic curves for the 11 substance use disorder (SUD) criteria assessed on the Substance Use Symptom Checklist among primary care patients who reported daily cannabis use only (n=16,140), other drug use only (n=4,791) and both daily cannabis and other drug use (n=2,373) on routine screening March 2015-March 2020

Figure 3.2 caption: Each of the 11 criteria is represented as a separate curve. The slope of the curve corresponds to the discrimination parameter (*a*). The point where each line intersects the horizontal line indicates the level of latent SUD severity where patients have a 50% probability of endorsing the criterion, which corresponds to the severity parameter (*b*).

TABLES FOR CHAPTER 3

Table 3.1. Sample characteristics among primary care patients who reported daily cannabis only, other drug use only, and both daily cannabis and other drug use on routine screening March 2015-March 2020

	Daily Cannabis Use Only		Other Drug Use Only		Daily Cannabis & Other Drug Use	
	N	*(%)*	*N*	*(%)*	*N*	*(%)*
TOTAL	16,140	(100.0)	4,791	(100.0)	2,373	(100.0)
Age group						
18-24	2,813	(17.4)	1,245	(26.0)	787	(33.2)
25-44	7,576	(46.9)	2,470	(51.6)	1,257	(53.0)
45-64	4,150	(25.7)	842	(17.6)	273	(11.5)
65+	1,601	(9.9)	233	(4.9)	55	(2.3)
Sex						
Female	7,754	(48.0)	2,097	(43.8)	897	(37.8)
Male	8,386	(52.0)	2,693	(56.2)	1,475	(62.2)
Race						
American Indian/Alaska Native	397	(2.5)	99	(2.1)	60	(2.5)
Asian	544	(3.4)	425	(8.9)	116	(4.9)
Black/African American	1,145	(7.1)	286	(6.0)	177	(7.5)
Native Hawaiian/Pacific Islander	247	(1.5)	92	(1.9)	41	(1.7)
White	12,397	(76.8)	3,391	(70.8)	1,734	(73.1)
Other/Unknown	1,400	(8.7)	497	(10.4)	244	(10.3)
Ethnicity						
Hispanic	1,045	(6.5)	390	(8.1)	195	(8.2)
Not Hispanic	14,252	(88.3)	4,113	(85.9)	2,028	(85.5)
Unknown	843	(5.2)	287	(6.0)	149	(6.3)
DSM-5 SUD Criteria						
No SUD (0-1 criteria)	11,898	(73.7)	3,345	(69.8)	1,144	(48.2)
Mild SUD (2-3 criteria)	2,585	(16.0)	468	(9.8)	478	(20.1)
Moderate SUD (4-5 criteria)	934	(5.8)	237	(4.9)	252	(10.6)
Severe SUD (6+ criteria)	723	(4.5)	741	(15.5)	499	(21.0)

Abbreviations: DSM-5=Diagnostic and Statistical Manual of Mental Disorders, 5th Edition; SUD=substance use disorder

Table 3.2: Prevalence of substance use disorder (SUD) criteria assessed on the Substance Use Symptom Checklist among primary care patients who reported daily cannabis only, other drug use only, and both daily cannabis and other drug use on routine screening March 2015-March 2020

Substance Use Symptom Checklist Item	Daily Cannabis Use Only (n=16,140)	Other Drug Use Only (n=4,791)	Daily Cannabis and Other Dug Use (n=2,373)
	n (%)	*n (%)*	*n (%)*
1) Tolerance	3536 (21.9)	944 (19.7)	985 (41.5)
2) Withdrawal	1248 (7.7)	760 (15.9)	495 (20.9)
3) Larger/longer	1501 (9.3)	984 (20.5)	622 (26.2)
4) Quit/control	1662 (10.3)	828 (17.3)	565 (23.8)
5) Time spent	774 (4.8)	666 (13.9)	483 (20.4)
6) Physical/psychological problems	3139 (19.4)	1207 (25.2)	899 (37.9)
7) Neglect roles	705 (4.4)	728 (15.2)	444 (18.7)
8) Hazardous use	919 (5.7)	570 (11.9)	494 (20.8)
9) Social/interpersonal problems	1571 (9.7)	1009 (21.1)	651 (27.4)
10) Craving	2693 (16.7)	989 (20.6)	876 (36.9)
11) Activities given up	1043 (6.5)	726 (15.2)	493 (20.8)
Total Number of DSM-5 SUD Criteria			
0-1 criteria (“no SUD”)	11,898 (73.7)	3,345 (69.8)	1,144 (48.2)
2-3 criteria (“mild SUD”)	2,585 (16.0)	468 (9.8)	478 (20.1)
4-5 criteria (“moderate SUD”)	934 (5.8)	237 (4.9)	252 (10.6)
6+ criteria (“severe SUD”)	723 (4.5)	741 (15.5)	499 (21.0)

Abbreviations: DSM-5=Diagnostic and Statistical Manual of Mental Disorders, 5th Edition; SUD=substance use disorder

Table 3.3: Item Response Theory (IRT) parameter estimates for the 11 substance use disorder (SUD) criteria assessed on the Substance Use Symptom Checklist among primary care patients who reported daily cannabis only, other drug use only, and both daily cannabis and other drug use on routine screening March 2015-March 2020

	Daily Cannabis Use Only (n=16,140)				Other Drug Use Only (n=4,791)				Daily Cannabis & Other Drug Use (n=2,373)			
	Discrimination		Severity		Discrimination		Severity		Discrimination		Severity	
Substance Use Symptom Checklist Item	*a*	*(95% CI)*	*b*	*(95% CI)*	*a*	*(95% CI)*	*b*	*(95% CI)*	*a*	*(95% CI)*	*b*	*(95% CI)*
1) Tolerance	1.42	(1.35-1.5)	1.21	(1.17-1.3)	2.79	(2.57-3.0)	1.00	(0.93-1.1)	1.55	(1.39-1.7)	0.31	(0.23-0.4)
2) Withdrawal	2.09	(1.96-2.2)	1.86	(1.79-1.9)	4.72	(4.29-5.2)	1.06	(0.97-1.2)	2.57	(2.30-2.9)	0.96	(0.87-1.1)
3) Larger/longer	2.57	(2.42-2.7)	1.60	(1.53-1.7)	4.46	(4.07-4.9)	0.88	(0.80,1.0)	3.02	(2.69-3.4)	0.72	(0.64-0.8)
4) Quit/control	2.37	(2.24-2.5)	1.57	(1.51-1.6)	4.02	(3.68-4.4)	1.02	(0.94-1.1)	2.70	(2.41-3.0)	0.83	(0.75-0.9)
5) Time spent	2.57	(2.40-2.8)	2.03	(1.93-2.1)	5.72	(5.13-6.4)	1.13	(1.02-1.3)	3.07	(2.73-3.5)	0.94	(0.84-1.0)
6) Physical/psychological problems	1.81	(1.71-1.9)	1.19	(1.15-1.2)	3.46	(3.18-3.8)	0.74	(0.68-0.8)	2.41	(2.16-2.7)	0.37	(0.30-0.4)
7) Neglect roles	2.84	(2.64-3.1)	2.02	(1.91-2.1)	4.67	(4.24-5.1)	1.09	(1.00-1.2)	3.61	(3.19-4.1)	0.97	(0.86-1.1)
8) Hazardous use	1.56	(1.46-1.7)	2.40	(2.31-2.5)	3.01	(2.75-3.3)	1.37	(1.27-1.5)	1.75	(1.56-2.0)	1.13	(1.03-1.2)
9) Social/interpersonal problems	2.05	(1.93-2.2)	1.71	(1.64-1.8)	4.41	(4.02-4.8)	0.86	(0.79-0.9)	2.78	(2.49-3.1)	0.69	(0.61-0.8)
10) Craving	2.09	(1.98-2.2)	1.26	(1.21-1.3)	4.47	(4.08-4.9)	0.87	(0.80-1.0)	2.32	(2.08-2.6)	0.40	(0.34-0.5)
11) Activities given up	2.64	(2.48-2.8)	1.82	(1.74-1.9)	5.13	(4.64-5.7)	1.08	(0.99-1.2)	3.09	(2.74-3.5)	0.92	(0.82-1.0)
Model fit indices												
CFI*	0.989				0.997				0.995			
RMSEA†	0.034				0.031				0.035			
SRMSR†	0.034				0.021				0.026			

Abbreviations: IRT=item response theory SUD=substance use disorder; CI=confidence interval; CFI=comparative fit index; RMSEA=root mean standard error of approximation; SMRSR=standardized root mean square residual

Note: Discrimination (*a*) characterizes how well an item differentiates patients with higher versus lower SUD severity; values can range -∞ to ∞ (but typically range 0 to 2) with higher values indicative of better discrimination. Severity (*b*) characterizes the value along the continuum of latent SUD severity at which an item best discriminates, which is also the level of latent SUD severity needed for patients to have a 50% chance of endorsing the item; values can range -∞ to ∞ (but typically range -3 to +3) with higher values endorsed at higher levels of SUD severity.

* >0.95 indicates acceptable model fit

† <0.05 indicates acceptable model fit

CHAPTER 4

Association between cannabis use disorder symptom severity and probability of clinically documented diagnosis and treatment in a primary care sample

INTRODUCTION

Cannabis use is increasingly common,[1] and frequent use can lead to development of cannabis use disorder (CUD).[2, 3] CUD is defined by the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5) as having 2 or more of 11 criteria reflecting clinically significant impairment and distress.[4] These criteria may be characterized by a loss of control (e.g., unsuccessful attempts to quit), social problems (e.g., activities given up), symptoms of physical dependence (e.g., withdrawal), and use in hazardous situations (e.g. before driving). The total number of criteria (0-11) can be used to determine the level of CUD severity, ranging from mild to severe.[4] CUD is associated with medical comorbidity[5, 6] and contributes two million years lived with disability worldwide.[7]

Five percent of United States (U.S.) adults meet criteria for past-year CUD;[8] however, the prevalence and consequences of CUD vary by sociodemographic subgroup,[8-10] likely in part a result of lived experiences. Specifically, young adults, men, and American Indian/Alaska Native peoples tend to have a higher prevalence of CUD.[8, 9] However, women may transition more rapidly from cannabis use to CUD,[10, 11] possibly due to intersections of biological and social factors. For example, greater cannabinoid sensitivity in females[11] may be compounded by social consequences resulting from misalignment between cannabis use and sociocultural pressures to adhere to expected

gender roles and behaviors.[11, 12] Rates of CUD are increasing more rapidly for Black/African American people than for other racialized and ethnic groups,[9, 13] likely resulting from anti-Black structural racism—a system of laws, policies, and norms that solidify systems of oppression.[14, 15] Black/African American people also experience a disproportionate rate of cannabis-attributable emergency department visits, enforcement of cannabis use and possession laws, and cannabis associated arrests.[13] For instance, national campaigns such as the War on Drugs developed federal laws to support racist beliefs and promote propaganda stigmatizing cannabis use thereby facilitating mass incarceration and disruption of Black communities.[14] Experiences of racism and discrimination are, in turn, associated with frequent use, earlier age of initiation, and risk factors for CUD.[16, 17] While cannabis laws and public sentiment is rapidly evolving in the U.S.,[18] CUD remains highly stigmatized.[19-21]

CUD is underrecognized and undertreated in medical settings. Only 1% of primary care patients have a documented CUD diagnosis.[22, 23] Though differences in clinician diagnosis of other mental health conditions across age, gender, race, and ethnicity are well documented,[24, 25] it is unknown whether clinician documentation of CUD diagnosis varies across sociodemographic subgroups.

Several lines of research suggest that clinician documentation of CUD might differ across sociodemographic groups. One recent study found substantial underdiagnosis of substance use disorders (SUDs) in clinical care, particularly among women, young adults, and Hispanic patients, but did not examine discrepancies in rates of CUD diagnosis and treatment, specifically.[26] Moreover, clinicians report uncertainty about when to diagnose and treat CUD,[27, 28] which may result in low diagnosis rates

and/or reliance on internal biases about cannabis and about patients most at risk of developing CUD. Therefore, it is important to understand whether patterns of diagnosis and treatment reflect the severity of patient-reported symptoms of DSM-5 CUD criteria, and whether these patterns vary across sociodemographic subgroups.

Brief population-based screening followed by standardized assessment of CUD symptoms in primary care patients with high-risk use may offer clinicians a way to appropriately diagnose and determine the severity of CUD to inform treatment decisions. One health system implemented routine screening for cannabis use and standardized follow-up assessment for CUD symptoms with results documented in electronic health records (EHRs).[29-35] We leveraged these routinely collected screening and assessment data to test whether the probability of clinically documented CUD and CUD treatment increased with patient-reported CUD symptoms. We also tested whether observed associations between patient-reported symptoms and clinically documented CUD and CUD treatment were moderated by patient sociodemographic factors representing social identities that determine lived experiences. We hypothesized a dose-response relationship in which higher levels of symptom severity would be associated with a higher probability of clinically documented CUD diagnosis and treatment. Further, we hypothesized this association would be moderated by age, gender, race, and ethnicity, reflecting potential bias in how patients with different social identities are diagnosed and treated for CUD.

METHODS

Study design and data source

Kaiser Permanente Washington (KPWA) is an integrated health system that provides health insurance and medical care to over 700,000 patients in Washington state, where adult medical and non-medical cannabis use is legal. This retrospective cohort study used data from the KPWA EHR and insurance claims for healthcare services received outside KPWA.

KPWA began annual population-based screening of adults for cannabis and other drug use in primary care in 2015, which spread to all primary care sites by 2018.[29-33] Screening is prompted by the EHR if the patient has not completed screening in the past 12 months and is typically administered on paper at check-in or via the online EHR portal prior to the visit. Patients who report daily cannabis use in the past year on the validated Single-Item Screen for Cannabis (SIS-C)[36] or any other drug use on a Single-Item Screen for Drugs (SIS-D), adapted from a previously validated screen,[37] are asked to complete standardized follow-up assessment using the Substance Use Symptom Checklist (described below). A medical assistant (MA) enters responses into the EHR for primary care provider review. Screening and assessment by portal are automatically entered into patients' EHRs.

Study Sample

Primary care patients 18 years or older were included if they reported daily cannabis use on the SIS-C and completed the follow-up Substance Use Symptom Checklist between March 1, 2015 and March 1, 2021, and within 7 days of the SIS-C. Patients were excluded if they: 1) were not enrolled in the year prior to completing the Substance Use Symptom Checklist to ensure adequate capture of covariates (≤45 day gaps ok); 2) were not enrolled for ≥108 days after completing the Substance Use

Symptom Checklist to ensure adequate capture of outcomes; and 3) had a CUD diagnosis in the year prior to the Substance Use Symptom Checklist (i.e., washout period) to ensure we were capturing incident CUD diagnoses. If patients completed ≥1 Substance Use Symptom Checklist during the study period, we selected the first.

Measures

Predictor. The *Substance Use Symptom Checklist* (hereafter "Symptom Checklist") is an 11-item self-report questionnaire (Appendix Figure 4.1) that asks patients whether they experienced each of the 11 DSM-5 SUD symptom criteria[4] (yes/no) within the past 12 months. The Symptom Checklist was developed in partnership with the clinical delivery system as a SUD assessment tool and piloted prior to implementation;[31] it has strong psychometric properties and performs consistently across ages, sexes, races, and ethnicities.[38] Summed scores reflect criteria counts ranging from 0-11 that may aid in determining SUD diagnosis (≥2 criteria) and SUD severity as defined in DSM-5 (mild: 2–3 criteria; moderate: 4-5 criteria; severe: 6–11 criteria), if clinicians determine symptoms are recurrent.[4] The same Symptom Checklist is administered to patients reporting daily cannabis or any other drug use to decrease patient burden.[4] Although patients have the option of selecting substances for which they are reporting symptoms from a list, this information is missing for more than 50% of Symptom Checklists. Therefore, we use patients' screen responses to determine whether symptoms are reflective of daily cannabis use only or daily cannabis with other drug use.

We use three measures of the Symptom Checklist to allow flexibility in our understanding of the association between patient-reported symptoms and clinically recognized diagnosis and treatment. First, we considered the Symptom Checklist score as

continuous measure (0-11) to characterize the dose-response relationship. Second, we considered a categorical measure of CUD severity levels (none, mild, moderate, severe) based on the Symptom Checklist to allow for non-linear associations. Third, we considered a binary measure of CUD based on the presence of ≥2 criteria endorsed on the Symptom Checklist, to facilitate simpler communication of main findings to clinical audiences.

Primary outcomes. CUD diagnoses, CUD treatment initiation, and CUD treatment engagement documented by clinicians in the EHR were defined consistent with the Healthcare Effectiveness Data and Information Set (HEDIS) measures.[39] Specifically, we created a binary indicator of *CUD diagnosis* documented by a clinician using an ICD-9 or ICD-10 code for cannabis abuse or dependence within 60 days of completing the Symptom Checklist. *Treatment initiation* was defined as ≥1 additional encounter with a CUD diagnosis within 0-14 days of diagnosis. *Treatment engagement* was defined as ≥2 additional encounters with a CUD diagnosis 0-34 days after treatment initiation. To explore whether HEDIS timeframes may be too short for assessing CUD diagnosis and treatment in primary care settings, we also used a secondary composite measure of *6-month diagnosis and treatment initiation*, defined as ≥1 CUD diagnosis and ≥1 other encounter with a CUD diagnosis within 180 days of completing the Symptom Checklist.

Moderators: Sociodemographic Measures. Demographic information documented in the EHR on the day of Symptom Checklist completion was used to approximate the social identities that shape the lived experiences (e.g., sexism[11, 12, 40], racism[41-43], other social determinants of health[44]) and health of patients at different developmental stages.[45] This included *age* (18-29, 30-49, 50-64, or ≥65), *gender* (man or woman), *race*

(American Indian/Alaska Native, Asian, Black, Native Hawaiian/Pacific Islander, or White), and *ethnicity* (Hispanic or non-Hispanic).

Covariates. Baseline patient need and enabling factors were considered as potential confounders.[46, 47] Patient need was defined as non-CUD *EHR-documented SUD and mental health* comorbidity, based on ICD-9 and ICD-10 diagnosis codes in the two years prior to the Symptom Checklist. An important enabling factor is *insurance status* (commercial, Medicare, subsidized/Medicaid, unknown), which can be a proxy for socioeconomic status and medical coverage.

Analyses

Using descriptive statistics, we characterized the study population at baseline, scores on the Symptom Checklist, and all outcomes. Analyses were stratified based on patient report of daily cannabis use only or report of both daily cannabis and other drug use.

We used logistic regression to estimate the association between the three Symptom Checklist measures (continuous score, categorical severity levels, binary CUD) and the odds of: 1) a clinical CUD diagnosis in the entire sample; 2) CUD treatment initiation among those diagnosed; and 3) CUD treatment engagement among those who initiated. For all models, cluster robust standard errors were used to account for potential correlation between patients from the same clinic[48] based on prior documentation of variability in SUD diagnosing at the clinic level[49] and because KPWA uses a team-based approach to behavioral health care (i.e., medical assistants typically administer Symptom Checklist prior to primary care provider visit; primary care providers often initiate a warm handoff to a social worker for substance-related care). We used a stepped approach

to covariate adjustment by testing 3 models for each outcome: 1) unadjusted; 2) adjusted for sociodemographic characteristics; and 3) adjusted for sociodemographic characteristics, need, and enabling factors. Unadjusted models were primary (with adjusted results in Appendix) because adjustment for sociodemographic characteristics can control for discrimination and racism in the causal pathway to differential diagnosis and treatment.[50] However, we describe results from adjusted models when they diverged from the unadjusted to characterize the independent association. The predicted probability of each outcome was estimated for categorical and binary measures based on the Symptom Checklist and expressed as a percent.

For moderation analyses, models were repeated with an interaction between the Symptom Checklist (continuous score, categorical levels, binary CUD) and each sociodemographic variable (age, gender, race, ethnicity), separately added and tested using a joint Wald's test with an alpha level of 0.05. Moderation analyses were restricted to the sample of patients reporting daily cannabis use only and to diagnosis and treatment initiation outcomes due to limited outcome events within subgroups. Models are considered unstable when there are fewer than 5-10 outcome events per variable.[51]

Analyses were conducted in Stata 15.1.

RESULTS

The study sample included 12,568 (90%) patients who reported daily cannabis use only and 1,379 (10%) who reported daily cannabis and other drug use (Figure 4.1). Patients were predominantly 30-45 years old, men, White race, non-Hispanic ethnicity, and commercially insured (Table 4.1). Nearly 24% of patients reporting daily cannabis

use only and 29% of patients reporting both daily cannabis and other drug use had a non-cannabis SUD documented in the two years prior to completing the Symptom Checklist while 47% and 42%, respectively, had a mental health disorder documented in the two years prior.

Patients reporting daily cannabis use without other drug use endorsed fewer criteria (mean=1.1 [SD=1.8]) on the Symptom Checklist than patients reporting both daily cannabis and other drug use (mean=2.7 [SD=3.1]; p<0.001). Patients reporting daily cannabis use only were also less likely than patients reporting both daily cannabis and other drug use to have a CUD diagnosis documented within 2 months after the Symptom Checklist (5.9% vs. 10.6%; p<0.001), subsequent treatment initiation within 14 days (0.8% vs 1.9%; ; p<0.001), and treatment engagement for CUD in the following 34 days (0.1% and 0.7%; p<0.001) documented in their EHRs, as a proportion of all patients in the study sample (Table 4.2).

Patients reporting daily cannabis use only

Among patients reporting daily cannabis use only, a 1-unit increase in Symptom Checklist score was associated with significantly higher odds of CUD diagnosis (OR=1.38 [95% CI: 1.33-1.44], p<0.001; Table 4.3). Across categorical levels, probability of diagnosis ranged 3.3% (2.5-4.1) for none, 10.2% (7.8-12.5) for mild, 17.2% (12.5-21.8) for moderate, and 25% (20.2-29.1) for severe severity (Figure 4.2). Probability of diagnosis was 14.0% (11.3-16.7) for any severity CUD.

Among those who were diagnosed, a 1-unit increase in Symptom Checklist score was associated with significantly higher odds of treatment initiation (OR=1.17 [1.09-13.6], p<0.001; Table 4.3). Across categorical levels, probability of treatment initiation

among those diagnosed ranged 9.2% (5.0-0.13) for none, 10.1% (5.5-14.7) for mild, 18.8% (8.4-29.2) for moderate, and 25.0% (17.4-32.9) for severe severity (Figure 4.2), or 16.6% (11.7-21.6) for any severity CUD.

Among patients who initiated treatment, a 1-unit increase in Symptom Checklist score was associated with significantly higher odds of treatment engagement (OR=1.25, [1.11-1.41], p<0.001; Table 4.3). Across categorical levels, probability of treatment engagement among those who initiated treatment was 3.4% (0.0-10.2) for none, 15.8% (0.7-30.9) for mild, 22.7% (10.9-34.6) for moderate, and 31.0% (14.2-47.9) for severe severity (Figure 4.2), or 24.3% (15.8-32.7) for any severity CUD.

Findings were similar when modeling the Symptom Checklist as categorical or binary (Table 4.3), and findings were consistent across adjustment for sociodemographic, need, and enabling factors although adjustment attenuated effect sizes and increased confidence intervals (Appendix Table 4.2).

Secondary analyses, designed to assess the impact of using relatively short HEDIS time windows for follow-up treatment, revealed that results were similar for the broader measure of 6-month diagnosis and treatment initiation (Appendix Table 4.3; Appendix Figure 4.2).

Moderation by age, gender, race, and ethnicity

Among patients reporting daily cannabis use only, gender significantly moderated the association between the Symptom Checklist and odds of both diagnosis and treatment initiation, but findings were inconsistent across predictor and outcome measures. For CUD diagnosis, there was a significant interaction between the continuous Symptom Checklist score and gender (interaction p-value=0.047; Table 4.4). Odds of diagnosis

increased at a greater rate for women than for men. However, adjustment for need and enabling variables resulted in non-significant moderation by gender (Appendix Table 4.4). Further, there was no significant interaction between gender and the other predictor measures (i.e., categorical levels of severity or binary CUD based on the Symptom Checklist) for documented CUD diagnosis. For CUD treatment initiation, there was no significant interaction between continuous Symptom Checklist score and gender, but there was a significant interaction between the categorical levels of severity and treatment initiation ($p=0.012$). Women had a higher probability of treatment than men at all but the highest level of severity (Figure 4.3).

There was no significant moderation by age, race, or ethnicity (Appendix Tables 4.5-4.10) despite observed variability across subgroups and severity levels (Figure 4.3).

Patients reporting daily cannabis and other drug use

For the smaller sample of patients reporting both daily cannabis and other drug use, main findings were similar to those for patients with daily cannabis only, with one exception. For patients who initiated treatment, the Symptom Checklist was not significantly associated with CUD treatment engagement (Table 4.3). Confidence intervals were larger due to a smaller number of patients reporting daily cannabis and other drug use (Figure 4.2).

DISCUSSION

This is the first study to our knowledge to examine the association between patient-reported symptoms of DSM-5 CUD documented in the EHR, and clinically documented CUD diagnoses and treatment. This study used routinely collected EHR

data from a large primary care population of patients reporting daily cannabis use (with or without other drug use) in a state where adult cannabis use is legal. Although the probability of CUD diagnosis and treatment increased in a dose-response manner as the number of DSM-5 SUD criteria increased on the Symptom Checklist, as hypothesized, the probability of diagnosis and treatment was generally low. For patients who used cannabis daily but reported no other drug use, only 14% of patients who reported any severity CUD on the Symptom Checklist had a documented CUD diagnosis. Even among patients reporting severe CUD, less than one quarter received a diagnosis, only one quarter of those with a diagnosis had documentation that they initiated treatment, and less than one third of those who initiated treatment continued to engage in treatment over the next month.

The prevalence of CUD treatment initiation among patients with a diagnosis was lower than a previous study of seven U.S. healthcare systems that used HEDIS measures to estimate CUD treatment initiation and engagement from 2014-2015, although the prevalence of treatment engagement among those who initiated in the present study was higher. Differences could reflect temporal differences due to increasing acceptability of cannabis in recent years, different health system practices (e.g., no systematic assessment), or differences in sample inclusion/exclusion (e.g., this study used a longer washout period). Findings are consistent with prior studies conducted at Veterans Health Administration (VA) that identified underdiagnosis of SUDs generally[26] and of CUD specifically.[22, 23] Our findings are also consistent with a prior study conducted among four independent community-based healthcare organizations finding underdiagnosis and undertreatment for alcohol and opioid use disorders.[49]

This study adds to the literature demonstrating a pattern of underdiagnosis and undertreatment across the spectrum of CUD severity and across sociodemographic subgroups. There are many possible reasons why, when patients report symptoms consistent with severe CUD, so few of them are diagnosed. Clinicians may not have the knowledge or time to discuss CUD symptoms in the context of a primary care visit or may lack confidence in treatment effectiveness. In qualitative studies, clinicians report feeling unprepared to have conversations about cannabis given the lack of product standardization, the paucity of high-quality evidence on the benefits and harms of cannabis, limited evidence-based treatment options (i.e., no FDA approved medications), and competing demands on visit time.[27, 52-55] One study found that discussion of depression was less likely if patients had competing demands from other physical ailments.[56] Clinicians also report prioritizing treatment of other substance use over CUD, believing cannabis is not as dangerous as alcohol or other drugs.[55, 57] Patients may feel the same way—that their cannabis use is not a problem or that treatment isn't necessary.[19, 58]

Only gender moderated the association between the Symptom Checklist score and diagnosis, with women more likely than men to be diagnosed with each additional symptom they reported. Further, need and enabling factors seemed to account for gender differences in diagnosis. Prior research suggests that cannabis-dependent women are more likely than cannabis-dependent men to have psychiatric comorbidities,[59, 60] and clinicians may be more likely to identify CUD when patients have comorbidities that exacerbate or may be exacerbated by cannabis.[3] Gender also moderated the categorical association between Symptom Checklist levels and treatment initiation, with women

more likely than men to initiate treatment at low levels of severity but much less likely to initiate treatment at the highest level of severity. This non-linear pattern suggests a complex relationship. A prior study found women with CUD enter treatment under especially challenging circumstances, involving severe withdrawal symptoms and co-occurring psychiatric disorders.[59] This greater need may explain why women initiate treatment at lower levels of severity. However, women with severe CUD experience more shame and blame than men, particularly if pregnant or parenting,[12] and this experience of stigma can create barriers to treatment initiation[11] or exacerbate mental health symptoms associated with more severe CUD.[11]

Contrary to our hypothesis, age, race, and ethnicity did not moderate the association between the Symptom Checklist (score or level) and diagnosis or treatment, and there was not strong evidence to suggest systemic bias in diagnosing or treatment patterns. Young adult, American Indian/Alaska Native, and Hispanic patients tended to have higher probability of diagnosis than their counterparts with the same level of CUD severity,[8, 9] and older adults, Asian, and non-Hispanic patients tended to have lower probability of diagnosis than their counterparts with the same level of CUD severity. These patterns require further exploration within subgroups.

Given increasing prevalence of cannabis use,[1] under-recognition of CUD and evidence of effective treatment, there is a need for health systems to improve identification of CUD and link patients to appropriate care. Primary care settings are well positioned to conduct population screening and follow-up assessment of cannabis use, as is often the case for tobacco and alcohol use. [35] Validated cannabis use screens and CUD symptom assessments are superior to relying on clinical impressions[61] and are

recommended by the U.S. Preventive Services Task Force.[62] Implementation of the Single-Item Screen for Cannabis (SIS-C) and Substance Use Symptom Checklist in primary care at KPWA was feasible,[29-31] affordable,[33] and acceptable to patients.[32, 34] While the Symptom Checklist is not formally used as a tool for diagnosis, a recent study evaluated the psychometric properties of the Symptom Checklist, finding it to be unidimensional, discriminative, and a scaled measure of CUD severity that performs equally well across sociodemographic subgroups.[38] Clinical guidelines and workflows could recommend use of the Symptom Checklist as a tool to support clinicians in providing cannabis-related care to address barriers and improve recognition of CUD, monitor severity, and offer shared decision-making about treatment options[63] (e.g., discussion of lower-risk cannabis use with primary care provider,[64] psychosocial treatment with a social worker, or referral to specialty-addictions treatment) that is based on patient-reported symptoms rather than implicit biases. Further research is needed on integrating evidence-based treatments for CUD (i.e., motivational enhancement therapy, cognitive behavioral therapy, and contingency management[54]) into primary care where patients face fewer barriers to care.[19, 58]

Limitations

This study uses EHR data, which may not accurately reflect patient substance use or symptoms; patients may under- or over-report cannabis use and CUD symptoms. EHR data also limits our ability to capture the social identities represented by age, gender, race, and ethnicity. The Symptom Checklist, while consistent with DSM-5 criteria[4] and demonstrated to have strong psychometric properties,[38] is not a gold-standard measure of CUD. However, the goal of this study was not to estimate the true prevalence of CUD but

to test whether the probability of clinically documented CUD diagnosis increases with higher levels of patient-reported symptom severity. Moreover, prevalence estimates of CUD using the Symptom Checklist are consistent with population-based estimates from national surveys.[65, 66] Despite a very large dataset, the relatively low prevalence of diagnosis and treatment combined with small samples for some sociodemographic groups (particularly people of color) prohibited us from evaluating moderation for treatment engagement or in patients who used drugs other than cannabis.[51] For patients reporting daily cannabis and other drug use, it is not known whether symptoms reflect CUD or another drug use disorder. Patients with co-occurring alcohol or substance use disorders may have received substance use treatment without clinical documentation of CUD if cannabis use was not the most significant cause of clinical impairment and distress. Finally, this study was conducted among a predominantly White, non-Hispanic patient population, in a health system with integrated behavioral health, in a U.S. state where adult cannabis is legal. Findings may not generalize to more diverse patient populations or other health systems and settings.

Conclusion

This study highlights the need to improve diagnosis and treatment of CUD in general medical settings. While the probability of clinically documented CUD diagnosis and treatment increased with patient-report of symptoms, most patients with severe CUD did not receive diagnosis or treatment. There were missed opportunities across all sociodemographic subgroups, but women with severe CUD may be one particularly vulnerable subgroup who are not initiating treatment despite diagnosis. Further research

is needed to identify optimal approaches for increasing diagnosis and treatment of CUD in outpatient medical settings.

REFERENCES FOR CHAPTER 4

1. Compton WM, Han B, Jones CM, Blanco C, Hughes A. Marijuana use and use disorders in adults in the USA, 2002-14: analysis of annual cross-sectional surveys. *Lancet Psychiatry*. Oct 2016;3(10):954-964. doi:10.1016/S2215-0366(16)30208-5

2. Compton WM, Saha TD, Conway KP, Grant BF. The role of cannabis use within a dimensional approach to cannabis use disorders. *Drug Alcohol Depend*. Mar 1 2009;100(3):221-7. doi:10.1016/j.drugalcdep.2008.10.009

3. National Academies of Sciences Engineering and Medicine. *The Health Effects of Cannabis and Cannabinoids: The Current State of Evidence and Recommendations for Research*. 2017:486. 978-0-309-45304-2. https://www.nap.edu/catalog/24625/the-health-effects-of-cannabis-and-cannabinoids-the-current-state

4. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders (5th ed.)*. 2013.

5. Matson TE, Carrell DS, Bobb JF, et al. Prevalence of Medical Cannabis Use and Associated Health Conditions Documented in Electronic Health Records Among Primary Care Patients in Washington State. *JAMA Netw Open*. 05 03 2021;4(5):e219375. doi:10.1001/jamanetworkopen.2021.9375

6. Bahorik AL, Satre DD, Kline-Simon AH, Weisner CM, Campbell CI. Alcohol, Cannabis, and Opioid Use Disorders, and Disease Burden in an Integrated Health Care System. *J Addict Med*. Jan/Feb 2017;11(1):3-9. doi:10.1097/adm.0000000000000260

7. Degenhardt L, Ferrari AJ, Calabria B, et al. The global epidemiology and contribution of cannabis use and dependence to the global burden of disease: results from the GBD 2010 study. *PLoS One*. 2013;8(10):e76635. doi:10.1371/journal.pone.0076635

8. Substance Abuse and Mental Health Services Administration. *Results from the 2020 National Survey on Drug Use and Health: Detailed tables*. 2021. https://www.samhsa.gov/data/

9. Hasin DS, Shmulewitz D, Sarvet AL. Time trends in US cannabis use and cannabis use disorders overall and by sociodemographic subgroups: a narrative review and new findings. *Am J Drug Alcohol Abuse*. 2019;45(6):623-643. doi:10.1080/00952990.2019.1569668

10. Lopez M, Blanco C. Epidemiology of Cannabis Use Disorder. In: Montoya ID, Weiss SRB, eds. *Cannabis Use Disorders*. Springer International Publishing AG; 2018:7-12:chap 2.

11. Greaves L, Hemsing N. Sex and Gender Interactions on the Use and Impact of Recreational Cannabis. *Int J Environ Res Public Health*. Jan 14 2020;17(2)doi:10.3390/ijerph17020509

12. Hemsing N, Greaves L. Gender Norms, Roles and Relations and Cannabis-Use Patterns: A Scoping Review. *Int J Environ Res Public Health*. Feb 4 2020;17(3)doi:10.3390/ijerph17030947

13. Montgomery L, Dixon S, Mantey DS. Racial and Ethnic Differences in Cannabis Use and Cannabis Use Disorder: Implications for Researchers. *Curr Addict Rep*. Mar 2022;9(1):14-22. doi:10.1007/s40429-021-00404-5

14. Solomon R. Racism and Its Effect on Cannabis Research. *Cannabis Cannabinoid Res*. Mar 1 2020;5(1):2-5. doi:10.1089/can.2019.0063

15. Oliver W. Cultural Racism and Structural Violence. *Journal of Human Behavior in the Social Environment*. 2001/06/01 2001;4(2-3):1-26. doi:10.1300/J137v04n02_01

16. Parker LJ, Benjamin T, Archibald P, Thorpe RJ. The Association Between Marijuana Usage and Discrimination Among Adult Black Men. *Am J Mens Health*. Mar 2017;11(2):435-442. doi:10.1177/1557988316664896

17. Dogan JN, Thrasher S, Thorpe SY, Hargons C, Stevens-Watkins D. Cultural race-related stress and cannabis use among incarcerated African American men. *Psychol Addict Behav*. May 2021;35(3):320-325. doi:10.1037/adb0000694

18. Compton WM, Han B, Jones CM, Blanco C. Cannabis use disorders among adults in the United States during a time of increasing use of cannabis. *Drug and alcohol dependence*. 2019;204:107468-107468. doi:10.1016/j.drugalcdep.2019.05.008

19. Kerridge BT, Mauro PM, Chou SP, et al. Predictors of treatment utilization and barriers to treatment utilization among individuals with lifetime cannabis use disorder in the United States. *Drug Alcohol Depend*. Dec 1 2017;181:223-228. doi:10.1016/j.drugalcdep.2017.09.032

20. Bottorff JL, Bissell LJL, Balneaves LG, Oliffe JL, Capler NR, Buxton J. Perceptions of cannabis as a stigmatized medicine: a qualitative descriptive study. *Harm Reduction Journal*. 2013/02/16 2013;10(1):2. doi:10.1186/1477-7517-10-2

21. Yang LH, Wong LY, Grivel MM, Hasin DS. Stigma and substance use disorders: an international phenomenon. *Curr Opin Psychiatry*. Sep 2017;30(5):378-388. doi:10.1097/yco.0000000000000351

22. Bonn-Miller MO, Bucossi MM, Trafton JA. The underdiagnosis of cannabis use disorders and other Axis-I disorders among military veterans within VHA. *Mil Med*. Jul 2012;177(7):786-8. doi:10.7205/milmed-d-12-00052

23. Bonn-Miller MO, Harris AHS, Trafton JA. Prevalence of cannabis use disorder diagnoses among veterans in 2002, 2008, and 2009. *Psychol Serv*. Nov 2012;9(4):404-416. doi:10.1037/a0027622

24. Garb HN. Race bias and gender bias in the diagnosis of psychological disorders. *Clinical Psychology Review*. 2021/12/01/ 2021;90:102087. doi:https://doi.org/10.1016/j.cpr.2021.102087

25. Bodner E, Palgi Y, Wyman MF. Ageism in mental health assessment and treatment of older adults. In: Ayalon L, Tesch-Romer, eds. *Contemporary perspectives on ageism*. Springer Open; 2018:241-262:chap 15. *International Perspectives on Aging*.

26. Williams EC, Fletcher OV, Frost MC, Harris AHS, Washington DL, Hoggatt KJ. Comparison of Substance Use Disorder Diagnosis Rates From Electronic Health Record Data With Substance Use Disorder Prevalence Rates Reported in Surveys Across Sociodemographic Groups in the Veterans Health Administration. *JAMA Network Open*. 2022;5(6):e2219651-e2219651. doi:10.1001/jamanetworkopen.2022.19651

27. Brooks E, Gundersen DC, Flynn E, Brooks-Russell A, Bull S. The clinical implications of legalizing marijuana: Are physician and non-physician providers prepared? *Addict Behav*. Sep 2017;72:1-7. doi:10.1016/j.addbeh.2017.03.007

28. Kansagara D, Morasco BJ, Iacocca MO, Bair MJ, Hooker ER, Becker WC. Clinician Knowledge, Attitudes, and Practice Regarding Cannabis: Results from a National Veterans Health Administration Survey. *Pain Medicine*. 2020;21(11):3180-3186. doi:10.1093/pm/pnz322

29. Bobb JF, Lee AK, Lapham GT, et al. Evaluation of a Pilot Implementation to Integrate Alcohol-Related Care within Primary Care. *Int J Environ Res Public Health*. Sep 8 2017;14(9)doi:10.3390/ijerph14091030

30. Glass JE, Bobb JF, Lee AK, et al. Study protocol: a cluster-randomized trial implementing Sustained Patient-centered Alcohol-related Care (SPARC trial). *Implement Sci*. Aug 6 2018;13(1):108. doi:10.1186/s13012-018-0795-9

31. Richards JE, Bobb JF, Lee AK, et al. Integration of screening, assessment, and treatment for cannabis and other drug use disorders in primary care: An evaluation in three pilot sites. *Drug Alcohol Depend*. Aug 1 2019;201:134-141. doi:10.1016/j.drugalcdep.2019.04.015

32. Sayre M, Lapham GT, Lee AK, et al. Routine Assessment of Symptoms of Substance Use Disorders in Primary Care: Prevalence and Severity of Reported Symptoms. *J Gen Intern Med*. Apr 2020;35(4):1111-1119. doi:10.1007/s11606-020-05650-3

33. Yeung K, Richards J, Goemer E, et al. Costs of using evidence-based implementation strategies for behavioral health integration in a large primary care system. *Health Serv Res*. 2020;55(6):913-923. doi:10.1111/1475-6773.13592

34. Bradley KA, Caldeiro RM, Hallgren KA, Kivlahan DR. Making measurement-based care for addictions a reality in primary care. *Addiction (Abingdon, England)*. 2019;114(8):1355-1356. doi:10.1111/add.14605

35. Bradley KA, Lapham GT, Lee AK. Screening for Drug Use in Primary Care: Practical Implications of the New USPSTF Recommendation. *JAMA Intern Med*. 08 01 2020;180(8):1050-1051. doi:10.1001/jamainternmed.2019.7335

36. Matson TE, Lapham GT, Bobb JF, et al. Validity of the Single-Item Screen - Cannabis (SIS-C) for cannabis use disorder screening in routine care. *Under Review*.

37. Smith PC, Schmidt SM, Allensworth-Davies D, Saitz R. A single-question screening test for drug use in primary care. *Arch Intern Med*. Jul 12 2010;170(13):1155-60. doi:10.1001/archinternmed.2010.140

38. Matson TE, Hallgren KA, Lapham GT, et al. Psychometric performance of a Substance Use Symptom Checklist to help clinicians assess substance use disorder in primary care. *Under Review*.

39. National Committee for Quality Assurance. *Initiation and Engagement of Alcohol and Other Drug Abuse or Dependence Treatment (IET)*. 2020. Accessed July 15, 2022. https://www.ncqa.org/hedis/measures/initiation-and-engagement-of-alcohol-and-other-drug-abuse-or-dependence-treatment/

40. Krieger N. Genders, sexes, and health: what are the connections--and why does it matter? *Int J Epidemiol*. Aug 2003;32(4):652-7. doi:10.1093/ije/dyg156

41. Boyd RW, Lindo E, G., Weeks LD, McLemore MR. On Racism: A New Standard For Publishing On Racial Health Inequities. *Health Affairs Blog*. 2020;

42. Ford CL, Airhihenbuwa CO. Critical Race Theory, race equity, and public health: toward antiracism praxis. *Am J Public Health*. Apr 01 2010;100 Suppl 1:S30-5. doi:10.2105/AJPH.2009.171058

43. Bender S. The Colors of Cannabis: Race and Marijuana. *UC Davis L Rev*. 2016;50(689)

44. Keyes KM, Galea S. *Population Health Science*. Oxford University Press; 2016.

45. Ben-Shlomo Y, Kuh D. A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives. *Int J Epidemiol*. Apr 2002;31(2):285-93.

46. Babitsch B, Gohl D, von Lengerke T. Re-revisiting Andersen's Behavioral Model of Health Services Use: a systematic review of studies from 1998-2011. *Psychosoc Med*. 2012;9:Doc11. doi:10.3205/psm000089

47. Andersen RM, Rice TH, Kominski GF. *Changing the US health care system, cafescribe: Key issues in health services policy and management*. John Wiley & Sons; 2011.

48. Williams RL. A note on robust variance estimation for cluster-correlated data. *Biometrics*. Jun 2000;56(2):645-6. doi:10.1111/j.0006-341x.2000.00645.x

49. Hallgren KA, Witwer E, West I, et al. Prevalence of documented alcohol and opioid use disorder diagnoses and treatments in a regional primary care practice-based research network. *J Subst Abuse Treat*. Mar 2020;110:18-27. doi:10.1016/j.jsat.2019.11.008

50. VanderWeele TJ, Robinson WR. On the causal interpretation of race in regressions adjusting for confounding and mediating variables. *Epidemiology*. Jul 2014;25(4):473-84. doi:10.1097/ede.0000000000000105

51. Vittinghoff E, McCulloch CE. Relaxing the rule of ten events per variable in logistic and Cox regression. *Am J Epidemiol*. Mar 15 2007;165(6):710-8. doi:10.1093/aje/kwk052

52. Christensen VA, Nugent SM, Ayers CK, Morasco BJ, Kansagara D. A qualitative study of VHA clinicians' knowledge and perspectives on cannabis for medical purposes. *Family Practice*. 2021;38(4):479-483. doi:10.1093/fampra/cmaa151

53. Kondo KK, Morasco BJ, Nugent SM, et al. Pharmacotherapy for the Treatment of Cannabis Use Disorder: A Systematic Review. *Ann Intern Med*. 03 17 2020;172(6):398-412. doi:10.7326/M19-1105

54. Sherman BJ, McRae-Clark AL. Treatment of Cannabis Use Disorder: Current Science and Future Outlook. *Pharmacotherapy*. 05 2016;36(5):511-35. doi:10.1002/phar.1747

55. Kristman-Valente AN, McCarty CA, Walker DD, Walker-Harding L. Barriers to Implementing a Cannabis Focused SBIRT in Adolescent Primary Care. *Subst Abuse*. 2022;16:11782218221111837. doi:10.1177/11782218221111837

56. Rost K, Nutting P, Smith J, Coyne JC, Cooper-Patrick L, Rubenstein L. The role of competing demands in the treatment provided primary care patients with major depression. *Arch Fam Med*. Feb 2000;9(2):150-4. doi:10.1001/archfami.9.2.150

57. Holland CL, Nkumsah MA, Morrison P, et al. "Anything above marijuana takes priority": Obstetric providers' attitudes and counseling strategies regarding perinatal marijuana use. *Patient Educ Couns*. Sep 2016;99(9):1446-51. doi:10.1016/j.pec.2016.06.003

58. Gates P, Copeland J, Swift W, Martin G. Barriers and facilitators to cannabis treatment. *Drug Alcohol Rev*. May 2012;31(3):311-9. doi:10.1111/j.1465-3362.2011.00313.x

59. Sherman BJ, McRae-Clark AL, Baker NL, et al. Gender differences among treatment-seeking adults with cannabis use disorder: Clinical profiles of women and men enrolled in the achieving cannabis cessation—evaluating N-acetylcysteine treatment (ACCENT) study. *The American Journal on Addictions*. 2017;26(2):136-144. doi:https://doi.org/10.1111/ajad.12503

60. Zhu H, Wu LT. Sex Differences in Cannabis Use Disorder Diagnosis Involved Hospitalizations in the United States. *J Addict Med*. Sep/Oct 2017;11(5):357-367. doi:10.1097/adm.0000000000000330

61. Wilson CR, Sherritt L, Gates E, Knight JR. Are clinical impressions of adolescent substance use accurate? *Pediatrics*. Nov 2004;114(5):e536-40. doi:10.1542/peds.2004-0098

62. Krist AH, Davidson KW, Mangione CM, et al. Screening for Unhealthy Drug Use: US Preventive Services Task Force Recommendation Statement. *JAMA*. Jun 9 2020;323(22):2301-2309. doi:10.1001/jama.2020.8020

63. Scott K, Lewis CC. Using Measurement-Based Care to Enhance Any Treatment. *Cogn Behav Pract*. Feb 2015;22(1):49-59. doi:10.1016/j.cbpra.2014.01.010

64. Fischer B, Russell C, Sabioni P, et al. Lower-Risk Cannabis Use Guidelines: A Comprehensive Update of Evidence and Recommendations. *Am J Public Health*. Aug 2017;107(8):e1-e12. doi:10.2105/ajph.2017.303818

65. Connor JP, Stjepanović D, Le Foll B, Hoch E, Budney AJ, Hall WD. Cannabis use and cannabis use disorder. *Nat Rev Dis Primers*. Feb 25 2021;7(1):16. doi:10.1038/s41572-021-00247-4

66. Budney AJ, Sofis MJ, Borodovsky JT. An update on cannabis use disorder with comment on the impact of policy related to therapeutic and recreational cannabis use. *Eur Arch Psychiatry Clin Neurosci*. Feb 2019;269(1):73-86. doi:10.1007/s00406-018-0976-1

FIGURES FOR CHAPTER 4

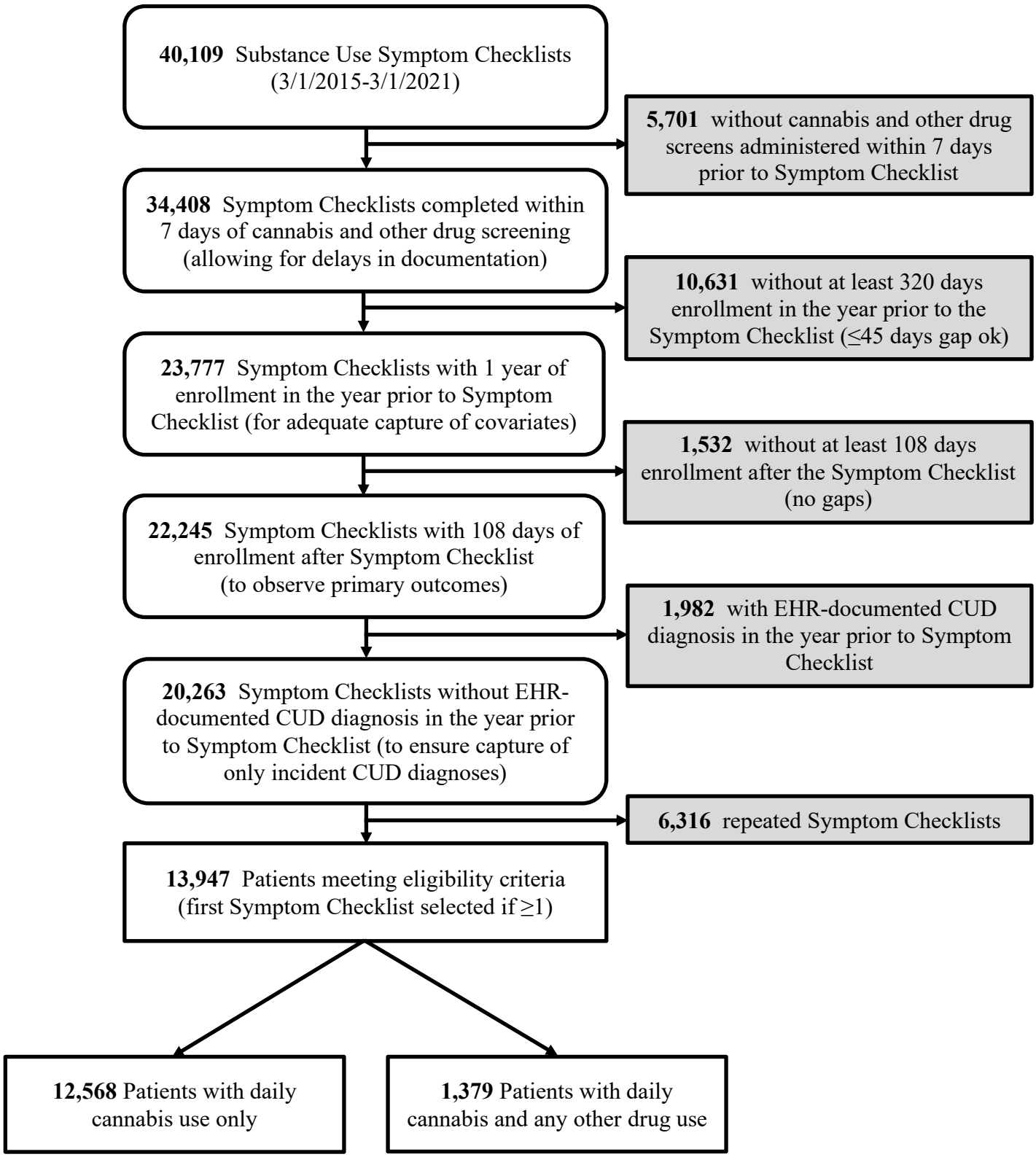


Figure 4.1. Process of selecting Substance Use Symptom Checklists ("Symptom Checklists") for inclusion in analyses.

Figure 4.1 Caption: DSM-5 Substance Use Symptom Checklists are typically administered in primary care after a positive cannabis screen (daily or more frequent use) and/or other drug screen (any use). Analyses were stratified based on report of daily cannabis only or both daily cannabis and other drug use. If patients completed more than one Symptom Checklist during the study period, the first checklist meeting eligibility criteria was selected.

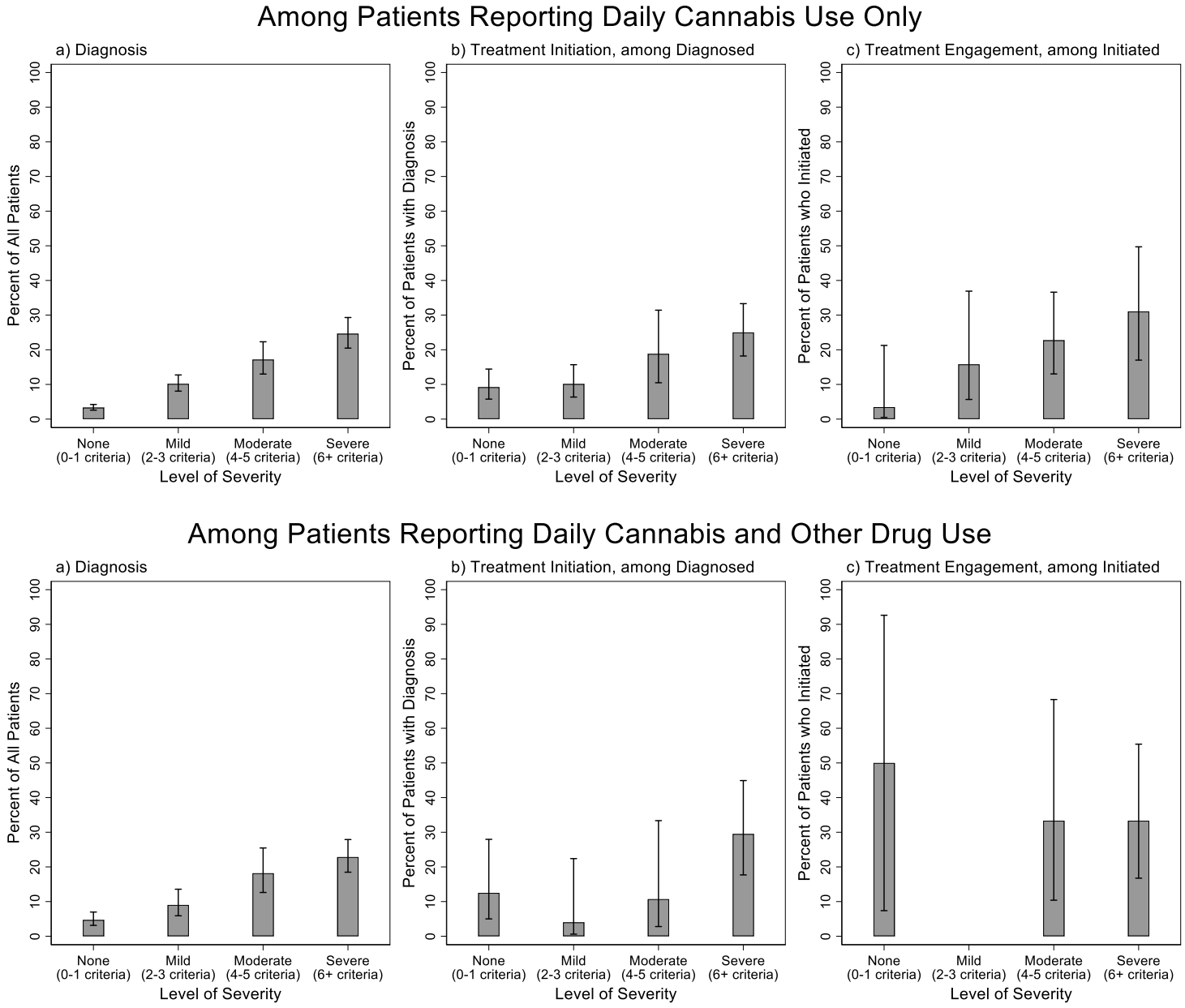
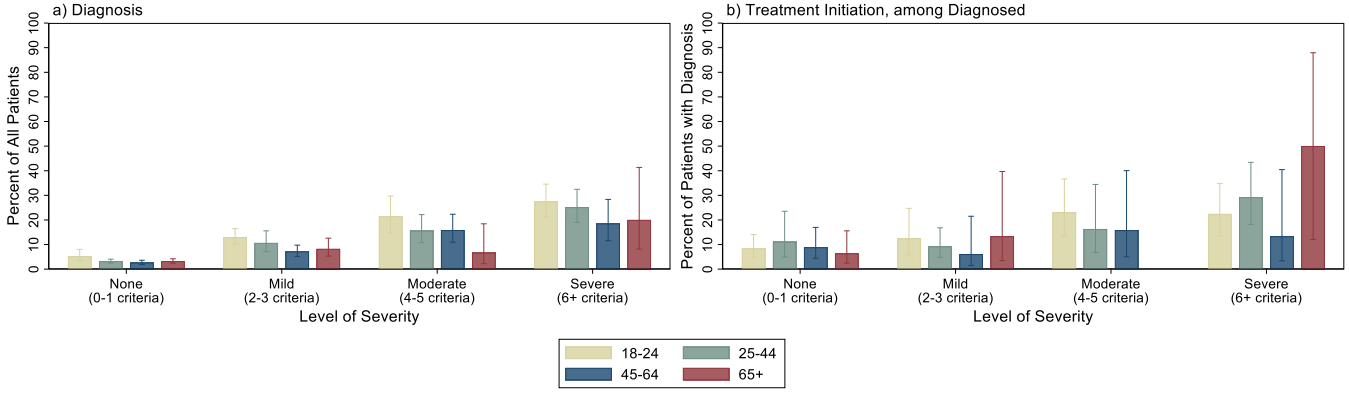
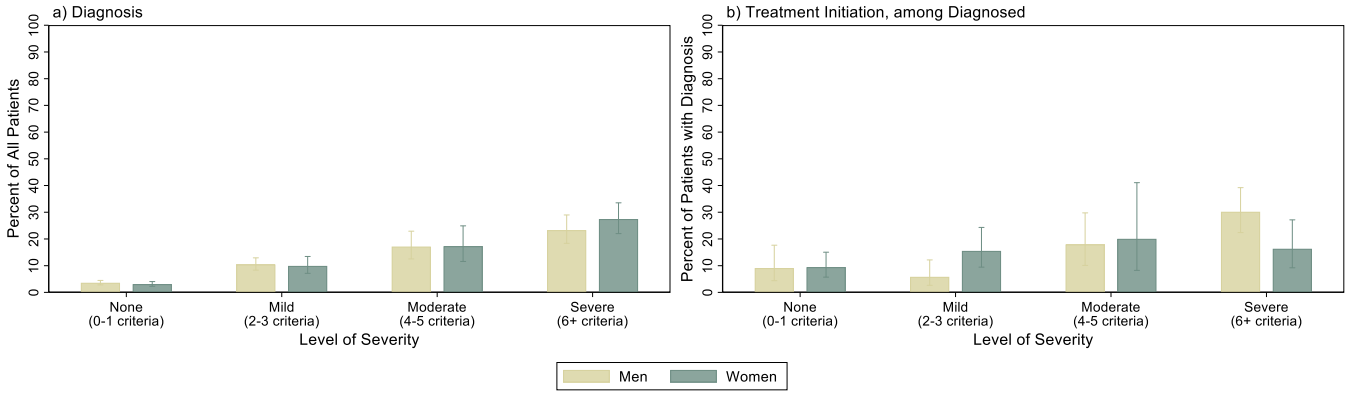


Figure 4.2. Percent of all patients with clinically documented CUD diagnosis (panel a), percent of diagnosed patients with CUD treatment initiation (panel b), and percent of initiated patients with CUD treatment engagement (panel c) across Substance Use Symptom Checklist levels of severity, and stratified by report of daily cannabis use only (top) or both daily cannabis use and other drug use (bottom) on screening

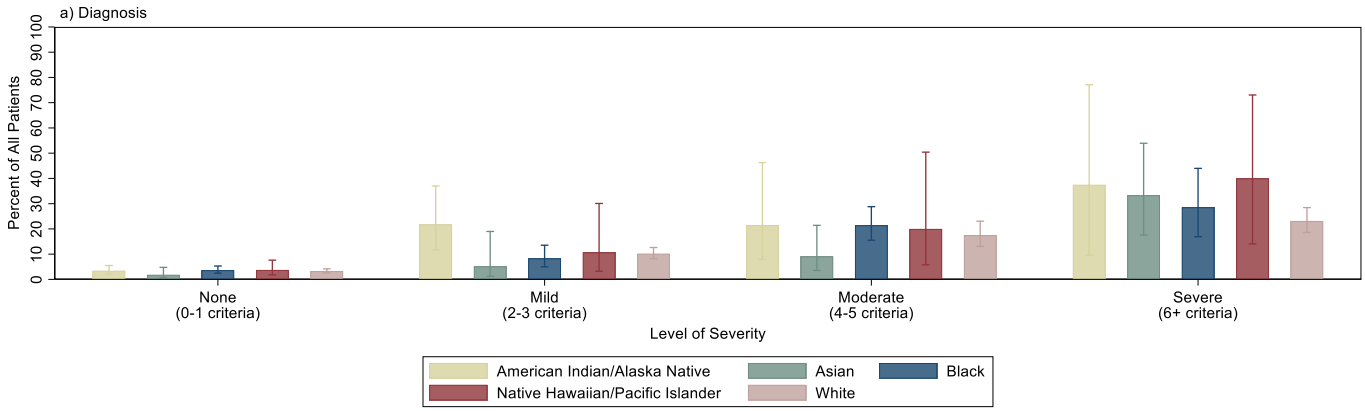
By Age



By Gender



By Race



By Ethnicity

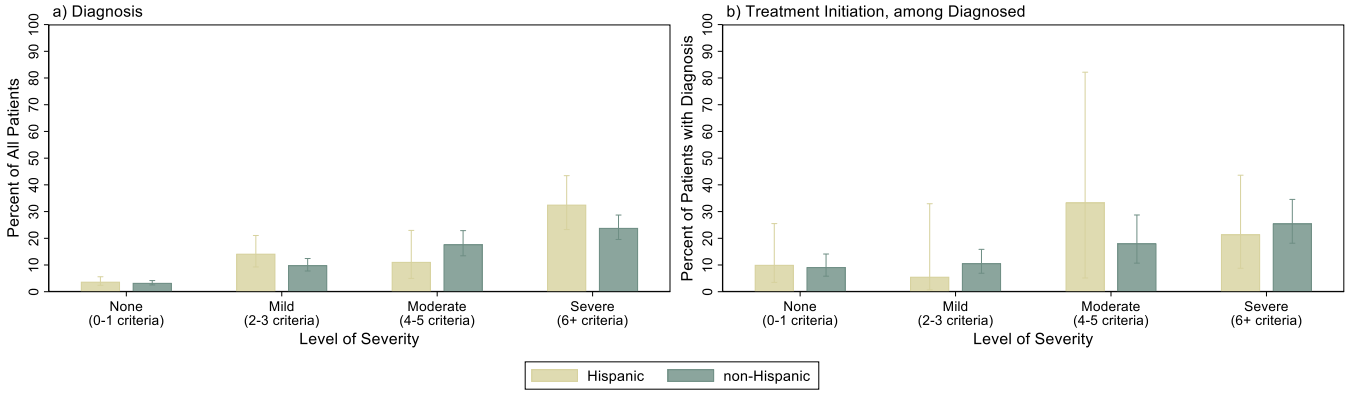


Figure 4.3. Among patients reporting daily cannabis use only on screening, percent of all patients with clinically documented CUD diagnosis (panel a) and percent of diagnosed patients with CUD treatment initiation (panel b) across Substance Use Symptom Checklist levels of severity for age, gender, race, and ethnicity subgroups

TABLES FOR CHAPTER 4

Table 4.1. Characteristics of primary care patients who completed a Substance Use Symptom Checklist 3/1/2015-3/1/2022, stratified by report of daily cannabis only or both daily cannabis and other drug use

	Daily cannabis only (N=12,568)		**Daily cannabis and other drug use** (N=1,379)		
	N	(%)	N	(%)	p-value[a]
Age					
18-29	2299	(18.3)	516	(37.4)	**<0.001**
30-44	4878	(38.8)	637	(46.2)	
45-64	3678	(29.3)	182	(13.2)	
65+	1713	(13.6)	44	(3.2)	
Gender					
Men	6372	(50.7)	873	(63.3)	**<0.001**
Women	6196	(49.3)	506	(36.7)	
Race					
American Indian/Alaska Native	328	(2.6)	36	(2.6)	**0.02**
Asian	403	(3.2)	64	(4.6)	
Black	880	(7.0)	97	(7.0)	
Native Hawaiian/Pacific Islander	177	(1.4)	26	(1.9)	
White	9809	(78.0)	1033	(74.9)	
Other or Unknown race	971	(7.7)	123	(8.9)	
Ethnicity					
Hispanic ethnicity	766	(6.1)	100	(7.3)	0.091
Not Hispanic	11802	(93.9)	1279	(92.7)	
Insurance status					
Commercial	8305	(69.9)	1019	(81.4)	**<0.001**
Medicaid/Subsidized	1478	(12.4)	169	(13.5)	
Medicare	2100	(17.7)	64	(5.1)	
EHR-documented diagnoses (in the past two years)					
Any mental health disorders	5942	(47.3)	584	(42.3)	**0.003**
Attention deficit disorder	515	(4.1)	82	(5.9)	**0.001**
Anxiety disorder	4005	(31.9)	382	(27.7)	**0.002**
Bipolar disorder	565	(4.5)	53	(3.8)	0.264
Depressive disorder	4387	(34.9)	434	(31.5)	**0.011**
Eating disorder	98	(0.8)	16	(1.2)	0.136
Posttraumatic stress disorder	642	(5.1)	53	(3.8)	**0.04**
Schizophrenia disorder	45	(0.4)	4	(0.3)	0.685
Other psychosis	58	(0.5)	7	(0.5)	0.811
Any substance use disorders	3013	(24.0)	395	(28.6)	**<0.001**
Alcohol use disorder	697	(5.5)	118	(8.6)	**<0.001**
Cannabis use disorder[b]	521	(4.1)	99	(7.2)	**<0.001**
Opioid use disorder	222	(1.8)	66	(4.8)	**<0.001**
Stimulant Use Disorder	80	(0.6)	57	(4.1)	**<0.001**
Tobacco use disorder	1291	(10.3)	157	(11.4)	0.198
Other drug use disorder	125	(1.0)	75	(5.4)	**<0.001**

Abbreviations: EHR=electronic health record

[a] Differences between patients reporting daily cannabis use only and patients reporting both daily cannabis and other drug use were tested using chi-squared test of independence. Bold indicates a significant difference at α=0.05

[b] Cannabis use disorder between one and two years prior to completing the Substance Use Symptom Checklist (patients with a cannabis use disorder diagnosis in the year prior had been excluded).

Table 4.2. Prevalence of patient-reported symptoms on the Substance Use Symptom Checklist documented in the electronic health record and clinician-documented CUD diagnosis and CUD treatment during follow-up, stratified by report of daily cannabis use only or both daily cannabis and other drug use on screening

	Daily cannabis only (N=12,568)		**Daily cannabis and other drug use** (N=1,379)		
	N	(%)	N	(%)	p-value[a]
Substance Use Symptom Checklist severity level					
0-1 criteria (No CUD)	9564	(76.1)	681	(49.4)	**<0.001**
2-3 criteria (Mild CUD)	1851	(14.7)	277	(20.1)	
4-5 criteria (Moderate CUD)	682	(5.4)	154	(11.2)	
6+ criteria (Severe CUD)	471	(3.8)	267	(19.4)	
CUD diagnosis	736	(5.9)	146	(10.6)	**<0.001**
CUD treatment initiation	99	(0.8)	26	(1.9)	**<0.001**
CUD treatment engagement	18	(0.1)	9	(0.7)	**<0.001**
6-month CUD diagnosis and treatment initiation[b]	281	(2.2)	65	(4.7)	**<0.001**

Abbreviations: CUD=Cannabis use disorder

[a] Differences between patients reporting daily cannabis use only and patients reporting both daily cannabis and other drug use were tested using chi-squared test of independence. Bold indicates a significant difference at $\alpha=0.05$

[b] A broader measure of treatment initiation, defined as having a CUD diagnosis and at least one CUD encounter within 6 months after completing the Symptom Checklist.

Table 4.3. Unadjusted association between Substance Use Symptom Checklist measures and subsequent CUD diagnosis and initiation and engagement in CUD treatment

	Daily Cannabis Only				Daily Cannabis and Other Drug Use			
	%[a]	OR[b]	(95% CI)	p-value	%[a]	OR[b]	(95% CI)	p-value
CUD diagnosis, among all patients								
Continuous Symptom Checklist[c]	-	1.38	(1.33-1.44)	**<0.001**	-	1.23	(1.18-1.27)	**<0.001**
Categorical Symptom Checklist[d]								
0-1 criteria (none)	3.3	ref	-	-	4.7	ref	-	-
2-3 criteria (mild)	10.2	3.32	(2.68-4.11)	**<0.001**	9.0	2.01	(1.01-3.99)	**0.045**
4-5 criteria (moderate)	17.2	6.08	(4.61-8.02)	**<0.001**	18.2	4.51	(3.05-6.65)	**<0.001**
6+ criteria (severe)	24.6	9.59	(6.65-13.84)	**<0.001**	22.8	6.01	(4.06-8.88)	**<0.001**
Binary Symptom Checklist[e]								
0-1 criteria (none)	3.3	ref	-	-	4.7	ref	-	-
2+ criteria (CUD)	14.0	4.79	(3.81-6.01)	**<0.001**	16.3	3.96	(2.71-5.77)	**<0.001**
CUD treatment initiation, among patients with diagnosis								
Continuous Symptom Checklist[c]	-	1.17	(1.09-1.25)	**<0.001**	-	1.21	(1.11-1.32)	**<0.001**
Categorical Symptom Checklist[d]								
0-1 criteria (none)	9.2	ref	-	-	12.5	ref	-	-
2-3 criteria (mild)	10.1	1.11	(0.62-1.98)	0.727	4.0	0.29	(0.03-2.64)	0.273
4-5 criteria (moderate)	18.8	2.28	(1.33-3.91)	**0.003**	10.7	0.84	(0.25-2.85)	0.780
6+ criteria (severe)	25.0	3.29	(1.91-5.65)	**<0.001**	29.5	2.93	(1.34-6.39)	**0.007**
Binary Symptom Checklist[e]								
0-1 criteria (none)	9.2	ref	-	-	12.5	ref	-	-
2+ criteria (CUD)	16.6	1.97	(1.32-2.93)	**0.001**	19.3	1.67	(0.8-3.52)	0.174
CUD treatment engagement, among patients who initiated								
Continuous Symptom Checklist[c]	-	1.25	(1.11-1.41)	**<0.001**	-	0.98	(0.76-1.26)	0.854
Categorical Symptom Checklist[d]								
0-1 criteria (none)	3.5	ref			50.0	ref		
2-3 criteria (mild)	15.8	5.25	(0.48-56.93)	0.173	-	-		
4-5 criteria (moderate)	22.7	8.24	(0.95-71.15)	0.055	33.3	0.50	(0.14-17.91)	0.704
6+ criteria (severe)	31.0	12.60	(2.59-61.37)	**0.002**	33.3	0.50	(0.23-10.67)	0.657
Binary Symptom Checklist[e]								
0-1 criteria (none)	3.4	ref			50	ref		
2+ criteria (CUD)	24.3	8.98	(1.5-53.89)	**0.016**	31.8	0.47	(0.02-10.71)	0.634

Abbreviations: CUD=cannabis use disorder; OR=odds ratio; CI=confidence interval; ref=reference group
Note: (-) indicates not estimatable; bold indicates significant at α=0.05
[a] Predicted probability, expressed as a percent
[b] OR estimated using logistic regression with cluster-robust standard errors
[c] OR associated with each 1-unit increase on the Symptom Checklist
[d] OR associated with each level of severity on Symptom Checklist relative to 0-1 criteria (none)
[e] OR associated with ≥2 criteria (consistent with any severity CUD) on Symptom Checklist relative to 0-1 criteria (none)

Table 4.4. Unadjusted gender-stratified association between Substance Use Symptom Checklist measures and subsequent CUD diagnosis and initiation and engagement in CUD treatment (moderation by gender), among patients reporting daily cannabis use only on screening

	Men				Women				Interaction
	%[a]	OR[b]	(95% CI)	p-value	%[a]	OR[b]	(95% CI)	p-value	Joint p-value[c]
CUD diagnosis, among all patients									
Continuous Symptom Checklist[d]	-	1.36	(1.30-1.41)	**<0.001**	-	1.42	(1.35-1.50)	**<0.001**	**0.047**
Categorical Symptom Checklist[e]									
0-1 criteria (none)	3.6	ref	-	-	3.0	ref	-	-	0.216
2-3 criteria (mild)	10.4	3.15	(2.44-4.06)	**<0.001**	9.9	3.49	(2.63-4.63)	**<0.001**	
4-5 criteria (moderate)	17.1	5.59	(3.96-7.89)	**<0.001**	17.2	6.64	(4.33-10.17)	**<0.001**	
6+ criteria (severe)	23.2	8.21	(5.44-12.40)	**<0.001**	27.4	12.02	(8.12-17.80)	**<0.001**	
Binary Symptom Checklist[f]									
0-1 criteria (none)	3.6	ref	-	-	3.0	ref	-	-	0.464
2+ criteria (CUD)	14.3	4.53	(3.52-5.83)	**<0.001**	13.6	5.03	(3.79-6.66)	**<0.001**	
CUD treatment initiation, among patients with diagnosis									
Continuous Symptom Checklist[d]	-	1.22	(1.09-1.35)	**<0.001**	-	1.11	(0.99-1.24)	**0.07**	0.277
Categorical Symptom Checklist[e]									
0-1 criteria (none)	9.0	ref	-	-	9.4	ref	-	-	**0.012**
2-3 criteria (mild)	5.8	0.62	(0.23-1.62)	0.325	15.5	1.77	(0.85-3.68)	0.129	
4-5 criteria (moderate)	17.9	2.20	(0.93-5.20)	0.074	20.0	2.41	(0.87-6.69)	0.091	
6+ criteria (severe)	30.1	4.34	(1.92-9.80)	**<0.001**	16.3	1.88	(0.84-4.17)	0.123	
Binary Symptom Checklist[f]									
0-1 criteria (none)	9.0	ref	-	-	9.4	ref	-	-	0.996
2+ criteria (CUD)	16.4	4.53	(3.52-5.83)	**<0.001**	16.9	5.03	(3.79-6.66)	**<0.001**	

Abbreviations: CUD=cannabis use disorder; OR=odds ratio; CI=confidence interval; ref=reference group
Note: (-) indicates not estimatable; bold indicates significant at α=0.05
[a] Predicted probability, expressed as a percent
[b] OR estimated using logistic regression with cluster-robust standard errors
[c] Joint Wald's test of interaction term(s)
[d] OR associated with each 1-unit increase on the Symptom Checklist
[e] OR associated with each level of severity on Symptom Checklist relative to 0-1 criteria (none)
[f] OR associated with ≥2 criteria (consistent with any severity CUD) on Symptom Checklist relative to 0-1 criteria (none)

CHAPTER 5

Conclusion

Summary of findings

This dissertation leverages routinely collected electronic health record (EHR) data from a large integrated health system to evaluate brief measures for screening and assessment of cannabis use disorder (CUD) and to evaluate whether there are potential biases in current CUD diagnosing and treatment practices. We found that the Single-Item Screen for Cannabis (SIS-C) was valid for identifying patients at-risk of CUD (Chapter 2), and a follow-up Substance Use Symptom Checklist demonstrated strong psychometric properties (Chapter 3). Both measures are brief, feasible to administer in primary care, and perform equally well across sociodemographic subgroups. Moreover, they performed well when administered as part of real-world care rather than a recruited research study with limited generalizability. However, compared to patient-report of symptoms, clinical diagnosis and treatment for CUD was extremely low and varied across sociodemographic subgroups (Chapter 3), highlighting missed opportunities to provide cannabis-related care.

Implications

Patients have access to and are using cannabis more than ever.[1,2] While not all patients who use cannabis experience health risks, 25-50% who use cannabis daily develop CUD. Patients have questions about how to use cannabis safely,[3] but most do not discuss their cannabis use and symptoms with a healthcare provider,[3,4] possibly due to perceived stigma or a lack of confidence in their providers knowledge of cannabis.[3] Providers, in turn, say that they feel unprepared to discuss cannabis use with patients.[5,6] While primary care is an ideal setting to identify cannabis use, engage patients in a balanced discussion of the benefits and harms of

cannabis, and manage cannabis-related care, including treatment for CUD if indicated,[7] primary care providers are ill-equipped to do so.

Valid screening and assessment tools, combined with workflows and training that support the use of these tools, are needed to improve cannabis-related care. These tools must be practical for routine use in busy primary care settings and demonstrate clinical utility. In fact, the National Academy of Science (NAS) recently called out the importance of using EHR data to study cannabis use but noted a lack of acceptable EHR measures.[8] This dissertation highlights one healthcare setting that implemented brief screening followed by standardized assessment for cannabis and other behavioral health conditions with results documented in the EHR.[9–13] These measures were developed at the request of clinical leaders and successfully integrated into routine care, but they had not been previously validated, nor were they recommended for making a CUD diagnosis. Our findings support the use of the SIS-C for identifying patients who may be at risk of CUD as well as the Symptom Checklist for diagnosing based on DSM-5 criteria and treatment planning based on symptom severity. However, implementing these tools in primary care may not be enough to improve recognition and treatment. Our findings demonstrate underdiagnosis and undertreatment of CUD across the spectrum of CUD severity and across sociodemographic subgroups. Clinical guidelines and training may be necessary to support providers in using the Symptom Checklist as a diagnostic tool and discussing lower-risk cannabis use with patients.[14] Additional research is needed on integrating evidence-based treatments for CUD into primary care,[15,16] where patients report fewer barriers to care than traditional specialty addictions settings.[17–19] Promising approaches include the use of integrated mental health specialists or mobile health technology to deliver psychosocial interventions that are typically too time-intensive to be conducted in the context of a primary care visit.[20,21]

With the development of new tools and automated processes, it is imperative that systems of inequity are not embedded into practices for identifying and managing cannabis-related care. Measurement may perpetuate biases that persist in the social world[22] or produce new paths for discrimination under the guise of objectivity[22,23] without intentional, critical, and ongoing examination. Each study of this dissertation intentionally evaluated differences in measurement or practice across ages, sexes and/or genders, races, and ethnicities in real world settings rather than controlled research laboratories. While it is promising that we did not find strong evidence of bias in measurement performance, nor in current patterns of clinical diagnosis and treatment, studies were conducted in a predominantly middle-aged, White, non-Hispanic patient population in a U.S. state where adult cannabis use is legal. Statistically, studies may have been underpowered to detect significant differences for minoritized racial and ethnic groups who are less represented in this patient population, and in research more generally.[24–26] Culturally, studies may reflect prevailing norms about cannabis use—such as its increasing acceptability,[27] reflected in the willingness of patients to report use and symptoms and, potentially, in provider underdiagnosis of CUD despite symptoms of impairment and distress. Findings require replication in more diverse patient populations, non-English speakers, as well as in regions where cannabis use is illegal, as patients may be less inclined to disclose cannabis use on screening and assessment tools, particularly marginalized groups who experience a disproportionate burden of legal repercussions for cannabis use.[28] Additionally, qualitative methods and/or stakeholder advisory groups may be useful for centering the narrative on the experiences of minoritized and marginalized patients[22,29] in order to understand how they interact with cannabis screening and assessment tools and how this may impact cannabis-related encounters with a healthcare provider. Finally, tools and practices require ongoing examination

as systems of inequity evolve over time.[22,23]

Conclusion

Measurement is a cornerstone of primary care for many chronic conditions,[30] but development of equivalent tools for cannabis-related care has lagged. This dissertation addresses a gap in research and in practice by evaluating screening and assessment tools as well as current diagnosing and treatment patterns under real world settings. A single-item screen for cannabis and a brief DSM-5 assessment of substance use symptoms demonstrated strong performance when administered as part of routine care in an integrated health system in Washington State. These measures have potential in improve recognition and treatment of CUD in primary care.

REFERENCES FOR CHAPTER 5

1. Hall W, Lynskey M. Assessing the public health impacts of legalizing recreational cannabis use: the US experience. *World Psychiatry*. 2020;19(2):179-186. doi:https://doi.org/10.1002/wps.20735

2. Compton WM, Baler R. The epidemiology of DSM-5 cannabis use disorders among U.S. Adults: Science to inform clinicians working in a shifting social landscape. *American Journal of Psychiatry*. Published online 2016. doi:10.1176/appi.ajp.2016.16030314

3. Rhidenour KB, Blackburn K, Barrett AK, Taylor S. Mediating Medical Marijuana: Exploring How Veterans Discuss Their Stigmatized Substance Use on Reddit. *Health Communication*. Published online February 18, 2021:1-11. doi:10.1080/10410236.2021.1886411

4. Merlin JS, Althouse A, Feldman R, et al. Analysis of State Cannabis Laws and Dispensary Staff Recommendations to Adults Purchasing Medical Cannabis. *JAMA Network Open*. 2021;4(9):e2124511-e2124511. doi:10.1001/jamanetworkopen.2021.24511

5. Christensen VA, Nugent SM, Ayers CK, Morasco BJ, Kansagara D. A qualitative study of VHA clinicians' knowledge and perspectives on cannabis for medical purposes. *Family Practice*. 2021;38(4):479-483. doi:10.1093/FAMPRA/CMAA151

6. Brooks E, Gundersen DC, Flynn E, Brooks-Russell A, Bull S. The clinical implications of legalizing marijuana: Are physician and non-physician providers prepared? *Addictive Behaviors*. Published online 2017. doi:10.1016/j.addbeh.2017.03.007

7. Matson TE, Bradley KA, Lapham GT. Self-reported Practices of Frontline Cannabis Dispensary Workers and the Implications for Clinicians. *JAMA Network Open*. 2021;4(9):e2125262-e2125262. doi:10.1001/jamanetworkopen.2021.25262

8. National Academies of Sciences T. *Committee on the Health Effects of Marijuana: An Evidence Review and Research Agenda Board on Population Health and Public Health Practice Health and Medicine Division A Report Of*.; 2017. doi:10.17226/24625

9. Sayre M, Lapham GT, Lee AK, et al. Routine Assessment of Symptoms of Substance Use Disorders in Primary Care: Prevalence and Severity of Reported Symptoms. *Journal of General Internal Medicine*. Published online 2020. doi:10.1007/s11606-020-05650-3

10. Richards JE, Bobb JF, Lee AK, et al. Integration of screening, assessment, and treatment for cannabis and other drug use disorders in primary care: An evaluation in three pilot sites. *Drug and Alcohol Dependence*. Published online 2019. doi:10.1016/j.drugalcdep.2019.04.015

11. Glass JE, Bobb JF, Lee AK, et al. Study protocol: a cluster-randomized trial implementing Sustained Patient-centered Alcohol-related Care (SPARC trial). *Implementation Science*. 2018;13(1):108.

12. Bobb J, Lee A, Lapham G, et al. Evaluation of a Pilot Implementation to Integrate Alcohol-Related Care within Primary Care. *International Journal of Environmental Research and Public Health*. 2017;14(9):1030. doi:10.3390/ijerph14091030

13. Yeung K, Richards J, Goemer E, et al. Costs of using evidence-based implementation strategies for behavioral health integration in a large primary care system. *Health Services Research*. 2020;55(6):913-923. doi:https://doi.org/10.1111/1475-6773.13592

14. Fischer B, Russell C, Sabioni P, et al. Lower-Risk Cannabis Use Guidelines: A Comprehensive Update of Evidence and Recommendations. *American Journal of Public Health*. 2017;107(8):e1-e12. doi:10.2105/AJPH.2017.303818

15. Parmar A, Sarkar S. Brief Interventions for Cannabis Use Disorders: A Review. *Addictive Disorders and their Treatment*. Published online 2017. doi:10.1097/ADT.0000000000000100

16. Sherman BJ, McRae-Clark AL. Treatment of Cannabis Use Disorder: Current Science and Future Outlook. *Pharmacotherapy*. Published online 2016. doi:10.1002/phar.1747

17. Bujarski SJ, Galang JN, Short NA, et al. Cannabis Use Disorder Treatment Barriers and Facilitators among Veterans with PTSD. *Psychology of Addictive Behaviors*. Published online 2016. doi:10.1037/adb0000131

18. Gates P, Copeland J, Swift W, Martin G. Barriers and facilitators to cannabis treatment. *Drug and Alcohol Review*. Published online 2012. doi:10.1111/j.1465-3362.2011.00313.x

19. Kerridge BT, Mauro PM, Chou SP, et al. Predictors of treatment utilization and barriers to treatment utilization among individuals with lifetime cannabis use disorder in the United States. *Drug and Alcohol Dependence*. Published online 2017. doi:10.1016/j.drugalcdep.2017.09.032

20. Glass JE, Matson TE, Lim C, et al. Approaches for implementing app-based digital treatments for drug use disorders into primary care: A qualitative, user-centered design study of patient perspectives. *Journal of Medical Internet Research*. 2021;23(7). doi:10.2196/25866

21. Wells EA, Kristman-Valente AN, Peavy KM, Jackson TR. Social Workers and Delivery of Evidence-Based Psychosocial Treatments for Substance Use Disorders. *Soc Work Public Health*. 2013;28(0):279. doi:10.1080/19371918.2013.759033

22. Benjamin R. *Race after Technology : Abolitionist Tools for the New Jim Code*. Polity; 2019.

23. Link BG, Phelan J. Social Conditions As Fundamental Causes of Disease Author. *Journal of Health and Social Behavior*. 1995;35:80-94. doi:10.2307/2626958

24. Redwood S, Gill PS. Under-representation of minority ethnic groups in research — call for action. *British Journal of General Practice*. 2013;63(612):342. doi:10.3399/bjgp13X668456

25. Humphreys K, Weisner C. Use of Exclusion Criteria in Selecting Research Subjects and Its Effect on the Generalizability of Alcohol Treatment Outcome Studies. *American Journal of Psychiatry*. 2000;157(4):588-594. doi:10.1176/appi.ajp.157.4.588

26. Murthy VH, Krumholz HM, Gross CP. Participation in Cancer Clinical TrialsRace-, Sex-, and Age-Based Disparities. *JAMA*. 2004;291(22):2720-2726. doi:10.1001/jama.291.22.2720

27. Compton WM, Han B, Jones CM, Blanco C, Hughes A. Marijuana use and use disorders in adults in the USA, 2002–14: analysis of annual cross-sectional surveys. *The Lancet Psychiatry*. Published online 2016. doi:10.1016/S2215-0366(16)30208-5

28. Montgomery L, Dixon S, Mantey DS. Racial and Ethnic Differences in Cannabis Use and Cannabis Use Disorder: Implications for Researchers. *Current Addiction Reports*. 2022;9(1):14-22. doi:10.1007/s40429-021-00404-5

29. Thomas SP. Trust Also Means Centering Black Women's Reproductive Health Narratives. *Hastings Center Report*. 2022;52(S1):S18-S21. doi:https://doi.org/10.1002/hast.1362

30. Fortney JC, Unützer J, Wrenn G, et al. A Tipping Point for Measurement-Based Care. *Psychiatric Services*. 2016;68(2):179-188. doi:10.1176/appi.ps.201500439

VITA

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APPENDIX

Chapter 2 Appendix

Appendix Table 2.1. Characteristics of the eligible primary care population (N=1688), stratified by severity of past-year cannabis use disorder (CUD)

	No CUD (CIDI <2)			Mild CUD (CIDI 2-3)			Moderate-Severe CUD (CIDI ≥4)		
	Unweighted No.	*Weighted %*	*(SE)*	*Unweighted No.*	*Weighted %*	*(SE)*	*Unweighted No.*	*Weighted %*	*(SE)*
Age[a]									
18-29	196	13.2	(32.9)	128	32.9	(7.1)	135	57.0	(4.3)
30-49	345	29.9	(52.6)	154	52.6	(8.9)	83	31.4	(3.9)
50-64	246	27.4	(4.0)	57	11.6	(2.8)	26	8.9	(1.9)
65+	283	29.5	(3.7)	25	2.8	(0.9)	10	2.7	(1.0)
Gender[a]									
Women	562	56.6	(47.9)	192	47.9	(9.5)	107	40.7	(4.6)
Men	508	43.4	(52.1)	172	52.1	(9.5)	147	59.3	(4.6)
Race[a]									
American Indian/Alaska Native	31	0.4	(0.2)	5	0.4	(0.2)	4	1.3	(0.7)
Asian	65	10.0	(2.6)	21	5.8	(2.6)	13	7.2	(4.2)
Black	92	4.8	(1.8)	44	4.9	(1.2)	27	6.0	(1.2)
Native Hawaiian/Pacific Islander	24	1.7	(0.1)	5	16.9	(13.7)	7	1.7	(0.1)
White	777	75.0	(3.9)	247	64.5	(11.1)	168	65.2	(4.8)
Other/Unknown	81	8.2	(2.7)	42	7.5	(1.9)	35	18.7	(4.0)
Hispanic Ethnicity[a]	99	3.0	(6.6)	42	6.6	(2.4)	33	7.8	(1.6)
Insurance[a]									
Medicaid/Subsidized	125	5.6	(12.9)	54	12.9	(3.8)	31	8.6	(1.7)
Medicare	284	28.8	(3.1)	28	3.1	(0.9)	11	2.5	(0.8)
Commercial	613	63.7	(81.6)	264	81.6	(4.4)	195	81.4	(3.0)
Unknown	48	1.9	(2.4)	18	2.4	(0.8)	17	7.6	(2.5)
Marital Status[b,c]									
Married/Living with partner	649	64.2	(40.1)	193	40.1	(7.8)	124	50.0	(4.5)
Widowed	38	3.1	(0.6)	5	0.6	(0.3)	0	0.0	(0.0)
Divorced/Separated	117	9.5	(5.5)	32	5.5	(1.7)	17	5.2	(1.4)
Single/Never married	261	22.2	(53.7)	133	53.7	(8.7)	111	44.3	(4.5)
Education[b,c]									
≤ High school	182	12.1	(20.7)	84	20.7	(5.4)	53	23.5	(3.9)
Some college	421	38.3	(45.7)	145	45.7	(9.8)	99	34.4	(3.9)
≥ 4 years of college	460	48.7	(33.5)	134	33.5	(6.8)	100	41.7	(4.6)
Employment[b,c]									
Employed full time	584	54.1	(75.4)	239	75.4	(5.7)	165	67.0	(4.1)
Employed part time	92	13.1	(5.5)	37	5.5	(1.5)	23	6.8	(1.5)
Retired	256	23.3	(3.3)	25	3.3	(1.0)	17	4.3	(1.1)
Other	103	8.1	(8.9)	48	8.9	(3.2)	35	17.3	(3.8)
Unemployed	30	0.4	(6.7)	14	6.7	(3.3)	14	4.6	(1.3)
EHR-Documented Past-Year Diagnoses[a]									
Mental health diagnosis	340	25.8	(35.1)	156	35.1	(7.2)	116	39.4	(4.1)
SUD diagnosis	63	5.3	(3.4)	25	3.4	(1.0)	18	5.3	(1.3)

Abbreviations: CUD = cannabis use disorder; CIDI = Composite International Diagnostic Interview; SUD = substance use disorder

[a] Data collected from electronic health records

[b] Data collected from confidential survey

[c] Subgroups do not sum to total N due to missing responses

Appendix Table 2.2. Differences in area under the receiver operating characteristic curve (AUC) estimates comparing: 1) performance of the SIS between demographic subgroups and 2) performance SIS to other survey measures

	Any CUD[a]		**Moderate-Severe CUD[b]**	
	Δ AUC[c]	*95% CI*[d]	*Δ AUC*[c]	*95% CI*[d]
Comparison of subgroups (reference vs. comparator)				
18-29 vs. 30-49	0.113	(-0.075, 0.276)	-0.037	(-0.105, 0.007)
18-29 vs. 50+	**-0.058**	**(-0.128, -0.02)**	**-0.064**	**(-0.130, -0.027)**
30-49 vs. 50+	**-0.171**	**(-0.330, -0.016)**	**-0.028**	**(-0.053, -0.008)**
Women vs. Men	-0.107	(-0.263, 0.050)	0.000	(-0.027, 0.026)
Black, not Hispanic vs. Hispanic	0.078	(-0.007, 0.245)	0.047	(-0.030, 0.155)
Black, not Hispanic vs. White, not Hispanic	0.017	(-0.039, 0.043)	0.004	(-0.022, 0.156)
Hispanic vs. White	-0.062	(-0.007, 0.227)	**-0.051**	**(0.010, 0.156)**

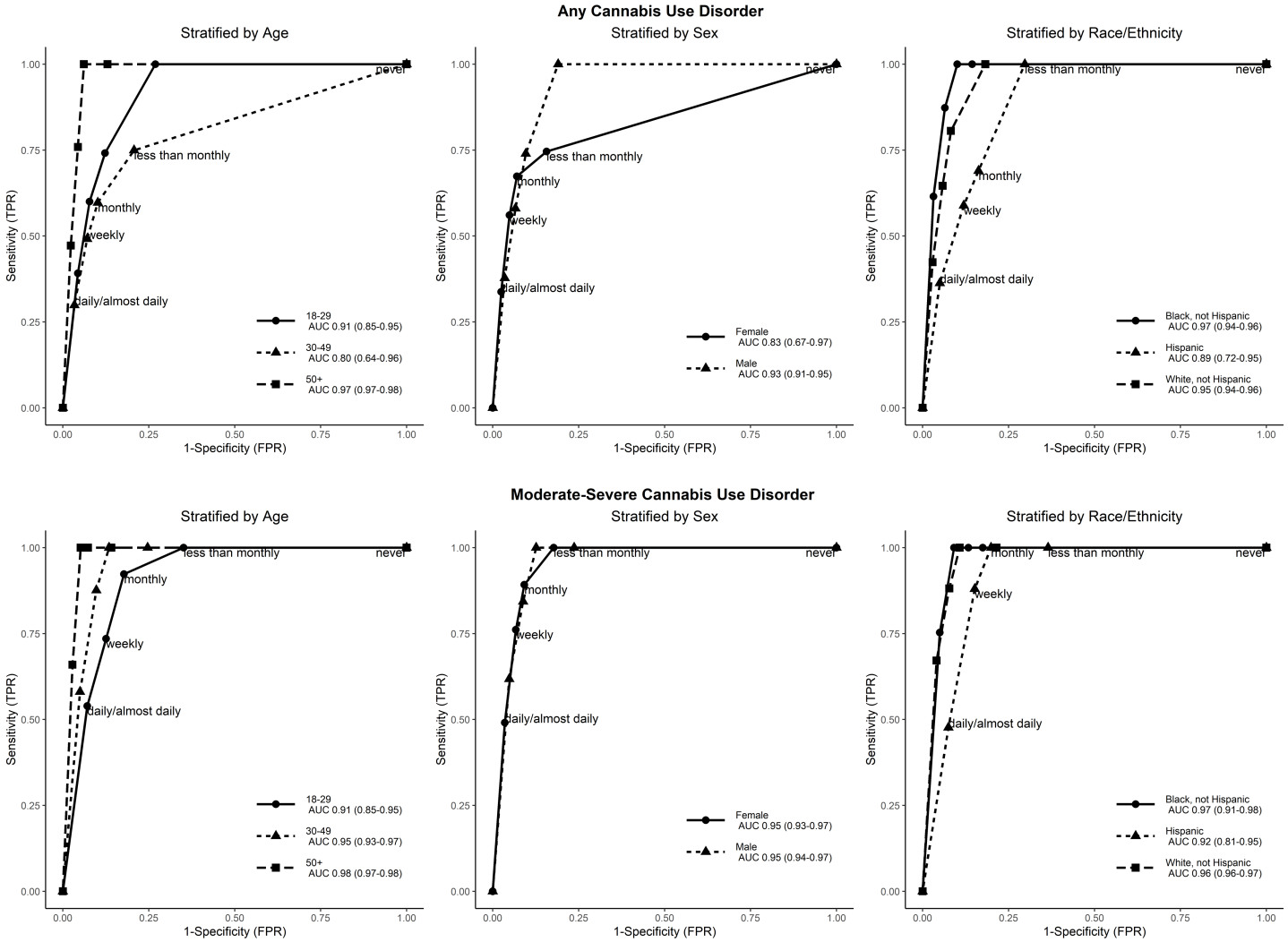
Abbreviations: CUD = cannabis use disorder; Δ = difference; AUC = area under the receiver operating characteristic curve; CI = confidence interval

[a] Endorsed ≥2 criteria on the Composite International Diagnostic Interview (CIDI)

[b] Endorsed ≥4 criteria on the Composite International Diagnostic Interview (CIDI)

[c] A positive difference indicates that the reference group or measure had better performance than the comparator; a negative difference indicates that the comparator group had better performance than the reference group.

[d] 95% CI for the difference in AUC estimates obtained using nonparametric bootstrapping. 95% CIs that do not contain zero indicate a significant between-group difference and denoted with **bold** font.



Appendix Figure 2.1. Receiver Operator Characteristic (ROC) curves for the Single-Item Screen - Cannabis (SIS-C) compared to the reference standard for past-year cannabis use disorder (CUD), stratified by subgroups.

Appendix Figure 2.1 caption: When compared to any CUD (top row), the performance of the SIS-C differed significantly by age (a higher AUC for patients ≥50 compared to patients 30-49 and 18-29) but not by sex or race/ethnicity. When compared to moderate-severe CUD (bottom row), the performance of the SIS-C differed significantly by age and race/ethnicity (a lower AUC for Hispanic patients compared to non-Hispanic White patients), but there was no significant difference by sex.

Chapter 3 Appendix

Over the past 2 weeks, how often have you been bothered by any of the following problems:

1. Little interest or pleasure in doing things?	**Not at all** 0	**Several days** 1	**More than half the days** 2	**Nearly every day** 3
2. Feeling down, depressed, or hopeless?	**Not at all** 0	**Several days** 1	**More than half the days** 2	**Nearly every day** 3

In the past year…

3. How often did you have a drink containing alcohol in the past year?	**Never** 0	**Monthly or less** 1	**2 to 4 times a month** 2	**2 to 3 times a week** 3		**4 or more times a week** 4
4. How many drinks containing alcohol did you have on a typical day when you were drinking in the past year?	**None** 0	**1 or 2 drinks** 0	**3 or 4 drinks** 1	**5 or 6 drinks** 2	**7 to 9 drinks** 3	**10 or more drinks** 4
5. How often did you have 6 or more drinks on one occasion in the past year?	**Never** 0	**Less than monthly** 1	**Monthly** 2	**Weekly** 3		**Daily or almost daily** 4
6. How often in the past year have you used marijuana?	**Never** 0	**Less than monthly** 1	**Monthly** 2	**Weekly** 3		**Daily or almost daily** 4
7. How often in the past year have you used an illegal drug (not marijuana) or used a prescription medication for non-medical reasons?	**Never** 0	**Less than monthly** 1	**Monthly** 2	**Weekly** 3		**Daily or almost daily** 4

Appendix Figure 3.1. Routine behavioral health screen with single items for cannabis and other drugs

Appendix Figure 3.1 Caption: The annual Behavioral Health Questionnaire includes single items for cannabis (#6) and any other drug use (#7). The questionnaire is prefaced with "*Once a year, we ask all our patients to complete this form on conditions that affect their health. Please help us provide you with the best medical care by answering the questions below*."

Substance Use Symptom Checklist

KAISER PERMANENTE

This checklist will help you and your provider understand how using marijuana or other drugs might be affecting your health.

Please think about your life in the 12 months. Then go through the questions below and answer "yes" or "no" for each one.

Patient Label

Name:_____

MRN: _____

Birth Date (MM/DD/YY): _____

In the last 12 months...

1. Did using the same amount of the drug have less effect than it used to? Or did you have to use more to feel the effect you wanted? *Please answer "yes" if either question is true for you.*	No	Yes
2. Did you have withdrawal symptoms when you weren't using the drug? Or did you use the drug to avoid having these symptoms? *Please answer "yes" if either question is true for you.*	No	Yes
3. Did you have times when you used the drug more or for longer than you wanted to?	No	Yes
4. Did you want to cut back or stop using the drug, but couldn't?	No	Yes
5. Did you spend a lot of time trying to get the drug, using the drug, or recovering from using it?	No	Yes
6. Did you continue to use the drug even though you thought it might be causing mental or physical problems–or making them worse?	No	Yes
7. Did using the drug make it harder for you to keep up with your responsibilities at work, school, or home?	No	Yes
8. Did you do something dangerous more than once after using the drug–like drive a car or operate machinery?	No	Yes
9. Did you use the drug even though you thought it might be causing problems with your family or other people?	No	Yes
10. Did you have strong desires or cravings for the drug?	No	Yes
11. Did you spend less time working, enjoying hobbies, or being with others because of your use of the drug?	No	Yes

Which drug(s) did you use in the last year? Please circle all that apply.

- Opiates, including heroin
- Marijuana or cannabis
- Meth or other stimulants
- Cocaine
- Benzodiazepines or other sedatives
- Other: _____

Appendix Figure 3.2. The Substance Use Symptom Checklist ("Symptom Checklist"): a DSM-5 SUD symptom assessment tool

Appendix Figure 3.2 Caption: The Substance Use Symptom Checklist is prefaced with: "*To help you and your provider understand how your marijuana or other drug use might be affecting your health, please complete the following questions."* Even though patients could circle substances that contribute to symptom burden, this information was missing for more than 50% of Symptom Checklists, which is why analyses stratified findings based on responses to cannabis and other drug screens that prompted assessment with the Symptom Checklist.

Abbreviations: DSM-5: Diagnostic and Statistical Manual of Mental Disorders, 5th Edition

Detailed Description of Item Characteristics

Daily cannabis only

All items had high discrimination parameters,[1] ranging from 1.42 (tolerance) to 2.84 (neglect roles), demonstrating a strong association with SUD severity. Severity parameter ranged from 1.19 (physical/psychological problems) to 2.40 (hazardous use). Items with lower severity parameters (e.g., tolerance, physical/psychological problems, craving) discriminated best when latent SUD was mild whereas items with higher severity parameters (e.g., time spent, neglect roles, and hazardous use) discriminated best when latent SUD was severe. See Table 3.3 for item parameters and Figure 3.2 for item characteristic curves among patients who reported daily cannabis use only.

Other drug use only

All items had extremely high discrimination parameters,[1] ranging from 2.79 (tolerance) to 5.72 (time spent) and severity parameters ranging from 0.74 (physical/psychological problems) to 1.37 (hazardous use). One item (physical/psychological problems) discriminated best when latent SUD was mild, and two items discriminated best when latent SUD was severe (time spent, hazardous use) See Table 3.3 for item parameters and Figure 3.2 for item characteristic curves among patients who reported other drug use only.

Daily cannabis and other drug use

All items had high discrimination parameters,[1] ranging from 1.55 (tolerance) to 3.61 (neglect roles) and severity parameters ranging from 0.31 (tolerance) to 1.13 (hazardous use). As with the cannabis-only subsample, some items (tolerance, physical/psychological problems, craving) discriminated best when latent SUD was mild whereas other items discriminated best when latent SUD was severe (withdrawal, time spent, neglect roles, hazardous use, and activities given up). See Table 3.3 for item parameters and Figure 3.2 item characteristic curves among patients who reported both daily cannabis and other drug use.

Detailed Description of Differential Item Functioning (DIF) Analyses

For each subsample (patients who reported daily cannabis only, other drug use only, both daily cannabis and other drug use), we tested for differential item functioning (DIF) by demographic factors and then examined the impact DIF had on the clinical utility of the Substance Use Symptom Checklist, as previously done for psychometric evaluation of an Alcohol Symptom Checklist.[2] Specifically, we tested whether item-level severity and discrimination parameters differed by age, sex, race, and ethnicity using a likelihood ratio test that compared a more complex model where item parameters were estimated separately (i.e., freely estimated) for each demographic subgroup to a simpler model that assumes item parameters are the same for subgroups.[3, 4] In the freely estimated model, discrimination and severity parameters were freely estimated for all items, with the exception of three "anchor" items for which we constrained parameters to be equal across demographic subgroups so that differences in the latent means and variances could be estimated between groups (e.g., male and female patients) without biasing DIF tests.[4, 5] We selected the three most consistently discriminating items[4] across the three subsamples to be anchor items: time spent, neglect roles, and activities given up. The most populous subgroup in each demographic category was selected as the reference group with latent means set at 0 and latent variances set at 1. Latent means and variances were freely estimated in other subgroups. We used an alpha level of 0.05/11 items to account for multiple comparisons. DIF results for each demographic subgroup within each subsample are presented in Appendix Tables 3.1-3.8.

DIF may be present without having clinically meaningful impact on the performance of the Substance Use Symptom Checklist. For example, DIF may be present in opposite directions for different items, effectively canceling out.[3] Additionally, DIF may be present in small amounts but still statistically significant due to a large sample size.[6] Because the total number of symptoms (i.e., DSM-5 criteria) endorsed on the Substance Use Symptom Checklist is used by clinicians to determine the presence and severity of SUD, it is useful to examine the impact of DIF on the total expected number (0-11) of criteria endorsed. Within each subsample, we used the IRT model that freely estimated item parameters to calculate: 1) the maximum difference between subgroups at any point along the severity continuum, and 2) the maximum difference between subgroups at mild (2-3 symptoms), moderate (4-5 symptoms), and severe (≥6 symptoms) thresholds of SUD,[7] which could affect clinical decision-making regarding diagnosis and treatment of SUD. Differences are summarized in the main paper, presented in Table 3.9, and graphically illustrated in Figures 3.3-3.5.

Lastly, we compared freely estimated models with correction for DIF and constrained models without correction for DIF to determine whether any item-level DIF led to meaningful differences. A difference in comparative fit indices (CFI) value >0.01 has been proposed[8] as another method for determining if there is meaningful DIF on the absolute model fit of the factor analysis. Differences in fit indices are presented in Table 3.10.

DIF findings for patients who reported daily cannabis only

Among the subsample who reported daily cannabis uses only, there was significant DIF associated with age (6 items), sex (3 items), and race (2 items), but not Hispanic ethnicity.

By age

Six items (tolerance, withdrawal, physical/psychological problems, hazardous use, social/interpersonal problems, and craving) had significant differential item functioning by age for both the discrimination and severity parameters.

In addition to DIF, there were differences in latent means and variances between some age groups. Patients age 18-24 had, on average, higher SUD severity (latent mean >0) than patients 25-44, whereas patients 45-64 and 65+ had, on average, lower SUD severity (latent mean <0) than patients 25-44. For all age groups, latent SUD was less variable (latent variance <1) than patients age 25-44.

Appendix Table 3.1. Differential item functioning (DIF) by age for primary care patients who reported daily cannabis use only on routine screening March 2015-March 2020 (n=16,140)

		25-44*		18-24		45-64		65+	
DSM-5 Checklist Item		*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*
1)	Tolerance	1.29	1.2	1.33	0.95	1.49	1.34	1.6	1.34
2)	Withdrawal	2.03	1.79	2.16	1.97	2.13	1.71	2.42	1.87
3)	Larger/longer	2.53	1.57	–	–	–	–	–	–
4)	Quit/control	2.32	1.55	–	–	–	–	–	–
5)	Time spent†	2.57	1.99	–	–	–	–	–	–
6)	Physical/psychological problems	2.02	1.21	1.74	1.28	1.93	0.90	1.69	0.85
7)	Neglect roles†	2.81	1.99	–	–	–	–	–	–
8)	Hazardous use	1.52	2.5	1.47	2.39	1.76	2.09	1.6	2.06
9)	Social/interpersonal problems	2.20	1.77	1.75	1.66	2.19	1.49	2.20	1.40
10)	Craving	1.95	1.21	1.94	1.18	2.18	1.30	2.80	1.25
11)	Activities given up†	2.56	1.81	–	–	–	–	–	–
Full Test Parameters									
	Latent mean	0.00		0.38		-0.27		-0.43	
	Latent variance	1.00		0.93		0.92		0.90	

Note. * = reference group, † = anchor item, *a* = discrimination parameter estimate, *b* = severity parameter estimate. Item parameters that significantly differed from the reference group are presented in the table; item parameters that did not significantly differ from the reference group or that were fixed as anchoring items are indicated with dashes (–). Latent means and variances were fixed to 0 and 1, respectively, for the reference group and were freely estimated for non-reference groups.

By sex

Three items (larger/longer, hazardous use, craving) had significant differential item functioning by sex for both discrimination and severity parameters.

In addition to DIF, female patients had lower and more variable SUD severity (latent mean <0 and latent variance >1), on average, than male patients.

Appendix Table 3.2. Differential item functioning (DIF) by sex for primary care patients who reported daily cannabis use only on routine screening March 2015-March 2020 (n=16,140)

	Male*		Female	
DSM-5 Checklist Item	*a*	*b*	*a*	*b*
1) Tolerance	1.39	1.11	–	–
2) Withdrawal	2.04	1.77	–	–
3) Larger/longer	2.48	1.57	2.65	1.40
4) Quit/control	2.31	1.48	–	–
5) Time spent†	2.51	1.94	–	–
6) Physical/psychological problems	1.77	1.08	–	–
7) Neglect roles†	2.78	1.93	–	–
8) Hazardous use	1.44	2.24	1.67	2.45
9) Social/interpersonal problems	2.00	1.61	–	–
10) Craving	2.04	1.21	2.08	1.07
11) Activities given up†	2.60	1.73	–	–
Full Test Parameters				
Latent mean	0.00		0.28	
Latent variance	1.00		1.07	

Note. * = reference group, † = anchor item, *a* = discrimination parameter estimate, *b* = severity parameter estimate. Item parameters that significantly differed from the reference group are presented in the table; item parameters that did not significantly differ from the reference group or that were fixed as anchoring items are indicated with dashes (–). Latent means and variances were fixed to 0 and 1, respectively, for the reference group and were freely estimated for non-reference groups.

By race

One item (quit/control) had significant DIF by race for the discrimination parameter and two items (tolerance, quit/control) had significant DIF for the severity parameter. Analyses may have been underpowered to detect DIF given small numbers for some races (see Table 3.1).
In addition to DIF, American Indian/Alaska Native, Asian, Black/African American, and Native Hawaiian/Pacific Islander patients had, on average, higher and less variable SUD severity (latent mean >0; latent variance <1) than White patients.

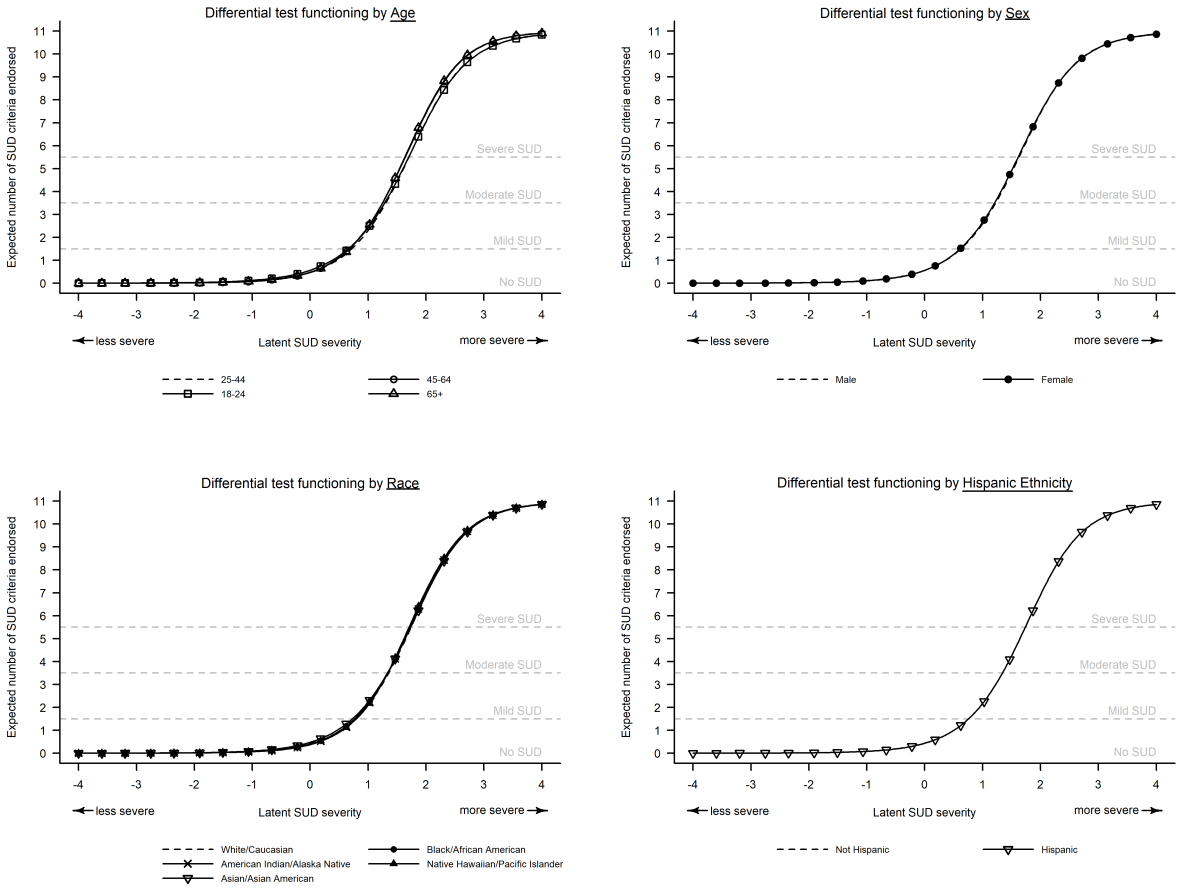
Appendix Table 3.3. Differential item functioning (DIF) by race for primary care patients who reported daily cannabis use only on routine screening March 2015-March 2020 (n=16,140)

		White *		American Indian / Alaska Native		Asian/Asian American		Black / African American		Hawaiian / Pacific Islander	
DSM-5 Checklist Item		*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*
1)	Tolerance	1.45	1.22	–	1.49	–	1.00	–	1.43	–	1.27
2)	Withdrawal	2.13	1.89	–	–	–	–	–	–	–	–
3)	Larger/longer	2.58	1.65	–	–	–	–	–	–	–	–
4)	Quit/control	2.44	1.63	2.86	1.36	2.00	1.67	2.33	1.38	3.90	1.42
5)	Time spent†	2.59	2.05	–	–	–	–	–	–	–	–
6)	Physical/psychological problems	1.83	1.20	–	–	–	–	–	–	–	–
7)	Neglect roles†	3.00	2.02	–	–	–	–	–	–	–	–
8)	Hazardous use	1.60	2.41	–	–	–	–	–	–	–	–
9)	Social/interpersonal problems	2.11	1.72	–	–	–	–	–	–	–	–
10)	Craving	2.12	1.29	–	–	–	–	–	–	–	–
11)	Activities given up†	2.69	1.84	–	–	–	–	–	–	–	–
Full Test Parameters											
	Latent mean	0.00		0.17		0.33		0.26		0.11	
	Latent variance	1.00		0.77		0.95		0.78		0.79	

Note. * = reference group, † = anchor item, *a* = discrimination parameter estimate, *b* = severity parameter estimate. Item parameters that significantly differed from the reference group are presented in the table; item parameters that did not significantly differ from the reference group or that were fixed as anchoring items are indicated with dashes (–). Latent means and variances were fixed to 0 and 1, respectively, for the reference group and were freely estimated for non-reference groups.

By ethnicity

There was no DIF by ethnicity although analyses may have been underpowered due to small numbers of some subgroups to detect any differences.



Appendix Figure 3.3. Cumulative impact of differential item functioning (DIF) across age, sex, race, and ethnicity for primary care patients who reported daily cannabis use only on routine screening March 2015-March 2020 (n=16,140)

Appendix Figure 3.3 Caption: Using freely estimated models that corrected for DIF, the total expected number of SUD criteria endorsed on the Substance Use Symptom Checklist (y-axis) was plotted as a function of latent SUD severity (x-axis) for each subgroup. The vertical distances between curves represent the difference in total expected scores between subgroups with the same latent SUD severity. This difference was small, as indicated by test characteristic curves that nearly overlap, and never diverged more than half of one criterion indicating that DIF had minimal cumulative impact.

DIF findings for patients who reported other drug use only

Among the subsample who reported other drug use only, there was significant DIF associated with age (2 items), sex (1 item), and ethnicity (1 items), but not race.

By age

Two items (tolerance and quit/control) had significant DIF by age for both discrimination and severity parameters.

In addition to DIF, patients 18-24 and 45-64 had higher SUD severity (latent mean >0) but severity was less variable (latent variance <1) than patients 25-44. Patients 65 and over had lower (latent mean <0) and less variable (latent variance <1) SUD severity.

Appendix Table 3.4. Differential item functioning (DIF) by age for primary care patients who reported other drug use only on routine screening March 2015-March 2020 (n=4,791)

	25-44*		18-24		45-64		65+	
DSM-5 Checklist Item	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*
1) Tolerance	3.1	1.03	3.21	0.85	3.12	1.01	5.37	0.79
2) Withdrawal	5.25	1.02	–	–	–	–	–	–
3) Larger/longer	4.97	0.85	–	–	–	–	–	–
4) Quit/control	4.13	0.99	5.55	1.06	4.47	0.88	7.89	0.74
5) Time spent†	6.36	1.08	–	–	–	–	–	–
6) Physical/psychological problems	3.86	0.74	–	–	–	–	–	–
7) Neglect roles†	5.19	1.05	–	–	–	–	–	–
8) Hazardous use	3.35	1.3	–	–	–	–	–	–
9) Social/interpersonal problems	4.92	0.84	–	–	–	–	–	–
10) Craving	5.02	0.85	–	–	–	–	–	–
11) Activities given up†	5.75	1.04	–	–	–	–	–	–
Full Test Parameters								
Latent mean	0.00		0.24		0.05		-0.14	
Latent variance	1.00		0.57		0.77		0.44	

Note. * = reference group, † = anchor item, *a* = discrimination parameter estimate, *b* = severity parameter estimate. Item parameters that significantly differed from the reference group are presented in the table; item parameters that did not significantly differ from the reference group or that were fixed as anchoring items are indicated with dashes (–). Latent means and variances were fixed to 0 and 1, respectively, for the reference group and were freely estimated for non-reference groups.

By sex

One item (hazardous use) had significant DIF by sex for both discrimination and severity parameters.

In addition to DIF, female patients had slightly lower (latent mean <0) and more variable SUD severity (latent variance >1) than male patients.

Appendix Table 3.5. Differential item functioning (DIF) by sex for primary care patients who reported other drug use only on routine screening March 2015-March 2020 (n=4,791)

	Male*		Female	
DSM-5 Checklist Item	*a*	*b*	*a*	*b*
1) Tolerance	2.64	0.98	–	–
2) Withdrawal	4.48	1.04	–	–
3) Larger/longer	4.22	0.85	–	–
4) Quit/control	3.81	1	–	–
5) Time spent†	5.42	1.11	–	–
6) Physical/psychological problems	3.28	0.71	–	–
7) Neglect roles†	4.42	1.08	–	–
8) Hazardous use	2.78	1.3	3.11	1.45
9) Social/interpersonal problems	4.18	0.83	–	–
10) Craving	4.26	0.84	–	–
11) Activities given up†	4.87	1.06	–	–
Full Test Parameters				
Latent mean	0.00		0.19	
Latent variance	1.00		1.29	

Note. * = reference group, † = anchor item, *a* = discrimination parameter estimate, *b* = severity parameter estimate. Item parameters that significantly differed from the reference group are presented in the table; item parameters that did not significantly differ from the reference group or that were fixed as anchoring items are indicated with dashes (–). Latent means and variances were fixed to 0 and 1, respectively, for the reference group and were freely estimated for non-reference groups.

By race

There was no DIF by race although analyses may have been underpowered to detect any differences due to small numbers of some subgroups.

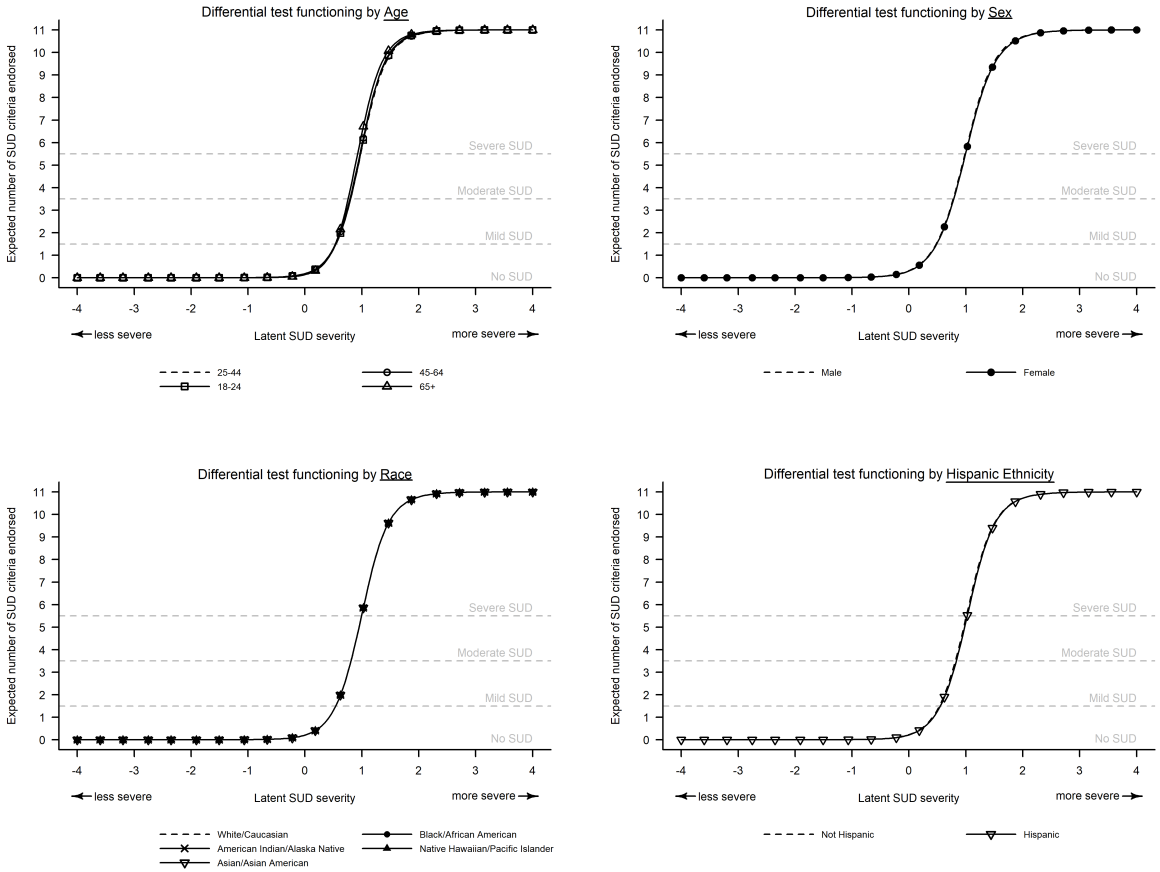
By ethnicity

One item (craving) had significant DIF by Hispanic ethnicity for the severity parameter. In addition to DIF, Hispanic patients had, on average, higher (latent mean >0) and less variable (latent variance <1) SUD severity than not Hispanic patients.

Appendix Table 3.6. Differential item functioning (DIF) by ethnicity for primary care patients who reported other drug use only on routine screening March 2015-March 2020 (n=4,791)

	Not Hispanic*		Hispanic	
DSM-5 Checklist Item	*a*	*b*	*a*	*b*
1) Tolerance	2.83	1.01	–	–
2) Withdrawal	4.76	1.05	–	–
3) Larger/longer	4.51	0.88	–	–
4) Quit/control	4.03	1.02	–	–
5) Time spent†	5.78	1.13	–	–
6) Physical/psychological problems	3.52	0.75	–	–
7) Neglect roles†	4.79	1.09	–	–
8) Hazardous use	3.07	1.37	–	–
9) Social/interpersonal problems	4.49	0.86	–	–
10) Craving	4.53	0.86	–	1.02
11) Activities given up†	5.21	1.08	–	–
Full Test Parameters				
Latent mean	0.00		0.11	
Latent variance	1.00		0.74	

Note. * = reference group, † = anchor item, *a* = discrimination parameter estimate, *b* = severity parameter estimate. Item parameters that significantly differed from the reference group are presented in the table; item parameters that did not significantly differ from the reference group or that were fixed as anchoring items are indicated with dashes (–). Latent means and variances were fixed to 0 and 1, respectively, for the reference group and were freely estimated for non-reference groups.



Appendix Figure 3.4. Cumulative impact of differential item functioning (DIF) across age, sex, race, and ethnicity for primary care patients who reported other drug use only on routine screening March 2015-March 2020 (n=4,791)

Appendix Figure 3.4 Caption: Using freely estimated models that corrected for DIF, the total expected number of SUD criteria endorsed on the Substance Use Symptom Checklist (y-axis) was plotted as a function of latent SUD severity (x-axis) for each subgroup. The vertical distances between curves represent the difference in total expected scores between subgroups with the same latent SUD severity. This difference was small, as indicated by test characteristic curves that nearly overlap, and never diverged more than two thirds of one criterion, indicating that DIF had minimal cumulative impact.

DIF findings for patients who reported both daily cannabis and other drug use
Among the subsample of patients who reported both daily cannabis use and other drug use, there was significant DIF associated with age (1 item) and sex (1 item), but not race or ethnicity.

By age
One item (tolerance) had DIF by age for the discrimination parameter, and three items (tolerance, quit/control, craving) had DIF by age for the severity parameter.

In addition to DIF, patients 18-24 had, on average, higher SUD severity (latent mean >0) and less variable (latent variance <1) than patients 25-44 while patients 45-64 and 65+ had, on average, lower SUD severity (latent mean <0) than patients 25-44. Patients 45-64 had more variable SUD severity (latent mean>1) while patients 65+ had less variable SUD severity (latent mean<1) than patients 25-44.

Appendix Table 3.7. Differential item functioning (DIF) by age for primary care patients who reported both daily cannabis use and other drug use on routine screening March 2015-March 2020 (n=2,373)

	25-44*		18-24		45-64		65+	
DSM-5 Checklist Item	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*
1) Tolerance	1.46	0.5	1.74	0.21	1.61	0.96	1.92	0.69
2) Withdrawal	2.66	1.07	–	–	–	–	–	–
3) Larger/longer	3.09	0.83	–	–	–	–	–	–
4) Quit/control	2.87	0.9	–	1.04	–	0.7	–	0.96
5) Time spent†	3.14	1.05	–	–	–	–	–	–
6) Physical/psychological problems	2.48	0.49	–	–	–	–	–	–
7) Neglect roles†	3.72	1.07	–	–	–	–	–	–
8) Hazardous use	1.79	1.24	–	–	–	–	–	–
9) Social/interpersonal problems	2.85	0.81	–	–	–	–	–	–
10) Craving	2.37	0.49	–	0.5	–	0.65	–	1.3
11) Activities given up†	3.16	1.03	–	–	–	–	–	–
Full Test Parameters								
Latent mean	0.00		0.40		-0.02		-0.07	
Latent variance	1.00		0.76		1.23		0.34	

Note. * = reference group, † = anchor item, *a* = discrimination parameter estimate, *b* = severity parameter estimate. Item parameters that significantly differed from the reference group are presented in the table; item parameters that did not significantly differ from the reference group or that were fixed as anchoring items are indicated with dashes (–). Latent means and variances were fixed to 0 and 1, respectively, for the reference group and were freely estimated for non-reference groups.

By sex

One item (hazardous use) had significant DIF by sex for the severity parameter.

In addition to DIF, female patients had, on average, lower and more variable SUD severity (latent mean <0; latent variance >1) than male patients.

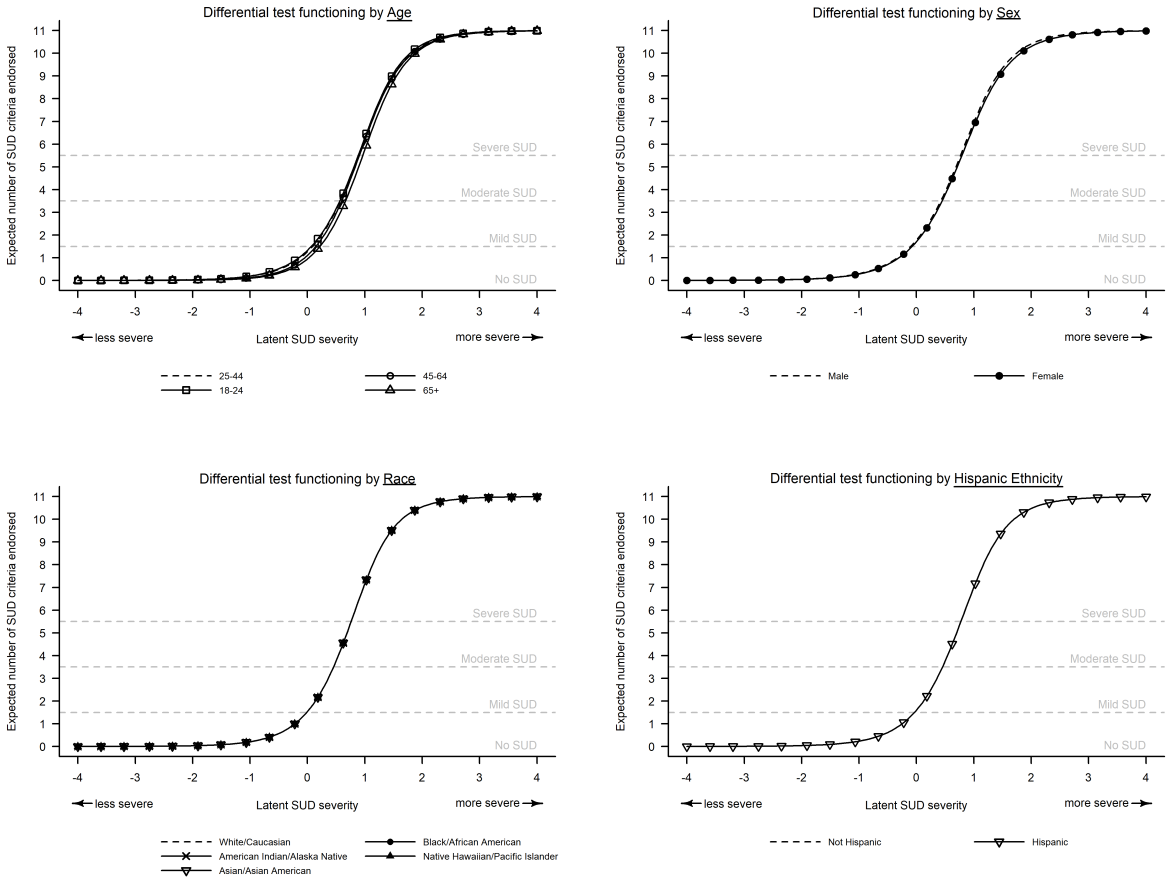
Appendix Table 3.8. Differential item functioning (DIF) by sex for primary care patients who reported both daily cannabis use and other drug use on routine screening March 2015-March 2020 (n=2,373)

	Male*		Female	
DSM-5 Checklist Item	*a*	*b*	*a*	*b*
1) Tolerance	1.46	0.28	–	–
2) Withdrawal	2.44	0.98	–	–
3) Larger/longer	2.85	0.71	–	–
4) Quit/control	2.55	0.83	–	–
5) Time spent†	2.87	0.95	–	–
6) Physical/psychological problems	2.27	0.34	–	–
7) Neglect roles†	3.42	0.98	–	–
8) Hazardous use	1.68	1.01	–	1.42
9) Social/interpersonal problems	2.62	0.68	–	–
10) Craving	2.19	0.38	–	–
11) Activities given up†	2.91	0.93	–	–
Full Test Parameters				
Latent mean	0.00		0.13	
Latent variance	1.00		1.35	

Note. * = reference group, † = anchor item, *a* = discrimination parameter estimate, *b* = severity parameter estimate. Item parameters that significantly differed from the reference group are presented in the table; item parameters that did not significantly differ from the reference group or that were fixed as anchoring items are indicated with dashes (–). Latent means and variances were fixed to 0 and 1, respectively, for the reference group and were freely estimated for non-reference groups.

By race and ethnicity

There was no significant DIF by race or ethnicity. Findings may have been underpowered to detect differences due to small numbers in some demographic subgroups.



Appendix Figure 3.5. Cumulative impact of differential item functioning (DIF) across age, sex, race, and ethnicity for primary care patients who reported both daily cannabis use and other drug use on routine screening March 2015-March 2020 (n=2,373)

Appendix Figure 3.5 Caption: Using freely estimated models that corrected for DIF, the total expected number of SUD criteria endorsed on the Substance Use Symptom Checklist (y-axis) was plotted as a function of latent SUD severity (x-axis) for each subgroup. The vertical distances between curves represents the difference in total expected scores between subgroups with the same latent SUD severity. This difference was small, as indicated by test characteristic curves that nearly overlap, and never diverged more than two thirds of one criterion, indicating that DIF had minimal cumulative impact.

Detailed description of the clinical impact DIF has on estimated SUD severity

Daily cannabis use only

For patients who reported daily cannabis use only, the clinical impact of DIF was minimal in all cases. Differences in expected DSM-5 criteria counts for persons from different demographic subgroups with the same latent SUD severity were small and never diverged more than half of one criterion (Appendix Figure 3.3), suggesting that differential item functioning had minimal cumulative impact on total criterion counts. When SUD severity was held constant, differential item functioning was expected to produce differences in SUD criteria that never exceeded 0.42 criteria (out of 11 possible) for age (patients 65+ reporting more criteria), 0.09 for sex (female patients reporting more criteria) 0.20 criteria for race (NH/PI patients reporting more criteria). These maximum differences tended to occur at high levels of latent SUD severity (e.g., more than 6 criteria). At clinical decision-making thresholds for mild, moderate, and severe SUD, differential item functioning was expected to produce even smaller differences (Appendix Table 3.9). Further, comparing models with versus without correction for DIF did not improve model fit (ΔCFI<0.01; Appendix Table 3.10). In other words, the gain in model fit by allowing parameters to be freely estimated for each demographic subgroup (versus constrained to be equal across demographic subgroups), was very small.

Other drug use only

For patients who reported other drug use only, the clinical impact of DIF was also minimal. Differences in expected DSM-5 criteria counts for persons from different demographic subgroups with the same latent SUD severity never diverged by more than two thirds of one criterion (Appendix Figure 3.4). When SUD severity was held constant, differential item functioning was expected to produce differences in SUD criteria that never exceeded 0.66 criteria (out of 11 possible) for age (patients 65+ reporting more criteria), 0.11 for sex (female patients reporting fewer criteria) 0.17 for ethnicity (Hispanic patients reporting fewer criteria). At clinical decision-making thresholds for mild, moderate, and severe SUD, the largest differences were expected at the severe threshold (Appendix Table 3.9). Comparing models with versus without correction for DIF did not improve model fit (ΔCFI<0.01; Appendix Table 3.10).

Both daily Cannabis and other drug use

For patients who reported both daily cannabis and other drug use, the clinical impact of DIF was again minimal. Differences in expected DSM-5 criteria counts for persons from different demographic subgroups with the same latent SUD severity never diverged by more than two thirds of one criterion (Appendix Figure 3.5). When SUD severity was held constant, differential item functioning was expected to produce differences in SUD criteria that never exceeded 0.57 criteria (out of 11 possible) for age (patients 65+ reporting fewer criteria) and 0.17 for sex (female patients reporting fewer criteria). At clinical decision-making thresholds for mild, moderate, and severe SUD, differential item functioning was expected to produce even smaller differences (Appendix Table 3.9). As with the prior two subsamples, comparing models with versus without correction for DIF did not improve model fit (ΔCFI<0.01; Appendix Table 3.10).

Appendix Table 3.9. Differences in expected DSM-5 criteria count at clinical decision-making thresholds for mild, moderate, and severe SUD among primary care patients who reported daily cannabis only, other drug use only, and both daily cannabis and other drug use on routine screening March 2015-March 2020

	Daily Cannabis Only (n=16,140)			Other Drug Use Only (n=4,791)			Both Daily Cannabis and Other Drug Use (n=2,373)		
	Mild	Moderate	Severe	Mild	Moderate	Severe	Mild	Moderate	Severe
Age									
18-24 vs. 25-44	0.13	0.09	0.03	0.01	0.01	0.04	0.06	0.04	0.02
18-24 vs. 45-64	0.03	-0.18	-0.32	-0.05	-0.11	-0.1	0.23	0.19	0.13
18-24 vs. 65+	0.05	-0.19	-0.36	-0.08	-0.48	-0.62	0.41	0.56	0.55
25-44 vs. 18-24	-0.13	-0.09	-0.03	-0.01	-0.01	-0.04	-0.06	-0.04	-0.02
25-44 vs. 45-64	-0.11	-0.27	-0.35	-0.06	-0.12	-0.15	0.17	0.14	0.11
25-44 vs. 65+	-0.09	-0.28	-0.39	-0.09	-0.49	-0.66	0.35	0.51	0.53
45-64 vs. 18-24	-0.03	0.18	0.32	0.05	0.11	0.1	-0.23	-0.19	-0.13
45-64 vs. 25-44	0.11	0.27	0.35	0.06	0.12	0.15	-0.17	-0.14	-0.11
45-64 vs. 65+	0.02	-0.01	-0.04	-0.03	-0.37	-0.52	0.18	0.37	0.42
65+ vs. 18-24	-0.05	0.19	0.36	0.08	0.48	0.62	-0.41	-0.56	-0.55
65+ vs. 25-44	0.09	0.28	0.39	0.09	0.49	0.66	-0.35	-0.51	-0.53
65+ vs. 45-64	-0.02	0.01	0.04	0.03	0.37	0.52	-0.18	-0.37	-0.42
Sex									
Female vs. Male	0.03	0.08	0.08	-0.04	-0.08	-0.1	-0.06	-0.12	-0.15
Male vs. Female	-0.03	-0.08	-0.08	0.04	0.08	0.1	0.06	0.12	0.15
Race									
AI/AN vs. Asian	-0.14	-0.02	0.06	–	–	–	–	–	–
AI/AN vs. Black	-0.05	-0.01	0.03	–	–	–	–	–	–
AI/AN vs. NH/PI	0.02	-0.02	0.1	–	–	–	–	–	–
AI/AN vs. White	-0.03	0.07	0.09	–	–	–	–	–	–
Asian vs. AI/AN	0.14	0.02	-0.06	–	–	–	–	–	–
Asian vs. Black	0.09	0.02	-0.03	–	–	–	–	–	–
Asian vs. NH/PI	0.16	0.01	-0.16	–	–	–	–	–	–
Asian vs. White	0.11	0.09	0.04	–	–	–	–	–	–
Black vs. AI/AN	0.05	0.01	-0.03	–	–	–	–	–	–
Black vs. Asian	-0.09	-0.02	0.03	–	–	–	–	–	–
Black vs. NH/PI	0.07	-0.01	-0.13	–	–	–	–	–	–
Black vs. White	0.02	0.07	0.06	–	–	–	–	–	–
NH/PI vs. AI/AN	-0.02	0.02	-0.1	–	–	–	–	–	–
NH/PI vs. Asian	-0.16	-0.01	0.16	–	–	–	–	–	–
NH/PI vs. Black	-0.07	0.01	0.13	–	–	–	–	–	–
NH/PI vs. White	-0.05	0.08	0.2	–	–	–	–	–	–
White vs. AI/AN	0.03	-0.07	-0.09	–	–	–	–	–	–
White vs. Asian	-0.11	-0.09	-0.04	–	–	–	–	–	–
White vs. Black	-0.02	-0.07	-0.06	–	–	–	–	–	–
White vs. NH/PI	0.05	-0.08	-0.2	–	–	–	–	–	–
Ethnicity									
Hispanic vs. Not Hispanic	–	–	–	-0.08	-0.16	-0.17	–	–	–

Not Hispanic vs. Hispanic	–	–	–	0.08	0.16	0.17	–	–	–

Abbreviations: DSM-5=Diagnostic and Statistical Manual of Mental Disorders, 5th Edition; SUD=Substance Use Disorder; AI/AN=American Indian/Alaska Native; NH/PI=Native Hawaiian/Pacific Islander

Note. Subgroups that had no significant DIF have no expected differences in criteria count, indicated with dashes (–). A negative estimate suggests fewer expected criteria endorsed relative to the comparator group while a positive estimate suggests more expected criteria endorsed relative to the comparator group at the same level of latent SUD severity.

Appendix Table 3.10. Comparison of models with and without correction for differential item functioning (DIF)

	Constrained model[a] (No correction for DIF)	Freely-estimated model[b] (Correction for DIF)	
	CFI	CFI	ΔCFI[c]
Daily cannabis use only			
Age	0.978	0.986	0.008
Sex	0.987	0.988	0.002
Race	0.989	0.989	0.001
Ethnicity[d]	0.988	0.988	0.000
Other drug use only			
Age	0.997	0.998	0.001
Sex	0.998	0.998	0.000
Race[d]	0.998	0.998	0.000
Ethnicity	0.998	0.998	0.000
Both daily cannabis and other drug use			
Age	0.990	0.994	0.004
Sex	0.994	0.995	0.001
Race[d]	0.995	0.995	0.000
Ethnicity[d]	0.994	0.994	0.000

Abbreviation: CFI = comparative fit index; DIF=differential item functioning; Δ=difference

[a] IRT model parameters are constrained to be the same for demographic subgroups

[b] IRT model parameters are freely estimated for demographic subgroups

[c] If the difference in comparative fit indices (CFI) is <0.01, it suggests that DIF did not have a meaningful impact on absolute model fit.

[d] DIF was not detected for this subgroup

References for Chapter 3 Appendix

1. Baker FB. *The Basics of Item Response Theory*. ERIC Clearinghouse on Assessment and Evaluation; 2001.

2. Hallgren KA, Matson TE, Oliver M, et al. Practical Assessment of Alcohol Use Disorder in Routine Primary Care: Performance of an Alcohol Symptom Checklist. *J Gen Intern Med*. Aug 16 2021;doi:10.1007/s11606-021-07038-3

3. Chalmers RP, Counsell A, Flora DB. It Might Not Make a Big DIF: Improved Differential Test Functioning Statistics That Account for Sampling Variability. *Educ Psychol Meas*. Feb 2016;76(1):114-140. doi:10.1177/0013164415584576

4. Lopez Rivas GE, Stark S, Chernyshenko OS. The Effects of Referent Item Parameters on Differential Item Functioning Detection Using the Free Baseline Likelihood Ratio Test. *Applied Psychological Measurement*. 2009/06/01 2008;33(4):251-265. doi:10.1177/0146621608321760

5. Kopf J, Zeileis A, Strobl C. Anchor Selection Strategies for DIF Analysis: Review, Assessment, and New Approaches. *Educ Psychol Meas*. Feb 2015;75(1):22-56. doi:10.1177/0013164414529792

6. Putnick DL, Bornstein MH. Measurement Invariance Conventions and Reporting: The State of the Art and Future Directions for Psychological Research. *Dev Rev*. Sep 2016;41:71-90. doi:10.1016/j.dr.2016.06.004

7. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders (5th ed.)*. 2013.

8. Cheung GW, Rensvold RB. Evaluating Goodness-of-Fit Indexes for Testing Measurement Invariance. *Structural Equation Modeling: A Multidisciplinary Journal*. 2002/04/01 2002;9(2):233-255. doi:10.1207/S15328007SEM0902_5

Substance Use Symptom Checklist

KAISER PERMANENTE

This checklist will help you and your provider understand how using marijuana or other drugs might be affecting your health.

Please think about your life in the 12 months. Then go through the questions below and answer "yes" or "no" for each one.

Patient Label

Name:_____

MRN: _____

Birth Date (MM/DD/YY): _____

In the last 12 months...

1. Did using the same amount of the drug have less effect than it used to? Or did you have to use more to feel the effect you wanted? *Please answer "yes" if either question is true for you.*	No	Yes
2. Did you have withdrawal symptoms when you weren't using the drug? Or did you use the drug to avoid having these symptoms? *Please answer "yes" if either question is true for you.*	No	Yes
3. Did you have times when you used the drug more or for longer than you wanted to?	No	Yes
4. Did you want to cut back or stop using the drug, but couldn't?	No	Yes
5. Did you spend a lot of time trying to get the drug, using the drug, or recovering from using it?	No	Yes
6. Did you continue to use the drug even though you thought it might be causing mental or physical problems–or making them worse?	No	Yes
7. Did using the drug make it harder for you to keep up with your responsibilities at work, school, or home?	No	Yes
8. Did you do something dangerous more than once after using the drug–like drive a car or operate machinery?	No	Yes
9. Did you use the drug even though you thought it might be causing problems with your family or other people?	No	Yes
10. Did you have strong desires or cravings for the drug?	No	Yes
11. Did you spend less time working, enjoying hobbies, or being with others because of your use of the drug?	No	Yes

Which drug(s) did you use in the last year? Please circle all that apply.

- Opiates, including heroin
- Marijuana or cannabis
- Meth or other stimulants
- Cocaine
- Benzodiazepines or other sedatives
- Other: _____

Appendix Figure 4.1. DSM-5 Substance Use Symptom Checklist ("Symptom Checklist")

Appendix Figure 4.1 Caption: The Symptom Checklist is a standardized follow-up assessment administered as part of routine care for patients with positive cannabis and other drug screens. A positive cannabis screen is report of daily or more frequent cannabis use; a positive drug screen is report of any other drug use. Although patients have the option of circling, on the Symptom Checklist, the substance(s) contributing to symptoms, this information is missing for more than 50% of Symptom Checklists. Therefore, report of daily cannabis use only or daily cannabis use and other drug use on screens were used to determine whether symptoms were indicative of a potential cannabis use disorder.

Appendix Table 4.1. Prevalence of clinician-documented CUD diagnosis and CUD treatment during follow-up, across levels of patient-reported Substance Use Symptom Checklist severity documented in the electronic health record, and stratified by report of daily cannabis use only or both daily cannabis and other drug use on screening

	Daily Cannabis Only (N=12,568)								**Daily Cannabis and Other Drug Use (N=1,379)**							
	Substance Use Symptom Checklist Severity Level								**Substance Use Symptom Checklist Severity Level**							
	None (n=9,406)		Mild (n=1,815)		Moderate (n=674)		Severe (n=464)		None (n=646)		Mild (n=271)		Moderate (n=151)		Severe (n=254)	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Cannabis use disorder diagnosis	315	(3.3)	188	(10.2)	117	(17.2)	116	(24.6)	32	(4.7)	25	(9.0)	28	(18.2)	61	(22.8)
CUD treatment initiation	29	(0.3)	19	(1.0)	22	(3.2)	29	(6.2)	4	(0.6)	1	(0.4)	3	(2.0)	18	(6.7)
CUD treatment engagement	1	(0.0)	3	(0.2)	5	(0.7)	9	(1.9)	2	(0.3)	0	(0.0)	1	(0.7)	6	(2.3)
6-month CUD treatment initiation[b]	95	(1.0)	68	(3.7)	57	(8.4)	61	(13.0)	10	(1.5)	6	(2.2)	11	(7.1)	38	(14.2)

Abbreviations: CUD=Cannabis use disorder

[b] A broader measure of treatment initiation, defined as having a CUD diagnosis and at least one CUD encounter within 6 months after completing the Symptom Checklist.

Adjusted Main Findings

Appendix Table 4.2. Adjusted association between Substance Use Symptom Checklist measures and subsequent CUD diagnosis and initiation and engagement in CUD treatment

	Daily Cannabis Only				Daily Cannabis and Other Drug Use			
	%[a]	OR[b]	(95% CI)	p-value	%[a]	OR[b]	(95% CI)	p-value
CUD diagnosis, among all patients								
Adjusted for sociodemographic characteristics								
Continuous Symptom Checklist[c]	-	1.36	(1.31-1.41)	**<0.001**	-	1.23	(1.18-1.27)	**<0.001**
Categorical Symptom Checklist[d]								
0-1 criteria (none)	3.4	ref	-	-	4.8	ref	-	-
2-3 criteria (mild)	9.7	3.10	(2.48-3.87)	**<0.001**	9.5	2.12	(0.99-4.51)	0.052
4-5 criteria (moderate)	16	5.55	(4.18-7.35)	**<0.001**	17.8	4.40	(2.77-6.97)	**<0.001**
6+ criteria (severe)	22.3	8.36	(5.76-12.14)	**<0.001**	23.8	6.36	(4.08-9.93)	**<0.001**
Binary Symptom Checklist[e]								
0-1 criteria (none)	3.4	ref	-	-	4.8	ref	-	-
2+ criteria (CUD)	13.0	4.33	(3.40-5.51)	**<0.001**	16.8	4.06	(2.64-6.23)	**<0.001**
Adjusted for sociodemographic characteristics, need and enabling factors								
Continuous Symptom Checklist[c]	-	1.34	(1.29-1.40)	**<0.001**	-	1.23	(1.18-1.28)	**<0.001**
Categorical Symptom Checklist[d]								
0-1 criteria (none)	3.5	ref	-	-	5.3	ref	-	-
2-3 criteria (mild)	9.9	3.07	(2.44-3.85)	**<0.001**	9.0	1.76	(0.79-3.93)	0.164
4-5 criteria (moderate)	16.6	5.63	(4.28-7.41)	**<0.001**	18.6	4.15	(2.56-6.74)	**<0.001**
6+ criteria (severe)	20.9	7.51	(5.25-10.73)	**<0.001**	25.2	6.18	(3.88-9.84)	**<0.001**
Binary Symptom Checklist[e]								
0-1 criteria (none)	3.5	ref	-	-	5.4	ref	-	-
2+ criteria (CUD)	13.1	4.24	(3.35-5.36)	**<0.001**	17.1	3.69	(2.39-5.69)	**<0.001**
CUD treatment initiation, among patients with diagnosis								
Adjusted for sociodemographic characteristics								
Continuous Symptom Checklist[c]	-	1.19	(1.11-1.28)	**<0.001**	-	1.20	(1.09-1.32)	**<0.001**
Categorical Symptom Checklist[d]								
0-1 criteria (none)	8.5	ref	-	-	16.8	ref	-	-
2-3 criteria (mild)	11.0	1.32	(0.75-2.33)	0.335	5.7	0.28	(0.03-2.41)	0.248
4-5 criteria (moderate)	18.3	2.43	(1.40-4.21)	**0.002**	10.8	0.58	(0.20-1.70)	0.319
6+ criteria (severe)	27.4	4.16	(2.33-7.41)	**<0.001**	29.1	2.16	(1.00-4.66)	**0.050**
Binary Symptom Checklist[e]								
0-1 criteria (none)	8.7	ref	-	-	16.6	ref	-	-
2+ criteria (CUD)	17.3	2.22	(1.46-3.37)	**<0.001**	20.3	1.31	(0.61-2.82)	0.497
Adjusted for sociodemographic characteristics, need and enabling factors								
Continuous Symptom Checklist[c]	-	1.20	(1.11-1.40)	**<0.001**	-	1.18	(1.08-1.30)	**<0.001**
Categorical Symptom Checklist[d]								
0-1 criteria (none)	8.2	ref	-	-	19.0	ref	-	-
2-3 criteria (mild)	10.6	1.34	(0.66-2.70)	0.414	5.9	0.25	(0.02-2.94)	0.268
4-5 criteria (moderate)	17.1	2.37	(1.39-4.04)	**0.002**	11.1	0.50	(0.15-1.69)	0.265
6+ criteria (severe)	28.0	4.57	(2.54-8.22)	**<0.001**	30.0	1.96	(0.88-4.38)	0.100
Binary Symptom Checklist[e]								
0-1 criteria (none)	8.3	ref	-	-	19.5	ref		
2+ criteria (CUD)	16.7	2.26	(1.45-3.53)	**<0.001**	20.9	1.11	(0.53-2.33)	0.790
CUD treatment engagement, among patients who initiated								
Adjusted for sociodemographic characteristics								
Continuous Symptom Checklist[c]	-	1.39	(1.16-1.67)	**<0.001**	-	0.92	(0.67-1.27)	0.602
Categorical Symptom Checklist[d]								
0-1 criteria (none)	-	-	-	-	-	-	-	-
2-3 criteria (mild)	-	-	-	-	-	-	-	-
4-5 criteria (moderate)	-	-	-	-	-	-	-	-
6+ criteria (severe)	-	-	-	-	-	-	-	-
Binary Symptom Checklist[e]								
0-1 criteria (none)	5.8	-	-	-	70.4	-	-	-

2+ criteria (CUD)	27.3	7.64	(1.43-40.78)	**0.017**	29.6	0.13	(0.00-4.90)	0.267
Adjusted for sociodemographic characteristics, need and enabling factors								
Continuous Symptom Checklist[c]	-	1.47	(1.18-1.83)	**<0.001**	-	0.75	(0.47-1.21)	0.242
Categorical Symptom Checklist[d]								
0-1 criteria (none)	-	-	-	-	-	-	-	-
2-3 criteria (mild)	-	-	-	-	-	-	-	-
4-5 criteria (moderate)	-	-	-	-	-	-	-	-
6+ criteria (severe)	-	-	-	-	-	-	-	-
Binary Symptom Checklist[e]								
0-1 criteria (none)	-	-	-	-	-	-	-	-
2+ criteria (CUD)	-	-	-	-	-	-	-	-

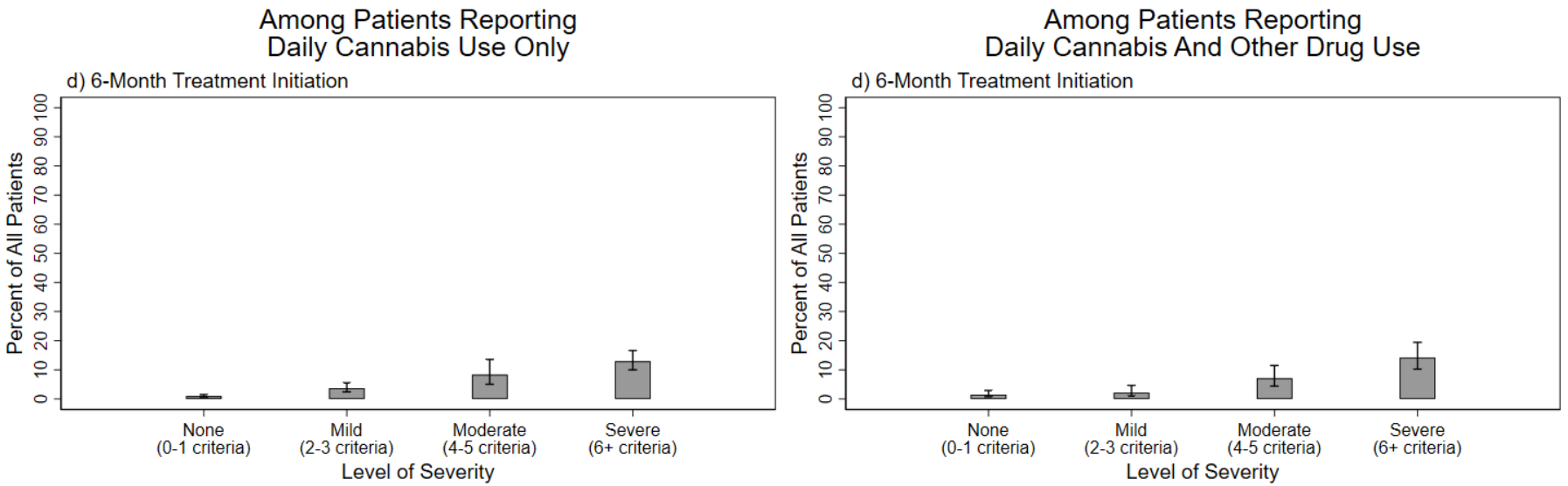
Abbreviations: CUD=cannabis use disorder; OR=odds ratio; CI=confidence interval; ref=reference group
Note: (-) indicates not estimatable; bold indicates significant at α=0.05
[a] Predicted probability, expressed as a percent
[b] OR estimated using logistic regression with cluster-robust standard errors
[c] OR associated with each 1-unit increase on the Symptom Checklist
[d] OR associated with each level of severity on Symptom Checklist relative to 0-1 criteria (none)
[e] OR associated with ≥2 criteria (consistent with any severity CUD) on Symptom Checklist relative to 0-1 criteria (none)

Secondary Outcome (unadjusted and adjusted)

Appendix Table 4.3. Unadjusted and adjusted association between Substance Use Symptom Checklist measures and 6-month CUD diagnosis and treatment initiation

	Daily Cannabis Only				Daily Cannabis and Other Drug Use			
	%[a]	OR[b]	(95% CI)	p-value	%[a]	OR[b]	(95% CI)	p-value
Broader 6 Month CUD Diagnosis and Treatment Initiation, among all patients								
Unadjusted								
Continuous Symptom Checklist[c]	-	1.42	(1.36-1.49)	**<0.001**	-	1.31	(1.25-1.37)	**<0.001**
Categorical Symptom Checklist[d]								
0-1 criteria (none)	1.0	ref	-	-	1.5	ref	-	-
2-3 criteria (mild)	3.7	3.80	(2.72-5.31)	**<0.001**	2.2	1.49	(0.51-4.31)	0.466
4-5 criteria (moderate)	8.4	9.09	(5.75-14.38)	**<0.001**	7.1	5.16	(2.31-11.51)	**<0.001**
6+ criteria (severe)	13.0	14.83	(9.28-23.69)	**<0.001**	14.2	11.13	(5.74-21.61)	**<0.001**
Binary Symptom Checklist[e]								
0-1 criteria (none)	1.0	ref	-	-	1.5	ref	-	-
2+ criteria (CUD)	6.2	6.58	(4.69-9.23)	**<0.001**	7.9	5.74	(2.94-11.20)	**<0.001**
Adjusted for sociodemographic characteristics								
Continuous Symptom Checklist[c]	-	1.40	(1.35-1.46)	**<0.001**	-	1.30	(1.25-1.36)	**<0.001**
Categorical Symptom Checklist[d]								
0-1 criteria (none)	1.0	ref	-	-	1.4	ref	-	-
2-3 criteria (mild)	3.8	3.96	(2.86-5.49)	**<0.001**	2.3	1.70	(0.53-5.44)	0.375
4-5 criteria (moderate)	7.9	8.67	(5.51-13.64)	**<0.001**	7.4	5.84	(2.28-14.94)	**<0.001**
6+ criteria (severe)	11.7	13.43	(8.63-20.92)	**<0.001**	14.1	12.24	(5.54-27.04)	**<0.001**
Binary Symptom Checklist[e]								
0-1 criteria (none)	1.0	ref	-	-	1.4	ref	-	-
2+ criteria (CUD)	5.9	6.29	(4.50-8.80)	**<0.001**	7.9	6.21	(2.80-13.77)	**<0.001**
Adjusted for sociodemographic characteristics, need and enabling factors								
Continuous Symptom Checklist[c]	-	1.38	(1.32-1.44)	**<0.001**	-	1.32	(1.25-1.40)	**<0.001**
Categorical Symptom Checklist[d]								
0-1 criteria (none)	1.0	ref	-	-	1.5	ref	-	-
2-3 criteria (mild)	4.0	4.02	(2.90-5.56)	**<0.001**	2.1	1.40	(0.38-5.10)	0.610
4-5 criteria (moderate)	7.9	8.44	(5.36-13.28)	**<0.001**	7.2	5.14	(1.98-13.31)	**0.001**
6+ criteria (severe)	10.7	11.83	(7.60-18.41)	**<0.001**	15.3	12.32	(5.38-28.20)	**<0.001**
Binary Symptom Checklist[e]								
0-1 criteria (none)	1.0	ref	-	-	1.5	ref	-	-
2+ criteria (CUD)	5.9	6.14	(4.38-8.61)	**<0.001**	8.1	5.67	(2.55-12.60)	**<0.001**

Abbreviations: CUD=cannabis use disorder; OR=odds ratio; CI=confidence interval; ref=reference group
Note: (-) indicates not estimatable; bold indicates significant at α=0.05
[a] Predicted probability, expressed as a percent;
[b] OR estimated using logistic regression with cluster-robust standard errors,
[c] OR associated with each 1-unit increase on the Symptom Checklist
[d] OR associated with each level of severity on Symptom Checklist relative to 0-1 criteria (none)
[e] OR associated with ≥2 criteria (consistent with any severity CUD) on Symptom Checklist relative to 0-1 criteria (none)



Appendix Figure 4.2. Percent of all patients with 6-month CUD diagnosis and treatment initiation, across Substance Use Symptom Checklist levels of severity, and stratified by patient report of daily cannabis use only or both daily cannabis and other drug use on screening.

Moderation Analyses (unadjusted and adjusted)

Appendix Table 4.4. Adjusted gender-stratified association between Substance Use Symptom Checklist measures and subsequent CUD diagnosis and initiation and engagement in CUD treatment (moderation by gender), among patients reporting daily cannabis use only on screening

	Men				Women				Interaction
	%[a]	OR[b]	(95% CI)	p-value	%[a]	OR[b]	(95% CI)	p-value	Joint p-value[c]
CUD diagnosis, among all patients									
Adjusted for sociodemographic characteristics									
Continuous Symptom Checklist[d]	-	1.33	(1.27-1.39)	**<0.001**	--	1.41	(1.34-1.48)	**<0.001**	**0.028**
Categorical Symptom Checklist[e]									
0-1 criteria (none)	3.8	ref	-	-	3.0	ref	-	-	
2-3 criteria (mild)	10.0	2.85	(2.19-3.71)	**<0.001**	9.4	3.38	(2.52-4.53)	**<0.001**	0.123
4-5 criteria (moderate)	16.0	4.89	(3.23-7.39)	**<0.001**	16.3	6.42	(4.21-9.77)	**<0.001**	
6+ criteria (severe)	21.6	7.11	(4.71-10.71)	**<0.001**	24.6	10.79	(7.2-16.17)	**<0.001**	
Binary Symptom Checklist[f]									
0-1 criteria (none)	3.8	ref	-	-	3.0	ref	-	-	0.272
2+ criteria (CUD)	13.6	4.00	(3.03-5.28)	**<0.001**	12.6	4.75	(3.54-6.37)	**<0.001**	
Adjusted for sociodemographic characteristics, need and enabling factors									
Continuous Symptom Checklist[d]	-	1.32	(1.26-1.38)	**<0.001**	-	1.39	(1.31-1.46)	**<0.001**	0.076
Categorical Symptom Checklist[e]									
0-1 criteria (none)	3.9	ref	-	-	3.1	ref	-	-	
2-3 criteria (mild)	10.2	2.82	(2.15-3.71)	**<0.001**	9.5	3.36	(2.49-4.53)	**<0.001**	0.325
4-5 criteria (moderate)	16.7	5.01	(3.31-7.59)	**<0.001**	16.7	6.43	(4.25-9.74)	**<0.001**	
6+ criteria (severe)	21.0	6.64	(4.49-9.81)	**<0.001**	21.9	9.05	(6.03-13.57)	**<0.001**	
Binary Symptom Checklist[f]									
0-1 criteria (none)	4.0	ref	-	-	3.1	ref	-	-	0.307
2+ criteria (CUD)	13.8	3.93	(2.98-5.18)	**<0.001**	12.6	4.63	(3.47-6.19)	**<0.001**	
CUD treatment initiation, among patients with diagnosis									
Adjusted for sociodemographic characteristics									
Continuous Symptom Checklist[d]	-	1.23	(1.11-1.37)	**<0.001**	-	1.13	(1.02-1.25)	**0.014**	0.278
Categorical Symptom Checklist[e]									
0-1 criteria (none)	7.6	ref	-	-	9.5	ref	-	-	
2-3 criteria (mild)	6.3	0.82	(0.33-2.05)	0.669	16.7	1.92	(0.94-3.93)	0.072	**0.038**
4-5 criteria (moderate)	18.3	2.75	(0.96-7.87)	0.060	18.9	2.24	(0.93-5.39)	0.073	
6+ criteria (severe)	30.5	5.49	(2.27-13.24)	**<0.001**	20.8	2.53	(1.16-5.5)	**0.019**	
Binary Symptom Checklist[f]									
0-1 criteria (none)	7.9	ref	-	-	9.6	ref	-	-	0.766
2+ criteria (CUD)	16.9	2.39	(1.13-5.07)	**0.023**	17.7	2.05	(1.2-3.49)	**0.008**	
Adjusted for sociodemographic characteristics, need and enabling factors									
Continuous Symptom Checklist	-	1.26	(1.12-1.41)	**<0.001**	-	1.11	(1.00-1.23)	**0.043**	0.140
Categorical Symptom Checklist[d]									
0-1 criteria (none)	7.6	ref	-	-	8.6	ref	-	-	
2-3 criteria (mild)	6.9	0.90	(0.34-2.38)	0.838	14.7	1.85	(0.8-4.26)	0.151	**0.017**
4-5 criteria (moderate)	16.9	2.53	(0.92-6.94)	0.072	18.1	2.39	(1-5.71)	**0.049**	
6+ criteria (severe)	35.0	7.04	(2.66-18.62)	**<0.001**	15.2	1.93	(0.91-4.11)	0.088	
Binary Symptom Checklist[f]									
0-1 criteria (none)	7.9	ref	-	-	8.7	ref	-	-	0.547
2+ criteria (CUD)	17.9	2.61	(1.2-5.69)	**0.016**	15.3	1.93	(1.17-3.17)	**0.010**	

Abbreviations: CUD=cannabis use disorder; OR=odds ratio; CI=confidence interval; ref=reference group
Note: (-) indicates not estimatable; bold indicates significant at α=0.05
[a] Predicted probability, expressed as a percent
[b] OR estimated using logistic regression with cluster-robust standard errors
[c] Joint Wald's test of interaction term(s)
[d] OR associated with each 1-unit increase on the Symptom Checklist
[e] OR associated with each level of severity on Symptom Checklist relative to 0-1 criteria (none)
[f] OR associated with ≥2 criteria (consistent with any severity CUD) on Symptom Checklist relative to 0-1 criteria (none)

Appendix Table 4.5. Unadjusted age-stratified association between Substance Use Symptom Checklist and subsequent CUD diagnosis and initiation and engagement in CUD treatment (moderation by age), among patients reporting daily cannabis use only on screening

	18-24				25-44				45-64				65+				Interaction
	%[a]	OR[b]	(95% CI)	p	%[a]	OR[b]	(95% CI)	p	%[a]	OR[b]	(95% CI)	p	%[a]	OR[b]	(95% CI)	p	Joint p[c]
CUD diagnosis, among all patients																	
Continuous Symptom Checklist[d]	-	1.32	(1.23-1.41)	**<0.001**	-	1.38	(1.33-1.44)	**<0.001**	-	1.37	(1.28-1.47)	**<0.001**	-	1.34	(1.20-1.50)	**<0.001**	0.561
Categorical Symptom Checklist[e]																	
0-1 criteria (none)	5.2	ref	-	-	3.2	ref	-	-	2.6	ref	-	-	3.2	ref	-	-	0.365
2-3 criteria (mild)	13.0	2.73	(1.83-4.07)	**<0.001**	10.6	3.64	(2.57-5.16)	**<0.001**	7.1	2.86	(1.9-4.31)	**<0.001**	8.2	2.71	(1.56-4.7)	**<0.001**	
4-5 criteria (moderate)	21.5	4.99	(3.01-8.29)	**<0.001**	15.6	5.67	(3.96-8.13)	**<0.001**	15.8	6.99	(4.11-11.89)	**<0.001**	6.7	2.16	(0.69-6.75)	0.187	
6+ criteria (severe)	27.4	6.88	(3.71-12.74)	**<0.001**	25.1	10.27	(6.96-15.15)	**<0.001**	18.5	8.45	(4.14-17.22)	**<0.001**	20.0	7.55	(2.67-21.34)	**<0.001**	
Binary Symptom Checklist[f]																	
0-1 criteria (none)	5.2	ref	-	-	3.2	ref	-	-	2.6	ref	-	-	3.2	ref	-	-	0.229
2+ criteria (CUD)	18.1	4.03	(2.65-6.11)	**<0.001**	14.1	5.04	(3.83-6.63)	**<0.001**	10.1	4.18	(2.76-6.32)	**<0.001**	8.9	2.95	(1.82-4.8)	**<0.001**	
CUD treatment initiation, among patients with diagnosis																	
Continuous Symptom Checklist[d]	-	1.15	(1.04-1.27)	**0.007**	-	1.17	(1.06-1.31)	**0.003**	-	1.06	(0.87-1.29)	0.547	-	1.37	(1.10-1.71)	**0.005**	0.497
Categorical Symptom Checklist[e]																	
0-1 criteria (none)	8.3	ref	-	-	11.1	ref	-	-	8.9	ref	-	-	6.4	ref	-	-	
2-3 criteria (mild)	12.5	1.57	(0.56-4.42)	0.392	9.2	0.81	(0.24-2.78)	0.739	6.1	0.66	(0.13-3.32)	0.618	13.3	2.26	(0.37-13.59)	0.374	0.317
4-5 criteria (moderate)	23.1	3.30	(1.25-8.7)	**0.016**	16.3	1.56	(0.66-3.64)	0.309	15.8	1.93	(0.55-6.78)	0.306	-	-	-	-	
6+ criteria (severe)	22.4	3.18	(1.42-7.16)	**0.005**	29.2	3.29	(1.33-8.18)	**0.010**	13.3	1.58	(0.36-6.95)	0.543	50.0	14.67	(2.14-100.66)	**0.006**	
Binary Symptom Checklist[f]																	
0-1 criteria (none)	8.3	ref	-	-	11.1	ref	-	-	8.9	ref	-	-	6.4	ref	-	-	
2+ criteria (CUD)	18.8	2.54	(1.22-5.3)	**0.013**	16.8	1.61	(0.71-3.68)	0.257	10.4	1.20	(0.52-2.79)	0.672	18.2	3.26	(0.81-13.08)	0.096	0.465

Abbreviations: CUD=cannabis use disorder; OR=odds ratio; CI=confidence interval; SC=Symptom Checklist; mod=moderate; ref=reference group

Note: (-) indicates not estimatable; bold indicates significant at α=0.05

[a] Predicted probability, expressed as a percent

[b] OR estimated using logistic regression with cluster-robust standard errors

[c] Joint Wald's test of interaction term(s)

[d] OR associated with each 1-unit increase on the Symptom Checklist

[e] OR associated with each level of severity on Symptom Checklist relative to 0-1 criteria (none)

[f] OR associated with ≥2 criteria (consistent with any severity CUD) on Symptom Checklist relative to 0-1 criteria (none)

Appendix Table 4.6. Adjusted age-stratified association between Substance Use Symptom Checklist measures and subsequent CUD diagnosis and initiation and engagement in CUD treatment (moderation by age), among patients reporting daily cannabis use only on screening

	18-24				25-44				45-64				65+				Interaction
	%[a]	OR[b]	(95% CI)	p	%[a]	OR[b]	(95% CI)	p	%[a]	OR[b]	(95% CI)	p	%[a]	OR[b]	(95% CI)	p	Joint p[c]
CUD diagnosis, among all patients																	
Adjusted for sociodemographic characteristics																	
Continuous Symptom Checklist[d]	-	1.32	(1.23-1.41)	**<0.001**	-	1.38	(1.32-1.44)	**<0.001**	-	1.37	(1.29-1.47)	**<0.001**	-	1.40	(1.25-1.56)	**<0.001**	0.543
Categorical Symptom Checklist[e]																	
0-1 criteria (none)	5.5	ref	-	-	3.1	ref	-	-	2.5	ref	-	-	3.2	ref	-	-	
2-3 criteria (mild)	12.8	2.53	(1.72-3.73)	**<0.001**	10.9	3.78	(2.69-5.31)	**<0.001**	7.3	3.02	(1.95-4.66)	**<0.001**	7.9	2.64	(1.5-4.67)	**0.001**	0.416
4-5 criteria (moderate)	22.4	4.98	(3.07-8.08)	**<0.001**	15.9	5.87	(3.87-8.91)	**<0.001**	15.9	7.23	(4.41-11.86)	**<0.001**	7.3	2.40	(0.76-7.56)	0.133	
6+ criteria (severe)	28.1	6.74	(3.76-12.1)	**<0.001**	24.3	9.97	(6.43-15.46)	**<0.001**	18.2	8.52	(4.26-17.03)	**<0.001**	22.3	8.81	(3.23-24.06)	**<0.001**	
Binary Symptom Checklist[F]																	
0-1 criteria (none)	5.5	ref	-	-	3.1	ref	-	-	2.5	ref	-	-	3.1	ref	-	-	0.220
2+ criteria (CUD)	18.4	3.87	(2.63-5.7)	**<0.001**	14.2	5.15	(3.85-6.88)	**<0.001**	10.1	4.32	(2.82-6.61)	**<0.001**	8.8	2.99	(1.83-4.87)	**<0.001**	
Adjusted for sociodemographic characteristics, need and enabling factors																	
Continuous Symptom Checklist[d]	-	1.31	(1.22-1.40)	**<0.001**	-	1.37	(1.31-1.43)	**<0.001**	-	1.35	(1.26-1.44)	**<0.001**	-	1.37	(1.22-1.52)	**<0.001**	0.608
Categorical Symptom Checklist[e]																	
0-1 criteria (none)	5.7	ref	-	-	3.0	ref	-	-	2.5	ref	-	-	4.7	ref	-	-	
2-3 criteria (mild)	12.6	2.42	(1.58-3.71)	**<0.001**	10.8	3.97	(2.84-5.54)	**<0.001**	7.0	2.88	(1.81-4.6)	**<0.001**	11.1	2.56	(1.45-4.54)	**0.001**	0.087
4-5 criteria (moderate)	23.7	5.24	(3.26-8.41)	**<0.001**	15.4	6.01	(3.96-9.13)	**<0.001**	15.8	7.26	(4.44-11.88)	**<0.001**	8.8	1.99	(0.62-6.35)	0.244	
6+ criteria (severe)	26.4	6.05	(3.18-11.51)	**<0.001**	22.1	9.37	(6.09-14.42)	**<0.001**	15.2	6.93	(3.62-13.26)	**<0.001**	26.9	7.67	(2.74-21.49)	**<0.001**	
Binary Symptom Checklist[f]																	
0-1 criteria (none)	5.7	ref	-	-	3.0	ref	-	-	2.5	ref	-	-	4.8	ref	-	-	0.107
2+ criteria (CUD)	18.3	3.76	(2.52-5.61)	**<0.001**	13.7	5.23	(3.93-6.96)	**<0.001**	9.6	4.11	(2.65-6.36)	**<0.001**	12.2	2.78	(1.69-4.56)	**<0.001**	
CUD treatment initiation, among patients with diagnosis																	
Adjusted for sociodemographic characteristics																	
Continuous Symptom Checklist[d]	-	1.14	(1.02-1.27)	**0.024**	-	1.24	(1.10-1.40)	**0.001**	-	1.08	(0.88-1.33)	0.462	-	1.46	(1.11-1.93)	**0.007**	0.341
Categorical Symptom Checklist[e]																	
0-1 criteria (none)	9.5	ref	-	-	8.2	ref	-	-	8.9	ref	-	-	6.1	ref	-	-	
2-3 criteria (mild)	14.4	1.61	(0.57-4.51)	0.365	10.1	1.26	(0.37-4.33)	0.712	6.3	0.69	(0.14-3.32)	0.640	12.9	2.32	(0.39-13.72)	0.354	0.476
4-5 criteria (moderate)	24.5	3.14	(1.21-8.16)	**0.019**	14.6	1.92	(0.52-7.07)	0.327	15.0	1.82	(0.54-6.11)	0.330	-	-	-	-	
6+ criteria (severe)	24.2	3.09	(1.23-7.77)	**0.017**	32.8	5.63	(2.03-15.62)	**0.001**	16.1	1.98	(0.38-10.28)	0.414	61.8	27.53	(2.39-317.36)	**0.008**	
Binary Symptom Checklist[f]																	
0-1 criteria (none)	9.5	ref	-	-	8.3	ref	-	-	9.0	ref	-	-	6.1	ref	-	-	0.435
2+ criteria (CUD)	20.6	2.51	(1.23-5.13)	**0.012**	17.8	2.42	(0.92-6.4)	0.075	10.9	1.24	(0.54-2.85)	0.613	18.3	3.49	(0.84-14.49)	0.085	
Adjusted for sociodemographic characteristics, need and enabling factors																	
Continuous Symptom Checklist[d]	-	1.18	(1.05-1.33)	**0.006**	-	1.22	(1.08-1.37)	**0.001**	-	1.09	(0.89-1.34)	0.404	-	1.42	(1.08-1.86)	**0.013**	0.612
Categorical Symptom Checklist[e]																	
0-1 criteria (none)	7.7	ref	-	-	7.7	ref	-	-	9.5	ref	-	-	7.4	ref	-	-	
2-3 criteria (moderate)	12.8	1.77	(0.69-4.55)	0.233	9.4	1.25	(0.32-4.87)	0.744	6.9	0.70	(0.13-3.8)	0.684	16.4	2.51	(0.39-16.15)	0.333	0.322
4-5 criteria (mod)	22.5	3.59	(1.4-9.22)	**0.008**	12.0	1.65	(0.53-5.16)	0.387	16.0	1.83	(0.55-6.06)	0.323	-	-	-	-	
6+ criteria (severe)	26.9	4.61	(1.71-12.42)	**0.003**	28.9	5.11	(1.81-14.45)	**0.002**	17.4	2.04	(0.38-10.94)	0.405	60.0	21.60	(1.78-261.48)	**0.016**	
Binary Symptom Checklist[f]																	
0-1 criteria (none)	7.6	ref	-	-	7.7	ref	-	-	9.7	ref	-	-	7.7	ref	-	-	0.330
2+ criteria (CUD)	19.9	3.09	(1.58-6.03)	**0.001**	15.3	2.20	(0.79-6.09)	0.131	11.7	1.25	(0.53-2.95)	0.617	22.0	3.47	(0.78-15.51)	0.103	

Abbreviations: CUD=cannabis use disorder; OR=odds ratio; CI=confidence interval; ref=reference group

Note: (-) indicates not estimatable; bold indicates significant at α=0.05

[a] Predicted probability, expressed as a percent

[b] OR estimated using logistic regression with cluster-robust standard errors

[c] Joint Wald's test of interaction term(s)

[d] OR associated with each 1-unit increase on the Symptom Checklist

[e] OR associated with each level of severity on Symptom Checklist relative to 0-1 criteria (none)

[f] OR associated with ≥2 criteria (consistent with any severity CUD) on Symptom Checklist relative to 0-1 criteria (none)

Appendix Table 4.7. Unadjusted race-stratified association between Substance Use Symptom Checklist measures and subsequent CUD diagnosis and initiation and engagement in CUD treatment (moderation by race), among patients reporting daily cannabis use only on screening

	American Indian/Alaska Native				Asian				Black				Native Hawaiian/Pacific Islander				White				Inter-action
	%[a]	OR[b]	(95% CI)	p	%[a]	OR[b]	(95% CI)	p	%[a]	OR[b]	(95% CI)	p	%[a]	OR[b]	(95% CI)	p	%[a]	OR[b]	(95% CI)	p	Joint p[c]
CUD diagnosis, among all patients																					
Continuous SC[d]	-	1.54	(1.29-1.84)	**<0.001**	-	1.57	(1.29-1.90)	**<0.001**	-	1.39	(1.27-1.53)	**<0.001**	-	1.55	(1.27-1.89)	**<0.001**	-	1.37	(1.32-1.43)	**<0.001**	0.240
Categorical SC[e]																					
0-1 criteria (none)	3.5	ref	-	-	1.8	ref	-	-	3.6	ref	-	-	3.7	ref	-	-	3.3	ref	-	-	
2-3 criteria (mild)	21.7	7.75	(3.32-18.07)	**<0.001**	5.1	2.88	(1.00-8.31)	0.051	8.3	2.41	(1.18-4.9)	**0.015**	10.7	3.10	(0.74-12.87)	0.120	10.2	3.35	(2.58-4.35)	**<0.001**	0.626
4-5 criteria (mod)	21.4	7.61	(1.85-31.21)	**0.005**	9.1	5.32	(1.15-24.67)	**0.033**	21.4	7.23	(4.53-11.54)	**<0.001**	20.0	6.45	(1.60-25.93)	**0.009**	17.5	6.26	(4.61-8.51)	**<0.001**	
6+ criteria (severe)	37.5	16.73	(2.49-112.3)	**0.004**	33.3	26.60	(7.56-93.61)	**<0.001**	28.6	10.60	(4.52-24.87)	**<0.001**	40.0	17.20	(3.70-79.86)	**<0.001**	23.2	8.89	(6.02-13.11)	**<0.001**	
Binary SC[f]																					
0-1 criteria (none)	3.5	ref	-	-	1.8	ref	-	-	3.6	ref	-	-	3.7	ref	-	-	3.3	ref	-	-	0.401
2+ criteria (CUD)	23.5	8.58	(4.07-18.09)	**<0.001**	10.6	6.31	(2.98-13.35)	**<0.001**	15.3	4.78	(2.88-7.93)	**<0.001**	16.3	5.02	(1.65-15.21)	**0.004**	13.9	4.75	(3.67-6.14)	**<0.001**	

Abbreviations: CUD=cannabis use disorder; OR=odds ratio; CI=confidence interval; SC=Symptom Checklist; mod=moderate; ref=reference group

Note: (-) indicates not estimatable; bold indicates significant at α=0.05

[a] Predicted probability, expressed as a percent

[b] OR estimated using logistic regression with cluster-robust standard errors

[c] Joint Wald's test of interaction term(s)

[d] OR associated with each 1-unit increase on the Symptom Checklist

[e] OR associated with each level of severity on Symptom Checklist relative to 0-1 criteria (none)

[f] OR associated with ≥2 criteria (consistent with any severity CUD) on Symptom Checklist relative to 0-1 criteria (none)

Appendix Table 4.8. Adjusted race-stratified association between Substance Use Symptom Checklist measures and subsequent CUD diagnosis and initiation and engagement in CUD treatment (moderation by race), among patients reporting daily cannabis use only on screening

	American Indian/Alaska Native				Asian				Black				Native Hawaiian/Pacific Islander				White				Inter-action
	%[a]	OR[b]	(95% CI)	p	%[a]	OR[b]	(95% CI)	p	%[a]	OR[b]	(95% CI)	p	%[a]	OR[b]	(95% CI)	p	%[a]	OR[b]	(95% CI)	p	Joint p[c]
CUD diagnosis, among all patients																					
Adjusted for sociodemographic characteristics																					
Continuous SC[d]	-	1.49	(1.25-1.76)	1.49	-	1.54	(1.26-1.89)	1.54	-	1.37	(1.24-1.50)	1.37	-	1.55	(1.28-1.88)	1.55	-	1.34	(1.29-1.40)	**<0.001**	0.193
Categorical SC[e]																					
0-1 criteria (none)	3.6	ref	-	-	1.7	ref	-	-	3.5	ref	-	-	3.6	ref	-	-	3.4	ref	-	-	
2-3 criteria (mild)	20.2	6.90	(2.91-16.35)	**<0.001**	4.2	2.51	(0.88-7.17)	0.085	7.5	2.25	(1.11-4.57)	**0.025**	8.9	2.65	(0.62-11.36)	0.191	9.9	3.12	(2.39-4.07)	**<0.001**	0.771
4-5 criteria (mod)	18.0	5.95	(1.45-24.5)	**0.014**	8.0	4.98	(1.06-23.52)	**0.042**	18.2	6.17	(3.78-10.06)	**<0.001**	17.6	5.76	(1.44-23.14)	**0.014**	16.0	5.45	(4.03-7.36)	**<0.001**	
6+ criteria (severe)	33.3	13.67	(2.00-93.26)	**0.008**	28.0	22.45	(6.02-83.81)	**<0.001**	24.7	9.12	(3.81-21.87)	**<0.001**	40.0	18.28	(4.1-81.4)	**<0.001**	20.9	7.55	(4.98-11.45)	**<0.001**	
Binary SC[f]																					
0-1 criteria (none)	3.6	ref	-	-	1.7	ref	-	-	3.5	ref	-	-	3.6	ref	-	-	3.4	ref	-	-	0.525
2+ criteria (CUD)	20.9	4.22	(3.24-5.5)	**<0.001**	8.7	7.20	(3.36-15.41)	**<0.001**	13.2	5.50	(2.53-11.95)	**<0.001**	13.8	4.23	(2.55-7.03)	**<0.001**	12.9	4.37	(1.4-13.61)	**0.011**	
Adjusted for sociodemographic characteristics																					
Continuous SC[d]	-	1.47	(1.23-1.75)	1.47	-	1.50	(1.24-1.82)	1.50	-	1.37	(1.25-1.49)	1.37	-	1.49	(1.21-1.83)	1.49	-	1.33	(1.28-1.39)	1.33	0.348
Categorical SC[e]																					
0-1 criteria (none)	3.7	ref	-	-	1.9	ref	-	-	3.6	ref	-	-	3.7	ref	-	-	3.5	ref	-	-	
2-3 criteria (mild)	19.4	6.36	(2.9-13.94)	**<0.001**	4.4	2.44	(0.85-7.02)	0.097	7.8	2.30	(1.09-4.84)	**0.029**	9.9	2.87	(0.68-12.15)	0.152	10.1	3.10	(2.37-4.04)	**<0.001**	0.935
4-5 criteria (mod)	18.4	5.92	(1.41-24.95)	**0.015**	8.6	5.02	(1.04-24.24)	**0.045**	19.4	6.64	(3.75-11.75)	**<0.001**	19.2	6.26	(1.58-24.81)	**0.009**	16.5	5.50	(4.08-7.4)	**<0.001**	
6+ criteria (severe)	30.7	11.81	(1.87-74.76)	**0.009**	25.6	18.57	(5.02-68.73)	**<0.001**	25.3	9.40	(4.1-21.58)	**<0.001**	26.5	9.56	(1.44-63.33)	**0.019**	19.5	6.76	(4.52-10.12)	**<0.001**	
Binary SC[f]																					
0-1 criteria (none)	3.7	ref	-	-	1.9	ref	-	-	3.6	ref	-	-	3.7	ref	-	-	3.5	ref	-	-	0.674
2+ criteria (CUD)	20.4	6.76	(3.28-13.92)	**<0.001**	8.6	4.99	(2.34-10.64)	**<0.001**	13.7	4.37	(2.56-7.46)	**<0.001**	13.4	4.06	(1.3-12.71)	**0.016**	13.0	4.13	(3.19-5.35)	**<0.001**	

Abbreviations: CUD=cannabis use disorder; Int=Interaction; OR=odds ratio; CI=confidence interval; SC=Symptom Checklist; mod=moderate; ref=reference group

Note: (-) indicates not estimatable; bold indicates significant at α=0.05

[a] Predicted probability, expressed as a percent

[b] OR estimated using logistic regression with cluster-robust standard errors

[c] Joint Wald's test of interaction term(s)

[d] OR associated with each 1-unit increase on the Symptom Checklist

[e] OR associated with each level of severity on Symptom Checklist relative to 0-1 criteria (none)

[f] OR associated with ≥2 criteria (consistent with any severity CUD) on Symptom Checklist relative to 0-1 criteria (none)

Appendix Table 4.9. Unadjusted ethnicity-stratified association between Substance Use Symptom Checklist measures and subsequent CUD diagnosis and initiation and engagement in CUD treatment (moderation by ethnicity), among patients reporting daily cannabis use only on screening

	Hispanic				Not Hispanic				Interaction
	%[a]	OR[b]	(95% CI)	p-value	%[a]	OR[b]	(95% CI)	p-value	Joint p-value[c]
CUD diagnosis, among all patients									
Continuous Symptom Checklist[d]	-	1.41	(1.30-1.52)	**<0.001**	-	1.38	(1.33-1.43)	**<0.001**	0.615
Categorical Symptom Checklist[e]									
0-1 criteria (none)	3.7	ref	-	-	3.3	ref	-	-	0.163
2-3 criteria (mild)	14.2	4.31	(2.37-7.82)	**<0.001**	9.9	3.24	(2.63-3.98)	**<0.001**	
4-5 criteria (moderate)	11.1	3.26	(1.61-6.61)	**0.001**	17.7	6.35	(4.78-8.44)	**<0.001**	
6+ criteria (severe)	32.6	12.60	(6.39-24.83)	**<0.001**	23.8	9.26	(6.38-13.42)	**<0.001**	
Binary Symptom Checklist[f]									
0-1 criteria (none)	3.7	ref	-	-	3.3	ref	-	-	0.571
2+ criteria (CUD)	17.0	5.33	(3.38-8.41)	**<0.001**	13.8	4.73	(3.78-5.92)	**<0.001**	
CUD treatment initiation, among patients with diagnosis									
Continuous Symptom Checklist[d]	-	1.18	(0.97-1.43)	0.101	-	1.17	(1.09-1.26)	**<0.001**	0.959
Categorical Symptom Checklist[e]									
0-1 criteria (none)	10.0	ref	-	-	9.2	ref	-	-	0.778
2-3 criteria (mild)	5.6	0.53	(0.04-6.56)	0.621	10.6	1.18	(0.68-2.02)	0.558	
4-5 criteria (moderate)	33.3	4.50	(0.52-39)	0.172	18.0	2.18	(1.27-3.75)	**0.005**	
6+ criteria (severe)	21.4	2.45	(0.59-10.22)	0.217	25.5	3.40	(1.88-6.14)	**<0.001**	
Binary Symptom Checklist[f]									
0-1 criteria (none)	10.0	ref	-	-	9.2	ref	-	-	0.818
2+ criteria (CUD)	15.8	1.69	(0.46-6.14)	0.427	16.7	1.99	(1.29-3.08)	**0.002**	

Abbreviations: CUD=cannabis use disorder; OR=odds ratio; CI=confidence interval; ref=reference group
Note: (-) indicates not estimatable; bold indicates significant at α=0.05
[a] Predicted probability, expressed as a percent
[b] OR estimated using logistic regression with cluster-robust standard errors
[c] Joint Wald's test of interaction term(s)
[d] OR associated with each 1-unit increase on the Symptom Checklist
[e] OR associated with each level of severity on Symptom Checklist relative to 0-1 criteria (none)
[f] OR associated with ≥2 criteria (consistent with any severity CUD) on Symptom Checklist relative to 0-1 criteria (none)

Appendix Table 4.10. Adjusted ethnicity-stratified association between Substance Use Symptom Checklist measures and subsequent CUD diagnosis and initiation and engagement in CUD treatment (moderation by ethnicity), among patients reporting daily cannabis use only on screening

	Hispanic				Not Hispanic				Interaction
	%	OR[a]	(95% CI)	p-value	%	OR[a]	(95% CI)	p-value	Joint p-value[c]
CUD diagnosis, among all patients									
Adjusted for sociodemographic characteristics									
Continuous Symptom Checklist[d]	-	1.42	(1.30-1.56)	**<0.001**	-	1.35	(1.30-1.41)	**<0.001**	0.267
Categorical Symptom Checklist[e]									
0-1 criteria (none)	3.1	ref	-	-	3.4	ref	-	-	
2-3 criteria (mild)	12.7	4.58	(2.51-8.38)	**<0.001**	9.5	3.03	(2.45-3.76)	**<0.001**	0.064
4-5 criteria (moderate)	7.8	2.64	(0.66-10.56)	0.170	16.5	5.72	(4.27-7.66)	**<0.001**	
6+ criteria (severe)	29.8	13.51	(6.28-29.08)	**<0.001**	21.7	8.03	(5.46-11.8)	**<0.001**	
Binary Symptom Checklist[f]									
0-1 criteria (none)	3.1	ref	-	-	3.4	ref	-	-	0.279
2+ criteria (CUD)	15.4	5.76	(3.18-10.43)	**<0.001**	12.9	4.26	(3.36-5.41)	**<0.001**	
Adjusted for sociodemographic characteristics, need and enabling factors									
Continuous Symptom Checklist[d]	-	1.46	(1.33-1.61)	**<0.001**	-	1.34	(1.29-1.39)	**<0.001**	0.058
Categorical Symptom Checklist[e]									
0-1 criteria (none)	3.0	ref	-	-	3.5	ref	-	-	
2-3 criteria (mild)	13.7	5.16	(2.75-9.65)	**<0.001**	9.7	2.98	(2.39-3.72)	**<0.001**	**0.007**
4-5 criteria (moderate)	8.2	2.87	(0.73-11.34)	0.132	17.1	5.79	(4.34-7.71)	**<0.001**	
6+ criteria (severe)	33.5	16.69	(7.33-38)	**<0.001**	20.0	7.03	(4.88-10.12)	**<0.001**	
Binary Symptom Checklist[f]									
0-1 criteria (none)	3.0	ref	-	-	3.5	ref	-	-	0.120
2+ criteria (CUD)	16.8	6.56	(3.53-12.19)	**<0.001**	12.9	4.14	(3.28-5.22)	**<0.001**	
CUD treatment initiation, among patients with diagnosis									
Adjusted for sociodemographic characteristics									
Continuous Symptom Checklist[d]	-	1.38	(1.13-1.69)	**0.002**	-	1.18	(1.09-1.28)	**<0.001**	0.161
Categorical Symptom Checklist[e]									
0-1 criteria (none)	-	-	-	-	-	-	-	-	-
2-3 criteria (mild)	-	-	-	-	-	-	-	-	-
4-5 criteria (moderate)	-	-	-	-	-	-	-	-	-
6+ criteria (severe)	-	-	-	-	-	-	-	-	-
Binary Symptom Checklist[f]									
0-1 criteria (none)	-	-	-	-	-	-	-	-	-
2+ criteria (CUD)	-	-	-	-	-	-	-	-	-
Adjusted for sociodemographic characteristics, need and enabling factors									
Continuous Symptom Checklist[d]	-	1.36	(1.13-1.62)	**0.001**	-	1.19	(1.10-1.29)	**<0.001**	0.172
Categorical Symptom Checklist[e]									
0-1 criteria (none)	-	-	-	-	-	-	-	-	-
2-3 criteria (mild)	-	-	-	-	-	-	-	-	-
4-5 criteria (moderate)	-	-	-	-	-	-	-	-	-
6+ criteria (severe)	-	-	-	-	-	-	-	-	-
Binary Symptom Checklist[f]									
0-1 criteria (none)	-	-	-	-	-	-	-	-	-
2+ criteria (CUD)	-	-	-	-	-	-	-	-	-

Abbreviations: CUD=cannabis use disorder; OR=odds ratio; CI=confidence interval; ref=reference group
Note: (-) indicates not estimatable; bold indicates significant at α=0.05
[a] Predicted probability, expressed as a percent;
[b] OR estimated using logistic regression with cluster-robust standard errors
[c] Joint Wald's test of interaction term(s)
[d] OR associated with each 1-unit increase on the Symptom Checklist
[e] OR associated with each level of severity on Symptom Checklist relative to 0-1 criteria (none)
[f] OR associated with ≥2 criteria (consistent with any severity CUD) on Symptom Checklist relative to 0-1 criteria (none)