The Cannabis Policy Scale: A New Research and Surveillance Tool for U.S. States

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ABSTRACT. Objective: Rapid shifts toward cannabis liberalization in the United States have created immense policy variability that is challenging to measure. We developed composite measures to characterize the restrictiveness of U.S. state cannabis policy environments. **Method:** Nine panelists, consisting of four research team members and five expert policy consultants, nominated distinct cannabis policies pertaining to cannabis prohibition, medicalization, and legalization for recreational use. For each of the 17 nominated policies, panelists developed implementation ratings and rated each policy's relative efficacy for reducing excessive cannabis use by adults, youth use, and impaired driving. Cannabis Policy Scale scores were then calculated for each state-year for all 50 states from 1999 to 2019 by weighting policies by their efficacy and implementation ratings, and then summing over policies. **Results:** Median Cannabis Policy Scale scores remained stable until 2008, when they started declining (representing policy liberalization), with steeper declines after 2012. In 2019, state Cannabis Policy Scale scores targeting excessive use among the general population ranged from 29.6 to 66.7 for recreational cannabis legalization states, and from 72.4 to 93.4 for medical cannabis legalization states. Cannabis Policy Scale scores using youth-specific and driving-specific efficacy ratings showed similar trends. **Conclusions:** The Cannabis Policy Scale reflects trends toward liberalization of cannabis policy in many U.S. states. Even within crude policy phenotypes (e.g., medical cannabis programs), Cannabis Policy Scale scores varied considerably between states and over time. The Cannabis Policy Scale is a new measure that can add nuance to cannabis policy research and help assess cannabis policy–outcome relationships. (*J. Stud. Alcohol Drugs, 83,* 829–838, 2022)

GLOBALLY, CANNABIS POLICY is undergoing rapid shifts toward liberalization for personal use and commercialization of medical and nonmedical cannabis (Kilmer & Pacula, 2017; Pacula & Smart, 2017; Smart & Pacula, 2019). This is especially true in the United States where, as of January 2021, 32 states and the District of Columbia have legalized cannabis containing more than 5% tetrahydrocannabinol (THC) for medical use, and 16 states and the District of Columbia have legalized cannabis for nonmedical (i.e., recreational) use; most of these 33 jurisdictions allow for commercial production, manufacturing, and sales. Little is known about how emerging cannabis policies are likely to affect cannabis use or whether changes in cannabis use may affect alcohol and tobacco use (Pacula & Smart, 2017; Smart & Pacula, 2019). The substantial variation between U.S. states and changes over time creates opportunities for policy researchers to conduct natural experiments on how cannabis policy affects cannabis use and other public health outcomes, including other substance use, traffic accidents, violence, and mental health.

These rapid policy shifts create methodological challenges for several reasons. There are many individual policies that comprise the overall cannabis policy environment, particular policies may be implemented more or less effectively in different states or in different time periods, and individual policies may be affected by the presence or absence of other policies. Therefore, simple dichotomous measures (e.g., presence or absence of recreational cannabis use or sale) may be insufficient for understanding the "strength" of the law within the context of the multiple dimensions of cannabis policy. Although researchers may study the effects of policy change using state phenotypes (e.g., a shift from prohibition to allowing cannabis for medical use), simple policy phenotypes may obscure meaningful policy differences within those phenotypes (e.g., restrictions on the number of dispensaries in a community, banning the sale of particular cannabis products, limits on the potency of cannabis products). Failing to account for this nuance may,

in turn, limit the validity of assessed relationships between policy changes and cannabis-related outcomes. To assess the impact of cannabis liberalization more robustly, it is crucial to assess the strength of the entire "cannabis policy environment," conceptualized as the combined effect of multiple, concurrent policies.

Composite measures (i.e., indices, scales) offer one way to operationalize the cannabis policy environment (Chapman et al., 2016; Moxham-Hall, 2019; Richard et al., 2021; Simons-Morton et al., 2010; Williams et al., 2016). Researchers use composite indicators to assess the relationships between policy environments and outcomes when singular dimensions of a policy (presence or absence) are insufficient to fully describe the environment. Composite measures can have statistical benefits by more parsimoniously representing complex and multidimensional policy measures. Furthermore, policymakers can use composite indicators to provide big-picture views, benchmark jurisdictions, and identify trends over time (MacDonald et al., 2005; McFadden, 2006; Nardo & Saisana, 2008; Nardo et al., 2005; Ritter, 2007, 2009; Saisana & Tarantola, 2002; Sevigny & Saisana, 2016).

The use of composite indicators as a measurement and evaluation tool in drug policy is not new but remains focused largely on outcomes and consequences of substance use rather than the policies themselves, with the exception of alcohol (MacDonald et al., 2005; McFadden, 2006; Moxham-Hall & Ritter, 2017; Ritter, 2009). Increasing the nuance of scales with efficacy ratings and implementation ratings has been shown to increase the goodness-of-fit with related outcomes compared with simpler scales made by simply summing the number of relevant policies that are implemented (Naimi et al., 2014).

Although there have been efforts to better characterize heterogeneity in cannabis policy, these efforts have had notable limitations. For instance, they have focused only on medical use policies (not incorporated recent policy changes) focused on policies in countries other than the United States, included only a single year of policy data, or were constructed such that all policy domains or provisions were weighted equally (Chapman et al., 2016; Moxham-Hall, 2019; Richard et al., 2021; Simons-Morton et al., 2010; Williams et al., 2016). Despite the increasing nuance of cannabis policy and variation between states, research on the effects of cannabis legalization has largely remained focused on dichotomous characterizations of legal status (e.g., yes or no) or examined limited provisions (Pacula et al., 2015). A comprehensive composite measure covering the full spectrum of cannabis liberalization, including commercialization for recreational cannabis use, would allow researchers to statistically parse otherwise seemingly similar states.

Our research team previously developed the Alcohol Policy Scale (APS), a composite indicator that has been used extensively to investigate the relationships between alcohol policy and various outcomes in both youth and adults, with higher APS scores (indicating more stringent alcohol policy environments) correlating with reduced binge drinking, alcoholic cirrhosis and alcohol-involved traffic fatalities, homicides, and suicides (Coleman et al., 2021; Hadland et al., 2015, 2016, 2017; Lira et al., 2019, 2020; Naimi, 2016; Naimi et al., 2014, 2018). Other composite measures include the Alcohol Policy Index and the International Alcohol Policy and Injury Index, both of which facilitate international comparisons of the strength of the alcohol policy environment between dozens of countries (Brand et al., 2007; Korcha et al., 2018). Similarly, the Tobacco Control Scale has been used to study and advance our understanding of tobacco control policies internationally (Feliu et al., 2019, 2020; Hublet et al., 2009; Joossens & Raw, 2006).

This article describes the development of the Cannabis Policy Scale (CPS) and characterizes state-level cannabis policy environments in U.S. states from 1999 to 2019, overall and by state policy phenotype (i.e., recreational allowances, medical allowances, decriminalization, prohibition) in order to characterize the nature of cannabis policy liberalization along a continuum of restrictiveness over time in the United States.

Method

Policy panelists

We engaged a convenience sample of U.S. policy experts to assist research team investigators with three tasks: (a) nominating and selecting effective cannabis policies for inclusion in the scale, (b) developing implementation ratings for each policy, and (c) rating the relative efficacy of those policies. The names, affiliations, and areas of expertise for the nine policy experts comprising the panel are summarized in online Appendix A. (A supplemental appendix appears as an online-only addendum to this article on the journal's website.) Panelists represented a range of academic disciplines and had policy expertise in cannabis, alcohol, or opioids.

Policy selection

A study kickoff meeting occurred in summer 2019 with investigators and panelists. Panelists were asked to nominate state-level cannabis policies they believed to be potentially effective—based on scientific evidence, theory, or expert opinion—for preventing or reducing excessive cannabis use, youth cannabis use, or cannabis-impaired driving. U.S. cannabis policy was defined as the laws, regulations, and practices used to influence cannabis consumption, which might include the presence or absence of supporting legislation, and/or operational aspects that reflect their implementation, enforcement, or resource allocation at the state level. Panelists were instructed to consider efficacy in terms of impact for affected persons and the number of people likely to be

affected by the policy in the general population, so these are implicitly accounted for in the efficacy ratings. After de-duplication, 20 unique cannabis policies were nominated by panelists. The 20 nominated policies are listed in online Appendix B.

Throughout summer 2019, from the 20 nominated policies, 17 were selected for inclusion in the CPS. "Minimum pricing" was excluded because the policy does not yet exist in any U.S. state, and developing a policy description for inclusion in the scale was not feasible given difficulties in determining a relevant and plausible price floor value (e.g., because of lack of state implementation of the policy and significant fluctuation of prices in the developing cannabis markets). "Government prevention" (a hypothetical collection of government efforts related to education, social marketing, research funding, and stakeholder panels) was excluded because of the lack of available policy data and challenges with operationalizing these types of interventions. Government-controlled monopoly (when the state owns all production, manufacturing, or retail operations) was excluded because no U.S. state has adopted the policy for cannabis.

Implementation rating scores

From fall 2019 through fall 2020, the study team, in consultation with panelists, developed an implementation rating (IR) scale for each policy, designed to reflect the extent to which states had enacted or imposed a restrictive version of each policy based on provisions or characteristics specific to each policy. Each of these provisions was weighted relative to the other provisions within the policy; but, for all policies, the total IR score by state and year could range from 0.0 (*no policy*) to 1.0 (*full implementation*), with higher scores reflecting more restrictiveness. Two example IR sheets are provided in online Appendix C. For example, the IR provisions for the home cultivation of cannabis included whether home cultivation was allowed for recreational use, medical use, or neither, and if allowed whether there were restrictions on the number of plants that could be grown, restrictions on third-party growing (i.e., growing for others), and restrictions on gifting home-cultivated cannabis. Because of the possibility that home cultivation may not be allowed in any context, the score starts at the most restrictive, 1, and decreases based on context and specific provisions. In contrast, because all states have some form of driving policies, the score for cannabis-impaired driving policies starts at the least restrictive, 0, and increases with the inclusion of more restrictive provisions. Although IR scores can vary by state-year, the scoring criteria applied to each policy were uniform across states and over time.

For each included policy, a public health lawyer with experience in legal epidemiology engaged in an iterative legal research process involving initial legal research using Westlaw and Nexis Advance, summarizing research findings, drafting lists of provisions applicable for particular policies, expert consultation, and data extraction and legal coding. The research team discussed and considered all proposed provisions for inclusion and weighting in each IR scale followed by additional legal research, and after several rounds the IR scales for each policy were finalized. Provisions were excluded when no states implemented them unless the research team believed some states were likely to adopt them soon because of proposed legislation incorporating these dimensions. Similarly, provisions that lacked between-state variation were excluded unless the research team believed it likely that states may adopt more variable provisions in the future (based again on legislation introduced, but not yet passed). In addition, enforceability was taken into account when considering which provisions to include. Finally, provisions were excluded when there were no reliable and consistent cross-state data available (e.g., data about the use and frequency of compliance checks by regulatory agencies at retail stores).

Data collection

A public health lawyer, using policy and provision definitions and criteria developed from the process described above, conducted legal research to extract data on the 17 included policies using Westlaw and LexisNexis and a variety of publicly available secondary sources (e.g., Prescription Drug Abuse Policy System, National Highway Traffic Safety Administration Digest of State Laws: Driving Under the Influence of Drugs, National Alliance for Model State Drug Laws, Alcohol Policy Information System) and privately accessible sources (e.g., databases from RAND Corporation, data collected by Dr. Anne Boustead). When new laws went into effect, state laws were coded according to whichever law had been in effect for most of the year, which meant that any law going into effect on or after July 1 was coded as not having gone into effect until the following year. All policy data were extracted from, or confirmed in, primary sources of legal authority (e.g., statutes, government agency rules), except rarely when data were not available in primary law sources, such as the number of retail outlets operating in each state.

Policy efficacy ratings

In November 2020, using an internet-based survey, panelists independently rated the efficacy of each policy for three health-related outcomes: (a) reducing excessive cannabis use in the general population, (b) reducing cannabis use among youth (<21 years), and (c) reducing cannabis-impaired driving. Although not explicitly defined in the survey, excessive use was meant to capture heavy use or use that is associated with adverse outcomes. Panelists were asked to perform mul-

tiple ratings in order to lay the groundwork for future studies that may assess whether policies may interact differently for different health outcomes. Panelists also rated the strength of the evidence about whether the policy is effective. When rating each policy, panelists were given a description of the policy and a bulleted list of the provisions included in the policy's IR scale described above. Panelists were instructed to rate the efficacy of each policy relative to the other 17 policies using a 5-point Likert scale with response options in intervals of 0.5 (i.e., a total of 9 possible rating options), where 1 = *less effective* and 5 = *more effective.* Panelists were also asked to rate the strength of evidence on the same 5-point rating scale that informed their efficacy rating for reducing excessive use in the general population and any use among youth. Each policy was presented in random order to each panelist to control for possible order effects.

After submitting initial policy ratings, the panelists met through an online meeting in January 2021 to review aggregated ratings and discuss the rationale for their individual ratings. A primary purpose of the meeting was to capitalize on special expertise of group members in select areas, as panelists were not equally familiar with all policies. Discussion during the in-person meeting focused on interpretation of policies, changes to the survey, and assumptions about the environments in which the policies were enacted.

Based on feedback from the in-person meeting, we clarified that panelists should (a) rate each policy relative to other policies in the context of a state with a recreational cannabis market; (b) assume each policy had been implemented long enough to be well established; and (c) rate the efficacy of the policies, assuming federal prohibition was still in effect. Based on the meeting, we added further questions about the strength of evidence ratings by querying whether those ratings were based on direct research evidence on cannabis, direct research evidence on other substances (e.g., alcohol, tobacco), and/or policy theory.

Subsequently, each panelist completed a second survey in February 2021 to re-rate the efficacy of each policy for the same three outcomes and to re-rate the strength of evidence informing their efficacy ratings. When completing the second survey, panelists were encouraged to consider their previous ratings, aggregate ratings from the initial survey, and the discussion from the meeting. Comparing the second survey to the first, there was a reduction in the mean of the variance of efficacy scores between panelists; specifically, the mean standard deviation decreased from 0.8 to 0.7 for efficacy among the general population, from 0.9 to 0.8 for efficacy among youth, and from 1.0 to 0.8 for efficacy for reducing cannabis-impaired driving. All subsequent analyses in this article are based on data from the second survey.

Calculation of Cannabis Policy Scale scores

The state-year specific IR scores for each of the 17 policies were multiplied by the efficacy ratings (ER) for their respective policies, and all 17 of the products were summed

to arrive at the CPS score. The approach is a commonly used aggregation technique in the composite indicator literature that involves summing weighted and normalized sub-indicators (Nardo et al., 2005). For this article, the median ER of each policy for reducing excessive cannabis use among the general population was used to develop CPS scores. The general formula to calculate the CPS scores is as follows:

$$CPS\ score_{jh} = \sum_{k=1}^{17}\left(ER_k * IR_{kjh}\right),$$

where j = state, h = year, k = policy, ER = efficacy rating, and IR = implementation rating.

Results

Overall, states' cannabis policy environments became less restrictive throughout the study period, as reflected by decreasing CPS scores (Figure 1). Scores began declining after 2008 but declined most rapidly after 2012. Compared to scores using ERs for reducing excessive cannabis consumption among adults, mean scores were very similar when using youth-specific or impaired driving–specific ERs. Specifically, mean CPS scores decreased from 92.2 (1999) to 76.8 (2019) when calculated with ERs for reducing excessive use in the general population, from 88.0 to 74.9 when calculated with ERs for reducing cannabis-impaired driving, and from 90.3 to 75.7 when calculated with ERs for reducing youth use.

Table 1 shows how individual policies had changed during the study period, as reflected by the IR score, which could range from 0 to 1 (where 1 is the most restrictive version of a policy). Across all policies, the average IR score decreased (reflecting policy liberalization) from 0.88 in 1999 to 0.72 in 2019 (Table 1). During the study period, IR scores increased for only two policies (clean indoor air and impaired driving) but decreased for the remaining 15 policies. IR scores for medical cannabis restrictions and track-and-trace requirements decreased the most. IR scores for home delivery remained high throughout the study period, whereas impaired-driving IR scores remained low throughout the study period.

By state, the median CPS score decreased between 1999 and 2019, from 92.7 (Montana) in 1999 to 76.5 (Arizona) in 2019 (data not shown). The state CPS: Excessive Use in the General Population (CPS:EUGP) score range also widened over time, with a range from 64.8 (California) to 95.9 (Georgia) in 1999 compared with a range from 29.6 (Nevada) to 96.2 (Indiana) in 2019. Nevada had the largest decrease (64 points). CPS:EUGP scores in 2009 (when CPS scores began changing more rapidly) were moderately correlated with CPS scores in 2019 ($r = .53$, $p < .001$). The movement in CPS:EUGP scores from 2009 to 2019 is displayed in Figure 2. Scores declined in most states during that time, which corresponds to the increase in states with either medical cannabis legalization (MCL) or recreational cannabis legalization
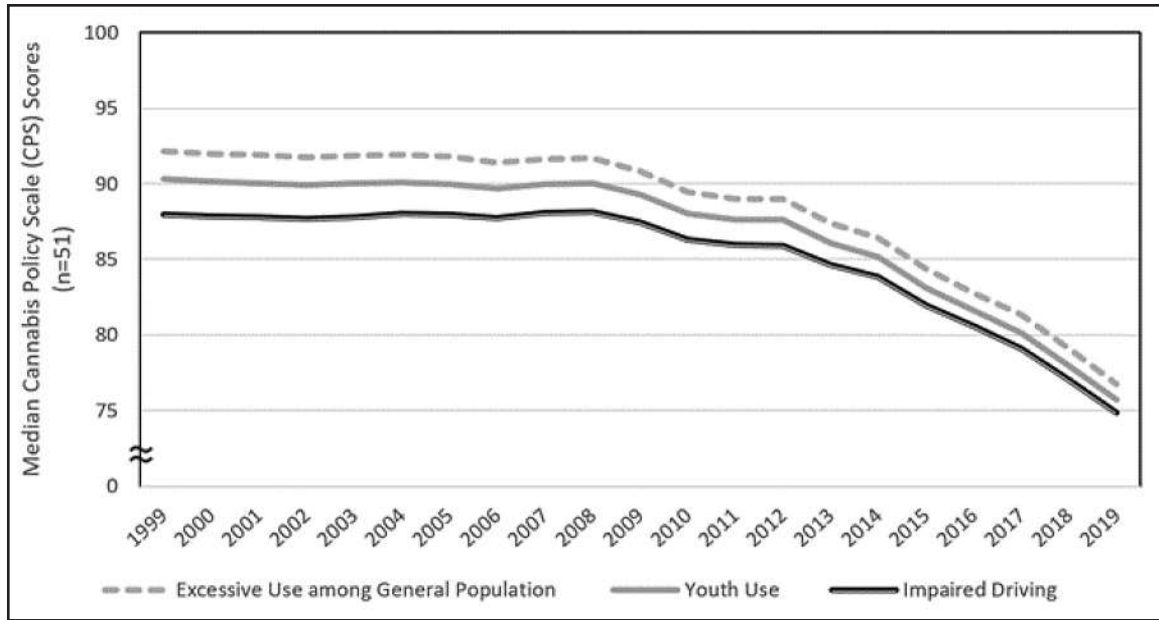
FIGURE 1. Median state Cannabis Policy Scale (CPS) scores as rated to reduce excessive cannabis use among the general population, youth cannabis use, and cannabis-impaired driving, by year from 1999 to 2019. The three CPS scores were calculated using the same methods, except that the efficacy ratings differed based on outcome (i.e., the presumed efficacy for reducing excessive cannabis use among the general population, youth cannabis use, or cannabis-impaired driving). Lines represent the average of state scores for each outcome.

TABLE 1. Mean implementation rating (IR) scores for the 17 policies comprising the Cannabis Policy Scale for U.S. states and Washington, D.C.—1999, 2009, and 2019

Cannabis policy[a]	Mean policy-specific IR during 1999, 2009, and 2019 (possible range: 0.0–1.0)		
	1999	2009	2019
Average of all 17 policies	0.88	0.86	0.72
Advertising restrictions	1.00	0.98	0.87
Cannabis possession limits	0.98	0.92	0.71
Clean air and smoke-free laws	0.20	0.37	0.52
Cultivation and manufacturing operations restrictions and requirements	0.99	0.98	0.82
Delivery restrictions of recreational cannabis to consumers	1.00	1.00	0.96
Home cultivation restrictions	0.97	0.89	0.74
Impaired-driving laws	0.47	0.51	0.52
Medical cannabis restrictions and requirements	0.95	0.82	0.59
Packaging and labeling restrictions and requirements	0.99	0.96	0.69
Penalties for adults who possess cannabis for personal use	0.65	0.63	0.50
Physical retail availability restrictions	0.99	0.98	0.84
Product design restrictions and requirements	0.99	0.98	0.75
Retail price restrictions	1.00	0.98	0.83
Retail operations	1.00	0.98	0.85
Taxes	1.00	0.99	0.86
Track-and-trace requirements	0.98	0.92	0.56
Youth policies	0.76	0.76	0.60

[a]Government-controlled monopoly (state owns all production, manufacturing, or retail operations) was excluded from the aggregate scale construction because no U.S. state has adopted the policy. Minimum pricing was excluded because the policy does not yet exist in any U.S. state, and developing a policy description for inclusion in the scale was not feasible given difficulties in determining a relevant and plausible price floor value (e.g., because of lack of state implementation of the policy and significant fluctuation of prices in the developing cannabis markets). Government prevention was excluded because of the lack of data for all states and years of the study period, challenges with operationalizing aspects of government prevention, and the national scope of some government prevention initiatives.
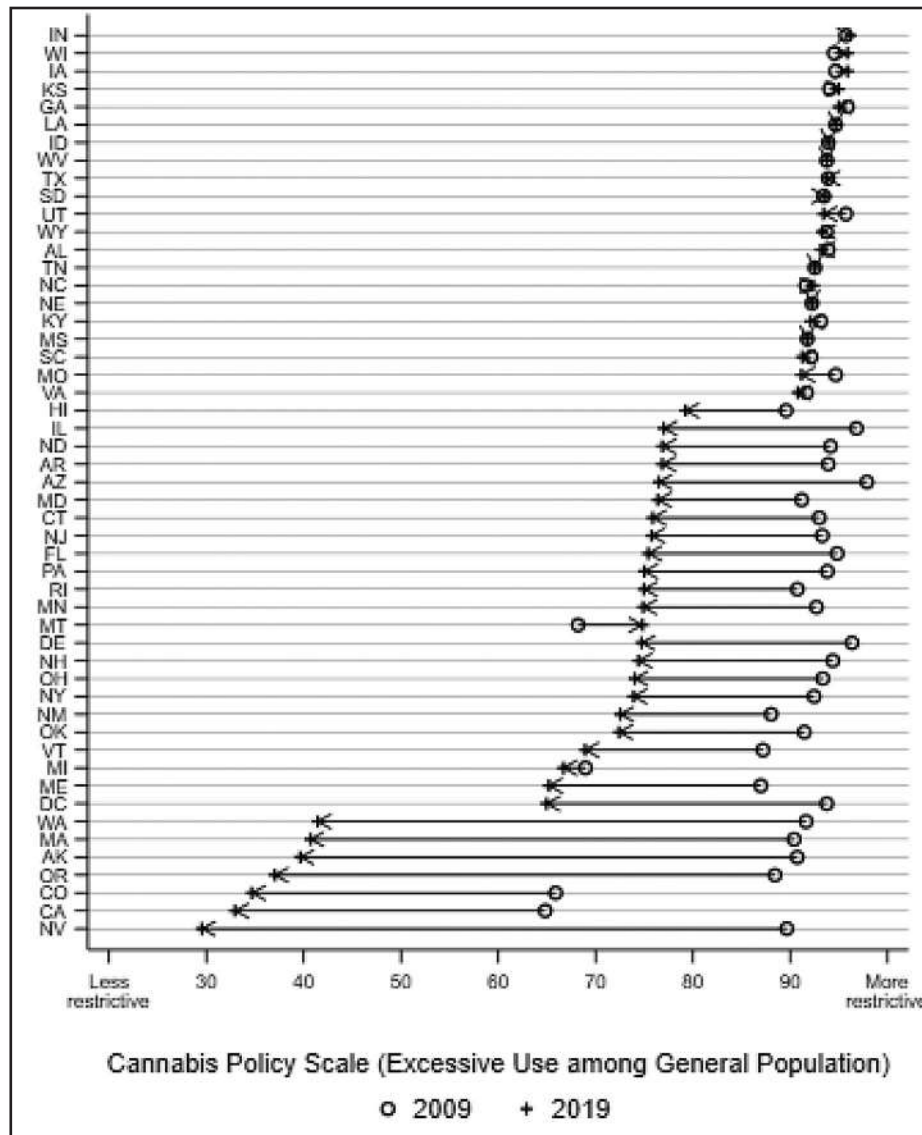
FIGURE 2.　Changes in state Cannabis Policy Scale: Excessive Use in the General Population (CPS:EUGP) scores between 2009 and 2019

(RCL) during that period from 14 to 32. However, seven states increased their CPS:EUGP scores from 2009 to 2019 (Figure 2). Except for Montana, all these states lacked legalization of cannabis for medical or recreational use, and their CPS:EUGP scores increased by less than 2 points (Montana's score increased by 6 points). Again, compared to scores using ERs for reducing excessive cannabis consumption among adults, results were very similar when using youth-specific or impaired driving–specific ERs (compare online Appendix Figures D, E, and F with Figure 2).

　　CPS:EUGP scores declined as states enacted decriminalization, MCL, and RCL policies (Figure 3). By June 30, 2019 (end of the study period), 17 states that maintained prohibition (failed to decriminalize cannabis or legalize cannabis for medical or recreational use) had a median and

range of CPS scores that remained very similar compared to scores for the 36 prohibition states in 2005 and the 27 prohibition states in 2012 (Figure 3). However, there was a meaningful amount of variation in policy stringency between states within the medical and recreational use phenotypes. For example, among states with RCL, the highest CPS score was 2.3 times higher than the lowest CPS:EUGP score. Even among states that allowed commercial availability of cannabis for recreational use, the highest CPS:EUGP score was 40% higher than the lowest CPS:EUGP score. The range of scores for MCL states in 2012 and 2019 overlapped with scores for states that had neither MCL nor RCL, indicating that some MCL states had more stringent cannabis policy environments than did states that had not legalized for any use.
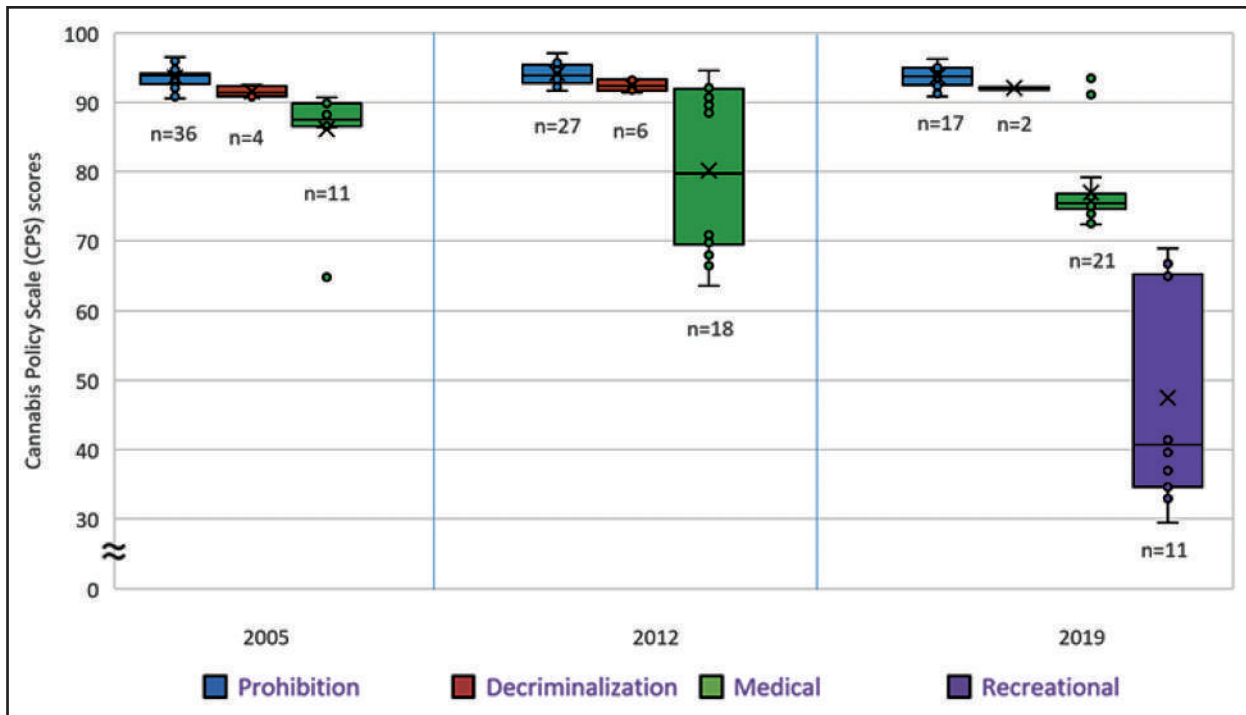
FIGURE 3. Distribution of state Cannabis Policy Scale: Excessive Use in the General Population (CPS:EUGP) scores for years 2005, 2012, and 2019 by state phenotype (prohibition, decriminalization without medical cannabis legalization [MCL], MCL without recreational cannabis legalization [RCL], and RCL). Boxes show interquartile ranges of CPS scores; lines outside of the boxes show ranges except for outliers; "x" symbols show the means; lines within the boxes show the medians; and dots represent data points. Prohibition states are those where possession of small amounts of cannabis for personal use was a criminal offense as of June 30 of the given year regardless of whether possession was for medical use; decriminalization states are those where possession of at least 10 grams of cannabis for personal use was decriminalized but not legalized for any type of use (i.e., medical) as of June 30 of the given year; medical states are those where medical use was legal but possession for nonmedical/recreational use was not legal as of June 30 of the given year; and recreational states are those where possession of cannabis for nonmedical/recreational use was legal as of June 30 of the given year.

Furthermore, 2019 RCL-state scores overlapped with 2012 MCL-state scores, indicating that some states without RCL had more permissive cannabis environments in 2012 than did some RCL states in 2019. From 2012 to 2019, the mean of CPS:EUGP scores for MCL states decreased (from 80.1 to 77.0), which indicates that the overall MCL environment became more permissive over time (e.g., MCL states increasingly allowed for commercial availability of medical cannabis). However, 9 of the 18 states that were MCL states in 2012 had scores that were lower than every one of the scores of states that were MCL states in 2019, which indicates that the most permissive MCL states of 2019 had enacted increased policy restrictiveness (e.g., increased industry regulations) relative to the most permissive MCL states of 2012. Over time, the between-state regulatory variation in CPS scores among MCL states decreased, with the standard deviation of CPS:EUGP scores for MCL states decreasing from 11.7 in 2012 to 5.3 in 2019.

By 2019, Nevada had the lowest CPS:EUGP score (29.6), and Indiana had the highest (96.2) (Figures 2 and 4). Midwest states tended to have higher CPS scores and included the three states (Indiana, Wisconsin, and Iowa) with the

highest scores in 2019. Michigan was the only Midwest state among those with the top 10 lowest scores. Pacific states had relatively low scores, with four of the five Pacific states (Alaska, California, Oregon, and Washington) among the seven states with the lowest scores.

Discussion

To our knowledge, the CPS represents the first comprehensive scale developed for cannabis policy in the United States. The CPS trends reflect the rapid liberalization of cannabis policies in U.S. states, particularly after 2012. There was substantial variation within states over time and substantial variation between states in any particular year. For the most part, declining scores represented adoption of new laws for MCL and RCL, rather than loosening of previously existing laws. Not surprisingly, cannabis policy differences between states were far greater in 2019 than in 2009, since a number of states had yet to adopt either MCL or RCL as of 2009.

Our analyses in Figure 3 show that early on in the liberalization process (through 2012) there was limited variation within some of the policy phenotype, and yet still we saw
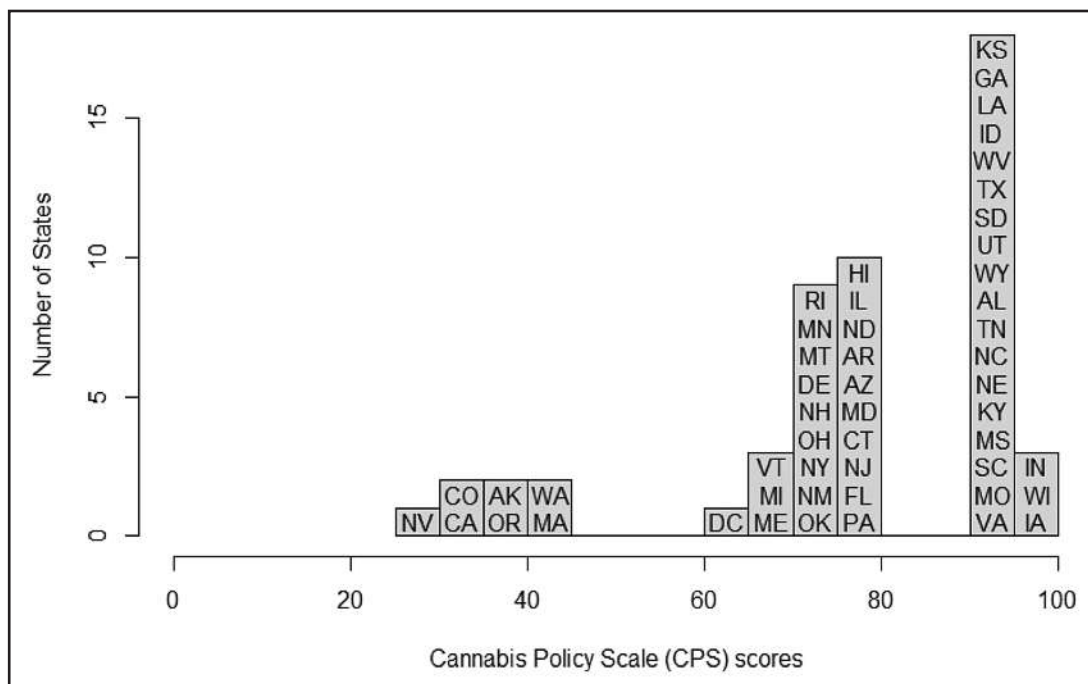
FIGURE 4.   Distribution of state Cannabis Policy Scale: Excessive Use in the General Population (CPS:EUGP) scores, 2019

CPS:EUGP scores overlapped across phenotypes (i.e., some states with MCL had scores that overlapped those of states that had no MCL, and some earlier MCL states had scores that overlapped with some RCL states). Moreover, Figure 3 also shows that scores shifted over time within phenotypes. For example, the MCL policy environment became more permissive from 2012 to 2019 but with a much narrower range, which shows that the MCL environment at the end of the study period was vastly different than just years earlier. This evidence shows the problem of simply categorizing states according to phenotype (i.e., prohibition, medical cannabis, recreational cannabis legalization) during this period of rapid policy change, as these classifications do not uniquely or sufficiently characterize the cannabis policy environment across states or over time.

Moving forward, these scores may be useful for comparing states with respect to their overall cannabis policy environments and for assessing change within states over time. This information can assist researchers with evaluating how groups of policies, individual policies, and the overall policy environment relates to cannabis-related behaviors (excessive use, impaired driving), as well as use of and harms from substances that are potentially interrelated with cannabis, such as alcohol and tobacco. Policymakers and public health practitioners may also use this information as a starting point to initiate a conversation about policy, as a piece of the puzzle for determining whether advancing policy is desirable, for evaluating policy, and as a tool to advocate for or against changes in laws.

Methods to develop the CPS were largely similar to those used to construct the APS (Naimi et al., 2014). However, there were a number of important differences. Alcohol policy as it relates to public health is relatively stable, and so its measure included a relatively static mix of policies. By contrast, the rapid changes in cannabis policy over a short period required us to adjust the scale to fit the policy landscape in the earlier half of the study period, as well as the latter half, and to design a scale that could also be a useful tool in future years. The recent liberalization of cannabis policy also meant there was a weaker evidence base (i.e., fewer research studies) to inform efficacy ratings. Furthermore, there were many secondary sources for alcohol laws that covered all years of the study period for the APS, whereas secondary data sources for cannabis laws were limited in number and each source generally covered a limited number of years. Those differences increased the time and challenges to develop the CPS.

This study is subject to additional caveats and limitations. First, the policies' efficacy and implementation ratings were informed by available scientific evidence and the opinions of a selected panel of experts. However, an alternate group may have drawn different conclusions regarding the relative efficacy and implementation ratings of certain cannabis policies. The CPS is intended to correlate with certain behaviors (i.e., excessive use and impaired driving) and, as such, some provisions considered favorable are not necessarily ideal provisions when taking other factors into consideration. For example, it may not be beneficial to society to send adults to

jail or to impose large fines on youth for simple possession of small amounts of cannabis, or to restrict patient access to medicines.

Second, an important motivating factor for the legalization of cannabis over the last decade has been to increase racial equity by reducing harms through the criminal justice system. The CPS was created to assess cannabis policies through a public health rather than a social justice lens. However, that is not to say that cannabis policies do not have effects on equity, and this research should be explored in the future.

Third, as we could not ask panelists about all policies in all contexts, we excluded some policies (e.g., minimum pricing) and policy provisions that do not yet exist but could in the future, and we asked panelists to rate policies in the context of federal prohibition. It is likely that the set of included policies and panelist ratings would differ in the context of federal legalization.

Finally, this scale was created for the context of the United States and is not intended for comparison with indices from other countries. It is possible that policy efficacy and implementation could differ widely across cultural contexts. However, similar methods could be used as a framework to potentiate future cross-country comparisons.

Subsequent work will validate the CPS by comparing its ability to explain variance in cannabis consumption and cannabis-related outcomes among states, particularly in comparison with cruder measures (e.g., state policy phenotypes). The CPS may be particularly helpful in policy assessment in RCL states, where there is a great deal of variability in how laws are constructed, in which case the CPS would be helpful for aiding research about the effects of cannabis policies, individually and in aggregate, to improve public health. The CPS is a simple metric that policymakers can use to understand how their policies sit relative to other states and how policy changes they make may strengthen public health. Last, the CPS captures additional dimensions and available options that policymakers may not initially consider when planning policy changes regarding cannabis.

Conclusions

The CPS is a nuanced scale of cannabis legalization that reflects trends toward liberalization of cannabis policy in many U.S. states. Even within crude policy phenotypes (e.g., medical cannabis programs), CPS scores varied considerably between states and over time. The scale can be used to advance scientific research, inform policy decisions, and implement policy surveillance.

Conflict-of-Interest Statement

The authors have no conflicts of interest to declare.

References

Brand, D. A., Saisana, M., Rynn, L. A., Pennoni, F., & Lowenfels, A. B. (2007). Comparative analysis of alcohol control policies in 30 countries. *PLoS Medicine, 4,* e151. doi:10.1371/journal.pmed.0040151

Chapman, S. A., Spetz, J., Lin, J., Chan, K., & Schmidt, L. A. (2016). Capturing heterogeneity in medical marijuana policies: A taxonomy of regulatory regimes across the United States. *Substance Use & Misuse, 51,* 1174–1184. doi:10.3109/10826084.2016.1160932

Coleman, S. M., Lira, M. C., Blanchette, J., Heeren, T. C., & Naimi, T. S. (2021). Alcohol policies, firearm policies, and suicide in the United States: A lagged cross-sectional study. *BMC Public Health, 21,* 366. doi:10.1186/s12889-021-10216-x

Feliu, A., Fernández, E., Baena, A., Joossens, L., Peruga, A., Fu, M., & Martínez, C. (2020). The Tobacco Control Scale as a research tool to measure country-level tobacco control policy implementation. *Tobacco Induced Diseases, 18,* 91. doi:10.18332/tid/128318

Feliu, A., Filippidis, F. T., Joossens, L., Fong, G. T., Vardavas, C. I., Baena, A., . . . Fernández, E. (2019). Impact of tobacco control policies on smoking prevalence and quit ratios in 27 European Union countries from 2006 to 2014. *Tobacco Control, 28,* 101–109. doi:10.1136/tobaccocontrol-2017-054119

Hadland, S. E., Xuan, Z., Blanchette, J., Sarda, V., Swahn, M. H., Heeren, T. C., & Naimi, T. S. (2016). Alcohol policies and motor vehicle injury fatalities among underage youth in the United States. *Journal of Adolescent Health, 58,* S13–S14. doi:10.1016/j.jadohealth.2015.10.042

Hadland, S. E., Xuan, Z., Blanchette, J. G., Heeren, T. C., Swahn, M. H., & Naimi, T. S. (2015). Alcohol policies and alcoholic cirrhosis mortality in the United States. *Preventing Chronic Disease, 12,* E177. doi:10.5888/pcd12.150200

Hadland, S. E., Xuan, Z., Sarda, V., Blanchette, J., Swahn, M. H., Heeren, T. C., . . . Naimi, T. S. (2017). Alcohol policies and alcohol-related motor vehicle crash fatalities among young people in the US. *Pediatrics, 139,* e20163037. doi:10.1542/peds.2016-3037

Hublet, A., Schmid, H., Clays, E., Godeau, E., Gabhainn, S. N., Joossens, L., & Maes, L. (2009). Association between tobacco control policies and smoking behaviour among adolescents in 29 European countries. *Addiction, 104,* 1918–1926. doi:10.1111/j.1360-0443.2009.02686.x

Joossens, L., & Raw, M. (2006). The Tobacco Control Scale: A new scale to measure country activity. *Tobacco Control, 15,* 247–253. doi:10.1136/tc.2005.015347

Kilmer, B., & Pacula, R. L. (2017). Understanding and learning from the diversification of cannabis supply laws. *Addiction, 112,* 1128–1135. doi:10.1111/add.13623

Korcha, R. A., Witbrodt, J., Cherpitel, C. J., Ye, Y., Andreccutti, G., Kang, J., & Monteiro, M. (2018). Development of the international alcohol policy and injury index. *Revista Panamericana de Salud Pública, 42,* e6. doi:10.26633/RPSP.2018.6

Lira, M. C., Sarda, V., Heeren, T. C., Miller, M., & Naimi, T. S. (2020). Alcohol policies and motor vehicle crash deaths involving blood alcohol concentrations below 0.08. *American Journal of Preventive Medicine, 58,* 622–629. doi:10.1016/j.amepre.2019.12.015

Lira, M. C., Xuan, Z., Coleman, S. M., Swahn, M. H., Heeren, T. C., & Naimi, T. S. (2019). Alcohol policies and alcohol involvement in intimate partner homicide in the U.S. *American Journal of Preventive Medicine, 57,* 172–179. doi:10.1016/j.amepre.2019.02.027

MacDonald, Z., Tinsley, L., Collingwood, J., Jamieson, P., & Pudney, S. (2005). *Measuring the harm from illegal drugs using the Drug Harm Index.* doi:10.1037/e634772007-001

McFadden, M. (2006). The Australian Federal Police Drug Harm Index: A new methodology for quantifying success in combating drug use. *Australian Journal of Public Administration, 65,* 68–81. doi:10.1111/j.1467-8500.2006.00505a.x

Moxham-Hall, V. (2019). *Investigating the utility of indexes in comparative drug policy analysis.* (Doctoral dissertation, University of New South Wales, Sydney, Australia). Retrieved from https://doi.org/10.26190/unsworks/21372

Moxham-Hall, V. L., & Ritter, A. (2017). Indexes as a metric for drug and alcohol policy evaluation and assessment. *World Medical & Health Policy, 9,* 103–126. doi:10.1002/wmh3.218

Naimi, T. S., Blanchette, J., Nelson, T. F., Nguyen, T., Oussayef, N., Heeren, T. C., . . . Xuan, Z. (2014). A new scale of the U.S. alcohol policy environment and its relationship to binge drinking. *American Journal of Preventive Medicine, 46,* 10–16. doi:10.1016/j.amepre.2013.07.015

Naimi, T. S., Xuan, Z., Cooper, S. E., Coleman, S. M., Hadland, S. E., Swahn, M. H., & Heeren, T. C. (2016). Alcohol involvement in homicide victimization in the U.S. *Alcoholism: Clinical and Experimental Research, 40,* 2614–2621. doi:10.1111/acer.13230

Naimi, T. S., Xuan, Z., Sarda, V., Hadland, S. E., Lira, M. C., Swahn, M. H., . . . Heeren, T. C. (2018). Association of state alcohol policies with alcohol-related motor vehicle crash fatalities among US adults. *JAMA Internal Medicine, 178,* 894–901. doi:10.1001/jamainternmed.2018.1406

Nardo, M., & Saisana, M. (2008). *OECD/JRC Handbook on constructing composite indicators. Putting theory into practice.* Retrieved from http://ec.europa.eu/eurostat/documents/1001617/4398416/S11P3-OECD-EC-HANDBOOK-NARDO-SAISANA.pdf

Nardo, M., Saisana, M., Saltelli, A., Tarantola, S., Hoffman, A., & Giovannini, E. (2005). *Handbook on constructing composite indicators: Methodology and user guide.* OECD Statistics Working Papers 2005/3. doi:10.1787/533411815016

Pacula, R. L., Powell, D., Heaton, P., & Sevigny, E. L. (2015). Assessing the effects of medical marijuana laws on marijuana use: The devil is in the details. *Journal of Policy Analysis and Management, 34,* 7–31. doi:10.1002/pam.21804

Pacula, R. L., & Smart, R. (2017). Medical marijuana and marijuana legalization. *Annual Review of Clinical Psychology, 13,* 397–419. doi:10.1146/annurev-clinpsy-032816-045128

Richard, E. L., Althouse, A. D., Arnsten, J. H., Bulls, H. W., Kansagara, D., Kerbag, M. N., . . . Starrels, J. L. (2021). How medical are states' medical cannabis policies?: Proposing a standardized scale. *International Journal of Drug Policy, 94,* 103202. doi:10.1016/j.drugpo.2021.103202

Ritter, A. (2007). Comparing alcohol policies between countries: Science or silliness? *PLoS Medicine, 4,* e153. doi:10.1371/journal.pmed.0040153

Ritter, A. (2009). Methods for comparing drug policies—The utility of composite drug harm indexes. *International Journal of Drug Policy, 20,* 475–479. doi:10.1016/j.drugpo.2009.02.012

Saisana, M., & Tarantola, S. (2002). *State-of-the-art report on current methodologies and practices for composite indicator development.* Ispra, Italy: European Commission-Joint Research Centre, Institute for the Protection and Security of the Citizen. Retrieved from https://op.europa.eu/en/publication-detail/-/publication/9253d939-b47b-4428-b792-619e6b6c8645

Sevigny, E. L., & Saisana, M. (2016). Measuring interstate variations in the consequences of illegal drugs: A composite indicator approach. *Social Indicators Research, 128,* 501–529. doi:10.1007/s11205-015-1042-2

Simons-Morton, B., Pickett, W., Boyce, W., ter Bogt, T. F., & Vollebergh, W. (2010). Cross-national comparison of adolescent drinking and cannabis use in the United States, Canada, and the Netherlands. *International Journal of Drug Policy, 21,* 64–69. doi:10.1016/j.drugpo.2009.02.003

Smart, R., & Pacula, R. L. (2019). Early evidence of the impact of cannabis legalization on cannabis use, cannabis use disorder, and the use of other substances: Findings from state policy evaluations. *American Journal of Drug and Alcohol Abuse, 45,* 644–663. doi:10.1080/00952990.2019.1669626

Williams, A. R., Olfson, M., Kim, J. H., Martins, S. S., & Kleber, H. D. (2016). Older, less regulated medical marijuana programs have much greater enrollment rates than newer 'medicalized' programs. *Health Affairs, 35,* 480–488. doi:10.1377/hlthaff.2015.0528