Changes in Cannabis Use-Related Factors Prior to a Self-Quit Attempt in Young Adults

Cannabis
2020, Volume 3 (1), 31-40
© Author(s) 2019
researchmj.org
DOI: 10.26828/cannabis.2020.01.004


OPEN ACCESS

Lydia A. Shrier[1,2], Ziming Xuan[3], Sion Kim Harris[1,2]
[1] Division of Adolescent/Young Adult Medicine, Boston Children's Hospital, Boston, MA, USA
[2] Department of Pediatrics, Harvard Medical School, Boston, MA, USA
[3] Boston University School of Public Health, Boston, MA, USA

ABSTRACT

Young adults who use cannabis frequently often attempt to quit on their own and may try several times before achieving cessation. Preparing to quit may increase the likelihood that abstinence will be achieved. However, little is known about the process of preparing to quit in this population and how that process relates to patterns of use during the quit attempt. In a community sample of 18-25 year olds reporting daily/near-daily cannabis use and planning to quit (N=34), we assessed changes in momentary and daily cannabis use-related factors during two weeks prior to a self-quit attempt, and evaluated whether these changes predicted abstinence, time to lapse, and cannabis use days during the 2-week quit attempt. Several factors changed from the first week to the second week prior to the quit attempt, including decrease in momentary positive affect, cannabis craving, availability, situational permissibility, use since last report, bad feeling following use, daily withdrawal symptoms and use in the past 24 hours, and increase in momentary and daily confidence to not use cannabis. Greater difference in cannabis use days between two weeks and one week (decrease in use) before the self-quit attempt predicted all three measures of quit success, including abstinence, longer time to lapse, and fewer use days. In summary, young adults preparing to quit cannabis demonstrated changes in advance of quitting that may reflect preparatory actions; only reducing cannabis use before a quit date predicted success with attempting abstinence. Further research on pre-quit changes will be important for developing effective tools and strategies to aid frequently-using young adults to successfully quit on their own.

Key words: cannabis, young adults, quit attempts, ecological momentary assessment

Young adults have the highest rates of frequent cannabis use of any age group; in 2017, from 6% (18 year olds) to 9.2% (23–24 year olds) used cannabis daily or near-daily (Miech et al., 2018; Schulenberg et al., 2018). Not surprisingly, young adults also have the highest rates of cannabis use disorder (CUD); in 2016, approximately 1.7 million young adults aged 18 to 25 (5%) had a CUD in the past year (Substance Abuse and Mental Health Services Administration, 2017). Rates of CUD are increasing among young adults (Hasin, Shmulewitz, & Sarvet, 2019). Despite the high risk of harm from early onset and heavy cannabis use (Volkow, Baler, Compton, & Weiss, 2014), only a small fraction of young adults with CUD receive substance use treatment (Substance Abuse and Mental Health Services Administration, 2017).

Corresponding Author: Lydia A. Shrier, Division of Adolescent/Young Adult Medicine, Boston Children's Hospital, 300 Longwood Avenue, Boston, MA 02115, email: lydia.shrier@childrens.harvard.edu, phone: 617-355-8306, fax: 617-730-0004.

Young adulthood is a unique developmental period marked by rising educational and occupational demands and shifting roles and relationships (Arnett, 2000). In this life course context (Hser, Longshore, & Anglin, 2007; Liebregts et al., 2013), many young adults using cannabis frequently recognize problems with their use and will attempt abstinence on their own, often briefly, repeatedly, and unsuccessfully (Copersino et al., 2006; Cunningham, 2000; Hughes, Naud, Budney, Fingar, & Callas, 2016; Shrier, Rhoads, Burke, Walls, & Blood, 2014). However, limited research has examined the process of self-quitting cannabis among frequently-using young adults.

Studies in adults suggest many factors that may facilitate or impede quitting, including cannabis effect expectancies (Boden, McKay, Long, & Bonn-Miller, 2013), negative affect (Buckner, Zvolensky, & Ecker, 2013), social context (e.g., being in situations where peers are using (Buckner et al., 2013), social support (Pettersen et al., 2019), self-efficacy and motivation to quit (Zvolensky et al., 2018), and withdrawal symptoms (Buckner et al., 2013; Levin et al., 2010). In a study of young adults age 18-25 years intending to quit daily/near-daily cannabis use, we conducted baseline assessments and then used Ecological Momentary Assessment (EMA) to evaluate momentary and daily cannabis use-related factors over two weeks prior to a self-quit attempt (Shrier, Sarda, Jonestrask, & Harris, 2018). We found that being in situations that permitted use, along with having lower baseline negative marijuana effect expectancies, perceived family support, and abstinence self-efficacy, predicted lapse during the quit attempt.

Although we instructed participants to use marijuana as they usually did for the two weeks, we observed that their use frequency declined from two weeks to one week before the quit attempt. We hypothesized that participants may have been preparing to quit to increase the likelihood that they would achieve abstinence (Hughes et al., 2016). Through analysis of the EMA intensive longitudinal momentary and daily data, we thus sought to answer the following research questions:

1) How do cannabis use-related factors change during the two weeks before a quit attempt?

2) Do changes in cannabis use-related factors pre-quit predict success during a quit attempt?

METHOD

Participants

We recruited a community sample of individuals age 18-35 years using cannabis ("marijuana") daily or near-daily (at least 5 days per week in the past 3 months) who wanted to quit and planned to try on their own; details of the study have been described (Shrier et al., 2018). In brief, we posted Craigslist recruitment advertisements twice a day from November, 2015 through October, 2016 (prior to legalization of recreational marijuana in the state where the study was conducted); 105 age-eligible individuals expressed interest and 66 (62.9%) were screened by phone.

Eligible individuals were not currently in treatment, were willing to abstain from cannabis for two weeks during the study, had their own smartphone, would not be out of their usual routines during the study period, and did not report hazardous alcohol consumption on the Alcohol Use Disorders Identification Test-Consumption (AUDIT-C) (Babor, Higgins-Biddle, Saunders, & Monteiro, 2001). Forty enrolled, of which 34 were included in the analyses (5 had a negative urinary tetrahydrocannabinol screen and 1 did not report use during the 2-week pre-quit use assessment period). Participants were a mean (+SD) age of 22.0 (+2.5) years and 16 (47.1%) were female; nearly all (91%) were in school or working. They began using cannabis at a young age [M(+SD) = 15.0+2.0 years] and all but 2 participants (94%) met criteria for cannabis use disorder. The investigators' affiliated institutional review board approved the study. At the end of study participation, individuals received up to $250 remuneration and information about marijuana and marijuana treatment.

Procedures

At baseline, participants completed a computerized survey that included sociodemographic characteristics and substance use history, and a timeline follow-back (TLFB) calendar of the past 28 days of substance use. Participants then put the study application

("app"; MetricWire, Inc.) on their personal smartphone and received training on completion of the EMA reports. Each day for 4 weeks, the app emitted signals at 6 quasi-random times (momentary reports) and one scheduled time (10 pm; daily reports). Momentary reports queried marijuana use since last signal, craving, marijuana availability, situational permissibility of marijuana use, and confidence not to use marijuana. Report of marijuana use prompted questions about the context of use, including companionship, time of day, reason for use, and feelings about use. Daily reports queried cannabis withdrawal symptoms, motivation to quit marijuana (readiness, importance, and confidence), social support (in general, for using marijuana, and for quitting marijuana), and past-24-hour marijuana use. After 2 days of practice, participants completed EMA reports for two weeks using marijuana as usual ("pre-quit"), then were instructed by text message and/or phone call to abstain for marijuana for two weeks ("quit attempt") while continuing to complete EMA reports. EMA response rates in this study (Shrier et al., 2018) were comparable to those in other substance use studies (meta-analysis pooled response rate, 75.06% (Jones et al., 2019). Participants completed a 28-day TLFB calendar of use at the end of the 4 weeks of EMA reporting. All participants (100%) completed baseline and follow-up surveys and TLFB calendars.

Measures

Marijuana use. We assessed marijuana use on each of the three data sources. On the momentary reports, we asked, "Since the last signal you answered, have you used marijuana?" and, if yes, when (early morning 12:00 am - 5:55 am, morning 6:00 am - 11:55 am, afternoon 12:00 pm - 5:55 pm, evening 6:00 pm - 11:55 pm). We identified the date of the use event based on the time block and the dates of the current and previous reports. On the daily reports, we asked whether the participant had used marijuana in the past 24 hours (yes/no). On the TLFB calendar, we recorded each marijuana event for the 28 days before starting EMA data collection and for the 28 days of EMA data collection (2 weeks pre-quit and 2 weeks during quit attempt; the 2-day practice period was not included).

Momentary variables. We assessed momentary affect with four positive and four negative items adapted from the Positive Affect-Negative Affect Schedule (Watson, Clark, & Tellegen, 1988; Shrier et al., 2014b); responses (1-Not at all to 5-Extremely) were summed and averaged to create positive and negative affect scores (each 1-5). We measured momentary craving for marijuana as "such a strong desire to use marijuana that you felt you would not be able to keep from using" (yes/no) (Johnston, O'Malley, Bachman, & Schulenberg, 2013; Litt, Cooney, & Morse, 1998; Shrier et al., 2014a). Participants reported ease of acquiring marijuana in the moment on a 5-point scale (Shrier et al., 2012), which we dichotomized into Very/Fairly easy vs Fairly difficult/Very difficult/Impossible owing to the skewed distribution. Participants also reported situational permissibility by responding to the question, "If you had marijuana, would you be able to use it in your current situation?" (yes/no) (Litt, Kadden, & Kabela-Cormier, 2009). We measured momentary confidence to abstain on a scale from 0-Not very confident to 9-Very confident (Shrier et al., 2014a).

Use event variables. When participants reported using marijuana since the last signal, they were prompted to report whether they used alone (yes/no) and, if not, with whom (family, friends, acquaintances, other). They also reported why they used marijuana (for social reasons, to cope with negative feelings, for pleasure, to conform to what others were doing, to expand my mind) (Simons et al., 1998); based on prior research (Ross et al., 2018), we examined using to cope vs. using for other reasons. We asked participants how they felt in general about the use (1-Very bad to 5-Very good) (Shiffman et al., 1997), dichotomized into bad (Very bad/A little bad) vs. other, and how guilty they felt (0-Not at all to 3-Very) (Shiffman et al., 1997), dichotomized into any guilt vs. none.

Daily variables. We measured withdrawal symptom intensity (19 items, each 0-10) and negative impact on normal daily activities (19 items, each 0-10) using the Cannabis Withdrawal Scale (Allsop, Norberg, Copeland, Fu, & Budney, 2011). Participants reported their daily motivation to quit marijuana on confidence, readiness, and importance scales (each 0-9). They indicated the degree of social support from the four people most important to them on three

items: general support, support of your marijuana use, and support of you stopping your marijuana use (each 0-9) (Zimet, Powell, Farley, Werkman, & Berkoff, 1990).

Analyses

We examined descriptive statistics for the momentary and daily variables by week (2 weeks and 1 week before the quit attempt), then compared the variables between the two pre-quit weeks. Bivariate analyses for dichotomous variables utilized the chi-square test in SUDAAN 11.0.1 software to account for clustering of observations within individuals. For continuous variables, we ran linear regression models with generalized estimating equations, nesting observations within individuals. Next, we created difference variables (2 weeks minus 1 week before the quit attempt) for those momentary and daily cannabis-use related factors significantly different between the two pre-quit weeks and examined the Pearson r correlations between these change variables. We conducted linear regression modeling to assess the association between changes in cannabis use-related factors before the quit attempt and each of the three outcomes for success during the quit attempt: 1) abstinence (no vs. any use during the 2-week quit attempt); 2) days to first cannabis use (lapse) as a time-to-event variable; and 3) number of cannabis use days as a continuous outcome. Specifically, we employed a logit link function for the outcome of any use, an identity link function for the outcome of use days, and used Cox regression to analyze time to first use (lapse) during the abstinence period. We applied a backward elimination procedure to identify the most parsimonious model in predicting each outcome. We conducted these regression analyses using SAS version 9.4 (SAS Institute, Inc.). Results with $p<0.05$ were deemed statistically significant.

RESULTS

Several factors related to cannabis use significantly changed from two weeks to one week prior to the self-quit attempt (Table 1). Among the momentary factors, positive affect, craving, availability, and being in a situation that permitted cannabis use declined, and confidence to not use increased across the weeks. Among the use event factors, use since last momentary report and bad feeling after use also declined. Among the daily factors, cannabis withdrawal symptoms and use in the past 24 hours decreased and confidence to not use increased.

Of the variables that changed significantly over the two weeks prior to the abstinence attempt, change in daily confidence to not use was positively correlated with change in momentary confidence to not use ($r = .63$) and negatively correlated with change in momentary craving ($r = -.57$). There were no other significant correlations among the significant change variables.

Approximately one-fifth of participants (21%) abstained from cannabis for the 2-week attempted abstinence period (Table 2). Time to first use was a mean of 1.52 days. Participants used a median of 7 out of 14 days. Only change in number of cannabis use days during the pre-quit period was significantly associated with each of the three quit success outcomes, such that greater difference in cannabis use days between 2 weeks and 1 week (decrease in use) before quit attempt predicted quit success. For each 1-day increase in the difference in cannabis use days from 2 weeks to 1 week (decrease in cannabis use days) before the quit attempt, the likelihood of abstinence increased by 2.73 times. For each 1-day increase in difference (decrease) in cannabis use days from 2 weeks to 1 week pre-quit, the hazard rate for lapse was reduced by 35%, although not significant at $p<0.05$. A greater difference in cannabis use days from 2 weeks to 1 week pre-quit predicted fewer days of use during the quit attempt, such that for each 1-day decrease in cannabis use days pre-quit, the number of days of use during the quit attempt was decreased by 1.6 days.

DISCUSSION

Young adults using cannabis daily/near-daily reported changes in several use-related factors in the two weeks prior to a self-quit attempt, including decreases in positive affect, cannabis craving, cannabis availability, situational permissibility, bad feeling following use, and withdrawal symptom intensity, and increase in confidence to not use cannabis. The findings suggest that participants were preparing to quit by spending less time in contexts in which they could easily obtain or use cannabis (e.g., by

changing where they spent time to avoid cannabis or by not having cannabis around in the contexts

Table 1. *Change in Cannabis Use-Related Factors 2 Weeks to 1 Week Before a Self-Quit Attempt*

Factor	T-2 weeks, *M*	T-1 week, *M*	Test statistic	*p*
Momentary	*n* = 1012	*n* = 921		
Positive affect (1-5)	3.14	2.97	β = 7.25	0.007
Negative affect (1-5)	1.85	1.85	β = 0.00	0.99
Craving (any)	24.2%	18.0%	χ^2 = 11.10	<0.01
Craving intensity (1-10)	6.9	6.5	β =.706	0.40
Availability	65.9%	58.7%	χ^2 = 10.5	0.001
Situational permissibility	61.1%	51.5%	χ^2 = 18.4	<0.0005
Confidence to not use (0-9)	6.7	6.9	β = 5.15	0.02
Use Event	*n* = 308	*n* = 216		
Use since last report	30.4%	23.5%	χ^2 = 12.0	0.001
Context of use				
At home	55.5%	53.2%	χ^2 = 0.27	0.61
In morning	30.0%	31.0%	χ^2 = 0.06	0.81
With friends	53.4%	45.8%	χ^2 = 2.86	0.09
Alone	32.7%	37.1%	χ^2 = 1.1	0.30
Use to cope	13.7%	12.2%	χ^2 = 0.23	0.63
Bad feeling about use	12.3%	6.9%	χ^2 = 4.4	0.04
Guilt after use	38.0%	35.7%	χ^2 = 0.30	0.58
Daily	*n* = 198	*n* = 179		
Cannabis withdrawal symptom intensity (0-190)	26.78	19.27	β = 3.09	<0.01
Cannabis withdrawal symptom negative impact (0-190)	17.22	13.81	β = 1.46	0.15
Motivation to not use (each 0-9)				
Confidence	6.27	6.87	β = -2.28	0.02
Readiness	5.49	6.03	β = -1.91	0.057
Importance	4.44	4.77	β = -1.04	0.30
Social support (each 0-9)				
General	5.76	5.75	β = 0.02	0.98
You using cannabis	4.59	4.43	β = 0.50	0.62
You not using cannabis	5.73	5.87	β = -0.45	0.65
Use in past 24 hours	76.9%	56.0%	χ^2 = 18.5	<0.01

Table 2. *Difference in Use Days from 2 Weeks to 1 Week Before a Self-Quit Attempt Predicting Quit Success Outcomes*

Outcome	Descriptive Statistics	Model	Estimate	Test statistic	*p*
Abstinence	21% (7/34)	Logistic regression	1.00	χ^2 = 6.03	0.01
Time to lapse	*M*(±*SD*) = 1.52(±0.94) days	Cox proportional hazard	-0.43	χ^2 = 3.82	0.05
Days of use	*Mdn*(*IQR*) = 7(2-12) days	Linear regression	-1.62	*t* = 2.05	0.049

where they spent time). Consistent with this finding, adults not in treatment have reported the perception that changing their environment was the most helpful strategy for quitting (Boyd et al.,

2005). It would be useful in future research to assess whether participants changed their cannabis acquisition to reduce their access or whether they told people close to them about their impending quit attempt, which has been associated with longer duration of abstinence (Hughes et al., 2016). Participants may have been feeling less positive over time as they anticipated their attempt at cannabis cessation, while also feeling less badly about their use and more confident in their ability to quit. Anticipation of an event that has positive and negative aspects to it (such as a quit attempt) is, not surprisingly, also an ambivalent experience (Kruschwitz et al., 2018). Ambivalence is a hallmark of the contemplation stage of change (Prochaska & Velicer, 1997), consistent with our recruitment of individuals who wished to quit cannabis.

Young adults in this study also reported using cannabis less frequently over the two weeks prior to their self-quit attempt. Reducing cannabis use in preparation for quitting may be considered a form of practicing abstinence. In so far as frequent cannabis use is a learned behavior, decreasing use frequency prior to quitting may foster learning during behavior extinction that contributes to subsequent successful behavior change (McCarthy, Bold, Minami, & Yeh, 2016). Consistent with this perspective, only reduction in cannabis use days prior to the quit attempt was associated with successful abstinence, as well as longer time to lapse and fewer use days during the quit attempt. Among smokers, reducing cigarettes per day increases the probability of cessation (Klemperer & Hughes, 2016). Additionally, in a study of adults smoking cigarettes daily, prescribed practice quitting prior to a target quit day delayed time to first lapse and prevented relapse among those who lapsed (McCarthy et al., 2016). Among adults intending to quit cannabis in the next three months, those who tried and failed to quit in the first month were more likely than those who did not have an unsuccessful quit attempt to try again in the second or third month, suggesting that repeated efforts to quit are part of the process of change in cannabis use behavior and may represent motivation to change (Hughes et al., 2016). As suggested by the limited prior research on adults attempting to stop or reduce cannabis use (Hughes et al., 2016; Hughes, Peters, Callas, Budney, & Livingston, 2008), our findings support the view that quitting cannabis exists on a behavior change continuum that begins with pre-quit changes.

As noted above, we observed that cannabis withdrawal symptom intensity declined (and negative impact of withdrawal symptoms also declined, although non-significantly) over the two weeks before the quit attempt. These changes were not correlated with decline in cannabis use frequency. The symptoms assessed with the Cannabis Withdrawal Scale are not specific to cannabis withdrawal and include lack of appetite, nausea, problems falling or staying asleep, restlessness, and other physical symptoms, as well as thoughts about cannabis or being stoned and negative mood. Some of these symptoms may motivate cannabis use and/or be a consequence of use. For example, difficulty with sleep is an intense cannabis withdrawal symptom that causes significant distress (Allsop, et al., 2011), a symptom that may prompt using cannabis (Lee, Neighbors, Hendersot, & Grossbard, 2009; Lintzeris, Driels, Elias, Arnold, McGregor, & Allsop, 2018), and a symptom that can result from cannabis use (Babson, Sottile, & Morabito, 2017). We did not assess reasons for changes in withdrawal symptoms, which may have been unrelated to cannabis use per se, but may have been related to anticipating cannabis cessation. Participants may have prepared for quitting by developing new health behaviors (e.g., eating or sleeping routines) or employing cognitive strategies (e.g., to distract from thinking about cannabis), resulting in a reduction in symptoms on the Cannabis Withdrawal Scale.

Our findings have implications for further research and for treatment. Although the majority of cannabis quit attempts appear to be preceded by a variety of preparatory activities (Hughes et al., 2016), we found that only reducing use was associated with quit success. Support for individuals wishing to quit frequent cannabis use may be strengthened by emphasizing use reduction prior to a quit attempt. Research is needed to determine whether formal abstinence practice improves quit success, as seen in a modest way for cigarette smoking (McCarthy et al., 2016). Further, although a self-report method, EMA assesses near-real time feelings, thoughts, contexts, and behaviors without necessarily requiring individuals to opine about the linkages among these constructs or to share their intent. In other words, the momentary and daily

assessments can be "just the facts," leaving determination of associations and patterns to the researchers. Future research should marry this approach with quantitative and qualitative information about the how and why of the changes we observed. For example, did participants intentionally change their environments? Avoid cannabis use opportunities? Avoid using even in the face of opportunity? How did they feel about the changes they made prior to trying to quit? Development of rapid assessment and feedback tools to study and intervene on this highly dynamic and individualized change process will inform research on and, ultimately, recommendations for strategies for optimizing self-quit success.

This study has several limitations. First, the sample was small and drawn from a single urban area in the northeastern United States, potentially limiting generalizability to other populations of young adults using cannabis frequently and planning to quit. Second, nationally, the legal and social landscape of cannabis use is rapidly changing toward more favorable attitudes and easier access to cannabis. These developments may influence quit motivations, pre-quit strategies, cannabis-related environments, and measures of quit success; replication and expansion on this study is required to elucidate the self-quit process in the current context. Third, participants may have changed their responses or behaviors as a result of the frequent assessments. Previous studies have been mixed on the effect of EMA self-monitoring alone on frequency of substance use (Litt, Cooney, & Morse, 1998; Peters & Hughes, 2009). Reactivity to EMA may be more likely to occur with extended periods of assessment, e.g., 8-12 weeks (Wray, Merrill, & Monti, 2014), review). We did not formally assess EMA reactivity in this study. However, we believe the phenomenon is unlikely to have occurred for at least two reasons. Although we saw changes in the pre-quit period in directions suggesting preparation for quitting, in general the significant changes from 2 weeks to 1 week pre-quit were not correlated with each other (the exception being daily confidence to not use and craving); we would have expected change secondary to response reactivity to result in highly correlated change among the variables. Additionally, even if reactivity occurred in our study, to influence the results of our analyses reactive changes would have to differ between those who reduced, delayed, or ceased cannabis use during the quit attempt, and those who did not. Fourth, we did not assess cannabis quantity or potency; it is possible that participants changed cannabis dose in the pre-quit period (e.g., decreased dose as part of preparing to quit, or increased dose to counter effects of reduced use frequency). Fifth, pre-quit strategies and quit success may have been influenced by the study-prescribed quit date. Finally, we observed an attempted abstinence period of only two weeks' duration. Individuals using cannabis frequently may make multiple, brief attempts to quit and may achieve use reduction rather than abstinence (Hughes et al., 2016); further research over longer periods are required to determine the effects of pre-quit changes on cannabis use and abstinence over time.

In summary, young adults preparing to quit cannabis in the context of a research study demonstrated changes in advance of quitting that may reflect preparatory actions. Only the often-recommended strategy of reducing use of a substance prior to attempting cessation was associated with improved success with trying not to use cannabis following the quit date. Further EMA research on momentary and daily changes in anticipation of cannabis cessation will be important for developing effective pre-quit tools and strategies to aid young adults using cannabis frequently to successfully quit on their own.

REFERENCES

Allsop, D. J., Norberg, M. M., Copeland, J., Fu, S., & Budney, A. J. (2011). The Cannabis Withdrawal Scale development: Patterns and predictors of cannabis withdrawal and distress. *Drug and Alcohol Dependence, 119*(1-2), 123-129.

Arnett, J. J. (2000). Emerging adulthood. A theory of development from the late teens through the twenties. *The American Psychologist, 55*(5), 469-480.

Babor, T. F., Higgins-Biddle, J. C., Saunders, J. B., & Monteiro, M. G. (2001). *The Alcohol Use Disorders Identification Test: Guidelines for Use in Primary Care. Second edition.* Retrieved from

Babson, K.A., Sottile, J. & Morabito, D. (2017). Cannabis, cannabinoids, and sleep: A review

of the literature. *Current Psychiatry Reports, 19*(4), 23. https://doi.org/10.1007/s11920-017-0775-9

Boden, M. T., McKay, J. R., Long, W. R., & Bonn-Miller, M. O. (2013). The effects of cannabis use expectancies on self-initiated cannabis cessation. *Addiction, 108*(9), 1649-1657. doi:10.1111/add.12233

Boyd, S. J., Tashkin, D. P., Huestis, M. A., Heishman, S. J., Dermand, J. C., Simmons, M. S., & Gorelick, D. A. (2005). Strategies for quitting among non-treatment-seeking marijuana smokers. *American Journal on Addictions, 14*(1), 35-42. doi:10.1080/10550490590899835

Buckner, J. D., Zvolensky, M. J., & Ecker, A. H. (2013). Cannabis use during a voluntary quit attempt: An analysis from ecological momentary assessment. *Drug and Alcohol Dependence, 132*(3), 610-616. doi:10.1016/j.drugalcdep.2013.04.013

Copersino, M. L., Boyd, S. J., Tashkin, D. P., Huestis, M. A., Heishman, S. J., Dermand, J. C., . . . Gorelick, D. A. (2006). Quitting among non-treatment-seeking marijuana users: Reasons and changes in other substance use. *American Journal on Addictions, 15*(4), 297-302. doi:10.1080/10550490600754341

Cunningham, J. A. (2000). Remissions from drug dependence: Is treatment a prerequisite? *Drug and Alcohol Dependence, 59*(3), 211-213.

Hasin, D. S., Shmulewitz, D., & Sarvet, A. L. (2019). Time trends in US cannabis use and cannabis use disorders overall and by sociodemographic subgroups: A narrative review and new findings. *American Journal of Drug and Alcohol Abuse*, 1-21. doi:10.1080/00952990.2019.1569668

Hser, Y. I., Longshore, D., & Anglin, M. D. (2007). The life course perspective on drug use: a conceptual framework for understanding drug use trajectories. *Evaluation Review, 31*(6), 515-547. doi:10.1177/0193841x07307316

Hughes, J. R., Naud, S., Budney, A. J., Fingar, J. R., & Callas, P. W. (2016). Attempts to stop or reduce daily cannabis use: An intensive natural history study. *Psychology of Addictive Behaviors, 30*(3), 389-397. doi:10.1037/adb0000155

Hughes, J. R., Peters, E. N., Callas, P. W., Budney, A. J., & Livingston, A. E. (2008). Attempts to stop or reduce marijuana use in non-treatment seekers. *Drug and Alcohol Dependence, 97*(1-2), 180-184. doi:10.1016/j.drugalcdep.2008.03.031

Jones, A., Remmerswaal, D., Verveer, I., Robinson, E., Franken, I. H. A., Wen, C. K. F., & Field, M. (2019). Compliance with ecological momentary assessment protocols in substance users: A meta-analysis. *Addiction, 114*(4), 609-619. doi:10.1111/add.14503

Klemperer, E. M., & Hughes, J. R. (2016). Does the magnitude of reduction in cigarettes per day predict smoking cessation? A qualitative review. *Nicotine & Tobacco Research, 18*(1), 88-92. doi:10.1093/ntr/ntv058

Kruschwitz, J. D., Waller, L., List, D., Wisniewski, D., Ludwig, V. U., Korb, F., . . . Walter, H. (2018). Anticipating the good and the bad: A study on the neural correlates of bivalent emotion anticipation and their malleability via attentional deployment. *Neuroimage, 183*, 553-564. doi:10.1016/j.neuroimage.2018.08.048

Lee, C. M., Neighbors, C., Hendershot, C. S., & Grossbard, J. R. (2009). Development and preliminary validation of a comprehensive marijuana motives questionnaire. *Journal of Studies on Alcohol and Drugs*, *70*(2), 279–287. doi:10.15288/jsad.2009.70.279

Levin, K. H., Copersino, M. L., Heishman, S. J., Liu, F., Kelly, D. L., Boggs, D. L., & Gorelick, D. A. (2010). Cannabis withdrawal symptoms in non-treatment-seeking adult cannabis smokers. *Drug and Alcohol Dependence, 111*(1-2), 120-127. doi:10.1016/j.drugalcdep.2010.04.010

Liebregts, N., van der Pol, P., Van Laar, M., de Graaf, R., van den Brink, W., & Korf, D. J. (2013). The role of study and work in cannabis use and dependence trajectories among young adult frequent cannabis users. *Frontiers in Psychiatry, 4*, 85. doi:10.3389/fpsyt.2013.00085

Lintzeris, N. , Driels, J. , Elias, N. , Arnold, J. C., McGregor, I. S. and Allsop, D. J. (2018), Medicinal cannabis in Australia, 2016: The Cannabis as Medicine Survey (CAMS-16). *Medical Journal of Australia*, 209: 211-216. doi:10.5694/mja17.01247

Litt, M. D., Cooney, N. L., & Morse, P. (1998). Ecological momentary assessment (EMA) with treated alcoholics: Methodological problems and potential solutions. *Health Psychology, 17*(1), 48-52.

McCarthy, D. E., Bold, K. W., Minami, H., & Yeh, V. M. (2016). A randomized clinical trial of a tailored behavioral smoking cessation preparation program. *Behaviour Research and Therapy, 78*, 19-29. doi:10.1016/j.brat.2015.11.015

Miech, R. A., Johnston, L. D., O'Malley, P. M., Bachman, J. G., Schulenberg, J. E., & Patrick, M. E. (2018). *Monitoring the Future national survey results on drug use, 1975–2017: Volume I, Secondary school students*. Retrieved from Ann Arbor: http://monitoringthefuture.org/pubs.html#monographs

Peters, E. N., & Hughes, J. R. (2009). The day-to-day process of stopping or reducing smoking: A prospective study of self-changers. *Nicotine & Tobacco Research, 11*(9), 1083-1092. doi:10.1093/ntr/ntp105

Pettersen, H., Landheim, A., Skeie, I., Biong, S., Brodahl, M., Oute, J., & Davidson, L. (2019). How social relationships influence substance use disorder recovery: A collaborative narrative study. *Substance Abuse, 13*, 1178221819833379. doi:10.1177/1178221819833379

Prochaska, J. O., & Velicer, W. F. (1997). The transtheoretical model of health behavior change. *American Journal of Health Promotion, 12*(1), 38-48. doi:10.4278/0890-1171-12.1.38

Ross, C. S., Brooks, D. R., Aschengrau, A., Siegel, M. B., Weinberg, J., & Shrier, L. A. (2018). Positive and negative affect following marijuana use in naturalistic settings: An ecological momentary assessment study. *Addictive Behaviors, 76*, 61-67. doi:10.1016/j.addbeh.2017.07.020

Schulenberg, J. E., Johnston, L. D., O'Malley, P. M., Bachman, J. G., Miech, R. A., & Patrick, M. E. (2018). *Monitoring the Future national survey results on drug use, 1975–2017: Volume II, College students and adults ages 19–55*. Retrieved from Ann Arbor: http://monitoringthefuture.org/pubs.html#monographs

Shrier, L. A., Rhoads, A., Burke, P. J., Walls, C., & Blood, E. A. (2014). Real-time, contextual intervention using mobile technology to reduce marijuana use among youth: A pilot study. *Addictive Behaviors, 39*, 173-180. doi:10.1016/j.addbeh.2013.09.028

Shrier, L. A., Sarda, V., Jonestrask, C., & Harris, S. K. (2018). Momentary factors during marijuana use as predictors of lapse during attempted abstinence in young adults. *Addictive Behaviors, 83*, 167-174. doi:10.1016/j.addbeh.2017.12.032

Substance Abuse and Mental Health Services Administration. (2017). *Key substance use and mental health indicators in the United States: Results from the 2016 National Survey on Drug Use and Health*. Retrieved from Rockville, MD: Retrieved from https://www.samhsa.gov/data/

Volkow, N. D., Baler, R. D., Compton, W. M., & Weiss, S. R. (2014). Adverse health effects of marijuana use. *New England Journal of Medicine, 370*(23), 2219-2227. doi:10.1056/NEJMra1402309

Wray, T. B., Merrill, J. E., & Monti, P. M. (2014). Using Ecological Momentary Assessment (EMA) to assess situation-level predictors of alcohol use and alcohol-related consequences. *Alcohol Research: Current Reviews, 36*(1), 19-27.

Zvolensky, M. J., Paulus, D. J., Garey, L., Manning, K., Hogan, J. B. D., Buckner, J. D., . . . Kathryn McHugh, R. (2018). Perceived barriers for cannabis cessation: Relations to cannabis use problems, withdrawal symptoms, and self-efficacy for quitting. *Addictive Behaviors, 76*, 45-51. doi:10.1016/j.addbeh.2017.07.011

Funding: This research was funded by the Boston Children's Hospital Research Faculty Council and presented in part at the 3rd annual meeting of the Research Society on Marijuana in Vancouver, WA in July 2019.

Copyright: © 2019 Authors et al. This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction, provided the original author and source are credited, the original sources is not modified, and the source is not used for commercial purposes.