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Does Accessibility of Cannabis Mediate the Relation Between Method of Acquisition and Cannabis Use Frequency among Adolescents?

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ABSTRACT

Cannabis use frequency among adolescents is associated with negative outcomes. Two variables associated with cannabis use frequency are method of acquisition and accessibility of cannabis. Prior research on the relation between methods of acquisition and cannabis use frequency is sparse. Differences in cannabis use in states in which the sale of recreational cannabis is legal (recreational states) compared to states in which it is not warrants research on how adolescents acquire cannabis in recreational states, and how easy it is for them to do so. The primary way in which adolescents acquire cannabis and the ease by which they can acquire cannabis may be associated with cannabis use frequency via specific interactions. We hypothesized that primarily acquiring cannabis from a store would be positively associated with cannabis use frequency when compared to other primary methods of acquisition, and that accessibility would meditate relations between primary method of acquisition and cannabis use frequency. This study used data from high school students who completed the 2019 Healthy Kids Colorado Survey (HKCS) who reported using cannabis in the past 30 days. Results indicated that primary method of acquisition was significantly differentially associated with 30-day cannabis use frequency, with participants who reported buying cannabis at a store reporting significantly higher 30-day cannabis use frequency than any other method of acquisition. Ease of accessibility was not significantly associated with 30-day cannabis use frequency and did not significantly mediate the relation between primary method of acquisition and 30-day cannabis use frequency. Results of the current study indicate that the ways in which adolescents acquire cannabis are associated with how often they use it. Further, the positive relation between primarily acquiring cannabis at stores and frequency of use provide evidence that access to stores may be a risk factor for cannabis use frequency among adolescents.

Key words: = cannabis stores; Healthy Kids Survey; perceived harmfulness

Cannabis use frequency among adolescents is associated with impaired cognition (Estoup et al., 2016), mental health problems (Buckner et al., 2010), risky behaviors (Caldeira et al., 2008), negative physical health outcomes (Aldington et al., 2008), and other negative outcomes (Simons et al., 2012). While research has identified certain factors associated with cannabis use, two understudied variables are method of acquisition (King et al., 2016) and ease of accessibility (Epstein et al., 2015; Haas et al., 2018). The ways in which these two variables interact and relate to cannabis use frequency is currently unknown. Prior research on the relation between cannabis accessibility and cannabis use frequency has largely used measures that are associated with state-wide accessibility (e.g. legalization status; Parnes et al., 2018), while studies that utilize self-

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report measures of accessibility are sparse. Similarly, prior research on the relation between methods of acquisition and cannabis use frequency has neglected several methods of acquisition and is sparse. The ways in which adolescents acquire cannabis and the ease by which they can acquire it may be associated with cannabis use frequency via specific interactions. More specifically, it is likely that certain methods of acquisition are related to varying levels of accessibility, and in turn, are associated with use frequency.

Based on prior research, the relation between method of acquisition and cannabis use frequency may be partially explained by the relation between method of acquisition and accessibility, followed by the relation between accessibility and cannabis use frequency (Harpin et al., 2018; Epstein et al., 2020; Anderson et al., 2019; Haas et al., 2018). For example, if adolescents are able to acquire cannabis at cannabis stores via the use of a fake ID, they may be able to access cannabis more easily, which would in turn partially explain how this method of acquisition may be associated with an increase in cannabis use frequency. The association between method of cannabis acquisition and cannabis accessibility is currently unknown.

There is evidence that cannabis use among the general population tends to increase following legalization (Epstein et al., 2020). Research has shown that daily, weekly, and monthly cannabis use are significantly higher among individuals living in recreational states, (Goodman et al., 2020) and legalization of recreational cannabis were associated with an increase in past year cannabis use (Bailey et al., 2020). This association between legalization and cannabis use appears to apply to adolescents as well as adults, as increases in cannabis use and perceived accessibility among adolescents have been observed after medical and nonmedical cannabis legalization (Mason et al., 2016; Borodovsky et al., 2017; Azofeifa et al., 2016). For example, cannabis use significantly increased among 8th and 10th graders after Washington state legalized recreational use (Anderson et al., 2019), and adolescents in Colorado reported that acquiring cannabis is easier after the implementation of recreational stores (Harpin et al., 2018).

Adolescent cannabis use in recreational states is significantly higher than in non-recreational states (Harpin et al., 2018); this warrants research on how adolescents acquire cannabis in recreational states, and how easy it is for them to do so. Cannabis legalization increases the number of methods by which an individual can acquire cannabis, as people over the age of 21 are able to purchase cannabis at cannabis stores and legally grow their own cannabis (Epstein et al., 2020). These additional methods of acquisition may result in people using cannabis more frequently. Further, the increased accessibility for adults may also impact the extent to which cannabis products are accessible to adolescents. That is, recreational legalization increases the amount of cannabis present in communities and the number of products accessible (Kepple & Freisthler, 2018), which may "trickle down" to the supply of cannabis products available to adolescents.

Few studies have examined the ways in which accessibility is associated with cannabis use. One such study found higher levels of community cannabis availability to be positively associated with chronic cannabis use trajectories in adolescents (Epstein et al., 2015). Additionally, a recent study exploring the interactions between adolescent use patterns, impulsivity, and ease of access to cannabis found that cannabis accessibility was positively associated with adolescent cannabis use (Haas et al., 2018). Researchers also identified a significant positive correlation between adolescent impulsivity and cannabis use was significantly moderated by the perceived level of access to cannabis (Haas et al., 2018).

Similarly, few studies have examined how method of acquisition is associated with cannabis use. One such study found that buying cannabis in a home, apartment, or dorm was positively associated with frequency of cannabis use among adolescents (King et al., 2016). This study also found that ~60% of adolescents did not buy cannabis the last time they used it, while ~40% of adolescents paid for cannabis, and 1.4% of adolescents reported that they traded something else for the cannabis they acquired. Further, researchers found that sex, ethnicity, age of initiation, and 30-day frequency were all associated with method of acquisition. Adolescents who used cannabis frequently were more likely to acquire cannabis for free than individuals who reported using cannabis infrequently (King et al., 2016). There is evidence that the most common way adolescents acquire cannabis is from friends,

though researchers did not ask participants to distinguish if they bought it or were given the cannabis for free (Wagner et al., 2021). A study conducted in Amsterdam found that among adolescents, the most common place to acquire cannabis was in coffeeshop/stores (Harrison et al., 2007). Moreover, one study found that the availability of cannabis stores was positively associated with a higher rates of use among 8th and 10th graders (Shi, 2016). These studies provide evidence that the presence of stores be positively associated with adolescent cannabis use.

Research has supported the idea that method of acquisition is associated with adolescent cannabis use (King et al., 2016), although research examining why method of acquisition is associated with adolescent cannabis use is limited. One explanation of this association may be that the ability to acquire cannabis via certain methods may increase accessibility to cannabis. For example, if adolescents can acquire cannabis from stores using fake ID's, their ability to access cannabis may be greater, as they can acquire from a source that virtually always has a supply of cannabis products. Higher accessibility to cannabis products has been shown to be positively associated with cannabis use (Epstein et al., 2015). Therefore, accessibility to cannabis may mediate the relation between primary method of acquisition and cannabis use.

One aim of this study was to examine how primary methods of acquisition vary in the ways they are associated with cannabis frequency. Another aim of this study was to examine if relations among primary methods of acquisition and cannabis use frequency are mediated by accessibility to cannabis. The purpose of these aims was to clarify the role accessibility plays in the associations between primary methods of acquisition and cannabis use frequency. One focus of the current study was to add to the existing literature regarding how cannabis legalization and policy may be related to adolescent cannabis use. Therefore, hypotheses of the current study focus on acquiring cannabis from stores. Based on the literature reviewed, we hypothesized that acquiring cannabis from a store would be significantly positively associated with cannabis use frequency compared to other primary methods of acquisition and that accessibility would meditate relations between primary methods of acquisition and cannabis use frequency. We hypothesized that the positive relation between primarily acquiring cannabis from a store and cannabis use frequency compared to other primary methods of acquisition would be partially explained by the positive relation between primarily acquiring cannabis from a store and accessibility, followed by positive the relation between ease of accessibility and cannabis use frequency.

METHODS

Sample

This study used data from high school students who completed the 2019 Healthy Kids Colorado Survey (HKCS), an anonymous biennial survey assessing the health and wellness of middle and high school students in Colorado (Colorado Department of Public Health and Environment [CDPHE], 2020). Given study hypotheses, we restricted the sample to only those adolescents who reported using cannabis in the 30 days prior to the day they completed the survey. HKCS is funded by the Colorado Departments of Education, Human Services, Public Safety, and Public Health and Environment and more than 30 additional organizations. The 2019 data were collected via a two-stage stratified cluster design from 46,537 students at 166 randomly selected high schools across 49 Colorado counties with a 52% response rate (CDPHE, 2020). For this study, we only analyzed data from participants who endorsed using cannabis in the 30 days prior to completing the survey (n= 4,370, described in Participants section). Schools were granted monetary compensation for participating in the survey and teachers were given verbal prompts and instructional videos to show to students before they completed the survey. The superintendents, school districts, principals, parents, and student participants were told they could withdraw from the survey at any time. HKCS was available in English and Spanish and both online and on paper based on school and student needs (CDPHE, 2020). Colorado State University Institutional Review Board approved the secondary data analyses of this data presented herein.

The survey was administered during a regular scheduled class period, and students were released back to their normal activities after the survey was completed. There were two modules of the 2019 survey, Module A and Module B, that incorporated

Table 1. *Sociodemographic Characteristics of Participants*

	n	*%*
Sex		
Male	2211	51.28
Female	2101	48.72
Gender Identity*		
Not transgender	4052	95.14
Transgender	76	1.78
Unsure if they are transgender	54	1.27
Do not understand the question	77	1.81
Race		
Non-Hispanic, White	2190	51.00
Hispanic/Latino/a/x	1610	37.49
Multiple Races	238	5.54
Black or African American	117	2.72
Asian	62	1.44
American Indian/Alaskan Native	58	1.35
Native Hawaiian or Other Pacific Islander	20	0.47

Note. N = 4,370. Participants were on average 15.98 years old (SD = 1.17).

* Participants were provided answer options for "No, I am not transgender," "Yes, I am transgender," "I am not sure if I am transgender," and "I do not know what this question is asking," so it is possible that participants whose gender identity was beyond transgender and cisgender (e.g., genderqueer, gender non-conforming, two-spirit) selected other answer options.

planned missingness to reduce the number of questions each participant answered. The present study used data from respondents who completed a subset of cannabis questions that were included in Module B assessing how one obtains cannabis, frequency of cannabis use, and accessibility of cannabis.

Participants

The analytic sample consisted of 4,370 participants between the ages of 12 and 18 (M = 15.98, SD = 1.17) who endorsed using cannabis in the 30 days prior to test administration. When asked about biological sex, 48.7% of participants identified as female and 51.3% identified as male. See Table 1 for a full summary of the sociodemographic characteristics.

Study Measures

To measure cannabis accessibility, students were asked, "During the past 30 days, how did you usually get the marijuana that you used?" Students were instructed to select one of the following options: "I did not use marijuana in the past 30 days," "I bought it at a marijuana store or center," "I bought it from someone else," "A parent or family member over the age of 21 gave it to me," "A friend over the age of 21 gave it to me," "Someone under the age of 21 gave it to me," and "I took it without permission from the owner." For the purposes of the present study, the answer options for "A parent or family member over the age of 21 gave it to me" and "A friend over the age of 21 gave it to me" were combined into one answer option that represented participants obtained cannabis from someone over the age of 21. This variable was treated as a categorical independent variable that was dummy coded with purchase at a store or center as the reference category. Frequencies for each option are presented in Table 2.

To measure ease of accessibility to cannabis, students were asked, "If you wanted to get some marijuana, how easy would it be for you to get some?" Answer options included: "Very hard," "Sort of hard," "Sort of easy," and "Very easy." This variable serves as a pseudo-continuous mediator in the present study. The descriptive statistics for this variable a presented in Table 2.

Table 2. *Variable Descriptives*

Variable	
Cannabis Acquisition	*% Endorsed*
"I bought it at a marijuana store"	3.9
"I bought it from someone else"	37.5
"Someone over the age of 21 gave it to me"	22.6
"Someone under the age of 21 gave it to me"	31.1
"I took it without permission from the owner"	4.9
Cannabis Accessibility	
"If you wanted to get some marijuana, how easy would it be for you to get some?"	*% Endorsed*
"Very easy"	31.2
"Sort of easy"	19.9
"Sort of hard"	16.8
"Hard"	32.1
Cannabis Use	*M (SD)*
"During the past 30 days, how many times did you use marijuana?"	3.6 (1.5)
30-Day Cannabis Use Frequency by Acquisition Category	*M (SD)*
"I bought it at a marijuana store"	4.7 (1.5)
"I bought it from someone else"	3.9 (1.5)
"Someone over the age of 21 gave it to me"	3.6 (1.5)
"Someone under the age of 21 gave it to me"	2.8 (1.1)
"I took it without permission from the owner"	3.9 (1.5)

Note. Cannabis Frequency scale 1 = "1 or 2 times," 2 = "3 to 9 times," 3 = "10 to 19 times," 4 = "20 to 39 times" and 5 = "40 or more times."

Students cannabis use was measured by a question asking, "During the past 30 days, how many times did you use marijuana?" Answer options included: "0 times," "1 or 2 times," "3 to 9 times," "10 to 19 times," "20 to 39 times" and "40 or more times." This variable was treated as a pseudo-count variable, with 0 =0, 1 = 1 to 2 times, 2 = 3 to 9 times, 3 = 10 to 19 times, 4 = 20 to 39 times, and 5 is 40 or more times. Descriptive statistics are presented in Table 2.

Analyses

The present study investigated the differential associations of methods of cannabis acquisition with 30-day cannabis use frequency and the mediating effect of accessibility of cannabis on the relation between methods of cannabis acquisition and 30-day cannabis use frequency in a sample of adolescents who reported using cannabis in the 30 days prior to the day they completed the survey. Initially a Little's MCAR test (Little, 1988) was conducted in SPSS, Version 27.0 (IBM Corp, 2020) to determine if there were patterns of missing data. We treated method of acquisition as the independent variable, ease of acquisition as the mediating variable, and cannabis use in the previous 30 days as the dependent variable. Given the distribution of the dependent variable (under-dispersed pseudo-count), study hypotheses were tested using Poisson regression (Tutz, 2011). in R, Version 4.0.5 (Shake & Throw; R Code Team, 2013). In Poisson regression, parameter estimates are exponentiated to calculate the incidence rate ratio (IRR) for ease of interpretation. Given that the independent variable was categorical, we compared methods of acquisition via dummy coding. Mediation was tested by multiplying the independent variable with the mediator, resulting in a dummy coded mediator. Alpha was set to 0.05 for all analyses.

RESULTS

Results of the Little's MCAR analysis indicated that data were missing completely at random (c^2 = 0.69, df = 2, p = 0.71). Results of the Poisson regression indicated that the hypothesized model

adequately fit the data (2270.634 4148 1(c^2 = 22.70, 63, *df* = 4148, p = 0.51). When examining the direct effects, results indicated that the methods of acquisition were significantly obtaining cannabis from a store or center was more strongly associated with 30-day frequency of use than were the other methods of acquisition ($p < 0.05$). The results from the Poisson regression are presented in Table 3. The results also indicated that ease of accessibility was not significantly associated with 30-day cannabis use frequency (Table 4). Ease of accessibility also did not significantly mediate the relation between methods of acquisition and 30-day cannabis use frequency (Figure 1). Specifically, the interaction term between primary method of acquisition and ease of acquisition did not significantly predict 30-cannabis use frequency for any method of acquisition.

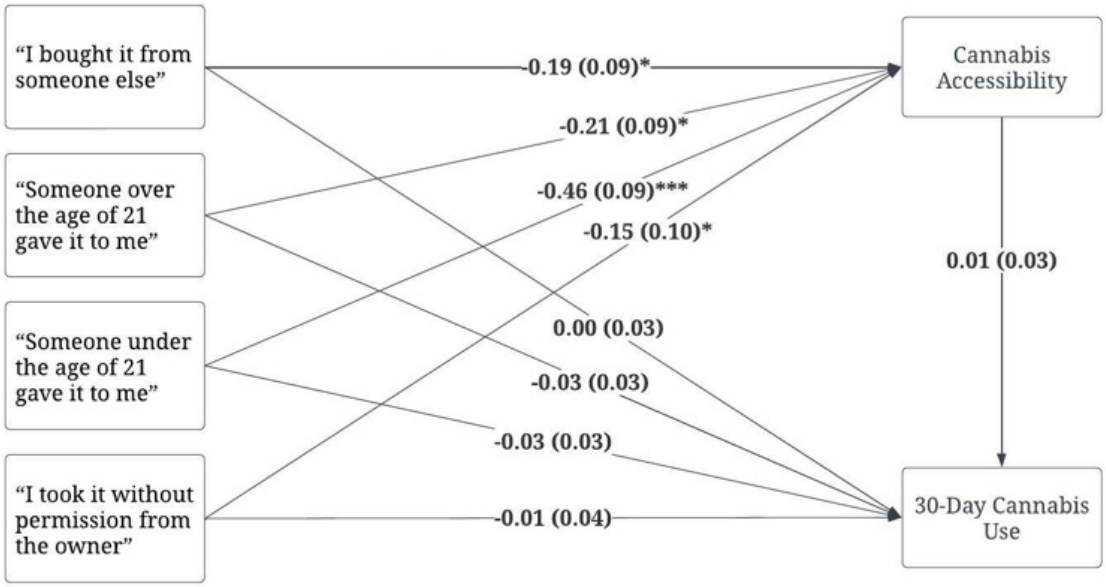
Subsequent exploratory analyses of the results indicated that individuals who reported "I bought it at a marijuana store or center," reported significantly higher 30-day cannabis use frequency than any other category (Table 3). Differences between the other categories were inconsequential, though individuals who reported that, in the last 30 days, they typically acquired cannabis by having a friend under the age of 21 give it to them reported the lowest 30-day cannabis use frequency. Means for 30-day cannabis use frequency by acquisition category are reported in Table 2.

Table 3. *30-Day Cannabis Use Frequency Predicted by Primary Method Acquisition*

	b	*se*	*p*	*IRR*
Intercept	1.53	0.08	<0.001	4.62
"I bought it at a marijuana store"				
"I bought it from someone else"	-0.19	0.04	<0.01	0.83
"Someone over the age of 21 gave it to me"	-0.27	0.04	<0.01	0.76
"Someone under the age of 21 gave it to me"	-0.53	0.04	<0.01	0.59
"I took it without permission from the owner"	-0.19	0.05	<0.01	0.83

Note. Exploratory analyses were run between all methods of acquisition using Kruskal Wallis pairwise comparisons given that the dependent variable was count-distributed. Pairwise comparisons revealed no significant differences between any of the other methods of acquisition and 30-day cannabis frequency. "I bought it at a marijuana store" was the comparison category and the intercept represents the relation between cannabis frequency and method of acquisition.

Figure 1. *Path Model for Cannabis Acquisition Predicting 30-Day Cannabis, Mediated by Cannabis Accessibility*



Note. "I bought it at a marijuana store" was the reference group. Nonsignificant effects not reported. Standardized coefficients and standard errors are shown in the figure. * p < .05, *** p < .001.

Table 4. *Correlation Matrix between Cannabis Acquisition and Cannabis Accessibility*

Variable	*Mean*	*SD*	1	2	3	4	5	6	7	8
1. *"Very Hard"*	0.32	0.47								
2. *"Sort of Hard"*	0.17	0.37	-0.31**							
3. *"Sort of Easy"*	0.20	0.40	-0.34**	-0.22**						
4. *"Very Easy"*	0.31	0.46	-0.46**	-0.30**	-0.34**					
5. "*I took it without permission from the owner"*	0.05	0.22	0.02	-0.02	-0.03	0.01				
6. *"Someone under the age of 21 gave it to me"*	0.31	0.46	-0.01	0.01	-0.01	0.01	-0.15**			
7. "Someone over the age of 21 gave it to me"	0.14	0.35	0.00	0.01	0.00	-0.01	-0.09**	-0.27**		
8. "I bought it from someone else"	0.09	0.28	-0.01	0.01	0.02	-0.01	-0.07**	-0.21**	-0.12**	
9. *"I bought it at a marijuana store"*	0.37	0.48	0.00	-0.01	0.01	0.00	-0.18**	-0.52**	-0.31**	-0.24**

Note. M and SD are used to represent mean and standard deviation, respectively.
* indicates $p < .05$. ** indicates $p < .01$.

DISCUSSION

Results of the current study indicate that the ways in which adolescents primarily acquire cannabis are associated with how often they use cannabis. Specifically, results indicated that individuals who reported "I bought it at a marijuana store or center," reported the highest 30-day cannabis use frequency. This is consistent with previous research showing that access to stores is associated with increases use among adolescents (Harpin et al., 2018; Kepple & Freisthler, 2018). This, in turn, may help explain the association between recreational cannabis legalization and increased cannabis use. Future research on this issue may help to discern if impacts of legalization on use are a function of increased methods of acquisition, or changes in beliefs regarding cannabis use. As cannabis use has been shown to be associated with negative outcomes among adolescents (Jacobus et al., 2009; D'Amico et al., 2017), findings reported herein are particularly valuable as they identify a significant association with frequent adolescent use, which can be particularly harmful.

It is important to note that about 4% of the sample of adolescents who reported cannabis use in the past 30 days reported getting cannabis from a store. Note that, in the state of Colorado, it is illegal for an individual under the age of 21 to purchase recreational cannabis and illegal for anyone without a medical card to purchase medical cannabis. Given that Colorado routinely assesses whether individuals under the age of 21 are able to enter stores and purchase recreational cannabis and that these assessments generally indicate a rate of at least 98% compliance with verifying age (https://norml.org/blog/2022/08/10/colorado-licensed-marijuana-retailers-compliant-with-minimum-age-restrictions/), it is unclear how adolescents are purchasing cannabis from cannabis stores. The epidemiological nature of the data collected via the HKCS did not allow us to analyze how adolescents are purchasing cannabis from cannabis stores. Future research should examine how adolescents are purchasing cannabis at a cannabis store.

The fact that ease of acquisition did not mediate the relation between primarily acquiring cannabis at a store and increased cannabis use frequency may indicate that the ability to acquire cannabis at stores does not increase how easily adolescents think they can acquire cannabis, as they may be able to access cannabis elsewhere. Instead, the relation between primarily acquiring cannabis at stores and increased use frequency may be a result of adolescents who are more invested in cannabis use using more frequently and going to greater lengths to acquire cannabis products.

Limitations

One limitation of this study was that cannabis use was measured by 30-day frequency. Measuring cannabis use with a measure of cannabis frequency fails to assess the quantity of cannabis used and the potency of the products being used. Therefore, differences in use frequency may not be indicative of true differences in overall cannabis use if individuals are using cannabis in varying quantities and potencies. Another limitation is that this study was a secondary data analysis study. That is, the patterns examined in the current manuscript did not inform the creation of the items used.

The use of self-report data was a limitation in the current study. Participant's estimates of how often they acquire cannabis via varying methods, the ease at which they can acquire cannabis, and the frequency at which they use cannabis may have been inaccurate. Moreover, participants may have felt particularly motivated to underestimate or deny cannabis use, as adolescent cannabis use is illegal in Colorado.

Another limitation is that participants were asked how they "usually" acquired cannabis. This method of assessing how participants acquire cannabis prevented the research team from examining if participants used several methods of acquisition or solely used one method of acquisition. Therefore, the current study was limited in its ability to accurately describe how participants acquired cannabis and examine how the nuances of participant's methods of acquisition are related to accessibility and 30-day frequency.

Results of the current study can only be generalized to certain populations. Results can be applied to adolescents who have recently used cannabis in states where recreational cannabis use and sales are legal for those over the age of 21. That is, results cannot be generalized to adults, children under the age of 12, adolescents who

have not used cannabis in the past 30-days, or individuals in states where use and sales of recreational cannabis is not legal.

Conclusion and Future Directions

Research further examining the ways in which adolescents acquire cannabis from stores is warranted. Strict guidelines regarding how cannabis stores accept identification should incentivize stores to effectively detect fake ID's, as consequences for failing to do so are severe (Buller et al., 2016). Firstly, understanding the extent to which both the use of fake ID's, and cannabis store lenience relate to this method of acquisition is imperative. Testing if cannabis store lenience is associated with adolescent endorsement of acquiring cannabis via stores is necessary. Further, testing if the age of adolescents is associated with endorsement acquiring from stores would further inform how fake IDs are being used. Overall, this study suggests that primarily acquiring cannabis from stores is a risk factor for using cannabis frequently among adolescents, and that the association between primarily acquiring from stores and frequent use is explained by something other than increased accessibility.

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