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Abstract

Background.—The ways in which young people learn about cannabis product availability and where they obtain cannabis products are important to understand for prevention and intervention efforts.

Methods.—Young adults who reported past month cannabis use (N=758) completed an online survey in 2018-2019 on how they obtained cannabis and the products they used in a newly legalized market in Los Angeles (mean age 21.6; 44% Hispanic, 27% white, 15% Asian).

Results.—Overall, 59.1% obtained cannabis from recreational cannabis retailers (RCRs), 51.5% from family or friends, 39.1% from medical cannabis dispensaries (MCDs), and 5.5% from strangers or dealers in the past month. Compared to those getting cannabis from family or friends, those getting cannabis from MCDs or RCRs spent more money, used more cannabis products, were more likely to use alone, used greater quantities of bud/flower, and reported more consequences from use. Further, those obtaining cannabis from MCDs were more likely to screen positive for cannabis use disorder (CUD). For type of products, those obtaining cannabis from MCDs or RCRs were more likely to use joints, bongs, pipes, dabs, vape, and consume edibles relative to those obtaining from family or friends. Subgroup differences were found for both source patterns and cannabis-related outcomes. Males and those with a cannabis medical card

reported spending more money on cannabis, using more types of products, and indicated more frequent use and greater CUD symptoms and consequences. Compared to Whites, Blacks spent more money on cannabis and used more products, and Hispanics reported using more products and greater quantities of cannabis bud/flower.

Conclusions.—Findings highlight the different ways that young adults obtain cannabis, and how young adults with a medical cannabis card may be at greater risk for problems compared to young adults who use cannabis recreationally.

Keywords

cannabis; marijuana; young adults; product availability; sources

Introduction

California became the first state to pass a comprehensive medical marijuana law in 1996. Since that time, the majority of states have legalized marijuana for medical purposes, and 11 states and the District of Columbia have legalized the possession and sale of retail cannabis for adults aged 21 and older. Given this rapidly changing landscape, researchers have been assessing changes in various outcomes among adolescents and young adults to try to understand, for example, the effects of density of cannabis outlets and signage on patterns of use (Shih et al., 2019), how consumption patterns differ across states with medical marijuana legalization (Pacula, Jacobson, & Maksabedian, 2016), and whether availability, price, and product variety of medical marijuana in school neighborhoods may be associated with adolescents' use of marijuana and susceptibility to use marijuana in the future (Shi, Cummins, & Zhu, 2018). One study using NSDUH 2012 data for adolescents age 12-17 found that about one-third of teens who reported using cannabis in the past year reported obtaining it for free from family and/or friends (34%); however, those who used marijuana in the past month were more likely to get it for free from a relative/family member, most likely because they were not able to legally purchase it (King, Merianos, & Vidourek, 2016). Overall, most studies have been cross-sectional, with only a few addressing longitudinal outcomes, including effects of medical cannabis advertising on adolescent cannabis use over a seven year period (D'Amico, Rodriguez, Tucker, Pedersen, & Shih, 2018), understanding factors during early and late adolescence that predict co-use of cannabis with tobacco and alcohol at age 21 (D'Amico et al., 2020), and an ecological study that used Washington state's Behavioral Risk Factor Surveillance System to examine the effects of recreational cannabis retailer density on changes in adult cannabis behaviors over time (Everson, Dilley, Maher, & Mack, 2019).

The changing legal cannabis landscape has coincided with increased availability of novel products like vaping cartridges and cannabis concentrates, which may be particularly appealing to young people. For example, in recent years, the emergence of e-cigarettes and other vaping products has led to a dramatic rise in prevalence of vaping both nicotine and cannabis among adolescents and young adults (Cullen et al., 2019; King, Jones, Baldwin, & Briss, 2020; Meng & Ponce, 2020; Patrick, Miech, Kloska, Wagner, & Johnston, 2020). This is concerning because the rapid adoption of these products by young people has dramatically outpaced our understanding of their potential health effects. In addition, in 2019, an outbreak

of E-cigarette or Vaping Associated Lung Injury (EVALI), in which many cases were linked to cannabis vaping (Centers for Disease Control and Prevention, 2020), starkly illustrates the potential risks of widespread availability and use of novel products by young people in the context of limited understanding of potential health consequences (King et al., 2020). Moreover, sources of cannabis vaping products appear to have played a role in EVALI, with particular risks associated with those products obtained from informal sources (e.g., friends, family, or in-person or online dealers) (Centers for Disease Control and Prevention, 2020). Emerging data has also shed light on the potential role of the cannabis regulatory climate in the EVALI outbreak, with recent work suggesting that cumulative incidence of EVALI in the U.S. was higher in states where cannabis was illegal compared to states with medical and/or recreational cannabis laws (Smith & Goniewicz, 2020).

The cannabis purchasing patterns of young people, both *what* they purchase and *where* they obtain it, are important to understand for informing prevention and intervention efforts. To date, little research has examined these questions concurrently. One recent paper examined the cannabis markets in Washington and Oregon, pointing out that although it is crucial for sales data to provide total sales by product type to estimate market size, it is also important to know characteristics of purchased products (e.g. potency, size, weight) given the potential harms that may be associated with certain products (Firth, Davenport, Smart, & Dilley, 2020). This study found that extracts and concentrates made up approximately 26% of the Oregon market each month, with the market share for flower decreasing over time, and noted that the price for these more potent products was lower in Oregon than Washington, perhaps leading to increased purchasing of these products (Firth et al., 2020). An increase in market share and lower price point of high potency products is of particular concern given the price consciousness of young adults. Point of sale and delivery data in California indicate that younger people who use cannabis spend less money compared to older age groups (Eaze Insights, 2019), and Washington State data show that younger people are also more likely to spend less money on cannabis and purchase high potency products (Headset Cannabis Market Insights, 2017).

In understanding the cannabis purchasing patterns of young adults, it is critical to consider the role of having a medical cannabis card, which documents that one is enrolled in the state's medical cannabis program and has access to legally purchase cannabis from medical dispensaries. Purchasing practices of medical cannabis patients at medical dispensaries in Los Angeles have been well documented. For example, patrons of medical cannabis dispensaries in Los Angeles spent an average of $41 during their visit in 2013 (Kepple & Freisthler, 2018). Furthermore, research has shown that having a medical cannabis card is associated with greater use and consequences among young people (Boyd, VeliBoyd, Veliz, & McCabe, 2015; Pedersen, Tucker, Seelam, Rodriguez, & D'Amico, 2019; Tucker et al., 2018). One recent longitudinal study from the same cohort in the current study assessed 671 youth in California from ages 13-19 who reported past month cannabis use, and found that youth with a medical cannabis card showed steeper increases in frequent cannabis use (i.e., 20-30 days of use in the past month) from ages 13 to 19 compared to young adults who did not have a card (Tucker et al., 2018). In addition, when card and non-card holders were matched on individual sociodemographic characteristics, youth who had a card were more likely to report negative consequences from use, selling marijuana/hashish, and driving

under the influence of cannabis in the past year. Furthermore, a two year study from this same cohort of young adults from ages 18-20 showed that acquiring a medical cannabis card during this developmental period was associated solely with frequency of cannabis use, even after controlling for mental health problems, with every additional day of use at the beginning of the study increasing odds of getting a card one year later by 7% (Pedersen et al., 2019).

These studies have provided important foundational work on the types of products available in different states, what consumers are buying, and factors that may contribute to heavier cannabis use during the important developmental periods of adolescence and young adulthood. What is missing, however, is a descriptive examination of where young adults obtain their cannabis in a recently legalized state (e.g., recreational cannabis outlets, medical dispensaries, strangers or dealers, friends), and how different sourcing patterns are associated with important cannabis-related outcomes. These outcomes include the amount of monthly income young adults are spending on cannabis, their frequency and quantity of use, and their experiences of cannabis-related consequences. Further, it is important to understand how source patterns and cannabis-related outcomes differ by demographics (e.g., gender and race/ethnicity) and medical cannabis card status to identify subgroups that may be at highest risk. The current study furthers our understanding of how young adults in a newly legalized market in Los Angeles obtain their cannabis, and how source patterns are associated with cannabis-related outcomes, such as quantity and frequency of use and likelihood of cannabis use disorder.

Methods

Procedures

Participants were young adults age 18-21 who lived in Los Angeles County and reported past month cannabis use in 2018-2019 using items from Monitoring the Future (Schulenberg et al., 2018). They are part of a longitudinal study of two cohorts of students in 6th and 7th grade in 2008, initially recruited from 16 middle schools in Southern California as part of a substance use prevention program, CHOICE (D'Amico et al., 2012). Cohorts were followed annually across 11 waves, through 2019. All participants consented to the study, and study procedures were approved by the RAND Human Subjects Protection Committee. Participants completed waves 1 through 5 during physical education classes at 16 middle schools. Adolescents transitioned from middle school to over 200 high schools following wave 5 and were subsequently re-contacted and re-consented to complete annual web-based surveys. At wave 6 (Spring 2013-Spring 2014), 61% of the sample participated in the follow-up survey. At subsequent annual assessments, retention rates ranged from 80% to 92%. At wave 11, fielded in 2018-2019, 2,497 participants completed the survey. Substance use at wave 10 did not significantly predict retention at wave 11, similar to previous waves (D'Amico, Rodriguez, et al., 2018; D'Amico et al., 2020); however, compared to those who did not complete wave 11, retained participants were slightly more likely to be female (94% vs. 91%) and tended to be slightly younger at wave 10 (mean=20.6 years vs. 20.9 years).

Measures

Predictors.—Using items from Kilmer et al (2013), we determined cannabis sources by asking individuals "Where did you get the marijuana you used during the last year? (check all that apply)." They had 15 options to choose from, including a write-in option (e.g., from a medical marijuana store or delivery service using my own medical marijuana prescription/card; from a recreational marijuana store or delivery service using my own ID to buy it; from a friend who used their medical marijuana prescription/card to get it from a medical marijuana store or a delivery service; from a friend who used their ID to buy it at a recreational marijuana store or delivery service). The complete list and frequencies are presented in Table 1. Note that response options are not mutually exclusive. Based upon these response options, we created a derived variable for analytic purposes that included the following four categories: family/friend regardless of where family or friend obtained cannabis (e.g., medical cannabis dispensary or recreational cannabis retailer); medical cannabis dispensary using their own ID; recreational cannabis retailer using their own ID; and stranger/dealer, regardless of where the stranger/dealer obtained cannabis. Family/friend was the reference category. It is important to note that obtaining cannabis by growing, stealing, or exchanging for things other than money were included in this list of 15 options; however, these options were not endorsed by any respondents in the current analytic sample and thus are not considered further.

Outcome Measures.—We assessed past-month use of several cannabis products: joint, blunt (cigar shell), hand pipe (bowl), bong (waterpipe), dabs (wax, shatter, budder, hash oil), edibles, personal vaporizer ("vape pen" or "mod"), and beverage (Schulenberg et al., 2018). Separate items assessed how many days they used each product in the past month (0 to 30 days), which was used to derive a dichotomous measure to reflect any use of a given product (# of days > 0 = Yes). A dichotomous measure was chosen given that the primary interest was in whether or not a given product was used. A single item assessed the number of times they used marijuana on the days they used. All participants in the analytic sample (i.e., used cannabis in the past 30 days) and who indicated using cannabis at least once on days used were also asked quantity of cannabis use, "on a typical use day, how much marijuana flower/bud do you personally consume (don't include amount you may have shared)?" (Kilmer et al., 2013). Responses ranged from 1 =< 0.25 grams to 10=more than 5 grams. Along with this item, participants were provided with pictures of 0.5 gram, 1.0 gram, and 3.5 grams (eighth ounce) of marijuana flower/bud (compared to the size of a bottle cap). Responses were then recoded to reflect the mid-point number of grams to produce a continuous score ranging from 0.25-5.0 grams. Those who reported not using marijuana at least once on days used were given zero values for this item. We also asked how much money participants spent on cannabis products containing THC in the past month using an open-ended item for dollar amount (Kilmer et al., 2013).

Participants completed the 3-item Cannabis Use Disorder Identification Test Short-Form (CUDIT-SF; (Bonn-Miller, Heinz, Smith, Bruno, & Adamson, 2016), which is a screener for CUD symptoms. Participants rated how often during the past six months they found that they: 1) were not able to stop using marijuana/cannabis once they had started; 2) devoted a great deal of their time to getting, using, or recovering from marijuana/cannabis; and 3) had

problems with their memory or concentration after using marijuana/cannabis. Responses were scored as 0=never to 4=daily or almost daily and then summed (α = .75). Scores of 2 or higher indicate a positive CUD screen. In addition, because solitary use has been shown to correlate with greater cannabis dependence and problem use (Creswell, Chung, Clark, & Martin, 2015; Van der Pol et al., 2013), individuals were asked "Do you ever use marijuana/ cannabis when you're by yourself?" (yes/no) (Tucker et al., 2014).

We assessed consequences of cannabis use via a 10-item measure based on items from the RAND Adolescent/Young Adult Panel Study (Ellickson, D'Amico, Collins, & Klein, 2005) and the Marijuana Consequences Questionnaire (Simons, Dvorak, Merrill, & Read, 2012). Individuals were asked about the number of times they experienced specific problems or events in the past year because of using marijuana/cannabis (e.g., missing school, work, or other obligations; getting into trouble; doing something you later felt sorry for). Each item was rated from 1=none to 7=20 or more times, which we dichotomized to represent none vs one or more times in past year for each consequence. The dichotomous consequences items were then summed to create a total composite score (range = 0 to 10; α = .92).

Demographic characteristics.—Participants reported their age, gender, sexual orientation, college status, and race/ethnicity. Participants were classified into one of five racial/ethnic groups: Hispanic, non-Hispanic white (reference group), non-Hispanic black, non-Hispanic Asian, and non-Hispanic other (e.g., Native American, Native Hawaiian, multi-racial). In addition, we asked whether they currently had a medical cannabis card[1] (Tucker et al., 2018),

Analysis

For each outcome of interest, we used either linear or logistic regression to test the association between predictors and continuous or dichotomous outcomes. For models using categorical predictors, (e.g., gender, cannabis sources) we formed dummy vectors to represent the predictor. Coefficients obtained from these models were used to calculate interpretable values rather than directly presenting model estimates requiring the reader to compute differences from reference groups. Additionally, where appropriate, effects sizes such as Cohen's d (small = 0.2, medium/moderate = 0.5, large = 0.8) and odds-ratios are presented to characterize the magnitude of significant differences. All models were estimated in R (R Core Team, 2019) using the *glm* (Generalized Linear Models for logistic models) and *lm* (Linear Model for linear regression) functions.

Results

Table 2 shows demographic and substance use characteristics for this sample of young adults who reported using cannabis in the past month. The average age was 21.6 (24 people were

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[1]·The 148 youth with a medical cannabis card were asked for what condition(s) they obtained the medical cannabis card, with a list of California's approved conditions (e.g., persistent muscle spasms, cancer, anorexia), followed by a number of other conditions (e.g., anxiety, depression, sleep, problems) and an open-ended item where participants could write-in their own personal condition(s) (California Department of Public Health, 2018). Participants' reported reasons for obtaining the card were categorized as: mental health (e.g., anxiety, depression), physical health (e.g., migraine, chronic pain;), and sleep problems. The majority reported at least two conditions (60%), with 8% reporting only mental health conditions, 22% reporting only physical health conditions, and 10% reporting only sleep problems.

under 21 (1=18yrs, 2=19yrs, 21=20yrs); 44% were Hispanic, 27% white, and 15% Asian, with approximately 60% of the sample currently in college. More than two-thirds of the sample reported solitary cannabis use (67.3%), and the average amount of money spent in the last month on cannabis was about $55 (median = $20; 10th percentile = $0, 90th percentile = $156). Participants reported experiencing about 2 consequences from cannabis use in the past year. The most frequently reported consequences because of using cannabis were: had less energy or felt tired (49%), had trouble concentrating (40%), had trouble remembering (40%), and had less motivation to do things (38%). In addition, 25% of participants said they spent too much too money on cannabis, 14% said they had relationships with friends, partners, or family negatively affected, 12% missed school, work or other obligations, 12% said they did something they later felt sorry for, 10% got into trouble, and 6% said they got into sexual situations that they later regretted because of their cannabis use.

Cannabis source patterns are presented in Table 3. Overall, the most common source of cannabis was recreational cannabis retailers (59.1%), followed by family or friends (51.5%), medical cannabis dispensaries[2] (31.8%), and stranger or dealer (5.5%). On average, participants reported getting cannabis from 1.5 different sources, with 39% of participants getting cannabis from more than one source (29% from two sources, 8% from three sources, and 2% from all four sources). As shown in Table 3, we found subgroup differences for the sources of cannabis. Compared to white respondents, Asians were 12% less likely to obtain cannabis from MCDs (p=.04, OR = 0.88), whereas Hispanics were 7% less likely to obtain cannabis from strangers or dealers (p <.01, OR = 0.93). Females were 9% less likely than males to obtain cannabis from medical cannabis dispensaries (p =.01, OR=0.91) and 4% less likely to obtain cannabis from strangers or dealers (p =.02, OR=0.96); however, females were 11% more likely to get cannabis from family or friends (p <.01, OR = 1.11). Respondents with a medical cannabis card were 88% more likely than those without a card to obtain cannabis from medical cannabis dispensaries (p <.01, OR=1.88), and 25% less likely to get cannabis from family or friends (p <.01, OR=0.75). Further, those with a card, on average, tended to obtain cannabis from more total sources (1.8) compared to those without a card (1.4) (p <.01), a moderate difference between groups (Cohen's d= 0.49).

Coefficients for differences on cannabis outcomes by gender, card status, and race/ethnicity were then examined. Results are presented in Table 4. Gender was significantly associated with all cannabis outcomes. Specifically, males spent $17 more a month on cannabis compared to females (p<.01, Cohen's d = 0.18), used slightly more cannabis products (3.5 vs 2.9) (p<.01, Cohen's d= 0.16), used cannabis moderately more frequently on days used (2.9 vs 2.1) (p<.01, Cohen's d=0.37), used slightly higher quantities of bud/flower (0.9 grams vs 0.7 grams) (p<.01, Cohen's d=0.37), were 12% more likely to use cannabis alone (p<.01, OR = 1.12), and reported slightly more cannabis consequences (2.7 vs 2.2) (p<.01, Cohen's d = 0.17). Similarly, card status was significantly associated with all cannabis outcomes. Compared to those without a card, those with a card spent 2.6 times more money

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[2].At the time of this study, more than half of the medical cannabis dispensaries were not licensed (Pedersen et al., 2020), and therefore may not have followed strict guidelines on cannabis purchasing in their stores. Thus, it is possible that who obtained cannabis from a medical cannabis dispensary may not have had a medical cannabis card.

on cannabis ($42 vs $107) (*p*<.01, Cohen's d=0.62), used moderately more cannabis products (3 vs 4.2) (*p*<.01, Cohen's d=0.57), used moderately more frequently on days used (2.2 times vs 3.7 times) (*p*<.01, Cohen's d=0.57), used 1.6 times more bud/flower (0.7 grams vs 1.2 grams) (*p*<.01, Cohen's d=0.49), were 34% more likely to use cannabis alone (*p*<.01, OR=1.34), reported slightly more cannabis consequences (2.3 vs 2.9) (*p*<.01, Cohen's d=0.19). With regard to CUDIT scores, males and those with a card not only had significantly higher scores than their counterparts (p<.01), they also met the threshold (score >2) for likely cannabis use disorder (CUD). Lastly, Blacks spent more than twice the amount of money on cannabis compared to Whites ($105 vs $51) (*p*<.01, Cohen's d=0.42) and used a moderately greater number of products (4 vs 3 products) (*p*=.04, Cohen's d=0.51). Hispanics, compared to Whites, reported using slightly more cannabis products (3.5 vs 3 products) (*p*<.01, Cohen's d=0.23) and 1.3 times more cannabis bud/flower (0.9 grams vs 0.7 grams) (*p*<.01, Cohen's d=0.27). In addition, Blacks, compared to Whites, reported using, on average, 1.4 times more cannabis bud/flower (1.1 grams vs. 0.7 grams), although this difference was not statistically significant (p=0.13).

Table 5 presents coefficients for differences on cannabis outcomes by sources. Increases in the number of total cannabis sources was significantly associated with increases in the amount of money spent, number of products used, number of times used on days used, quantity of bud/flower used, CUDIT score, solitary use, and cannabis consequences (all *p*'s <.01). Respondents who obtained cannabis from medical cannabis dispensaries or recreational cannabis retailers, compared to those who got cannabis from family or friends, spent significantly (all *p*'s <.01) more money (3 times and 2.3 times more, respectively), used more cannabis products (1.6 times and 1.3 times more), and reported using greater quantities of bud/flower (1.7 times and 1.3 times more). Relative to those obtaining cannabis from family or friends, solitary use was significantly (all *p*'s .01) more likely among those who obtained cannabis from medical cannabis dispensaries (OR=1.34), recreational cannabis retailers (OR=1.36), or from strangers/dealers (OR=1.19). Compared to those obtaining cannabis from family or friends, total number of consequences was 1.3 times greater for those getting cannabis from medical cannabis dispensaries or recreation dispensary retailers, and 1.8 times greater for those getting cannabis from strangers/dealers (all p's .01). With regard to frequency of use on days used, compared to those getting cannabis from family or friends, those obtaining it from medical cannabis dispensaries used 1.6 times more, recreational cannabis retailers used 1.2 times more, and strangers/dealers reported using 1.5 times more (all *p*'s .01). Lastly, compared to those purchasing cannabis from family or friends, CUDIT scores were 2.9 times higher for those obtaining it from medical cannabis dispensaries, 2.1 times higher from recreational cannabis retailers, and 3 times higher from strangers/dealers (all *p*'s <.01), with those obtaining it from medical cannabis dispensaries or from strangers/dealers exceeding the threshold for likely CUD (score>2.0).

Coefficients for differences in cannabis product type by sources are presented in Table 6. Model 1 in Table 6 shows that 46% of the sample reported using a joint in the last month, 42% vaped cannabis, 40% used a blunt, 33% used a pipe, 24% used a bong, 11% used dabs, and 4% used cannabis via beverage. As the total number of cannabis sources increased, there was a significant increase in the likelihood of using joints, pipes, bongs, dabs, edibles, vape,

and beverages as well as the total number of products used (all p's < .05). Compared to those who got their cannabis from family or friends, those who obtained it from a stranger/dealer, medical cannabis dispensaries or recreational cannabis retailers were more likely to use joints (OR=1.17, OR=1.18, OR=1.08, respectively) and bongs (OR=1.22, OR=1.28, OR=1.15). Those who obtained cannabis from medical cannabis dispensaries or recreational cannabis retailers were more likely to use pipes (OR=1.16, OR=1.11, respectively), dabs (OR=1.30, OR=1.09), vapes (OR=1.22, OR=1.13), and consume edibles (OR=1.07, OR=1.10) relative to those who got it from family or friends. Relative to those getting cannabis from family or friends, those who obtained it from medical cannabis dispensaries were more likely to use blunts (OR=1.22) and beverages (OR=1.11). Lastly, the average total number of products used was 1.6 times higher for those getting it from medical cannabis dispensaries (3.74 products) and 1.3 times higher from recreational cannabis retailers (3.04 products) compared to those getting cannabis from family or friends (2.35 products).

Discussion

The current study assessed cannabis sourcing patterns from 758 racially/ethnically diverse young adults based in California who reported cannabis use in the last 30 days. Findings highlight important subgroup differences in how young adults get their cannabis, and suggest that different sourcing patterns are associated with increased heaviness of use and consequences.

Overall, many participants (39%) reported getting their cannabis from more than one source. More than 50% of young adults said that they obtained their cannabis from recreational cannabis retailers or from family and friends. About one-third got their cannabis from medical cannabis dispensaries, whereas very few said they obtained cannabis from strangers or dealers. However, males were more likely to obtain cannabis from strangers/dealers than females, and whites were more likely than Hispanics to obtain cannabis from strangers/dealers than Hispanics. In addition, young adults with a medical cannabis card were more likely than those without a card to obtain cannabis from more sources overall than those who used cannabis but did not have a card. Similar to what has been found in other legalized countries, some young adults may solely purchase cannabis from retailers after legalization whereas others continue to purchase cannabis from multiple legal and illegal (or 'social supply') sources. In Canada, statistics show that adults continued to obtain cannabis from friends, drug dealers, and other illegal sources even after legalization, and those who used non-medical cannabis were more than twice as likely to obtain cannabis from illegal sources after legalization (STATCAN, 2019). It is unclear whether adults who purchased cannabis from illegal sources will continue to do so as legal cannabis markets becomes more established over time. It is therefore important to continue to monitor cannabis purchasing practices as they are an important indicator of how well legalization has reduced illegal cannabis sales.

We next assessed whether there might be differences on characteristics across cannabis outcomes. Black young adults reported spending twice as much money and using more cannabis products than Whites, and Hispanic young adults reported using greater quantities

of cannabis bud/flower than Whites. Furthermore, young adults with a medical cannabis card used approximately four times a day compared to two times a day for those without a card. In addition, young adults with a card were much more likely to use cannabis alone, and were more likely to screen positive for CUD by having a CUDIT score of 2 or more than those without a medical cannabis card.

We also found important subgroup differences based on source patterns. Young adults that reported obtaining their cannabis from more sources (e.g., medical dispensary, friends/ family) tended to report greater quantities of use, more consequences; they also spent more money, and used more types of cannabis products. Particularly, young adults who purchased cannabis from outlets reported spending more and buying more types of products compared to young adults who obtained cannabis from friends/family. This suggests that the commercialization of cannabis and purchasing cannabis from outlets may expand the range of available products and also encourage use of high potency products. In Washington state, for example, research has shown that young adults are more likely to purchase high potency products (Headset Cannabis Market Insights, 2017). Of note, we also found that the particular source where young adults obtained their cannabis affected cannabis outcomes. Specifically, compared to young adults who obtained cannabis from family or friends, those who got cannabis from medical or recreational outlets or from strangers/dealers were more likely to use cannabis while alone, experience more consequences from use, and to screen positive for CUD. Thus, it may be that young adults who obtain cannabis from family or friends are more likely to use socially, and therefore do not use as regularly, thus decreasing their risk of problems. Other research has shown, for example, that youth who report solitary use of cannabis also report more negative consequences and more difficulty resisting offers to use cannabis (Tucker et al., 2014). Many prevention and intervention programs address peer influence (Buckner, Neighbors, Walukevich-Dienst, & Young, 2019; D'Amico, Parast, et al., 2018; Kulis, Ayers, & Harthun, 2017); however, youth who are using cannabis alone may be using for coping reasons, for example, to decrease anxiety or stress (Buckner & Ecker, 2016; Spinella, Stewart, & Barrett, 2019), highlighting the need to address to alternative ways to cope with negative emotions. Young adults who were more likely to use alone may also have done so because of the reinforcing effects of cannabis, such as alleviating negative affect or elevating mood (Colder, Lee, Frndak, Read, & Wieczorek, 2019).

Findings have implications for prevention and intervention efforts for young adults as they become of legal age. First, they highlight that clinicians and primary care providers should be screening not only for cannabis use, but also for whether a young adult has a medical cannabis card given that those who reported having a card were at higher risk for problems compared to young adults who used cannabis recreationally. Even though young adults may be using cannabis for a medical condition, results indicate that the quantity of flower/bud used, and frequency of use among those with a medical card is at a level where problems are beginning to occur, such as not meeting obligations at school or work, having trouble remembering things, and having relationships negatively affected. In addition, young adults with a medical cannabis card are experiencing enough problems where they are more likely to meet the criteria for CUD compared to young adults who use cannabis, but do not have a medical card. Thus, if providers screen for cannabis use and the young adult has a medical

cannabis card, they could go one step further by providing brief advice/intervention, for example, by asking about amount of use, reviewing relative risks of different types of products or modes of administration, and discussing the pros and cons of use to obtain a better understanding of reasons for use and potential consequences experienced. For those using more heavily and experiencing numerous consequences, it may be helpful to discuss ways to reduce use to avoid these negative experiences. In fact, recent studies have shown that young people (high school students ages 14-18) who report experiencing numerous consequences from cannabis use and/or who have a diagnosis of CUD responded positively to a 15-minute brief motivational intervention focused on reasons for use and willingness and confidence to change use if ready, reporting less cannabis use and consequences one year later (D'Amico, Parast, et al., 2018; D'Amico et al., 2019). It is likely that a similar discussion would be received positively by this young adult age group, and there are a few studies of such interventions that are promising (e.g., Laporte et al., 2017; Stein et al., 2018).

Given the changing landscape of products with the emergence of commercialized cannabis, it's also important to understand how young adults are using cannabis. Joints, vaping cannabis, and blunts were the most frequently reported products, with fewer young adults reporting use of dabs and beverages. Of note, the percent of young adults who reported vaping cannabis (42%) was almost equal to the percent who reported using a joint (46%). This is not surprising given that non-combustible cannabis products make up an increasing share of the cannabis market sales over time (Firth et al., 2020). Rates of cannabis vaping have risen dramatically among young people in the U.S. Data from the nationally representative Monitoring the Future (MTF) showed a more than 50% increase in cannabis vaping among college students between 2017 and 2018 (5% to 11%) (Schulenberg et al., 2019). Although recent evidence indicates that vaping *nicotine* is associated with lower levels of exposure to various known toxicants compared to combustible cigarettes (Goniewicz et al., 2018; National Academies of Sciences, 2018), very little is known about health risks associated with cannabis vaping versus combustible cannabis use. Among hospitalized individuals who reported vaping cannabis, most (78%) reported acquiring these products only through informal sources (e.g., family/friends, dealers, online) as opposed to formal retail settings; however, in our study, young adults were least likely to report acquiring vaping products from friends (42%) or strangers/dealers (38%) compared to acquiring vape products from medical or recreational outlets (61% and 54%, respectively). In addition, young adults who obtained cannabis from either a medical or recreational outlet were also more likely to use joints, bongs, pipes, dabs, edibles, and to vape cannabis compared to those who obtained cannabis from friends or family. This is not surprising given the variety of novel cannabis products and modes of administration sold in outlets (Spindle, Bonn-Miller, & Vandrey, 2019).

Given the potentially fatal consequences of using some cannabis vaping products, particularly in the context of limited product regulation, understanding where young people are obtaining vaping products and what types of products they use has critical implications for protecting public health. Many young people also reported using dabs and edibles, which may expose individuals to considerably higher doses of THC compared to dried flower (Hudak, Severn, & Nordstrom, 2015; Raber, Elzinga, & Kaplan, 2015). Although viewed as less harmful than combustible products (Lamy et al., 2016), edibles are often mislabeled

with respect to THC content (Vandrey, Raber, Raber, Miller, & Bonn-Miller, 2015), which can lead to higher-than-intended doses and unintended or unpredictable effects for individuals who consume these products. Dabs or concentrates also carry risks of toxicity (e.g., associated with residual solvent materials) and acute health effects including acute psychosis (Alzghari, Fung, Rickner, Chacko, & Fleming, 2017; Raber et al., 2015). As such, these products may pose elevated risks for dependence and other consequences associated with cannabis use (Loflin & Earleywine, 2014).

Current cannabis product packaging and labeling requirements are inadequate, and often do not provide consumers with enough information to monitor or titrate their THC consumption. Policy strategies aimed at increasing product transparency by adopting packaging and labeling rules specific to each product type and mode of ingestion may promote better THC titration and minimize potential unintended harms of concentrate and edible use (Hammond, 2019). Furthermore, it is important that each state continue to have age restrictions for card approval and purchase given the variety and potency of available products in MCDs and RCRs. In addition to policy interventions, clinicians and primary care providers need to be aware of how young adults are consuming cannabis and be able to explain the different risks associated with different types of product use.

The current study has several limitations, most notably that the data are cross-sectional. Although data come from a 12 year longitudinal study, we only recently began asking detailed questions about where young adults obtained their cannabis and the types of products they use given the changing legal landscape of cannabis in California (D'Amico, Tucker, Pedersen, & Shih, 2017). Longitudinal work is needed in this area as young people continue to have greater access to different types of products, many of which may have unpredictable side-effects. Future work could also address whether certain products are used more regularly to better understand patterns of use. In addition, data are self-reported; however, as previous work with this cohort has shown, rates of use in our sample map onto rates seen in large national surveys, such as Monitoring the Future (Schulenberg et al., 2019). We also did not ask information about specific brands or location of retailers or license status, which has implications for potency of products, and potential for contaminated or counterfeit products, increasing health risks. Our previous work on locating medical and recreational outlets in urban settings has shown that rapid changes can take place in a short period of time, with unlicensed shops "disappearing and reappearing" with different names (Pedersen et al., 2020). In addition, the sample is from Los Angeles, California, and results may not generalize to other geographic areas which have different cannabis laws and regulations. Finally, we had a relatively small sample of black youth.

In sum, this study provides insight into cannabis source patterns among a diverse sample of California young adults reporting current cannabis use approximately one year after recreational cannabis was legalized. Findings highlight the importance of screening not only for use, but also for having a medical card, as young adults with a card tended to use more, have more problems, and were more likely to screen positive for CUD. It is also key to determine whether young adults are using multiple products as this may put them at higher risk for potential health issues, particularly given the high potency and unpredictable effects that can occur with newer products (e.g., vaping products, concentrates), for which the long-

term health consequences of use are yet unknown. Monitoring cannabis purchasing practices is crucial to understanding the public health and societal impacts of cannabis legalization and emerging commercial cannabis market.

Acknowledgements:

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Highlights

- Young adults who reported past month cannabis use were most likely to obtain cannabis from recreational cannabis retailers using their own ID (59.1%) and from family or friends (51.5%).

- Young adults who obtained cannabis from medical and recreational outlets reported a wider variety of product use than those who got it from family and friends.

- Young adults who obtained cannabis from either medical or recreational outlets were more likely to screen positive for Cannabis Use Disorder than young adults who got cannabis from family or friends.

- Almost equal numbers of young adults reported smoking cannabis in a joint (46%) as vaping cannabis (42%).

Table 1.

List of response options and frequencies for sources of cannabis

	N (%)
Medical Cannabis Dispensary (own ID)	241 (31.8%)
Recreational Cannabis Dispensary (own ID)	448 (59.1%)
Friend	
Medical Cannabis Dispensary	138 (18.2%)
Recreational Cannabis Dispensary	197 (26.0%)
Not sure where they obtained it	207 (27.3%)
Family	
Medical Cannabis Dispensary	36 (4.7%)
Recreational Cannabis Dispensary	45 (5.9%)
Not sure where they obtained it	34 (4.4%)
Stranger/Dealer	
Medical Cannabis Dispensary	8 (1.1%)
Recreational Cannabis Dispensary	9 (1.2%)
Not sure where they obtained it	40 (5.3%)

Table 2.

Demographics and cannabis measures

n=758	M(SD) or n(%)
Age	21.6 (0.8)
Female	373 (49.2%)
White	207 (27.3%)
Black	21 (2.8%)
Hispanic	334 (44.1%)
Asian	112 (14.8%)
Other	84 (11.1%)
Heterosexual	600 (79.1%)
In College	451 (59.5%)
Medical Cannabis Card	148 (19.8%)
Number of cannabis products in past 30 days	3.2 (2.0)
Number of times cannabis used on days used	2.5 (2.3)
Quantity of flower/buds (grams) on days used	0.8 (0.8)
Money spent on cannabis in past 30 days	54.7 (91.9)
CUDIT	1.7 (2.6)
Solitary Use	504 (67.3%)
Cannabis Consequences	2.4 (2.7)

Note: Age: range 18-25; Money spent on cannabis: range 0-500; Number of cannabis products: range 0-8; Number of times cannabis used on days used: range 0-12; Quantity of flower/buds (grams): range 0-5; CUDIT: range 0-12; Cannabis consequences: range 0-10.

Table 3.

Differences in source patterns by demographic characteristics

Specific Source	Medical Cannabis Dispensary		Recreational Cannabis Retailer		Family or Friend		Stranger or Dealer		Total Sources	
	Est.	*p*	Est.	*p*	Est.	*p*	Est.	*p*	Est.	*p*
Race/ethnicity										
White (ref)	0.36	<.01	0.60	<.01	0.51	<.01	0.10	<.01	1.58	<.01
Black	0.24	0.24	0.76	0.15	0.43	0.47	0.05	0.30	1.48	0.56
Hispanic	0.32	0.34	0.60	0.95	0.49	0.59	0.03*	<.01	1.44	0.04
Asian	0.25*	0.04	0.56	0.53	0.55	0.48	0.05	0.07	1.42	0.07
Other	0.30	0.28	0.52	0.24	0.60	0.20	0.06	0.16	1.48	0.30
Gender										
Male (ref)	0.36	<.01	0.61	<.01	0.46	<.01	0.07	<.01	1.54	<.01
Female	0.27*	0.01	0.56	0.16	0.57*	<.01	0.03*	0.02	1.50	0.40
Sexuality										
Not straight (ref)	0.28	<.01	0.65	<.01	0.53	0.00	0.06	<.01	1.52	<.01
Straight?	0.33	0.32	0.58	0.08	0.51	0.76	0.06	0.92	1.47	0.44
College										
Not in College	0.34	<.01	0.63	<.01	0.50	<.01	0.05	<.01	1.51	<.01
In College	0.31	0.39	0.57	0.11	0.52	0.56	0.06	0.33	1.46	0.37
Medical Cannabis Card										
No card	0.19	<.01	0.59	<.01	0.57	<.01	0.06	<.01	1.41	<.01
Yes card	0.83*	<.01	0.63	0.34	0.28*	<.01	0.04	0.36	1.78*	<.01
Age										
Intercept	0.60	0.21	−0.02	0.97	1.29	0.01	0.15	0.52	2.02	0.01
Slope	−0.01	0.55	0.03	0.23	−0.04	0.13	0.00	0.69	−0.03	0.47

Note. Estimates are actual proportions for each group computed from regression model coefficients. Estimates denoted (*) reflect significant differences (p<.05) from the reference group. Coefficients for age reflect the unit change associated with respondent age. Statistical significance (p-value) is also presented for the reference groups (i.e., intercept) to indicate whether the estimate is significantly different from zero.

Table 4.

Differences on cannabis outcomes by gender and medical cannabis card status

	Money Spent	# of products	# of times used/day	Quantity of flower/buds	CUDIT	Solitary Use	Consequences
Gender							
Male	62.39 *p*<.01	3.48 *p*<.01	2.87 *p*<.01	0.92 *p*<.01	2.03 *p*<.01	0.73 *p*<.01	2.67 *p*<.01
Female	45.70* *p*=.01	2.96* *p*<.01	2.05* *p*<.01	0.68* *p*<.01	1.23* *p*<.01	0.60* *p*<.01	2.21* *p*=.02
MC card							
No	41.86 *p*<.01	3.02 *p*<.01	2.24 *p*<.01	0.72 *p*<.01	1.48 *p*<.01	0.61 *p*<.01	2.34 *p*<.01
Yes	107.27* *p*<.01	4.15* *p*<.01	3.67* *p*<.01	1.18* *p*<.01	2.43 *p*<.01	0.91* *p*<.01	2.86* *p*=.03
Race/Ethnicity							
White	50.67 *p*<.01	3.02 *p*<.01	2.46 *p*<.01	0.70 *p*<.01	1.71 *p*<.01	0.71 *p*<.01	2.47 *p*<.01
Black	105.05* *p*<.01	3.95* *p*=.04	2.52 *p*=.91	1.01 *p*=.13	2.43 *p*=.22	0.86 *p*=.17	2.81 *p*=.58
Hispanic	60.33 *p*=.24	3.49* *p*=.01	2.490 *p*=.92	0.90* *p*=.01	1.55 *p*=.48	0.66 *p*=.23	2.17 *p*=.20
Asian	40.81 *p*=.36	2.75 *p*=.25	2.63 *p*=.53	0.74 *p*=.74	1.71 *p*=.99	0.62 *p*=.11	2.85 *p*=.23
Other	47.81 *p*=.81	3.15 *p*=.60	2.38 *p*=.78	0.67 *p*=.78	1.63 *p*=.80	0.65 *p*=.32	2.73 *p*=.47

Note. Estimates are computed from regression model coefficients. Coefficients denoted (*) reflect significant differences (p<.05) between groups. Statistical significance (p-value) is also presented for the reference groups (i.e., intercept) to indicate whether the estimate is significantly different from zero.

Table 5.

Differences on cannabis outcomes by purchasing patterns

	Money Spent	# of products	# of times used/day	Quantity of flower/buds	CUDIT	Solitary Use	Consequences
Model 1							
Intercept	22.98 p<.01	2.21 p<.01	2.22 p<.01	0.52 p<.01	0.21 p=.29	0.38 p<.01	1.43 p<.01
Total Sources Types[#]	21.29[*] p<.01	0.69[*] p<.01	0.57[*] p<.01	0.19[*] p<.01	0.98[*] p<.01	0.20[*] p<.01	0.68[*] p<.01
Model 2							
Family/Friend (ref)	22.12 p<.01	2.35 p<.01	1.85 p<.01	0.55 p<.01	0.69 p<.01	0.39 p<.01	1.85 p<.01
Medical Cannabis Dispensary	66.59 p<.01	3.74[*] p<.01	2.87[*] p<.01	0.96[*] p<.01	2.03[*] p<.01	0.68[*] p<.01	2.45[*] p<.01
Recreational Cannabis Retailer	50.34 p<.01	3.04[*] p<.01	2.30[*] p<.01	0.72[*] p=.01	1.48[*] p<.01	0.69[*] p<.01	2.37[*] p<.01
Stranger/Dealer	49.03 p=.06	2.81 p=.12	2.76[*] p<.01	0.74 p=.15	2.06[*] p<.01	0.56[*] p=.01	3.35[*] p<.01

Note. Model 1 coefficients are estimates from regression with slopes denoted ([#]). Model 2 are actual proportions for each group computed from regression coefficients. Significant differences in Model 2 reflect differences with the reference group (i.e., Family/Friend source of cannabis). All significant effects are at p<.05 and denoted (*). Statistical significance (p-value) is also presented for the reference groups (i.e., intercept) to indicate whether the estimate is significantly different from zero.

Table 6.

Differences in cannabis product type by purchasing patterns

	Joint	Blunt	Pipe	Bong	Dabs	Edible	Vape	Beverage	Total Products
Model 1									
Intercept	0.46 $p<.01$	0.40 $p<.01$	0.33 $p<.01$	0.24 $p<.01$	0.11 $p<.01$	0.24 $p<.01$	0.42 $p<.01$	0.04 $p=.06$	2.21 $p<.01$
Total Sources Types [#]	0.10[*] $p<.01$	0.03 $p=.23$	0.12[*] $p<.01$	0.15[*] $p<.01$	0.09[*] $p<.01$	0.06[*] $p=.01$	0.09[*] $p<.01$	0.03[*] $p=.04$	0.69[*] $p<.01$
Model 2									
Family/ Friend (ref)	0.52 $p<.01$	0.35 $p<.01$	0.40 $p<.01$	0.28 $p<.01$	0.10 $p<.01$	0.25 $p<.01$	0.42 $p<.01$	0.04 $p=.02$	2.35 $p<.01$
Medical Cannabis Dispensary	0.69[*] $p<.01$	0.55[*] $p<.01$	0.55[*] $p<.01$	0.53[*] $p<.01$	0.37[*] $p<.01$	0.32[*] $p=.05$	0.61[*] $p<.01$	0.15[*] $p<.01$	3.74[*] $p<.01$
Recreational Cannabis Retailer	0.60[*] $p=.04$	0.39 $p=.27$	0.50[*] $p=.01$	0.43[*] $p<.01$	0.19[*] $p=.01$	0.34[*] $p=.01$	0.54[*] $p<.01$	0.06 $p=.28$	3.04[*] $p<.01$
Stranger/ Dealer	0.68[*] $p=.04$	0.38 $p=.72$	0.48 $p=.29$	0.49[*] $p=.01$	0.04 $p=.36$	0.32 $p=.31$	0.38 $p=.63$	0.04 $p=.92$	2.81 $p=.13$

Note. Model 1 coefficients are estimates from regression with slopes denoted ([#]). Model 2 are actual proportions for each group computed from regression coefficients. Significant differences in Model 2 reflect differences with the reference group (i.e., Family/Friend sources of cannabis). All significant effects are at $p<.05$ and denoted (*). Statistical significance (p-value) is also presented for the reference groups (i.e., intercept) to indicate whether the estimate is significantly different from zero.