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Trends in marijuana edible consumption and perceptions of harm in a cohort of young adults

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Abstract

Background: Rates of marijuana legalization have increased rapidly in recent years resulting in the marketing of alternative products like edibles that do not involve inhaling smoke. Edibles however pose unique public health challenges due to their greater risk for over-intoxication.

Methods: 1858 young adults were surveyed every six months from 2016 to 2018. Logistic regression models examined trends in use and perceptions of harm. Chi-squared tests compared demographic and behavioral characteristics of edible users and non-users by frequency of marijuana use.

Results: Perceptions of no harm from edibles increased (25.4%, 27.3%, 26.7%, 28.4%, 29.6%; p=0.006) while it declined for smoking marijuana (12.2%, 13.5%, 11.7%, 10.6%, 9.1%; p < 0.001). Among non-daily marijuana users, edible use increased (20.3%, 24.8%, 30.5%, 36.2%, 36.6%; p<0.001) while smoking marijuana declined for both daily and non-daily users. Among daily users, edible users were more likely to use all modes of consumption than non-edible users. Among non-daily users, edible users were less likely to smoke marijuana and perceive harm from edibles and were more likely to perceive harm from smoking marijuana and have visited a dispensary than non-edible users.

Conclusions: Edibles are increasingly consumed and perceived to not be harmful, despite the greater danger of over-intoxication. However, daily use of edibles alone is uncommon. The finding that edible users were more likely to have visited a dispensary provides a potential intervention

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BAR designed the research question, conducted the study analyses and wrote the first draft of the manuscript. RMJ oversaw item development. ELS originated the study idea. All authors provided critical feedback and approved final submission.

Conflict of Interest

No conflict declared.

point for consumer education. Strong scientific evidence is needed to guide policymakers in best practices for communicating knowledge and potential harms of these products.

Keywords

Cannabis; Marijuana; Edibles; Harm Perceptions

1. Introduction

The number of states passing medical and recreational marijuana laws has increased rapidly in recent years. At the end of 2018, 10 states and Washington, D.C. had legalized recreational marijuana and 33 medical. As a result, the marijuana industry is one of the fastest growing industries with legal marijuana sales projected to reach $23 billion by 2022 (Pellechia, 2018). Legalization has created opportunities for entrepreneurs and prompted the marketing and development of products and drug delivery systems that appeal to a wider range of consumers attracted by non-combustible methods that do not involve inhaling smoke, can be used with discretion, and are more convenient (Ghosh et al., 2015; Giombi et al., 2018). Edibles (marijuana-infused food products) in particular have become popular. During the first year of legal recreational sales in Colorado, edibles accounted for nearly half of total marijuana sales (Brohl et al., 2015). National data suggest 30% of adults and 47% of 18–34-year-old marijuana users have consumed marijuana in edible form (Schauer et al., 2016; Steigerwald et al., 2018).

Edible products pose unique risks. The first risk is over-intoxication. While smoking marijuana typically results in an immediate high, intoxication from consuming edibles can take 2 to 4 hours, varying from person-to-person depending on their weight, metabolism, gender and eating habits (Barrus et al., 2016; Grotenhermen, 2003; Huestis et al., 2007; Vandrey et al., 2017). This causes individuals to accidently consume more edibles than recommended, resulting in unexpected, stronger and longer-lasting highs. Although not lethal, many of the reported cases of marijuana-induced psychosis have occurred following the ingestion of edibles (Bui et al., 2015; Favrat et al., 2005; Hudak et al., 2015). Second, edibles are packaged to mimic popular candies and sweets, resulting in increased emergency room visits for child poisonings (Monte et al., 2015) and edible-related calls to poison control centers (Cao et al., 2016). Marketing of edibles as high-end food products may imply less harm and promote first-time use (Fergusson et al., 2003; MacCoun and Mello, 2015). Limited studies show edibles are perceived to be less harmful (Giombi et al., 2018; Johnson et al., 2016; Yoo et al., 2018). Although edibles may not have the same harms as smoking marijuana as it relates to lung function and cancer risk, regular use of marijuana regardless of mode of consumption may have adverse effects on brain development, psychiatric and heart health (Volkow et al., 2014, 2016). We are not aware of any studies that have examined recent trends in edible consumption or perceptions of harm among young adults. The purpose of this study was to (1) examine trends in use and perceptions of harm specific to the use of edibles and smoking marijuana over a two-year period, and (2) characterize edible users in a cohort of young adults.

2. Method

2.1 Sample

Data are from a cohort of young adults who participated in the ACE (*Assessment of the College Experience*) and ACE II (*Assessment of the Post-College Experience)* studies. The goal of ACE was to assess smokeless tobacco trajectories and their correlates in a cohort of college students (Wolfson et al., 2015). In Fall 2010, 3146 students were recruited as freshman from 11 colleges in the Southeast. Lifetime smokeless tobacco users, current smokers and males were oversampled. More detail on initial study recruitment is described elsewhere (Spangler et al., 2018). Ace II focuses on use of all tobacco products during the transition to adulthood following the same cohort. Data were collected at least annually from 2010 to 2018 using a web-based survey. The present study analyzes data from fives waves of data collected post-college every six months beginning in Fall 2016 through Fall 2018. The study protocol was approved by the study institution Institutional Review Board and additional privacy protection was provided by obtaining a Certificate of Confidentiality from the U.S. Department of Health and Human Services.

2.2 Measures

Demographic characteristics included age, sex, race/ethnicity, and mother's education. Participants were asked how many days out of the past 30 they used marijuana, with the following response options: 0, 1–2, 3–5, 6–9, 10–19, 20–29, and all 30. Participants were considered current marijuana users if they reported using marijuana at least once in the past 30 days. Daily or almost daily use was defined as using on 20 days or more. Beginning in Fall 2016, current marijuana users were asked all the ways they used marijuana in the past 30 days including smoking, vaporizing, waterpipe, edibles, and dabbing. Perceived harm from consuming edibles and smoking marijuana was assessed for all participants with the following items: In your opinion, how harmful is it to [smoke, ingest marijuana edibles] regularly? Response options ranged from: 1=not at all harmful to 4=very harmful. We compared those who believed it was 'not at all harmful' to all others. Other behaviors assessed included past 30-day cigarette, e-cigarette, waterpipe, and little cigar and cigarillo use. Participants were also asked if they ever visited a marijuana dispensary.

2.3 Analysis

Logistic regression models were estimated in PROC SURVEYLOGISTIC to test trends over the five waves of data collection in marijuana use, mode of consumption and perceptions of harm. Among current marijuana users, we compared past-month edible users and non-users stratified by frequency of marijuana use (daily vs not daily) at the last wave of data collection on demographic characteristics, and tobacco and marijuana use behaviors using PROC SURVEYFREQ in SAS Version 9.4. All models accounted for the repeated measures and complex survey design.

3. Results

The sample of 1858 young adults completing the survey in Fall 2016 was 52% female, 85% White, 6% Hispanic, and 64% had a mother with a college education. The mean age was

24.2 years. The prevalence of current marijuana use increased over the five waves of data collection (19.8% in Fall 2016, 21.0% in Spring 2017, 21.2% in Fall 2017, 23.9% in Spring 2018, 23.5% in Fall 2018; p=0.002) while rates of daily use remained stable (5.1%, 5.3%, 5.3%, 5.2%, 5.5%; p=0.969). Among current marijuana users, daily use decreased slightly (25.9%, 25.2% 24.9%, 21.9%, 23.4%; p=0.421). Perceptions that edibles are not harmful increased over the same time period (25.4%, 27.3%, 26.7%, 28.4%, 29.6%; p=0.006) while perceptions for smoking declined (12.2%, 13.5%, 11.7%, 10.6%, 9.1%; p<0.001) (Figure 1a). Among non-daily marijuana users, past-month edible use increased (20.3%, 24.8%, 30.5%, 36.2%, 36.6%; p<0.001) but remained stable among daily users (37.8%, 37.3%, 37.2%, 38.3%, 35.8%; p=0.998) (Figure 1b). Smoking marijuana in the past-month decreased among both non-daily (77.1%, 76.5%, 72.3%, 61.3%, 55.6%; p<0.001) and daily (95.2%, 92.3%, 89.7%, 79.6%, 82.7%; p=0.005) marijuana users.

Daily marijuana users who consumed edibles in the past month were more likely to have used blunts (47.6% vs 23.4%; p=0.010), vaped (72.8% vs 44.5%; p=0.014), dabbed (37.6% vs 12.6%; p=0.004), and used a waterpipe (28.6% vs 7.9%; p=0.002) in the past month and marginally more likely to have visited a dispensary (71.6% vs 53.6%; p=0.056) than daily users who did not consume edibles (Table 1). Non-daily marijuana users who consumed edibles in the past month were less likely to use little cigars and cigarillos (0.4% vs 3.6%; p=0.009) and smoke marijuana (45.3% vs 61.5%; p=0.012) and perceive smoking marijuana to not be harmful (5.8% vs 17.4%; p=0.003) than non-edible users but more likely to perceive edibles to not be harmful (61.5% vs 46.8%; p=0.023) and to have visited a dispensary (65.4% vs 50.8%; p=0.023).

4. Discussion

In this cohort of young adults, increases in current marijuana use echo national trends. However, unlike national data that show increases in daily or near daily marijuana use among those aged 18 or older (Azofeifa et al., 2016), these rates remained stable in our cohort with a slight decrease among current users. This finding coupled with recent increases in current marijuana use suggests new users in our sample may be non-daily users. Still, rates of daily or near daily use among current users in our study of young adults remain high (approximately 25%); a particular concern because it is associated with more adverse consequences including addiction (Volkow et al., 2014).

In order to more fully understand changes in marijuana use in a rapidly evolving landscape, it is important to examine not just prevalence of marijuana use but mode of use. In our cohort of young adults, edible consumption increased among non-daily marijuana users but remained stable among daily users. Smoking marijuana, however, declined for both daily and non-daily users. With legal access to marijuana increasing in the U.S., we are seeing the emergence of alternative modes of consumption, in particular non-combustible delivery systems like ingestion and vaping. Edible products which are rapidly hitting the market, specifically premium and artisan edibles may be attracting first-time, not yet daily, adult marijuana users (MacCoun and Mello, 2015; Montgomery, 2017). Even though smoking declined for both daily and non-daily users in our cohort, smoking was still the most prevalent mode of consumption (62% of marijuana users smoked it in a joint/bowl/bong in

the past month). However, with the availability of other modes of consumption, we are seeing increases in the popularity of these alternative drug delivery systems (e.g. 44% of marijuana users vaped and 26% consumed edibles in the past month). Further, we found that daily marijuana users who consumed edibles were more likely to use all modes of consumption compared to non-edible users. This is consistent with data suggesting edible users use a combination of drug delivery systems (Monte et al., 2019). This was not true for non-daily users suggesting daily use of edibles alone is uncommon whereas non-daily marijuana users may only use one mode of consumption (e.g. edibles).

Perceptions that consuming edibles was not at all harmful (57%) was more common than perceptions that smoking marijuana was not at all harmful (18%) in our sample. Perceptions of no harm also increased for edibles over time and decreased for smoking which may also explain the increases in use of edible products and declines in smoking in our cohort. There is extensive evidence that commercial industries, including tobacco, alcohol and food, use product packaging to create product appeal and perceptions of healthfulness (Fernqvist & Ekelund, 2014; Machiels and Karnal, 2016; Wakefield et al. 2002). Package design includes text and visual elements that explicitly and implicitly communicate about the product to reinforce product appeal and reduce harm perceptions and ultimately increase use. It is not surprising then that edibles packaged as appealing food products are perceived as less harmful than other modes of consumption, in particular combustible methods. In fact, edibles “with high-end beautiful packaging and savvy marketing” were ranked as a top 2019 food trend by the Specialty Food Association (Marchat, 2019).

Despite the marketing appeals of edible products, edibles pose serious public health concerns. Edibles carry an increased risk for overconsumption of tetrahydrocannabinol (THC), the psychoactive component of marijuana because it takes longer to feel their intoxicating effects (often more than two hours), varying from person-to-person depending on weight, metabolism, sex, type of edible consumed and other foods eaten (Barrus et al., 2016; Grotenhermen, 2003; Huestis, 2007; Vandrey et al., 2017). More marijuana than is recommended is often consumed in an effort to feel the effects of the product. A recent study of adult emergency department (ED) visits in Colorado found that intoxication, acute psychiatric symptoms and cardiovascular symptoms were more common in ED visits attributable to edible marijuana exposure than inhaled marijuana (Monte et al., 2019).

Finally, we found that edible users were more likely to live in recreational states and less likely to live in medical only states than non-edible users (both daily and non-daily). This finding was not statistically significant but could suggest edibles are less likely to be purchased by medical marijuana users. However, only about a quarter of edible users live in a recreational state suggesting edibles are obtained from other sources (e.g. home-made, black market). This may place users at greater risk for adverse consequences due to possible lack of state oversight (e.g. THC levels, warning labels). Still, more than half of edible users have visited a dispensary suggesting a potential intervention point for consumer education of potential harms.

There are limitations to our study. First, findings have limited generalizability and may not be representative of young adults who did not attend college. Further, although now living in

other geographic areas, these young adults were recruited from colleges in two Southeastern states within the US. Second, marijuana use was based on self-report and may have been underreported. However, with the increasing legalization of marijuana, we expect this to be minimal.

5. Conclusions

This study of young adults found recent increases in marijuana use with changes in modes of consumption. Among non-daily marijuana users, edible consumption increased and among both daily and non-daily users, smoking marijuana declined. Edibles were increasingly perceived to be less harmful than smoking marijuana, despite the greater danger of over-consumption. However, daily use of edibles is uncommon. The finding that edible users were more likely to have visited a dispensary provides support for consumer education at the point-of-sale. However, with only a quarter of edible users living in recreational marijuana states broader education may be necessary. Given edibles rapid rise to the market, scientific evidence is needed to guide policymakers as they establish regulations for edibles including best practices for communicating knowledge and potential harms.

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Highlights

- Perceptions of harm is declining for edibles while use is increasing particularly among non-daily marijuana users
- Perceptions of harm is increasing for smoking marijuana while use is declining among both non-daily and daily marijuana users
- Non-daily edible users are more likely to have visited a dispensary than non-edible users providing a potential intervention point for communicating knowledge and potential harms of these products

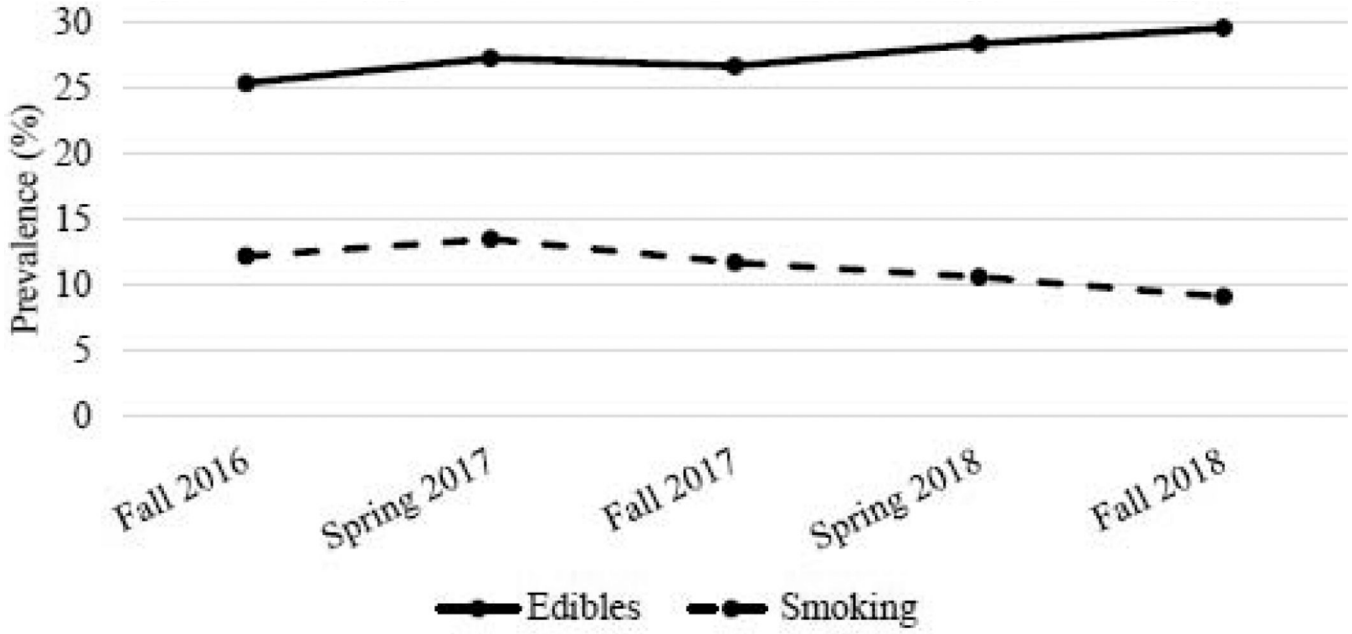

Figure 1a.
Perception Mode Not At All harmful Among Entire Sample

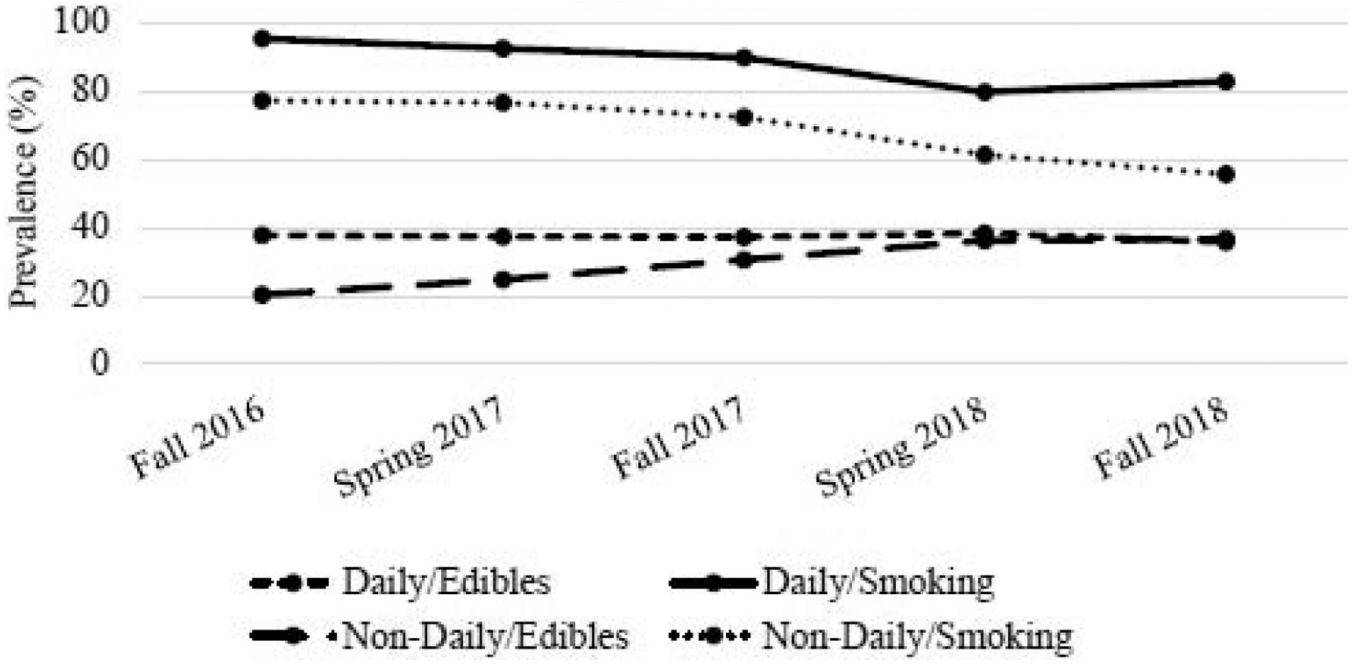

Figure 1b.
Mode of Consumption by Frequency of Past Month Marijuana Use

Table 1.

Characteristics of Past Month Edible Users and Non-Users by Daily/Non-Daily Use of Marijuana in Fall 2018.

	Total (n=537)	Daily Marijuana Users		p-value	Non-Daily Marijuana Users		p-value
		Edible (n=60)	Non-Edible (n=145)		Edible (n=81)	Non-Edible (n=251)	
Demographics (%)							
Female	55.5	52.2	49.5	0.796	58.2	56.4	0.772
Non-White	14.8	16.7	18.6	0.805	13.7	14.0	0.931
Hispanic	8.1	8.9	14.9	0.351	6.8	6.6	0.947
Mom College Educated	63.7	60.8	66.0	0.623	62.9	64.0	0.871
Current Tobacco Use Behaviors (%)							
Cigarettes	16.0	18.2	23.8	0.505	15.0	13.0	0.631
E-cigarettes	22.4	29.2	29.5	0.975	15.2	23.2	0.094
Waterpipe	4.6	5.0	2.0	0.259	6.0	4.6	0.652
Little Cigars and Cigarillos	2.6	5.2	1.9	0.170	0.4	3.6	**0.009**
Current Marijuana Behaviors (%)							
Perceive Edibles Not At All Harmful	57.2	80.4	69.6	0.292	61.5	46.8	**0.023**
Perceive Smoking Marijuana Not At All Harmful	14.8	28.7	16.0	0.155	5.8	17.4	**0.003**
Ever Visited a Marijuana Dispensary	57.0	71.6	53.6	0.056	65.4	50.8	**0.023**
Live in a State with Recreational Marijuana Laws	20.2	28.3	14.8	0.129	25.2	17.6	0.145
Live in a State with Medical Marijuana Only	15.9	11.1	14.1	0.629	11.8	19.6	0.094
Smoked Marijuana in a Joint/ Bowl/Bong	61.9	87.1	80.2	0.366	45.3	61.5	**0.012**
Smoked Marijuana in a Blunt	18.6	47.6	23.4	**0.010**	12.1	15.9	0.362
Vaped Marijuana	44.2	72.8	44.5	**0.014**	33.4	45.4	0.056
Dabbed Marijuana	8.5	37.6	12.6	**0.004**	5.1	4.3	0.734
Smoked Marijuana in a Waterpipe	6.5	28.6	7.9	**0.002**	3.8	3.9	0.985
Age First Used Marijuana	18.9	17.8	18.2	0.456	19.6	18.9	0.099