Does Unit-Dose Packaging Influence Understanding of Serving Size Information for Cannabis Edibles?

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ABSTRACT. Objective: Edible cannabis products have increased in popularity, particularly in jurisdictions that have legalized nonmedical cannabis. Rates of adverse events from cannabis edibles have also increased, in part because of difficulties identifying and titrating tetrahydrocannabinol (THC) levels. The current study tested whether packaging cannabis in separate units enhances consumer understanding of serving sizes. **Method:** An experimental task was conducted as part of the 2018 International Cannabis Policy Study online survey. Participants were recruited from the Nielsen Global Insights Consumer Panel. A total of 26,894 participants (61.5% female) ages 16–65 years from Canada and the United States were randomly assigned to view a cannabis brownie packaged according to one of three conditions: (a) multiserving edible ("control condition"), (b) single-serving edible, and (c) single-serving edible packaged separately ("unit-dose packaging"). Participants were asked to identify a standard serving based on information on the product label. Logistic regression was used to test the influence of packaging condition on the likelihood of a correct response, adjusting for key covariates. **Results:** Compared with the multiserving edible control (50.6%), participants were significantly more likely to correctly identify the serving size in the single-serving edible condition (55.3%; adjusted odds ratio = 1.22, CI [1.15, 1.29], $p < .001$) and the unit-dose packaging condition (54.3%; adjusted odds ratio = 1.17, CI [1.10, 1.24], $p < .001$). **Conclusions:** Packaging in which each product unit contained one dose of THC enhanced consumers' ability to identify how much of a product constitutes a standard serving or dose. Packaging products as individual doses eliminates the need for mental math and could reduce the risk of accidental overconsumption of cannabis. (*J. Stud. Alcohol Drugs, 81,* 173–179, 2020)

EDIBLE PRODUCTS HAVE BECOME a common mode of cannabis administration in jurisdictions with and without legal cannabis sales (Barrus et al., 2016; Borodovsky et al., 2017; Schauer et al., 2016). In Colorado, where legal sales of recreational cannabis commenced in 2014, retail edible sales increased between 31% and 67% from 2015 to 2017, accounting for about 13% of the market share of adult-use products in 2017 (Brohl et al., 2015; Hartman et al., 2018; Orens et al., 2019). In Oregon, sales of edibles began midway through 2016 and increased through 2018, concurrent with increases in inventory (Oregon Liquor Control Commission, 2019). In the year before recreational cannabis legalization in Canada, past-12-month use of cannabis edibles increased by 9% (Health Canada, 2018). Use of cannabis edibles in Canada is expected to increase even further given that legal sales began in December 2019, more than a year after federal legalization of dried herb and cannabis oil (Government of Canada, 2019b).

Edible cannabis products have inherent differences from traditional routes of administration. When cannabis is inhaled, the effects of tetrahydrocannabinol (THC) occur within seconds to minutes, reach their peak within 15–30 minutes, and may last 2–3 hours. In contrast, the psychoactive effects of orally ingested cannabis take 30–90 minutes to set in, reach their peak 2–3 hours after ingestion, and persist for 4–12 hours (Grotenhermen, 2003). Because of this delayed onset compared with inhaled cannabis, in the absence of an immediate effect, many cannabis edible users have challenges with titration and overconsumption (Barrus et al., 2016; Cao et al., 2016). Symptoms of overconsumption of cannabis include depression of the central nervous system, including depressed respiration, tachycardia, vomiting, anxiety, confusion, and panic attacks (Cao et al., 2016; Grotenhermen, 2003).

U.S. states that have legalized nonmedical cannabis have established "standard" servings of THC for edibles in order to assist consumers with dose titration. To date, Alaska, Massachusetts, and Oregon use 5 mg of THC as the standard serving, whereas California, Colorado, Nevada, and Washington use 10 mg of THC. In addition, Alaska and Oregon have restricted the amount of THC per multiserving package to 50 mg, whereas the remaining states allow up to 100 mg (Alaska Department of Commerce, 2019; California Department of Public Health, 2019; Colorado Department of Revenue, 2019; Oregon Liquor Control Commission, 2018b; State of Massachusetts, 2019; State of Nevada Department of Taxation, 2017; Washington State Legislature, 2018). Some states have undertaken additional measures to reinforce standard servings of THC in response to concerns related to adverse outcomes and increased rates of hospitalization (Rocky Mountain High Intensity Drug Trafficking Area, 2017). For example, Colorado now requires that each serving of THC is individually marked with the state's universal THC symbol (Colorado Department of Revenue,

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2019). The effectiveness of this approach on consumer understanding has yet to be assessed; however, focus groups conducted before the implementation of this system revealed that few consumers knew the meaning of the universal THC symbol (Kosa et al., 2017). Using a more progressive approach, Canada requires that each 10-mg THC serving of edibles is packaged separately (Government of Canada, 2019a), similar to the concept of unit-dose packaging. Unit-dose packaging has been used in the pharmaceutical industry for more than 50 years and has been shown to decrease accidental pediatric drug exposures (Buchanan, 1985; Wang et al., 2018). In a legal retail cannabis market, enacting tight regulations on labeling and standardization of dose and packaging—such as mandating unit-dose packaging—could reduce the potential for increased harm related to cannabis use (Lynskey et al., 2016).

A large body of research from other domains (including tobacco and nutrition) indicates that labeling influences consumer understanding of product characteristics and health effects (Campos et al., 2011; Hammond, 2011). However, there has been little research into the impact of packaging and labeling on the understanding of cannabis edible product attributes (Kosa et al., 2017), such as dosage amounts, despite the rapidly growing nonmedical cannabis industry. U.S. states that have legalized nonmedical cannabis (herein "legal" states), such as Oregon and Washington, require that packages of edible cannabis indicate the serving size and number of servings per container (Oregon Liquor Control Commission, 2018a; Washington State Legislature, 2019). However, this may not guarantee consumer understanding of dosage information. Research on nutrition labeling consistently indicates that consumers have difficulty understanding serving size information on food packages (Cowburn & Stockley, 2005; Hobin et al., 2016; Levy & Fein, 1998; Rothman et al., 2006; Shen-Tu et al., 2014; Zhang et al., 2016). Moreover, certain subgroups—including males, older individuals, and those with a lower income or education—tend to have extra difficulty with this information (Cowburn & Stockley, 2005; Goodman et al., 2011; Levy & Fein, 1998; Miller et al., 2017; Rothman et al., 2006). Many consumers, including but not limited to those with low health literacy, also have difficulty understanding dosage information on prescription drug labels (Davis et al., 2006). Preliminary research on labels for edible cannabis has indicated that although some consumers use serving size information as a benchmark for how much to consume, many have difficulty understanding serving size or THC potency information (Kosa et al., 2017). Research on food labels has shown that understanding of serving size and/or calorie information can be enhanced by using standard serving sizes across products or indicating serving sizes per container (Hobin et al., 2015; Vanderlee et al., 2012). The primary objective of this study was to examine whether using unit-dose packaging influences consumer understanding of standard serving size information for cannabis edibles.

Method

Data are from Wave 1 of the International Cannabis Policy Study (ICPS) (Hammond et al., 2018), conducted in Canada and the United States. Data were collected via self-completed web-based surveys conducted from August 27 to October 7, 2018, with respondents aged 16–65 years. Participants were recruited through the Nielsen Consumer Insights Global Panel and their partners' panels. Email invitations (with a unique link) were sent to a random sample of panelists (after targeting for age and country criteria); panelists known to be ineligible were not invited. Surveys were conducted in English in the United States and English or French in Canada. The median survey time was 19.9 minutes. Respondents provided consent before completing the survey. Respondents received remuneration in accordance with their panel's usual incentive structure (e.g., points-based or monetary rewards, chances to win prizes). The study was reviewed by and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE# 22392). A full description of the study methods can be found in the ICPS Wave 1 (2018) Technical Report (Goodman & Hammond, 2019; Hammond et al., 2020).

Measures

Before the experiment, participants were asked about their knowledge of standard serving size information ("self-reported THC knowledge") using the question, "Do you know how much THC is in one standard serving of an edible marijuana product?" (*yes, no, don't know, refuse*).

Individual-level characteristics assessed as covariates were sex, age, visible minority status, highest level of education, jurisdiction, self-reported THC knowledge, and past-12-month cannabis edible use (see Table 1 for response categories).

The impact of labeling on understanding of standard serving size of edible products was analyzed using an experimental task. Respondents were randomized to one of three experimental conditions in which they saw cannabis brownie(s) packaged as (a) a multiserving edible (control condition), (b) single-serving edibles, or (c) single-serving edibles packaged separately (unit-dose packaging) (see Supplemental Figure A). (Supplemental material appears as an online-only addendum to the article on the journal's website.) While the product image was on the screen, participants were asked, "Based on the information provided, how much of the product should someone eat on one occasion if they want a standard serving?" (*¼ of a brownie; ½ of a brownie; ¾ of a brownie; 1 brownie; 2 brownies; 3 brownies; 4 brownies; more than 4 brownies; don't know; refuse*).

TABLE 1. Logistic regression model predicting likelihood of correct response to experimental task (main effects model) (n = 26,894)

Variable	% correct (n)	AOR [95% CI]	p
Experimental condition		$\chi^2(2) = 47.51$	<.001
Multiserving control (ref.)	50.6% (4,540)		
Single-serving edibles	55.3% (4,943)	1.22 [1.15, 1.29]	<.001
Unit-dose packaging	54.3% (4,875)	1.17 [1.10, 1.24]	<.001
Age		$\chi^2(1) = 23.78$	<.001
		0.99 [0.99, 0.99]	<.001
Sex		$\chi^2(1) = 120.65$	<.001
Female (ref.)	56.3% (9,319)	–	
Male	48.7% (5,039)	0.75 [0.72, 0.79]	<.001
Education		$\chi^2(3) = 88.47$	<.001
Bachelor's degree or higher (ref.)	56.2% (5,766)	–	
Some college[a]	52.9% (5,123)	0.89 [0.84, 0.94]	<.001
High school diploma or equivalent	48.2% (1,967)	0.71 [0.66, 0.76]	<.001
Less than high school	52.4% (1,502)	0.81 [0.73, 0.89]	<.001
Visible minority		$\chi^2(2) = 127.47$	<.001
No (ref.)	54.5% (13,006)	–	
Yes	46.2% (1,120)	0.70 [0.64, 0.76]	<.001
Unstated	39.3% (232)	0.49 [0.42, 0.59]	<.001
Jurisdiction[b]		$\chi^2(2) = 236.92$	<.001
U.S. legal states (ref.)	59.2% (4,356)	–	
U.S. illegal states	55.5% (5,328)	0.89 [0.83, 0.94]	<.001
Canada	47.1% (4,674)	0.63 [0.60, 0.67]	<.001
Self-reported THC knowledge[c]		$\chi^2(1) = 94.95$	<.001
No/don't know (ref.)	53.9% (13,596)	–	
Yes	45.4% (762)	0.59 [0.53, 0.66]	<.001
Past-12-month edible cannabis use		$\chi^2(1) = 62.57$	<.001
No (ref.)	52.6% (12,572)	–	
Yes	59.6% (1,786)	1.39 [1.28, 1.51]	<.001

Notes: 95% CI = 95% confidence interval; AOR = adjusted odds ratio; ref. = reference category; THC = tetrahydrocannabinol. [a]Includes some college, technical/vocational training, college certificate/diploma, apprenticeship, or some university; [b]states that had and had not legalized nonmedical cannabis are referred to as "legal" and "illegal" states, respectively; [c]refers to self-reported knowledge of the amount of THC in a standard serving of an edible cannabis product.

Data analysis

A total of 28,471 respondents completed the survey. After we removed those with invalid responses to data quality questions (reported inability to answer questions honestly or incorrect selection of the current month), ineligible country of residence, smartphone use (due to screen size restrictions), or missing data on the experimental task or covariates (n = 1,577), 26,894 respondents were included in the analysis. Analysis of variance (age) and chi-square test (remaining covariates) were used to test for differences in covariates between experimental conditions. Logistic regression (1 = *correct,* 0 = *incorrect/don't know*) was used to test for differences in the likelihood of responding correctly to the experimental task. Two-way interactions between covariates and experimental condition were added to the model in a subsequent step. Models were adjusted for the following covariates: age, sex, education, visible minority status, jurisdiction (Canada, U.S. states that had and had not legalized nonmedical cannabis, referred to as "legal" and "illegal" states, respectively), self-reported THC knowledge, and past-12-month cannabis edible use; adjusted odds ratios (AORs) are reported. Analyses were conducted using SPSS Statistics for Windows, Version 25 (IBM Corp., Armonk, NY).

Results

Sample characteristics are shown in Supplemental Table A. Analysis of variance and chi-square test indicated no significant differences between experimental conditions on the seven covariates tested ($p > .05$). Only 6.2% (n = 1,680) of participants reported knowing the amount of THC in a standard serving of a cannabis edible.

As shown in Table 1, in the main effects model, respondents in the single-serving edible (55.3%) and unit-dose packaging (54.3%) conditions were significantly more likely to correctly identify a standard serving than those in the multiserving control (50.6%). There were no significant differences between the single-serving edible and unit-dose packaging conditions (AOR = 0.96, 95% CI [0.90, 1.02], p = .17).

There were significant main effects of all seven covariates ($p < .001$ for all). Briefly, the likelihood of responding correctly was higher among those with a university education, those identifying as a visible minority, past-12-month edible users, and those who reported not knowing the amount of THC in a standard serving of a cannabis edible (Table 1).

In the subsequent model, two-way interactions revealed that the effect of condition differed by sex, $\chi^2(2) = 17.87$,

$p < .001$; age, $\chi^2(2) = 9.42$, $p < .01$; and jurisdiction, $\chi^2(4) = 29.21$, $p < .001$. First, although males performed more poorly than females overall, the magnitude of difference between sexes was significantly greater in the control condition compared with the single-serving edible (AOR = 1.25, 95% CI [1.10, 1.41], $p = .001$) and unit-dose packaging conditions (AOR = 1.27, 95% CI [1.13, 1.44], $p < .001$). Second, the decline in performance with age was significantly greater in the unit-dose packaging compared with the single-serving edible (AOR = 1.01, 95% CI [1.00, 1.01], $p < .01$) and control conditions (AOR = 1.01, 95% CI [1.00, 1.01], $p = .02$). Third, although the number of correct responses was highest in U.S. legal states and lowest in Canada, the magnitude of difference between U.S. legal and illegal states was significantly greater in the control compared with the single-serving edible (AOR = 1.28, 95% CI [1.10, 1.50], $p < .01$) and unit-dose packaging conditions (AOR = 1.29, 95% CI [1.12, 1.48], $p < .001$). The difference between U.S. illegal states and Canada was significantly smaller in the control compared with the single-serving edible (AOR = 0.70, 95% CI [0.61, 0.80], $p < .001$) and unit-dose packaging conditions (AOR = 0.78, 95% CI [0.67, 0.91], $p < .01$).

Discussion

The results of this study indicate that packaging cannabis edibles in single doses—either using unit-dose packaging where each dose is wrapped separately or multidose packaging in which each product unit in the package equals one dose—significantly enhanced the understanding of standard serving (or dosage) information. Another recent study found that symbols or simple units of measurement (e.g., doses) used to indicate standard serving size on cannabis cookies were more easily comprehended by young adults than were THC amounts (Leos-Toro et al., 2020). Consistent with research on food labeling, we observed a greater understanding of serving size information among females and those with higher education (Cowburn & Stockley, 2005; Goodman et al., 2011; Levy & Fein, 1998; Rothman et al., 2006). We also found greater understanding among cannabis edible users, likely because of prior experience or experimentation with dosage and/or exposure to this information on labels if edibles were purchased from a retailer. Nevertheless, across all packaging conditions, only about half of respondents could correctly identify a standard serving, and only 6.2% reported knowing the amount of THC in a standard serving. Similarly, a recent study on cannabis found that very few young adults were able to correctly identify a standard serving of a cannabis cookie (Leos-Toro et al., 2020). These findings suggest that consumer understanding of THC levels and edible servings is generally low (Hammond, 2019), likely because of the recent emergence of legal recreational markets. In the wake of legalizing cannabis edibles in Canada, recent efforts have been made to help the public understand labels and dosage information for edibles (Canadian Centre on Substance Use and Addiction, 2019). However, there is a lack of scientific consensus regarding a standard serving for THC, largely because of the diversity of the product market and the fact that THC concentrations and metabolism differ across products and routes of administration (Freeman & Lorenzetti, 2019). More work must be done to define what constitutes a single serving of cannabis (or THC) and to communicate this information to the public in a manner similar to what has been done for alcohol (National Institute on Alcohol Abuse and Alcoholism, 2019; RethinkYourDrinking.ca, 2016).

The findings also suggest that consumer perceptions of understanding are a poor indicator of actual comprehension: participants who reported knowing the amount of THC in a standard serving of an edible cannabis product actually performed worse on the experimental task. Research on nutrition labeling suggests that consumers struggle to understand standard serving size information and that many consumers overestimate their ability to use standing servings to estimate consumption amounts (Cowburn & Stockley, 2005; Hobin et al., 2016; Levy & Fein, 1998; Rothman et al., 2006; Shen-Tu et al., 2014; Zhang et al., 2016). It is possible that consumers with greater confidence are less likely to engage with information contained in cannabis product labels, although further research is required to examine this issue.

Sociodemographic differences were also observed. When the standard serving equaled a quarter of the product, males were less likely to correctly identify a standard serving than females. This may be attributable to a difference in what males versus females would consider a standard serving. In other words, because males consume more calories in general and more servings of cannabis edibles per day than females (Health Canada, 2017; Statistics Canada, 2017), they might anticipate a standard serving to be larger. Indeed, in the multiserving control condition, 9% more males than females chose a serving size greater than the correct response of "¼ brownie" (data not shown). The findings may also relate to more general sex differences in the use of labels, which is higher among females than males. In addition, modest differences were observed across age groups, in which unit-dose packaging was moderately more effective at improving understanding of edible serving size information among younger individuals. Research on nutrition labeling suggests better understanding of labels among younger compared with older individuals (Cowburn & Stockley, 2005); however, the differences in the current study were modest, which reflects the relatively low levels of comprehension among the entire sample. Future research should consider the efficacy of cannabis labeling among younger age groups, given the relatively high levels of cannabis use among youth and young adults (Government of Canada, 2018). Given that unit-dose packaging of pharmaceuticals has been found to reduce unintentional ingestion and poisoning mortality in

pediatric populations (Tenenbein, 2005), it is possible that packaging THC servings separately may help reduce accidental overconsumption of cannabis edibles among young people.

Finally, with regard to jurisdiction, the superior understanding of serving size information observed in U.S. legal states was likely due to greater familiarity with mandatory THC labeling on cannabis packages. Nevertheless, the difference in understanding between U.S. illegal and legal states was modest and was largely attenuated in the conditions where each product unit contained one dose of THC. In Canada, the packaging condition had a lesser effect. Familiarity with cannabis edible packaging was lower in Canada compared with U.S. illegal states, where exposure to packaging from legal markets may have resulted from cross-border shopping or product diversion (Hansen et al., 2018).

Limitations

This study is subject to limitations common to survey research. Respondents were recruited using non-probability-based sampling; therefore, the findings do not provide nationally representative estimates. However, analyses confirmed that randomization was successful in terms of equally distributing age, sex, education, and other covariates across experimental conditions. Second, images were shown on a computer screen, and we expect that the effect of packaging would be more salient in a retail environment. Therefore, the current findings may underestimate real-world differences between the labeling practices examined herein. Because the study aimed to examine the effect of unit-dose packaging, we did not manipulate the wording of serving size information; future studies might test the effect of more explicit wording (e.g., "1 brownie bite contains 10 mg of THC; each brownie bite contains 1 standard serving") compared with product norms (e.g., "40 mg of THC per package; 4 servings"). Last, the wording of the experimental question was adapted from a previous study (Leos-Toro et al., 2020). The current findings revealed a low self-reported knowledge of standard THC servings; the experiment therefore may have yielded different results had the question wording not referred to a "standard serving."

Conclusions

This study is among the first, to our knowledge, to experimentally test the effect of packaging and labeling attributes on the understanding of serving size information for edible cannabis products. Overall, understanding of THC amounts and servings of edible cannabis products was relatively poor. The concept of standard servings of THC is relatively new and consumer awareness was low even in jurisdictions where cannabis edibles were legal and standard servings were in use. This lack of familiarity with the concept of THC dosage is likely exacerbated by a low understanding of THC amounts in general (Hammond, 2019). As legal cannabis markets evolve, public education efforts will be required to increase consumer understanding of standard servings of THC, particularly for cannabis edibles and extracts. The findings also provide preliminary support for regulatory measures that apply standard serving sizes to product packages, such as the requirement in Canada that each 10-mg edible must be packaged separately (Government of Canada, 2019a). As is the case for nutrition labeling, standard servings do not constrain consumption amounts; rather, they facilitate the identification and titration of desired THC amounts, including among consumers who wish to consume substantially more than the 5- or 10-mg serving sizes used in various legal jurisdictions. More effective consumer dosing has the potential to reduce adverse outcomes, including the acute effects of overconsumption, and could also mitigate the downstream effects of delayed intoxication, including drug-impaired driving.

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