



# Adolescent exposure to cannabis marketing following recreational cannabis legalization in Canada: A pilot study using ecological momentary assessment

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## ABSTRACT

**Objective:** The goal of this pilot study was to assess the feasibility of a 9-day, smartphone-based ecological momentary assessment (EMA) protocol for tracking the frequency of Canadian adolescents' exposures to cannabis marketing, their reactions to such exposures, and the context in which exposures occur in the real-world and in real-time.

**Method:** Participants were  $n = 18$  adolescents between the ages of 14 and 18 years of age. They used an EMA application to capture and describe cannabis marketing exposures through photographs and brief questionnaires assessing marketing channel and context. Participants also rated their reactions to each exposure in real-time.

**Results:** Results showed that participants were generally compliant with the protocol. Participants recorded 40 total exposures to cannabis marketing, representing an average of 2.2 ( $SD$  2.3) exposures per participant during the 9-day study. Exposures tended to occur in the afternoon (45.0%) or evening (37.5%), and while participants were at home (70%) and alone (52.5%). Most exposures occurred through promotion by public figures (27.5%) or explicitly marked internet ads (27.5%).

**Conclusion:** This is the first study to demonstrate the feasibility and utility of EMA to capture adolescent exposures to cannabis marketing as it occurs in participants' natural environments. Our research offers an early look at the predictable wave of cannabis advertising targeting youth and a promising approach for studying its impacts in a post-legalization context, as well as a strategy for assessing policies, such as advertising restrictions, intending to mitigate the harms of early cannabis use among youth.

## 1. Introduction

In 2018, Canada became the second country in the world to legalize adult recreational cannabis use (Cox, 2018; Government of Canada, 2018), following its legalization for medical use in 2001 (Government of Canada, 2020). Canada's Cannabis Act dictates that cannabis policies should "keep cannabis out of the hands of youth", "keep profits out of the pockets of criminals" and "protect public health and safety by allowing adults access to legal cannabis" (Department of Justice, 2018). Canada's emphasis on youth cannabis prevention or delayed initiation is evidence-based. Earlier and more frequent adolescent cannabis use is associated with greater risk of harm to the developing brain (Fischer

et al., 2017; George & Vaccarino, 2015; Levine, Clemenza, Rynn, & Lieberman, 2017) and multiple adverse outcomes including impaired neurocognitive functioning, affective problems, suicidality, psychosis, cannabis dependence syndrome, and cannabis-related morbidity in later years (Duperrouzel, Granja, Pacheco-Colón, & Gonzalez, 2020; Levine et al., 2017; Morin et al., 2019).

With the legalization of adult recreational cannabis use, however, adolescents may experience increased cannabis availability, increased social acceptance of cannabis, and confusing messages about whether cannabis use is safe (Hopfer, 2014; Shi, Lenzi, An, & Doran, 2015; UNODC, 2017). Evidence regarding the effects of adult cannabis legalization on adolescents is mixed. Some studies show that more permissive

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cannabis laws increase rates of adolescent cannabis use (Ammerman et al., 2015; Stolzenberg, D'Alessio, & Dariano, 2016; Wen, Hockenberry, & Cummings, 2015) while others do not (Cerdá et al., 2018; Choo et al., 2014; Hasin et al., 2015). Although research surrounding the impact of recreational cannabis legalization on youth in Canada is scarce, national survey data show a gradual increase in cannabis use among youth coinciding with increased public discourse on the topic (Zuckermann, Battista, de Groh, Jiang, & Leatherdale, 2019). The extent to which Canada's shift towards more liberal cannabis policies, practices and culture will impact youth cannabis attitudes, intentions, and use are largely unknown.

A key influence on youth cannabis attitudes, beliefs, expectancies, and intentions to use, is cannabis-related marketing (D'Amico, Miles, & Tucker, 2015; D'Amico, Tucker, Pedersen, & Shih, 2017; D'Amico, Rodriguez, Tucker, Pedersen, & Shih, 2018). Though it is illegal to market cannabis products to youth in Canada, recent studies (Cecco, 2018; Rup, Goodman, & Hammond, 2020), and a long history of research on other age-restricted substances with abuse potential (i.e., tobacco, alcohol), demonstrate that companies ignore these laws and intentionally target their products to youth (Brodwin, 2013; Farber & Folan, 2017). Research on alcohol and tobacco marketing shows strong correlations between youth exposure to marketing and earlier initiation, and higher consumption among those already using (Whitehill, Tran-genstein, Jenkins, Jernigan, & Moreno, 2019). All told, exposure to cannabis marketing could similarly spur youth cannabis use (Whitehill et al., 2019).

While emerging research suggests that cannabis marketing puts Canadian youth at risk (D'Amico, Miles, et al., 2015; D'Amico, Tucker, et al., 2017; D'Amico, Rodriguez, et al., 2018), preliminary studies are limited because they use inexact measures such as general awareness of marketing and receptivity to marketing that rely on retrospective recall, which are subject to participant recall error and bias (Shiffman et al., 1997). Existing studies also describe marketing exposures in aggregate, obfuscating the context of individual exposures, such as when and where exposures occur, and other psychosocial factors which could influence their effects (Ebner-Priemer & Trull, 2009). In particular, existing research does not describe the channels through which cannabis marketing exposures occur, nor the ways in which federal marketing prohibitions are violated. Policymakers also need research that shows whether cannabis marketing of different types and through different channels has varying impacts on youth.

Real-time, real-world assessment techniques such as Ecological Momentary Assessment (EMA) (Shiffman, Stone, & Hufford, 2008) may be used to reduce bias and increase the reliability, accuracy, and acuity of information about adolescents' exposures to cannabis marketing. In EMA protocols, participants use smartphone technology - that they already use throughout the day in multiple settings (Statistics Canada, 2021) - to track a range of phenomena as they occur in participants' natural environments. Previously, we created an EMA protocol for tracking youth exposure to alcohol and tobacco marketing (Scharf, Martino, Setodji, Staplefoote, & Shadel, 2013). Middle- and high-school participants made electronic time-stamped recordings of tobacco and alcohol marketing exposures, demonstrating that exposures primarily occurred in the afternoon, at point-of-sale locations, and on days leading up to the weekend (Scharf et al., 2013). To our knowledge, no research has similarly documented Canadian adolescent cannabis marketing exposures using an EMA approach.

The goal of this pilot study was to assess the feasibility of a 9-day, smartphone-based EMA protocol to obtain a preliminary understanding of the frequency of Canadian adolescents' exposures to cannabis marketing, their reactions to such exposures, and the context in which exposures occur in the real-world and in real-time. The intent of this research was not to provide a definitive description of how and how often Canadian adolescents are exposed to cannabis marketing, but to provide and test a tool that could facilitate such future research. With this tool, we also aim to provide preliminary data demonstrating the

existence and potential impacts of cannabis advertising on youth.

## 2. Methods

### 2.1. Study setting and participants

Participants in this pilot, proof-of-concept study were 18 community-dwelling adolescents from Thunder Bay, Ontario, Canada. Participants were between the ages of 14–18 inclusive, could speak, read, and write in English, and owned their own cellular phone.

### 2.2. Smartphone devices and software

Participants recorded cannabis marketing exposures on their personal smartphones (Apple or Android) through a customized Expiwell (Expiwell.com) smartphone application ("app"). Before beginning the EMA portion of the study, participants completed baseline surveys using Google Forms.

### 2.3. Procedures

Data collection occurred between March 2020 and February 2021. We recruited participants through print and digital advertising including Facebook, Instagram and other social media sites. Recruitment materials contained no information about cannabis; prospective participants responded to advertisements with a general goal of using cell phones to study advertising. Research assistants screened individuals over email or Facebook messenger to determine eligibility. Eligible individuals attended a virtual baseline session with a parent or legal guardian where they provided written informed consent and assent if they were under the age of 18. Participants who were 18 years of age provided written informed consent.

All adolescents completed a baseline questionnaire assessing demographics, social determinants of cannabis use, and cannabis use history (see Section 3). Parents/guardians were informed that they would not have access to their child's study data.

Participants were trained to download and use the Expiwell app to photograph/screenshot (when possible) and describe each individual cannabis advertising exposure that occurred during the 9-day study period through a brief (<1min) questionnaire. The questionnaire assessed advertising channel (e.g., billboard, internet ad), message, and context (e.g., at home, in car), followed by participants' real-time ratings of cannabis use expectancies and intentions. Participants also responded to two daily randomly issued (control) prompts, which also included questions about cannabis use expectancies and future cannabis use risk. Participants who completed the study received \$75 or 5 hours towards 40 hours of volunteer service required for a high school diploma in Ontario. Participants received full compensation if they completed at least 70% of the device-issued random prompts within 5 min of the notification; those who completed <70% of random prompts within the 5-minute window received \$50 or 3.5 hours of high school volunteer time. All procedures were reviewed and approved by Lakehead University's Research Ethics Board.

### 2.4. EMA training

Participant training occurred on study day 1. It included extensive descriptions and images defining each type of marketing to be recorded (see Martino, Scharf, Setodji, & Shadel, 2012) and how to record information about each exposure in the app. Participants were trained to respond to twice-daily, randomly scheduled daytime prompts (i.e.,

random prompts) that occurred between 10:35 AM and 10:30 PM.<sup>1</sup> The purpose of these prompts was to measure participants' cannabis expectancies and intentions in neutral, non-marketing exposure moments so that participants can serve as their own controls. We also used random prompts to assess protocol compliance (i.e., carrying the phone; engaging with the study app). Previous studies have shown that adolescents have been highly compliant with similar protocols, routinely carrying study smartphones and responding within 2 min to ~80% of random prompts (Gwaltney, Bartolomei, Colby, & Kahler, 2008; Scharf et al., 2013; Van Zundert, Ferguson, Shiffman, & Engels, 2010).

## 2.5. Exit interviews

On study day 9, participants completed an exit interview (in-person or video call) to answer pre-planned questions about their experience with the study including ease of completing study procedures, problems with the app, and any lapses in reporting exposures or other gaps in compliance. They also reviewed and removed any picture they took through the study app that did not have to do with cannabis marketing prior to submitting data to the research team.

## 2.6. Protocol reactivity

To mitigate any risk from having attended to cannabis advertising during the study period, upon exiting the study, adolescents received a copy of Canada's Lower Risk Cannabis Use Guidelines and parents/guardians received Canada's Cannabis Talk Kit: Know How to Talk with Your teen ([https://www.drugfreedkidscanada.org/wp-content/uploads/pdf/Cannabis-Talk-Kit\\_EN.pdf](https://www.drugfreedkidscanada.org/wp-content/uploads/pdf/Cannabis-Talk-Kit_EN.pdf)). Upon study exit, adolescents were also provided with information about local substance use resources for teens.

## 2.7. Measures

### 2.7.1. Baseline characteristics

We assessed demographics including age, gender identity, school grades, and ethnicity with select questions adapted from the Ontario Student Drug Use and Health Survey (OSDUHS) – Secondary Form A. We assessed cannabis use history with the OSDUHS cannabis history item (Boak, Hamilton, Adlaf, & Mann, 2015), "In the last 12 months, how often did you use cannabis (also known as marijuana, "weed", "pot", "grass", hashish, "hash", hash oil, etc.)?" Responses were 1–2 times, 3–5 times, 6–9 times, 10–19 times, 20–39 times, 40+ times; used, but not in the last 12mos; never used in lifetime; don't know what cannabis is.

### 2.7.2. EMA assessments

Participants logged each cannabis marketing exposure event in the Expiwell app by photographing or screenshotting the ad (where possible) and completing information about the exposure channel/type and context, vividness of the exposure, and an assessment of cannabis use expectancies and intentions. Items, adapted from previous studies using EMA to monitor alcohol and tobacco marketing (Martino et al., 2012; Scharf et al., 2013; Shadel, Martino, Setodji, & Scharf, 2012) are described in detail below. Each marketing exposure entry included an electronic time and date stamp.

### 2.7.3. Marketing channel and type

Participants categorized each marketing exposure (labelled in the app as "I see an ad") as one of: print, billboard/poster, internet (anything marked ad), point of sale (store), personal item (clothing, backpack, sticker), coupon, sponsored activity, radio/podcast, TV/movie/game,

<sup>1</sup> We conducted a series of focus groups with study-eligible adolescents and their parents/guardians in 2019 to help inform the acceptability and feasibility of this study design.

and promotion by public figure.

### 2.7.4. Cannabis expectancies

Cannabis expectancy was measured with one question related to negative affect management from the Smoking Consequences Questionnaire (SCQ; Brandon & Baker, 1991). The item assessed participants' level of agreement with the statement "When I'm feeling down, cannabis can really make me feel good" on a 5-point Likert scale in half point increments from 1 (disagree) to 5 (agree). The SCQ is validated for use with adolescent cigarette smokers (Wahl, Turner, Mermelstein, & Flay, 2005).

### 2.7.5. Intentions to use cannabis

Participants completed one cannabis-adapted item from the Smoking Intentions Scale (Choi, Gilpin, Farkas, & Pierce, 2001), wherein higher scores indicate a stronger intention to use cannabis. The item assessed participants' likelihood of using cannabis with the statement "Do you think you will use cannabis any time soon"? On a 5-point Likert scale from "definitely not" to "definitely yes".

### 2.7.6. Exposure saliency

Participants described the saliency of each cannabis marketing exposure with an item consistent with the advertising saliency self-report approach used by Simola, Kuisma, Öörni, Uusitalo, and Hyönä (2011). This item assessed participants' level of agreement with one question: "About the cannabis marketing you just saw: How vivid/new/noticeable was it?" on a 5 point-Likert scale from 1 ("Very slightly or not at all") to 5 ("Extremely").

## 3. Data analysis

### 3.1. Quantitative analyses

Because this was a pilot, proof-of-concept study, our analyses are limited to descriptive statistics that characterize the sample at baseline and quantify the total number, type, time, and physical and social context of adolescent exposures to cannabis marketing, plus their relationship to self-reported cannabis expectancies and intentions to use cannabis. Descriptive statistics of attrition and missing data were to assess compliance. All analyses were run in SPSS v27.0.

### 3.2. Qualitative coding of cannabis marketing images

Two members of the research team (CN, CA) coded each cannabis marketing exposure image (photo/screenshot) in order to validate participant reporting of exposure type and to extract additional information using the same categories described in participant training (i.e., exposure type, details). Each image was double-coded by members of the research team and inconsistencies were resolved through consensus. Rates and types of disagreements between researchers and teens are described in the results.

## 4. Results

Eighteen participants completed the study. Participants were 15.3 (*SD* 1.3) years of age, 50.0% female, and largely Caucasian (72.2%). Some ( $n = 3$ ; 16.8%) had used cannabis in the past 12 months, but most ( $n = 15$ ; 83.3%) expressed that they had never used cannabis in their lifetime.

Overall, participants were moderately compliant with the study protocol. Devices issued 14 random prompts per participant during the study period, and participants responded to 61.1% (*SD* 33.0) of random prompts within 5 min of the alarm. Rates of compliance ranged from 5.6% to 100.0%. During mid-protocol check-ins and exit interviews, approximately 40.0% ( $n = 7$ ) of participants reported not hearing or receiving notifications from the app. In comparison, rates of compliance

for the majority of participants ( $n = 11$ ; 61.1%) who did not experience issues with receiving application notifications were high (84.9%) and consistent with prior research (e.g., Scharf et al., 2013).

Across the 9-day EMA period,  $n = 14$  (78.8%) participants reported at least one exposure to cannabis marketing. In total, they logged 40 ad exposures and on average, participants encountered  $M = 2.2$  ( $SD 2.3$ ) cannabis ads each. Participant-coded ad types agreed with researcher ratings 95% of the time, and research interrater reliability was 100%. Five ( $n = 5$ ; 26.3%) participants reported missing at least one cannabis ad exposure entry, for a combined total of six (6) missing entries. Table 1 shows the number and proportion of cannabis-related advertising exposures that occurred through various channels. Most cannabis-related exposures occurred through promotion by public figures (27.5%) or explicitly marked internet ads (27.5%). Fig. 1 contains illustrative examples of cannabis advertising exposures recorded by participants during the study.

Cannabis-related exposures occurred consistently throughout the week, with 42.4% of exposures occurring during the weekend (Friday 18.2%; Saturday 9.1%; Sunday 15.2%), and 57.6% of exposures occurring on weekdays (Monday 18.2%; Tuesday 18.2%; Wednesday 12.1%; Thursday 9.1%).

Following the procedures of Martino et al. (2012), we assessed exposures in 6-hr time blocks (Fig. 2): night (12:00–5:59 am), morning (6–11:59 am), afternoon (12:00–5:59 pm), and evening (6:00–11:59 pm). Most cannabis-related media exposures occurred in the afternoon (45.0%) or evening (37.5%), with many fewer occurring at night (5.0%) or in the morning (12.5%).

Participants also documented the social and physical context where ad exposures occurred. The majority of cannabis-related marketing exposures occurred while participants were alone (52.5%), occasionally in the presence of family (37.5%) and much less with others (friends 7.5%; classmates 5.0%; other adults 2.5%). Consistent with the channels through which exposures occurred, most exposures occurred while participants were browsing the internet ( $n = 23$ ; 57.5%), talking with others ( $n = 6$ ; 15.0%), or watching TV/listening to music/playing video games ( $n = 4$ ; 10.0%). Moreover, most exposures occurred at home ( $n = 28$ ; 70.0%) with many fewer in other locations (in a car  $n = 6$ ; 15.0%; friends' houses  $n = 2$ , 5.0%; outside  $n = 2$ , 5.0%, and at school  $n = 2$ , 5.0%).

We assessed participant ratings of marketing saliency and then compared participants' cannabis use expectancies and intentions, all assessed with 5-point likert scales in half point increments. Participants rated the level of saliency of marketing exposures as  $M = 3.3$  ( $SD 1.2$ ). Visual inspection of means suggests that participants rated cannabis expectancies ("When I'm feeling down, cannabis can really make me feel good") higher during exposure  $M = 1.1$  ( $SD 1.1$ ) vs. non-exposure  $M = 0.8$  ( $SD 0.5$ ) events, but small sample size precluded statistical testing of this difference. We did not observe a difference in participant ratings of intentions to use cannabis ("Do you think you will use cannabis any time soon?") occurring during exposure 0.89 ( $SD 0.8$ ) and non-exposure events 0.96 ( $SD 1.0$ ).

**Table 1**

Number and proportion of exposures to cannabis-related media through each promotion type.

Type of Exposures	Number of exposures	Percent of exposures (%)
Public figure	11	27.5
Internet	11	27.5
Billboard/Poster	5	12.5
TV/Movie/Game	5	12.5
Personal item	4	10.0
Point of sale	3	7.5
Sponsored activity	1	2.5
Total	40	100

## 5. Discussion

Historical research on other legalized, recreational drugs (e.g., alcohol, tobacco) suggests that Canadian youth are likely cannabis marketing targets, but to date, almost no data exists regarding the scope and impact of cannabis marketing on Canadian youth in a post-legalization context (Rup et al., 2020; Stanwick, 2020). This study presents some of the very first data that demonstrate that cannabis marketing to youth is actively occurring in Canada, and that researchers and policymakers must begin to take action on the issue in order to protect youth and public health.

To our knowledge, this is the very first study to use EMA to capture adolescent cannabis marketing exposures, in Canada or elsewhere. A particular strength of the EMA approach is that it enables detailed data collection about each exposure (e.g. location, timing, social context, and others), and its immediate impacts, that are otherwise obscured or blurred in retrospective self-report. (e.g., Hébert et al., 2017; Scharf et al., 2013). Thus, the current study provides novel evidence for a powerful tool that researchers and policymakers can use to obtain detailed information about cannabis marketing exposure characteristics (i.e., when and where advertisers are reaching youth, and with what messages), and strategies for assessing their subsequent effect on adolescents' cannabis-related expectancies and intentions.

We recognize that EMA methods overall are not new, and that Shiffman (e.g., 1997) and others have been advancing the science of EMA for more than 30 years. The newness of cannabis legalization in Canada and the associated taboo of cannabis in some communities (e.g., educational settings, workplaces), however, necessitated this extensive pilot work, not only to demonstrate the concept of the work (i.e., that cannabis marketing is reaching Canadian youth), but also that our recruitment procedures, messaging, and protections were acceptable to adolescents and their guardians, as all of these components of the study are essential to effectively conduct the research.

Overall, our results show that the protocol is feasible. Although overall rates of compliance (i.e., responses to random prompts) were slightly lower than previous EMA studies of adolescents, rates among the participants whose app was working well were directly in-line with other work (Gwaltney et al., 2008; Scharf et al., 2013; Van Zundert et al., 2010). Unexpectedly, a major task of this pilot research was to resolve software compatibility issues between the Expiwell app and older versions of Android platforms, including identifying device setting issues such as "do not disturb" or "battery saver" mode on individuals' phones that interfered with participants receiving notifications from the study app. Participant compliance rates were much better among those with newer phones whose platforms were more compatible with the app. Researchers replicating or extending this research will need to consider the pros and cons of allowing participants to use their own devices for data capture (free, convenient, possibility of increased compliance) as compared to using a study-issued device (guaranteed app compatibility, equity in data collection) (Fillo et al., 2016).

Despite its feasibility design, this study also provides new, albeit very preliminary knowledge regarding the quantity and characteristics of cannabis marketing currently reaching Canadian adolescents; information that has previously only been described in aggregate, retrospectively, and by self-report. Overall, data showed that nearly all participating adolescents had cannabis marketing exposures during the study period. This included an average of about two cannabis-related marketing exposures per week, substantiating previous research (Cecco, 2018; Rup et al., 2020). This finding demonstrates cannabis companies' success in skirting current cannabis-related marketing laws which categorically prohibit marketing of cannabis products to youth.

Our data also showed that most cannabis-related exposures occurred through promotion by public figures and through ads on the internet. This finding is likely influenced by the COVID-19 context (periodic restrictions on mobility, socializing, use of public spaces) in which data were collected, and it is consistent with a significant increase among



Fig. 1. Participant submissions of cannabis marketing exposures. Note: This figure shows a submission of an internet ad (A), a billboard/poster (B), and two submissions of promotions by public figures (C and D).

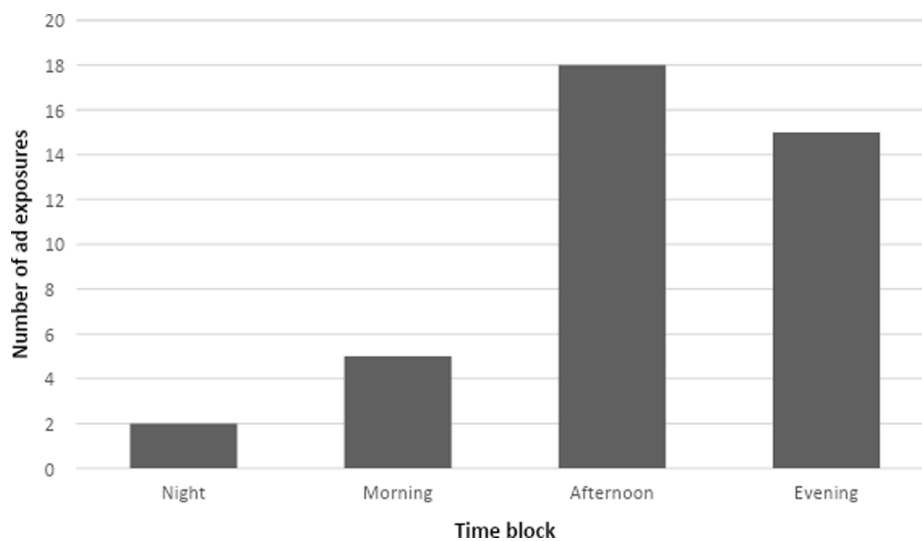


Fig. 2. Number of cannabis-related ad exposures by 6-hour time blocks. Note: Time blocks defined as follows: night (12:00–5:59 am), morning (6–11:59 am), afternoon (12:00–5:59 pm), and evening (6:00–11:59 pm).

youth in the use of social media, streaming services, gaming sites and apps (Ellis, Dumas, & Forbes, 2020; Fernandes, Biswas, Tan-Mansukhani, Vallejo, & Essau, 2020). At the same time, previous research has demonstrated that cannabis has an established and sophisticated presence specific to the internet based on creative advertisements designed for social media platforms (e.g., Facebook, Instagram and Snapchat), regardless of legality or media company policies (Kelly, Berry, Comello, & Ray, 2021). Indeed, while alcohol and tobacco industries developed their original marketing campaigns decades ago using traditional media channels (e.g., point of sale, print, billboards, radio), Canada’s sale and legalization of cannabis began in the digital age, and as a result, cannabis companies rely mostly on social media to market their products (Trangenstein, Whitehill, Jenkins, Jernigan, & Moreno, 2019). Information shared through social media and the internet may also be viewed as more relevant or persuasive to youth, with the social endorsement by trusted celebrities or peers (Cialdini, 2018). This is concerning, as an increase in social media use and novel

potential for social engagement and peer network integration could increase youth vulnerability to cannabis marketing through social medical channels (Jernigan, 2012; Montgomery, Chester, Grier, & Dorfman, 2012; Trangenstein et al., 2019). Youth exposure to online cannabis marketing is especially concerning when it is accompanied by dispensary practices facilitating easy access to cannabis (e.g., the option for youth to pre-purchase marijuana online to streamline and expedite the experience, direct-to-home delivery options) (Cavazos-Rehg et al., 2019). Altogether, if replicated in a larger, more representative sample and during less unusual times, data showing that most exposures occur through online formats may suggest the need to better describe and reinforce online cannabis-related marketing to mitigate harms to youth.

We also found that the timing and social context for cannabis-related marketing exposures occurred consistently throughout the week, mostly in the afternoon and the evening, while youth were alone and at home. This finding makes sense given that the majority of exposures occurred through the internet or public figures while youth were browsing social

media online. As the majority of exposures also occurred through the internet or public figures, it is possible that cannabis advertisements influenced adolescents' view of injunctive norms (perceptions of others' approval of a behaviour) by suggesting high levels of peer approval of cannabis use and/or demonstrating or reinforcing positive outcome expectations related to cannabis use; this is particularly alarming because exposures generally occurred in the absence of family member who could buffer these effects (Nathanson, 2001; Youn & Shin, 2019). Research that identifies clusters in the context of cannabis-related marketing exposures is also important as it can inform cannabis marketing regulations, such as the need for tighter restrictions on marketing channels that frequently reach youth, especially in vulnerable contexts (e.g., alone).

We also found that youth described cannabis marketing as relatively visually engaging. This is consistent with research demonstrating that companies marketing age-restricted substances create designs that likely appeal to youth, including bright colours, cheerful messages, cartoon and/or animal characters, and other features explicitly prohibited by legislation (Brodwin, 2013; Farber & Folan, 2017). Unfortunately, we do not have sufficient data to conclude whether the vividness of ads impact adolescents' cannabis expectancies or intentions to use cannabis. Policymakers and public health officials will likely benefit from larger and more detailed analyses of the features and content of cannabis ads that put them at the greatest risk for future cannabis use. Comparisons among cannabis naïve and experienced adolescents will likely be of considerable interest.

Limitations of this feasibility study include its small sample size and its geographically unique sample of convenience. In Northern Ontario, adolescent cannabis use rates are high (23%) compared to major centres of the province (e.g., Greater Toronto Area, 19%; Boak, Hamilton, Adlaf, & Mann, 2017). This smartphone owning sample may have been more willing or able to utilize EMA effectively than youth in the general population, although data now show that more than 85% of Canadian youth own and operate a smartphone (Vanier Institute, 2017). Second, information related to youths' exposure to educational cannabis-related information and anti-cannabis information, and its subsequent effect on cannabis-related cognitions and cannabis use was not collected as part of this protocol, although it could be in the future. Lastly, this small sample size did not support meaningful statistical comparisons of random prompt and exposure occurrences, and assessment of differences according to demographic or SES factors. Larger studies, conducted beyond the immediate impacts of the COVID-19 pandemic, are needed to verify the type and impact on cognitions and cannabis use for cannabis-related marketing exposures.

In conclusion, to our knowledge, we have provided the first example of an EMA protocol that adolescents can use to systematically demonstrate whether Canadian cannabis marketing regulatory efforts are comprehensive, effective, and the extent to which Canadian adolescents are exposed to cannabis marketing. Policymakers, educators, families and communities need to know the nature and extent of Canadian adolescents' exposure to cannabis marketing and its impact on their attitudes, beliefs, and ultimately their decisions to use cannabis. With data from larger, more diverse samples, this information could be used to hold companies accountable, to validate and enhance current regulations, and to minimize public harm of early cannabis use among youth.

#### CRedit authorship contribution statement

**Chelsea Noël:** Writing – original draft, Writing – review & editing, Formal analysis, Visualization. **Christopher Armiento:** Conceptualization, Writing – original draft, Investigation, Formal analysis. **Anna Koné Péfayo:** Conceptualization, Formal analysis. **Rupert Klein:** Conceptualization, Investigation, Formal analysis. **Michel Bédard:** Conceptualization, Formal analysis, Writing – original draft. **Deborah Scharf:** Supervision, Funding acquisition, Writing – original draft, Writing – review & editing, Formal analysis.

#### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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