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Youth Tobacco and Cannabis Use and Co-Use: Associations with Daily Exposure to Tobacco Marketing within Activity Spaces and by Travel Patterns

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Abstract

Background: We investigated youth daily activity spaces, travel patterns, exposure to tobacco retail marketing, and tobacco and cannabis use and co-use.

Methods: Data included 1,060 daily assessments from 100 participants (16–20 years old) in 8 California cities. Using GPS-enabled smartphones with a survey application, youth completed brief daily surveys, and location coordinates were obtained at one-minute intervals. Tobacco outlets in study cities were visited by observers to record outlet GPS point locations and data concerning tobacco marketing. Tobacco outlet addresses and GPS location coordinates were geocoded. Activity spaces were constructed by joining sequential location points. Measures included the number of outlets with outdoor tobacco marketing within 50 meters of activity space polylines and the amount of time participants were within 50 meters of these outlets each day. Participants also reported tobacco and cannabis use and whether they saw tobacco ads by their neighborhood, school, workplace, and anywhere else each day. Additionally each day they reported how much time they traveled by different modes of transportation, with parents/guardians, and with friends.

Results: In mixed effects multinomial regression models, perceived exposure to tobacco marketing was associated with co-use of tobacco and cannabis on a given day (RRR=1.66,

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p<0.05). Although perceived exposure to tobacco marketing was not associated with tobacco use only, moderation analysis indicated that the likelihood of tobacco use was greater among youth who walked/biked/skated more (RRR=5.22, p<0.05).

Conclusion: Perceived exposure to tobacco marketing contributes to youth tobacco and cannabis use or co-use, especially for those who travel by walking/biking/skating.

Keywords

Tobacco advertising and promotion; Tobacco Outlets; Tobacco; Cannabis; Geographic Ecological Momentary Assessment (GEMA)

1. Introduction

Youth rates of tobacco and cannabis use and co-use are prevalent in the United States (Lemyre et al., 2019; Rabin & George, 2015; Wang et al., 2019). Data from a nationally representative high school student sample showed that 19.5% used tobacco and 19.8% used cannabis in the past 30 days (Kann et al., 2018). In another study of adolescents and young adults in California, 7.3–11.3% reported co-use of tobacco and cannabis (Nguyen et al., 2019). Importantly, co-use of tobacco and cannabis during adolescence is associated with potentially synergistic and additive adverse health (e.g., substance use and dependency) and social consequences (e.g., involvement in crime) (Agrawal et al., 2012; Lemyre et al., 2019; Meier & Hatsukami, 2016; Rabin & George, 2015; Tucker et al., 2019). Therefore, understanding tobacco and cannabis co-use is important for public health efforts.

Tobacco use has been attributed to tobacco industry marketing targeting youth, which includes increased tobacco advertising inside and on storefronts, price promotion, and greater availability of tobacco products that appeal to young people at point of sale. An extensive literature of cross-sectional, longitudinal, and experimental research has documented the link between tobacco marketing in the retail environment and young peoples' smoking initiation, repeated use, and continued use (Berg et al., 2018; Gilpin et al., 2007; Lee et al., 2015). DiFranza and colleagues conducted a large literature review and concluded that there is a causal relationship between tobacco marketing and young people's smoking initiation (DiFranza et al., 2006). Further, result of meta-analysis shows that frequent, compared to less frequent, exposure to point-of-sale marketing is associated with 1.6 times higher odds of young people trying smoking (Robertson et al., 2016). However, there are a few important gaps in the existing research on youth exposure to retail tobacco marketing.

First, the extent to which tobacco marketing influences other substance use, including cannabis, is limited. To our knowledge, no study has examined these relationships. One way tobacco marketing may influence cannabis use or tobacco and cannabis co-use is through shared mechanisms of use. Tobacco and cannabis share many modes of use (e.g., smoking or vaping), tools of administration (e.g., pipe or papers), and are commonly used simultaneously (e.g., blunts, spliffs, etc.) (Ramo et al., 2013; Schauer et al., 2017). Many tobacco and cannabis products also look very similar (e.g., e-liquids) and are marketed similarly by the tobacco and cannabis industries (Richter & Levy, 2014). Further, it may

be that individuals call upon the shared schema (i.e., a cognitive developmental construct describing how individuals organize information) (Kan et al., 2020; Kean & Albada, 2003) for tobacco and cannabis when exposed to tobacco marketing give these commonalities. As such, it is important to assess how exposure to tobacco retail marketing may be related to use and co-use of these substances to inform policy and prevention efforts.

Second, measurement in the existing research generally relies on participant perceptions and self-reports with few studies using objective measures of exposure. Of 13 studies included in a recent review of tobacco marketing at the point of sale and its effects on youth smoking, 11 used self-reported exposure measures (Robertson et al., 2015). Although, self-reported measures provide important information about youth exposures, these indices are limited by recall and same-source bias.

Third, although a growing body of research has shown the importance of considering the broader environment where youth spend their time (i.e., activity spaces) to accurately capture exposure to tobacco marketing and access (Caryl et al., 2019; Kowitt & Lipperman-Kreda, 2020; Lipperman-Kreda et al., 2015; Lipperman-Kreda et al., 2020; Shareck et al., 2016, 2020), few published studies have used these methods. Merging temporal and geographic aspects of movement, geographically-explicit ecological momentary assessments (GEMA) allow researchers to track participants using navigation data, often through the ease of smartphones (Kowalczyk, 2017). Further, GEMA approaches may help researchers to address limitations stemming from self-reported marketing exposures by objectively tracking when youth are near tobacco outlets (Lipperman-Kreda et al., 2020).

Finally, evidence suggests that daily modes of transportation and with whom youth travel may be relevant factors to consider when assessing environmental conditions that contribute to youth tobacco or other substance use (Mason et al., 2009; Mennis & Mason, 2011). For example, youth who walk or bike may encounter tobacco outlets and marketing more directly compared to youth who drive or take public transportation, and therefore, may perceive greater exposure to tobacco marketing in their environments. Alternatively, youth who have access to a car are likely to have larger activity spaces, which may increase exposure to tobacco outlets and marketing. Furthermore, youth who travel more often with their parents/guardians within activity spaces are probably less likely to use tobacco than youth who travel with friends. Still, the relationships between youth travel patterns, exposure to tobacco marketing at the point of sale, and tobacco and cannabis use and co-use have not been examined.

The goal of this research is to address the aforementioned gaps and limitations by using a 14-day GEMA study of youth in California. Specifically, we address the following research questions: (1) Is daily exposure to tobacco retail marketing within activity spaces associated with tobacco and cannabis use and co-use by youth on that day and (2) Do youth travel patterns moderate associations between retail exposure to tobacco marketing within activity spaces and tobacco and cannabis use and co-use behaviors? Overall, we anticipate that greater exposure to tobacco retail marketing, via daily exposure within activity spaces, will contribute to higher reporting of tobacco and cannabis use and co-use.

2. Methods

2.1 Study Cities and Participants

GEMA data were collected from 101 youth aged 16–20 years in 8 mid-sized California city areas, between February 2017 and May 2019. To assure power to address the aims of the overall project, we stratified by tobacco use status at screening (~50% any past-month tobacco users). Details on participant screening and city selection methods can be seen in previous publications (Kowitt & Lipperman-Kreda, 2020; Lipperman-Kreda et al., 2020). All participants provided signed consent or assent to participate in the research. The Pacific Institute for Research and Evaluation (PIRE) institutional review board (Federalwide Assurance #FWA00003078) approved the study prior to implementation.

2.2 Procedures

Upon recruitment, participants completed a 30-minute online survey that included questions about demographic characteristics. Researchers then provided GPS-enabled phones with a survey application to participants and explained the study procedures. Participants responded to brief daily surveys, and their location coordinates (latitude and longitude) were obtained at one-minute intervals for 14 days. The phone survey application was programed to send reminders to complete the survey each evening at 8:00 PM with a 3-hour window to respond to the survey. Participants were compensated for their time and provided resources on tobacco use. Details can be found in previous studies (Kowitt & Lipperman-Kreda, 2020; Lipperman-Kreda et al., 2020).

2.3 Analytical Sample

Data were obtained from participants for a total of 1,483 days. From this total, we excluded data for days in which participants were tracked for less than 360 minutes ($n = 123$) and days where participants provided data for more than 14 study days ($n = 73$). Of the remaining 1,287 days, 227 days were missing study variables used for the analyses. The final analytic sample included 1,060 days, which were clustered within 100 participants. Sample demographic characteristics are in Table 1.

2.4 Measures

2.4.1 Tobacco and cannabis use and co-use—At each daily survey, participants were asked, “Since this time yesterday, did you…” (1) smoke at least one cigarette? (2) smoke any cigar, cigarillo, or little cigar? (3) use chewing tobacco snuff or dip, such as Redman, Levi Garrett, Beechnut, Skoal, Skoal Bandits, or Copenhagen? (4) use an e-cigarette or vape device, including e-pen, vape pen, cigalikes, e-hookah, personal vaporizers, or mods to get nicotine? (5) use cannabis, marijuana or hash? (6) smoke part or all of a cigar, cigarillo, or little cigar with marijuana in it (a blunt)? Participants could respond yes (1) or no (0). If a participant reported the use of any of the products in questions 1–4 on a specific day, they were coded as having used tobacco on that day. If a participant reported the use of cannabis (question 5), they were coded as having used cannabis on that day. If a participant reported any tobacco use and any cannabis use or blunt use (question 6), they were coded as co-using tobacco and cannabis on that day. We created a multinomial outcome measure with

no tobacco and cannabis use as the reference category (0), tobacco use only (1), cannabis use only (2), and co-use of tobacco and cannabis (3) on each day.

2.4.2 Perceived exposure to tobacco marketing—Each day, participants were asked in four separate questions, “Since this time yesterday, did you see any ads for cigarettes, e-cigarettes, or any other tobacco or nicotine products inside or outside of a store or on a billboard in or near…” (1) Your neighborhood? (2) Your school? (3) Your workplace? and (4) Anywhere else? Participants could respond yes (1) or no (0). We summed responses to all four questions, such that greater scores indicated greater perceived exposure to tobacco marketing (range: 0–4).

2.4.3 Exposure to tobacco outlets with outdoor marketing—We identified tobacco outlets in the 8 city areas using previously reported methods (Kowitt & Lipperman-Kreda, 2020; Lipperman-Kreda et al., 2020). Outlet observations were conducted by traind field observers using an adapted version of the Standardized Tobacco Assessment for Retail Settings (STARS) surveillance tool (Henriksen et al., 2016). To assess inter-rater agreement, 13% of the outlets (n=69) were independently visited by two observers. In this study, we combined items asking field observers to indicate whether there were (1) any tobacco or nicotine ads (marketing materials) visible from the outside and (2) any price promotions outside the store for any of the following products: regular cigarettes, menthol cigarettes, cigarillos/little cigars, large cigars, chew, moist or dry, snuff/snus, loose or pipe tobacco, hookah/shisha, e-cigarette/vape devices, e-hookah, e-cigars, or e-liquid. Indication of yes to any of these items was coded 1 for each outlet. Inter-rater agreement for the combined items was acceptable (kappa=.67).

Tobacco outlet addresses and participants’ GPS locations were geocoded, and activity spaces were constructed by joining sequential GPS points into a polyline, which was then buffered and overlaid with tobacco outlet locations. Examples of participants’ activity spaces have been previously published (Lipperman-Kreda et al., 2015). Exposure measures included the number of tobacco outlets with outdoor marketing within 50m of these polylines each day, and the number of minutes participants were within 50m of tobacco outlets with outdoor marketing each day. The downloaded GPS data had a field of accuracy for each point. The average accuracy was 20m. To minimize potential errors, we used the 50-meter buffer. All exposure measures were weighted by the time participants were within the study area. Objective exposure measures were linked to daily surveys by calendar days.

2.4.4 Daily travel patterns—Each day, participants were asked “since this time yesterday, how much time (if any) did you spend traveling from place to place by…”: (1) car, (2) bus or other public transportation, (3) bicycle, skateboard, or skates, and (4) walking. Participants could respond none (0), less than 30 minutes (1), between 30 minutes to 1 hour (2), or more than 1 hour (3). We calculated the proportion of overall time participants reported walking or biking/skating within their activity space each day. To assess the frequency of traveling with parents/guardians and with friends each day, we asked participants, “Since this time yesterday, when you traveled around from place to place (if at all), how often were you with…”: (1) parents/guardians, and (2) friends. Response options

included not at all (0), some of the time (1), about half of the time (2), most of the time (3), or all of the time (4).

2.4.5 Control measures—Control measures assessed in the initial survey included sex assigned at birth (male, female, or intersex), race (White or non-White), ethnicity (Latino or non-Latino), age group (less than 18 or 18+), and perceived SES using the item, "Compared with other people in America, how rich or poor do you consider yourself?" Respondents could answer on a 7-point Likert scale (1=rich to 7=poor).

2.5 Data Analysis

We first examined means, standard deviations, or frequencies of all measures. Using multinomial logistic regression, we then conducted two sets of analyses to examine our research questions. To account for the clustering of assessments within participants, we used cluster robust standard errors in all analyses. We controlled for demographic characteristics identified in exploratory analyses as significantly associated with the outcome measure (i.e., age group and perceived SES). In the first set of analyses, we examined associations of perceived and objective exposure to tobacco marketing and travel patterns with tobacco use only (1), cannabis use only (2), co-use of tobacco and cannabis (3), compared to no tobacco and cannabis use (0). Similar to past research (Kowitt & Lipperman-Kreda, 2020; Lipperman-Kreda et al., 2020), we ran separate models for the three exposure measures given the large correlation between our two objective exposure measures (r=0.43) and the possibility of controlling for a mediator when considering objective and perceived exposures. In the second set of analyses, we included interactions between each travel pattern (i.e., the proportion of time walking/biking/skating within activity spaces, frequency traveling with parents/guardians, and frequency of traveling with friends) and the perceived and objective exposure to tobacco marketing. Results from the multinomial logistic regression models include Relative Risk Ratio (RRR) and 95% confidence intervals (CI). For analyses, we used Stata v.16.1 (StataCorp., 2017), set critical a = .05, and used 2-tailed statistical tests.

3. Results

3.1 Descriptive Statistics

Of the 1,060 observations in this study, most days (68.6%) did not include tobacco or cannabis use, 6.7% included tobacco use only, 6.6% included cannabis use only, and 18.1% included tobacco and cannabis co-use (Table 1). On average, participants were exposed to 1.5 (*SD*=2.1) tobacco outlets with outdoor marketing within 50m of polylines each day and they spent, on average, 3.9 (*SD*=11.4) minutes within 50m of tobacco outlets with outdoor marketing each day. On average, participants reported seeing tobacco ads in 0.6 (*SD* =1.0) areas within their activity spaces each day. Descriptive statistics, including 95% CI for exposure to tobacco marketing and travel patterns by the outcome categories are displayed in Table 2.

3.2 Exposure to tobacco marketing and travel patterns: Main effects

Results of the multinomial logistic regression analyses are displayed in Tables 3a, 3b, and 3c. Controlling for demographics, perceived exposure to tobacco marketing in any additional area within youth activity spaces was associated with 53% increase in risks for cannabis use only (RRR=1.53, $p<0.05$) and with 65% increase in risks for tobacco and cannabis co-use (RRR=1.65, $p<0.05$) each day. No associations were observed between objective measures of exposure to tobacco marketing and tobacco and cannabis use or co-use. Focusing on travel patterns, in adjusted models, traveling with friends was positively associated with cannabis use only compared to no use of tobacco and cannabis on a given day.

3.3 Exposure to tobacco marketing and travel patterns: Moderation effects

Controlling for demographics, the proportion of time participants walked/biked/skated within their activity spaces moderated the relationship between perceived exposure to tobacco marketing within activity spaces and tobacco use only, such that the likelihood of tobacco use only was greater among youth who walked/biked/skated more (RRR=6.05, 95% CI=1.23, 29.52; $p<0.05$). Also, the proportion of time participants walked/biked/skated within their activity spaces moderated the relationship between number of outlets as well as number of minutes within 50m of outlets with tobacco marketing and cannabis use only such that the likelihood of cannabis use only was lower among youth who walked/biked/skated more (RRR=0.36, 95% CI=0.13, 0.96; $p<0.05$ and RRR=0.75, 95% CI=0.58, 0.96; $p<0.05$, respectively). No other moderation effects were observed.

4. Discussion

To our knowledge, this study is the first to consider how perceived and objective measures of exposure to tobacco marketing within youth activity spaces are associated with tobacco and cannabis use and co-use and whether these associations are moderated by youth travel patterns. We found that perceived exposure to tobacco marketing was associated with cannabis use only and with co-use of tobacco and cannabis on a given day. Although perceived exposure to tobacco marketing was not associated with tobacco use only, the proportion of time participants walked/biked/skated within their activity spaces moderated this relationship, demonstrating that the likelihood of tobacco use was greater among youth who walked/biked/skated more.

Extending previous research showing association between retail tobacco marketing and youth tobacco use (Berg et al., 2018; Gilpin et al., 2007; Lee et al., 2015), our results suggest that exposure to tobacco marketing may influence the co-administration of tobacco with other substances, including cannabis. Given the parallels between tobacco and cannabis in products, mode of use (Ramo et al., 2013; Schauer et al., 2017), and industry marketing practices (Richter & Levy, 2014), the role of syngergistic mechanisms is plausible. The cognitive developmental construct of schemas (Kan et al., 2020; Kean & Albada, 2003) may also help to explain the synergetic effects. Schemas are knowledge structures that individuals develop to help organize information, which can inform future understanding and behavior. Similarities between tobacco and cannabis in terms of devices for use or methods of use and the potentially shared social-environmental antecedents and consequences of use (Kirisci &

Tarter, 2001) may prompt storing tobacco and cannabis marketing related information within a single schema. Individuals may be cued to call on this single schema during exposure and reaction to marketing. Alternatively, given that use of specific products, such as little cigars and cigarillos, are prevalent among young people and are highly correlated with cannabis use in the form of blunts (Sterling et al., 2016), it is possible that marketing of these tobacco products may contain messages that implicitly or explicitly promote co-use. As suggested elsewhere, our findings highlight the importance of incorporating measures to capture types of co-administration (e.g., blunts) as we attempted to do in this study (McClure, 2021).

We also found that perceived, but not objective exposure to tobacco marketing at the point of sale contributed to youth tobacco and cannabis use or co-use. It is possible that self-reported measures capture youth noticing and attending to tobacco marketing and thereby, provide an important assessment of exposure. Moreover, this result aligns with the social cognitive theories (Ajzen, 1991; Ajzen & Albarracín, 2007; Bandura, 1986; Fishbein & Ajzen, 2011; Lipperman-Kreda & Grube, 2009) that suggest that people's beliefs play a prominent role in human behaviors, including substance use. In our case, objective exposure to tobacco outlets and marketing at the point of sale may have elicited various beliefs (e.g., tobacco norms), including tobacco marketing perceptions. Additional research is also needed to better understand the ways through which objective exposure to tobacco marketing may shape perceived exposure and use.

Finally, consistent with previous research (Mason et al., 2009; Mennis & Mason, 2011), our results also support the importance of youth travel patterns and activity spaces to a better understanding of how environments affect their tobacco and substance use behaviors. While little research has investigated youth activity spaces with specific attention to mode of transportation, a recent study demonstrated that adolescents traveling by foot to their school or stopping by a tobacco retail outlet on their walking routes had a greater likelihood of using tobacco products (Trapl et al., 2020). In this study, we found that the association between perceived exposure and tobacco use was greater among youth who walked/biked/skated more. Findings suggest that opportunities to engage with outlet outdoor tobacco marketing may be greater when walking/biking/skating compared to motorized transportation (e.g., cars, buses), as the former often occurs on sidewalks close to stores. For these youth, interventions, such as placing anti-tobacco ads at the point of sale, may help to reduce the influence of tobacco marketing on tobacco use behaviors.

No associations were found in the full adjusted models between the frequency of traveling with parents/guardians or with friends on tobacco and cannabis use or co-use. Though this was unexpected given the vast research on predictive influences of family and peer factors (Villanti et al., 2011), in a previous study using the same data, we showed that greater numbers of tobacco outlets within activity spaces were associated with greater tobacco use on a given day through exposure to peer use (Kowitt & Lipperman-Kreda, 2020). It may be that the travel patterns assessed in this study simply capture travel time with no inferences to parental/guardian supervision and peer influence.

A few study limitations should be noted. First, we did not consider youth exposure to cannabis outlets to distinguish effects of exposure to tobacco marketing at the point of sale

from potential exposure to medical cannabis dispensaries, which may be in proximity to tobacco outlets. Although data collection for the current study coincided with legalization of recreational use of cannabis in California, the number of recreational cannabis outlets was quite limited at the time. Nevertheless, California's tobacco and cannabis policy environment during data collection differs from other states in important ways, particularly regarding medical cannabis laws, which may correlate with higher rates of tobacco and cannabis co-use. As such, findings from our convenience sample of youth in California may not generalize to other populations or locations. Second, we relied on self-reported measures of tobacco and cannabis use. Third, we did not control for or consider other potential factors that may have influenced youth tobacco and cannabis use behaviors, such as family or peer tobacco use, tobacco beliefs, or exposure to other environmental factors, such as neighborhood deprivation or local smoking norms within activity spaces. Future research should operationalize and examine effects of momentary changes in such environmental factors within individuals' activity spaces. Finally, we cannot definitively determine the direction of causality. For example, although in the current study we obtained novel, fine-grained spatial and temporal information on individuals' mobility patterns, environmental exposures, and behaviors, our analyses do not allow for an examination of the possibility that youth may select certain environments (e.g., tobacco outlets) based on their tobacco use behaviors (i.e., selective daily mobility) (Chaix et al., 2012, 2013) or consider the cumulative effects of exposures or how exposure may lead to use or co-use on a later day.

5. Conclusions

Despite these potential limitations, by using a cutting-edge methodology to assess the effects of real-time exposure to tobacco marketing at the point of sale on youth tobacco and cannabis use and co-use, this study highlights the importance of policies and interventions addressing young people's exposure to and perception of exposure to tobacco marketing at the point of sale in the broader environment to reduce tobacco and cannabis use and co-use. Such efforts may include restrictions on point-of-sale marketing or real-time text messages about risks of tobacco use and co-use with cannabis in order to counter effects of exposure to marketing messages. Currently, the point of sale remains the least regulated channel for tobacco marketing (Campaign for Tobacco-Free Kids., 2018; Center for Public Health Systems Science, 2014; Frick et al., 2012; Ribisl et al., 2017). These interventions may be especially important and timely given the high prevalence of co-use of tobacco and cannabis in youth, the adverse health and social effects of co-use, and the changes in the tobacco and cannabis sales and regulation landscape.

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Highlights

- Assess day-to-day exposure to retail tobacco marketing within youth activity spaces
- Retail tobacco marketing contributes to youth tobacco and marijuana co-use
- Retail tobacco marketing increases tobacco use among youth who walk/bike/skate more
- Policies and prevention activities should consider tobacco and marijuana co-use

Table 1.

Participant demographic characteristics and study variables

	N	%	*M*	*SD*	Range
Youth (*N* = 100)					
Age (<18 years)	38	38.0			
Gender (Female)	60	60.0			
Race/ethnicity (non-Latinx white)	37	37.0			
Subjective socioeconomic status[1]			3.8	1.4	1–7
Past month any tobacco use	34	37.4			
Daily observations (*N* =1,060)					
Tobacco and cannabis use					
No use of tobacco or cannabis	727	68.6			
Tobacco use only	71	6.7			
Cannabis use only	70	6.6			
Tobacco and cannabis co-use	192	18.1			
Number of outlets within 50m of activity space polylines with tobacco marketing			1.5	2.1	0–10.9
Number of minutes within 50m of outlets with tobacco marketing within activity space			3.9	11.4	0–206.2
Perceived exposure to tobacco marketing			0.6	1.0	0–4
Proportion of time walking/biking/skating within activity spaces			0.3	0.3	0–1
Frequency of traveling with parents/guardians			0.9	1.2	0–4
Frequency of traveling with friends			1.3	1.3	0–4

[1]7-point scale from 1 (“well below average”) to 7 (“well above average”)

Table 2.

Daily exposure to tobacco marketing/ads and travel pattern by tobacco and cannabis use and co-use (n =1,060 days)

	No Use	Tobacco Only	Cannabis Only	Tobacco and Cannabis Co-use
	***M* (95% CI)**	***M* (95% CI)**	***M* (95% CI)**	***M* (95% CI)**
Number of outlets within 50m of activity space polylines with tobacco marketing	1.60 (1.45, 1.76)	1.07 (0.68, 1.47)	1.07 (0.65, 1.48)	1.48 (1.17, 1.77)
Number of minutes within 50m of outlets with tobacco marketing within activity space	4.35 (3.42, 5.29)	2.55 (1.34, 3.75)	2.57 (1.38, 3.76)	3.53 (2.40, 4.66)
Perceived exposure to tobacco marketing	0.49 (0.42, 0.56)	0.45 (0.21, 0.69)	0.79 (0.52, 1.05)	0.99 (0.83, 1.16)
Proportion of time walking/biking/skating within activity spaces	0.30 (0.29, 0.32)	0.25 (0.19, 0.31)	0.24 (0.17, 0.30)	0.35 (0.31, 0.38)
Frequency of traveling with parents/guardians	1.07 (0.98, 1.16)	0.59 (0.36, 0.82)	1.01 (0.71, 1.32)	0.74 (0.60, 0.88)
Frequency of traveling with friends	1.14 (1.05, 1.23)	1.22 (0.89, 1.57)	1.54 (1.23, 1.85)	1.59 (1.39, 1.79)

Table 3a.

Multilevel multinomial regressions to account for nesting of days (n=1,060) within participants (n = 100) to examine associations between exposure to number of outlets with tobacco marketing/ads within activity spaces and tobacco and cannabis use behaviors

	Tobacco use[1]		Cannabis Use[1]		Tobacco and Cannabis Co-Use[1]	
	RRR (95% CI)	***p***	**RRR (95% CI)**	***p***	**RRR (95% CI)**	***p***
Perceived exposure to tobacco marketing	1.11 (0.74, 1.66)	0.52	**1.53 (1.05, 2.23)**	**0.03**	**1.65 (1.23, 2.22)**	**0.00**
Proportion of time walking/biking/skating within activity spaces	0.55 (0.08, 3.85)	0.55	0.25 (0.03, 2.00)	0.19	1.82 (0.57, 5.81)	0.31
Frequency of traveling with parents/guardians	0.79 (0.62, 1.02)	0.07	1.10 (0.85, 1.40)	0.72	0.81 (0.63, 1.04)	0.10
Frequency of traveling with friends	1.07 (0.80, 1.42)	0.66	**1.38 (1.04, 1.83)**	**0.03**	1.20 (0.97, 1.49)	0.10
Under 18 years	**0.12 (0.04, 0.37)**	**0.00**	**0.22 (0.07, 0.68)**	**0.01**	**0.30 (0.13, 0.73)**	**0.01**
Subjective socioeconomic status	**0.60 (0.39, 0.93)**	**0.02**	1.47 (0.70, 3.06)	0.31	0.73 (0.52, 1.03)	0.07

[1]No tobacco or cannabis use as a reference category

Boldface denotes statistically significant results at p<0.05

Table 3b.

Multilevel multinomial regressions to account for nesting of days (n=1,060) within participants (n = 100) to examine associations between exposure to number of outlets with tobacco marketing/ads within activity spaces and tobacco and cannabis use behaviors

	Tobacco use[1]		Cannabis Use[1]		Tobacco and Cannabis Co-Use[1]	
	RRR (95% CI)	***p***	**RRR (95% CI)**	***p***	**RRR (95% CI)**	***p***
Number of outlets within 50m of activity space polylines with tobacco marketing	0.84 (0.70, 1.01)	0.06	0.85 (0.71, 1.03)	0.10	0.93 (0.82, 1.05)	0.25
Proportion of time walking/biking/skating within activity spaces	0.65 (0.10, 4.61)	0.67	0.32 (0.04, 2.50)	0.28	2.10 (0.71, 6.08)	0.18
Frequency of traveling with parents/guardians	0.79 (0.61, 1.02)	0.07	1.12 (0.88, 1.41)	0.35	0.85 (0.67, 1.08)	0.17
Frequency of traveling with friends	1.10 (0.83, 1.46)	0.50	**1.43 (1.07, 1.92)**	**0.02**	1.24 (1.00, 1.55)	0.05
Under 18 years	**0.11 (0.04, 0.36)**	**0.00**	**0.26 (0.08, 0.83)**	**0.02**	**0.34 (0.14, 0.85)**	**0.02**
Subjective socioeconomic status	**0.59 (0.39, 0.92)**	**0.02**	1.41 (0.71, 2.79)	0.33	0.72 (0.53, 0.99)	0.05

[1] No tobacco or cannabis use as a reference category

Boldface denotes statistically significant results at p<0.05

Table 3c.

Multilevel multinomial regressions to account for nesting of days (n = 1,060) within participants (n = 100) to examine associations between number of minutes within outlets with tobacco marketing/ads within activity spaces and tobacco and cannabis use behaviors

	Tobacco use[1]		Cannabis Use[1]		Tobacco and Cannabis Co-Use[1]	
	RRR (95% CI)	***p***	**RRR (95% CI)**	***p***	**RRR (95% CI)**	***p***
Number of minutes within 50m of outlets with tobacco marketing within activity space	0.96 (0.91, 1.02)	0.19	0.97 (0.94, 1.01)	0.14	0.98 (0.95, 1.01)	0.31
Proportion of time walking/biking/skating within activity spaces	0.62 (0.10, 4.27)	0.63	0.31 (0.04, 2.49)	0.27	2.08 (0.70, 6.21)	0.19
Frequency of traveling with parents/guardians	0.78 (0.61, 1.00)	0.06	1.12 (0.88, 1.42)	0.36	0.84 (0.67, 1.07)	0.16
Frequency of traveling with friends	1.09 (0.82, 1.46)	0.53	**1.43 (1.07, 1.91)**	**0.02**	1.24 (1.00, 1.54)	0.05
Under 18 years	**0.12 (0.04, 0.37)**	**0.00**	**0.26 (0.08, 0.81)**	**0.02**	**0.34 (0.14, 0.85)**	**0.02**
Subjective socioeconomic status	**0.60 (0.39, 0.92)**	**0.02**	1.41 (0.71, 2.81)	0.32	0.73 (0.53, 1.00)	0.05

[1] No tobacco or cannabis use as a reference category

Boldface denotes statistically significant results at $p < 0.05$