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**Proximity and Child-appealing Marketing Activities of Recreational
Marijuana Dispensaries and Adolescents' Marijuana Use**

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ABSTRACT

Objective: This study examined the associations of the proximity and child-appealing marketing activities of recreational marijuana dispensaries (RMDs) with adolescents' marijuana use.

Methods: Data on adolescents from the 2017-8 California Student Tobacco Survey were merged with auditing data on RMDs. The sample included 96,011 adolescents in 244 schools. Marijuana use outcomes included current use, heavy use, and curiosity. The primary predictors included 1) the proximity between a school and its nearest RMD and 2) the presence of child-appealing marketing activities in the nearest RMD. Multi-level regressions were conducted to examine associations.

Results: The association between RMDs' proximity and marijuana use and the associations between RMDs' child-appealing marketing activities and marijuana use were all nonsignificant. After interacting RMDs' proximity with marketing activities, the presence of child-appealing paraphernalia was associated with a higher odds of current use (OR = 1.40, 95%CI = [1.03, 1.90]) if the school had its nearest RMD located within a 1-to-3 mile buffer. The presence of child-appealing products and packages was associated with a higher odds of heavy use (OR = 1.40, 95%CI = [1.00, 1.96]) if the school had its nearest RMD located within a 1-mile buffer.

Conclusions: There was some evidence suggesting that child-appealing marketing activities in RMDs with closer proximity to schools might be associated with adolescents' marijuana use.

KEYWORDS

Recreational Marijuana Dispensary; Outlet Proximity; Point-Of-Sale Marketing; Marijuana Use;

Adolescents

ABBREVIATIONS

CSTS: California Student Tobacco Survey

RMD: Recreational Marijuana Dispensary

INTRODUCTION

Adolescents' marijuana use is associated with adverse neurobehavioral and health effects from adolescence through adulthood. (Hall and Degenhardt 2009, Volkow et al. 2014) According to the Monitoring the Future study, secondary- and high-school students reported increasing trends in past-year and past-month marijuana use in the past decade (22.9% to 25.2% and 13.8% to 15.6% from 2009 to 2019, respectively). (Johnston et al. 2020) These trends coincided with the increasing recreational marijuana legalization and commercialization in the US since 2012. Emerging evidence suggested that statewide recreational marijuana legalization or commercialization might be associated with a reduction in perceived harmfulness and increases in marijuana use and marijuana use disorder among adolescents. (Cerdeña et al. 2020, Cerdeña et al. 2017, Shi and Liang 2020)

There is scant research on the influences of local variations in marijuana regulatory and retail environments on adolescents' marijuana use outcomes. Within a state with recreational marijuana legalization and commercialization, local jurisdictions may opt to prohibit recreational marijuana dispensaries (RMDs) or restrict their density and locations. RMDs may select their locations for cost and demand considerations. These local variations have resulted in considerable differences in the availability, proximity, and density of RMDs at neighborhood level. Although adolescents are prohibited from purchasing marijuana in RMDs, the presence of RMDs near where they congregate such as schools may promote the visibility and awareness of marijuana and shape favorable perceptions, attitudes, and behaviors towards marijuana use. Indirect access to RMDs through third party adults, such as older friends, relatives, and street dealers, could also increase the availability of and accessibility to marijuana among adolescents. (Harrison, Fulkerson, and Park 2000) To date, only a few studies have evaluated the association

between RMDs' availability and crime rates using aggregate data at neighborhood level (e.g., census blocks). (Freisthler et al. 2017, Hughes, Schaible, and Jimmerson 2020) No studies have focused on RMDs' proximity and density and marijuana use outcomes in adolescent population.

Another major concern on RMDs is their point-of-sale marketing activities, particularly those targeting adolescents. Dispensary storefronts have become the most commonly reported source of advertising among adolescents and adults after recreational marijuana commercialization. (Fiala et al. 2018, Fiala et al. 2020) In a study conducted by our team in 2018, we observed that nearly three quarters of RMDs in school neighborhoods had marketing activities that were appealing to children. (Cao et al. 2020) Informed by strong scientific evidence from tobacco literature that marketing activities promote initiation and use of tobacco among adolescents, (Ammerman et al. 2015) the American Academy of Pediatrics policy statement "strongly recommends strict enforcement of rules and regulations that limit access and marketing and advertising to youth". (Committee on Substance Abuse and Committee on Substance Abuse Committee on 2015) However, empirical evidence regarding the associations between RMDs' marketing activities and adolescents' marijuana use outcomes is still lacking.

The goal of this study was to provide the first data point on the relationships of proximity and child-appealing marketing activities of RMDs with adolescents' marijuana use. We had three hypotheses. First, the proximity of RMDs is positively associated with the likelihood of adolescents' marijuana use (main effects). Second, the presence of child-appealing marketing activities in RMDs is positively associated with the likelihood of adolescents' marijuana use (main effects). Third, the associations between RMDs' child-appealing marketing activities and adolescents' marijuana use depend upon the proximity of RMDs (interaction effects). The study

findings are expected to inform prevention and regulatory strategies that aim to protect adolescents from the negative influences of RMDs in school neighborhoods.

METHODS

Data Source and Study Sample

This was a cross-sectional association study using multiple data sources on adolescents, RMDs, schools, and census tracts.

California Student Tobacco Survey (CSTS) 2017-8

The California Student Tobacco Survey (CSTS) is a repeated cross-sectional and state-representative school survey among California middle and high school students (8th, 10th, and 12th graders). It has been administered biennially since 2001-2 with the purpose of monitoring adolescents' tobacco use behaviors and perceptions. This study used CSTS 2017-8, which was administered between September 2017 and June 2018. CSTS 2017-8 used a two-stage cluster random sampling approach, where public and nonsectarian schools were first randomly selected from regions and then classrooms in selected schools were invited to participate. All the participating schools were invited to survey all the students in a particular grade. If a school chose not to survey all the students in a grade, five classrooms were randomly selected to participate. Of the 623 schools invited, 359 schools fielded the survey. The final data excluded 26 schools with response rates below certain thresholds, resulting in 151,404 adolescents in 333 schools in CSTS 2017-8. The survey was administered online in both English and Spanish and completed between 15 and 25 minutes. Details about CSTS 2017-8 sampling approaches and survey implementation have been reported elsewhere. (Zhu, Gamst, and Zhuang 2019)

Because California started legal sales of marijuana in RMDs on January 1st, 2018, RMDs presumably had no impacts on adolescents' reporting on past-month marijuana use before

February 2018. Therefore, we restricted our analysis to the 244 school that completed the survey on or after February 1st, 2018. There were 103,914 adolescents surveyed in these 244 schools. After removing adolescents with incomplete information on demographics and marijuana use, the final study sample included 96,011 adolescents. It accounted for 73% of the schools and 67% of the adolescents in the complete CSTS 2017-8 sample.

Standardized Marijuana Dispensary Assessment – Children Focused (SMDA-CF)

Between June and September 2018, our team collected data on locations and marketing activities of RMDs that had the closest proximity to the CSTS 2017-8 participating schools. Six trained fieldworkers obtained a list of marijuana dispensaries closest to the participating schools from crowdsourced online websites, including Weedmaps, Wheresweed, Leafly, and Yelp. Fieldworkers then made calls to verify dispensaries' street addresses, operation status, and dispensary classification (medical or recreational). We excluded dispensaries that were delivery-only, inactive, or classified as medical marijuana dispensaries (requiring a doctor's recommendation or a patient ID for purchase). When the dispensary closest to a school was excluded for the above reasons, the second closest dispensary was verified until an active RMD with a storefront was identified.

We developed and pilot-tested a Web/smartphone-based surveillance tool for dispensary auditing, namely "Standardized Marijuana Dispensary Assessment-Children Focused (SMDA-CF)". SMDA-CF assessed physical, economic, and marketing characteristics of RMDs, with special attention to marketing activities appealing to children. SMDA-CF items had moderate to high reliability overall, with a median kappa score of 0.8. After receiving training, fieldworkers audited the call-verified RMDs in teams of two to improve the reliability of data collection. Each visit to an RMD took 10-15 minutes on average.

Details about auditing procedures and SMDA-CF instruments have been reported elsewhere. (Cao et al. 2020)

School and Census Tract Characteristics

School characteristics were obtained from the 2015-2016 Common Core of Data provided by the National Center for Educational Statistics. Census tract characteristics were obtained from the 2012-2016 American Community Survey five-year estimates.

Measures

Adolescents' Marijuana Use Outcomes

Three binary marijuana use outcomes were assessed, including (1) current marijuana use, defined as any marijuana use in the past 30 days, (2) current heavy use, defined as marijuana use in 20 days or more in the past 30 days, and (3) curiosity about marijuana use, coded to 1 if the adolescent reported being “very curious”, “somewhat curious”, or “a little curious” about using marijuana and coded to 0 if the adolescent reported being “not at all curious” about using marijuana.

Recreational Marijuana Dispensary Predictors

The primary predictors of interest included 1) the proximity of a school to the nearest RMD and 2) the presence of child-appealing marketing activities in the nearest RMD. We also control for the density of RMDs in school neighborhoods.

The proximity between a school and its nearest RMD was computed with straight-line method using ArcGIS Version 10.5. In the main analysis, three proximity indicators were assessed: ≤ 1 mile, 1-3 miles, and > 3 miles. The 1- and 3-mile cutoffs were chosen based on common practices in tobacco and alcohol literature and geographic distribution of the RMDs around schools. The 1-mile buffer has been frequently used to represent a walkable distance to

tobacco and alcohol outlets. The 3-mile buffer represents a distance that is easily reachable by bicycles, vehicles, and public transportation. In addition, the 1- and 3-mile cutoffs provided sufficient sample sizes of schools and adolescents in each cell for statistical analysis. In the sensitivity analysis, we also tested the sensitivity of results to different cutoffs, including 2-, 4-, and 5-mile.

Child-appealing marketing activities in SMDA-CF were defined as products, packages, paraphernalia, and advertisements that are “characterized by promotional characters (e.g., cartoons, animals, toys, or children), shaped like commercially sold products usually consumed by children (e.g., gummy bears, lollipop, fruits), or using bright colors (in products, mostly edibles) or bubble-like fonts (on packages, branding, advertisements, or signage)”. (Cao et al. 2020) Separate binary indicators were created to indicate the presence of child-appealing products/packages, paraphernalia, and advertisements in RMDs.

To account for the influences of other RMDs that were more distantly located yet close enough to schools, we also considered the density of RMDs in school neighborhoods. It was measured as the weighted number of RMDs within a 3-mile buffer of a school, with weight .7 assigned to the number of RMDs within the 1-mile buffer and weight .3 assigned to the number of RMDs within the 1-3 mile buffer. To avoid double counting and collinearity, the computation excluded the audited RMD itself, which had the closest proximity to the school.

Individual, School, and Census Tract Characteristics

Individual demographic characteristics included race/ethnicity, gender, and grade. School characteristics included total number of students enrolled and school locale. Census tract characteristics included total population size, proportion of population under 21 years old, and proportion of population below the poverty line.

Statistical Analysis

Descriptive statistics were computed for individual, RMD, school, and census tract variables. To examine the associations between the proximity and marketing activities of RMDs with adolescents' marijuana use, a series of multilevel logistic regressions were conducted with the first level of students nested in the second level of schools. All the statistical analyses were conducted using R packages.

The three marijuana use outcomes were analyzed separately. Current use was analyzed among all the adolescents included in this study, heavy use was analyzed among current users who used marijuana in the past 30 days, and curiosity was analyzed among never users who never used marijuana before. We took a stepwise approach to test the three hypotheses. We first included proximity indicators in the model (first hypothesis), then added indicators of marketing activities simultaneously with proximity indicators (second hypothesis), and finally added interaction terms between the proximity and marketing activities along with indicators of proximity and marketing activities (third hypothesis). All the regressions controlled for RMD density and individual, school, and census tract characteristics. Sampling weights were applied to all the analyses on adolescents.

In the sensitivity analysis, we tested the robustness of results to different proximity cutoff values (2-, 4-, and 5-mile).

RESULTS

Descriptive Statistics

Table 1 reports the characteristics of the adolescent study sample. Among the 96,011 adolescents, 11.30% were current marijuana users. Among the 12,125 current users, 22.37%

were current heavy users. Among the 69,179 never users, 30.86% were curious about using marijuana.

Table 2 reports the characteristics of RMDs, schools, and census tracts. The proportions of schools having the nearest RMD located with 1 mile, 1 to 3 miles, and over 3 miles were 21.31%, 26.23%, and 52.46%, respectively. Excluding the nearest RMD, the schools on average had 2.32 RMDs located within a 3-mile buffer.

Table S1 compares the characteristics of the included schools that were surveyed after February 1st, 2018 and the excluded schools that were surveyed before February 1st, 2018. The differences were mainly driven by the timing of survey implementation: a greater proportion of middle schools were surveyed in 2017 whereas a greater proportion of high schools were surveyed in 2018.

Multilevel Logistic Regression Results: Main Analysis

Table 3 reports the estimates on the associations between RMDs' proximity and adolescents' marijuana use outcomes. The proximity indicators were not associated with current use, heavy use, or curiosity. A greater weighted number of RMDs within a 3-mile buffer was associated with a lower odds of heavy use (OR = .98, 95% CI = [.96, 1.00]).

Table 4 reports the estimates on the associations between RMDs' child-appealing marketing activities and adolescents' marijuana use outcomes. Controlling for RMDs' proximity, the presence of child-appealing products/packages, paraphernalia, and advertisements were not associated with current use, heavy use, or curiosity. A greater weighted number of RMDs within a 3-mile buffer was associated with a lower odds of heavy use (OR = .98, 95% CI = [.96, 1.00]).

Table 5 reports the estimates on the associations of the interactions between RMDs' proximity and child-appealing marketing activities with adolescents' marijuana use outcomes.

As reported in Table 3 and Table 4, the main effects of RMDs' proximity and child-appealing marketing measures were nonsignificant. Some interaction terms, however, were found to be associated with marijuana use outcomes. The presence of child-appealing paraphernalia was associated with a higher odds of current use (OR = 1.40, 95% CI = [1.03, 1.90]) if the school had its nearest RMD located within a 1-to-3 mile buffer. The presence of child-appealing products and packages was associated with a higher odds of heavy use (OR = 1.40, 95% CI = [1.00, 1.96]) if the school had its nearest RMD located within a 1-mile buffer. A greater weighted number of RMDs within a 3-mile buffer was again associated with a lower odds of heavy use (OR = .97, 95% CI = [.95, 1.00]).

Multilevel Logistic Regression Results: Sensitivity Analysis

We replaced the 3-mile buffer with 2-, 4-, and 5-mile buffers in the sensitivity analysis. Table S2 reports sensitivity results on the associations between RMDs' proximity and adolescents' marijuana use outcomes. Compared to the reference group, some indicators of closer proximity (≤ 1 mile, 1-4 miles, and 1-5 miles) were associated with lower odds of heavy use or curiosity.

Table S3 reports sensitivity results on the associations of the interactions between RMDs' proximity and child-appealing marketing activities with adolescents' marijuana use outcomes. The presence of child-appealing products and packages was associated with a higher odds of heavy use if the school had its nearest RMD located within a 1-mile buffer (OR = 1.48, 95% CI = [1.06, 2.06] when >2 -mile buffer was the reference; OR = 1.44, 95% CI = [1.02, 2.03] when >5 -mile buffer was the reference).

DISCUSSION

This study was the first attempt to assess the relationships between objectively measured recreational marijuana retail environments and adolescents' marijuana use. We audited the locations and point-of-sale marketing activities of RMDs in school neighborhoods and merged auditing data with school survey data on a large sample of adolescents in California. We paid particular attention to child-appealing marketing activities, which were presumably more influential to adolescents than general marketing activities. Instead of aggregating data at zip code or census tract level, we examined individual-level outcomes and simultaneously accounted for between- and within-school variations.

Our first hypothesis that a closer proximity of RMDs is associated with a greater likelihood of adolescents' marijuana use was not supported by the findings. In fact, a closer proximity was found to be associated with lower likelihoods of some outcomes in some model specifications in sensitivity analysis. Although no similar studies on RMDs can be used to compare to our findings, existing evidence on medical marijuana dispensaries did show mixed relationships between dispensaries' proximity and marijuana use among adolescents. (Shi 2016, Shi, Cummins, and Zhu 2018) Whether and how the proximity of RMDs in school neighborhoods is associated with adolescents' marijuana use outcomes deserve further research.

Our second hypothesis that the presence of child-appealing marketing activities in RMDs is associated with a greater likelihood of adolescents' marijuana use was not supported by the findings, either. However, when we examined the third hypothesis (interaction effects of RMDs' proximity and marketing activities), we did find some evidence that child-appealing products, packages, and paraphernalia in RMDs in very close proximity to schools (≤ 1 mile or 1-3 miles) might be associated with a greater odds of current use or heavy use. It is likely that these items were resold or freely distributed to adolescents by third party adults, such as older friends,

relatives, street dealers, who resided or worked in school neighborhoods. The interaction effects of RMDs' proximity and marketing activities were not found on child-appealing advertisements. One plausible explanation is that nearly all (98%) RMDs we audited complied with age restrictions by ID check. (Cao et al. 2020) Adolescents therefore had little chance to see advertisements inside of the RMDs, which could not be taken out by third party adults. It should be noted that the findings on interaction effects were sensitive to the selection of proximity cutoffs and model specifications. This is why we considered the strength of the evidence on interaction effects to be only moderate. Future research is strongly encouraged to add more data points.

The findings have policy implications. If the impacts of point-of-sale child-appealing marketing activities depend upon the proximity of RMDs to schools, stronger surveillance may be needed to monitor marijuana-related perceptions and behaviors in schools that have RMDs located near to them. Even though almost all states with legal sales of recreational marijuana prohibit products and advertisements specifically targeting children, (Cao et al. 2020) our dispensary auditing data demonstrated a wide presence of these prohibited items in school neighborhoods. Actions should be taken to reduce child-appealing marketing activities and prevent adolescents from potential exposure.

This study has limitations. First, the cross-sectional examination of associations should not be interpreted as causality. Second, the study sample was restricted to 73% of the CSTS 2017-8 schools that completed the survey on or after February 1st, 2018. The generalizability of the findings to the entire California may be a concern. Third, we audited RMDs after the CSTS 2017-8 was completed in order to have an accurate and complete list of surveyed schools and conduct auditing in a cost-efficient manner. To what extent our observations on RMDs applied to

the time when the schools were actually surveyed was unknown. Fourth, the marketing activity predictors were indicators of presence instead of continuous quantity measures due to feasibility considerations in fieldwork. We were not able to examine the quantity of marketing items (e.g., number of child-appealing advertisements). Lastly, our findings may not be applied to RMDs around adolescents' homes, adolescents in private schools, or jurisdictions outside of California. With the dynamics in marijuana retail environments and government surveillance and law enforcement, the findings in the early stage of recreational marijuana commercialization may also lack generalizability to the most recent regulatory and retail contexts.

CONCLUSION

This study provided no evidence on the associations of the proximity or child-appealing marketing activities of RMDs with greater odds of marijuana use outcomes among adolescents. There was some evidence suggesting that child-appealing marketing activities with closer proximity to schools might be associated with greater odds of adolescents' marijuana use outcomes, but the findings were sensitive to proximity cutoffs and model specifications. A conservative interpretation of the findings calls for continuous monitoring of marijuana retail environments and dispensaries' compliance to marketing restrictions in school neighborhoods.

Data Availability: The 2017-8 California Student Tobacco Survey can be requested at <https://www.calschooltobacco.org/csts/>.

Human Subjects Approval: This study was exempt from the review of the Human Research Protections Program at the University of California San Diego because CSTS 2017-8 was existing data and observations on RMDs were non-human subject research. CSTS 2017-8 was approved by the Human Research Protections Program at the University of California San Diego and the California State Committee for the Protection of Human Subjects.

Conflict of Interest: None declared.

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Tables and Figures

Table 1. Adolescent Sample Characteristics

	Full Sample N=96,011	Current Users N=12,125	Never Users N=69,179
	%		
Marijuana Use			
Current Marijuana Use (past 30-day use)			
<i>Yes</i>	11.30	100	0
<i>No</i>	88.70	0	100
Current Heavy Use (≥ 20 day use)			
<i>Yes</i>	2.29	22.37	0
<i>No</i>	97.71	77.63	0
Curiosity about Marijuana Use			
<i>Yes</i>	NA	NA	30.86
<i>No</i>	NA	NA	69.14
Demographic Characteristics			
Race/ethnicity			
<i>Non-Hispanic White</i>	14.30	18.38	14.33
<i>Hispanic</i>	54.12	52.18	52.90
<i>Non-Hispanic Asian</i>	10.49	4.23	13.08
<i>Non-Hispanic Other</i>	21.10	25.21	19.69
Gender			
<i>Female</i>	47.10	43.44	47.68
<i>Male</i>	42.94	40.50	44.78
<i>Other</i>	9.96	16.06	7.54
Grade			
8 th	29.99	10.83	34.92
10 th	37.90	36.62	38.16
12 th	32.11	52.55	26.92

Table 2. Characteristics of RMDs, Schools, and Census Tracts (School N=244)

	N (%) or Mean (SD)
Nearest RMD to School	
Proximity, N (%)	
≤ 1 mile	52 (21.31)
1-3 miles	64 (26.23)
> 3 miles	128 (52.46)
Child-appealing Marketing Activities, N (%)	
<i>Products/Packages</i>	142 (58.20)
<i>Paraphernalia</i>	79 (32.38)
<i>Advertisements</i>	59 (24.18)
Weighted Number of RMDs Within a 3-Mile Buffer of School #, mean (sd)	2.32 (4.98)
School Characteristics	
Total Students Enrolled (in thousands), mean (sd)	1.72 (.81)
Locale, N (%)	
<i>Urban</i>	104 (42.62)
<i>Suburban</i>	123 (50.41)
<i>Rural</i>	17 (6.97)
Census Tract Characteristics	
Total Population (in thousands), mean (sd)	4.88 (2.08)
Proportion of Population Under 21 Years Old, mean (sd)	27.31 (8.68)
Proportion of Population Below Poverty Line, mean (sd)	13.59 (16.48)

The nearest RMD was excluded from this calculation. The number of RMDs within a 1-mile buffer was assigned with 0.7 weight and the number of RMDs within a 1-3 mile buffer was assigned with 0.3 weight.

Table 3. The Association between RMDs' Proximity and Adolescents' Marijuana Use

	Current Use	Heavy Use	Curiosity
Odds Ratio [95% Confidence Interval]			
RMD Characteristics			
Proximity between School and the Nearest RMD			
≤1 mile	.89 [.75, 1.07]	1.03[.85, 1.25]	1.02[.95, 1.10]
1-3 miles	.93 [.81, 1.06]	.91[.79, 1.05]	.91[.81, 1.01]
>3 miles (ref.)	1	1	1
Weighted Number of RMDs Within a 3-Mile Buffer of School #	.99[.97, 1.00]	.98[.96, 1.00]*	.99[.98, 1.00]
Adolescent, School, and Census Tract Characteristics			
Adolescent Characteristics			
Race/ethnicity			
<i>Non-Hispanic White (ref.)</i>	1	1	1
<i>Hispanic</i>	.96[.91, 1.02]	.88[.78, 1.00]*	1.05[1.00, 1.11]*
<i>Non-Hispanic Asian</i>	.33[.30, .37]***	.46[.35, .60]***	.72[.68, .77]***
<i>Non-Hispanic Other</i>	1.01[.95, 1.07]	1.02[.89, 1.17]	.92[.82, .88]**
Gender			
<i>Female (ref.)</i>	1	1	1
<i>Male</i>	.99[.95, 1.03]	2.29[2.07, 2.52]***	.85[.82, .88]***
<i>Other</i>	1.99[1.87, 2.12]***	3.04[2.65, 3.48]***	1.05[.99, 1.12]
Grade			
8 th (ref.)	1	1	1
10 th	3.26[2.71, 3.92]***	1.00[.75, 1.32]	1.25[1.13, 1.38]***
12 th	6.26[5.21, 7.53]***	1.15[.87, 1.53]	1.34[1.21, 1.48]***
School Characteristics			
Total Students Enrolled (in thousands)	.92[.71, .90]**	.98[.90, 1.07]	.99[.98, 1.00]
Locale			
<i>Urban (ref.)</i>	1	1	1
<i>Suburban</i>	.80[.71, .90]***	.92[.82, 1.05]	.93[.87, 1.00]*
<i>Rural</i>	.67[.52, .87]**	.84[.61, 1.17]	.78[.67, .91]***
Census Tract Characteristics			
Total Population (in thousands)	1.00[.97, 1.03]	1.01[.97, 1.04]	1.00[.99, 1.02]
Proportion of Population Under 21 Years Old	1.00[.99, 1.01]	1.00[.99, 1.01]	1.00[1.00, 1.00]
Proportion of Population Below Poverty Line	1.00[1.00, 1.01]	1.00[1.00, 1.00]	1.00[.99, 1.00]
Intercept	.06[.04, .08]***	.19[.13, .28]***	.48[.40, .58]***
Random Effects			

σ^2	3.29	3.29	3.29
τ_{00} School	.14	.05	.04
ICC	.04	.01	.01

*p<.05, **p<.01, ***p<.001

The nearest RMD was excluded from this calculation. The number of RMDs within a 1-mile buffer was assigned with 0.7 weight and the number of RMDs within a 1-3 mile buffer was assigned with 0.3 weight.

Table 4. The Association between RMDs' Child-appealing Marketing Activities and Adolescents' Marijuana Use

	Current Use	Heavy Use	Curiosity
	Odds Ratio [95% Confidence Interval]		
RMD Characteristics			
Nearest RMD to School			
Proximity			
≤1 mile	.89[.74, 1.06]	1.01[.83, 1.23]	.91[.82, 1.02]
1-3 miles	.93[.81, 1.06]	.90[.78, 1.04]	1.03[.96, 1.11]
>3 miles (ref.)	1	1	1
Child-appealing Marketing Activities			
Products/Packages	.99[.88, 1.11]	1.03[.92, 1.16]	.94[.88, 1.01]
Paraphernalia	1.09[.96, 1.23]	1.04[.92, 1.19]	1.06[.98, 1.13]
Advertisements	.96[.84, 1.10]	.91[.79, 1.05]	1.03[.95, 1.11]
Weighted Number of RMDs Within a 3-Mile Buffer of School #	.99[.97, 1.00]	.98[.96, 1.00]*	.99[.98, 1.00]
Adolescent, School, and Census Tract Characteristics			
Adolescent Characteristics			
Race/ethnicity			
Non-Hispanic White (ref.)	1	1	1
Hispanic	.96[.91, 1.02]	.88[.78, 1.00]*	1.06[1.00, 1.11]*
Non-Hispanic Asian	.33[.30, .37]***	.46[.35, .60]***	.72[.68, .77]***
Non-Hispanic Other	1.01[.94, 1.07]	1.03[.90, 1.18]	.92[.87, .97]**
Gender			
Female (ref.)	1	1	1
Male	.99[.95, 1.03]	2.28[2.07, 2.52]***	.85[.82, .88]***
Other	1.99[1.87, 2.13]***	3.03[2.65, 3.47]***	1.05[.99, 1.13]
Grade			
8 th (ref.)	1	1	1
10 th	3.30[2.74, 3.97]***	1.01[.76, 1.33]	1.25[1.14, 1.38]***
12 th	6.34[5.27, 7.62]***	1.16[.88, 1.54]	1.34[1.22, 1.48]***
School Characteristics			
Total Students Enrolled (in thousands)	.92[.84, .1.00]*	.98[.90, 1.07]	.97[.92, 1.02]
Locale			
Urban (ref.)			
Suburban	.80[.71, .91]***	.93[.82, 1.05]	.94[.88, 1.01]
Rural	.68[.52, .88]**	.84[.60, 1.18]	.80[.69, .93]**
Census Tract Characteristics			
Total Population (in thousands)	1.00[.97, 1.03]	1.01[.97, 1.04]	1.00[.99, 1.02]

Proportion of Population Under 21 Years Old	1.00[.99, 1.01]	1.00[.99, 1.01]	1.00[.99, 1.00]
Proportion of Population Below Poverty Line	1.00[1.00, 1.01]	1.00[1.00, 1.00]	1.00[1.00, 1.00]
Intercept	.06[.04, .08]***	.19[.13, .28]***	.48[.40, .58]***
Random Effects			
σ^2	3.29	3.29	3.29
τ_{00} School	.14	.05	.04
ICC	.04	.01	.01

*p<.05, **p<.01, ***p<.001

The nearest RMD was excluded from this calculation. The number of RMDs within a 1-mile buffer was assigned with 0.7 weight and the number of RMDs within a 1-3 mile buffer was assigned with 0.3 weight.

Table 5: The Associations between RMDs' Proximity and Child-appealing Marketing Activities and Adolescents' Marijuana Use, with Interactions between RMDs' Proximity and Marketing Activities

	Current Use	Heavy Use	Curiosity
	Odds Ratio [95% Confidence Interval]		
RMD Characteristics			
Nearest RMD to School			
Proximity			
≤ 1 mile	.93[.71, 1.22]	.83[.60, 1.14]	.91[.77, 1.07]
1-3 miles	.91[.73, 1.13]	.97[.77, 1.22]	1.03[.91, 1.17]
>3 miles (ref.)	1	1	1
Child-appealing Marketing Activities			
Products/Packages	1.01[.86, 1.18]	.98[.83, 1.15]	.96[.88, 1.05]
Paraphernalia	1.00[.83, 1.19]	1.08[.89, 1.29]	1.00[.90, 1.11]
Advertisements	1.07[.89, 1.28]	.96[.80, 1.15]	1.08[.97, 1.20]
Interactions between Proximity and Marketing Activities			
Products/Packages* ≤ 1 mile	1.01[.75, 1.36]	1.40[1.00, 1.96]*	.99[.83, 1.18]
Products/Packages*1-3 miles	1.00[.76, 1.31]	1.00[.76, 1.32]	.98[.84, 1.14]
Products/Packages* >3 miles (ref.)	1	1	1
Paraphernalia* ≤ 1 mile	.98[.72, 1.34]	.96[.69, 1.33]	1.09[.91, 1.31]
Paraphernalia*1-3 miles	1.40[1.03, 1.90]*	.96[.70, 1.31]	1.11[.93, 1.32]
Paraphernalia* >3 miles (ref.)	1	1	1
Advertisements* ≤ 1 mile	.86[.61, 1.22]	1.01[.70, 1.47]	.90[.74, 1.11]
Advertisements*1-3 miles	.75[.54, 1.03]	.76[.53, 1.09]	.92[.77, 1.10]
Advertisements* >3 miles (ref.)	1	1	1
Weighted Number of RMDs Within a 3-Mile Buffer of School #	.99[.97, 1.00]	.97[.95, 1.00]*	.99[.98, 1.00]
Adolescent, School, and Census Tract Characteristics			
Adolescent Characteristics			
Race/ethnicity			
Non-Hispanic White (ref.)	1	1	1
Hispanic	.96[.91, 1.02]	.88[.78, .99]*	1.06[1.00, 1.11]*
Non-Hispanic Asian	.33[.30, .37]***	.46[.35, .60]***	.72[.68, .77]***
Non-Hispanic Other	1.01[.94, 1.07]	1.02[.89, 1.17]	.92[.87, .97]**
Gender			
Female (ref.)	1	1	1
Male	.99[.95, 1.03]	2.28[2.07, 2.52]***	.85[.82, .88]***
Other	1.99[1.87, 2.12]***	3.04[2.65, 3.48]***	1.05[.99, 1.12]
Grade			
8 th (ref.)	1	1	1
10 th	3.29[2.74, 3.96]***	.98[.74, 1.30]	1.24[1.13, 1.37]***
12 th	6.33[5.27, 7.61]***	1.13[.85, 1.50]	1.33[1.20, 1.47]***
School Characteristics			

Total Students Enrolled (in thousands)	.90[.83, .98]*	1.00[.91, 1.09]	.97[.92, 1.02]
Locale			
<i>Urban (ref.)</i>	1	1	1
<i>Suburban</i>	.81[.72, .92]**	.92[.82, 1.05]	.94[.88, 1.01]
<i>Rural</i>	.67[.51, .86]**	.85[.61, 1.19]	.79[.68, .92]**
Census Tract Characteristics			
Total Population (in thousands)	1.00[.97, 1.03]	1.00[.97, 1.04]	1.00[.99, 1.02]
Proportion of Population Under 21 Years Old	1.00[.99, 1.00]	1.00[.99, 1.01]	1.00[.99, 1.00]
Proportion of Population Below Poverty Line	1.00[1.00, 1.01]	1.00[1.00, 1.01]	1.00[1.00, 1.00]
Intercept	.06[.04, .08]***	.19[.13, .28]***	.49[.40, .58]***
Random Effects			
σ^2	3.29	3.29	3.29
τ_{00} School	.13	.04	.04
ICC	.04	.01	.01

*p<.05, **p<.01, ***p<.001

The nearest RMD was excluded from this calculation. The number of RMDs within a 1-mile buffer was assigned with 0.7 weight and the number of RMDs within a 1-3 mile buffer was assigned with 0.3 weight.