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Exposure to cigar Point-of-Sale marketing and use of cigars and cigarettes among young adults

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ABSTRACT

Introduction: Few studies examine the impact of objective exposure to point-of-sale (POS) marketing for cigars including little cigars and cigarillos (LCCs) on tobacco use. The present study aimed to examine the relationship between exposure to LCC marketing at the POS and current and future use of LCCs and cigarettes among young adult college students.

Method: Data on LCC and cigarette use from 4201 young adult students (mean age = 22.8 [SD = 2.3]; 35.9% non-Hispanic whites) attending 24 Texas colleges was linked to objective assessments of POS marketing at 220 tobacco retail outlets within one mile of the colleges. Multilevel logistic regression analyses examined the impact of LCC marketing at the POS on use of LCCs and cigarettes currently and 6-months later.

Results: Participants were, on average, exposed to 43 LCC marketing materials per week. Results from cross-sectional analyses indicated that exposure to LCC POS marketing was associated with higher odds of current use of LCCs (AOR = 1.003, 95% CI = 1.0002, 1.0053) and cigarettes (AOR = 1.006, 95% CI = 1.0050, 1.0075). The relationship between LCC POS marketing exposure and LCC use was not significant in longitudinal models; however, exposure to LCC POS marketing at baseline did predict current cigarette use at 6-month follow-up (AOR = 1.004, 95% CI = 1.0021, 1.0052).

Conclusion: Findings suggest a substantial influence of LCC marketing exposure at the POS. Regulations on LCC marketing at the POS, especially around college campuses, should be considered.

1. Introduction

According to the first wave of the Population Assessment of Tobacco and Health Study (PATH, 2013–2014), approximately 14.2% of young adults aged 18–24 used little cigars and cigarillos (LCCs), ranking them in second place for the most popular non-cigarette tobacco products in this age group (Kasza et al., 2017). In addition, dual and/or poly use with cigarettes and cigar products is commonly reported (Sung, Wang, Yao, Lightwood, & Max, 2018). Compared to cigarettes, cigar tobacco contains more toxins and carcinogenic compounds (Baker et al., 2000). Use of LCCs, either alone or as dual/poly use with other tobacco products, elevates a young adult users' risk for addiction and chronic diseases (Apelberg et al., 2014; Baker et al., 2000; Naitonal Cancer Cancer, 1998; Nyman, Sterling, Weaver, Majeed, & Eriksen, 2016; Sterling, Fryer, Nix, & Fagan, 2015).

The Family Smoking Prevention and Tobacco Control Act, which took effect in 2009, authorized the Food and Drug Administration (FDA) to regulate the manufacture, distribution, and marketing of a wide variety of tobacco products (U.S. Food and Drug Administration, 2020a). However, many restrictions for cigarettes do not apply to LCCs. The price of LCCs, for instance, is lower per unit, making it possible for price-sensitive smokers to switch from more costly cigarettes to less costly LCCs rather than reduce consumption or quit smoking (Cantrell et al., 2013; U.S. Food and Drug Administration, 2020b). Moreover, the ban on flavored cigarettes does not apply to LCC products. By offering a variety of flavors including candy, fruit, and alcohol that can mask the heavy taste, comfort the throat, and lure the users to inhale, LCCs are highly attractive to young and inexperienced smokers (Kostygina, Glantz, & Ling, 2016; Sterling et al., 2015).

The popularity of LCCs may be due, in part, to their product marketing. Federal restrictions on tobacco marketing have limited marketing of cigarettes, and more recently other tobacco products (U.S. Food

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and Drug Administration, 2020). However, point-of-sale (POS) marketing at tobacco retail outlets (TROs) is one of the few remaining marketing channels still allowed, and has become more important to tobacco companies (Cohen et al., 2008; Lavack & Toth, 2006). A growing number of studies indicate that POS displays stimulate an impulse purchase among a quarter of current smokers and exposure to POS marketing is a risk factor for smoking initiation and maintenance, and an inhibitor of smoking cessation behaviors (Henriksen et al., 2010; Siahpush et al., 2016; Wakefield, 2008). Shadel, Martino, Setodji, and Scharf (2013) in an experimental study, found that, after exposure to pro-smoking marketing at the POS, college students reported greater future smoking susceptiblity. Thus, tobacco companies have invested a great deal of money at the POS – more than 95% of the tobacco industry's marketing budget, amounting to $8.7 billion, was allocated to POS marketing in 2018 (Federal Trade Commission, 2019a, 2019b). Moreover, POS has become the predominate channel to promote smoking behaviors in the areas near college campuses (Shadel et al., 2013). From 2011 to 2013, among 334 retailers surveyed within a five-mile radius of college campuses in Virginia, all stores offered at least one tobacco product, more than 95% of stores displayed at least one interior advertisement, and 70% had promotions regardless the type of tobacco (Wagoner et al., 2018). Although recent data regarding LCC marketing are lacking, a study conducted from 2011 to 2012 indicated that 80% of licensed TROs in Washington, DC sold LCC products, with 95% of those offering flavored LCCs, and 12% displaying exterior LCC advertisements. (Cantrell et al., 2013). Additionally, communities with a higher proportion of young adults had more exterior LCC advertising and lower unit price for LCCs (Cantrell et al., 2013).

Compared to cigarettes, the role of POS marketing of other tobacco products on tobacco use has been relatively less studied. In the work that has been done, a positive association between exposure to POS marketing and smoking-related behaviors has been found among children and adolescents (Kong, Queen, Golden, & Ribisl, 2020; Paynter & Edwards, 2009; Robertson, Cameron, McGee, Marsh, & Hoek, 2016; Robertson, McGee, Marsh, & Hoek, 2015). However, no studies assess objective exposure to LCC marketing at the POS and link exposure to use behaviors. Further, limited work has examined these associations in young adult populations, although they are the youngest legal targets of the tobacco industry. Given that little cigars were designed to be as similar to a cigarette as possible and marketing for LCCs has promoted similarities between little cigars and cigarettes (Delnevo, 2006; Delnevo & Hrywna, 2007), the cross-product marketing effects of LCC marketing on cigarette use are important to examine. As young adults may mature out of dual or poly-use of tobacco products (Loukas, Marti, & Perry, 2019), this further emphasizes the need to understand how the exposure to marketing of LCCs may be associated with cigarette use, particularly over time.

The current research extends the literature by investigating the association between exposure to objectively audited LCC marketing at the POS on young adult college students' current and future use of LCCs and cigarettes. Both LCC use and cigarette use are of interest because concurrent use of conventional cigarettes is common among LCC users and no studies have examined cross-product marketing effects of LCCs on cigarette use (Messer et al., 2015; Sterling, Fryer, Pagano, & Fagan, 2016). We hypothesize that exposure to objectively audited LCC marketing at TROs around colleges/universities will be positively associated with increased odds of current and future (6-months later) use of LCCs and cigarettes among young adults.

2. Methods

2.1. Study design

The Marketing and Promotions Across Colleges in Texas (Project M−PACT) study is a multi-wave, rapid response surveillance system designed to monitor and respond to changes in tobacco marketing exposure and trends in tobacco use behaviors among Texas young adult college students (Creamer et al., 2018; Loukas et al., 2019, 2016). College students were recruited from 24 colleges in the four largest metropolitan areas across the state: Austin, Dallas/Fort Worth, Houston, and San Antonio. Three colleges of each type (two-year and four-year institution) were selected from each city resulting in a total of 24 colleges. To be eligible for participation, students had to be between 18 and 29 years old and be full-time or part-time, degree or certificate-seeking undergraduate students at one of the 24 colleges during the first wave (November 2014 – February 2015). Eligible students who wished to participate in the study were invited to provide informed consent and then complete the online survey regarding tobacco use. Survey data used for the current study were from wave 5, that occurred between October and November 2016, and wave 6, that occurred between April and May 2017 as the wave 5 survey linked with the most recent TRO audit data.

2.2. Tobacco retail outlet audits

TRO information was obtained from the tobacco licensing records held by the comptroller's office in 2014 when the project began. TROs were included if they fell within a one-mile radius of the 24 college/university campuses included in Project M−PACT. Distance from the college was determined via ArcGIS using projection NAD 1983 Texas Centric Mapping System Albers. For each college, at least twelve outlets were included. If the total number of outlets surrounding a college was less than twelve, all outlets were included; if there were twelve or more outlets, then twelve or half of the outlets, whichever was greater up to a total of 40 outlets, were randomly selected for inclusion. Therefore, a total of 338 TROs were included for data collection around the 24 college campuses in the Fall of 2016.

TROs were audited using protocols adapted from previous research (Feld, Johnson, Byerly, & Ribisl, 2016; Henriksen et al., 2016, 2008; Pasch, Komro, Perry, Hearst, & Farbakhsh, 2007; Poulos & Pasch, 2015; Ribisl et al., 2017) to document the prevalence of all types of tobacco product marketing. TRO data were collected by trained researchers using FileMaker® Go (FileMaker Inc.) hosted on iPod Touch® (Apple Inc.). Data collectors received a full day training on tobacco marketing at the TRO and the TRO data collection tool. Data collectors were also required to complete at least five practice audits and their data were reviewed by a trained research assistant who provided extensive, detailed feedback. After completing at least two practice audits with no corrections required, data collectors began the TRO audits. The TRO audit tool allowed collectors to capture pictures and take notes on indoor and outdoor marketing materials, including placement, advertisements, and price promotion, for all types of tobacco products (e.g. cigarettes, e-cigarettes, smokeless products, cigar products). Outlet data collection for the present study was completed between 8/1/2016–10/22/2016. Of 338 assigned outlets, 65.1% ($N = 220$) had complete data. Data were missing due to store closures or being unable to complete the audit (e.g. asked to leave). To assess inter-rater reliability, 47 outlets were assigned to two data collectors and an average of 90% agreement was found between the two data collectors. TRO audits were completed within 4–8 weeks prior to the administration of the wave 5 M−PACT survey (Fall 2016).

For all audits, advertisements were defined as those that were printed (not hand-written) and were "displayed as a branded (name or logo) sign, poster, banner, or neon light, are intended to sell tobacco products." This definition applied to any signage on the grounds of the outlet. LCC marketing thus included all advertisements and price promotions for non-flavored, menthol, and flavored LCC products both inside and outside the TRO.

2.3. Student participants

Overall, 13,714 students from the 24 colleges were eligible to participate in the project, and 40% ($N = 5482$) provided consent and

completed the survey at the first wave. The retention rate for the wave 5 survey was 77%. Thus, a total of 4201 participants were included at wave 5 (baseline for the present study) and 4009 in this cohort completed the follow-up survey at wave 6, six months later. Students were 20–32 years old at wave 5 and the majority of students were female (64.9%). Regarding race/ethnicity, 35.9% of students were non-Hispanic white, 30.6% were Hispanic/Latino, 7.8% were African American/Black, 18.3% were Asian, and 7.6% reported another race/ethnicity.

2.4. Measures

2.4.1. Current LCC use

All participants were asked "During the past 30 days, how many days did you smoke a cigar product as intended? Please enter the number of days (from 0 to 30 days)." "As intended" was included to differentiate the use of tobacco-filled cigars from other types of substances. Students who responded with 1 or more days were presented with three images of different types of cigar products (large cigars, little-filtered cigars, and cigarillos) and asked to select one image that looks like the cigar type they most often smoked in the past 30 days. Those who picked the images of cigarillos and little-filtered cigars were considered current LCC users. Due to sample size, these two items were combined to reflect the use of LCCs.

2.4.2. Current cigarette use

Current use of cigarettes was assessed with a single statement: "On how many of the past 30 days did you smoke cigarettes? Please enter the number of days (from 0 to 30 days)." Students who reported smoking 1 or more days in the past month were considered current cigarette users.

2.4.3. Weekly exposure to LCC POS marketing

The total number of LCC marketing materials at TROs within one mile of each college was calculated from the TRO audit data. This college-level value was then combined with the self-reported frequency of store visits for each student (Feighery, Henriksen, Wang, Schleicher, & Fortmann, 2006; Henriksen, Schleicher, Feighery, & Fortmann, 2010). Self-reported frequency of store visits was assessed for five different store types (i.e., convenience/corner stores or gas stations, grocery stores, drug stores, liquor stores, and vape shops). For example, "During the past 30 days, how often did you go to convenience stores?" Possible responses were "never", "once a month", "two or three times a month", "once a week", "two or three times a week", or "almost every day". Then, store visit frequency was transformed to reflect weekly exposure, thus responses were equal to "never", "0.23 times per week" ($1/30 \times 7 = 0.23$), "0.58 times per week" ($2.5/30 \times 7 = 0.58$), "once a week", "2.5 times a week", or "6 times a week". Objective exposure to LCC marketing at the POS was calculated by multiplying the total amount of LCC marketing materials at each of the different store types (convenience, grocery, drug, liquor, or vape stores) around each college by the weekly frequency of visits to each of those stores for each participant. For example, the total number of LCC marketing materials at convenience stores around the participant's school was multiplied by the number of times the participant reported going to convenience stores. This was done for each outlet type and then summed to represent total LCC marketing exposure at all TROs. Exposure to LCC marketing was used as a continuous variable.

2.4.4. Covariates

Demographic characteristics including age, sex, race/ethnicity, and type of college (2- vs. 4-year) were included as covariates. Age was used as a continuous variable. Biological sex was a binary variable with male coded as 0 and female as 1. Due to the sample size, race/ethnicity was recoded into three mutually exclusive categories: non-Hispanic white, African American/Black, and other (which included Hispanic, Asian, and students who reported another race/ethnicity). College type was included as a covariate with two-year colleges coded as 0 and four-year colleges coded as 1. Current use of LCCs and cigarettes at wave 5 were also controlled for in the two longitudinal models, corresponding to the appropriate outcome (i.e., wave 5 LCC use for the outcome of wave 6 LCC use; wave 5 cigarette use for the outcome of wave 6 cigarette use).

2.5. Data analysis

Descriptive statistics, using t-tests and chi-square statistics as appropriate, were performed to examine demographic characteristics of the overall sample and for current LCC users, and current cigarette users. Multilevel logistic regression models were fit to determine the cross-sectional association between exposure to LCC POS marketing and current LCC and cigarette use at wave 5, using separate models for each outcome. All participants were included in this analysis (n = 4201). Longitudinal models were then conducted to determine if baseline exposure to LCC marketing at the POS predicted current use of LCCs and cigarettes at 6-month follow-up, again with each outcome in a separate model. Participants with data at both wave 5 and wave 6 were included in longitudinal analyses (n = 4009). Both unadjusted and adjusted (for covariates of age, sex, race/ethnicity, college type, and current use of either cigarettes or LCCs (e.g. wave 5 LCC use for the outcome of wave 6 LCC use) models are presented. Dual use was not included as an outcome due to the small sample size (<2% dual use). All statistical analyses were conducted using Stata 14.2 (College Station, TX).

3. Results

The descriptive characteristics of the entire sample, and current LCC and cigarette users at wave 5 by age, sex, race/ethnicity, and college type are presented in Table 1. Males and older students were more likely to be current users of LCCs and cigarettes, as compared to females and younger students, respectively. A higher proportion of current LCC users were African American/Black, while current cigarette users were more likely to be non-Hispanic white. No differences in college type were found between current users and nonusers. On average, students were exposed to 43.2 LCC marketing materials at the POS per week (SD = 65.4) or about 6 per day. Notably, current cigarette users were significantly more likely to be exposed to LCC POS marketing as compared to current cigarette nonusers.

Of the 4201 participants at wave 5, 2.64% ($n = 111$) were current LCC users, 16.14% ($n = 678$) were current cigarette users, and 1.67% ($n = 70$) were dual users of LCCs and cigarettes (see Table 2). Six months later, the prevalence of use for these products did not change significantly.

Table 3 presents the results of cross-sectional analyses examining the association between exposure to LCC POS marketing and current use of LCCs and cigarettes at wave 5, after controlling for covariates. The adjusted odds ratio (AOR) indicates that young adults with greater exposure to LCC marketing at the POS had significantly higher odds of current LCC use (AOR = 1.003, 95% CI = 1.0002, 1.0053) and current cigarette use (AOR = 1.006, 95% CI = 1.0050, 1.0075).

Similarly, Table 4 presents the results of longitudinal analyses that examine wave 5 exposure to LCC POS marketing and current use of LCCs and cigarettes at follow-up, six months later. After controlling for covariates and current cigarette use at wave 5, exposure to LCC POS marketing at baseline predicted current cigarette use at 6-month follow-up (AOR = 1.004, 95% CI = 1.0021, 1.0052). The AOR was not significant for current LCC use at 6-month follow-up (AOR = 1.001, 95% CI = 0.9987, 1.0042).

4. Discussion

The purpose of this study was to investigate the influence of exposure to LCC POS marketing on the current and future use of LCCs and conventional cigarettes among Texas young adult college students. The

Table 1
Description of the full sample, current LCC users, and current cigarette users by age, sex, race/ethnicity, and college type; Marketing and Promotions Across College in Texas (Project M−PACT) wave 5, Fall 2016.

	Total (N = 4201)	Current LCC users (n = 111)	Current LCC nonusers (n = 4090)	p-value	Current cigarette users (n = 678)	Current cigarette nonusers (n = 3523)	p-value
Age (M [SD])	22.8 (2.3)	23.5 (2.6)	22.8 (2.3)	<0.001*	23.4 (2.8)	22.7 (2.2)	<0.001*
Female (%)	64.9	46.9	65.4	<0.001*	54.6	66.9	<0.001*
Non-Hispanic white (%)	35.9	24.3	36.2	0.010*	42.5	34.6	<0.001*
African American (%)	7.8	16.2	7.5	0.001*	4.1	8.5	<0.001*
Other race/ethnicity (%)	56.4	59.5	56.3	0.509	53.4	57.0	0.086
Four-year college (%)	93.3	92.8	93.3	0.833	92.6	93.4	0.452
Exposure to LCC POS marketing (M [SD])	43.2 (65.4)	51.4 (82.6)	43.0 (64.9)	0.185	68.4 (96.1)	38.4 (56.4)	<0.001*

Table 2
Prevalence of current use of LCCs and conventional cigarettes at wave 5 and at wave 6; Marketing and Promotions Across College in Texas (Project M−PACT), Fall 2016 and Spring 2017.

	Wave 5 (N = 4,201)	Wave 6 (N = 4,009)
Current LCC use	2.64% (111)	2.74% (110)
Current cigarette use	16.14% (678)	15.59% (625)
Concurrent use of LCCs and cigarettes	1.67% (70)	1.52% (61)

Table 3
Concurrent associations between exposure to LCC POS marketing and current use of LCCs and cigarettes; Marketing and Promotions Across College in Texas (Project M−PACT) wave 5, Fall 2016.

	Current LCC use		Current cigarette use	
	AOR[a]	95% CI	AOR[a]	95% CI
Exposure to LCC POS marketing	1.003*	1.0002–1.0053	1.006***	1.0050–1.0075
Age	1.12**	1.04–1.20	1.11***	1.08–1.15
Female	0.43***	0.29–0.64	0.63***	0.53–0.75
African American	3.56***	1.87–6.75	0.43***	0.28–0.65
Other race/ethnicity	1.62*	1.02–2.59	0.84	0.70–1.01
Four-year college	1.09	0.47–2.51	0.94	0.62–1.42

[a] Adjusted for age, sex, race/ethnicity, and college type.
* p-value < 0.05.
** p-value < 0.01.
*** p-value < 0.001.

Table 4
Prospective associations between exposure to LCC POS marketing at wave 5 and current use of LCCs and cigarettes at wave 6; Marketing and Promotions Across College in Texas (Project M−PACT), Fall 2016 and Spring 2017.

	Current LCC use		Current cigarette use	
	AOR[a]	95% CI	AOR[a]	95% CI
Exposure to LCC POS marketing	1.001	0.9987–1.0042	1.004***	1.0021–1.0052
Age	1.00	0.92–1.09	1.01	0.97–1.06
Female	0.65*	0.43–0.98	0.73**	0.58–0.91
African American	4.47***	2.29–8.73	0.64	0.37–1.10
Other race/ethnicity	1.81*	1.08–3.04	0.96	0.76–1.22
Four-year college	0.71	0.32–1.55	0.74	0.45–1.22
Current LCC use at wave 5	19.36***	11.80–31.77		
Current cigarette use at wave 5			35.40***	28.10–44.61

[a] Adjusted for age, sex, race/ethnicity, college type, and current use at wave 5, respectively.
* p-value < 0.05.
** p-value < 0.01.
*** p-value < 0.001.

results from cross-sectional analyses indicate that greater exposure to LCC POS marketing materials at TROs was associated with a small, but significant, higher odds of current LCC use after adjusting for multiple other factors. However, when we examined this relationship longitudinally, it was not significant. Results from this study are consistent with a prior study revealing a strong association between TRO density and initiation of non-cigarette combustible tobacco products, which included LCCs, among young adults aged 18–24 (Cantrell et al., 2016). Longitudinal results, however, are inconsistent with a study of adolescents indicating that self-reported recall of POS advertising at baseline significantly predicted current use of cigar products at 6-month follow-up (Pasch, Nicksic, Opara, Jackson, Harrell, & Perry, 2018). One possible reason the current study did not find a significant longitudinal relationship is that the sample size of LCC users at follow-up was limited and after controlling for baseline LCC use there may have been limited variability remaining for LCC marketing to predict use. As such, more evidence is needed with larger and more diverse samples to clarify the relationship between LCC marketing exposure at the POS and use of LCC products among young adults over time.

For cigarette smoking, results indicated a significant positive association between baseline exposure to POS LCC marketing on current cigarette use and cigarette use six months later even after accounting for baseline cigarette use. This finding is important as it suggests that exposure to marketing for LCC products increased the odds of current and future cigarette use. While there are no studies that examine cross-product marketing effects, our findings are consistent with previous cross-sectional studies reporting a positive association between exposure to POS cigarette marketing and cigarette smoking behaviors (Henriksen et al., 2010, 2008; Kim et al., 2014; Paynter & Edwards, 2009; Wakefield, 2008). It is worth noting that longitudinal studies regarding POS marketing and cigarette use have mostly focused on youth. One study with young adult smokers found that self-reported recall of e-cigarette POS displays was a significant barrier for smoking cessation (Mantey, Pasch, Loukas, & Perry, 2019). This study extends the body of research examining the impact of exposure to LCC advertising and price promotions on tobacco use among young adults.

Additional findings indicated that current LCC users were likely to report concurrent use of conventional cigarettes. More than half of current LCC users were using cigarettes in the past 30 days at both waves, which means exclusive use of LCCs is less common. This finding is consistent with the pattern reported in previous studies (Messer et al., 2015; Sterling, Fryer, & Fagan, 2016; Sung et al., 2018). Concurrent use of LCCs and cigarettes may play an important role in the maintenance of tobacco use and addiction. Moreover, dual use may contribute to an elevated risk of tobacco-related chronic diseases. Therefore, it is important for future studies to continue to examine the associations between LCC marketing and tobacco use broadly to determine if LCC marketing is a risk factor for cigarette and other tobacco use.

The current study was one of the first to examine the impact of objectively measured exposure to POS LCC marketing on LCC and cigarette use. Moreover, we applied cross-sectional models in conjunction with longitudinal models to investigate the relationship between

exposure and current and future use of LCCs and conventional cigarettes. There are several implications for public health. First, many young adult smokers are in the initiation phase of tobacco use and their smoking patterns have not yet been established. As such, they are very likely to undergo a transition back to nonusers or to become more heavy users (Biener & Albers, 2004). Therefore, policies that regulate LCC advertising and price promotions at the POS should be considered in order to control tobacco use, especially around areas with large populations of young adults, such as colleges. Second, given that the concurrent use of LCCs and cigarettes is common, interventions should include information on both products; otherwise, prevention efforts for tobacco control may be undermined.

While there are many strengths to the present study, there are also limitations. First, although significant, the AORs were relatively small. However, these AORs represent the increased odds of use for each one-unit increase in exposure to LCC marketing, which represents one additional piece of marketing. Given that young adults in the study were exposed to 43 pieces of LCC marketing on average in a week, this one unit increase represents a very small dose of exposure. Further, the sample was from colleges in Texas. While a focus on Texas can help to inform tobacco marketing regulation as the industry spends the most marketing its products in Texas as compared to the rest of the U.S. (Federal Trade Commission, 2019a, 2019b), replication of these results with larger, representative samples of LCC users is needed. Additionally, the data used in this analysis were from waves 5 and 6 but the outlets included in the audits were based on the colleges attended at wave 1 (two years earlier). While a majority of the sample was 18–20 years old at the start of the study, and likely still remained at the same college at wave 5, we are not able to directly determine their locations. In addition, exposure to LCC POS marketing was a product of the number of LCC advertisements and price promotions at POS and shopping frequency, thus LCC displays and placements may have been excluded in the exposure measure if they did not contain traditional advertisements or price promotions. We also did not limit the questions about frequency of visiting outlets to those around their school. Future studies are needed that expand the exposure measure and explore the influence of other types of POS marketing such as the position and area of product displays and placements on tobacco use behaviors, as well as determine the similarity of outlets across outlet type and location. Finally, our models do not allow us to determine the direct causal relationship between marketing exposure and use behaviors. For example, those who use tobacco products may be more likely to frequent TROs and thus may be more likely to be exposed to all tobacco marketing. Tobacco marketing may also reinforce tobacco use. In our longitudinal analyses, we did control for previous use to attempt to account for potential confounding. Further research is needed to continue to disentangle the reciprocal relationships likely at play.

Despite these limitations, findings from this study add to a limited yet growing body of evidence on the relationship between exposure to LCC marketing at the POS and current use of LCCs and conventional cigarettes among young adults. The results of our study provide not only the impact of marketing exposure to LCCs on current LCC and cigarette use but also the impact on future cigarette use. Regulation efforts to minimize all types of POS marketing are needed as POS marketing continues to remain a significant risk factor for tobacco use.

5. Contributors

YZ and KP conceived of the research question. YZ conducted the analyses and drafted the initial manuscript. KP provided critical review of the manuscript and helped interpret the data. AL and CP provided critical review and conceived of the larger study. KS provided critical review. All authors contributed to and approved of the final submitted manuscript.

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CRediT authorship contribution statement

Yenan Zhu: Conceptualization, Formal analysis, Writing - original draft. **Keryn E. Pasch:** Conceptualization, Methodology, Investigation, Resources, Writing - review & editing, Supervision, Project administration. **Alexandra Loukas:** Investigation, Resources, Writing - review & editing, Project administration, Funding acquisition. **Kimberle L. Sterling:** . **Cheryl L. Perry:** .

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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