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Demographic and psychological moderators of the relationship between neighborhood cigarette advertising and current smoking in New York City

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Abstract

Background: Tobacco advertising in retailers influences smoking, but little research has examined how this relationship differs among population subgroups. This study merged data on neighborhood cigarette advertising with geocoded survey data to assess the association between advertising prevalence and current smoking among New York City (NYC) residents, and whether demographic and psychological characteristics moderate this relationship.

Methods: Audit data from a stratified, random sample of 796 NYC tobacco retailers generated neighborhood prevalence estimates of cigarette advertising, which were linked with unweighted 2017 NYC Community Health Survey data (n=7,837 adult respondents with residential geocodes). Multilevel regression estimated adjusted odds ratios (aOR) of current smoking by level of neighborhood cigarette advertising (quartiles). Interactions assessed differences in this relationship by demographic characteristics and current depression (analyses conducted in 2019).

Results: There was no main effect of advertising on smoking status or significant interactions with demographic variables, but current depression was an effect modifier (p=0.045). Cigarette advertising was associated with current smoking among those with current depression (p=0.023), not those without (p=0.920). Specifically, respondents with depression who resided in neighborhoods in the highest quartile for cigarette advertising prevalence had higher odds of

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current smoking, compared to those living in the lowest advertising quartile [aOR: 1.72 (1.04, 2.86)].

Conclusion: Retail cigarette advertising may serve as an environmental cue to smoke among adults with depression. Efforts to restrict or counteract this practice, such as the development of community-level public health interventions and counter-marketing programs, may particularly benefit those with depression and, perhaps, other mental health disorders.

Keywords

tobacco; smoking; advertising; neighborhoods; mental health

INTRODUCTION

Cigarette manufacturers in the U.S. spend over \$8 billion annually on product advertising and other promotional activities.¹ Nearly 80% of this budget is dedicated to marketing strategies that occur at the point-of-sale (POS), such as coupons, price promotions, and shelving displays. Perhaps the most visible form of cigarette promotion in tobacco retailers – physical advertisements – is known to influence a range of smoking behaviors. Youth with more frequent exposure to cigarette ads, for example, have higher odds of smoking initiation and susceptibility to future smoking.^{2,3} Adults who observe more tobacco advertising in local retailers report lower quit success and more intense cigarette cravings compared to those with less advertising exposure.^{4,5} Although the link between tobacco advertising in communities and individual-level smoking behaviors is well-established among the general population, it is less clear whether this relationship differs among groups disproportionately burdened by tobacco use. Identifying subgroups that may be more susceptible to the influence of tobacco advertising can inform the development of community-level public health interventions and counter-marketing programs that more effectively reduce smoking disparities.

Smoking and its resultant health harms are now concentrated among socially and economically disadvantaged populations in the U.S. Cigarette use is substantially higher among individuals who have lower levels of educational attainment and income, certain racial/ethnic groups, and sexual minorities.⁶ Reasons for these disparities may include reduced access to and use of cessation therapies;⁷ and psychosocial stressors such as financial strain, perceived discrimination, and neighborhood stress;^{8,9} but exposure to tobacco industry marketing is also thought to play a key role.¹⁰ Notably, POS tobacco advertising and cigarette price promotions are more prevalent in low-income and predominantly non-white neighborhoods, potentially inducing cravings to smoke.¹¹ While unequal exposure to tobacco advertising may contribute to observed sociodemographic smoking disparities, research on subgroup membership as an effect modifier in the relationship between neighborhood advertising and smoking behaviors is lacking.¹² That is, it is unclear whether the magnitude of this association differs among groups that experience smoking-related inequities.

Perhaps no group bears a greater burden of tobacco use and its consequences than individuals with mental illnesses, who smoke at rates that greatly exceed national averages

and who have not benefitted as much from tobacco control efforts.^{13–16} Whereas the overall prevalence of current smoking in the U.S. reached a historic low of 14% in 2017, more than 35% of adults reporting serious psychological distress currently smoked.⁶ The Centers for Disease Control and Prevention (CDC) estimate that nearly a third of all cigarettes consumed in the U.S. are smoked by individuals with a mental illness.¹³ Depression, the most common psychiatric condition in the U.S.,¹⁷ is a known risk factor for smoking,¹⁸ and individuals experiencing depressive symptoms are less likely to quit and more likely to relapse compared to those without depression.¹⁹ Although the mechanistic association between depression and smoking behaviors is not fully understood, evidence from laboratory studies suggests that cue-induced urges to smoke are significantly stronger among those with depressive symptoms,^{20,21} potentially contributing to lower quit success. These patterns hold true in New York City (NYC), as well. New Yorkers with serious psychological distress demonstrated no decline in smoking prevalence compared to a significant 28% decline among New Yorkers with low/moderate psychological distress between 2003 and 2012.¹⁶

NYC, the largest U.S. city, is an ideal setting in which to study the influence of community-level tobacco promotion, given its high tobacco retailer and population density, and the heterogeneity and diversity of its many neighborhoods. In this study, we merged ecological data on neighborhood cigarette advertising with geocoded, population-based survey data to assess the association between advertising prevalence in local retailers and current smoking among New York City (NYC) residents, and whether demographic and psychological factors moderate this relationship.

METHODS

Data Sources

NYC Community Health Survey—The NYC Community Health Survey (CHS) is an annual telephone survey of adult NYC residents.²² Conducted every year since 2002, the survey is a key surveillance tool for measuring self-reported health behaviors over time and across neighborhoods. The 2017 CHS included 10,005 respondents and had a response rate of 13.7% and a cooperation rate of 85.6% (AAPOR Response and Cooperation Rate #3).²³ All respondents in 2017 were asked to provide their address or the street intersection nearest to their home. Addresses were entered into a geolocator during the live interview, and interviewers asked for clarification if the address provided could not be assigned latitude and longitude coordinates. Respondents who provided an address or cross streets that could not be geocoded using the live geolocator were manually reviewed by a geographical information systems (GIS) team, which assigned latitude and longitude coordinates when possible. Of the 10,005 respondents, geographic data were available for 7,837 (78.3%).

NYC Tobacco Marketing Surveillance (Project TOMAS)—A list of all licensed tobacco retailers in NYC (n=8,291) and their latitude and longitude coordinates were obtained from the NYC Open Data Portal in July 2017.²⁴ Retailer locations were geocoded and imported into ArcGIS (v. 10.5.1), and each point was joined to its underlying Neighborhood Tabulation Area (NTA, n=188). NTAs, city administrative boundaries used as

the operational definition of “neighborhood” in this study, are aggregations of census tracts, have a minimum population of 15,000 residents, and often approximate boundaries of historical NYC neighborhoods (e.g., Upper West Side, Chinatown).²⁵ Using a stratified, random sampling approach, 10% of retailers from each residential NTA were selected for in-person audits (n=879), during which the research team coded for the presence of internal and external cigarette advertisements. An “advertisement” was defined as an industry-made sign larger than the size of a standard index card featuring a tobacco company’s logo and/or an image of the product. All store visits were completed between July–October 2017. Detailed descriptions of study methods have been published previously.^{26–29}

Measures

Current Smoking—Current smoking was measured by first asking whether the respondent has smoked at least 100 cigarettes in their entire life, and if so, whether they now smoke cigarettes every day, some days, or not at all. Those who reported smoking every day or some days were considered to currently smoke.

Demographics—Demographic variables included: sex, age group, race/ethnicity [i.e., white, non-Hispanic (NH); Black, NH; Hispanic; Asian or other Pacific Islander, NH; Other, NH], educational attainment (i.e., less than high school, high school graduate, some college, college graduate), poverty status [i.e., <200% federal poverty level (FPL), 200% FPL], housing status (i.e., owned, public housing or rental assistance, other), and sexual orientation. Individuals who reported being heterosexual or straight were considered “heterosexual,” while those who reported being lesbian, gay, or bisexual were considered “LGB.”

Current Depression—Current depression was measured using the PHQ-8 scale, a validated diagnostic measure for depressive disorders.³⁰ Questions on the eight-item scale include whether during the last two weeks the respondent has been bothered by: (1) feeling little interest or pleasure in doing things; (2) feeling down, depressed, or hopeless; (3) having trouble falling or staying asleep or sleeping too much; (4) feeling tired or having little energy; (5) having a poor appetite or overeating; (6) feeling bad about yourself or that you are a failure or have let yourself or your family down; (7) having trouble concentrating on things, such as reading the newspaper or watching TV; (8) moving or speaking so slowly that other people could have noticed, or being so fidgety or restless that you have been moving around a lot more than usual. The answer choices to each question were “not at all” (0 points) “several days” (one point), “more than half the days” (two points) and “nearly every day” (three points). Respondents with a score greater than 10 were considered to have current depression.³⁰

Neighborhood Cigarette Advertising—Using data from Project TOMAS, we calculated the prevalence of any cigarette advertising (i.e., interior or exterior) among stores in each NTA (mean: 56.0%, sd: 31.1%). NTAs were subsequently categorized into quartiles based on the distribution of cigarette advertising prevalence (Q1: 0.0–33.2% of stores advertised cigarettes, Q2: 33.3–50.0%, Q3: 50.1–75.0%, Q4: 75.1–100%). Respondents were assigned the advertising quartile of their residential NTA. After examining

characteristics of the tobacco retail environment across neighborhoods, five NTAs containing major business districts were excluded from the analytic data set, as they were not representative of NYC's residential neighborhoods and were extreme statistical outliers. Tobacco retailer density in these NTAs, for example, was greater than two standard deviations above the city mean. Indeed, businesses in these neighborhoods, which contain massive transit hubs such as Penn Station and Grand Central Station, and tourist attractions such as Times Square and Broadway, generally cater more to the millions of daily commuters and visitors³¹ than to the residents who live there. Excluding these NTAs reduced the effective sample size by $n=129$.

Statistical Analysis

We first calculated the prevalence of current smoking by demographic characteristics, current depression, and neighborhood cigarette advertising. To assess the main effects of cigarette advertising, we estimated the adjusted odds of current smoking, controlling for demographics and current depression, using generalized estimating equations (GEEs). GEEs, alternatively known as population-average models, account for within-cluster variance and are commonly used to examine associations between neighborhood characteristics and individual-level health outcomes.^{32,33} Because participants in the analytic dataset were nested within NTAs, GEEs were an appropriate inferential framework to handle this multilevel data and estimate fixed-effect associations of interest. Finally, in a subsequent series of adjusted models, we tested the interaction between cigarette advertising quartile and demographic/psychological variables historically associated with smoking disparities (i.e., race/ethnicity, poverty status, housing status, sexual orientation, current depression) to assess effect modification. If any interaction term was statistically significant, stratified adjusted regression examined the extent to which the association between neighborhood-level cigarette advertising and current smoking differed across levels of that variable. All GEEs were estimated using the GENMOD procedure in SAS (version 9.4), which specified a logit link function, a binomial probability distribution, and used a critical alpha of .05. Analyses were conducted in 2019.

CHS data are typically weighted to represent the NYC adult population. However, given that 22% of respondents were excluded from this study because they did not have geographic data for their home address, and given that geographic data missingness was correlated with race/ethnicity and educational attainment, we did not use survey weights in our analysis of the smaller analytic sample. It should be noted, however, that most of the differences in data missingness between groups were small (i.e., <5 percentage points), with the exception of Asian/Pacific Islander respondents (30% missing geocodes vs. 22% overall). Although the analytic sample was similar to the full CHS sample on demographic, psychological, and smoking characteristics, the study is not necessarily generalizable to the NYC adult population. Instead, findings are only representative of this large sample of NYC residents who provided geographic data. The Institutional Review Boards at Columbia University Medical Center and the NYC Department of Health and Mental Hygiene approved all study methods.

RESULTS

Unweighted sample characteristics are presented in Table 1. Over half of respondents were female (56.0%), nearly two-thirds were non-white (64.7%), less than half had a college degree (42.4%), and 43.9% had a household income below 200% of the federal poverty line. Approximately 10% of the sample had current depression, and 13% currently smoked. The odds of current smoking varied by selected demographic characteristics (Table 2).

Females were less likely to currently smoke than males [aOR: 0.61 (0.52, 0.71)], Hispanic participants were less likely to currently smoke than those who were non-Hispanic white [aOR: 0.58 (0.46, 0.72)], and participants without a college degree were more likely to currently smoke than participants who were college graduates (aOR: 1.84 – 2.14). The odds of smoking were also significantly higher among LGB adults compared to those who were heterosexual [aOR: 1.43 (1.08, 1.90)], and among respondents in public housing or receiving rental assistance versus those who owned their own home [aOR: 2.07 (1.58, 2.73)]. Notably, the prevalence of current smoking was highest among respondents with current depression (23.7%), significantly higher compared to those without depression [aOR: 1.96 (1.60, 2.41)].

Overall, there was no main effect of cigarette advertising prevalence on smoking status ($p=0.839$), and no significant interactions with the demographic variables we assessed. The interaction with current depression, however, was statistically significant ($p=0.045$). Subsequent stratified analyses found that smoking status was associated with neighborhood cigarette advertising among participants exhibiting current depression ($p=0.023$, Table 3).

Specifically, respondents with depression who resided in neighborhoods with the highest cigarette advertising prevalence (i.e., Q4 neighborhoods) had higher odds of current smoking compared to those living in Q1 neighborhoods [aOR: 1.72 (1.04, 2.86)], controlling for all covariates. A similar relationship was observed among those living in Q2 neighborhoods [aOR: 1.94 (1.21, 3.10)]. In contrast, smoking status was not associated with cigarette advertising among respondents without current depression ($p=0.920$).

DISCUSSION

Demographic correlates of current smoking in this large sample of NYC residents were consistent with disparities observed in other settings, as well as nationally.⁶ Namely, smoking prevalence was significantly higher among adults with lower socioeconomic status (i.e., lower income and education levels), sexual minorities, and those with depression. Despite substantial declines in NYC's smoking rate over the last several years, largely the result of the city's progressive and comprehensive tobacco control plan,³⁴ continued efforts are needed to minimize smoking-related inequalities. Recent strategies to this end included price measures such as an increased minimum cigarette pack price floor (\$13.00 as of June 1, 2018)³⁵ designed to have more impact on lower income, price sensitive adults; anti-tobacco media campaigns targeted to men;³⁶ and outreach to residents living in public housing to improve linkages to cessation services following the U.S. Department of Housing and Urban Development's ban on smoking in public housing.³⁷

Contrary to existing research, the prevalence of cigarette advertising in neighborhoods was not associated with individual-level smoking behaviors in the overall sample. One possible explanation is that NYC's tobacco retailer density and cigarette advertising volume are generally high across all neighborhoods, reflecting the city's extremely high population density.³⁸ Less between-neighborhood variability in cigarette advertising compared to other settings may partially explain the null finding regarding the main effects of advertising. Alternatively (or additionally), NYC's strong tobacco retail policies, such as a ban on cigarette price discounts and high minimum cigarette prices, may minimize or neutralize the impact of advertising exposure.

Our study did find evidence of an interaction by depression status, such that higher cigarette advertising prevalence was positively associated with current smoking among individuals with current depression. This relationship, however, did not follow a clear "dose-response" pattern; individuals residing in Quartile 3 neighborhoods did not have higher smoking rates compared to those in Quartile 1 neighborhoods. This may be attributed to sample size: Quartile 3 neighborhoods had the smallest sample size of individuals overall (n=1452) and with current depression (n=134), which could have impacted estimates. Additionally, there may be characteristics of Quartile 3 neighborhoods that explain the lower smoking rate among those with current depression. We carefully examined these neighborhoods to identify features (e.g., tobacco retail environment, universities, large ethnic enclaves) that might make them or their populations "different" from other neighborhoods, but could not identify any obvious, unique characteristics. Nevertheless, unobserved differences may exist.

Historically, the tobacco industry has used marketing tactics that targeted population subgroups with elevated rates of mental illnesses, an audience segment referred to as a "downscale market" in archival studies of previously-secret tobacco industry documents.³⁹ An RJ Reynolds market research study once suggested that this "downscale" demographic profile is "more impressionable to marketing/advertising...they're more susceptible. They're less formed intellectually... more malleable."³⁹ While the company's characterization of these marginalized groups is offensive, to say the least, their remarks about susceptibility to advertising may have some behavioral plausibility. The findings from our study provide population-level support for several lab-based studies documenting stronger cue-induced urges to smoke among adults with depressive symptoms.^{20,21} Indeed, greater exposure to POS cigarette advertising — an environmental smoking stimulus — among this at-risk group might increase cravings to smoke and make it more difficult to quit.

We note several study limitations. First, neighborhood-level cigarette advertising prevalence was generated from a representative sample of NYC retailers,^{26,27} but it may not represent actual levels or volume of exposure. The data collection instrument for Project TOMAS did not document the number or size of cigarette advertisements in each retailer, features that may impact consumer behavior. Moreover, the advertising variable was linked with residential geocodes from the CHS. Although the neighborhoods in which people live can certainly influence health behaviors, the communities in which they work and spend free time are also important when examining the intersection between "place" and health. Second, nearly a quarter of CHS respondents did not provide their addresses and were excluded from the study. Given the potentially biased sample and unweighted analyses, our

findings may not be generalizable to NYC residents or other populations. Rather, we documented an association between the local tobacco retail environment and smoking behaviors in a large sample of NYC residents with geographic data. We note, however, that respondents without geographic data were demographically similar to the analytic sample and did not differ by smoking status nor current depression. We do not believe that results would meaningfully change had we been able to include these individuals; in fact, the findings related to depression may have intensified with a larger sample size. Third, the results of this cross-sectional study cannot demonstrate that a causal relationship exists between advertising exposure and smoking behaviors. Finally, our analyses related to psychological moderators were limited to self-reported current depression status, since CHS does not routinely collect information about other mental health conditions. It is important to note that individuals screened positive for current depression often have multiple clinical diagnoses (e.g., comorbid anxiety disorders) or might be experiencing a depressive episode of bipolar disorder. Future research should consider whether findings differ among those with mental health comorbidities and those with other types of mental illnesses beyond depression.

Tobacco advertising in retailers may serve as an environmental cue to smoke among adults with depression, which could have implications for clinical and public health interventions. Clinicians, cessation counselors, and other addiction specialists may need to consider and explicitly address marketing exposure as another potential trigger when treating patients with depression, who may be more susceptible to these ubiquitous practices. Retail-based tobacco control initiatives, such as counter-marketing programs and policies that restrict advertising, prohibit price promotions, raise prices, and reduce tobacco retailer density, can help mitigate the influence of the tobacco industry's marketing activities and are gaining momentum as a way to reduce tobacco use and minimize smoking-related disparities. This study suggests that these efforts may particularly benefit those with depression and, perhaps, other mental health disorders.

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HIGHLIGHTS

- Neighborhood cigarette advertising linked with smoking among those with depression
- Tobacco advertising may induce urges to smoke among at-risk groups in particular
- Restricting tobacco advertising may benefit those with mental health disorders

Table 1.

Sample demographics, 2017 NYC Community Health Survey respondents with geographic data, unweighted (n=7793)

	n	%
Sex		
Male	3427	44.0
Female	4360	56.0
Age group		
18–24 years	579	7.4
25–29 years	566	7.3
30–34 years	1945	25.0
45+ years	4695	60.3
Race/ethnicity		
White, NH ^a	2749	35.3
Black, NH	1783	22.9
Hispanic	2203	28.3
Asian or Pacific Islander, NH	848	10.9
Other, NH	210	2.7
Educational attainment		
Less than high school	1166	15.0
High school graduate	1731	22.3
Some college	1581	20.4
College graduate	3289	42.4
Poverty status		
<200% FPL ^b	3422	43.9
200% FPL	4371	56.1
Housing status		
Owned	2469	32.3
Public housing or rental assistance	1246	16.3
Other	3921	51.4
Sexual orientation		
LGB ^c	413	5.5
Heterosexual	7074	94.5
Current depression^d		
Yes	728	9.8
No	6672	90.2
Smoking status^e		
Current	1013	13.0
Former	1750	22.6
Never	5007	64.4

^aNH: non-Hispanic;

^b FPL: federal poverty level;

^c Included those who reported being lesbian, gay, or bisexual;

^d Current depression determined by a score >10 on the PHQ-8 scale;

^e Current smokers defined as those who have smoked 100 cigarettes in a lifetime and currently smoke every day or some days

Table 2.

Prevalence and adjusted odds^a of current smoking^b by demographic characteristics and neighborhood cigarette advertising, unweighted

	%	aOR ^c	95% CI	p-value
Sex				
Male	16.3	Ref.		<.0001
Female	10.5	0.61	(0.52, 0.71)	
Age group				
18–24 years	9.0	0.60	(0.41, 0.88)	<.0001
25–29 years	14.0	1.17	(0.90, 1.51)	
30–34 years	15.5	1.44	(1.19, 1.75)	
45+ years	12.4	Ref.		
Race/ethnicity				
White, NH ^d	11.9	Ref.		<.0001
Black, NH	14.9	0.90	(0.72, 1.12)	
Hispanic	11.8	0.58	(0.46, 0.72)	
Asian or Pacific Islander, NH	14.3	0.93	(0.70, 1.22)	
Other, NH	20.6	1.53	(1.03, 2.25)	
Educational attainment				
Less than high school	16.4	2.09	(1.63, 2.67)	<.0001
High school graduate	15.6	1.84	(1.48, 2.29)	
Some college	16.5	2.14	(1.72, 2.67)	
College graduate	8.8	Ref.		
Poverty status				
<200% FPL ^e	15.8	1.18	(0.99, 1.40)	0.067
200% FPL	10.9	Ref.		
Housing status				
Owned	8.8	Ref.		<.0001
Public housing or rental assistance	19.4	2.08	(1.58, 2.73)	
Other	13.5	1.45	(1.71, 1.78)	
Sexual orientation				
LGB ^f	18.4	1.43	(1.08, 1.90)	0.025
Heterosexual	13.0	Ref.		
Current depression ^g				
Yes	23.7	1.96	(1.60, 2.41)	<.0001
No	11.7	Ref.		
Cigarette advertising prevalence ^h				
Quartile 1 (0.0% – 33.2%)	12.8	Ref.		0.839
Quartile 2 (33.3% – 50.0%)	13.5	1.04	(0.85, 1.28)	
Quartile 3 (50.1% – 75.0%)	12.7	0.99	(0.80, 1.22)	

	%	aOR ^c	95% CI	p-value
Quartile 4 (75.1% – 100.0%)	13.6	1.09	(0.87, 1.37)	
Cigarette advertising * race/ethnicity ⁱ				0.827
Cigarette advertising * educational attainment				0.261
Cigarette advertising * poverty status				0.757
Cigarette advertising * housing status				0.35
Cigarette advertising * sexual orientation				0.226
Cigarette advertising * current depression				0.045

^a Adjusted for sex, age, race/ethnicity, education, poverty status, housing status, sexual orientation, current depression, cigarette advertising prevalence;

^b Current smokers defined as those who have smoked 100 cigarettes in a lifetime and currently smoke every day or some days;

^c aOR: adjusted odds ratio;

^d NH: non-Hispanic;

^e FPL: federal poverty level;

^f Included those who reported being lesbian, gay, or bisexual;

^g Current depression determined by a score >10 on the PHQ-8 scale;

^h Prevalence of cigarette advertising in a sample of retailers from respondents' residential Neighborhood Tabulation Areas; boldface indicates statistical significance (p<0.05);

ⁱ Interaction terms are from a series of subsequent models after an initial model tested main effects. Including interaction terms did not meaningfully change the aOR estimates for the other modeled variables, so the interaction p-values are appended to the original model estimates.

Table 3.

Adjusted odds^a of current smoking^b by neighborhood cigarette advertising, stratified by current depression, unweighted

	Current depression ^c = Yes n=673				Current depression = No n=6134			
	%	aOR ^d	95% CI	p-value	%	aOR	95% CI	p-value
Cigarette advertising prevalence ^e								
Quartile 1 (0.0% – 33.2%)	18.7	Ref.			11.7	Ref.		
Quartile 2 (33.3% – 50.0%)	31.4	1.94	(1.21, 3.10)	0.023	11.6	0.93	(0.73, 1.18)	0.920
Quartile 3 (50.1% – 75.0%)	18.1	1.04	(0.59, 1.83)		12.2	0.97	(0.77, 1.22)	
Quartile 4 (75.1% – 100.0%)	25.1	1.72	(1.04, 2.86)		11.7	1.00	(0.77, 1.29)	

^a Adjusted for sex, age, race/ethnicity, education, poverty status, housing status, sexual orientation, current depression, cigarette advertising prevalence;

^b Current smokers defined as those who have smoked 100 cigarettes in a lifetime and currently smoke every day or some days;

^c Current depression determined by a score >10 on the PHQ-8 scale;

^d aOR: adjusted odds ratio;

^e Prevalence of cigarette advertising in a sample of retailers from respondents' residential Neighborhood Tabulation Areas; boldface indicates statistical significance (p<0.05)