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**THE POTENTIAL IMPACT OF RESTRICTING THE SALE OF
TOBACCO AT TOBACCO RETAIL OUTLETS SURROUNDING
SCHOOLS ACROSS MAJOR METROPOLITAN AREAS OF TEXAS
ON TOBACCO ADVERTISEMENTS**

UDOKA C. OBINWA

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by

UDOKA C OBINWA, MPH, BSC

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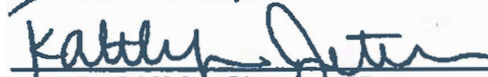
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DEDICATION

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THE POTENTIAL IMPACT OF RESTRICTING THE SALE OF TOBACCO AT
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METROPOLITAN AREAS OF TEXAS ON TOBACCO ADVERTISEMENTS

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Retail outlets that sell tobacco (ROST) are the leading channel of advertisements and promotional efforts for tobacco companies. Tobacco companies strategically target youth, young adults, racial and ethnic minorities and individuals in lower SES areas with more advertisements, which in turn influences their tobacco use behavior. Researchers have proposed instituting place-based restriction strategies as a way to control tobacco use. This dissertation examined the potential impact of i) restricting the sale of tobacco at ROST within 1000ft of schools and 2000ft of colleges and ii) restricting the sale of tobacco at ROST within 500ft of other ROST, on the number of tobacco advertisements around schools and colleges. We also examined if there were more tobacco advertisements around middle and high schools with a higher enrollment of White, Black, Hispanic or economically disadvantaged students. Methods: For paper 1, we utilized advertisement data at 130 convenience stores and gas stations audited around Public, Private, and Charter schools that participated in the Texas Adolescent Tobacco and Marketing Surveillance Study (TATAMS 2014-2015, n=53). For paper 2, we utilized the advertisement data at 151 convenience stores and gas stations audited around colleges that participated in the Marketing and Promotions

across Colleges in Texas (M-PACT 2014-2015, n=22). For paper 3, we utilized the advertisement data at 103 convenience stores and gas stations audited around Public and Charter Schools that participated in TATAMS (n=42) and linked this with their enrollment data. The ROST were audited for tobacco advertisements in 2017. The ArcGIS software was used for the mapping procedures and Independent Sample T-tests and Mann-Whitney U Test were used for testing mean difference where appropriate. Results: For paper 1, we found that ROST within 1000ft of schools had a significantly higher mean number of advertisements in comparison to ROST located 1000ft – 2000ft of the schools. Implementing the 1000ft ROST ban around schools led to more reduction in advertisements in comparison to the 500ft ROST ban. For paper 2, we also found that the mean number of tobacco advertisements at ROST within 2000ft of the colleges was slightly higher than that at ROST located 2000ft – 4000ft of the colleges. For paper 3, we found that the mean number of tobacco advertisements at ROST around schools with a higher enrollment of Hispanic and economically disadvantaged students was significantly higher than that of schools with lower enrollment of these sociodemographic groups. In congruence, the mean number of tobacco advertisements was significantly lower for schools with a higher enrollment of White students. Implementation of the 1000ft ban led to a slight reduction in this marketing disparity among the Hispanic enrollment group. Conclusion: More tobacco advertisements were observed at ROST closest to schools and colleges. We strongly recommend implementing a 1000ft ban on sales of tobacco as a way to control exposure to tobacco marketing to, in turn, reduce tobacco use among youth, young adults, racial-ethnic minorities and individuals of low SES.

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BACKGROUND

Literature Review

Tobacco use remains the leading cause of preventable deaths in the United States (US).¹ More than 480,000 deaths that occurred annually in the U.S. between 2005 and 2009 were due to tobacco use, which translates to about 1300 deaths every day.¹ Tobacco use has taken more than 10 times the number of lives of Americans than all of the nation's wars combined.¹ In addition to increasing mortality risks, tobacco use is associated with significant morbidity. More than 16 million people currently suffer illnesses due to smoking, with attendant health and economic costs.¹ Smoking has been documented as the cause of certain cancers, lung disease, stroke, heart diseases, diabetes, chronic obstructive pulmonary disease¹ and a risk factor for tuberculosis, certain eye diseases and immune system problems. Around \$300 billion are spent annually on smoking related illness in the United States^{1,2}. About \$170 billion go to direct medical costs for adults while more than \$156 billion are due to lost productivity.^{1,2}

Since the release of the 1964 Landmark Surgeon General's report, tobacco control efforts (e.g., policies, programs, regulation) have reduced cigarette smoking rates by more than half.¹ Most Americans now see cigarette smoking as a threat to individual and public health.¹ Health centers routinely ask visiting patients about their smoking status and advise them against smoking. Nevertheless, more than 42 million Americans continue to smoke cigarettes.¹ Data from wave 1 (2013-2014) of the nationally representative Population Assessment of Tobacco and Health (PATH) National Health Interview Survey indicate that 37.6% of young adults (ages 18-24) in the US reported current use of any tobacco product.³

This included current use of cigarettes (25.5%), cigars (14.1%), e-cigarettes (8.9%), hookah (18.2%), smokeless tobacco (5.2%) and pipe tobacco (2.2%).³ Tobacco use is also significant among adolescents. In 2018, 40.4 million (27.1%) of high school students and 840,000 (7.2%) of middle school students reported current use of any tobacco product.⁴ By product, this translates to a high prevalence among high school and middle school students' current use of cigarettes (8.1% and 1.8%, respectively), e-cigarettes (20.8% and 4.9%), cigars (7.6% and 1.6%), smokeless tobacco (5.9% and 1.8%), hookahs (4.1% and 1.2%) and pipe tobacco (1.1% and 0.3%)⁴. More than 3000 kids under 18 years old try smoking cigarettes for the first time while 2100 occasional youth and young adult smokers become regular daily smokers¹.

The diversification of the tobacco product marketplace has transformed the landscape of tobacco use in the last decade. In 2009, the Family Smoking Prevention and Tobacco Control Act (FSPTCA) passed in the US, banning the characterization of flavors other than tobacco and menthol in cigarettes⁵. There has been no such restriction on the production, marketing and sale of flavored non-cigarette or new non-traditional smokeless tobacco products yet which exists in more than 460 brands and 45 flavors^{6,7}. Following the epidemic of vaping among teens and recent spate of serious lung illnesses, the FDA stated it would carry out regulatory action to remove flavored e-cigarettes from the market⁸. Juul Labs also announced the suspension of the sale of several types of flavored e-cigarettes⁹. Given the stricter tax policies, marketing and smoking restriction that exists against cigarettes, cigarette companies and consumer interests may have shifted to other tobacco products¹⁰. The sale of cigarettes has reduced by 2% every year since 1998^{11,12}. However, this reduction in cigarette

consumption may partially be due to the use of other products¹⁰. In particular, e-cigarettes, introduced to the US market in 2007, have dramatically altered youth use of tobacco. The most common reasons for use of e-cigarettes among middle and high school students includes: friend or family member use (39.0%); availability of flavors such as mint, candy, fruit or chocolate (31.0%); and belief that they are less harmful than other forms of tobacco such as cigarettes (17.1%)¹³. Other reasons include ease of access compared to other products, cheaper cost, and use in areas where other tobacco products like cigarettes are not allowed¹³. Between 2011 and 2012, the percentage of middle and high school students in the US who use e-cigarettes more than doubled. This increase has continued to rise almost exponentially over time, such that in 2018, 20.8% of high school students and 4.9% of middle school students reported current use of e-cigarettes⁴. Among current users of e-cigarettes, 27.7% and 16.2% of high and middle school students were frequent users, (≥ 20 of the past 30 days), respectively⁴. There are approximately 1.5 million more youths who are current users of e-cigarettes in 2018 (3.6 million) in comparison to 2017 (2.1 million)¹⁴. A growing body of literature documents that the use of e-cigarettes can lead to subsequent cigarette smoking among both youth and young adults¹⁵⁻¹⁷. According to one estimate, 5.6 million kids who are alive and under 18 today will ultimately die from causes attributable to cigarette smoking¹.

Flavors Encourage Use of Tobacco

The variety of flavored tobacco products appeals to youth and young adults and encourages initiation and continued use^{18,19}. Menthol flavored cigarettes have been determined by the FDA to increase cigarette initiation, nicotine addiction and decrease successful quit attempts among youth

and young adults^{20,21}. Among middle and high school students who were current users of tobacco in 2014, 70% reported use of at least one flavored tobacco product in the past 30 days¹⁹. Extracts from the Nielsen's Convenience Track System (during a nationally representative survey of youth and young adults) show that flavored cigars drove the sale of cigars and were responsible for 75% of the total increase in sales between 2008 and 2011²². Approximately 94% females and 71% of males in the study preferred cigar brands with flavored variety²². The nationally representative Truth Initiative Young Adult Cohort data show that 52% of young adult smokers (ages 18-24) used a menthol flavored cigarette at first use which was higher in comparison to adults in the 25-34 age bracket²⁰. The menthol-flavor initiators were less likely to feel nauseated at first cigarette use when compared to non-menthol initiators²⁰. Among college (undergraduate) students, flavored cigarettes elicited higher positive expectancies (latent factor which includes satisfying, fun, exciting, interesting, smell good, taste good, friends would like, stimulating, good with a drink, sophisticated, mature, mild, and low tar) than non-flavored cigarettes among non-smokers, regular smokers and those susceptible to smoking²³.

Tobacco Advertisements at the Retail Environment

Advertisements specific to all tobacco products except e-cigarettes have been banned on TV, radio, billboards, sports sponsorship and transit ads^{24,25}. However, there are few regulations of advertisements for any tobacco products (e.g., cigarettes, cigars, smokeless tobacco, e-cigarettes) at retail outlets. The retail environment is now the leading channel of advertisement and promotional efforts for tobacco companies²⁶. There are approximately 380,000 retail outlets that sell tobacco in the US, which include grocery stores, gas stations, convenience stores and pharmacies²⁷. In Texas,

there are currently 43,669 cigarette/tobacco outlets with an active permit or who have been active within the last 4 years²⁸.

The density of tobacco retail stores in an area directly influences the residents' use of tobacco products, including cigarettes, non-cigarette combustible products (cigars, little cigars/cigarillos/bidis, hookah, pipe)²⁹⁻³¹, and e-cigarettes³²⁻³⁴. This may be because the residents are exposed to more branded advertisements for tobacco products that prompt demand and subsequent use^{35,36}. Several studies have demonstrated a longitudinal relationship between tobacco advertisement and increased likelihood of tobacco initiation and consumption for cigarettes^{37,38} and smokeless tobacco^{39,40}. Cross-sectional associations between e-cigarette advertisements and e-cigarette use have also been shown in multiple studies^{32,34,41,42}. In addition to increased tobacco advertisement exposure, a higher number of retail outlets that sell tobacco increases proximity and easy access to the products³⁵.

Tobacco companies target and excessively market their products to racial and ethnic minorities and residents of low socioeconomic neighborhoods⁴³⁻⁴⁵. Significantly greater amounts of point-of-sale marketing exist in low-income and racial-ethnic minority neighborhoods in comparison to higher income, better educated and predominantly White neighborhoods⁴⁵. Urban neighborhoods and neighborhoods with more Blacks have more marketing for menthol cigarettes⁴⁴. Black neighborhoods receive up to 10 times more tobacco advertisements than other neighborhoods⁴⁶. This disproportionate marketing contributes to disparities in tobacco use by socioeconomic status and race/ethnicity⁴⁷. Nationally representative data show that prevalence of the use of any tobacco product is

highest among adults with a GED certificate (50%) and lowest among adults with a graduate degree (6.4%)⁴⁸. Adults who earned less than \$20,000 annually also have the highest prevalence (32%) of the use of any tobacco⁴⁸. Black high school students and adults have the highest prevalence of cigar smoking^{4,49}. Approximately 85% of all Black smokers use menthol cigarettes²¹, compared to 29% of White smokers.

Youth and Young Adults as Targets of Retail Tobacco Advertisement

Youth and young adults are often the target of tobacco advertisements. The density of retail outlets especially around schools and related frequency of exposure to point of sale displays is associated with increased use of cigarettes, non-cigarette combustible product and e-cigarettes^{29,32,50} and reduced quit attempts⁵¹. This is problematic because smoking initiated during youth is likely to continue into adulthood⁴⁰. Greater amounts of point-of-sale advertisement have been documented in neighborhoods with a larger number of youth⁵² and close to schools with higher proportion of Blacks⁵² and Hispanic students²⁹. About 85% of youth report being exposed to tobacco advertisements at a retail outlet⁵³. Approximately 76% of US students in grades 6 – 12 in the National Youth Tobacco Survey report seeing tobacco advertisements in stores. Data from the California Student Tobacco Survey indicate that the proportion of advertisements for menthol cigarettes increased by approximately 6% for every 10% increase in the proportion of African American students in neighborhoods in southern California⁵². For every 10% increase in the number of youth ages 10 – 17, advertisement for menthol cigarettes increased by more than 11 percent⁵².

College students are also targets of tobacco companies and are much more likely to see tobacco advertising and media than non-college adults⁵⁴. A poll conducted among 2880 adults to

find out how frequently they encounter tobacco advertisements, including in-store, show that 73 percent of college students encounter tobacco advertisements one or more times per week in comparison to 51 percent overall⁵⁴. The tobacco companies also target youth and young adults at the retail environment through price-promotions (e.g. through dropping wholesale prices, offering coupons and multi pack discounts)¹⁵⁰.

Tobacco Industry Rationale for Point-of-Sale Advertising

The current point-of-sale advertising environment did not occur by chance. Documents retrieved from the tobacco companies show that point-of-sale advertising was initiated in response to real or anticipated advertising restrictions⁵⁵. The Master Settlement Agreement which happened in 1998 aimed at curbing smoking, especially among youths⁵⁶. It involved 46 US States, the District of Columbia and five US territories⁵⁷. In the agreement, the tobacco companies agreed to pay billions of dollars in compensation for taxpayer money that had been spent on tobacco related diseases. The agreement also put forth restrictions on the marketing of tobacco in several platforms including outdoor, billboards and public transits. Targeting of youths and kids through cartoon advertisement and other means were also eliminated.

Tobacco company executives in the US have acknowledged the need for retail advertising given the Master Settlement Agreements⁵⁷. To secure co-operation from retailers, tobacco companies pay financial incentives to enable them to post point-of-sale advertising and signage, display products and provide pricing and promotional incentives to consumers at the retail environment⁵⁸. The tobacco companies pay huge slotting fees (allowances) to retailers to secure prime display spots, put up more enticing product displays and grant competitive retail prices⁵⁸⁻⁶⁰. In

2001, a state-wide study of stores in California show that approximately 85% of all products were displayed within 4ft of the checkout counter, while 11% of exterior advertisement signs were larger than the specified size⁶¹. Another study carried out in California in 1999 show that the average financial incentives received per retailer from tobacco companies was \$2472⁶². These slotting display allowances were received by 62.4% of retailers which is higher than any other product category⁶². The sole purpose of these activities is to secure retailer loyalty and monopolize display spots while building a prominent and friendly brand name the consumers can associate with^{55,63}. The influence of tobacco advertisements on youth and young adult behavior can be explained by the Elaboration Likelihood Model.

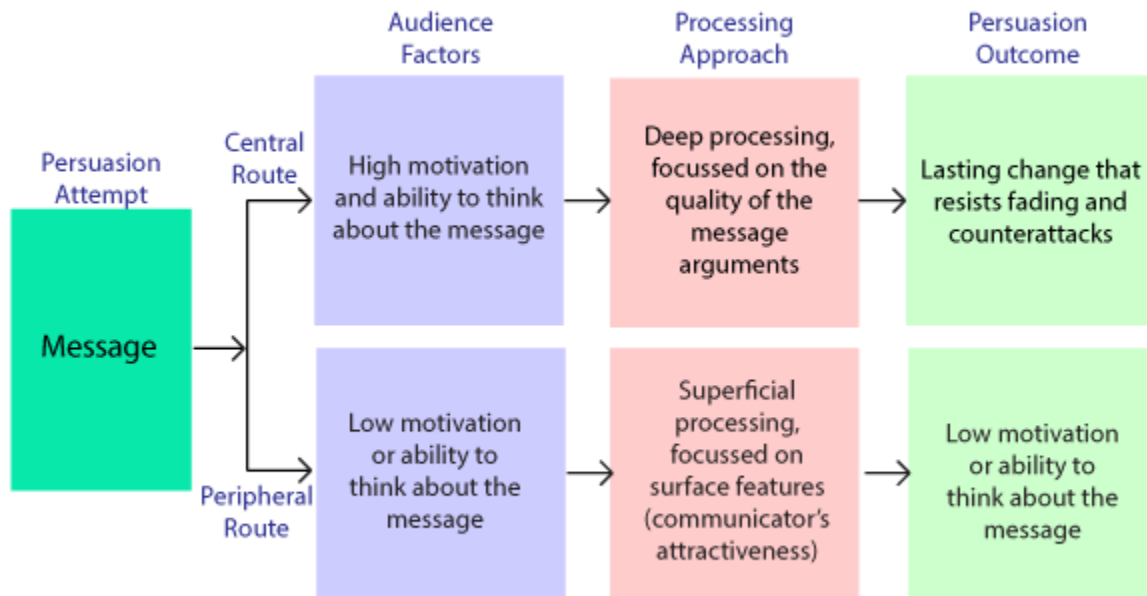
Elaboration Likelihood Model

The Elaboration Likelihood Model (ELM) describes the dual process through which persuasion can occur after a person has been exposed to information (e.g. a tobacco advertisement)^{64,65}. The ELM assumes that people do not have the ability nor the motivation to carefully evaluate everything,⁶⁶ so people reserve effortful thought processes and energy to only tasks they feel are most deserving of it and to situations they have the time and ability to consider. At any point in time when there is a decision to be made, people can be lined up along a ‘thinking continuum’, or degree to which they can devote a certain amount of time (ranging from little to considerable) to the situation⁶⁶. The ELM describes the process through which they can arrive at a decision, depending on the amount of issue-relevant thinking (‘elaboration’) and time-engagement that goes into it⁶⁴. The central idea of the ELM is that two basic different persuasion processes can be engaged when a person encounters an information or persuasive topic before the individual

develops a reasonable attitude towards the message in question. These persuasion routes or paths are referred to as the Central route and the Peripheral route⁶⁴⁻⁶⁸.

Figure 1: Diagram comparing the Central and Peripheral Routes of the Elaboration

Likelihood Model



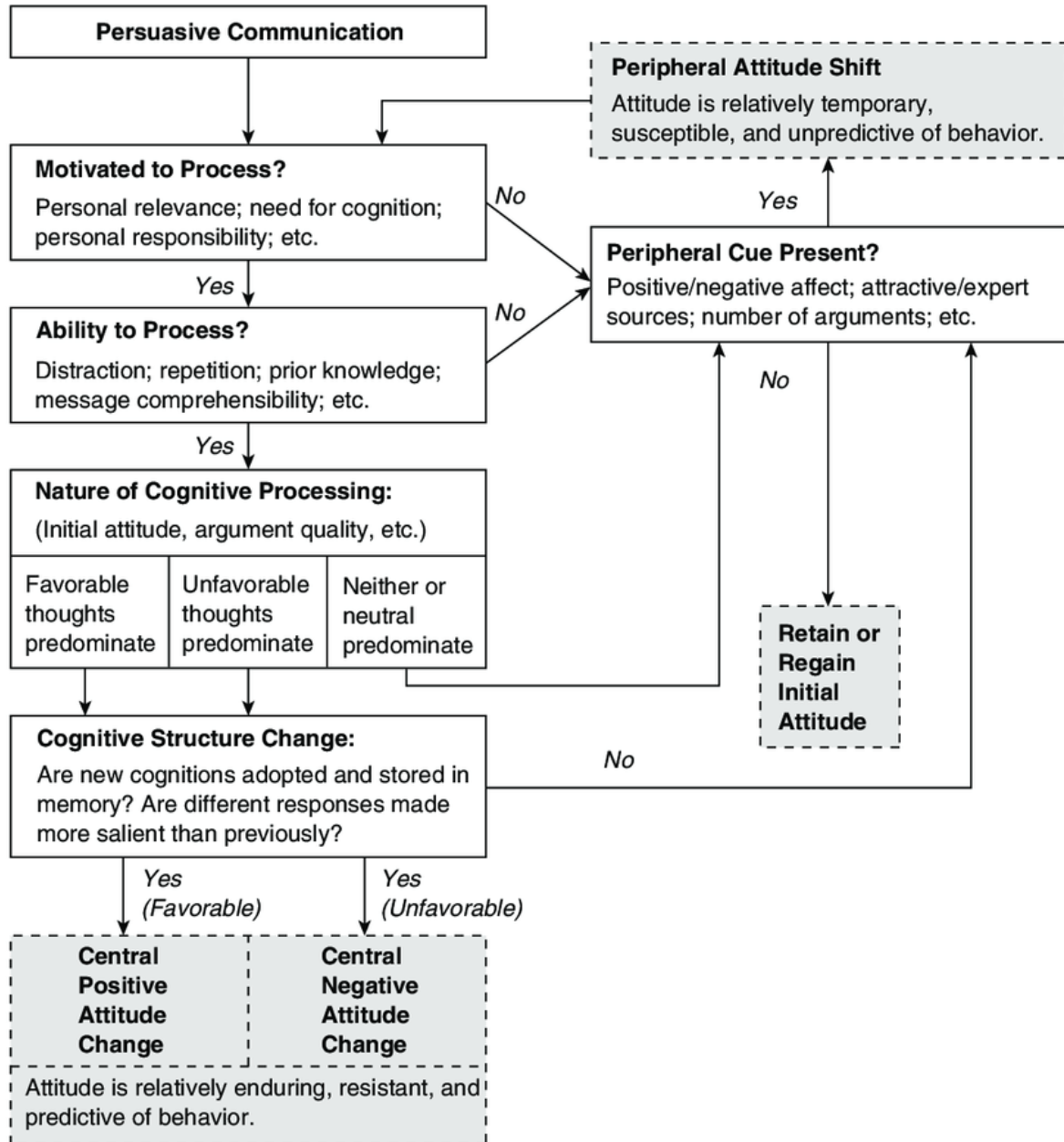
Source: Businesstopia, 2019⁶⁹.

The persuasive route that will be followed depends on many factors such as the relevance of the topic to the individual, prior knowledge of the topic, presence of distraction in the persuasion setting, receiver's motivation, channel of persuasion, context, available time and so on^{64,66}. The ELM states that the Central route is most appropriately used when the recipient of the persuasive information is motivated to think about the message and possesses the ability to do so⁶⁸. The Central route involves effortful elaboration on the received message, paying careful attention to the details of

the information and relating it to prior knowledge and beliefs^{64,66,68}. If the message contains strong and sound arguments and pro-attitudinal (in line with receiver's attitude), then a predominant positive valence is developed, leading to persuasion, agreement and implementation of the message received. If the elaboration or close examination of the message reveals weak arguments or dubious reasoning, then a negative valence is developed (boomerang effect), and persuasion does not occur.

Figure 2: Diagram Depicting Possible Endpoints after Exposure to Persuasive

Communication according to the Elaboration Likelihood Model



Source: Petty et al, 2005⁶².

On the other hand, the peripheral route is most appropriately used when the recipient of the

message is not motivated to think about it and does not have the required ability, knowledge and time to deliberate on it^{64,66,68}. Here, the outcomes of the persuasive efforts on the recipient depends on heuristics (simple rules without much thinking), activated through ‘peripheral cues’, or extrinsic aspects of the message situation. Some of these heuristic factors include the communicator’s apparent credibility, receiver’s liking of the communicator, communicator/source attractiveness, message length, other people’s reaction to the message and so on^{64,66}. Attitudes formed through the central route persuasions are relatively easy to be remembered, relatively persistent and stable, relatively resistant to challenge from competing messages and relatively predictive of the individual’s attitude-relevant judgements and behavior, respectively in comparison to those formed through the peripheral path⁶⁶.

When young people see a tobacco advertisement at the tobacco retail outlet, the information is processed either through the central or peripheral route depending on the relevance of the information to them, their motivation and ability to think of the message received. Particularly for adolescents, there are biological and psychological factors that interfere with their ability to process these messages in a balanced manner, making them especially susceptible to these advertisements from tobacco companies^{70,71}. During adolescence, biological changes associated with puberty and incomplete development of the cortical inhibitory control lead to negative emotions and strong urges⁷²⁻⁷⁵. This leaves adolescents prone to risky and impulsive decisions (persuasion) after exposures to tobacco advertisements⁷⁵. Also, their emerging ability to think abstractly and to be socially aware as puberty takes its course, makes them self-conscious and insecure⁷⁵. At this stage, the adolescents rely on consumption symbols for self-definition and self-worth. Peer pressure peaks

at this time and they are more likely to choose an antisocial behavior suggested by their peers in lieu of prosocial behavior when compared to younger children^{76,77}. So, it becomes easy for them to fall prey to the extrinsic features associated with a tobacco advertisement, which may be processed through the peripheral route and lead to persuasion. Studies have described tobacco industry's targeting of youths with advertisements as an unfair exploitation^{78,79}.

Young adults as targets of tobacco marketing also possess unique features that makes them vulnerable to tobacco advertisements. As certain researchers have pointed out, the period from late adolescence through the twenties (ages 18-25) are an 'emerging adulthood' stage⁸⁰. People in this age group do not believe that they have reached full 'adulthood', in contrast to those in their thirties^{80,81}. The majority of people within ages 18-25 are still in school or training for a long-time adult occupation, unmarried and childless in comparison to true adults in their thirties. Hence, they are relatively independent from social roles and normative expectations, leaving them with a lot of opportunities to explore life possibilities in the areas of love, work and worldviews⁸⁰. Many emerging adults have more opportunities to engage in risky behaviors in their search for self-identity and wide-ranging intense experiences before they can settle down into full adulthood roles^{80,82}. These motivations help inform their decisions either through the central or peripheral part of the ELM as they are exposed to tobacco advertisements. They have more freedom to engage in sensational experiences as they mostly live away from home and not monitored by their parents. Studies have shown that substance use and other risky behaviors peak at the emerging adulthood stage⁸³. Reduction of advertisements at the point-of-sale may help reduce the persuasive tobacco advertisements that youths and young adults are especially predisposed to at the retail environment.

Place-based Strategies for Restricting Retail outlets that sell tobacco

In response to a robust set of research that documented the link between alcohol availability and alcohol-related problems, alcohol control advocates campaigned on the use of “local government land use” law to restrict the location for alcohol retail outlets in the 1980s. Soon, local government in several States, led by California issued ordinances (zoning and conditional use permits) to restrict location and operation of liquor outlets^{84,85}. Though these innovative local ordinances were challenged legally by several liquor store owners, they were ultimately upheld at the courts^{86,87}. Following the success of these alcohol outlet restrictions in reducing alcohol consumption, there is increased interest to see if such strategies could be applied to tobacco^{88,89}. One such approach is placing a hard cap on the number of retailers allowed to operate and/or sell tobacco products⁹⁰. This hard cap on the number of retailers could be based on population size or geographic area⁹⁰. Varieties of this capping were implemented in California (Contra Costa County in 2017^{91,92}, Sonoma County in 2016^{93,94} and San Francisco in 2015^{95,96}), in Minnesota (suburb of Little Canada at Minneapolis⁹⁷) and in Philadelphia in 2016^{98,99}. Prohibition of tobacco product sales at pharmacies & other health institutions has also been suggested¹⁰⁰. About 14.3% of retailers who sold tobacco also had a pharmacy counter in 2015. This sends mixed messages about the health risks associated with tobacco use. Licensing and land use regulations through communities are also suggested strategies that could be effective in controlling tobacco outlet density and consequent tobacco use^{101,102}.

Other place-based strategies that have been suggested include limiting the number and density of retail outlets. The Institute of Medicine recommends public health agencies regulate the

number and location of retail outlets as a way to decrease tobacco use¹⁰³. A second strategy is to limit retailer density by mandating a minimum distance between retailers. Variations of this strategy have been implemented in very few counties in the US. In California, new tobacco retailers are prohibited within 500Ft of other retailers in Palo Alto in 2017¹⁰⁴ and within 200Ft of other outlets in Huntington Park in 2011¹⁰⁵. In Benton County Oregon, they are prohibited from operating within 1000Ft of other retailers in 2016¹⁰⁶. Finally, some local ordinances limit the proximity of retail outlets that sell tobacco to schools and other youth areas⁹⁰. For example, tobacco retailers are prohibited from operating within 1000Ft of primary or secondary schools in the city of Bishop California in 2016¹⁰⁷ and also playgrounds, houses of worship and other youth-oriented facilities in Renville County, Southern Minnesota in 2015¹⁰⁸. The proposed project will examine the impact that two of these place-based strategies (i.e. banning of the sale of tobacco products in retail outlets that sell tobacco (RSTOs) within 1000ft of schools/colleges and within 500ft of other retail outlets that sell tobacco) will have on the number of tobacco advertisements based on an existing audit of tobacco advertisements in retail outlets around schools/colleges in major metropolitan areas of Texas.

Public Health Significance

In 2009, the Food and Drug Administration (FDA) was given the authority to regulate the manufacture, sale, and marketing of tobacco products. In 2010, the FDA asked for public comments and research on the potential impact of a ban on tobacco retail outlet advertisements^{25,109}. Most of the tobacco advertisements occur at the retail environment, and experts have suggested that a ban on tobacco retailers or the sale of tobacco products within 1000ft of schools and 500ft of other retail

stores would help reduce tobacco use among youth and young adults^{110,111}. Only a few studies have examined the impact a 1000ft ban on retail outlets around schools will have on the density of retail tobacco outlets in a few states and localities^{111,112}. However, the potential impact of the ban on the existing number of tobacco advertisements at these retail outlets is unknown.

Most of the existing estimates come from studies the tobacco companies have carried out in a dozen states in the US for litigation purposes¹¹¹. The tobacco industry has argued that a 1000ft advertisement ban around schools and playgrounds will be equal to a general ban, with no outlet escaping the prohibition¹¹³. Based on their estimate, the rule will keep 85% - 95% of the total land area in the US off limits to tobacco advertisement¹¹³. In another lawsuit, the tobacco companies contended that the 1000ft ban was unconstitutional as they allege it's not narrowly tailored¹¹⁴. They argued that the ban will severely restrict the few remaining channels they had to communicate with adult tobacco consumers¹¹⁴. An attempt to institute a cigarette and smokeless tobacco product ban within 1000ft of schools in Massachusetts was struck down at the courts in 2001¹¹⁴.

The Family Smoking Prevention and Tobacco Control Act (FSPTCA) of 2009 clarified the regulatory authority of states and communities, noting that they can oversee the location, time and type of tobacco advertisement and promotional efforts under their jurisdiction^{5,115}. In addition, the FCLAA has made provision for state and local governments to impose "specific bans or restrictions on the time, place, and manner, but not content, of the advertising or promotion of any cigarettes" that are "based on smoking and health"¹¹⁶. This means that states and local governments are free to adopt measures that could restrict the time, place and manner of tobacco advertisements as long as it

does not conflict with the first amendment²⁵. Some localities and states have been able to successfully restrict the proximity of retail outlets around schools¹⁰⁹. The City of New Orleans successfully restricted the sale of tobacco within a 300 foot radius of schools and playgrounds in 2009¹¹⁷. In 2010, Santa Clara County in California passed an ordinance that banned tobacco retailers from opening new stores within 1000ft of schools and 500ft of other outlets¹¹⁸. An ordinance banning the sale of flavored products, including menthol cigarettes within 500ft of elementary, middle or secondary schools were passed in Chicago in 2013 and within 600ft in Berkeley, California in 2015^{119,120}.

A 1000ft ban on the sale of tobacco products in tobacco outlets around schools and within 500ft of other retail tobacco outlets close to schools both hold promise also, as a potential tool to eradicate the disparity in tobacco marketing and use by race-ethnicity and socioeconomic status observed in the US¹²¹. Ribisl and colleagues, in their study of retail outlets in New York and Missouri, reported that the number of tobacco retailers per 1000 people would drop from 1.28 to 0.36 in the lowest income quartile, while reducing from 0.84 to 0.45 in the highest income quartile¹²¹ if tobacco product sales were banned within 1000ft of schools.

To our knowledge, no other study has investigated the impact a 1000ft ban on tobacco sales around schools and within 500ft of other retail tobacco outlets close to schools, will have on the existing number and types of tobacco advertisements, if implemented. There is also insufficient knowledge as to the extent that this ban can help address the existing

disparity in tobacco retail outlet marketing and tobacco use observed in neighborhoods in the US.

Research Goal and Specific Aims

The goal of this proposed project is to quantify the impact a ban on the sales of tobacco at retail outlets that sell tobacco within 1000ft of schools and colleges will have on the number and types of tobacco advertisements. The study will also examine the impact of a ban on the sales of tobacco at retail outlets that sell tobacco within 500ft of other outlets will have on the number of tobacco advertisements. In addition, the study will examine if this 1000ft ban will reduce disparities in retail tobacco marketing by SES (enrollment percentage of economically disadvantaged students), Race (enrollment percentage of Black students and White students) and Ethnicity (enrollment percentage of Hispanic students) in the largest metropolitan areas of Texas (i.e., Houston, Dallas-Ft. Worth, San Antonio, Austin).

The first paper is a secondary data analysis and it utilized objective measures of tobacco advertisements and price promotions at retail outlets that sell tobacco (convenience stores and gas stations) within a half mile (2640ft) of public, charter, and private middle and high schools that participated in the Texas Adolescent Tobacco and Marketing Surveillance Study to:

- i. Determine if the mean number of tobacco advertisements at retail outlets that sell tobacco within 1000ft of the schools is significantly different from the mean number of tobacco advertisements at retail outlets that sell tobacco located between 1000ft and 2000ft of the schools.

- ii. Determine the percent reduction in the number of tobacco advertisements if the sales of tobacco were banned in retail outlets within 1000ft of participating middle and high schools.
- iii. Report the percentages of reductions in tobacco advertisements: by location of the tobacco advertisement (outdoor and indoor), by product type (cigarettes, e-cigarettes, cigar products, smokeless tobacco) and by flavors (menthol, flavored non-menthol and non-flavored) after implementation of the 1000ft ban outlined in aim 2.
- iv. Determine the percent reduction in the number of tobacco advertisements if the sales of tobacco were banned in retail outlets within 500ft of each other within a half mile of middle and high schools that participated in the study.

The second paper is a secondary data analysis and it utilized objective measures of tobacco advertisements and price promotions at retail outlets that sell tobacco (convenience stores and gas stations) within 1 mile (5280ft) of 2- and 4-year colleges that participated in the Marketing and Promotions across Colleges in Texas Study to:

- i. Determine if the mean number of tobacco advertisements at retail outlets that sell tobacco within 2000ft of the schools is significantly different from the mean number of tobacco advertisements at retail outlets that sell tobacco located between 2000ft and 4000ft of the colleges.
- ii. Determine the percent reduction in the number of tobacco advertisements if the sales of tobacco were banned in retail outlets within 2000ft of participating colleges.

- iii. Report the percentages of reductions in tobacco advertisement: by location of the tobacco advertisement (outdoor and indoor), by product type (cigarettes, e-cigarettes, cigar products, smokeless tobacco) and by flavors (menthol, flavored non-menthol and non-flavored) after implementation of the 2000ft ban outlined in aim 2.
- iv. Determine the percent reduction in the number of tobacco advertisements if the sales of tobacco were banned in retail outlets within 500ft of each other within 1 mile of colleges that participated in the study.

The third paper is a secondary data analysis and it utilized objective measures of tobacco advertisements and price promotions at retail outlets that sell tobacco (convenience stores and gas stations) within a half mile (2640ft) of public and charter schools that participated in the Texas Adolescent Tobacco and Marketing Surveillance Study to examine for disparity in tobacco retail marketing by the school enrollment (percentage enrollment of Black, White, Hispanic and Economically disadvantaged students). Specifically, the aims for paper 3 include:

- i. Provide summary statistics on the number of tobacco advertisements surrounding the public and charter schools that participated in TATAMS after categorizing them into two roughly equal groups of higher or lower percentage enrollment of a) Black, b) White, c) Hispanic, and d) Economically disadvantaged students, using their respective medians as cut-points.

- ii. Determine if the mean number of tobacco advertisements were significantly different for the groups obtained in aim 1 by the categories of percentage enrollment of a) Black, b) White, c) Hispanic, and d) Economically disadvantaged students.
- iii. Determine if the mean number of tobacco advertisements were significantly different for the groups obtained in aim 1 by the categories of percentage enrollment of a) Black, b) White, c) Hispanic and d) Economically disadvantaged students after implementation of the ban of the sale of tobacco products at retail outlets that sell tobacco within 1000ft of the schools.

JOURNAL ARTICLE 1

The Impact of Restricting Tobacco Sales in Retail Outlets around Middle and High Schools across Major Metropolitan Areas in Texas on Tobacco Advertisements

Proposed Journal: JAMA Pediatrics

Tobacco use remains the leading cause of death in the United States¹. More than 480,000 deaths in the US are caused by cigarette smoking every year. This translates to about 1 in 5 deaths in the US¹. Cigarette smoking has killed 10 times as many U.S citizens prematurely than all the wars fought by the United States combined¹. A report from the Surgeon General estimates that 5.6 million youth younger than 18 years of age will die prematurely from a tobacco-related illness if the current adolescent smoking rate persists¹. The total economic costs of tobacco use are estimated at over \$289 billion annually. According to a study carried out by Lightwood and colleagues on all States in the US from 1992 to 2009, a 10% reduction in smoking in every state will lead to a \$63 billion reduction in health care expenditures the following year². More than 3200 youths under 18 years of age try cigarette for the first time every day in the US and 2100 occasional users become daily users every day¹. -

Tobacco products are sold in approximately 380,000 retail locations in the US where the largest tobacco companies spend almost \$9 billion annually to market their products^{3,4}. Although all advertisements for tobacco products except e-cigarettes have been banned on TV, radio, billboards and transit ads, there are few regulations of advertisements for any tobacco products at retail outlets, including advertisements for cigarettes, cigars, e-cigarettes,

and smokeless tobacco⁵. Lack of political will, the first Amendment, and the tobacco industry resistance remain major barriers to serious policy enactment at the retail environment. In 2016, the tobacco industry spent about \$7.1 billion just to market and promote cigarettes and smokeless tobacco at retail outlets⁶. This represents over 75% of all the industry's total marketing expenditure on cigarettes and smokeless tobacco combined and approximately 96% when the inclusion of price discounts and promotional allowances are included⁶. About 85% of youth report seeing tobacco advertisements at the retail environment^{7,8}. Youth perceptions and attitudes towards smoking are influenced even by brief exposure to tobacco advertisements⁹.

The National Cancer Institute¹⁰ of the National Institutes of Health has concluded that there is a longitudinal relationship between tobacco advertisements and increased levels of tobacco initiation and consumption⁹. Specifically, exposure to point of sale tobacco promotion has been positively linked to increased smoking among young people by two different systematic reviews^{11,12}. The density of tobacco marketing at the retail environment has also been linked to ever^{13,14} and current smoking¹⁵ among youths. For a typical convenience store in the US, the tobacco display units are situated behind the register where every customer is bound to see it while checking out. This area is typically referred to as the “power wall”. All types of tobacco products including cigarettes and non-cigarette products like e-cigarettes, SNUS, little cigars, cigarillos are seen are included in the power wall. These brand impressions likely influence youth as data from a 2011-2012 nationally representative survey show that almost half of 13 – 16 year olds visit a convenience store at least once a week¹⁶. This represents about 4.1 million US adolescents visiting stores at least weekly¹⁶.

There are more tobacco marketing materials in convenience stores than any other store type¹⁷. Research has shown that kids who shop frequently at convenience stores are more likely to initiate smoking than their counterparts who do not shop frequently at convenience stores¹⁸.

The density of tobacco retailers around schools can also influence the tobacco use behavior of students. A study that examined tobacco outlets within half-mile of 135 high schools in California showed that high retailer density (> 5 stores) increased the overall smoking prevalence by 3.2% in comparison to schools with low or no retailers⁷. Students attending schools within walkable distances of multiple outlets had higher smoking prevalence than students in schools with little or no retailers⁷. Henriksen and colleagues, in their longitudinal study of the impact of exposure to tobacco retail marketing, report that the incidence of tobacco initiation was 29% among middle school students who visited convenience, liquor or grocery stores at least twice a week in comparison to only 9% among students who visited less than twice per month¹⁸. Tobacco advertisements and promotions at the retail environment also create a pathway for students not just to initiate smoking, but also to become established users. A 2007 study of 8th, 10th and 12th graders in the US showed greater advertising in stores increased the odds of transiting from a never-smoker to a puffer, while presence of promotions increased the odds of moving from experimentation to regular smoking¹⁹.

Retail marketing encourages tobacco initiation, promotes regular consumption and represses quitting¹⁹⁻²². As a way to control advertisements and tobacco use, The Institute of Medicine recommends that public health agencies regulate the number and location of retail

outlets²³. Two of the suggested policy solutions include: i) prohibition of retail outlets that sell tobacco within 1000ft of schools and ii) maintaining a minimum distance of 500ft between retail outlets that sell tobacco^{24,25}. The tobacco companies have argued against a 1000ft advertisement ban around schools, stating that it interferes with their first amendments speech protection rights²⁶. They affirmed that a 1000ft advertisement ban around schools would be tantamount to a general ban with virtually no store escaping the prohibition²⁷. They cited estimates from studies they conducted themselves on more than a dozen large US cities during litigation²⁷. The FDA seeks comments and research about the impact of a 1000ft ban of any outdoor cigarette or smokeless tobacco advertisements around schools and playgrounds^{28,29}. To our knowledge, no new policy has been announced or implemented yet in reference to their finding.

The first paper is a secondary data analysis and it utilized objective measures of advertisements and price promotions at retail outlets that sell tobacco (convenience stores and gas stations) within a half mile (2640ft) of public, charter, and private middle and high schools that participated in the Texas Adolescent Tobacco and Marketing Surveillance Study to:

- i. Determine if the mean number of tobacco advertisements at retail outlets that sell tobacco within 1000ft of the schools is significantly different from the mean number of tobacco advertisements at retail outlets that sell tobacco located between 1000ft and 2000ft of the schools.

- ii. Determine the percent reduction in the number of tobacco advertisements if the sales of tobacco were banned in retail outlets within 1000ft of participating middle and high schools.
- iii. Report the percentages of reductions in tobacco advertisements: by location of the tobacco advertisement (outdoor and indoor), by product type (cigarettes, e-cigarettes, cigar products, smokeless tobacco) and by flavors (menthol, flavored non-menthol and non-flavored) after implementation of the 1000ft ban outlined in aim 2.
- iv. Determine the percent reduction in the number of tobacco advertisements if the sales of tobacco were banned in retail outlets within 500ft of each other within a half mile of middle and high schools that participated in the study.

METHODS

Study Design and Setting

Secondary data analysis was conducted, utilizing objective advertisements and price promotions at retail outlets that sell tobacco (convenience stores and gas stations) within a half mile (2640ft) of middle and high schools that participated in the Texas Adolescent Tobacco and Marketing Surveillance Study (TATAMS). TATAMS is a longitudinal surveillance study designed to examine the impact of tobacco marketing on tobacco use behaviors among adolescents attending public, charter and private schools in the 4 largest Metropolitan areas (Houston, Dallas/Fort Worth, San Antonio, and Austin) in 5 counties (Bexar, Dallas, Harris, Tarrant and Travis) in Texas³⁰. The design of the TATAMS study is described elsewhere³⁰. Seventy-nine schools were recruited at the first wave of TATAMS

and data collection took place between October 2014 and June 2015. The addresses of the retail outlets that sell tobacco (ROST) were obtained from the Comptroller's Office in 2014 and the ROST were audited to document tobacco marketing from January to April 2017. The audit (census sample) around all of the TATAMS' schools included 261 stores: 109 (41.7%) were located in Austin, 85 (32.6%) in Houston, 37 (14.2%) in Dallas and 30 (11.5%) in San Antonio. The store types originally included beer, wine and liquor stores, discount stores, drug/pharmacy stores, grocery stores, tobacco, vape or smoke shops, and convenience stores with or without gas stations.

Our study included only convenience stores and gas stations because of the feasibility of implementing the ban in these store types. In addition, they contained most of the advertisements. Our study included 130 retail outlets that sell tobacco (convenience stores and gas stations) audited around 53 TATAMS Schools. We excluded other store types (n=106) and incompletely audited ROST (n=25). Thirty-six of the schools were high schools while 23 were middle schools. Six of the schools were both middle and high schools.

Available Data

At each of the ROST, data collectors documented information on indoor regular advertisements for all product types (cigarettes, cigars, cigarillos, smokeless tobacco, and e-cigarettes), outdoor advertisements for all product types, menthol indoor advertisements for all product types, e-cigarette flavored indoor advertisements, cigarillo flavored indoor advertisements, cigarillo menthol indoor advertisements, outdoor brands of tobacco products

advertisements, indoor and outdoor tobacco promotions. All advertisement and price promotion data were included in this study and collectively referred to as advertisements.

Measures

First, all cigar and cigarillo related advertisements were combined to obtain a single cigar category. The documented advertisements in each of the outlets that sell tobacco were grouped by location of the advertisement (outdoor and indoor), by tobacco product (cigarettes, cigar products, smokeless tobacco, and e-cigarettes), and by flavor (unflavored, menthol, and flavored non-menthol). Then, these were summed to obtain the following 10 advertisement variables for each of the retail outlets that sell tobacco: i)total number of outdoor advertisements, ii)total number of indoor advertisements, iii)total number of cigarette advertisements, iv)total number of e-cigarette advertisements, v)total number of cigar advertisements, vi)total number of smokeless tobacco advertisements, vii) total number of menthol flavored tobacco product advertisements, viii)total number of non-menthol flavored tobacco product advertisements, ix)total number of non-flavored tobacco product advertisements and x)total number of all tobacco product advertisements. Then, these 10 advertisement variables in all the retail outlets that sell tobacco were aggregated by middle and high schools. The overall sum of all advertisements around the schools were also obtained.

Data Analysis

Geocoding

The first step of data analyses involved geocoding schools and the ROST. The TIGER/Line Shape files for counties were obtained from the U.S. Census Bureau department of Commerce public file³¹ and imported into ArcMap vs 10.2.2. Address locators for the addresses (both school and retail outlets) were created using ArcMap vs 10.2.2. An address locator essentially turns the textual descriptions of the addresses into geographic features. State plane projected coordinate system was used. Schools and the retail outlets that sell tobacco were mapped as point features. In order to accommodate the distance between the school centroid and boundary, an 1150ft buffer was created around the school point addresses instead. These 1150ft buffer distance essentially represents an approximate 1000ft ban and have been utilized in previous studies³². Retail outlets that sell tobacco were overlaid over the school map.

For conducting the analysis for aim 1, retail outlets that sell tobacco within 1000ft of the schools and those between 1000ft and 2000ft of the schools were identified on the GIS platform and grouped likewise. Therefore, we had two groups of outlets: retail outlets that sell tobacco within 1000ft of schools (n=21), and those between 1000ft and 2000ft of the schools (n=66).

Evaluation of the difference in the mean number of advertisements at retail outlets that sell tobacco within 1000ft of the schools verses those located 1000ft - 2000ft of the schools.

For aim 1, we evaluated if there was a significant difference in the mean number of advertisements at retail outlets that sell tobacco within 1000ft of schools that participated in TATAMS and those located between 1000ft and 2000ft of the schools using the Independent

Sample T-test³³ (Table 1). We also evaluated for this mean difference around Middle schools and High schools separately. The Independent sample t-test is a parametric statistical technique used to analyze difference in the mean number between 2 independent groups. The required assumptions of independence, normality (using Shapiro-Wilks test) and equality of variance (using Levene's test) were verified. A type I error rate of 0.05 was utilized.

Implementation of the ban and evaluation of percent reduction in the number of advertisements

For aim 2, each of the retail outlets that sell tobacco that sell tobacco contained the 10 advertisement variables (measures) described above. The 'proximity tool set' and 'multiple buffer analysis procedures' on the ArcGIS platform were used to remove retail outlets that sell tobacco that are within the 1150ft buffer on the ArcGIS platform. Removal of an outlet on the GIS software directly means removal of all the tobacco advertisements associated with that retail outlet that sell tobacco. After implementation of the 1000ft ban, the remaining number of advertisements were recorded. The percent reduction in the total number of tobacco advertisements around the middle and high schools were calculated. Percent reduction was calculated by obtaining the difference between the original number of tobacco advertisements and the number of advertisements after implementation of the 1000ft advertisement ban around the schools and dividing by the original number of advertisements. The percent reduction in total tobacco advertisements was calculated for middle and high schools separately as well.

For Aim 3, we examined how the implementation of the 1000ft ban of retail outlets that sell tobacco around the middle and high schools affected the 10 advertisement measures. We reported

the number of tobacco advertisements by the categories of location, product type and flavor, before and after implementation of the 1000ft ban (Table 2, 3 and 4). The graph of the advertisement types before and after the ban for all schools were also presented. (Figure 1).

For Aim 4, a 500ft buffer was created around each retail outlet that sell tobacco. The ‘proximity tool set’ and ‘buffer analysis procedures’ in ArcGIS were used to remove retail outlets that sell tobacco within 500ft of other retail outlets that sell tobacco. The retail outlets that sell tobacco were removed in reference to the closest school. This means at each point where 2 of these tobacco retailers were within 500ft of each other, the one closest to a school was removed. The percent reduction in the number of tobacco advertisements after implementation of the ban was calculated and reported.

Human Subjects

This study used addresses of schools enrolled in the TATAMS study. The TATAMS study was approved by the University of Texas Health Science Center’s Institutional Review Board (HSC-SPH-13-0377). Similarly, publicly available addresses of the outlets were obtained from the Texas Comptroller’s office. The protocol of this dissertation was reviewed and approved (exempt category, HSC-SPH-19-0313) by the University of Texas Health Science Center’s Committee for Protection of Human Subjects.

RESULTS

Sample Characteristics

One hundred and thirty retail outlets that sell tobacco (convenience stores and gas stations) were included in this analysis. Fifty-four (41.6%) of these outlets were in Austin, 22 (16.9%) were in Dallas, 35 (26.9%) were in Houston, and 19 (14.6%) were in San Antonio. The 130 retail outlets that sell tobacco were audited around 53 TATAMS public, private and charter schools. Seventeen (32.1%) of the schools were in Austin, 15 (28.3%) were in Dallas, 15 (28.3%) were in Houston, while 6 (11.3%) were in San Antonio. Thirty-six of the schools were high schools while 23 were middle schools. Six of the schools were both middle and high schools.

Aim 1: Difference in mean number of advertisements at retail outlets that sell tobacco within 1000ft of TATAMS' schools verses those located 1000-2000ft of the schools

After grouping the retail outlets that sell tobacco by their proximity to the schools, 21 of them were within 1000ft of the schools, while 66 were located 1000-2000ft of the schools. Forty-three of the retail outlets that sell tobacco were beyond 2000ft of the schools and were not included in the analysis for aim 1. The mean of tobacco advertisements at retail outlets that sell tobacco within 1000ft of the schools were significantly higher than that of those located 1000-2000ft of the schools (Table 1).

Table 1: Mean difference for tobacco advertisements at ROST within 1000ft verses ROST located 1000ft – 2000ft of the TATAMS' schools (n=87 ROST; n=4185 ads)

Group (n)	Number of advertisements	Mean (Std.)	Normality (P-value)	Equality of Variance (P-value)	T-test (P-value)
1000ft (21)	1257	59.9 (28.6)	0.3489	0.8613	0.0285
1001-2000ft (66)	2928	44.4 (27.5)	0.0771		

The test of normality was conducted using the Shapiro-Wilk method. Equality of variance was examined using the Levene's test.

Fifty-five ROST were audited around middle schools. After grouping the ROST by their proximity to the middle schools, 11 of the ROST were within 1000ft of middle schools, while 30 were located 1000-2000ft of the middle schools. Fourteen ROST were beyond 2000ft of the middle schools and were not included in this mean difference analysis for middle schools. The mean of tobacco advertisements at ROST within 1000ft of the middle schools were significantly higher than that of ROST located 1000-2000ft of the middle schools (Table 2).

Table 2: Mean difference for tobacco advertisements at ROST located within 1000ft verses ROST located 1000ft – 2000ft of TATAMS' Middle schools (n=41 ROST; n=2135 ads)

Group (n)	Number of advertisements	Mean (Std.)	Normality (P-value)	Equality of Variance (P-value)	T-test (P-value)
1000ft (11)	733	66.6 (22.4)	0.8450	0.4933	0.0291
1000-2000ft (30)	1402	46.7 (25.7)	0.1360		

The test of normality was conducted using the Shapiro-Wilk method. Equality of variance was examined using the Levene's test.

Eighty-three ROST were audited around high schools. After grouping the ROST by their proximity to the high schools, 11 of the ROST were within 1000ft of the high schools, while 38 were located 1000-2000ft of the high schools. Thirty-four ROST were beyond 2000ft of the high schools and were not included in this mean difference analysis for high schools. The mean of tobacco advertisements at ROST located within 1000ft of the high schools were higher than that of ROST located 1000-2000ft of the high schools, but the difference was not significant (Table 3).

Table 3: Mean difference for tobacco advertisements at ROST located within 1000ft verses ROST located 1000ft – 2000ft of TATAMS' High schools (n=49 ROST; n=2178 ads)

Group (n)	Number of advertisements	Mean (Std.)	Normality (P-value)	Equality of Variance (P-value)	T-test (P-value)
1000ft (11)	599	54.5 (32.8)	0.2936	0.6592	0.2155
1000-2000ft (38)	1579	41.6 (29.2)	0.0632		

The test of normality was conducted using the Shapiro-Wilk method. Equality of variance was examined using the Levene's test.

Aim 2: Percentage reduction in tobacco advertisements around all TATAMS schools after the 1000ft Ban

The total number of tobacco advertisements in all 130 ROST combined before the ban was 6470. Twenty-one of these ROST were within 1000ft of the schools and were selected out on the ArcGIS platform. The total number of advertisements in the remaining 109 ROST were 5213. The percentage reduction of tobacco advertisements with implementation of the 1000ft ban of retail outlets that sell tobacco is 19.4%. The percentage reduction of ROST with implementation of the 1000ft ban is 16.2%.

Aim 3: Percentage reduction in tobacco advertisement types around middle and high schools after the 1000ft Ban

The tobacco advertisement types before and after the ban are presented below (Table 4, 5 and 6).

The percentage reduction in each advertisement type after the ban are also shown below (Table 7). A graph of the advertisement types before and after the ban for the schools combined are also presented (Figure 1).

Table 4: Total Number of Tobacco Advertisements by Location before and after the 1000ft Ban of Retail outlets that sell tobacco around the TATAMS Schools (n=130 ROST; n=6470 ads)

Schools (n)	Indoor		Outdoor		Total	
	Before	After	Before	After	Before	After
All Schools (53)	6170	4948	300	265	6470	5213
Middle School (23)	2693	1980	140	120	2833	2100
High School (36)	3779	3199	185	166	3964	3365

NB: 6 of the schools were both middle and high schools

Table 5: Total Number of Tobacco Advertisements by Tobacco Type before and after the 1000ft Ban of Retail outlets that sell tobacco around the TATAMS Schools (n=130 ROST; n=6470 ads)

Schools (n)	Cigarette		E-Cigarette		Smokeless		Cigar	
	Before	After	Before	After	Before	After	Before	After
All Schools (53)	3992	3254	518	396	1245	976	715	587
Middle School (23)	1787	1333	195	141	544	398	307	228
High School (36)	2407	2069	337	268	752	614	468	414

NB: 6 of the schools were both middle and high schools

Table 6: Total Number of Tobacco Advertisements by Tobacco Flavor before and after the 1000ft Ban of Retail outlets that sell tobacco around the TATAMS Schools (n=130 ROST; n=6470 ads)

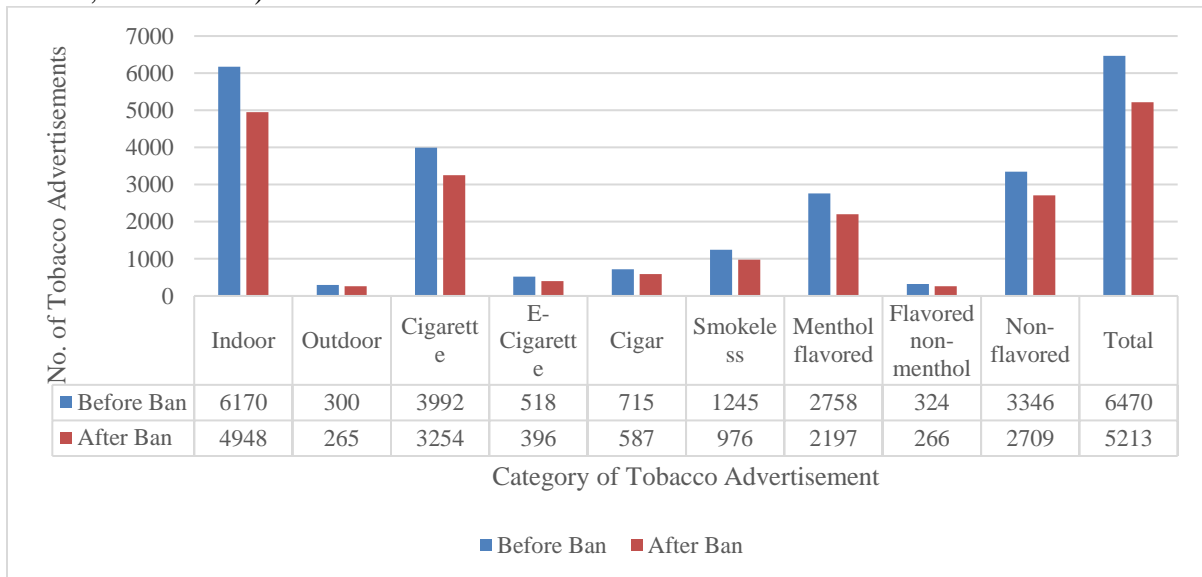
Schools	Menthol		Flavored Non-Menthol		Non-flavored	
	Before	After	Before	After	Before	After
All Schools (53)	2758	2197	324	266	3346	2709
Middle School (23)	1245	924	125	94	1433	1054
High School (36)	1638	1353	226	198	2081	1794

NB: 6 of the schools were both middle and high schools. 42 of the advertising were not classified as menthol, flavored non-menthol or non-menthol advertising.

Table 7: Percentage Reduction in Tobacco Advertisement Types after the 1000ft ban of Tobacco Outlets around the TATAMS Schools (n=130 ROST; n=6470 ads)

	Middle School	High School
Advertisement Type	% Reduction	% Reduction
Total	25.9	15.1
Indoor	26.5	15.3
Outdoor	14.3	10.3
Cigarette	25.4	14.0
E-Cigarette	27.7	20.5
Smokeless	26.8	18.4
Cigar	25.7	11.5
Menthol	25.8	17.4
Flavored Non-Menthol	24.8	12.4
Non-Flavored	26.4	13.8

Figure 1: Number of Tobacco Advertisements by Location, Type and Flavor before and after the 1000ft Ban of Retail outlets that sell tobacco around the TATAMS schools (n=130 ROST; n=6470 ads)



Aim 4: Percentage reduction in tobacco advertisements after removal of tobacco sales in ROST within 500Ft of other ROST

The total number of tobacco advertisements in the 130 ROST before the implementation of the 500ft outlet ban is 6470. Twenty-eight of these ROST were within 500ft of other ROST and were removed on the ArcGIS platform. The total number of advertisements in the remaining 102 ROST was 5311. The percent reduction in the total tobacco advertisement with implementation of the 500ft ROST ban is 17.9%. The percentage reduction in the number of ROST with implementation of the 500ft ban is 21.5%.

DISCUSSION

Our study found that retail outlets that sell tobacco within 1000ft of the TATAMS' schools had a significantly higher mean of advertisements in comparison to those located 1000ft – 2000ft of the schools, particularly around middle schools. We also found that restriction of tobacco sales in retail outlets within 1000ft of schools, as a place-based tobacco control policy would lead to a reduction in the number of tobacco advertisements that youth would see as they go to or from their schools. Implementation of a 500ft ban of ROST within other ROST would also lead to a reduction in the potential number of tobacco advertisements that youths would be exposed to. Nonetheless, it leads to less reduction in the number of tobacco advertisements when compared to the 1000ft ban of ROST around schools. Several studies have suggested implementing place-based strategies (like the 1000ft ban of ROST around schools and the 500ft ban of ROST around other ROST) as a way to control tobacco use among youth. This study is the first study to examine the actual impact such policies will have on the number of tobacco advertisements that youth are exposed to.

Notably, ROST around middle schools in this study carried a significantly higher number of advertisements in comparison to ROST further away from the middle schools. Documents obtained from tobacco companies detail how corporate marketers target convenience stores and other ROST near schools and other playgrounds in an effort to recruit young smokers^{34,35}. Other studies that have examined the marketing activities of tobacco companies have also documented strategic targeting of youths³⁶. A study conducted in Washington DC 2009 – 2010 show that ROST that were closer to schools were more likely to display exterior tobacco advertising³⁶. A multi-media exploration of retail tobacco on a neighborhood level by the Philadelphia Department of Health and Smoke Free Philly show that a 13-year old child passes 16 ROST on his 15-minute walk to school³⁷. The density of these ROST and subsequent advertisements students see can influence their tobacco use behavior. Some studies have shown that schools that have more ROST within walking distance of the schools have higher smoking prevalence in comparison to schools that have less ROST within walking distance^{7,38}.

Implementing the 1000ft ban led to a 16.2% percent reduction in the number of ROST around the TATAMS schools. Other studies that have examined the impact of such ban also obtained similar results. A study conducted in North Carolina in 2014 reported that a ban of tobacco sales within 1000ft of schools led to an 17.8% reduction in the number of ROST across the State³⁹. Another study carried out in 2010 showed that a 1000ft ban of ROST around schools led to a 22% and 51% reduction in the number of outlets in Missouri and New York, respectively²⁵. Tobacco companies have argued that implementation of a 1000ft ban would effectively mean a blanket ban on all tobacco advertising, with no outlet

escaping the prohibition²⁷. Based on a research they conducted themselves in a dozen cities in the US, they estimated that the ban will keep 85% - 95% of the total land area in the US off limits to tobacco advertisement²⁷. This study adds to existing peer-reviewed literature that shows that a 1000ft ban of ROST around schools will lead to some reduction in the number of outlets, but not nearly all outlets as the tobacco companies have claimed.

While the 1000ft ban led to a 16.2% reduction in the number of retail outlets that sell tobacco, implementation of the 500ft ban of outlets around other outlets led to a 21.5% reduction in the number of ROST. Another study that compared the impact of both bans on outlet density in North Carolina in 2014 obtained similar results³⁹. While the 500ft ROST ban around other ROST led to a 22.1% reduction at the state level, the 1000ft ROST ban around other ROST led to a 17.8% reduction³⁹. In our study, the 1000ft ban of ROST around schools led to a 19.4% reduction in the number of tobacco advertisements, while the 500ft ROST ban around other ROST led to a slightly smaller 17.9% reduction. We observed that while the 500ft ROST ban led to a higher percentage reduction in the number of retailers that sell tobacco, the percent reduction in the number of advertisements removed were slightly higher for the 1000ft ban. This further emphasizes the point that ROST closer to schools carry more tobacco advertisements than ROST further away from the schools.

With the implementation of the 1000ft ban, we see that the percentage reduction for all advertisement types was consistently higher for ROST audited around middle schools in comparison to ROST audited around high schools. Our study had more high schools than middle schools as participants. Therefore, the overall number of advertisements were higher around the high school. However, the mean of advertisements at ROST closer to the middle

schools were significantly higher than that at ROST further away from the middle schools. Likewise, the mean of advertisements at ROST closer to the high schools were higher than that at ROST further away from the high schools, but the difference was not significant statistically. This significant higher mean of advertisements closer to middle schools and the greater reduction of the advertisements around middle schools after implementation of the 1000ft ban indicate that the ROST closer to them carry more tobacco advertisements in comparison to ROST closer to the high schools. A nationally representative study from the 2014 National Youth Tobacco survey show that approximately 55% of middle school students report seeing tobacco advertisements, particularly e-cigarette advertising sometimes, most of the times or always at retail stores around them⁴⁰. Implementation of a 1000ft ban of ROST around schools could help reduce this huge exposure to tobacco advertisements.

We found wide-ranging percentage reductions for the advertisement types if the 1000ft ban of ROST around schools is implemented. For both middle and high schools, the lowest percentage reduction was observed for outdoor advertisements (14.3% and 10.3%) while the maximum percentage reduction was observed for e-cigarettes (27.7 and 20.5%), respectively. As a policy alternative, we see this ban had a great impact in the number of e-cigarette advertisements. E-cigarette use has been rising in recent years among youth with its prevalence substantially surpassing that of cigarettes and other tobacco products⁴¹. Between 2017 and 2018, there was a 78% (11.7% - 20.8%) and 48% (3.3% - 4.9%) increase in the use of e-cigarettes among high school and middle school students respectively⁴². Approximately 3.6 million kids (3.05 million high school students and 570,000 middle school students) were currently using e-cigarettes in 2018⁴². This is a big cause for concern as the emergence of e-

cigarettes has resulted in an overall increase in tobacco use among youth, reversing the declines observed in previous years⁴³. In addition, its health effects are not fully known, though e-cigarette-related sickness is beginning to emerge. E-cigarettes can increase the possibility of strokes⁴⁴ and lung disease^{45,46}. As of October 8, 2019, the number of people who have been reported to suffer from vaping-related severe lung disease had increased to 1299 across 49 states with 26 confirmed deaths in 21 states⁴⁷. Implementation of this 1000ft ban of retail outlets that sell tobacco around schools could help reduce marketing exposures to e-cigarette product advertising that may encourage youth to use these products.

We see that the smallest reduction was in the outdoor tobacco advertisement category. This suggests that banning only outdoor advertisements within 1000ft of schools will only lead to a small reduction in the number of tobacco advertisements. An effective place-based tobacco control strategy would involve prohibiting tobacco sale and marketing activities both within and outside the stores.

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JOURNAL ARTICLE 2

The Impact of Restricting Tobacco Sales in Retail Outlets around Colleges across Major Metropolitan Areas in Texas on Tobacco Advertisements

Proposed Journal: Nicotine and Tobacco Research

Tobacco use remains the leading cause of preventable death in the United States with attendant high economic cost¹. More than \$300 billion are spent annually on smoking related illness in the United States^{1,2}. About \$170 billion go to direct medical costs for adults while more than \$156 billion are due to lost productivity^{1,2}. Since the publication of the first Surgeon General's report in 1964, tobacco has killed more than 20 million people prematurely¹.

Tobacco products are sold in approximately 380,000 retail locations in the US where the largest tobacco companies spend almost \$9 billion annually to market their products^{26,27}. Most of the expenditures go towards promotions at the retail locations^{151,152}. Although tobacco advertisements have been banned on TV, radio, billboards and transit ads, there are few regulations of tobacco advertisements at the retail outlets²⁴. Most of the tobacco advertisements and promotions occur at these retail outlets or points-of-sale²⁴. More than 95% of tobacco retailers sampled nationwide display tobacco marketing with an average store exhibiting 29.5 marketing items¹⁵³.

The National Cancer Institute⁴¹ of the National Institutes of Health has concluded that there is a causal relationship between tobacco advertisements and increased levels of tobacco initiation and consumption¹²⁵. Strategic marketing plans are directed at young adults

by the tobacco industry¹⁵⁴. The young adulthood stage is a critical time period in which long term tobacco use patterns could be formed^{155,156}. The density of tobacco marketing at the retail environment has been linked to smoking initiation among young adults³¹. Prior research reports that most tobacco users who smoke on daily basis (88%) in the United States try their first cigarette at age 18 and practically all of them have initiated by age 26 (99%)⁴⁰. Recently, it's been discovered that young adults now have a higher incidence rate of initiating ever and current use of any/all tobacco products in comparison to youths¹⁵⁷. The prevalence of 30-day use of all tobacco products is highest for the young adults group (age 18-24) in comparison to all other age groups³. Exposure to tobacco advertisements and promotions increases the likelihood of initiation and continuation of tobacco use among young adults^{40,158}. Young adults are also twice as likely to make an unplanned tobacco product purchase when exposed to point-of-sale advertising¹⁵⁹.

Young adults as targets of tobacco marketing possess unique features that makes them vulnerable to tobacco advertisements. As certain researchers have pointed out, the period from late adolescence through the twenties are merely (ages 18-25) are an 'emerging adulthood' stage⁸⁰. The majority of people within ages 18-25 are still in school or training for a long-time adult occupation, unmarried and childless in comparison to true adults in their thirties. Hence, they are relatively independent from social roles and normative expectations, leaving them with opportunities to explore life possibilities in the areas of love, work and worldviews⁸⁰. These emerging adults have more opportunity to engage and experiment with different risky behaviors in their search for self-identity and wide-ranging intense experiences before they can settle down into full adulthood roles^{80,82}.

The abundance of flavored tobacco advertisement and products at the retail environment also drives purchase and use^{6,160} as well as establishment of life-long tobacco-use patterns among young adults¹⁶¹. There are more than 45 flavors of non-cigarette and new non-traditional smokeless tobacco products being marketed⁶. These flavored products are marketed aggressively with appealing advertisements and colorful packaging, often emphasizing the flavors with bright colors and descriptions like ‘refreshing citrus’, ‘crisp apple’, ‘bold wintergreen’, limited-flavor editions and so on^{162,163}. They are generally sold individually and cheaply, further endearing them to young adults¹⁶³. Sometimes, the non-traditional flavored products (excluding cigarettes and smokeless tobacco) are placed on counter tops or next to candy displays, making them more visible and accessible¹⁶³. The marketing restrictions placed on cigarettes after the passage of the Family Smoking Prevention and Tobacco Control Act (Tobacco Control Act) in 2009 were not extended to other products, like e-cigarettes.

In 2018, the FDA announced a proposed ban on menthol cigarettes, flavored cigars and restriction of flavored e-cigarettes¹⁶⁴. However, these proposed compliance policy changes do not include mint and menthol flavored electronic nicotine delivery system (ENDS) products^{164,165}. In addition, the proposals will take a long time before implementation, as they will definitely face litigations from the tobacco companies. States and local authority regulatory action against menthol and other flavors are urgently needed as flavored tobacco appeals to young adults and increases use^{6,22,166}. Eighty percent (4 out of 5) of young adults (ages 18 to 24) who have ever used tobacco reported that their first product was flavored¹⁶³. Between 2008 and 2015, the sale of flavored cigars increased by almost 50%

and constitute over half of the cigar market¹⁶⁰. Data from a nationally representative sample of young adults show that 18.5% of tobacco users report using flavored tobacco products in 2012⁶. The dual use of menthol and other flavors ranged from 1% (for nicotine products), to 72% (for chewing tobacco)⁶. Between 2014 – 2015, 69% of e-cigarette users among young adults used non-tobacco and non-menthol flavors¹⁶⁶.

The Institute of Medicine recommends that public health agencies regulate the number and location of retail outlets as a way to decrease tobacco advertisements and tobacco use¹⁰³. There have been several policy suggestions for tobacco retailer and advertisement reduction. Two of those include: i) Prohibition of retail outlets within 1000ft of schools and other youth locations ii) maintaining a minimum distance of 500ft between outlets^{110,111}. The FDA has sought for comments and research of the impact of a 1000 Ft ban of tobacco advertisements around schools at various distances^{25,109}. Although the focus has been on youths and youth serving areas, it is imperative that a ban of advisements and sale of tobacco advertisements within a certain distance be extended to colleges. Several studies have reported that the widespread presence of tobacco outlets and advertisements encourages initiation and discourages cessation of tobacco use^{127,167}. Recent research now shows young adults now have a higher initiation rate for tobacco products in comparison to youths¹⁵⁷. By age 26, 99% of all smokers have initiated tobacco use¹⁶⁸. College age adults (18 – 29 years) are among the biggest users of tobacco¹⁶⁸ and are more likely to make unplanned tobacco purchases due to advertisement exposure at the point-of-sale¹⁵⁹. Banning tobacco outlets near colleges will certainly contribute in reducing advertisement exposures, cues and tobacco use among the over 20 million students enrolled in colleges and universities across the US¹⁶⁸.

This study is a secondary data analysis and it utilized objective advertisements and price promotions at retail outlets that sell tobacco (ROST) (specifically convenience stores and gas stations) within 1 mile (5280ft) of 2- and 4-year colleges that participated in the Marketing and Promotions across Colleges in Texas Study to:

- i. Determine if the mean number of tobacco advertisements at retail outlets that sell tobacco within 2000ft of the schools is significantly different from the mean number of tobacco advertisements at retail outlets that sell tobacco located between 2000ft and 4000ft of the colleges.
- ii. Determine the percent reduction in the number of tobacco advertisements if the sales of tobacco were banned in retail outlets within 2000ft of participating colleges.
- iii. Report the percentages of reductions in tobacco advertisement: by location of the tobacco advertisement (outdoor and indoor), by product type (cigarettes, e-cigarettes, cigar products, smokeless tobacco) and by flavors (menthol, flavored non-menthol and non-flavored) after implementation of the 2000ft ban outlined in aim 2.
- iv. Determine the percent reduction in the number of tobacco advertisements if the sales of tobacco were banned in retail outlets within 500ft of each other within 1 mile of colleges that participated in the study.

METHODS

Study Design and Setting

Secondary data analyses were conducted, utilizing objective measures of advertisements and price promotions at retail outlets that sell tobacco (convenience stores and gas stations) within 1 mile (5280ft) of colleges (n=24) that participated in the Marketing and Promotions across Colleges in Texas Study (M-PACT). Due to the differences in the size of campuses, 12 or half of the number of retail outlets that sell tobacco around a college up to 40 were selected for the audit. M-PACT is a rapid response surveillance study of tobacco use among 2- or 4-year college students in the 4 largest Metropolitan areas of (Houston, Dallas/Ft. Worth, San Antonio and Austin) in 5 counties (Bexar, Dallas, Harris, Tarrant and Travis) in Texas. The addresses of the retail outlets that sell tobacco were obtained from the comptroller's office in 2014 and they were extensively audited between January and April 2017. The audit included 312 outlets: 88 (35.1%) were located in Austin, 72(28.7%) in Houston, 48(19.1%) in Dallas and 43(17.1%) in San Antonio. The store types originally included beer, wine and liquor stores, discount stores, drug/pharmacy stores, grocery stores, tobacco, vape or smoke shops, and convenience stores with or without gas stations.

Our study included only convenience stores and gas stations because of the feasibility of implementing the ban in these stores. In addition, they contained most of the advertisements. Our study included 151 ROST (convenience stores and gas stations) audited around 22 M-PACT colleges. We excluded other store types (n=108), ROST with incorrect/missing addresses (n=11), and incompletely audited ROST (n=42). Twelve of the M-PACT colleges were 2-yr colleges while 10 were 4-yr universities.

Available Data

At each of the retail outlets that sell tobacco, data collectors documented information on store types, indoor regular advertisements for all product types (cigarettes, cigars, cigarillos, smokeless tobacco, and e-cigarettes), outdoor regular advertisements for all product types, menthol indoor advertisements for all product types, e-cigarette flavored indoor advertisements, cigarillo flavored indoor advertisements, cigarillo menthol indoor advertisements, outdoor brands of tobacco products advertisements, indoor and outdoor tobacco promotions. All advertisement and price promotion data were included in this study and collectively referred to as advertisements.

Measures

First, all cigar and cigarillo related advertisements were combined to obtain a single cigar category. The documented advertisements in each of the ROST were grouped by location of the advertisement (outdoor and indoor), by tobacco product (cigarettes, cigar products, smokeless tobacco, and e-cigarettes), and by flavor (unflavored, menthol, and flavored non-menthol). Then, these were summed to obtain the following 10 advertisement variables for each ROST: i)total number of outdoor advertisements, ii)total number of indoor advertisements, iii)total number of cigarette advertisements, iv)total number of e-cigarette advertisements, v)total number of cigar advertisements, vi)total number of smokeless tobacco advertisements, vii) total number of menthol flavored tobacco product advertisements, viii)total number of non-menthol flavored tobacco product advertisements, ix)total number of non-flavored tobacco product advertisements and x)total number of all tobacco product

advertisements. Then, these 10 advertisement variables in all ROST were aggregated by 2- and 4-year colleges. The overall sum of all advertisements around the colleges were also obtained.

Data Analysis

Geocoding

The first step of data analyses involved geocoding colleges and retail outlets. The TIGER/Line Shape files for counties were obtained from the U.S. Census Bureau department of Commerce public file¹³⁶ and imported into ArcMap vs 10.2.2. Address locators for the addresses (both colleges and retail outlets) were created using ArcMap vs 10.2.2. An address locator essentially turns the textual descriptions of the addresses into geographic features. State plane projected coordinate system was used. College and outlet addresses were mapped as point features. In order to accommodate the distance between the college centroid and boundary, a 2500ft buffer was created around the college point address instead. These 2500ft buffer distance essentially represents an approximate 2000ft ban. Studies of this kind have not been conducted around colleges before. However, the GIS software was used to obtain the approximate distance between the college centroid and the boundaries. Retail outlets that sell tobacco were overlaid over the school map.

ROST within 2000ft of colleges and ROST located between 2000ft and 4000ft of the colleges were identified on the GIS platform and grouped likewise. Therefore, we had two groups of outlets: ROST within 2000ft of the colleges (n=15) and ROST between 2000ft and 4000ft of the colleges (n=54) which was utilized in the analysis for aim 1. Eighty-two ROST were beyond 4000ft of the colleges and were not included in the analysis for Aim 1.

Evaluation of the difference in the mean number of advertisements at ROST within 2000ft of colleges verses ROST located 2000ft - 4000ft of the colleges.

For aim 1, we evaluated if there was a significant difference in the mean number of advertisements at outlets within 2000ft of colleges that participated in M-PACT and outlets located between 2000ft-4000ft using the Independent Sample T-test¹³⁷. We also evaluated the mean difference in the number of advertisements around 2-yr Colleges and 4-yr Universities separately. The Independent sample t-test is a parametric statistical technique used to analyze difference in the mean number between 2 independent groups. The assumptions of independence, normality of advertisement distribution (using Shapiro-Wilks test) and equality of variance (using Levene's test) were verified before the tests. The advertisement distribution was not normally distributed. Therefore, it was transformed using the square root. After transformation, the advertisement variable was normally distributed. A type I error rate of 0.05 was utilized.

Implementation of the ban and evaluation of percent reduction in the number of advertisements

For aim 2, each ROST contained the 10 advertisement variables (measures) described above. The 'proximity tool set' and 'multiple buffer analysis procedures' on the ArcGIS platform were used to remove ROST that are within the 2500ft buffer (representing a 2000ft ban of ROST) on the ArcGIS platform. Removal of a ROST on the GIS software directly means removal of all the tobacco advertisements associated with that store. After implementation of the 2000ft ban, the remaining number of advertisements were recorded. The percent reduction in the total number of

tobacco advertisements around the 2- and 4-year colleges were calculated. Percent reduction was calculated by obtaining the difference between the original number of tobacco advertisements and the number of advertisements after implementation of the 2000ft advertisement ban around the schools and dividing by the original number of advertisements. The percent reduction in total tobacco advertisements were calculated separately also for 2-yr colleges and 4-year universities.

For Aim 3, we examined how the implementation of the 2000ft ban of a ROST around the 2- and 4-year colleges affected the 10 advertisement measures. We reported the number of tobacco advertisements by the categories of location, product type and flavor for the 2- and 4- year colleges before and after implementation of the 2000ft ROST ban (Table 2, 3 and 4). This was calculated for the 10 advertisement variables for the 2-year colleges and 4-year universities separately. The graph of the advertisement types before and after the ban for all colleges were also presented (Figure 1).

For Aim 4, a 500ft buffer was created around each ROST. The ‘proximity tool set’ and ‘buffer analysis procedures’ in ArcGIS were used to remove ROST that are within 500ft of other ROST. The ROST were removed in reference to the closest school. This means at each point where 2 ROST were within 500ft of each other, the ROST closest to a school was removed. The percent reduction in the number of tobacco advertisements after implementation of the 500ft ban was calculated and reported.

Human Subjects

This study makes use of addresses of colleges that participated in the MPACT study. The MPACT study was approved by the University of Texas at Austin’s Institutional Review Board

(2013-06-0034). Publicly available addresses of the outlets were obtained from the Texas Comptroller's office. The protocol of this dissertation was reviewed and approved (exempt category, HSC-SPH-19-0313) by the University of Texas Health Science Center's Committee for Protection of Human Subjects.

RESULT

Sample characteristics

One hundred and fifty-one ROST (convenience stores and gas stations) audited were included in this analysis. Forty-four (29.1%) of the ROST were in Austin, 29 (19.2%) were in Dallas, 46 (30.5%) were in Houston while 32 (21.2%) were in San Antonio. They were audited around 22 colleges. Twelve of these were colleges (2-year programs) while 10 were universities (4-year programs). Five of the colleges were in Austin (22.7%), 6 (27.3%) were in Dallas, 6 (27.3%) were in Houston while 5 (22.7%) were in San Antonio.

Aim 1: Difference in mean number of advertisements for ROST within 2000ft of colleges versus ROST located 2000-4000ft of the colleges.

After grouping the ROST by their proximity to the colleges using ArcGIS, 15 of the ROST were within 2000ft of the colleges, while 54 were located 2000ft – 4000ft of the colleges. There was no significant difference in the mean of advertisements for the two group of ROST (Table 1).

Table 1: Mean difference for tobacco advertisements at ROST located within 2000ft verses ROST located 2000ft – 4000ft of the M-PACT colleges (n=69 ROST; n=2687 ads)

Group (n)	Number of advertisements	Mean (Std.)	Normality (P-value)	Equality of Variance (P-value)	T-test (P-value)
2000ft (15)	613	40.9 (36.0)	0.8113	0.0863	0.8864
2000-4000ft (54)	2074	38.4 (27.3)	0.5910		

The test of normality was conducted using the Shapiro-Wilk method. Equality of variance was examined using the Levene's test. The tests were conducted after transformation of the advertisement variable using the square root.

After grouping the ROST by their proximity to MPACT 2-yr colleges using ArcGIS, 6 of the ROST were within 2000ft of the 2-yr colleges, while 23 were located 2000ft – 4000ft of the colleges. There was no significant difference in the mean of advertisements for the two group of ROST (Table 2).

Table 2: Mean difference for tobacco advertisements at ROST located within 2000ft verses ROST located 2000ft – 4000ft of M-PACT 2-yr Colleges (n=29 ROST; n=1187 ads)

Group (n)	Number of advertisements	Mean (Std.)	Normality (P-value)	Equality of Variance (P-value)	T-test (P-value)
2000ft (6)	242	40.3 (36.1)	0.2700	0.5278	0.9575
2000-4000ft (23)	945	41.1 (29.2)	0.0804		

The test of normality was conducted using the Shapiro-Wilk method. Equality of variance was examined using the Levene's test.

After grouping the ROST by their proximity to MPACT 4-yr Universities using ArcGIS, 9 of the ROST were within 2000ft of the 4-yr Universities, while 31 were located 2000ft – 4000ft of the 4-yr Universities. There was no significant difference in the mean of advertisements for the two group of ROST (Table 3).

Table 3: Mean difference for tobacco advertisements at ROST located within 2000ft verses ROST located 2000ft – 4000ft of the M-PACT 4-yr Universities (n=40 ROST; n=1500 ads)

Group (n)	Number of advertisements	Mean (Std.)	Normality (P-value)	Equality of Variance (P-value)	T-test (P-value)
2000ft (9)	371	41.2 (38.1)	0.1948	0.1110	0.6653
2000-4000ft (31)	1129	36.4 (26.2)	0.0918		

The test of normality was conducted using the Shapiro-Wilk method. Equality of variance was examined using the Levene's test.

Aim 2: Percentage reduction in tobacco advertisements around all colleges after the 2000Ft ban

The total number of tobacco advertisements in all the 151 ROST before the ban is 7155. Fifteen of these ROST were within 2000Ft of the colleges and were removed on the ArcGIS platform. The total number of advertisements in the remaining 136 ROST after the ban was 6542. Percent reduction in tobacco advertisements around all MPACT Colleges was 8.6%.

Aim 3: Percent reduction in tobacco advertisement types around colleges and universities after the 2000Ft ban

The tobacco advertisement types before and after the ban are presented below (Table 4, 5, and 6). The percentage reduction for each advertisement type are also provided (Table 7). A graph of the advertisement types before and after the ban of the ROST around the colleges are also presented (Figure 1).

Table 4: Total Number of Tobacco Advertisements by Location before and after the 2000ft Ban of Retail outlets that sell tobacco around the M-PACT Colleges (n=151 ROST; n=7155 ads)

All Colleges (n=22)	Indoor		Outdoor		Total	
	Before	After	Before	After	Before	After
All Colleges (22)	6711	6145	444	397	7155	6542
2-Yr Colleges (12)	2439	2203	125	119	2564	2322
4-Yr Universities (10)	4272	3942	319	278	4591	4220

Table 5: Total Number of Tobacco Advertisements by Tobacco Type before and after the 2000ft Ban of Retail outlets that sell tobacco around the M-PACT Colleges (n=151 ROST; n=7155 ads)

All Colleges (n=22)	Cigarette		E-Cigarette		Smokeless		Cigar	
	Before	After	Before	After	Before	After	Before	After
All Colleges (22)	4740	4353	506	456	982	909	927	824
2-Yr Colleges (12)	1665	1532	165	144	353	332	381	314
4-Yr Universities (10)	3075	2821	341	312	629	577	546	510

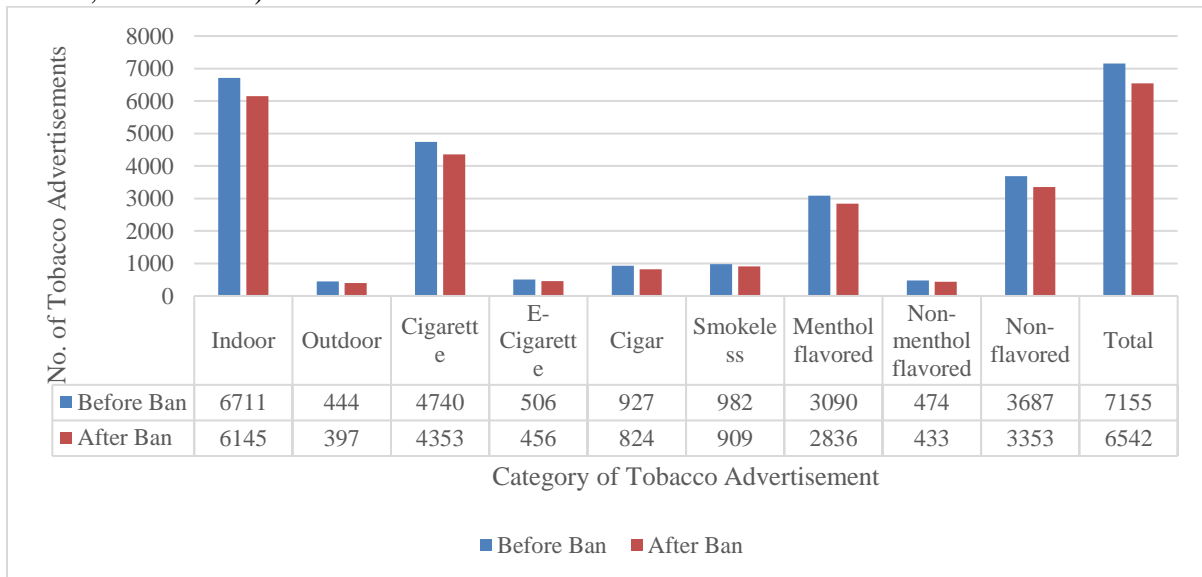
Table 6: Total Number of Tobacco Advertisements by Tobacco Flavor before and after the 2000ft Ban of Retail outlets that sell tobacco around the M-PACT Colleges (n=151 ROST; n= 7155 ads)

All Colleges (n=22)	Menthol		Flavored Non-Menthol		Non-flavored	
	Before	After	Before	After	Before	After
All Colleges (22)	3090	2836	474	433	3687	3353
2-Yr Colleges (12)	1024	948	175	154	1383	1242
4-Yr Universities (10)	2066	1888	299	279	2304	2111

Table 7: Percentage Reduction in Tobacco Advertisement Types after the 2000ft Ban of Retail outlets that sell tobacco around the M-PACT Colleges (n=151 ROST)

	2-Yr Colleges	4-Yr Universities
Advertisement Type	% Reduction	% Reduction
Total	9.4	8.1
Indoor	9.7	7.7
Outdoor	4.8	12.9
Cigarette	8.0	8.3
E-Cigarette	12.7	8.5
Smokeless	5.9	8.3
Cigar	17.6	6.6
Menthol	7.4	8.6
Flavored Non-Menthol	12.0	6.7
Non-Flavored	10.2	8.4

Figure 1: Number of Tobacco Advertisements by Location, Type and Flavor before and after the 2000ft Ban of Retail outlets that sell tobacco around the M-PACT Colleges (n=151 ROST; n=7155 ads)



Aim 4: Percentage reduction in tobacco advertisements after removal of ROST within 500ft of other ROST

The total number of tobacco advertisements in the 151 ROST before the implementation of the 500ft outlet ban is 7155. Thirty-five of these ROST were within 500ft of other ROST and were removed on the ArcGIS platform. The ROST were removed in reference to the colleges i.e. the ROST closest to a college was removed whenever two outlets were within 500ft of each other. The total number of advertisements in the remaining 116 ROST was 5411. The percent reduction was 24.4%.

DISCUSSION

Our study found that retail outlets that sell tobacco within 2000ft of the colleges had a slightly higher mean of advertisements in comparison to those located 2000ft – 4000ft of the colleges, though the difference was not statistically significant. ROST within 2000ft of the 4-yr universities also carried marginally higher number of advertisements in comparison to ROST located 2000ft – 4000ft of the 4-yr universities. We also found that restriction of tobacco advertisements within 2000ft of colleges, as a place-based tobacco-use prevention policy would lead to a reduction in the number of tobacco advertisements that young adults encounter near their colleges. Implementation of a 500ft ban of ROST within other ROST around the colleges would also lead to a reduction in the potential number of tobacco advertisements that young adults in colleges are exposed to. Nonetheless, it leads to less reduction in the number of tobacco advertisements when compared to the 2000ft ban of tobacco advertising around colleges. Several studies have suggested implementing place-based strategies as a way to control tobacco use among youth. This study is the first study to

examine the actual impact such policies will have on the number of tobacco advertisements that youth are exposed to on a near daily basis.

The mean number of advertisements at ROST within 2000ft of the colleges were higher than that at ROST located 2000ft – 4000ft of the colleges, though the difference was not statistically significant. Other studies have reported similar marketing activities of tobacco companies targeting young adults^{54,154,169}. A poll conducted among 2880 college and non-college attending young adults show that 73% of college students encounter tobacco advertisements one or more times per week at the retail environment in comparison to 51% overall⁵⁴. The point-of-sale around colleges have been reported as the most common location where college students encounter tobacco marketing¹⁷⁰. A study conducted among 11 college communities in North Carolina and Virginia showed that indoor and outdoor e-cigarette advertising at retail outlets that sell tobacco increased from 12.7% to 50.6% and from 7.6% to 22.8% respectively at retail outlets that sell tobacco between 2012 and 2013¹⁷¹.

Implementing the 2000ft ban led to an 8.6% reduction in the number of tobacco advertisements across all colleges and universities. To our knowledge, no other study has examined the influence such place based tobacco prevention policy could have on the number of advertisements or retail outlets that sell tobacco around colleges. Most of the tobacco control efforts at colleges have focused on addressing individual behaviors and prohibiting smoking within the campus itself. Over 2469 campuses in the US have adopted 100% smoke-free campus policies as of October 2019¹⁷². However, the immediate environment from the campus have abundant tobacco marketing outlets and advertisements that influence the tobacco use behavior of these young adults^{54,173,174}, offsetting the gains

from prevention policies within the campuses themselves. College age adults are the youngest audience to which the tobacco companies can legally market their products. Many states are beginning to raise the legal age of smoking from 18 to 21. The legal sale age for tobacco in 18 states including Texas is now 21 as of September 2019¹⁷⁵. With these age-limit increase, it is reasonable to address tobacco advertising around these colleges, which provides unwanted cues and easy access to young adults that may be striving to quit smoking.

While implementation of the 2000ft ban led to an 8.6% reduction in the number of tobacco advertisements, the 500ft outlet ban led to a 24.4% reduction in tobacco advertisements. The 500ft outlet ban also affected more retail outlets that sell tobacco than the 2000ft advertising ban (35 verses 15). This finding suggests that the 500ft outlet ban may be more effective in reducing the number of tobacco advertising to which college students are exposed. There was a wide-ranging percentage reduction in the advertisement types with the implementation of the 2000ft advertisement ban. The reduction ranged from 4.8% (outdoor) to 17.6% (Cigar) for colleges and from 6.6% (Cigar) to 12.9% (outdoor) for Universities. Often, tobacco companies target young adults through aggressive price promotions at these point-of-sale outlets¹⁵¹. Young adults are known to be sensitive to these prices and sometimes make impulse purchases when they are offered discounts and attractive prices for these products¹⁵¹. In addition, they are also vulnerable as ‘emerging adults’ and are likely to engage in risk behaviors in search of self-identity and wide-ranging experiences before they settle into full adulthood roles^{80,82}. Therefore, both the 2000ft ban of ROST

around colleges and the 500ft ban of ROST around other ROST could help reduce the persuasive effects of these advertisements around their colleges.

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JOURNAL ARTICLE 3

The Impact of Restricting Tobacco Sales in Retail Outlets around Middle and High Schools across Major Metropolitan Areas of Texas on Tobacco Retail Marketing Disparity

Proposed Journal: Journal of School Health

Following the ban of cigarette advertisements on TV, radio, billboards, and transit ads and with cartoon characters and brand-sponsored youth focused events¹, retail locations are now the primary channel of advertisements for tobacco companies. Low socioeconomic (SES) and racially and ethnically diverse neighborhoods have become the target of tobacco companies where tobacco companies intensively market their products^{2,3}. There are disparities in the number and location of retail outlets that sell tobacco in these areas where residents are subjected to a disproportionate number of marketing campaigns⁴⁻⁶. In their study conducted in Erie County in New York, Hyland and colleagues reported a higher number of retailers on roadways in the lowest income quartile compared to the highest quartile⁴. A similar pattern was also observed by race where the quartile with the highest number of African Americans had a higher number of retailers⁴. Research conducted at the tract level in New Jersey show that tracts with lower median household income and greater percentage of African-American or Hispanic residents had a higher density of tobacco outlets⁷. A nationwide assessment of all 64,909 census tracts in the continental US indicate that higher tobacco outlet density was associated with greater proportions of Blacks, Hispanics and women with lower education level⁶. This disparity in retail tobacco marketing is also observed in school neighborhoods. A 2005-2006 study conducted among 156 schools

in California shows that the percentage of menthol advertising increased by 5.9 percentage point for every 10 percentage increase in the proportion of Black students⁸.

Documents obtained from tobacco companies show that they target convenience stores, grocery stores and other vendors near schools and playgrounds in marketing of their products^{9,10}. Tobacco companies also provide more advertisements and display spots for their products in stores where adolescents visit often¹¹. Approximately 64% of US adolescents report seeing cigarette advertisements all or most of the time when they visit convenience stores, supermarkets and gas stations¹². The closer retailers were to public schools, the greater the probability of displaying exterior advertisements¹³. This directly affects young people as studies have shown that students who attend schools located in neighborhoods with a high density of tobacco outlets were more likely to be smokers and more likely to make purchase attempts as well¹⁴.

This excessive marketing and exposure to tobacco products contributes to unequal tobacco use by SES and race/ethnicity. A nationally representative study reported that 26.3% of individuals below the poverty line in comparison to 15.2% of those at or above the poverty line smoked cigarettes in 2014¹⁵. While only 10% of college graduates and 12% of people with annual income of \$100,000 used some forms of tobacco, about 32% of adults with only a high school degree and who earned less than \$20,000 per year did¹⁶.

Youth are particularly vulnerable to tobacco advertising as it shapes their attitudes and encourages tobacco initiation¹⁷. Specifically, exposure to point of sale tobacco promotion has been positively linked to increased smoking by two different systematic reviews^{17,18}. A school-based longitudinal study of adolescents (ages 11-14years) who had never smoked

show that incidence of initiation was 29% among those who visited convenience, liquor or small grocery at least twice a week and only 9% among those that visited less than twice per month¹⁹. The odds of initiation were more than double for the former in comparison to the latter, even after adjusting for multiple risk factors¹⁹. Students attending high schools in neighborhoods with highest tobacco retail outlet density reported higher current smoking prevalence in 2006²⁰. In another study in 2008 there was also a positive association between retail outlet density and the number of cigarettes consumed by secondary school students in the previous seven days²¹. Data from a national youth tobacco survey indicate that current use of any tobacco product was higher for Hispanic (9.5%) compared to non-Hispanic Whites (6.6%) and Black (6.8%) among Middle school students in 2018²².

One of the proposed policy solutions to eradicate disparities in the location and marketing of retail outlets that sell tobacco is to ban the sales of tobacco in retail outlets that sell tobacco within 1000ft of schools. The FDA has requested for public comments and research on the ban of any outdoor cigarette or smokeless ads within 1000 feet of schools or playgrounds²³. State and local government are not preempted from enacting additional tobacco control measures as the statutory scheme “reserves regulation at the manufacturing stage exclusively to the federal government, but allows states and localities to continue to regulate sales and other consumer-related aspects of the industry in the absence of conflicting federal regulation”²⁴. In addition, the FCLAA has made provision for state and local governments to impose “specific bans or restrictions on the time, place, and manner, but not content, of the advertising or promotion of any cigarettes” that are “based on smoking and health”²⁵. A few studies have examined the impact of the proposed ban on the density of

outlets in some States^{26,27}. Some localities and States have been able to restrict the proximity of retail outlets that sell tobacco around schools²³. The City of New Orleans successfully restricted the sale of tobacco within 300Ft radius of schools and playgrounds in 2009²⁸. In 2010, the Santa Clara County in California passed an ordinance that banned tobacco retailers from opening new stores within 1000Ft of schools and 500Ft of other outlets²⁹. An ordinance banning sale of flavored products, including menthol within 500Ft of Schools were passed in Chicago in 2013 and in Berkeley, California in 2015^{30,31}.

This study is a secondary data analysis and it utilized objective measures of tobacco advertisements and price promotions at retail outlets that sell tobacco data (convenience stores and gas stations) within a half mile (2640ft) of public and charter schools that participated in the Texas Adolescent Tobacco and Marketing Surveillance Study to examine for disparity in tobacco retail marketing by the school enrollment (percentage enrollment of Black, White, Hispanic and economically disadvantaged students). Specifically, the aims for paper 3 include:

- i. Provide summary statistics on the number of tobacco advertisements surrounding the public and charter schools that participated in TATAMS after categorizing them into two roughly equal groups of higher or lower percentage enrollment of a) Black, b) White, c) Hispanic, and d) Economically disadvantaged students, using their respective medians as cut-points.
- ii. Determine if the mean number of tobacco advertisements were significantly different for the groups obtained in aim 1 by the categories of percentage

enrollment of a) Black, b) White, c) Hispanic, and d) Economically disadvantaged students.

- iii. Determine if the mean number of tobacco advertisements were significantly different for the groups obtained in aim 1 by the categories of percentage enrollment of a) Black, b) White, c) Hispanic and d) Economically disadvantaged students after implementation of the ban of the sale of tobacco products at retail outlets that sell tobacco within 1000ft of the schools.

Hypothesis

We hypothesized that schools with a higher percentage of enrollment of Black students, Hispanic students or economically disadvantaged students will be exposed to more tobacco advertisements, compared to those with lower percentage of enrollment for any of the 3 categories. Schools with a higher enrollment percentage of White students will be exposed to less tobacco advertisements, compared to those with higher percentage enrollment of White students. With the implementation of the 1000ft ban of tobacco advertisements around schools, the disparity in tobacco retail marketing by Race (percentage enrollment of Black and White students), Ethnicity (percentage enrollment of Hispanic students) and SES (percentage enrollment of economically disadvantaged students) will be reduced.

METHODS

Study Design and Setting

Secondary data analyses were conducted, utilizing objective tobacco retail outlet (convenience stores and gas stations) advertisement and price promotion data collected

within a half mile (2640ft) of public and charter schools that participated in the Texas Adolescent Tobacco and Marketing Surveillance System (TATAMS) and enrollment data (percentage enrollment of Black, White, Hispanic and Economically disadvantaged students) of the schools. TATAMS is a longitudinal surveillance study designed to examine impact of tobacco marketing on tobacco use behaviors among adolescents attending public, charter and private schools in the 4 largest Metropolitan areas (Houston, Dallas/Fort Worth, San Antonio, and Austin) in 5 counties (Bexar, Dallas, Harris, Tarrant and Travis) in Texas³². The design of the TATAMS study is described elsewhere³². Seventy-nine schools were recruited at the first wave of TATAMS and data collection took place between October 2014 and June 2015. The addresses of the retail outlets that sell tobacco (ROST) were obtained from the Comptroller's Office in 2014 and all of these outlets audited from January to April 2017 (i.e., a census sample). The audit included 261 stores: 89 (42.6%) were located in Austin, 65(31.1%) in Houston, 31(14.8%) in Dallas and 24 (11.5%) in San Antonio. The store types originally included beer, wine and liquor stores, discount stores, drug/pharmacy stores, grocery stores, tobacco, vape or smoke shops, and convenience stores with or without gas stations.

Our study included only tobacco advertisement data from convenience stores and gas stations audited around the public and charter schools that participated in the TATAMS study. Convenience stores and gas stations were selected because of the feasibility of implementing such ban in these stores. In addition, they contained most of the advertisements. Public and Charter schools were selected because their enrollment data was available from the Texas Education Agency (TEA).

Available Data

At each retail outlet that sold tobacco (ROST), data collectors documented information on store types, sale of tobacco products, indoor regular advertisements for all product types (cigarettes, cigars, cigarillos, smokeless tobacco, and e-cigarettes), outdoor regular advertisements for all product types, menthol indoor advertisements for all product types, e-cigarette flavored indoor advertisements, cigarillo flavored indoor advertisements, cigarillo menthol indoor advertisements, outdoor brands of tobacco products advertisements, indoor and outdoor tobacco promotions. All advertisement and price promotion data were included in this study and collectively referred to as advertisements. The percentage enrollment of Black students, White students, Hispanic students and economically disadvantaged students for public and charter schools (2014 – 2015) that participated in the TATAMS study were obtained from TEA 2014-2015 Sampling frame data.

Measures

First, all cigar and cigarillo related advertisements were combined to obtain a single cigar category. The documented advertisements and price promotions in each of the ROST were grouped by location of the advertisement (outdoor and indoor), by tobacco product (cigarettes, cigar products, smokeless tobacco, and e-cigarettes), and by flavor (unflavored, menthol, and flavored non-menthol). Then, these were summed to obtain the following 10 advertisement variables for each ROST: i)total number of outdoor advertisements, ii)total number of indoor advertisements, iii)total number of cigarette advertisements, iv)total number of e-cigarette advertisements, v)total number of cigar advertisements, vi)total

number of smokeless tobacco advertisements, vii) total number of menthol flavored tobacco product advertisements, viii) total number of non-menthol flavored tobacco product advertisements, ix) total number of non-flavored tobacco product advertisements and x) total number of all tobacco product advertisements.

The median for the percentage enrollment of i) Black students ii) White students iii) Hispanic students and iv) Economically disadvantaged students were obtained and used as a cut-point. The schools were grouped into a) $>$ median enrollment percentage or b) \leq median enrollment percentage for each of the 4 enrollment variables.

Data Analysis

Geocoding

The first step of data analysis involved geocoding schools and retail outlets that sell tobacco. The TIGER/Line Shape files for counties were obtained from the U.S. Census Bureau department of Commerce public file³³ and imported into ArcMap vs 10.2.2. Address locators for the addresses (both school and retail outlets) were created using ArcMap vs 10.2.2. An address locator essentially turns the textual descriptions of the addresses into geographic features. State plane projected coordinate system was used. Schools and ROST were mapped as point features. In order to accommodate the distance between the school centroid and boundary, an 1150ft buffer was created around the school point address instead. These 1150ft buffer distance essentially represents an approximate 1000ft ban and have been utilized in previous studies³⁴. Retail outlets that sell tobacco were overlaid over the school map for each county.

ROST were assigned to the schools around which they were audited. The 10 advertisement variables at each ROST were summed within the schools they were assigned. Each school was placed in one of the two groups: $>$ median or \leq median percentage enrollment for each of the 4 respective enrollment variables.

Aim 1: Reporting of summary statistics for the advertisements

The number and mean of the 10 advertisements measures before and after implementation of the 1000ft ban of ROST around the schools were obtained and reported for the school enrollment groups (Table 1 to 3). The mean number of the advertisements before and after the 1000ft ban were also illustrated for the school enrollment groups using graphs (Figure 1 to 4).

Aim 2 and 3: Evaluation of significant difference in the mean number of advertisements

Significant difference between the mean number of advertisements for the school enrollment groups were evaluated using the Independent Two Sample T-Test (t-test)³⁵. The Independent t-test is a parametric statistical technique used to analyze differences in the mean between 2 independent groups. In our case, the groups were schools above the median of the percentage enrollment of the variable of interest verses schools at or below the percentage enrollment of the variable of interest. Type I error rate of 0.05 was utilized. Therefore, we have 4 tests evaluating the mean by percentage enrollment for Blacks, Whites, Hispanics and Economically disadvantaged students before the ban and another 4 tests after the ban. The assumptions of Independence of observations, normality (using Shapiro-Wilks test), and equality of variance (using Levene's test) were verified before the test^{35,36}. The

non-parametric Mann-Whitney U Test³⁷ was used in conducting the mean difference test for the advertisement variables where the assumptions were violated. The Mann-Whitney U Test compares differences between two independent groups when the dependent variable is continuous, but not normally distributed.

Human Subjects

This study uses addresses of schools that participated in the TATAMS study. The percentage of enrolled Black, Hispanic and economically disadvantaged students were obtained from TEA 2014 – 2015 Sampling frame data. The TATAMS study was approved by the University of Texas Health Science Center's Institutional Review Board (HSC-SPH-13-0377). Publicly available addresses of the outlets were obtained from the Texas Comptroller's office. The protocol of this dissertation was reviewed and approved (exempt category, HSC-SPH-19-0313) by the University of Texas Health Science Center's Committee for Protection of Human Subjects.

RESULTS

Sample characteristics

One hundred and three ROST (convenience stores and gas stations) were audited around 42 public and charter schools and were utilized in this study. Forty-four (42.7%) of these ROST were in Austin, 16 (15.5%) were in Dallas, 24 (23.3%) were in Houston while 19 (18.5%) were in San Antonio. After removal of ROST within 1000ft of the school, we had 85 ROST left. Fifteen (35.7%) of the public and charter schools were in Austin, 9 (21.4%) were in Dallas, 12 (28.6%) were in Houston, while 6 (14.3%) were in San Antonio.

Aim 1: Summary statistics for tobacco advertisements around public and charter schools by percentage enrollment of Black, White, Hispanic and economically disadvantaged students.

The number and mean of the tobacco advertisements in each of the school enrollment categories before and after the 1000ft ban are presented below (Table 1 to 3). The median percentage enrollment for non-Hispanic Blacks, non-Hispanic White, Hispanic and economically disadvantaged students is 10.5, 11.5, 69 and 72.5 percent respectively.

Table 1: Number and mean of Tobacco Advertisements by Location and School Enrollment before and after the 1000ft Ban of Tobacco Advertisements around the TATAMS Schools (n=42 schools; n=103 ROST; n=5256 ads)

% Enrollment (no. of schools)	Indoor		Outdoor		Total	
	Before	After	Before	After	Before	After
% Black						
≤ the median (24)	3021 (125.9)	2193 (91.4)	160 (6.7)	136 (5.7)	3181 (132.5)	2329 (97.0)
> the median (18)	1988 (110.4)	1768 (98.2)	87 (4.8)	81 (4.5)	2075 (115.3)	1849 (102.7)
% White						
≤ the median (25)	3658 (146.3)	3181 (127.2)	163 (6.5)	155 (6.2)	3821 (152.8)	3336 (133.4)
> the median (17)	1351 (79.5)	780 (45.9)	84 (4.9)	62 (3.6)	1435 (84.4)	842 (49.5)
% Hispanic						
≤ the median (21)	1609 (76.6)	1319 (62.8)	66 (3.1)	58 (2.8)	1675 (79.8)	1377 (65.6)
> the median (21)	3400 (161.9)	2642 (125.8)	181 (8.6)	159 (7.6)	3581 (170.5)	2801 (133.4)
% Disadvantaged						
≤ the median (21)	1795 (85.5)	1205 (57.4)	92 (4.4)	69 (3.3)	1887 (89.9)	1274 (60.7)
> the median (21)	3214 (153)	2756 (131.2)	155 (7.4)	148 (7.0)	3369 (160.4)	2904 (138.3)

Table 2: Number and mean of Tobacco Advertisements by Types and School Enrollment before and after the 1000ft Ban of Tobacco Advertisements around the TATAMS Schools (n=42 schools; n=103 ROST; n=5256 ads)

% Enrollment (no. of schools)	Cigarette		E-cigarette		Cigar		Smokeless	
	Before	After	Before	After	Before	After	Before	After
% Black								
≤ the median (24)	1979 (82.5)	1497 (62.4)	266 (11.1)	169 (7.0)	319 (13.3)	228 (9.5)	617 (25.7)	435 (18.1)
> the median (18)	1290 (71.7)	1157 (64.3)	143 (7.9)	119 (6.6)	278 (15.4)	253 (14.1)	364 (20.2)	320 (17.8)
% White								
≤ the median (25)	2412 (96.5)	2131 (85.2)	262 (10.5)	211 (8.4)	476 (19.0)	436 (17.4)	671 (26.8)	558 (22.3)
> the median (17)	857 (50.4)	523 (30.8)	147 (8.6)	77 (4.5)	121 (7.1)	45 (2.6)	310 (18.2)	197 (11.6)
% Hispanic								
≤ the median (21)	1015 (48.3)	838 (39.9)	153 (7.3)	114 (5.4)	178 (8.5)	149 (7.1)	329 (15.7)	276 (13.1)
> the median (21)	2254 (107.3)	1816 (86.5)	256 (12.2)	174 (8.3)	419 (20.0)	332 (15.8)	652 (31.0)	479 (22.8)
% Disadvantaged								
≤ the median (21)	1059 (50.4)	737 (35.1)	213 (10.1)	114 (5.4)	200 (9.5)	136 (6.5)	415 (19.8)	287 (13.7)
> the median (21)	2210 (105.2)	1917 (91.3)	196 (9.3)	174 (8.3)	397 (18.9)	345 (16.4)	566 (27.0)	468 (22.3)

Table 3: Number and mean of Tobacco Advertisements by Flavor and School Enrollment before and after the 1000ft Ban of Tobacco Advertisements around the TATAMS Schools (n=42 schools; n=103 ROST; n=5256 ads)

% Enrollment (no. of schools)	Menthol		Flavored non-Menthol		Non-flavored	
	Before	After	Before	After	Before	After
% Black						
≤ the median (24)	1359 (56.6)	994 (41.4)	160 (7.3)	117 (5.1)	1647 (68.6)	1203 (50.1)
> the median (18)	885 (49.2)	786 (43.7)	103 (6.4)	94 (5.9)	1064 (59.1)	946 (52.6)
% White						
≤ the median (25)	1627 (65.1)	1411 (56.4)	215 (9.3)	191 (8.0)	1972 (78.9)	1726 (69.0)
> the median (17)	617 (36.3)	369 (21.7)	48 (3.2)	20 (1.3)	739 (43.5)	423 (24.9)
% Hispanic						
≤ the median (21)	704 (33.5)	583 (27.8)	66 (3.5)	57 (3.0)	890 (42.4)	724 (34.5)
> the median (21)	1540 (73.3)	1197 (57.0)	197 (10.4)	154 (7.7)	1821 (86.7)	1425 (67.9)
% Disadvantaged						
≤ the median (21)	778 (37.0)	518 (24.7)	100 (5.3)	68 (3.6)	993 (47.3)	672 (32.0)
> the median (21)	1466 (69.8)	1262 (60.1)	163 (8.6)	143 (7.2)	1718 (81.8)	1477 (70.3)

Aim 2: Significant difference in the mean number of tobacco advertisements by percentage enrollment of Black, White, Hispanic and economically disadvantaged students before the ban

Mean difference in tobacco advertisements by Black students' percentage enrollment before the 1000ft ban (\leq median enrollment versus $>$ median enrollment)

After transformation, the assumptions of normality (using Shapiro-Wilks test), equality of variance (using Levene's test) and mean difference (using T-test or Mann-Whitney U Test) were tested and reported (Table 4–7). The advertisement types were normally distributed with the exception of outdoor, e-cigarettes and flavored tobacco advertisements (Column 2, Table 4-7). The variance of all advertisement types was equal for all groups being compared (Column 3, Table 4–7).

There was no statistically significant difference in the mean number of tobacco advertisements, for all measures around schools with higher and lower enrollment of Black students before the ban (Column 4-6, Table 4).

Table 4: Tests of Normality, equality of variance and mean difference for the advertisement variables among Black students before the 1000ft ban (n=42 schools; n=103 ROST; n=5256 ads)

	Normality after transformation (Square Root)	Equality of Variance	Difference in mean (no of schools)		
	Shapiro-Wilk (P-Values)	Levene's (P-Value)	Mean (Std.) ≤ median % enrollment (n=24)	Mean (Std.) > median % enrollment (n=18)	T-test or Mann-Whitney U (P-Value)
Total ads	0.8145	0.2692	132.5 (72.2)	115.3 (100.9)	0.3055
Indoor	0.9379	0.2422	125.9 (68.0)	110.4 (95.5)	0.3209
Outdoor	0.0022	0.4562	6.7 (6.5)	4.8 (8.1)	0.1306
Cigarettes	0.5368	0.1196	82.5 (46.1)	71.7 (68.2)	0.2512
E-Cigarettes	0.0119	0.2996	11.1 (11.4)	7.9 (7.5)	0.5388
Cigars	0.7027	0.9769	13.3 (12.5)	15.4 (12.3)	0.5750
Smokeless	0.6270	0.3386	25.7 (19.0)	20.2 (25.2)	0.2033
Menthol	0.6517	0.1087	56.6 (31.4)	49.2 (49.7)	0.2594
Non-menthol	0.0291	0.6219	7.3 (6.2)	6.4 (5.8)	0.6882
Non-flavored	0.8256	0.4006	68.6 (38.0)	59.1 (47.7)	0.3191

Mean difference in tobacco advertisements by White students' percentage enrollment before the 1000ft ban (≤ median enrollment versus > median enrollment)

The mean number of total advertisement, indoor, cigarettes, cigars, menthol flavored, non-menthol flavored and unflavored tobacco advertisements was significantly lower in schools with a higher enrollment of White students in comparison to schools

with a lower enrollment of White students before the ban (Column 4-6, Table 5). The mean number of outdoor, e-cigarettes and smokeless tobacco advertisements were not significantly different between the two White students' enrollment groups.

Table 5: Tests of normality, equality of variance and mean difference for the advertisement variables among White students before the 1000ft ban (n=42 schools; n=103 ROST; n=5256 ads)

	Normality after transformation (Square Root)	Equality of Variance	Difference in mean number of advertisements (no of schools)		
	Shapiro-Wilk (P-Values)	Levene's (P-Value)	Mean (Std.) for \leq median % enrollment (n=25)	Mean (Std.) for $>$ median % enrollment (n=17)	T-test or Mann-Whitney U (P-Value)
Total ads	0.8145	0.3269	152.8 (94.2)	84.4 (47.3)	0.0070
Indoor	0.9379	0.3109	146.3 (88.3)	79.5 (44.1)	0.0052
Outdoor	0.0022	0.9433	6.5 (7.7)	4.9 (6.5)	0.3972
Cigarettes	0.5368	0.6325	96.5 (60.8)	50.4 (34.3)	0.0040
E-Cigarettes	0.0119	0.0974	10.5 (11.6)	8.6 (6.9)	0.9897
Cigars	0.7027	0.5630	19.0 (13.2)	7.1 (6.3)	0.0006
Smokeless	0.6270	0.0219	26.8 (26.4)	18.2 (11.3)	0.5652
Menthol	0.6517	0.6774	65.1 (44.5)	36.3 (24.0)	0.0127
Non-menthol	0.0291	0.4227	9.3 (6.1)	3.2 (3.3)	0.0015
Non-flavored	0.8256	0.2076	78.9 (46.5)	43.5 (22.6)	0.0054

Mean difference in tobacco advertisements by Hispanic students' percentage enrollment before the 1000ft ban (\leq median enrollment versus $>$ median enrollment)

The mean number of total advertisements, indoor, outdoor, cigarettes, smokeless, cigars, menthol flavored, non-menthol flavored and unflavored tobacco advertisements was significantly higher in schools with a higher enrollment of Hispanic students in comparison to schools with lower enrollment of Hispanic students before the ban (Column 4-6, Table 6). The mean number of e-cigarette advertisement was not significantly different between the two Hispanic students' enrollment groups.

Table 6: Tests of normality, equality of variance and mean difference for the advertisement variables among Hispanic students before the 1000ft ban (n=42 schools; n=103 ROST; n=5256 ads)

	Normality after transformation (Square Root)	Equality of Variance	Difference in mean (no of schools)		
	Shapiro-Wilk (P-Values)	Levene's (P-Value)	Mean (Std.) ≤ median % enrollment (n=21)	Mean (Std.) > median % enrollment (n=21)	T-test or Mann-Whitney U (P-Value)
Total ads	0.8145	0.3869	79.8 (44.1)	170.5 (92.4)	0.0001
Indoor	0.9379	0.4049	76.6 (42.9)	161.9 (86.8)	0.0001
Outdoor	0.0022	0.8408	3.1 (5.3)	8.6 (7.9)	0.0028
Cigarettes	0.5368	0.5634	48.3 (30.2)	107.3 (61.0)	0.0001
E-Cigarettes	0.0119	0.0722	7.3 (6.2)	12.2 (12.3)	0.3046
Cigars	0.7027	0.4276	8.5 (9.1)	20.0 (12.6)	0.0004
Smokeless	0.6270	0.1485	15.7 (12.2)	31.0 (26.5)	0.0437
Menthol	0.6517	0.5880	33.5 (21.0)	73.3 (44.6)	0.0003
Non-menthol	0.0291	0.7458	3.5 (3.7)	10.4 (5.9)	0.0003
Non-flavored	0.8256	0.3038	42.4 (22.8)	86.7 (45.6)	0.0002

Mean difference in tobacco advertisements by economically disadvantaged students' percentage enrollment before the 1000ft ban (≤ median enrollment versus > median enrollment)

The mean number of total advertisements, indoor, cigarettes, cigars, menthol flavored, non-menthol flavored and unflavored tobacco advertisements were significantly higher in schools with higher enrollment of economically disadvantaged students in comparison to schools with lower enrollment of economically disadvantaged students before the ban (Column 4-6, Table 7). The mean number of outdoor, e-cigarettes and smokeless tobacco advertisements were not significantly different between the two groups of economically disadvantaged students' enrollment.

Table 7: Tests of normality, equality of variance and mean difference for the advertisement variables among economically disadvantaged students before the 1000ft ban (n=42 schools; n=103 ROST; n=5256 ads)

	Normality after transformation (Square Root)	Equality of Variance	Difference in mean (no of schools)		
	Shapiro-Wilk (P-Values)	Levene's (P-Value)	Mean (Std.) ≤ median % enrollment (n=21)	Mean (Std.) > median % enrollment (n=21)	T-test or Mann-Whitney U (P-Value)
Total ads	0.8145	0.3677	89.9 (51.1)	160.4 (97.9)	0.0050
Indoor	0.9379	0.3935	85.5 (49.2)	153.0 (91.5)	0.0043
Outdoor	0.0022	0.2440	4.4 (5.4)	7.4 (8.5)	0.2944
Cigarettes	0.5368	0.3522	50.4 (29.5)	105.2 (63.3)	0.0008
E-Cigarettes	0.0119	0.7279	10.1 (10.7)	9.3 (9.3)	0.7901
Cigars	0.7027	0.3385	9.5 (11.3)	18.9 (11.7)	0.0031
Smokeless	0.6270	0.0596	19.8 (13.8)	27.0 (27.5)	0.6433
Menthol	0.6517	0.4469	37.0 (22.2)	69.8 (46.9)	0.0057
Non-menthol	0.0291	0.4202	5.3 (6.2)	8.6 (5.4)	0.0334
Non-flavored	0.8256	0.3550	47.3 (26.6)	81.8 (47.9)	0.0056

Aim 3: Significant differences in the mean number of tobacco advertisements by percentage enrollment of Black, White, Hispanic and economically disadvantaged students after the 1000 ft ban

Mean difference in number of tobacco advertisements by Black students' percentage enrollment after the 1000ft ban (\leq median enrollment versus $>$ median enrollment)

After transformation and implementation of the 1000ft ban of retail outlets that sell tobacco around the schools on the ArcGIS platform, the assumptions of normality (using Shapiro-Wilks test), equality of variance (using Levene's test) and mean difference (using T-test or Mann-Whitney U Test) were tested and reported (Table 4–7). The advertisement types were normally distributed with the exception of outdoor, e-cigarettes, flavored, smokeless and menthol tobacco advertisements (Column 2, Table 8-11). The variance of all advertisement types was equal for all groups being compared (Column 3, Table 8–11).

There was no statistically significant difference in the mean number of all tobacco advertisement measures for schools with higher and lower enrollment of Black students after the ban (Column 4-6, Table 8). However, we see a higher reduction in total tobacco advertisements around schools with lower enrollment of Black students after the ban (Figure 1).

Table 8: Tests of normality, equality of variance and mean difference for the advertisement variables among Black students after the 1000ft ban (n=42 schools; n=103 ROST; n=5256 ads)

	Normality after transformation (Square Root)	Equality of Variance	Difference in mean (no of schools)		
	Shapiro-Wilk (P-Values)	Levene's (P-Value)	Mean (Std.) ≤ median % enrollment (n=24)	Mean (Std.) > median % enrollment (n=18)	T-test or Mann-Whitney U (P-Value)
Total ads	0.0770	0.6405	97.0 (79.9)	102.7 (88.4)	0.7061
Indoor	0.0838	0.6729	91.4 (74.4)	98.2 (83.8)	0.6764
Outdoor	<0.0001	0.8390	5.7 (6.9)	4.5 (7.5)	0.3236
Cigarettes	0.0704	0.9506	62.4 (50.6)	64.3 (60.8)	0.8953
E-Cigarettes	0.0002	0.1640	7.0 (8.4)	6.6 (6.2)	0.7646
Cigars	0.0584	0.8844	9.5 (12.7)	14.1 (12.4)	0.1774
Smokeless	0.0387	0.8453	18.1 (18.6)	17.8 (21.8)	0.8281
Menthol	0.0428	0.8769	41.1 (33.5)	43.7 (43.3)	0.9898
Non-menthol	0.0014	0.8590	5.1 (6.4)	5.9 (5.4)	0.5026
Non-flavored	0.0681	0.4697	50.1 (42.4)	52.6 (42.4)	0.6681

Mean difference in number of tobacco advertisements by White students' percentage enrollment after the 1000ft ban (≤ median enrollment versus > median enrollment)

After the ban, we observed that disparity still existed in the mean number of advertisements between schools with higher and lower enrollment of White students. The difference was still significant for total advertisement, indoor, cigarettes, cigars, menthol-flavored, non-menthol flavored and unflavored tobacco advertisements (Column 4-6, Table 9). There was no difference in the mean number of e-cigarettes and smokeless tobacco advertisements around schools with a higher enrollment of White students in comparison to those with lower enrollment of White students. We observed a higher reduction in total tobacco advertisements among schools with higher enrollment of White students after the ban (Figure 2).

Table 9: Tests of normality, equality of variance and mean difference for the advertisement variables among White students after the 1000ft ban (n=42 schools; n=103 ROST; n=5256 ads)

	Normality after transformation (Square Root)	Equality of Variance	Difference in mean (no of schools)		
	Shapiro-Wilk (P-Values)	Levene's (P-Value)	Mean (Std.) ≤ median % enrollment (n=25)	Mean (Std.) > median % enrollment (n=17)	T-test or Mann-Whitney U (P-Value)
Total ads	0.0770	0.3773	133.4 (85.6)	49.5 (45.2)	0.0001
Indoor	0.0838	0.3799	127.2 (79.7)	45.9 (41.8)	<0.0001
Outdoor	<0.0001	0.9201	6.2 (7.4)	3.6 (6.6)	0.0527
Cigarettes	0.0704	0.3316	85.2 (56.2)	30.8 (31.5)	0.0001
E-Cigarettes	0.0002	0.2961	8.4 (8.3)	4.5 (5.6)	0.1246
Cigars	0.0584	0.0847	17.4 (13.2)	2.6 (3.4)	<0.0001
Smokeless	0.0387	0.4008	22.3 (22.7)	11.6 (12.4)	0.0867
Menthol	0.0428	0.3832	56.4 (39.8)	21.7 (21.7)	0.0010
Non-menthol	0.0014	0.1289	8.0 (6.2)	1.3 (2.1)	0.0003
Non-flavored	0.0681	0.3939	69.0 (43.1)	24.9 (22.1)	<0.0001

Mean difference in number of tobacco advertisements by Hispanic students' percentage enrollment after the 1000ft ban (≤ median enrollment versus > median enrollment)

After the ban, we observed that the disparity in the mean number of advertisements between schools with higher and lower enrollment of Hispanic students reduced some. However, the difference was still statistically significant for total advertisement, indoor, outdoor, cigarettes, cigars, menthol-flavored, non-menthol flavored and unflavored tobacco advertisements (Column 4-6, Table 10). There was no statistically significant difference in the mean of e-cigarettes and smokeless tobacco advertisements around schools with higher enrollment of Hispanic students in comparison to schools with lower enrolment of Hispanic students. We observed a higher reduction in total tobacco advertisements among schools with a higher enrollment of Hispanic students after the ban (Figure 3).

Table 10: Tests of normality, equality of variance and mean difference for the advertisement variables among Hispanic students after the 1000ft ban (n=42 schools; n=103 ROST; n=5256 ads)

	Normality after transformation (Square Root)	Equality of Variance	Difference in mean (no of schools)		
	Shapiro-Wilk (P-Values)	Levene's (P-Value)	Mean(Std.) for \leq median % enrollment (n=21)	Mean(Std.) for $>$ median % enrollment (n=21)	T-test or Mann-Whitney U (P-Value)
Total ads	0.0770	0.2939	65.6 (47.6)	133.4 (96.5)	0.0212
Indoor	0.0838	0.3162	62.8 (46.3)	125.8 (90.2)	0.0231
Outdoor	<0.0001	0.4021	2.8 (5.3)	7.6 (8.0)	0.0079
Cigarettes	0.0704	0.3204	39.9 (31.9)	86.5 (62.7)	0.0131
E-Cigarettes	0.0002	0.1030	5.4 (5.7)	8.3 (8.9)	0.4395
Cigars	0.0584	0.5765	7.1 (9.4)	15.8 (14.2)	0.0161
Smokeless	0.0387	0.1786	13.1 (12.6)	22.8 (24.4)	0.2347
Menthol	0.0428	0.3128	27.8 (21.1)	57.0 (44.6)	0.0167
Non-menthol	0.0014	0.3476	3.0 (3.9)	7.7 (6.7)	0.0180
Non-flavored	0.0681	0.3109	34.5 (25.4)	67.9 (48.7)	0.0260

Mean difference in number of tobacco advertisements by economically disadvantaged students' percentage enrollment after the 1000ft ban (\leq median enrollment versus $>$ median enrollment)

After the ban, we observed that the disparity in the mean number of advertisements between schools with higher and lower enrollment of economically disadvantaged students still existed. The difference was still statistically significant for total advertisement, outdoor, cigarettes, cigars, menthol-flavored, non-menthol flavored and unflavored tobacco advertisements (Table 11). There was no significant difference in the mean number of e-cigarettes and smokeless tobacco advertisements around schools with a higher enrollment of economically disadvantaged students in comparison to schools with a lower enrollment of economically disadvantaged students. The reduction in total tobacco advertisements after the ban seems to be the same for the two groups (Figure 4).

Table 11: Tests of normality, equality of variance and mean difference for the advertisement variables among economically disadvantaged students after the 1000ft ban (n=42 schools; n=103 ROST; n=5256 ads)

	Normality after transformation (Square Root)	Equality of Variance	Difference in mean (no of schools)		
	Shapiro-Wilk (P-Values)	Levene's (P-Value)	Mean (Std.) ≤ median % enrollment (n=21)	Mean (Std.) > median % enrollment (n=21)	T-test or Mann-Whitney U (P-Value)
Total ads	0.0770	0.3081	60.7 (54.3)	138.3 (88.8)	0.0006
Indoor	0.0838	0.2788	57.4 (51.7)	131.2 (82.6)	0.0006
Outdoor	<0.0001	0.3756	3.3 (5.5)	7.0 (8.2)	0.0555
Cigarettes	0.0704	0.4655	35.1 (32.5)	91.3 (58.1)	0.0002
E-Cigarettes	0.0002	0.5363	5.4 (6.3)	8.3 (8.5)	0.3026
Cigars	0.0584	0.4649	6.5 (11.5)	16.4 (12.0)	0.0006
Smokeless	0.0387	0.4013	13.7 (12.9)	22.3 (24.4)	0.2605
Menthol	0.0428	0.5479	24.7 (22.3)	60.1 (41.6)	0.0011
Non-menthol	0.0014	0.4861	3.6 (6.1)	7.2 (5.4)	0.0032
Non-flavored	0.0681	0.2257	32.0 (28.7)	70.3 (44.7)	0.0008

Figure 1: Mean number of Tobacco Advertisements by Percentage Enrollment of Black Students for All Schools before and after the 1000ft Ban (n=42 schools; n=103 ROST; n=5256 ads)

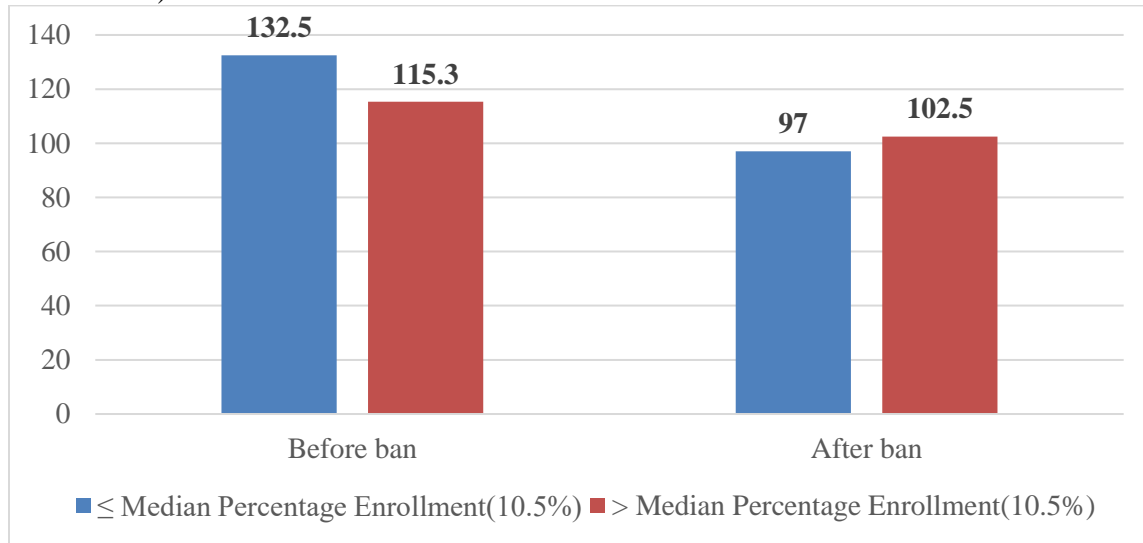


Figure 2: Mean number of Tobacco Advertisements by Percentage Enrollment of White Students for All Schools before and after the 1000ft Ban (n=42 schools; n=103 ROST; n=5256 ads)

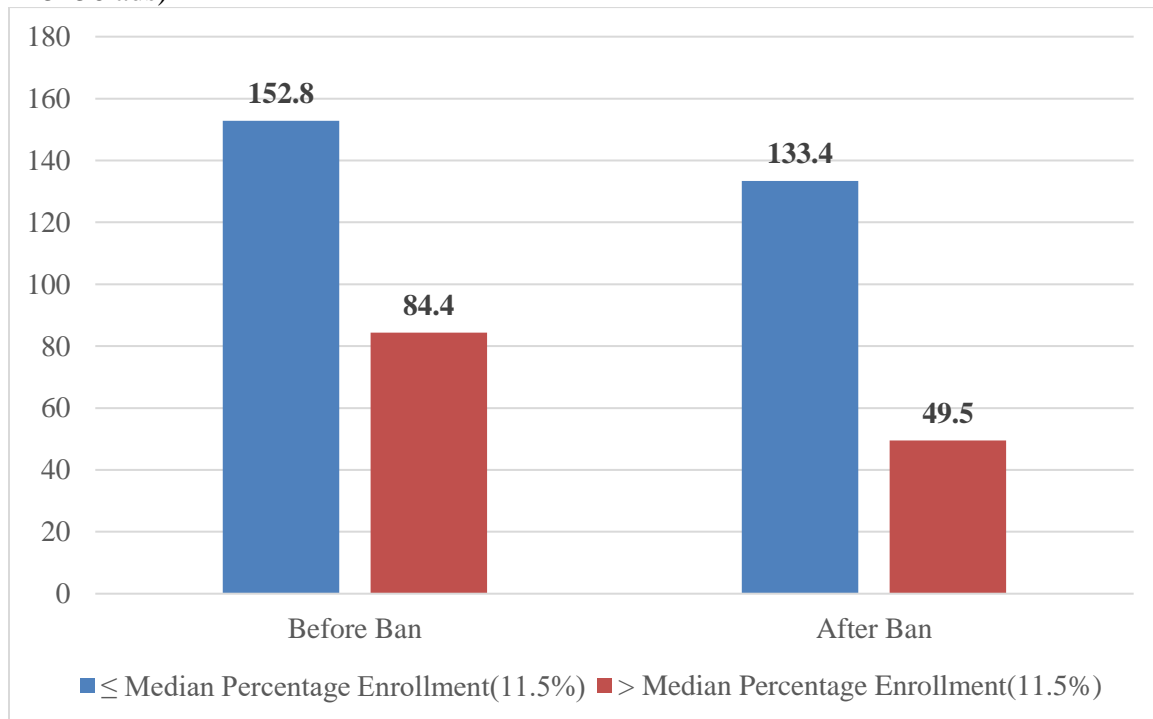


Figure 3: Mean number of Tobacco Advertisements by Percentage Enrollment of Hispanic Students for All Schools before and after the 1000ft Ban (n=42 schools; n=103 ROST; n=5256 ads)

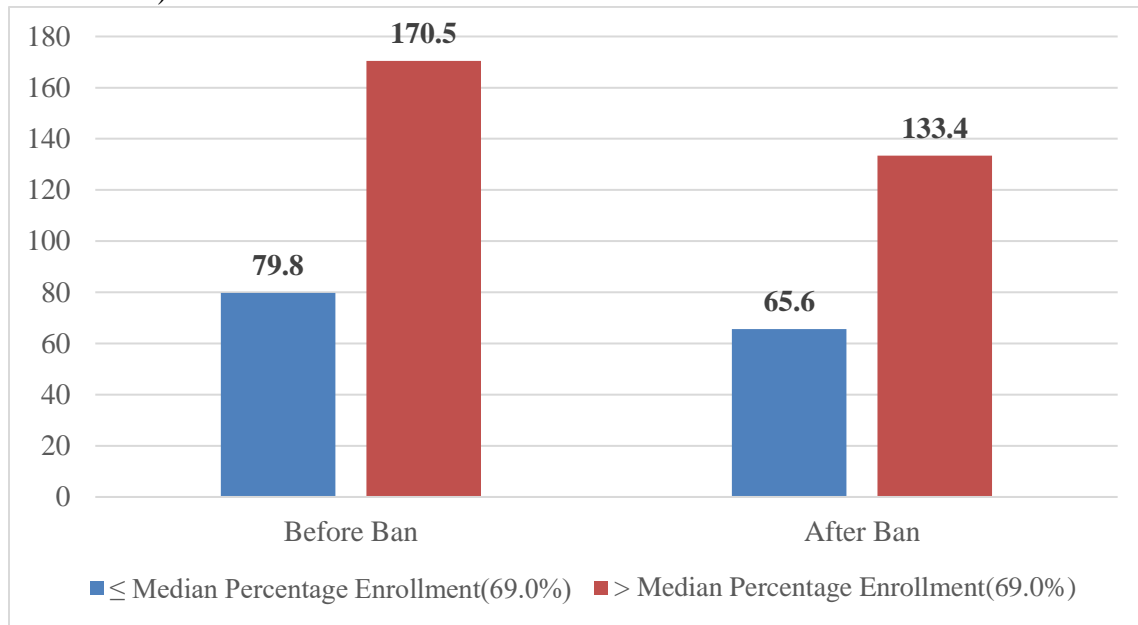
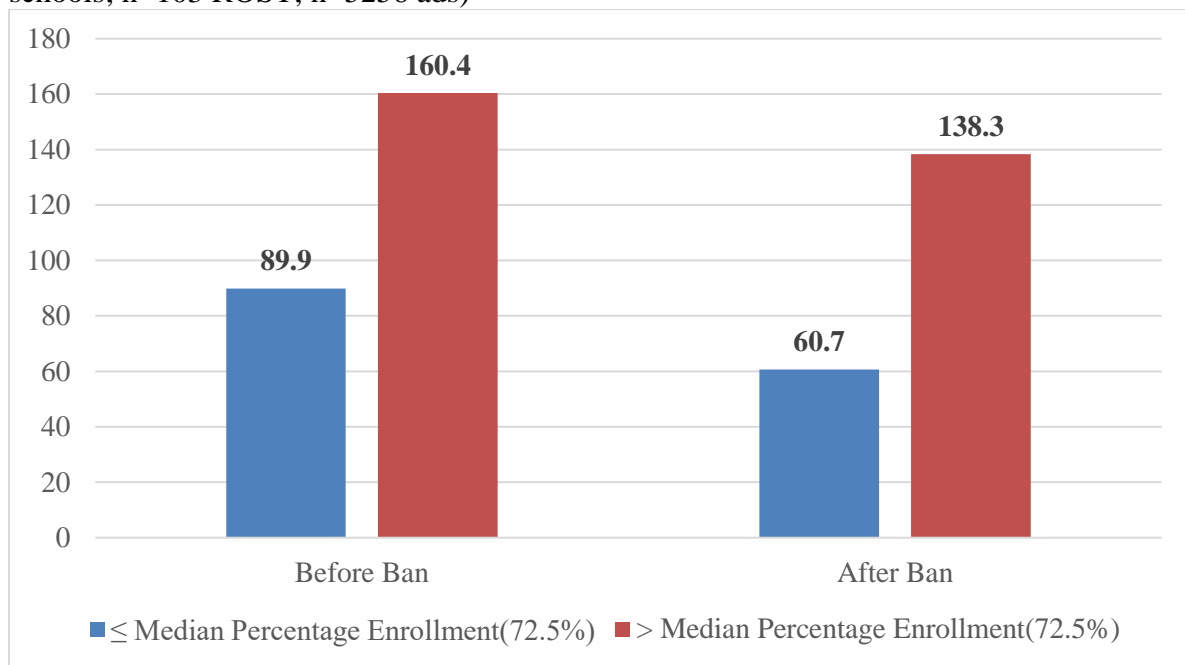


Figure 4: Mean number of Tobacco Advertisements by Percentage Enrollment of Economically Disadvantaged Students for All Schools before and after the 1000ft Ban (n=42 schools; n=103 ROST; n=5256 ads)



DISCUSSION

Our study found that schools with a higher enrollment of Hispanic and economically disadvantaged students have more tobacco advertisements around them in comparison to schools with lower enrollment of Hispanic and economically disadvantaged students. In congruence, schools with a higher enrollment of White students have less tobacco advertisements around them in comparison to schools with a lower enrollment of White students. With implementation of a 1000ft ban of retail outlets that sell tobacco around schools, we observed a small reduction in this disparity in tobacco marketing among Hispanic students. Many studies have suggested that implementation of a 1000ft ban of retail outlets that sell tobacco around schools will help in reducing the unequal tobacco marketing exposures directed at minorities and youth. This study is the first to examine the impact such place-based tobacco-use prevention policy will have on the actual number of tobacco advertisements around these group.

We observed that schools with a higher enrollment of Hispanic and economically disadvantaged students had more tobacco advertisements at retail outlets that sell tobacco around them, while those with higher enrollment of White students had less advertisements around them. Other studies have also documented the disparity in tobacco retailer density. A study conducted by Hyland and colleagues in Erie, New York show as much as 4.0 retailers per 10 km of roadway located in the lowest income quartile, while only 1.2 retailers were present in the highest income quartile⁴. Demographic data from the 2000 census in a Midwestern US county show that census tracts with lower median household income and higher percentage of Latino residents had a greater density of retail outlets that sell tobacco⁵.

Another study conducted in New Jersey in 2004 show that percentage of Hispanics and median household income were most strongly associated with the distribution of retail outlets that sell tobacco³⁸. A nationwide assessment of all 64,909 census tracts in the US in 2012 indicate that retail outlets that sell tobacco are more concentrated in tracts with more Hispanics and other minorities⁶. Our study did not find a greater number of tobacco advertisements around schools with a higher number of Black students. Other research have reported a higher density of retail outlets that sell tobacco in tracts and neighborhoods with a higher number of Blacks^{6,34,38}.

In our study, we observed a slight reduction in the disparity of tobacco marketing based on the enrollment of Hispanic students after implementation of the ban. There was a higher reduction in the number of total tobacco advertisements around schools with higher enrollment of Hispanic students in comparison to schools with lower enrollment of Hispanic students. Some researchers have suggested that a 1000ft ban of retail outlets that sell tobacco around schools could help reduce tobacco-marketing disparities^{26,39}. Some studies have examined the disparity-reducing potential of this tobacco control policy alternative on outlet density³⁴. A study conducted by Ribisl and colleague in 2016 found that the number of retail outlets that sell tobacco per 1000 people reduced from 1.28 to 0.36 in the lowest income quintile, while reducing from 0.84 to 0.45 in the highest income quintile with implementation of the 1000ft ban around schools in New York³⁴. In Missouri, same study found that the number of retail outlets that sell tobacco per 1000 people reduced from 1.18 to 0.82 in the lowest income quintile, while reducing from 0.48 to 0.37 in the highest income quintile³⁴. We

did not observe any reduction in the disparity of tobacco marketing by percentage enrollment of Black, White or economically disadvantaged students.

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CONCLUSION

Principal Findings

This dissertation described the number of tobacco advertisements at retail outlets that sell tobacco in relation to schools and colleges in Texas. Second, we examined the impact of implementing two place-based tobacco control strategies; i) ban on tobacco sales at retail outlets that sell tobacco within 1000ft of schools and 2000ft of colleges and ii) ban on tobacco sales at retail outlets that sell tobacco within 500ft of other tobacco retailers, on the number of advertisements around the schools and colleges. Third, we examined if there was a higher number of tobacco advertisements around schools with a higher enrollment of White, Black, Hispanic or economically disadvantaged students. Fourth, we examined if implementation of the 1000ft advertisement ban around the schools could lead to a reduction in the marketing disparity observed by enrollment of the students.

We found that the mean number of advertisements at ROST closer to the schools (within 1000ft) was significantly higher than those at ROST further away (1001-2000ft) of the schools. More so, the mean number of tobacco advertisements at ROST around middle schools was significantly higher than that further away from the middle schools. We also found that the mean of ROST closer to the colleges (within 2000ft) was slightly higher than those at ROST further away (2000-4000ft).

Implementation of a 1000ft ban of ROST around schools showed a consistently higher reduction in number the tobacco advertisements around middle schools in comparison to the reduction in number of tobacco advertisements around high schools. There was also a wide-ranging variation in the reduction of advertisement types with the least reduction

among outdoor tobacco advertisements and the highest reduction among e-cigarette advertisements. Implementing the 1000ft advertisement ban around the schools affected 15.7% of the ROST and led to an 18.5% reduction in tobacco advertisements, while the 500ft outlet ban led removed 21.5% of the ROST and led to an 18.1% reduction in tobacco advertisements. These findings indicate a greater advertisement-reducing efficacy for the 1000ft ban of ROST around schools in comparison to the 500ft ban of a ROST from another ROST.

We also found that the mean number of tobacco advertisements around schools with a higher enrollment of Hispanic and economically disadvantaged students was significantly higher when compared to schools with lower enrollment of these groups. Correspondingly, the mean number of tobacco advertisements around schools with higher enrollment of White students was significantly lower. Implementing the 1000ft advertisement ban led to a small reduction in the marketing disparity observed by the Hispanic enrollment category.

This study had some limitations. We utilized tobacco advertisements data at convenience stores and gas stations audited within half mile of middle and high schools and within 1 mile of 2- and 4-year colleges that participated in the TATAMS and M-PACT studies respectively. The TATAMS and M-PACT study originally included 79 schools and 24 colleges in the 4 largest Metropolitan areas (Houston, Dallas-Fort Worth, San Antonio and Austin) in 5 counties in Texas (Bexar, Dallas, Harris, Tarrant, and Travis). This means that this study did not include all the advertisements around all schools in all counties in Texas. Therefore, our results may not be generalizable to all counties in Texas or to other counties in other parts of the US. Nevertheless, we believe it is a good representation of the

ROST density and advertisements typically observed around middle and high schools and colleges nationwide. In addition, enrollment data was only available for public and charter schools that participated in the TATAMS study. This further limited the number of schools, retail outlets that sell tobacco and advertisements included in study 3.

Despite these limitations, this study has some strengths. Our study is the first to examine the potential impact of a 1000ft ban on tobacco sales around schools and 500ft ban on tobacco sales around other outlets on the number of advertisements around schools. It is also the first to examine these around colleges. A few studies have only examined the potential impact of such ban on the density of outlets in certain Counties and States in the US. Second, we examined which of the policies (1000ft advertisement ban vs 500ft outlet ban) had more impact in reducing tobacco advertisements. Our study is also the first to examine if ROST closer to the schools (within 100ft) had more advertisements in comparison to ROST further away (1001-2000ft). We also examined if there were more advertisement around schools based on the enrollment of students. The ROST included in this study were extensively audited and include valuable information on the advertisement types, flavor and location as commonly observed around schools and colleges in the US. Therefore, the tobacco advertisements analyzed in this study are representative of the typical advertisements seen in convenience stores and gas stations nationwide.

Tobacco companies may be targeting youths, especially middle school students with more tobacco advertisements, given their vulnerability. They may also be directing more of their tobacco advertisements to racial minorities (Hispanic students in our case) and students of low SES. Implementation of the 1000ft ban of retail outlets that sell tobacco around the

schools led to a reduction in the number of advertisements that these kids are exposed to. The reduction in tobacco advertisements was higher with this tobacco control strategy in comparison to the 500ft ban of a ROST from another ROST, even while affecting less number of ROST. In addition, the 1000ft ban of a ROST around the schools slightly reduced the disparity in tobacco marketing observed around schools with higher enrollment of Hispanic students in comparison to schools with lower enrollment of Hispanic students. Given the efficacy and disparity-reducing potential of these strategy observed in this study, we strongly recommend the implementation of a 1000ft ban of tobacco retail outlets that sell tobacco around middle and high schools in the US.

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