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Cigarette price variation around high schools: evidence from Washington DC

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Abstract

This study examines lowest cigarette prices in all tobacco retail outlets in Washington D.C. ($n=750$) in relation to the type and number of high schools nearby, controlling for confounders. The lowest overall and Newport menthol prices were significantly lower at outlets near public non-charter and charter schools compared with outlets near private schools. Given higher smoking prevalence and more price-sensitive youth subgroups in U.S. public schools, exposure to low prices may contribute to tobacco-related health disparities in minority and low-income populations. Tobacco taxes combined with policies to minimize the increasing use of price as a marketing tool are critical.

Keywords

Tobacco control; Tobacco pricing; Youth tobacco use; Schools; Tobacco industry marketing

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Declaration of Interests

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1. Introduction

Extensive research links lower tobacco prices to higher youth smoking (Chaloupka et al., 2011; U.S. Department of Health and Human Services 2012; Kostova et al., 2011; Kim et al., 2013; Nikaj and Chaloupka 2014). The tobacco industry strategically utilizes price reductions to increase market share (Chaloupka et al., 2002; Tauras et al., 2006) offset the impact of tobacco taxes and policies (Keeler et al., 1996; Slater et al., 2001; Loomis et al., 2006), target cigarette marketing geographically and by user population. (Chaloupka et al., 2002; Miura 2010; Burton et al., 2013).

Price reductions are often implemented at the point-of-sale (POS) through price discounts and promotional allowances to retailers and wholesalers. In 2011, spending on price-related marketing in the U.S. comprised 90% of the tobacco industry's \$8.4 billion advertising budget, a proportion that has increased by 20% since 2002 (Federal Trade Commission 2013). The broad reach of multinational tobacco companies and the ubiquity of POS advertising and price promotions make this issue relevant worldwide (Burton et al., 2013; World Health Organization 2013; Carter 2003).

Despite an increase in research examining the relationship between POS advertising and youth smoking, little research has looked at how cigarette prices are distributed in relation to schools. Low price advertising and availability near schools may encourage youth to purchase cigarettes, particularly among older students who are more likely than younger teens to obtain tobacco from commercial sources (Harrison et al., 2000; Gruber and Zinman 2000; Lipperman-Kreda et al., 2014). Henriksen et al. found lower Newport prices and a higher likelihood of prices being discounted in high school neighborhoods with more African America students (Henriksen et al., 2012). Further, low retail prices near schools have been associated with higher high school smoking prevalence (Lovato et al., 2007; Lovato et al., 2013) and an increased likelihood of youth initiation (Slater et al., 2007). Reduced pricing near schools may be an attractive marketing strategy for the industry, given the large concentration of price-sensitive youth nearby (Lovato et al., 2007; Lovato et al., Feb 2013; Adams et al., Feb 2013).

Marketing of lower-priced cigarettes may also vary by the type of schools in the area. Level of disposable income is an important predictor of adolescent cigarette smoking (Chen et al., 2013; Wen et al., 2009; Wong et al., 2007) While all youth are found to be a price-sensitive population (Kostova et al., 2011; Chaloupka et al., 2002; Salti et al., 2013; Chaloupka and Warner 1999), private school students often come from more privileged backgrounds than public school students (U.S. Department of Education 2011–12a,b). Tobacco companies may be interested in reducing prices nearby public high schools to increase cigarette accessibility for students with less disposable income. The industry may also target by school demographics. With a greater proportion of minority students in U.S. public and public charter schools (U.S. Department of Education 2011–12a,b) and higher price-sensitivity among minority youth (Tauras et al., 2013; Nonnemaker and Farrelly 2011) pricing strategies may differ around these schools compared with private schools (Henriksen et al., 2012).

Given youths' responsiveness to lower prices and increased price sensitivity among certain youth subgroups, tobacco pricing in retail outlets may vary depending on the local school context which in turn may be a driver of health disparities. This study examines whether cigarette prices differ in relation to the number and type of high schools near retail outlets in Washington, D.C.

2. Methods

2.1. Sample

From September 2011 to March 2012, we surveyed all licensed tobacco retail outlets in Washington, D.C. ($n = 1,060$), a mid-sized urban city of the U.S. with a large African American population (U.S. Census Bureau 2012). We excluded outlets that were no longer in business, not open to the public ($n = 212$) or did not sell tobacco ($n = 98$). Trained fieldworkers collected data on the final sample ($n = 750$), examining store exteriors and interiors utilizing a mobile-phone based survey and photos. Store categorization, survey development and reliability assessment are detailed elsewhere (Author 2014; Author 2013; Author 2012; Author2 2014).

2.2. Measures

We created two primary outcome variables: lowest overall displayed pack price and lowest Newport menthol pack price. We chose Newport, a premium brand in the U.S., because it is commonly used among U.S. youth and is the most popular brand among African Americans (Substance Abuse and Mental Health Services Administration 2007).

Lowest overall price was based on data collected on exterior and interior displayed prices. Fieldworkers collected data on lowest advertised exterior price and lowest interior price displayed, including both price advertisements and shelf tags with prices. The lower of the exterior and interior displayed prices was defined as the lowest overall displayed pack price. The brand of the lowest priced product was captured, and coded into premium, discount or both for the analysis. Fieldworkers also collected menthol and discounted price status of the lowest priced product. For Newport menthol prices, fieldworkers collected the lowest price if prices were displayed (including ads or shelf tags); if Newport menthols were available but no prices were displayed, fieldworkers asked retail staff for the lowest pack price. Interrater reliability (Shrout and Fleiss 1979; McGraw and Wong 1996) on price data ranged from 89% (clerk-reported price on Newports) to 100% (exterior low price).

Store addresses were geocoded in ArcGIS (ArcGIS Desktop: Advanced [Computer software] 2012) and linked to U.S. census demographic information, zoning data, and a comprehensive list of Washington D.C. high schools, which include public-non-charter, public charter and private schools (charter schools are considered public in D.C.). The final analytic sample of stores was located within 265 census block groups. Block group census variables were derived from the American Community Survey 2010 (U.S. Census Bureau 2006-2010), including median family income and percentages aged 15–17, 18–29, African American, and Hispanic. We also included a measure for outlet density linked to each store, created using a static bandwidth kernel density estimation (KDE) approach which

extrapolates point data over a study area (i.e., the entire Washington D.C. district) (Kirchner et al., 2014) using a specific bandwidth (Carlos et al., 2010) resulting in a continuous density surface where every location in the assigned study area has a density value (Kirchner et al., 2014). To produce the final density surface in ArcGIS, a Gaussian kernel with an “optimized” fixed 5-mile bandwidth was used (Cromley and McLafferty 2002). The resulting density surface had a cell size of 30 m. We then extracted the density value for each high school utilizing the extraction toolset in ArcGIS.

We obtained zoning and school geographical data (District of Columbia, Office of the Chief Technology Officer 2012) and utilized ArcGIS to merge spatial data on the location of all public non-charter, public charter, and private schools to capture the school environment in 2011–2012. The current study used high schools only, resulting in 45 high schools across the District: 18 public, 13 charter and 14 private high schools. For each retail tobacco outlet, the proximity to the closest high school was calculated and the type of high school noted. We also calculated a count of the total number of schools within each outlet’s 1.0 mile walkable network service area (Pollack et al., 2005; Lee et al., 2003) which ranged from 0 to 11.

2.3. Statistical analysis

Using Stata 13.1 (StataCorp, 2012), we ran linear multilevel regression models with full maximum likelihood estimation with a random intercept at the block group level. All models used robust standard errors, which are reasonably insensitive to the misspecification of variance and covariance at each level and to distributive assumptions (Snijders and Bosker 1999; Raudenbush and Bryk 2002). Outcomes included lowest overall pack price and lowest Newport menthol pack price as a function of closest school type and number of schools in a 1-mile area, census block group factors, zoning designation, store type, store size, and lowest-priced product characteristics. Number of schools in a 1-mile area (range 0–11) was included in the model as continuous (Tabachnick and Fidell 2007). In the overall lowest price model, we included Newport menthol price as a predictor to control for relative prices. Data were not available to control for relative prices in the Newport price model. Neighborhood predictors were centered at their mean, and those that represent percentages were scaled to equate a one-unit increase with an increase of 10 percentage points while population density was scaled to represent an increase of 1,000 residents per square mile. Collinearity diagnostics were conducted with findings indicating high collinearity with models that included both median family income and percentage African American. Since both are important for understanding price differences, we ran all models twice: one set of models included all predictors described above and percentage African American only (model results presented in tables) and another set included all predictors above and median family income (model results described in text). Missing data on individual outlet variables were minimal (1–4%) and listwise deleted.

We provide a visual analysis of findings from the lowest overall pack price model. We mapped the geographic distribution of schools and utilized the Geostatistical Analysts extension toolbar to produce a prediction map of overall lowest pack price using kriging methodology. Kriging produces an estimate of the underlying surface by a weighted average of the data, with weights declining with distance between the point at which the surface is

being estimated and the locations of the data points. Data points, and the associated surface, at nearby locations are assumed to be more similar to each other than points at locations distant from each other. For our prediction map, data points are the spatial locations of schools that have an associated low price. We then chose ordinary kriging using a K-Bessel model to produce the kriged surface. This model tends to produce surfaces that are more smooth locally than other models.

3. Results

Prices for cigarettes were visible on 29% of storefronts and inside 68% of stores. Newport was the brand with the lowest price most commonly displayed on the store exterior; Maverick, a popular discount brand in the U.S. owned by Lorillard, was most commonly displayed on the interior. Ninety-two percent of stores carried Newport menthol cigarettes, and 63% of these stores displayed the Newport price. Ninety-five percent of outlets had a school within a 1-mile radius; and 75% had three schools or more. The lowest exterior price averaged across stores was \$6.51 for the store exterior and \$6.54 for store interior. The lowest overall price (considering both exterior and interior displayed prices) was \$6.47 and the lowest Newport menthol price was \$7.80 (see Table 1). The lowest displayed Newport price was the lowest displayed interior price in only 11% of cases.

There was a strong association between the overall lowest displayed pack price and the nearest high school type (see Table 2). Prices were \$0.26 (95% CI: -0.45, -0.06) lower if the school closest to the outlet was public charter and \$0.30 (95% CI: -0.47, -0.14) lower if public non-charter. The association of price with number of schools within the outlet 1-mile buffer area was positive and significant. None of the neighborhood variables were significant predictors of price in either the model with percentage African American (Table 2) or the model with median family income (data not shown). Results demonstrated a negative relationship between lowest Newport menthol price and type of high school, with prices lower by \$0.28 (95% CI: -\$0.49, -\$0.07) for stores closest to a public charter school and \$0.19 (95% CI: -0.36, -0.02) for those closest to a public non-charter school (see Table 2). The association of price with the number of schools in the area was negative but not significant. The association between lowest Newport price and neighborhood proportion of African Americans was negative and significant, with prices decreasing as minority composition increased (see Table 2). In the model with median family income, this neighborhood variable was positively associated with price and significant (\$0.03, CI: 0.01, 0.05) (data not shown). Figure 1 shows the prediction map of lowest overall price across block groups and school types. The map illustrates lower predicted prices (lighter color) near public non-charter and public charter schools and higher predicted prices (darker color) near private schools.

4. Discussion

This study extends existing research on cigarette pricing in relation to youth and schools. To our knowledge, this study is the first to address the issue of cigarette pricing in relationship to school type. When the closest school was either a charter or non-charter public school, the lowest price overall and the lowest Newport menthol price was significantly lower than if the

closest school was a private school, after controlling for neighborhood sociodemographics, zoning, outlet density and other factors. U.S. public school students are 30% more likely than private school students to have used cigarettes in the past month (Wen et al., 2009). Some studies abroad have shown similar findings (Mathur et al., 2008; Pinto Dda and Ribeiro 2007; Pradhan et al., 2013). Lower prices in outlets near public schools may be a factor influencing greater smoking prevalence among U.S. public school students. With lower prices in closer proximity, public high school students, whether in charter or non-charter schools, may be more likely to attempt to purchase and share cigarettes (Chaloupka 2003), thereby increasing overall cigarette availability among students. With greater minority and low-income students in public and public charter schools in D.C. and nationally (U.S. Department of Education 2011–12a,b) and greater price sensitivity among these groups, pricing variation is a potential source of tobacco-related disparities.

Results on the association of price with the number of schools near the outlet were mixed – with overall lowest price being higher as the number of schools nearby increased, while there was no association with the number of schools nearby and Newport menthol prices. Mixed results are similar to Toomey et al., which found that the number of schools within a 1-mile outlet radius was associated with significantly lower prices of a discount brand, but not with a premium or menthol brand or with overall mean price (Toomey et al., 2009). McCarthy et al. examined price discounting in Victoria, Australia, an area in which price is one of the few remaining marketing strategies for the industry as restrictions on tobacco advertising and promotion have increased over time. Results indicated that price discounting was found more often in milk bars near secondary schools in low SES compared to high SES areas (McCarthy et al., 2011). In post hoc analyses, we examined whether the positive association between number of schools nearby and price varied by low and high SES areas and found no significant differences. It may be the case that lower price marketing near schools is more common in environments where other types of POS marketing are not available.

We did not examine pricing strategies for specific brands other than Newport due to time and cost limitations. Examination of price differences across a variety of brands rather than overall mean low price may yield more precise information on geographic or racially/ethnically targeted pricing strategies by individual tobacco companies for specific brands. We attempted to control for various factors related to local market dynamics that may also influence price, and have adjusted for clustering of stores (and prices) through multilevel modeling with random and fixed effects, but there may be unmeasured area effects. We included a variable to capture relative prices in the model for lowest overall pack price but we did not have such information available to include in the Newport menthol model. We captured single cigarette pack prices only; the influence of any multipack discounts are not reflected in the lowest mean price. Further, price measurements are not validated in the POS literature; however, reliability analyses of the three price outcome measures produced ICCs of 0.89 and above. In addition, the lowest overall price is based on the lowest of either the posted exterior price or any interior displayed prices. Thus the lowest displayed price may overestimate the price of the cheapest pack if prices that were not displayed were consistently lower. However, for Newport menthol, we collected lowest price whether it was displayed or not and the displayed prices were significantly lower than the non-displayed

price. If the same were the case for lowest overall pack price, the lowest pack price would not be overestimated. Study findings may not generalize to other areas, but are likely reflective of other medium to large U.S. urban areas with large minority populations living in segregated neighborhoods.

Lower prices in outlets near public high schools may increase the attractiveness and availability of cigarettes and influence smoking experimentation and initiation among subgroups of youth most responsive to low prices. The tobacco industry has long used pricing strategies to expand market share among price-sensitive groups (Chaloupka et al., 2002), and few countries or localities ban POS advertising or price promotions WHO, (World Health Organization 2013). In countries that have banned POS advertising, price marketing may be increasingly important (Burton et al., 2013; McCarthy et al., 2011; Wakefield et al., 2012). The increase in marketing expenditures for price discounting and promotions in recent years may increase disparities and undermine tobacco tax policies. The 2009 U.S. Family Smoking Prevention and Tobacco Control Act grants state and local governments the authority to enact laws restricting the discounted sale of tobacco products within their jurisdictions (Author1 et al., Family Smoking Prevention and Tobacco Control Act). Tobacco taxes and additional policies to minimize the use of price as a marketing tool (Gilmore et al., 2013) should be considered. Examination of differential pricing is critical for understanding potential environmental sources of tobacco-related disparities..

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Fig. 1. shows the prediction map of lowest overall price across block groups and school types. The map illustrates lower predicted prices (lighter color) near public non-charter and public charter schools and higher predicted prices (darker color) near private schools

Table 1

Descriptive statistics of cigarette advertising and pricing across Washington D.C. tobacco retail outlets.

	% / Mean ^a	SD	Minimum	Maximum
Among stores with displayed pack price (on exterior and/or interior) (n=526)				
Lowest pack price averaged across stores (in \$) ^a	6.47	0.92	3.45	11.00
Lowest pack price is a special price ^a	51%			
Lowest pack price is a discount brand ^a	22%			
Lowest pack price is menthol ^a	54%			
Among stores selling Newport (n = 690)				
Lowest pack price averaged across stores (in \$) ^b	7.80	0.95	5.45	11.65
Pack price was advertised or displayed ^b	63%			
Non-displayed pack price (in \$) (n = 252) ^c	8.33	1.01	6.22	11.65
Advertised or displayed pack price (in \$) (n=430) ^d	7.49	0.76	5.45	10.75

Abbreviations: SD - standard deviation.

^a Among the sample of stores with displayed pack prices on exterior and/or interior.

^b Among the sample of stores selling Newport.

^c Among the sample of stores selling Newport with no displayed prices.

^d Among the sample of stores selling Newport with prices displayed.

Table 2

Regression coefficients (and 95% CI) for lowest pack price regressed on school and store characteristics and neighborhood demographics.

	Lowest displayed pack price (n = 479)		Newport menthol pack price (n = 675)	
	Coef	95% CI	Coef	95% CI
Intercept	2.64 ***	1.96 3.31	8.62 ***	8.32, 8.94
Closest school type ^a				
Public - non-charter	-0.30 ***	-0.47, -0.14	-0.19 *	-0.36, -0.02
Public - charter	-0.26 **	-0.45, -0.06	-0.28 **	-0.49, -0.07
Schools within 1 mile buffer	0.03 *	0.01, 0.06	-0.02	-0.06, 0.01
Lowest price on exterior ^b	-0.12	-0.33, 0.08		
Brand category ^c				
Discount	0.42 ***	0.56, 0.29		
Unspecified or both ^d	-0.23 **	-0.41 -0.05		
Special price status ^e				
Yes	-0.06	-0.20, 0.07		
Both ^f	-0.05	-0.43, 0.33		
Menthol status ^g				
Menthol	0.33 ***	0.21, 0.45		
Both ^h	0.33	-0.08, 0.75		
Lowest Newport menthol price	0.55 ***	0.47, 0.63		
Newport price is displayed ⁱ			-0.50 ***	-0.63, -0.37
Store type ^j				
Gas station	-0.15	-0.33, 0.02	-0.08	-0.28, 0.12
Pharmacy	-0.57 ***	-0.83, -0.31	-0.56 ***	-0.85, -0.27
Grocery store	-0.03	-0.23, 0.16	0.40 ***	0.20, 0.60
Liquor store	-0.04	-0.19, 0.11	0.12	-0.04, 0.29

	Lowest displayed pack price (n = 479)		Newport menthol pack price (n = 675)	
	Coef	95% CI	Coef	95% CI
Other	0.43 ^{***}	0.21, 0.65	0.43 ^{***}	0.25, 0.61
# registers ^k				
3 or more	-0.16	-0.37, 0.04	-0.02	-0.25, 0.22
Zoning ^j				
Residential	0.13	-0.06, 0.31	-0.07	-0.25, 0.11
Mixed use	-0.00	-0.59, 0.59	0.37	-0.15, 0.90
Unzoned	1.54	0.35, 2.73	0.75	-0.72, 2.21
Population density	0.00	-0.01, 0.01	-0.00	-0.01, 0.00
% aged 15-17	0.02	-0.22, 0.26	-0.06	-0.33, 0.21
% aged 18-29	-0.01	-0.06, 0.04	-0.01	-0.06, 0.04
% African American	-0.02	-0.05, 0.01	-0.08 ^{***}	-0.11, -0.06
% Hispanic	-0.03	-0.09, 0.03	-0.04	-0.11, 0.03
Outlet density	-0.01	-0.02, 0.01	0.01	-0.01, 0.03

Abbreviations: Coef. - coefficient; CI - confidence interval

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$.

^aReference category is private school.

^bReference is lowest price on interior or exterior/low price is equivalent.

^cReference is premium.

^dA price could be both discount or elite if the lowest price was on more than one brand and brand types varied.

^eReference is non-special price.

^fA price could be both special and non-special if the lowest price was on more than 1 brand and the special price status differed.

^gReference is non-menthol.

^hA price could be both menthol and non-menthol if the lowest price was on more than 1 brand and menthol status of the brand differed.

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- j Reference is non-displayed Newport price.
- j Reference is convenience store.
- k Reference is > 3 registers.
- j Reference is commercial.