A comparison of three policy approaches for tobacco retailer reduction ☆

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ABSTRACT

Background. The Institute of Medicine recommends that public health agencies restrict the number and regulate the location of tobacco retailers as a means of reducing tobacco use. However, the best policy strategy for tobacco retailer reduction is unknown.

Purpose. The purpose of this study is to test the percent reduction in the number and density of tobacco retailers in North Carolina resulting from three policies: (1) prohibiting sales of tobacco products in pharmacies or stores with a pharmacy counter, (2) restricting sales of tobacco products within 1000 ft of schools, and (3) regulating to 500 ft the minimum allowable distance between tobacco outlets.

Methods. This study uses data from two lists of tobacco retailers gathered in 2012, one at the statewide level, and another "gold standard" three-county list. Retailers near schools were identified using point and parcel boundaries in ArcMap. Python programming language generated a random lottery system to remove retailers within 500 ft of each other. Analyses were conducted in 2014.

Results. A minimum allowable distance policy had the single greatest impact and would reduce density by 22.1% at the state level, or 20.8% at the county level (range 16.6% to 27.9%). Both a pharmacy and near-schools ban together would reduce density by 29.3% at the state level, or 29.7% at the county level (range 26.3 to 35.6%).

Conclusions. The implementation of policies restricting tobacco sales in pharmacies, near schools, and/or in close proximity to another tobacco retailer would substantially reduce the number and density of tobacco retail outlets.

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Background

Tobacco remains the leading cause of preventable death and disability in the United States, resulting in the premature loss of over 480,000 lives and $289 billion in economic costs annually (United States Department of Health and Human Services, Office of the Surgeon General, 2014). Tobacco products are sold in approximately 378,000 locations in the US including convenience stores, gas stations, grocery stores, and pharmacies (Center for Public Health Systems Science, 2014a).

The density of tobacco retail outlets in a defined geographic area (e.g. school catchment area or census tract) is associated with the tobacco use behaviors of the people who live or study in that neighborhood (Henriksen et al., 2008; Scully et al., 2013). One potential mechanism to explain this relationship is that residents of high tobacco retailer density areas have greater physical access to tobacco products, and therefore reduced retrieval costs, which can increase consumption (Schneider et al., 2005). In addition, residents in areas with high retailer density are exposed to more branded advertisements for tobacco products at stores, which can stimulate demand and increase tobacco use (Schneider et al., 2005; Loomis et al., 2012; Robertson et al., 2014; Henriksen et al., 2010). US tobacco companies collectively spend over $7 billion each year marketing and promoting tobacco products in retail outlets (Federal Trade Commission, 2013).

Given this compelling evidence, the Institute of Medicine recommends that public health agencies restrict the number and regulate the location of tobacco retailers as a means of reducing tobacco use (Institute of Medicine of the National Academies, 2007). By implementing policy, systems, and environmental interventions to reduce the number and density of tobacco retail outlets, states and

localities have the potential to mitigate the burden of tobacco and decrease tobacco consumption.

Several policy solutions can reduce the number and density of tobacco retailers (Center for Public Health Systems Science, 2014b). One option is to prohibit the sales of tobacco products in pharmacies or stores with pharmacy counters. The primary function of pharmacies is to dispense medications and provide health care services; however, pharmacies deliver a conflicting message when they also sell tobacco products. The display and availability of tobacco products in what is perceived as a "healthy" store wrongly suggests that tobacco is a safe and acceptable product (Katz, 2008). For these reasons, bans on the sale of tobacco products are supported both by the pharmacy community and the general public (Hudmon et al., 2006; Smith et al., 2012; Kotecki and Hillery, 2002; Farley et al., 2015; Patwardhan et al., 2013; Kroon et al., 2013). In 2014, CVS voluntarily removed tobacco products over 7600 U.S. stores (PR Newswire CVS Caremark, 2014). A second option is to restrict the location of tobacco retail outlets, for example, prohibiting outlets within 1000 ft of schools or other youth serving locations (Center for Public Health Systems Science, 2014b; Luke et al., 2011). The presence of tobacco retailers near schools puts children at particular risk: in school areas with high outlet density, smoking experimentation (McCarthy et al., 2009) and prevalence (Henriksen et al., 2008) are higher, and students are more likely to report buying their own cigarettes rather than getting them from friends or other sources (Leatherdale and Strath, 2007). Finally, a third policy option is to require a minimum distance between outlets, for example, 500 ft. Tobacco outlet density is higher in US communities with lower median household income (Schneider et al., 2005; Hyland et al., 2003; Loomis et al., 2013) or a higher percentage of African American (Schneider et al., 2005; Hyland et al., 2003) or Latino families (Schneider et al., 2005; Hyland et al., 2003). This policy, therefore, may have the potential to reduce tobacco outlet clustering and density in communities where density is already highest, as has been shown from similar policies to restrict the number of alcohol retailers (Livingston et al., 2007; Campbell et al., 2009).

Tobacco control practitioners and policy makers would benefit from an analysis of the potential impact of these three policy solutions. Only one study in New Zealand has assessed the relative effectiveness of various policy solutions for reducing the number and density of tobacco retailers (e.g. 95% reduction in the total number of outlets, permitting sales only at 50% of alcohol outlets, eliminating sales within 1 or 2 km of schools) (Pearson et al., 2015). No study has compared multiple retailer reduction policies in the US context. This study aims to quantify and compare the reduction in the number and density of tobacco retailers in North Carolina resulting from three potential policy solutions: (1) prohibiting sales of tobacco products in pharmacies and stores with pharmacy counters, (2) restricting sales of tobacco products within 1000 ft of schools, and (3) regulating to 500 ft the minimum allowable distance between tobacco retail outlets.

Methods

Identification of tobacco retail outlets

North Carolina does not require retail tobacco outlet licensing, therefore no comprehensive list of retailers was available. Two alternate lists were used: (1) a statewide list based on "malt beverage/off-premise" alcohol retailers that is used by law enforcement to conduct youth access compliance checks for tobacco products (North Carolina Alcohol Beverage Control Commission, 2012) because many stores that sell beer and wine (e.g., supermarkets, gas stations, pharmacies) also sell cigarettes and a (2) three-county, field verified gold standard list created for research purposes described elsewhere (Rose et al., 2013; D'Angelo et al., 2014).

The first, statewide list was retrieved on February 6, 2012 from the North Carolina Alcohol Law Enforcement Agency (ALE) and it contained 7950 stores. The list was formatted for geocoding, and cleaned to remove 373 (4.7%) stores with incomplete or non-geographically-referenced P.O. Box addresses, 134 (1.7%) stores known to not sell tobacco at the time of data collection in 2012

(e.g., Target, but not CVS who abandoned sales in 2014), and 29 duplicates (0.4%), leaving 7414 stores for analysis.

The second, three-county list contained tobacco retailers in Buncombe, Durham, and New Hanover counties, and was generated via neighborhood canvassing as part of the Healthy Stores Healthy Communities study (HSHC) (Rose et al., 2013; D'Angelo et al., 2014). The HSHC list represents a gold-standard true census with field validation and the collection of GPS coordinates for each tobacco retail outlet (eliminating error introduced by geocoding of retail outlet addresses). The HSHC list contained 654 tobacco retail outlets: 218, 231, and 205 each in Buncombe, Durham and New Hanover counties, respectively.

Identification of pharmacies and stores with pharmacy counters

Current bans on tobacco sales in pharmacies apply not only to stand-alone pharmacies but also to retail establishments that operate health care institutions within them, such as a grocery store with a pharmacy counter (Tobacco Control Legal Consortium, 2012). In both lists, stores known to be pharmacies (e.g. CVS, Walgreens) and stores known not to be pharmacies (e.g., Exxon) were coded using SAS version 9.3. Next, two methods were used to determine whether the remaining stores were pharmacies or contained a pharmacy counter. In the HSHC list, online store locators were used to verify whether each store had a pharmacy. The ALE list contained over 1000 stores belonging to supermarket chains (e.g., Wal-Mart and Kroger which sometimes, not always, contain a pharmacy counter), so it was not feasible to determine the status of each store. Instead, online store locators were used to determine the proportion of stores in a supermarket chain that had a pharmacy counter in one large North Carolina city, and that chain-specific percentage was applied to the ALE list.

### Tobacco retail outlet proximity to schools

North Carolina public and private school point location data (latitude/longitude coordinates) were obtained from the National Center for Education Statistics (NCES) and applied to retailers on both lists (National Center for Education Statistics, 2012). For the HSHC counties only, digital countywide parcel (property) boundary data were obtained from county governments. School point locations were overlaid on the parcel data to identify school parcel boundaries, then Google Maps and the parcel owner (e.g. county government) were used to verify point locations and parcel shapes. Given that digital parcel boundary files are not available for every county in North Carolina and it is very time consuming to collect them, only the schools located in HSHC counties were matched to parcel boundaries. Schools in the other 97 NC counties statewide were mapped as points. The average distance from the parcel centroid to the parcel boundary for the three HSHC counties was 611 ft. Using this information, a 1000-foot buffer was generated around school parcel boundaries for the three HSHC counties, and a 1611-foot buffer was generated around school points statewide to accommodate for the average distance from the point location to the parcel boundaries. ArcMap 10.1 (ESRI, Redlands, California) was used for all geospatial analyses.

Tobacco retail outlet proximity to another tobacco retail outlet

ArcMap was used to identify all tobacco retailers within 500 ft of another tobacco retailer. A custom script was written in Python to randomly select one tobacco retailer to be deleted from the list. This process continued iteratively until the list contained zero tobacco retail outlets within 500 ft of another retailer. This random-choice analysis yields different results each time the process is run (see Figs. 1 and 2). Thus, the process was run 1000 times and the mean number of retailers was removed from each list. Further description of these methods is available in the Supplementary material.

Outcome measures

Retailer density was calculated as the number of tobacco retailers per 1000 residents at the county and state level. Population measures were taken from the American Community Survey 2012 5-year estimate. For each of the three policy solutions, outcomes of interest were (a) the number of retailers removed, and (b) the percent reduction in retailer density (which is mathematically the same as the percent of retailers removed).
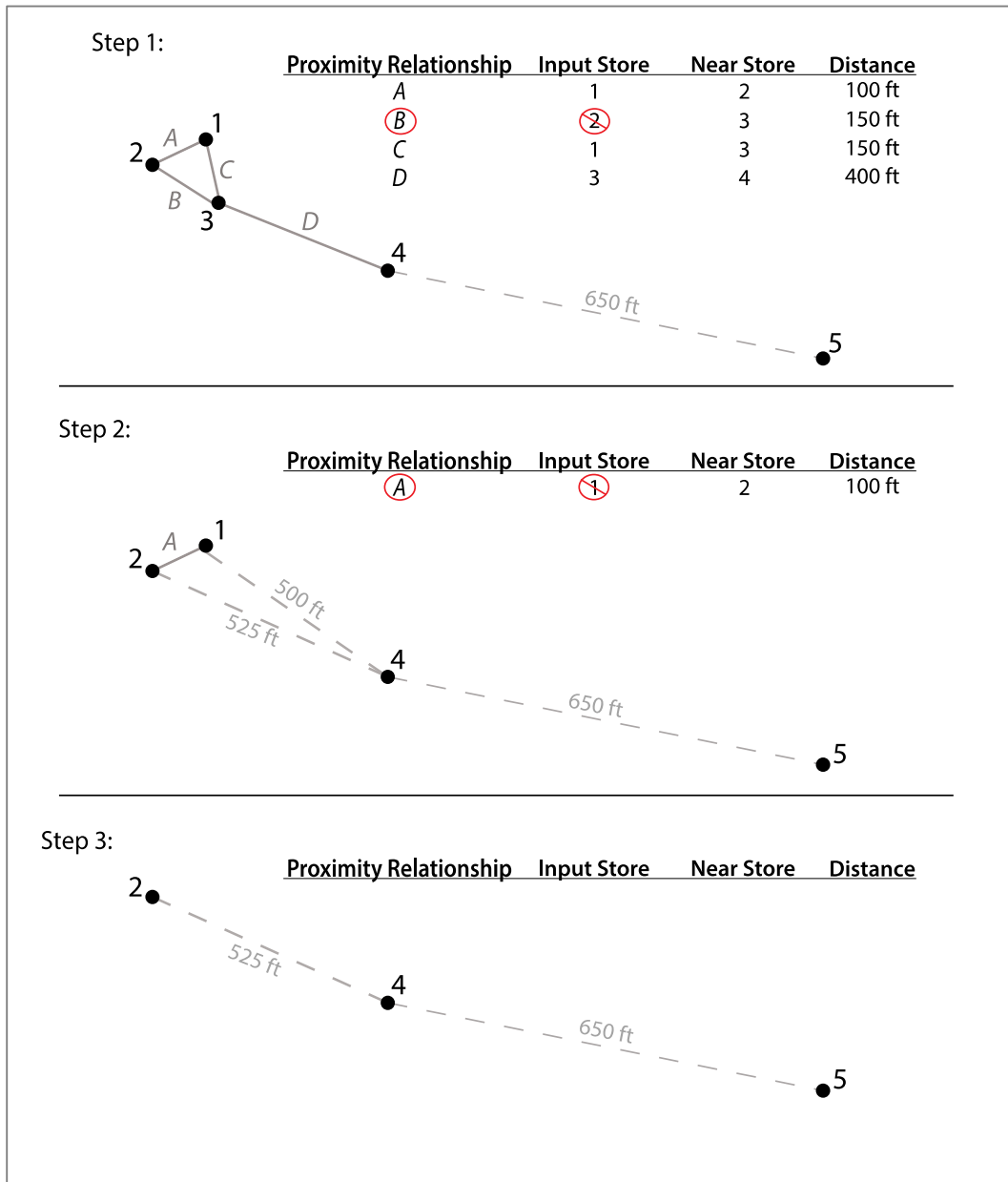
Fig. 1. Scenario 1 of random choice-removal proximity analysis used to compute the impact of a proximity ban. Step 1: A point distance analysis of all tobacco retailer locations within 500 ft of another tobacco retailer is calculated and results in a nearest table of 4 proximity relationships. A proximity relationship is two retailers within 500 ft of each other. Proximity relationship B is randomly selected from the 4 possible relationships. Stores 2 and 3 are in proximity relationship B. Store 3 is randomly selected from the pair to be removed. Step 2: Store 3 is removed from the table and a new point distance analysis is calculated, resulting in a new nearest table. There is one remaining proximity relationship left: A. Store 4 is no longer in a proximity relationship. Stores 1 and 2 are in proximity relationship A. Store 1 is randomly selected from the pair to be removed. Step 3: Store 1 is removed from the table and a new point distance analysis is calculated. The resulting nearest table has no proximity relationships, signaling that the process is complete.

Results

Table 1 presents the results of analyses to test reductions in the number and density of tobacco retailers resulting from three policy solutions. Analyses were conducted in 2014.

State-level outcomes

State-level outcomes were computed using the NC ALE list containing 7414 retailers. Implementation of a pharmacy ban would remove 1031 retailers and reduce density by 13.9%, a 1000-foot near-schools' ban would remove 1323 retailers and reduce density by 17.8%, and a 500-foot retailer proximity ban would remove 1640 retailers and reduce density by 22.1%. If both a pharmacy ban and a near-schools' ban were implemented together, 2169 retailers would be removed, and statewide tobacco retail outlet density would be reduced by 29.3%.

County-level outcomes

County-level outcomes were computed using both lists. Based on the ALE list, in Buncombe, Durham or New Hanover counties, a pharmacy ban would reduce current retailer density by an average of 16.2% (range 13.1% to 18.3%), a near-schools' ban by an average of 22.3% (range 17.7% to 28.1%), and a retailer proximity ban by an average of 22.2% (range 20.4% to 24.6%). Implementation of both a pharmacy-ban
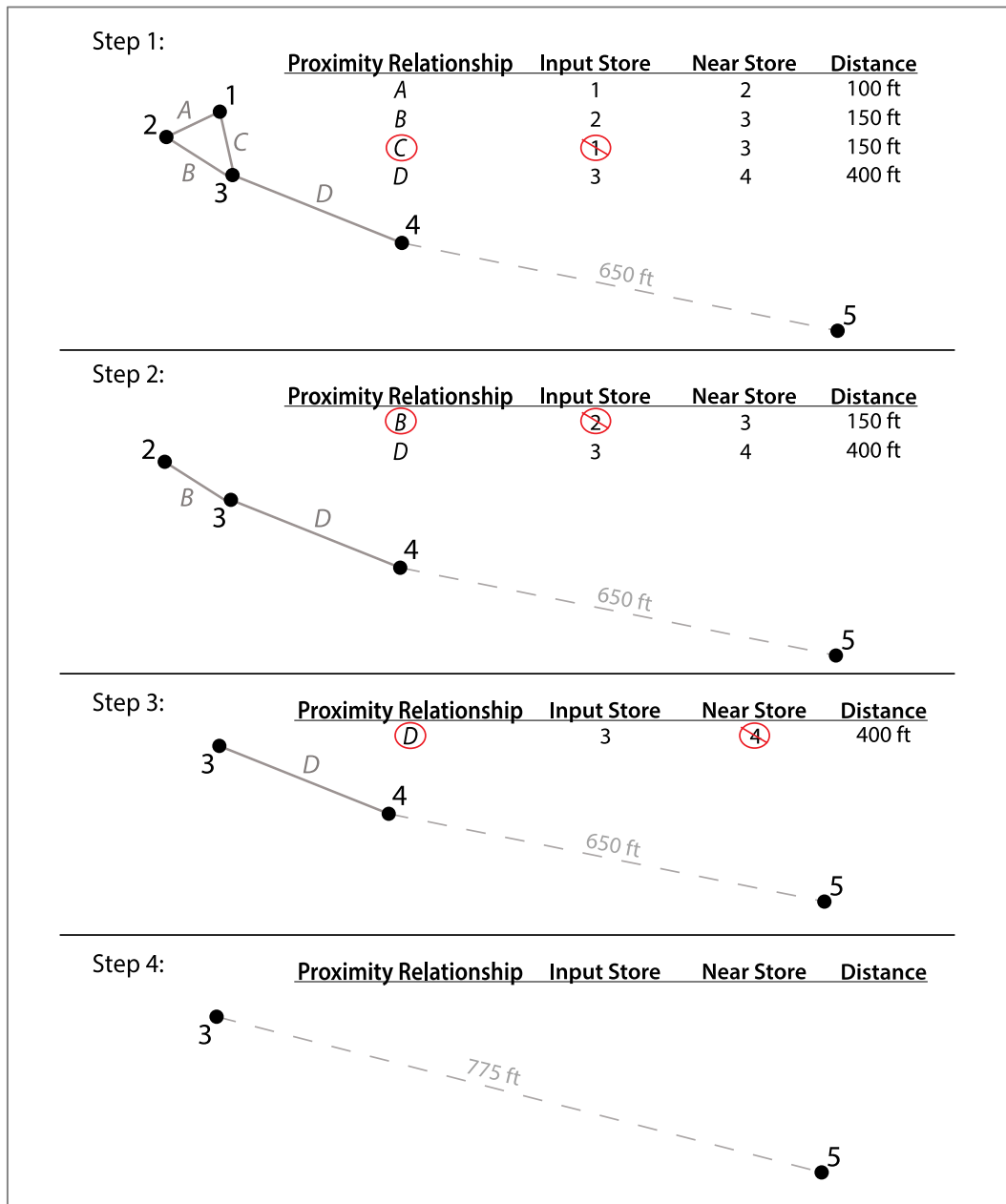
Fig. 2. Scenario 2 of random choice-removal proximity analysis used to compute the impact of a proximity ban. Step 1: A point distance analysis of all tobacco retailer locations within 500 ft of another tobacco retailer is calculated and results in a nearest table of 4 proximity relationships. A proximity relationship is two retailers within 500 ft of each other. Proximity relationship C is randomly selected from the 4 possible relationships. Stores 1 and 3 are in proximity relationship C. Store 1 is randomly selected from the pair to be removed. Step 2: Store 1 is removed from the table and a new point distance analysis is calculated, resulting in a new nearest table. There are two proximity relationships left: B and D. Proximity relationship B is randomly selected from the 2 possible relationships. Stores 2 and 3 are in proximity relationship B. Store 2 is randomly selected from the pair to be removed. Step 3: Store 2 is removed from the table and a new point distance analysis is calculated, resulting in a new nearest table. There is one remaining proximity relationship left: D. Stores 3 and 4 are in proximity relationship D. Store 4 is randomly selected from the pair to be removed. Step 4: Store 4 is removed and a new point distance analysis is calculated. The resulting nearest table has no proximity relationships, signaling that the process is complete.

and a near-schools' ban would reduce retailer density by an average of 35.5% (range 32.8% to 38.7%).

Based on the gold-standard HSHC list and parcel-boundary geographic referencing, in Buncombe, Durham or New Hanover counties, a pharmacy ban would reduce current retailer density by an average of 16.8% (range 16.1% to 18.0%), a near-schools' ban by an average of 15.4% (range 11.7% to 21.5%), and a retailer proximity ban by an average of 20.8% (range 16.6% to 27.9%). Implementation of both a pharmacy-ban and a near-schools' ban would reduce current retailer density by an average of 29.7% (range 26.3% to 35.6%).

Discussion

Any of the three potential policies would lead to substantial reductions in tobacco retailer density. Calculations with the statewide list demonstrate that implementing a policy to restrict tobacco sales in pharmacies, near-schools, or within close proximity to another tobacco retailer would reduce density between 13.9% and 22.1% percent at the state level and between 13.1% and 28.1% percent at the county level. Using the gold-standard county-level list, analyses indicate that implementing any one of the three policies would reduce tobacco

Table 1
Reduction in number and density of tobacco retail outlets in North Carolina.

| | | State of North Carolina | | | | Buncombe County | | | | Durham County | | | | New Hanover County | | | |
| | | Population: 9,544,249 | | | | Population: 239,000 | | | | Population: 269,283 | | | | Population: 203,276 | | | |
		Number of tobacco retailers removed	Number of tobacco retailers remaining	Tobacco retailer density[a]	% Reduction in density from baseline[b]	Number of tobacco retailers removed	Number of tobacco retailers remaining	Tobacco retailer density[a]	% Reduction in density from baseline[b]	Number of tobacco retailers removed	Number of tobacco retailers remaining	Tobacco retailer density[a]	% Reduction in density from baseline[b]	Number of tobacco retailers removed	Number of tobacco retailers remaining	Tobacco retailer density[a]	% Reduction in density from baseline[b]
Statewide cleaned ALE list	Baseline	–	7414	0.78	–	–	186	0.78	–	–	199	0.74	–	–	191	0.94	–
	1. After pharmacy ban	1031	6383	0.67	13.9%	34	152	0.64	18.3%	26	173	0.64	13.1%	33	158	0.78	17.3%
	2. After near-schools' ban (1000 ft)	1323	6091	0.64	17.8%	33	153	0.64	17.7%	56	143	0.53	28.1%	40	151	0.74	20.9%
	1 + 2. After pharmacy & near-Schools' bans	2169	5245	0.55	29.3%	61	125	0.52	32.8%	77	122	0.45	38.7%	67	124	0.61	35.1%
	3. After retailer proximity ban (500 ft)	1640	5774	0.60	22.1%	40	146	0.61	21.5%	49	150	0.56	24.6%	39	152	0.75	20.4%
'Field-validated HSHC three-county list	Baseline					–	222	0.93	–	–	233	0.87	–	–	205	1.01	–
	1. After pharmacy ban					40	182	0.76	18.0%	38	195	0.72	16.3%	33	172	0.85	16.1%
	2. After near-schools' ban (1000 ft)					29	193	0.81	13.1%	50	183	0.68	21.5%	24	181	0.89	11.7%
	1 + 2. After pharmacy & near-schools' bans					60	162	0.68	27.0%	83	150	0.56	35.6%	54	151	0.74	26.3%
	3. After retailer proximity ban (500 ft)					40	182	0.76	18.0%	65	168	0.62	27.9%	34	171	0.84	16.6%

ALE, Alcohol Law Enforcement.
HSHC, Healthy Stores Healthy Communities.
[a] Density = number of tobacco retailers per 1000 population [calculated as number of retailers*1000/population].
[b] Percent reduction in density from baseline is calculated [(old value–new value)]/[(ABS) old value].

retailer density at the county-level between 11.7% and 27.9%. Of note, both lists produced similar results: that restricting retailer proximity resulted in the most significant reduction in density, and that the range of density reduction for any single strategy was roughly 12% to 28%.

This is one of few studies to estimate the impact of policies that reduce the number and density of tobacco retail outlets. A 2011 geospatial study found that restricting tobacco advertising or sales within 1000 ft of schools would affect 22% in Missouri and 51% in New York (Luke et al., 2011). In comparison, restricting tobacco sales within 1000 ft of schools in North Carolina would impact nearly 18% of tobacco retail locations, which is similar to Missouri, but much lower than a more urbanized state such as New York. Further, a 2014 New Zealand study identified that a 1-km (3280.84 ft) buffer zone around schools would impact 89% of retail locations (Pearson et al., 2015). A very large buffer zone like the one in New Zealand was not used here because it is likely not feasible to implement policies that would prevent tobacco sales at the majority of existing outlets in the US. With regard to pharmacy bans, evidence from Massachusetts suggests that a pharmacy ban would remove nearly 10% of tobacco retailers in the state, based on the number of licensed pharmacies also holding a tobacco retailer license (Seidenberg et al., 2013). Our results indicate even greater reductions from a pharmacy ban in North Carolina, removing nearly 14% of retailers. The variation in estimated effects shown here given policy type, buffer zone distance and geographic locality offers support for estimating policy effects prior to policy selection. Our study also shows that the same policy has different effects depending on the county or geographic unit selected. For instance, banning stores near schools had a greater impact in Durham, which is a more urban area than the coastal or mountain county.

Despite emerging science on estimated impacts, in practice, several US locations have already implemented proximity-based restrictions on tobacco sales and pharmacy bans. In 2008, the City of New Orleans limited the sale of tobacco products within 300 ft of schools, churches, playgrounds, libraries or other youth-serving entities (Eggler, 2014). Santa Clara County followed in 2010 with a retailer licensing law that prohibited any new tobacco retailers to locate within 1000 ft of a school in any unincorporated county area (Santa Clara County Supes Pass Tobacco Ordinances, 2010). A 500-foot buffer zone between tobacco retailers is indicated by ChangeLab Solutions as model retailer licensing policy in California (Public Health Law and Policy (ChangeLab Solutions), 2012) and has been implemented in Santa Clara County and the City of Huntington Park (American Lung Association in California, The Center for Tobacco Policy and Organizing, 2013). In 2008, San Francisco, California implemented the first ban on tobacco sales in pharmacies via local tobacco retailer licensing law (Henriksen et al., 2008). From 2008 to February 20, 2014, an additional 80 cities in Massachusetts banned tobacco sales in pharmacies (Municipal Tobacco Control Technical Assistance Program, 2014). Empirical support for the long-term behavioral impact of retailer reduction policies is emerging: recent findings from India demonstrate that banning tobacco sales near schools may reduce student risk for tobacco use (Mistry et al., 2015).

Policy interventions affecting the environmental level (e.g., tobacco outlets) can have strong and sustainable health impact and high population reach (Frieden, 2010), however, policy implementation is a complex and challenging process. Policy theorist Kingdon articulated that policies are adopted most readily if an effective policy solution, awareness of a problem and political support come together in a 'window of opportunity' (Kingdon, 2011). Whereas this study provides support for effective policy solutions, public health professionals must partner with community citizens, the media, legal teams, and public health advocacy groups to generate awareness of the problem and build political support (Leeman et al., 2014). Given that any of the policies examined in this study can substantially reduce the number and density of retailers, jurisdictions might consider selecting the policy strategy that is most feasible and could gain the highest political support.

Given sufficient political support, several legal mechanisms may be used to reduce the number of tobacco retailers, and each works differently for implementation. Stand-alone ordinances are introduced, passed, signed into law and enforced to directly regulate tobacco retailing at either the local or state level (Center for Public Health Systems Science, 2014b; McLaughlin et al., in preparation). Licensing grants rights to a person or business (e.g., tobacco retailers) whereas zoning laws issue rights to the land (e.g., specific neighborhoods within a city) (Center for Public Health Systems Science, 2014b; McLaughlin et al., in preparation). State or local licensing laws require a license for retailers that sell tobacco, and may restrict licenses from being issued to retail outlets that violate certain conditions of operation or eligibility requirements (e.g., if they are located near schools) (ChangeLab Solutions, 2012). Local zoning codes can create specific land areas where tobacco sales are prohibited (ChangeLab Solutions, 2012). To date, retailer reduction strategies enacted through land use or zoning laws have been applied only to new tobacco retailers, and have "grandfathered in" existing retailers that fail to comply with the new density restrictions, though this is not legally necessary except in rare cases (McLaughlin, 2014). Grandfathering has been done to protect against a potential legal challenge on the theory that the government has "taken" a tobacco retailer's property rights (the "right" to sell tobacco), which is protected under the 5th Amendment. However, under the law of regulatory takings, a business owner has a viable "takings" claim only if application of the new law would deprive the business of almost all economic viability, which is not the case for tobacco retailers that sell other goods. Jurisdictions that are considering implementing retailer reduction policies should consider (1) using a tightly-drafted licensing law (which does not create any property rights claims) rather than zoning/land use (McLaughlin et al., in preparation; ChangeLab Solutions, 2012), and (2) phasing out existing retailers that do not comply with the law through "amortization" (giving them a reasonable amount of time to phase out their existing stock of tobacco products) or by "lottery" to determine which businesses can continue to operate when there are several existing nonconforming retailers clustered together (McLaughlin, 2014), as was modeled in this study.

This study is unique because it is the first to prospectively estimate the potential impact of three unique tobacco retailer reduction policies in the US context. Strengths of the study are that it uses two datasets, one smaller field validated "gold-standard" list and a second statewide "silver-standard" list. Another strength is real world application for practitioners and policy makers as they pursue place-based public health interventions. Our findings inform the selection of politically feasible policy solutions and community education for policy change. Our study, however, has several limitations. First, our analyses are specific to North Carolina and are not generalizable to the rest of the United States. Second, gold-standard retailer lists and geographic referencing techniques were limited to only three counties and may further compromise external validity; for example, our pharmacy coding protocol may have overestimated the number of pharmacies in rural areas. Given the similar pattern of policy impact between the gold-standard and the statewide lists, we feel this limitation is mitigated. Third, the statewide list of off-premise alcohol retailers is only a proxy measure for tobacco retailers, yet is a promising alternative for many jurisdictions that lack an updated list of licensed tobacco retailers. Finally, this study examines only the estimated impact of these policies, because we cannot predict real-world policy implementation.

The implementation of policies restricting tobacco sales in pharmacies, near schools or in close proximity to another retailer would reduce the number and density of tobacco retail outlets, an important step in decreasing physical access to tobacco products and limiting exposure to tobacco marketing. Future research should establish the potential impact of tobacco retailer reduction policies on mitigating or reversing disparities in retailer density by neighborhood aggregate income level or racial/ethnic composition. Future studies should also evaluate the

effect of reducing tobacco retailer density on discouraging smoking initiation and promoting cessation at the population level.

Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx. doi.org/10.1016/j.ypmed.2015.01.025.

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