Tobacco-Free Pharmacy Laws and Trends in Tobacco Retailer Density in California and Massachusetts

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Objectives. To examine the impact of local laws prohibiting tobacco sales in pharmacies in California and Massachusetts, the only 2 US states in which such municipal laws exist.

Methods. We analyzed longitudinally the tobacco retailer density at the city level from tobacco retailer license data in California (2005–2013) and Massachusetts (2004–2014).

Results. After adjustments, the reduction in tobacco retailer density over time was 1.44 (95% confidence interval [CI] = 1.37, 1.51) to 3.18 (95% CI = 1.11, 5.25) times greater in cities with a tobacco-free pharmacy law than in cities without such a law.

Conclusions. Tobacco-free pharmacy laws are associated with a greater reduction in tobacco retailer density over time in California and Massachusetts. (*Am J Public Health.* 2016;106:679–685. doi:10.2105/AJPH.2015.303040)

See also Galea and Vaughan, p. 592.

The United States is one of the leading consumers of tobacco products in the world.[1] In 2014, nearly 264 billion cigarettes were purchased in the United States,[2] where tobacco sales in pharmacies account for nearly 5% of total tobacco sales.[3] A recent study suggests that sales in pharmacies increased by 22.7% from 2005 to 2009, while during the same time period, total US cigarette sales decreased about 17.4%.[3] If this trend continues, pharmacies are estimated to account for 14.6% of the nation's cigarette sales market by 2020.[3]

Many countries outside of the United States, such as the United Kingdom, Australia, and all provinces and territories of Canada except for British Columbia, have used national or local laws (or both) to prohibit the sale of tobacco products in pharmacies ("tobacco-free pharmacy laws").[4–6] In the United States, although most health-focused venues, including hospitals and outpatient facilities, have adopted policies to ban the sale of tobacco, many pharmacies continue to sell tobacco products.[7] The American Pharmacists Association and other health professionals have opposed tobacco sales in pharmacies, because selling tobacco products directly conflicts with the role of pharmacies as public health facilities.[8–11] After 4 decades of recommendations, the large pharmacy chain CVS voluntarily stopped selling tobacco products in 2014; however, tobacco products are still sold in most pharmacies in the United States.

California and Massachusetts have taken the lead in efforts to ban tobacco sales in pharmacies. San Francisco prohibited tobacco sales in pharmacies in 2008, followed by several other California communities, including the City of Richmond and the unincorporated area in Santa Clara County in 2010, and Marin County and the City of Berkeley in 2014. To date, more than 100 cities or towns in Massachusetts have enacted such policies, which cover approximately 60% of the Massachusetts population.[12,13] The tobacco-free pharmacy laws in the 2 states prohibit tobacco sales in all pharmacies, including independent and chain pharmacies as well as supermarkets and "big box" stores with pharmacies.

Few studies have examined the potential benefits of banning tobacco sales in pharmacies. Although tobacco-free pharmacy laws are primarily designed to affect social norms by emphasizing that tobacco sales are incompatible with the promotion of health, there is reason to believe that such laws may also reduce the density of tobacco retailers and, accordingly, the availability of cigarettes. Seidenberg et al. assessed the availability of tobacco products sold in pharmacies in cities in Massachusetts without tobacco sales restrictions. They found that pharmacies composed 10% of the licensed tobacco market, suggesting that the tobacco-free pharmacy laws might directly reduce the density of tobacco retailers.[14] In a simulation study, Myers et al. suggested that prohibiting sales of tobacco products in pharmacies would reduce tobacco retailer density by approximately 17% at the county level in North Carolina.[15]

To our knowledge, there are no studies examining the effect of tobacco-free pharmacy laws on tobacco retailer density in a real-world setting. It is important to determine whether the tobacco-free pharmacy laws effectively reduced the tobacco retailer density, or if such laws resulted in unintended consequences by, for example, enticing new types of retailers to begin selling tobacco products.[16] We aimed to fill this gap by examining the impact of tobacco-free pharmacy

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laws on the density of tobacco retail licenses over time in the 2 states that have such laws.

METHODS

For each state (California and Massachusetts) in this study, we drew data from licenses for tobacco retailers. In California, tobacco license data are maintained in the Special Taxes Policy and Compliance Division at the California Board of Equalization, and the data are updated weekly. We obtained tobacco retail license data from January 1, 2005, through December 31, 2013, to ensure that we had 3 years of observation prior to the implementation of San Francisco's tobacco-free pharmacy law. In Massachusetts, we obtained tobacco license data from the Department of Revenue, Litigation Bureau. According to the Department of Revenue, tobacco retailer licenses expire on September 30 of each year ending in an even digit. The license records were available in 2-year periods from October 1, 2004, through September 30, 2014. Therefore, we had 4 years of data before the first city in Massachusetts (Boston) implemented the tobacco-free pharmacy law.

Case and Control Cities in California and Massachusetts

This study focused on incorporated cities in California and Massachusetts. To ensure that we had enough follow-up time to see the impact of tobacco-free pharmacy laws, we included the cities and towns that had at least 1 pharmacy and had the law in effect prior to September 30, 2012. Among the 482 incorporated cities in California, 451 cities had at least 1 pharmacy with a tobacco retailer license. We considered San Francisco and Richmond to be case cities that prohibited tobacco sales in pharmacies. Of 351 cities and towns in Massachusetts, 321 had at least 1 pharmacy with a tobacco retailer license. We considered 37 municipalities that met the inclusion criteria to be case cities in Massachusetts. We considered the incorporated cities without tobacco-free pharmacy laws to be control cities in each state. Address information is available for tobacco retailers in the license data. We identified tobacco retailers within each community by city names and zip codes, which were extracted from the address data. We successfully mapped all eligible retailers to the corresponding communities.

Measures

Tobacco retail license measures. For cities in California, we created quarterly license data from January 2005 to December 2013. In total, there were 36 quarterly records that included the number of licensed tobacco retailers in each city. Because the tobacco license data in Massachusetts were available in 2-year periods, we created 5 records that included the number of licensed tobacco retailers in each municipality. In addition, we calculated per capita tobacco retailer density in each city and town as the number of retail establishments per 10 000 persons.

Tobacco-free pharmacy laws. We created a dichotomous variable to indicate when the tobacco-free pharmacy law was implemented. For each observation time, we coded the indicator as 1 if a city had a tobacco-free pharmacy law in effect at that time and as 0 otherwise.

Other local tobacco control policies. To distinguish the impact of the pharmacy laws from a more general effort in the community to reduce the tobacco sales environment, we included city-level tobacco control policies in the analysis. We reviewed the city-level tobacco control policies that were potentially associated with the tobacco sale environment[17–19] using various databases, including those of the American Lung Association and the American Nonsmokers' Rights Foundation.[20–24] We thus considered the following local tobacco control policies: (1) indoor smoke-free laws, (2) laws restricting the use of electronic cigarettes in smoke-free venues, and (3) licensing laws and youth access laws (laws requiring tobacco retailers to obtain and renew licenses, prohibiting the distribution of free or low-cost tobacco products, or restricting tobacco retailers from being located near schools). We considered only city laws that were more restrictive than statewide laws. For example, California's statewide smoke-free law prohibited smoking in bars and restaurants (but not other workplaces) starting in 1998. Therefore, we included only city-level laws that barred smoking in nonhospitality workplaces. For each law, we created a dichotomous indicator. According to the effective date of each city law, we coded the indicator as 1 if the law was in effect at a certain time and as 0 otherwise.

City characteristics. City-level characteristics included population size estimates, demographic characteristics, and economic status.[17] For cities in California, because quarterly population estimates were not available at the city level, we obtained yearly population estimates for each city from 2005 to 2014 from the US Census Bureau.[25,26] For cities and towns in Massachusetts, we calculated average population estimates for every 2 years so that they would be consistent with the biannual license data.

Demographic characteristics at the city level were available from the 2010 US Census.[27] We included the percentage of persons younger than 18 years, the percentage of the population that was Hispanic, and ratios that compared the percentages of the population in different racial groups to the percentage of the population that was White (Black vs White, Asian vs White, and other races vs White).

Finally, the city economic indicator was the unemployment rate. Monthly unemployment rates for each city in California and Massachusetts were available from the California Employment Development Department and the Massachusetts Executive Office of Labor and Workforce Development, respectively.[28,29] To ensure consistency across the time measures, we calculated average quarterly and biannual unemployment rates using the monthly data from the 2 states.

Statistical Analysis

We used generalized linear mixed models with a log link function to examine the relationship between the tobacco-free pharmacy laws in California and Massachusetts and license density. We used mixed-effect negative binomial regression with an offset to account for the overdispersion of the distribution of outcome measures. In addition, the mixed models can also account for different policy enactment times for each city and random effects at city level. We fit separate models for California and Massachusetts. To calculate the outcome measure as tobacco retailer density, we included the population

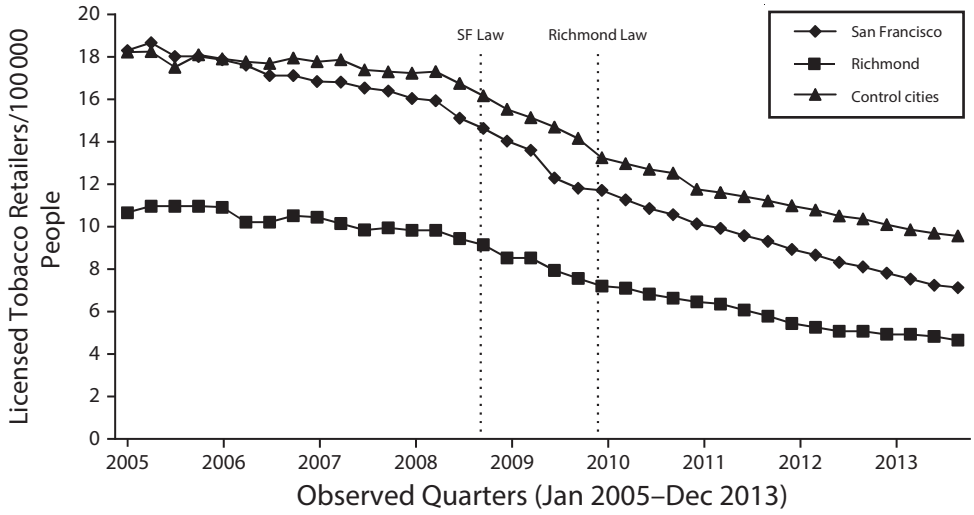

FIGURE 1—Licensed Tobacco Retailer Density Over Time, by Case (San Francisco and Richmond) and Control Cities: California, 2005–2013

size for each city as an offset in each model. Thus, we calculated the outcome measure as the number of licensed tobacco retailers over the population size. The primary independent variables included a tobacco-free pharmacy law implementation indicator, a time indicator, and an interaction between policy implementation and time indicators. In addition, we included a quadratic term for time in the Massachusetts model to account for the quadratic trend in tobacco retailer density over time. We included local tobacco control policies, city-level demographic variables, and unemployment rates in the models to adjust for potential confounders at the city level. We calculated rate ratios to estimate the change in the density rates over time among cities with tobacco-free pharmacy laws versus those without.

Confirmatory Analysis

Because we found a complex trend of tobacco retailer density over time in Massachusetts, we conducted a matching-based confirmatory analysis, which does not rely on parametric model assumptions such as mixed models. We used the data for the 37 case cities in the main statistical analysis, and for each case city we selected the 5 closest matching control cities on the basis of the following criteria: (1) geographic location (for each case city, we found control cities within the same county or adjacent counties), (2) local tobacco control policies (the control cities had the same policies as the case cities),

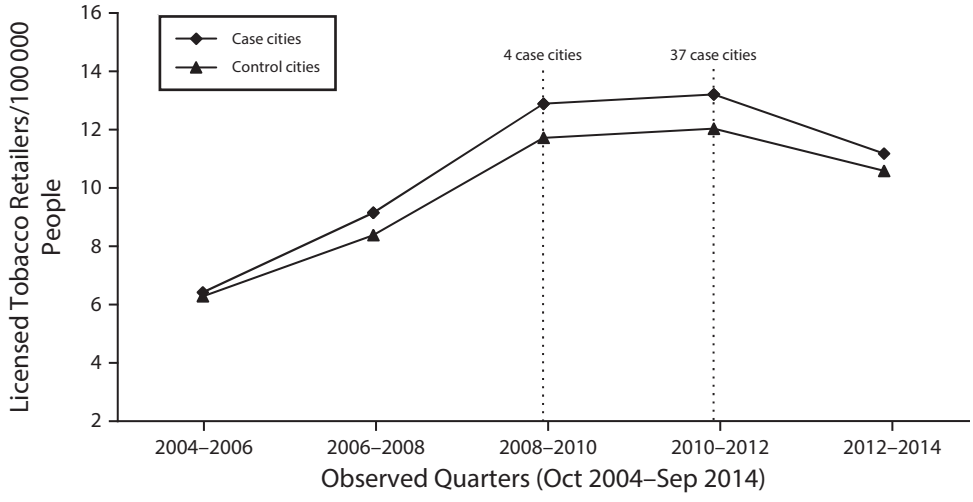

FIGURE 2—Licensed Tobacco Retailer Density Over Time, by Case and Control Cities: Massachusetts, 2005–2013

TABLE 1—Rate Ratios of Tobacco-Free Pharmacy Laws, City Demographics, and Tobacco Retailer Density: California and Massachusetts, 2005–2013

Variable	Tobacco Retailer Density[a]	
	California Model,[b] Adjusted RR (95% CI)	Massachusetts Model,[c] Adjusted RR (95% CI)
Tobacco-free pharmacy law effect		
Pharmacy Law	1.25 (1.17, 1.33)	1.60 (1.06, 2.42)
Time	0.98 (0.97, 0.98)	1.52 (1.46, 1.59)
Law × time	0.99 (0.98, 0.99)	0.89 (0.79, 0.99)
Quadratic time	...	0.93 (0.92, 0.93)
Local tobacco control laws		
Smoke-free law	0.96 (0.94, 0.98)	...
E-cigarettes law	0.97 (0.96, 0.99)	0.92 (0.80, 1.06)
Licensing and youth access	0.96 (0.94, 0.97)	1.10 (0.96, 1.26)
City demographic characteristics		
Unemployment rate	1.00 (0.99, 1.00)	1.06 (1.04, 1.07)
% aged < 18 y	0.94 (0.93, 0.96)	0.98 (0.97, 0.98)
% Black vs % White	0.93 (0.64, 1.39)	1.37 (0.57, 3.35)
% Asian vs % White	0.72 (0.63, 0.83)	0.29 (0.03, 3.09)
% other races vs % White	0.52 (0.35, 0.80)	1.84 (0.19, 17.46)
% Hispanic	5.17 (3.03, 8.53)	1.42 (0.14, 13.93)

Note. RR = rate ratio; CI = confidence interval.

Source. California tobacco license data (2005–2013), Massachusetts tobacco license data (2004–2014), US Census data (2010), American Lung Association and American Nonsmokers Rights Foundation tobacco control policy databases (2005–2014).

[a]Defined as the number of retail establishments per 10 000 persons.

[b]California model is adjusted for a random intercept for each city and the covariates listed in the table, except for the quadratic term of time.

[c]Massachusetts model is adjusted for a random intercept for each city or town and the covariates listed in the table, except for the workplace smoking ban.

and (3) Mahalanobis distance[30] (calculated on the basis of the city demographic characteristics mentioned in "Measures" subsection), which measures the similarity between case cities and other cities. A smaller distance indicates that a control city is more similar to a case city with respect to demographic characteristics. We used nearest-neighbor matching without replacement on the basis of the calculated Mahalanobis distance to ensure that we selected different control cities for each case city. We calculated the tobacco retailer density for each case city and the average tobacco retailer density of the corresponding control cities for each time period. We performed a difference-in-differences test using a Wilcoxon signed rank test to assess the retailer density change from baseline to the end of the study. We conducted all analyses using SAS version 9.3 (SAS Institute, Cary, NC) and Stata version 13.0 (StataCorp LP, College Station, TX).

RESULTS

Figure 1 and Figure 2 present the long-term trend of tobacco retailer density by case and control city status in California and Massachusetts, respectively. There was an overall decreasing trend in tobacco retailer density from 2005 to 2013 in California. Among the cities without tobacco-free pharmacy laws, the average retailer density decreased from 18.2 to 9.6 per 10 000 persons. Compared with control cities, Richmond appears to have a similar trend and San Francisco appears to have experienced a greater reduction. Interestingly, there appears to be a convex trend in tobacco retailer density from 2004 to 2014 in Massachusetts. The tobacco retailer density gradually increased from 2004 to 2010 and started to decrease during the period 2010 to 2012, when a large number of cities implemented tobacco-free pharmacy laws. The effective date of tobacco-free pharmacy laws in each case city and the tobacco retailer density at baseline and endpoint is in Table A (available as a supplement to the online version of this article at http://www.ajph.org), and the city-level characteristic among case and control cities is in Table B (available as a supplement to the online version of this article at http://www.ajph.org).

Table 1 presents the results of the longitudinal mixed-effect negative binomial model. The results indicate a negative association between the presence of tobacco-free pharmacy laws and tobacco retailer density over time in California ($P < .001$). After adjusting for the quadratic trend of time, we observed a similar negative association in Massachusetts ($P = .028$). In addition, after adjusting for the effects of pharmacy laws and city characteristics, we found that workplace smoke-free laws, restrictions on the use of electronic cigarettes, and licensing and youth access policies were all significantly associated with lower tobacco retailer density in California. However, there was no significant relationship between local tobacco control policies (apart from the tobacco-free pharmacy laws) and tobacco retailer density in Massachusetts. A higher percentage of the population younger than 18 years was associated with a lower density of tobacco retailers in the 2 states ($P < .001$).

Table 2 presents the percentage of reduction and relative reduction in tobacco retailer density by cities with and without a tobacco-free pharmacy laws. In California, after adjustment for city-level factors in the model, tobacco retailer density among cities without tobacco-free pharmacy laws decreased by 2.1% (95% confidence interval [CI] = 2.1%, 2.2%) each quarter; the density among cities with such laws decreased by 3.5% (95% CI = 3.2%, 3.7%) each quarter. Overall, starting from the first implementation of the tobacco-free pharmacy law, the tobacco retailer density in California decreased about 50.7% (95% CI = 47.0%, 51.7%) among cities with tobacco-free pharmacy laws, whereas among cities without such a law, the density decreased about 35.2% (95% CI = 34.8%, 35.6%). Since the first implementation of such laws, the decrease in tobacco retailer density among cities with such laws was 1.44 (95% CI = 1.37, 1.51)

TABLE 2—Adjusted Percentage of Reduction and Relative Reduction in Tobacco Retailer Density by Cities With and Without Tobacco-Free Pharmacy Laws: California and Massachusetts, 2005–2013

	Tobacco Retailer Density[a]			
Cities	Adjusted % Reduction Per Unit Time[b] (95% CI)	Adjusted Relative Reduction Per Unit Time[b] (95% CI)	Adjusted % Reduction From Baseline[c] (95% CI)	Adjusted Relative Reduction From Baseline[c] (95% CI)
California[d]				
Cities with the laws	3.5 (3.2, 3.7)	1.62 (1.51, 1.73)	50.7 (47.0, 51.7)	1.44 (1.37, 1.51)
Cities without the laws	2.1 (2.1, 2.2)	1 (Ref)	35.2 (34.8, 35.6)	1 (Ref)
Massachusetts[e]				
Cities with the laws	...	...	28.5 (11.7, 42.1)	3.18 (1.11, 5.25)
Cities without the laws	...	...	9.0 (5.7, 12.1)	1 (Ref)

Note. CI = confidence interval.

Source. California tobacco license data (2005–2013), Massachusetts tobacco license data (2004–2014), US Census data (2010), American Lung Association and American Nonsmokers Rights Foundation tobacco control policy databases (2005–2014).

[a]Defined as the number of retail establishments per 10 000 persons.

[b]Time unit is by quarter.

[c]Baseline is the effective date of first city that implemented the tobacco-free pharmacy law in each state. California baseline: October 1, 2008; Massachusetts baseline: February 11, 2009.

[d]California model is adjusted for city-level smoke-free workplace policy, electronic cigarettes ban, youth access policy, city demographic characteristics, unemployment rate, and a random intercept for each city.

[e]Massachusetts model is adjusted for city-level electronic cigarettes ban, youth access policy, city demographic characteristics, unemployment rate, a quadratic term of time, and random intercept for each city or town.

times as great as the decrease among cities without such laws.

In Massachusetts, because the trend of tobacco retailer density was not linear, we report the adjusted change starting from the time the first city had such a law in effect. Between the period 2008 to 2010 and the period 2012 to 2014, the density decreased about 28.5% (95% CI = 11.7%, 42.1%) among case cities and decreased about 9.0% (95% CI = 5.7%, 12.1%) among control cities, after adjustment for city-level factors and a quadratic term for time. The reduction among case cities was about 3.18 (95% CI = 1.11, 5.25) times as great as the reduction among control cities. Initially, the average tobacco retailer density among case cities was greater than in control cities. Tobacco-free pharmacy laws were associated with a change that made the case and control cities more similar over the years. These results indicate that tobacco-free pharmacy laws had a significant impact on the reduction of tobacco retailer density in both California and Massachusetts.

The results of confirmatory analysis are consistent with the results mentioned in this section. The difference-in-differences Wilcoxon signed rank test indicates that the reduction in tobacco retailer density among case cities was significantly greater than the reduction among control cities over time (z score = 2.135; P = .033).

DISCUSSION

Tobacco-free pharmacy laws were associated with a significant decrease in tobacco retailer density in both California and Massachusetts. In cities with a law, the reduction of retailer density was 1.44 to 3.18 times as great as the reduction among cities without such a law. One possible reason for the differences in the size of the reduction we observed could be that with more cities involved in the tobacco-free pharmacy initiatives, the rapidly shifting norms relating to tobacco sales in Massachusetts may have discouraged potential new tobacco retailers from entering the market or encouraged other businesses to stop selling tobacco.

To our knowledge, this was the first study to empirically examine the impact of tobacco-free pharmacy laws on retailer density. Seidenberg et al. estimated that a tobacco-free pharmacy law would remove approximately 10% of tobacco retailers in Massachusetts based on the number of pharmacies that had a tobacco retailer license in 2013.[14] Our results indicate a greater reduction than Seidenberg et al. projected. With the decreasing trend in tobacco retailer density beginning in 2010, the cities without tobacco-free pharmacy laws experienced a 9% reduction in tobacco retailer density, whereas among the cities with such a law there was approximately a 29% reduction in tobacco retailer density. Our finding shows that tobacco-free pharmacy laws, if implemented statewide, could lead to a nearly 20% reduction in tobacco retailer density in Massachusetts. More importantly, our results do not indicate that the removal of tobacco products from pharmacies might unintentionally encourage other retailers to enter the market.

The implication of this finding is that these laws, by lowering tobacco retailer density, may also serve to lower tobacco use and subsequent adverse health outcomes.[31] Paul et al. found that a high density of tobacco retailers promoted tobacco purchases among younger smokers in Australia.[32] In addition, a study based on data from the 2003–2004 California Student Tobacco Survey and retail licensing data revealed that a high density of tobacco retailers near schools was associated with experimental smoking.[33] In other studies, a higher density of tobacco retailers was associated with an increased likelihood of relapse among smokers trying to quit.[34] Therefore, although this study does not present direct evidence that tobacco-free pharmacy laws are associated with reduced tobacco use, our finding of an association between the pharmacy laws and reduced tobacco retailer density suggests that the laws may lower tobacco use.

These results may help to inform decision-makers in cities or states that are considering adopting tobacco-free pharmacy laws. However, this study has several limitations. First, our analyses focused on California and Massachusetts, and the results

might not be generalizable to the rest of the United States; the same policy may not have the same effect in other geographic areas. Second, because only San Francisco and Richmond implemented their laws before September 30, 2012, in California, we were somewhat limited in our statistical power. We found that the effect of the pharmacy laws on reduced tobacco retailer density in California was mainly driven by San Francisco. It might be potentially due to high rental costs in San Francisco, which make it difficult for new retailers to enter the market. As the number of cities that adopt tobacco-free pharmacy laws grows, further analysis is needed to better understand the impact of such laws in California. Our ability to see more fine-grained changes was also limited by the tobacco retailer license data in Massachusetts, as they were only available in 2-year periods.

Third, the statistical model with a quadratic term of time might not be able to fully explain the convex trend of tobacco retailer density in Massachusetts. However, the consistent results from the confirmatory analysis suggest that the results of the modeling approach are correct. Fourth, tobacco retailer density in this study was measured at the city level, which is a larger geographic unit than neighborhoods or census tracts. The optimal geographic unit to examine density effects varies in different study settings. In this study, a smaller geographic unit may be too small for analysis, because the laws are implemented at the city level and the number of pharmacies within a neighborhood or a census tract is limited. Fifth, although we controlled for several local tobacco control policies, there might be unmeasured policies that were implemented at or around the time a city enacted the tobacco-free pharmacy laws. This might limit the ability to distinguish the effect of tobacco-free pharmacy laws on reducing tobacco retailer density from other related policies.

There might also be other potential confounders we did not account for. For example, it is possible that the effect of tobacco-free pharmacy laws is magnified because the case cities are more likely to have big box stores with pharmacies, which are also affected by the sales ban. Because the demographic data at city-level were not available quarterly or yearly, the demographic factors included in the model were not time dependent. There might be residual confounding on the change of demographics over time. In addition, merely controlling for the unemployment rate at the city level in the model may not fully account for the economic circumstance, such as the recession from 2008 to 2010, as well as the variation in socioeconomic status, such as household income and educational level.

In conclusion, this study suggests that tobacco-free pharmacy laws can effectively reduce tobacco retailer density, which may further decrease the accessibility of tobacco products and limit exposure to tobacco displays and advertisements. Future research should further investigate the underlying mechanism of the overall reduction in tobacco retailer density, the impacts of tobacco-free pharmacy laws on the revenues of pharmacies as well as other retailers, the impacts of such laws on illegal sales of tobacco products, and the effect on the prevalence of tobacco use, tobacco purchasing behavior, and smoking initiation and cessation. AJPH

CONTRIBUTORS

Y. Jin brought ideas, collected data, conducted statistical analyses, and interpreted the results. B. Lu provided guidance on all statistical analyses. E. G. Klein, M. Berman, R. E. Foraker, and A. K. Ferketich brought ideas and provided insights for literature guidance, interpretation of results, and policy implications. All authors approved the final version and hold themselves jointly and individually responsible for the content.

HUMAN PARTICIPANT PROTECTION

No protocol approval was necessary because this study did not involve human participants.

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