

Impact of CVS Pharmacy's Discontinuance of Tobacco Sales on Cigarette Purchasing (2012–2014)

Jennifer M. Polinski, ScD, MPH, Benjamin Howell, PhD, MPP, Michael A. Gagnon, MA, Steven M. Kymes, PhD, Troyen A. Brennan, MD, JD, MPH, and William H. Shrank, MD, MSHS


Objectives. To assess the impact of CVS Health's discontinuation of tobacco sales on cigarette purchasing.

Methods. We used households' purchasing data to assess rates at which households stopped cigarette purchasing for at least 6 months during September 2014 to August 2015 among 3 baseline groups: CVS-exclusive cigarette purchasers, CVS+ (CVS and other retailers), and other-exclusive (only non-CVS retailers). In state-level analyses using retailers' point-of-sale purchase data, an interrupted time series compared cigarette purchasing before (January 2012 to August 2014) and after (September 2014 to April 2015) tobacco removal in 13 intervention states with CVS market share of at least 15% versus 3 control states with no CVS stores.

Results. Compared with other-exclusive purchasers, CVS-exclusive purchasers were 38% likelier (95% confidence interval = 1.06, 1.81) to stop cigarette purchasing after tobacco removal. Compared with control states, intervention states had a significant mean decrease of 0.14 (95% confidence interval = 0.06, 0.22) in packs per smoker per month.

Conclusions. After CVS's tobacco removal, household- and population-level cigarette purchasing declined significantly. Private retailers can play a meaningful role in restricting access to tobacco. This highlights one approach to reducing tobacco use and improving public health. (*Am J Public Health.* 2017;107:556–562. doi:10.2105/AJPH.2016.303612)

smoking cessation.⁸ Little is known about whether such a decision by a large retail pharmacy chain led to reductions in tobacco use, or if consumers simply switched their purchasing to alternative retailers. We sought to examine the effect of CVS's decision on cigarette purchasing by evaluating 2 complementary data sources. With household-level data, we compared the effect of CVS Health's decision to stop selling tobacco on cigarette purchasing by consumers who previously purchased cigarettes at CVS versus those who purchased at other retail outlets. We used state-level data to assess whether the CVS decision led to population-level reductions in cigarette purchasing, comparing states with substantial CVS retail market share to states with no CVS retail presence. We hypothesized that restricting access to tobacco would reduce cigarette purchasing at the household and population levels.

 See also Galea and Vaughan, p. 500.

Smoking is the leading cause of preventable morbidity and mortality in the United States, accounting for more than 480 000 deaths each year, \$133 billion in medical costs, and \$156 billion in lost productivity.^{1,2} Although smoking rates have declined, nearly 1 in 4 US adults still use tobacco, and 16.8% of persons in the United States smoke cigarettes.^{3,4} Reducing tobacco use continues to be a public health priority.

Accumulating evidence suggests that restricting access to and limiting opportunities to smoke tobacco reduces tobacco use.^{5–7} Prohibiting smoking in public and private locations, increasing financial costs through taxation, and raising the tobacco purchasing age are all linked to decreases in smoking prevalence.^{5,7} Limiting the

number of locations where tobacco can be purchased is also effective. When San Francisco, California, and Boston, Massachusetts, prohibited tobacco sales in pharmacies, cigarette purchasing declined.⁶

On September 3, 2014, after changing its name to CVS Health, CVS removed tobacco products from its more than 7800 retail stores in 47 states nationwide and began a high-profile media and advertising campaign both in and outside of its stores to encourage

METHODS

Data were provided by IRi Worldwide, a firm that collects retail purchasing data by using various methods to understand and track consumers' purchasing behaviors for specific retail goods.⁹ To assess changes in cigarette purchasing associated with tobacco removal, we used monthly data for unique households participating in IRi's Household Panel Survey, a nationally representative, opt-in panel in which household members regularly scan

ABOUT THE AUTHORS

At the time of the study, all of the authors were with CVS Health, Woonsocket, RI.

Correspondence should be sent to Jennifer M. Polinski, ScD, MPH, CVS Health, 400 Scenic View Drive, #142252, Cumberland, RI 02864 (e-mail: jennifer.polinski@cvscaremark.com). Reprints can be ordered at <http://www.ajph.org> by clicking the "Reprints" link.

This article was accepted December 6, 2016.
doi: 10.2105/AJPH.2016.303612

and report all retail purchases and corresponding purchasing locations. All purchases are recorded, regardless of retailer. Data included unique households' demographic data (female or male head of household's age, race, education, marital status, occupation, and Hispanic ethnicity; family size; presence of children; income; rented or owned residence) and monthly cigarette pack purchasing volume, frequency, and location. IRi tracks households' participation monthly and flags those households who do not report any purchases of any retail good within a given month. We used this participation flag to determine households' study eligibility and, when appropriate, to censor those households that were no longer contributing information to the panel. All households were de-identified.

Because many readers may be unfamiliar with such companies and data collection, it may be useful to think of an analogous situation: the Nielsen Company's monitoring of television viewership, in which households are asked to report on their television program viewing on a monthly basis to understand shows' popularity, what the characteristics are of people who are watching, and other data.¹⁰

To compare state-level purchasing of tobacco products before and after CVS tobacco removal in states where CVS Pharmacies are located versus states with no CVS Pharmacies, IRi provided monthly point-of-sale cigarette purchasing data from all drug, food, big box, dollar, convenience, and gas station retailers in 26 states: Alabama, Arizona, Arkansas, Colorado, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maryland, Michigan, Missouri, Nevada, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, Tennessee, Vermont, Virginia, Washington, and Wisconsin. Only 26 states' data were available because of competitive restrictions. To protect retailers' competitive information, IRi only releases data if there are more than 2 retailers reflected in the relevant household purchase behaviors (in this case, cigarettes) at all levels of geography (e.g., local market, county, state).

Study Designs

Household-level study. The main household-level study used an open cohort

study design, which recognized that the incidence of the outcome, stopping cigarette purchasing, was likely to vary during the follow-up period. Cohort study-eligible households reported 1 or more purchase of any retail good in each of June, July, and August 2014 (i.e., they were actively participating in IRi's panel survey, collectively defined as the 3-month baseline period). Households were followed for 52 weeks immediately following tobacco removal at CVS, September 2014 to August 2015. Households could leave the panel during follow-up.

Recognizing that the cohort design itself could not account for the seasonality of tobacco use, we conducted a sensitivity analysis by using a cross-sectional, difference-in-differences approach. We compared changes in cigarette purchasing in the months immediately before and after tobacco removal at CVS in September 2014 (tobacco-removal period): the baseline months were July and August 2014, and the follow-up months were September 2014 to February 2015. To understand the cigarette purchasing behaviors of households in the absence of tobacco removal by CVS, we repeated this comparison 1 year earlier, which we refer to as the comparison period: July and August 2013 (baseline) and September 2013 to February 2014 (follow-up). Eligible households purchased 1 or more cigarette packs during baseline and 1 or more retail goods every month to ensure they remained in the IRi panel, consistent with the cross-sectional design. Figure A, available as a supplement to the online version of this article at <http://www.ajph.org>, depicts each of the household-level study design approaches.

State-level studies. We used an interrupted time series design with 40 monthly measurements for each state, 32 before (January 2012–August 2014) and 8 after tobacco removal (September 2014–April 2015).

Exposure

Household-level studies. In the cohort study, we created 3 groups, defined in the baseline period, to examine whether greater CVS loyalty as a source for cigarettes was associated with a greater likelihood of stopping cigarette purchasing after tobacco

removal. CVS-exclusive purchasers only bought cigarettes at CVS, CVS+ purchasers bought at both CVS and non-CVS stores, and other-exclusive purchasers bought exclusively at non-CVS locations and acted as the reference group. In the difference-in-differences sensitivity analysis, we compared CVS-exclusive purchasers with mixed purchasers—households that bought cigarettes at both CVS and non-CVS stores or that bought exclusively at non-CVS stores. These groups are mutually exclusive. In both studies, we explored effect modification by greater baseline cigarette consumption: 3-or-more-pack purchasers bought 3 or more packs during the baseline period, the equivalent of 1 pack per month in the cohort study's baseline period, admittedly a low cutpoint. We wanted to test the hypothesis that even at low consumption levels, CVS-exclusive purchasers who consumed even slightly more cigarettes were more likely to show disruption in their cigarette purchasing behaviors as a result of CVS's action, and therefore might be more likely to stop purchasing cigarettes altogether.

State-level studies. In our primary population-level analysis, we compared 13 intervention-group states (AL, FL, GA, IL, IN, MD, NV, NY, NC, OH, PN, SC, VA) where CVS had market share of 15% or higher (based on all retail sales) to a control group of the only 3 states with no CVS Pharmacy retail stores (CO, OR, WA). To assess whether there was a dose-response association between CVS market share and cigarette purchasing after tobacco removal, we next analyzed data from all 26 states with any value of CVS market share, using the log of CVS Pharmacy's market share (to account for the observed nonlinear pattern that as market share increased, changes in cigarette purchasing diminished, the phenomenon known as the "law of diminishing returns") as a continuous exposure.

Outcomes and Censoring

Household-level studies. A household stopped cigarette purchasing when no cigarette purchases were made during any 6-month span in the follow-up period. In the open cohort study with a 12-month follow-up period, the outcome was specified as the first month after the 6-month criterion was

met, because, by definition, the outcome was not possible to ascertain until the full 6 months had passed. We censored households at the first month when no consumer good purchases were reported (indicating that the household had left the panel), occurrence of the outcome, or the end follow-up. In the difference-in-differences sensitivity analysis, the follow-up period was 6 months, so we assessed the outcome only once, at the very end of the follow-up period.

State-level studies. The state-level outcome was cigarette packs per smoker, calculated for each state as purchased cigarette packs divided by the state's number of adult smokers. Each state's smoking population was estimated as the number of adults (from the American Community Survey)¹¹ times the prevalence of adult smokers (from the Behavioral Risk Factor Surveillance System),¹² each updated yearly for 2012 to 2014; 2015 data were not yet available, so we used 2014 data again.

Statistical Analysis

Household-level studies. In the cohort study, descriptive statistics depict household characteristics and cigarette purchasing frequency (number of cigarette purchase transactions during the baseline period) and volume (number of cigarette packs during the baseline period for all and ≥ 3 pack purchasers). We calculated unadjusted risks (number of households that stopped cigarette purchasing divided by total households) and rates (number of households that stopped cigarette purchasing divided by household-months). We calculated household-months as the sum of the months contributed by each household before having the outcome or being censored. We evaluated the unadjusted and adjusted hazards of stopping cigarette purchases by using Cox proportional hazards models and generalized estimating equations to account for repeated measurements across households.^{13,14} Adjusted models included all household demographic characteristics. We also adjusted for baseline cigarette purchasing frequency and purchasing volume, as we anticipated that these might differ substantially between CVS-exclusive and other purchasers.

In the cross-sectional study, we calculated the same descriptive statistics and unadjusted

risks as described previously. In a multivariable logistic regression, we compared changes in stopping cigarette purchasing between the tobacco removal period and the comparison period occurring 1 year before for CVS-exclusive versus mixed purchasers, adjusting for all covariates described previously, including purchasing frequency and volume. Because of the rarity of the outcome, the resulting odds ratio approximated a risk ratio.

State-level studies. For each interrupted time series, linear regression models allowed for an immediate-level change in September 2014 at tobacco removal and a postremoval slope change to assess longer-term trend effects. All models used generalized estimating equations to account for repeated measurements.^{13,14} We adjusted for known seasonality in cigarette purchasing (e.g., New Year's resolutions to quit smoking) with quarterly indicators and for state-specific, time-varying tobacco control and health care program changes that might influence cigarette purchasing: cigarette taxes,¹⁵ Medicaid expansion (or not) that expanded access to smoking cessation resources,¹⁶ and the yearly ratio of a state's tobacco control spending to the Centers for Disease Control and Prevention's recommended spending for that state.^{17,18} Using only the statistically significant parameter result (slope change), we quantified how many fewer packs were purchased per smoker over the 8-month follow-up by summing the results across the 8 months:

$$(1) \quad (\text{slope change} * \text{month } 1) \\ + (\text{slope change} * \text{month } 2) + \dots \\ + (\text{slope change} * \text{month } 8).$$

We then extrapolated this result to calculate how many fewer packs were purchased in states with CVS market share of greater than or equal to 15% over the 8 months after removal by multiplying the pack purchasing changes per adult smoker in the 8 months by the total estimated adult smokers in each of the states with CVS market share greater than or equal to 15%, and then summed all these states' results. We then calculated the percentage change in pack purchases in these states over the 8 months after removal by comparing how many fewer packs were purchased to the estimated total pack

purchases in these states had tobacco removal from CVS not occurred.

RESULTS

Results from the household-level studies are described first, followed by those from the state-level studies.

Household-Level Studies

In the cohort study, 8952 households purchased cigarettes during baseline, with 5366 purchasing 3 or more packs (Table A, available as a supplement to the online version of this article at <http://www.ajph.org>). Among all purchasers, CVS-exclusive purchasers (29%) were more likely to be employed in professional, managerial, or administrator jobs compared with CVS+ (22%) or other-exclusive (22%) purchasers. Fully 42% of CVS-exclusive purchasers reported household incomes greater than or equal to \$60 000, compared with CVS+ (30%) and other-exclusive purchasers (28%).

Compared with only 16% of CVS-exclusive purchasers who bought cigarettes in all 3 baseline months (June–August 2014), 65% of CVS+ purchasers bought cigarettes in all 3 baseline months (Table 1). During the 3-month baseline period, CVS-exclusive purchasers bought fewer cigarette packs (mean = 13, [SD = 25]; compared with mean = 41, [SD = 42] for CVS+ and mean = 30, [SD = 44] for other-exclusive purchasers).

Among all purchasers in adjusted models, CVS-exclusive purchasers' rates of stopping cigarette purchases (0.04 per household-month) were at least twice as high as rates among CVS+ (0.01 per household-month) and other-exclusive (0.02 per household-month) purchasers (Table 2). Compared with other-exclusive purchasers, CVS-exclusive purchasers were 38% more likely (95% confidence interval [CI] = 1.06, 1.81) to stop cigarette purchases, with adjustment for all other factors. The likelihood was even greater for 3-or-more-pack purchasers buying exclusively at CVS (hazard ratio [HR] = 2.31; 95% CI = 1.55, 3.44). CVS+ purchasers' likelihood of stopping cigarette purchases was comparable with that of other-exclusive purchasers: among all smokers

TABLE 1—Cigarette Pack Purchasing Frequency and Volume in the Baseline Period: Household-Level Cohort Study, United States, June–August 2014

Variable	CVS Exclusive	CVS+	Other-Exclusive	P
All purchasers^a				
No.	185	453	8314	
Pack frequency, no. (%)				
≥ 1 pack in only 1 mo	128 (69)	44 (10)	3560 (43)	<.001
≥ 1 pack in each of 2 mo	27 (15)	114 (25)	1894 (23)	
≥ 1 pack in each of 3 mo	30 (16)	295 (65)	2860 (34)	
Pack volume^b				
At CVS, mean ±SD	13 ±25	15 ±25	0	<.001
At CVS, median (IQR)	4 (2–12)	5 (2–16)	0	
At all other non-CVS retailers, mean ±SD	0	26 ±34	30 ±44	
At all other non-CVS retailers, median (IQR)	0	13 (4–33)	10 (3–38)	
At any retailer, mean ±SD	13 ±25	41 ±42	30 ±44	
At any retailer, median (IQR)	4 (2–12)	26 (11–60)	10 (3–38)	
≥ 3 pack purchasers^c				
No.	88	326	4952	
Pack frequency, no. (%)				
≥ 1 pack in only 1 mo	59 (67)	38 (12)	1673 (34)	<.001
≥ 1 pack in each of 2 mo	8 (9)	55 (17)	1011 (20)	
≥ 1 pack in each of 3 mo	21 (24)	233 (71)	2268 (46)	
Pack volume				
At CVS, mean ±SD	25 ±33	19 ±28	0	<.001
At CVS, median (IQR)	12 (6–24)	8 (2–24)	0	
At all other non-CVS retailers, mean ±SD	0	34 ±36	46 ±50	
At all other non-CVS retailers, median (IQR)	0	20 (10–49)	29 (10–66)	
At any retailer, mean ±SD	25 ±33	53 ±44	46 ±50	
At any retailer, median (IQR)	12 (6–24)	40 (20–77)	29 (10–66)	

Note. IQR = interquartile range. CVS-exclusive purchasers only bought cigarettes at CVS, CVS+ purchasers bought at both CVS and non-CVS stores, and other-exclusive purchasers bought exclusively at non-CVS locations.

^aAll purchasers were households that purchased at least 1 cigarette pack in the baseline period.

^bPack volume was the sum of all cigarette pack purchases in the baseline period, June–August 2014. Only 1 pack purchase is required during the 3-mo period.

^c≥ 3 pack purchasers were households that purchased at least 3 cigarette packs in the baseline period.

(HR = 0.82; 95% CI = 0.61, 1.09); among 3-or-more-pack purchasers (HR = 0.81; 95% CI = 0.55, 1.22).

The difference-in-differences sensitivity study's household demographic characteristics and cigarette purchasing frequency and volume were similar to those in the cohort study (data not shown). Among all households there were 121 CVS-exclusive and 4914 mixed purchasers in the pre-tobacco-removal period (baseline = July–Aug 2013; follow-up = September 2013–April 2014) and 94 CVS-exclusive and 4884 mixed purchasers in the comparator post-tobacco-removal period (baseline = July–Aug 2014; follow-up = September 2014–April 2015). Among 3-or-more-pack purchasers, there

were 60 CVS-exclusive and 3503 mixed purchasers in the pre- and 51 CVS exclusive and 3416 mixed purchasers in the post-tobacco-removal periods. CVS-exclusive purchasers' likelihood of stopping cigarette purchases increased 10% (all purchasers) and 20% (≥ 3 pack purchasers) in the post-tobacco-removal period, whereas mixed purchasers' risk did not change (Table 3). When we adjusted for all covariates including baseline purchasing frequency and volume, CVS exclusive purchasers had a higher likelihood of stopping purchases versus mixed purchasers: mixed purchasers' risk ratio was 2.14 (95% CI = 1.02, 4.46); 3-or-more-pack purchasers' risk ratio was 6.04 (95% CI = 1.45, 25.16).

State-Level Studies

In 2012, the smoking prevalence ranged from 12.6% in California to 28.3% in Kentucky (Table B, available as a supplement to the online version of this article at <http://www.ajph.org>) and generally decreased with time. Cigarette taxes were largely stable. Thirteen states expanded Medicaid in 2014; 2 in 2015.

After tobacco removal, there was no short-term change in cigarette pack purchases between intervention and control states (Table 4). However, over the 8-month follow-up, compared with control-state smokers, intervention-state smokers did decrease cigarette purchases after tobacco removal by a mean of 0.14 (95% confidence interval [CI] = 0.06, 0.22) packs per smoker per month. On average, in the 8 months after removal, intervention state smokers reduced purchasing by an additional mean of 5.31 (95% CI = 2.25, 8.36) packs. Similarly, increasing CVS market share was not associated with a short-term change in pack purchases, but each 5% increase in CVS market share was associated with a mean decrease of 0.15 (95% CI = 0.01, 0.29) packs per smoker per month.

DISCUSSION

To our knowledge, this is the first study to evaluate the impact of a large retail company's decision to end cigarette sales on unique household and population-level cigarette purchasing. Our findings suggest that the decision to eliminate cigarette sales at 1 retail pharmacy chain had a meaningful effect on cigarette purchasing behavior. Although some consumers of tobacco products at CVS certainly altered their cigarette purchasing locations when cigarettes became unavailable at CVS, our findings demonstrate that other CVS tobacco consumers purchased less tobacco.

In survival analyses, households that had purchased cigarettes exclusively at CVS Pharmacy were 38% more likely to stop buying cigarettes after CVS stopped tobacco sales, and those CVS Pharmacy consumers who bought more cigarettes, "3-or-more-pack purchasers," were more than twice as likely to stop buying cigarettes, likely reflecting the greater disruption in their

TABLE 2—Risk, Rate, and Hazards of Stopping Cigarette Purchasing During the Follow-Up Period: Household-Level Cohort Study, United States, September 2014–August 2015

Variable	Risk of Stopping Cigarette Purchasing, ^a No. (%)			Rate of Stopping Cigarette Purchasing, per Household-Month ^b			Unadjusted HR (95% CI) ^c		Adjusted HR ^{c,d} (95% CI)	
	CVS-Exclusive Purchasers	CVS+ Purchasers	Other-Exclusive Purchasers	CVS-Exclusive Purchasers	CVS+ Purchasers	Other-Exclusive Purchasers	CVS-Exclusive Purchasers	CVS+ Purchasers	CVS-Exclusive Purchasers	CVS+ Purchasers
All purchasers ^e	58 (31)	49 (11)	1582 (19)	0.04	0.01	0.02	2.44 (1.88, 3.17)	0.43 (0.32, 0.57)	1.38 (1.06, 1.81)	0.82 (0.61, 1.09)
≥ 3 pack purchasers ^f	27 (31)	26 (8)	661 (13)	0.04	0.01	0.02	3.76 (2.56, 5.52)	0.51 (0.34, 0.75)	2.31 (1.55, 3.44)	0.81 (0.55, 1.22)

Note. CI = confidence interval; HR = hazard ratio. CVS-exclusive purchasers only bought cigarettes at CVS, CVS+ purchasers bought at both CVS and non-CVS stores, and other-exclusive purchasers bought exclusively at non-CVS locations.

^aUnadjusted risks were calculated as the number of households that stopped cigarette purchasing divided by total households.

^bUnadjusted rates were calculated as the number of households that stopped cigarette purchasing divided by household-months. Household-months were calculated as the sum of the months contributed by each household before having the outcome or being censored.

^cThe reference group for each model is households that exclusively purchased cigarettes at other retailers, “Other-exclusive purchasers.”

^dModel adjusted for head of household’s age, gender, race, Hispanic ethnicity, education level, marital status, and employment type; household’s income, household size, presence of children in the household, and whether residence is rented or owned; baseline cigarette pack purchasing frequency; and baseline cigarette pack purchasing volume.

^eAll purchasers purchased ≥ 1 pack of cigarettes during the baseline period.

^f≥ 3-pack purchasers purchased ≥ 3 packs of cigarettes during the baseline period.

tobacco use and purchasing behaviors when CVS removed tobacco. Separate difference-in-differences analyses corroborated these findings. Similarly, at the population level, in the 13 states with greater than or equal to 15% CVS Pharmacy retail market share, consumers purchased 95 million fewer packs of

cigarettes over the 8 months subsequent to tobacco removal (equivalent to 5 fewer packs per smoker), representing a 1% reduction in sales in these states. In another population-level analysis, we observed a dose-response relationship between CVS Pharmacy retail market share and reductions in cigarette

purchasing that confirmed the directionality and magnitude of the intervention versus control state findings.

We used numerous approaches and data sources, as each had limitations. We characterized households as having stopped purchasing cigarettes, but we were unable to

TABLE 3—Impact of CVS’s Tobacco Removal on Stopping Cigarette Purchasing: Household-Level Cross-Sectional Difference-in-Differences Study, United States

Variable	Households Who Stopped Cigarette Purchasing, No. (%)		Difference in Stopping Cigarette Purchasing, %		Likelihood of Stopping Cigarette Purchasing, ^e RR (95% CI)	
	Comparison Follow-Up Period ^a	Tobacco Removal Follow-Up Period ^b	Between Periods ^c	Between Purchasers ^{d,e}	Unadjusted	Adjusted ^f
All purchasers ^g				10		
CVS-exclusive purchasers	20 (17)	25 (27)	10		1.78 (0.91, 3.49)	2.14 (1.02, 4.46)
Mixed purchasers	578 (12)	589 (12)	0		1 (Ref)	1 (Ref)
≥ 3 pack purchasers ^h				20		
CVS-exclusive purchasers	3 (5)	13 (25)	20		6.81 (1.79, 25.87)	6.04 (1.45, 25.16)
Mixed purchasers	226 (6)	211 (6)	0		1 (Ref)	1 (Ref)

Note. CI = confidence interval; RR = risk ratio. CVS-exclusive purchasers only bought cigarettes at CVS, and mixed purchasers bought cigarettes at both CVS and non-CVS stores or that bought exclusively at non-CVS stores.

^aSeptember 2013–February 2014.

^bSeptember 2014–February 2015.

^cBetween the tobacco removal period and comparison period.

^dDifference in differences.

^eAssociated with CVS tobacco removal.

^fModel adjusted for head of household’s age, gender, race, Hispanic ethnicity, education level, marital status, and employment type; household’s income, household size, presence of children in the household, and whether residence is rented or owned; baseline cigarette pack purchasing frequency; and baseline cigarette pack purchasing volume.

^gAll purchasers bought ≥ 1 pack of cigarettes during the baseline period.

^h≥ 3-pack purchasers bought ≥ 3 packs of cigarettes during the baseline period.

TABLE 4—Reductions in Cigarette Pack Purchases Per Smoker After CVS Tobacco Removal: State-Level Interrupted Time Series Study, United States

Variable	Cigarette Packs Purchased Per Smoker, Mean (95% CI)		
	Intercept Change, Sep 2014	Long-Term Slope Change, Per Month, Sep 2014–Apr 2016	Total Reduction in the 8 Mo After CVS Tobacco Removal, ^a
Analysis 1 ^b	0.52 (−0.12, 1.15)	−0.14 (−0.22, −0.06)	−5.31 (−8.36, −2.25)
Analysis 2 ^c	−0.19 (−1.26, 0.87)	−0.15 (−0.29, −0.01)	−5.27 (−10.31, −0.23)

Note. CI = confidence interval. The total reduction in states with $\geq 15\%$ market share in the 8 months after CVS tobacco removal, calculated by multiplying the -5.31 packs purchased per smoker result by the estimated number of adult smokers in all states with $\geq 15\%$ CVS market share, in millions, was mean = -95.2 (95% CI = $-38.6, -151.8$).

^aCalculated by using only the statistically significant, long-term slope change from months 1–8 after tobacco removal: $(-0.14*1) + (-0.14*2) + (-0.14*3) + (-0.14*4) + (-0.14*5) + (-0.14*6) + (-0.14*7) + (-0.14*8)$.

^bStates with $\geq 15\%$ CVS market share vs states with no CVS stores (16 states).

^cPer 5% increase in CVS market share (26 states).

confirm smokers' actual quitting efforts or intentions.¹⁹ We were similarly unable to determine whether single or multiple smokers resided within a household, so our analyses may underestimate effects. Recognizing disparities in baseline characteristics between exposure groups, we explicitly adjusted for cigarette pack purchasing volume, purchasing frequency, and demographics in analyses. Although survey households may not have been generalizable to the broader population of smokers who did not opt in to a household survey or to residents of a particular state, the CVS decision was associated with a reduction in cigarette purchasing among CVS-exclusive purchasers, and this reduction suggests that the decision was effective in tobacco harm reduction.

Several other issues deserve mention. The retail point-of-sale data were more generalizable, but did not allow for the identification of unique individuals or households and their longitudinal cigarette purchasing patterns. However, we estimated the number of adult smokers in a state to determine the denominator, and looked at a comprehensive sample of retailers selling tobacco to assess overall cigarette sales. Moreover, the September 4 tobacco removal date occurred a full month before the timeline communicated to the public, reducing the likelihood that people switched their purchasing behaviors right before the removal date (e.g., stockpiling cigarette purchases from CVS or leaving abruptly, which would have biased the analyses).

We were unaware of any specific tobacco-cessation efforts that occurred at the same time, but we cannot exclude the

possibility. In a related vein, 2015 Behavioral Risk Factor Surveillance System data were not available, so we used 2014 data for both 2014 and 2015 smoking prevalence. To address threats to the validity, analyses included both historical and concurrent controls, to take into account the underlying decline in smoking prevalence in the United States,³ the rising popularity of electronic nicotine-delivery devices, and other trends.

Finally, we were only able to include 26 states in our analyses. Because excluded states might differ from included states in important factors (e.g., greater cigarette purchasing because of higher nicotine consumption), we cannot ensure the generalizability of the study to all 50 states. However, our analyses relied on IRi data, widely regarded as among the best available, highly accurate data to understand consumer purchasing.²⁰ Taken together, we are reassured that multiple study designs, data sources, and analytic approaches produced consistent results, both in direction and magnitude.

Overall, our results are consistent with those from the broader tobacco literature. Multiple studies examining the impact of restricting tobacco access have observed reductions in tobacco use similar or greater in magnitude to those we observed. In 2011, New York City implemented a sales ban on flavored noncigarette tobacco products (e.g., cigars and smokeless tobacco). Compared with sales in 10 proximal counties, the ban was associated with a 10.2% greater absolute decrease ($P < .01$) in flavored noncigarette tobacco sales.²¹ Raising the tobacco purchasing age from 18 to 21 years in 1 suburban Massachusetts community was associated with a 6 percentage point decline

in smoking prevalence (from 13% in 2006 to 7% in 2010) among high-school youths, compared with a 3 percentage point decline in 16 surrounding communities.⁸

In this study, we found that a large, nationwide retailer's decision to remove tobacco from its stores meaningfully reduced household-level and population-level cigarette purchasing and, thus, presumably, consumption. Our findings have implications for public health professionals seeking to further reduce tobacco use. Currently, many large retailers in the United States sell cigarettes, including multiple pharmacy chains.^{22,23} Our research indicates that if these retailers, particularly pharmacies, stop selling cigarettes, there would be an overall reduction in tobacco consumption, and, as a result, a substantial health benefit. The findings from this study highlight another strategy that can reduce tobacco use and improve the nation's health. **AJPH**

CONTRIBUTORS

J. M. Polinski conceptualized and designed the study, acquired data, performed analyses, and wrote the article. B. Howell, M. A. Gagnon, and S. M. Kymes designed the study, performed analyses, and revised the article. T. A. Brennan and W. H. Shrank conceptualized and designed the study and revised the article.

ACKNOWLEDGMENTS

CVS Health funded the study and was involved in the design and conduct of the study; collection, management and analysis, and interpretation of the data; and preparation, review, and approval of the article.

Note. J. M. Polinski, B. Howell, and T. A. Brennan are all employees of CVS Health and hold stock in CVS Health. M. A. Gagnon is an employee of CVS Health. At the time of the study, S. M. Kymes and W. H. Shrank were employees of CVS Health. S. M. Kymes holds stock in CVS Health. IRi was involved in the collection and management of the data, which CVS Health purchased

from IRI. IRI reviewed the article, but CVS Health retained full control over the study's execution, writing the article, and the decision to submit the article for publication.

HUMAN PARTICIPANT PROTECTION

All data were de-identified household panel survey data. There were not individual participants.

REFERENCES

- Centers for Disease Control and Prevention. Quick-Stats: number of deaths from 10 leading causes—National Vital Statistics System, United States, 2010. *MMWR Morbid Mortal Wkly Rep.* 2013;62(8):155.
- US Department of Health and Human Services. *The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General.* 2014. Available at: <http://www.surgeongeneral.gov/library/reports/50-years-of-progress>. Accessed February 2, 2016.
- King BA, Dube SR, Tynan MA. Current tobacco use among adults in the United States: findings from the national Adult Tobacco Survey. *Am J Public Health.* 2012; 102(11):e93–e100.
- Jamal A, Homa DM, O'Connor E, et al. Current cigarette smoking among adults—United States, 2005–2014. *MMWR Morbid Mortal Wkly Rep.* 2015;64(44): 1233–1240.
- Brennan TA, Schroeder SA. Ending sales of tobacco products in pharmacies. *JAMA.* 2014;311(11): 1105–1106.
- Brennan TA, Shrank WH, Sussman A, et al. The effect of a policy to eliminate sales of tobacco in pharmacies on the number of smokers in the region. CVS Health. 2014. Available at: http://www.cvshealth.com/sites/default/files/styles/TobaccoPolicyResearchLetter_Final.pdf. Accessed February 2, 2016.
- Kessel Schneider S, Buka SL, Dash K, Winickoff JP, O'Donnell L. Community reductions in youth smoking after raising the minimum tobacco sales age to 21. *Tob Control.* 2016;25(3):355–359.
- CVS Health. We're tobacco free. 2014. Available at: <https://cvshealth.com/thought-leadership/we-are-tobacco-free>. Accessed February 2, 2016.
- IRI Worldwide. National Consumer Panel, IRI's Consumer Network. Available at: <http://www.iriworldwide.com>. Accessed February 2, 2016.
- Nielsen Company. TV ratings. Available at: <http://www.nielsen.com/us/en/solutions/measurement/television.html>. Accessed February 2, 2016.
- American Community Survey. Available at: <https://www.census.gov/programs-surveys/acs/data.html>. Accessed February 2, 2016.
- Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System. Available at: https://www.cdc.gov/brfss/data_documentation/index.htm. Accessed February 2, 2016.
- Liang KY, Zeger SL. Longitudinal data analysis using generalized linear models. *Biometrika.* 1986;73(1):13–22.
- Liang KY, Zeger SL. Regression analysis for correlated data. *Annu Rev Public Health.* 1993;14:43–68.
- Tax Policy Center. Cigarette taxes, 2001–2015. Available at: <http://www.taxpolicycenter.org/taxfacts/displayafact.cfm?Docid=433>. Accessed February 2, 2016.
- Medicaid.gov. State Medicaid and CHIP profiles. Available at: <https://www.medicaid.gov/medicaid-chip-program-information/by-state/by-state.html>. Accessed February 2, 2016.
- Campaign for Tobacco-Free Kids. History of spending for state tobacco prevention programs FY2008–FY2015. Available at: http://www.tobaccofreekids.org/content/what_we_do/state_local_issues/settlement/FY2015/2014_12_11_history_tobacco_prevention.pdf. Accessed February 2, 2016.
- Campaign for Tobacco-Free Kids. Broken promises to our children: a state-by-state look at the 1998 state tobacco settlement 16 years later. Available at: http://www.tobaccofreekids.org/content/what_we_do/state_local_issues/settlement/FY2015/2014_12_11_brokenpromises_report.pdf. Accessed February 2, 2016.
- Malarcher A, Dube S, Shaw L, Babb S, Kaufmann R. Quitting smoking among adults—United States, 2001–2010. *MMWR Morbid Mortal Wkly Rep.* 2011;60(44): 1513–1519.
- IRI Worldwide. Facts about us. Available at: <http://www.iriworldwide.com/en-US/company/about-IRI>. Accessed February 2, 2016.
- Rogers T, Gammon D, Loomis BR, et al. Controlled evaluation of the impact of the New York City ban on the sale of flavored non-cigarette tobacco products. Paper presented at: 2015 Annual Meeting of the American Public Health Association; November 4, 2015; Chicago, IL. Available at: <https://apha.confex.com/apha/143am/webprogram/Paper323974.html>. Accessed February 2, 2016.
- Japsen B. Why Walgreen's won't stop selling tobacco like CVS Health. *Forbes.* September 4, 2014. Available at: <http://www.forbes.com/sites/brucejapsen/2014/09/04/why-walgreen-wont-stop-selling-tobacco-like-cvs-health/#77551c3e484e>. Accessed February 2, 2016.
- EIN Newsdesk. Retailers with pharmacies: halt all tobacco sales, says American Lung Association. 2015. Available at: http://www.einnews.com/pr_news/248341585/retailers-with-pharmacies-halt-all-tobacco-sales-says-american-lung-association. Accessed February 2, 2016.