Title: Cross-sectional and Longitudinal Associations of Local Cigarette Prices and Smoking Bans with Smoking Behavior in the Multi-Ethnic Study of Atherosclerosis

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Supplemental Table 1. Included versus Excluded Participants for Alternative Store Buffers

Sample Characteristics	2 Mile Buffer At each person's first exam			3 Mile Buffer At each person's first exam			5 Mile Buffer At each person's first exam		
	Included	Excluded	P-value[a]	Included	Excluded	P-value[a]	Included	Excluded	P-value[a]
N	3,163	3,651		4,884	1,930		5,796	1,018	
Demographic Characteristics									
Mean age (SD)	61.7 (10.1)	62.5 (10.3)	0.0008	61.5 (10.1)	63.8 (10.4)	<0.0001	61.8 (10.2)	64.1 (10.4)	<0.0001
Gender (%)			0.8			0.3			0.5
Male	1,496 (47.3)	1,717 (47.0)		2,285 (46.8)	928 (48.1)		2,743 (47.3)	470 (46.2)	
Female	1,667 (52.7)	1,934 (53.0)		2,599 (53.2)	1,002 (51.9)		3,035 (52.7)	548 (53.8)	
Race (%)			<0.0001			<0.0001			<0.0001
White	1,284 (40.6)	1,338 (36.7)		1,972 (40.4)	650 (33.7)		2,305 (39.8)	317 (31.1)	
Chinese	656 (20.7)	148 (4.1)		710 (14.5)	94 (4.9)		726 (12.5)	78 (7.7)	
Black/African American	533 (16.9)	1,359 (37.2)		1,053 (21.6)	839 (43.5)		1,457 (25.1)	435 (42.7)	
Hispanic	690 (21.8)	806 (22.1)		1,149 (23.5)	347 (18.0)		1,308 (87.4)	188 (18.5)	
Education (%)			0.0005			0.03			<0.0001
≤ High school graduate	1,098 (34.7)	1,363 (37.6)		1,742 (36.7)	719 (37.7)		2,053 (35.4)	408 (41.0)	
Some college	874 (27.6)	1,063 (29.3)		1,373 (28.1)	564 (29.6)		1,621 (28.0)	316 (31.8)	
≥ Bachelor's degree	1,191 (37.7)	1,202 (33.1)		1,769 (36.2)	624 (32.7)		2,122 (36.6)	271 (27.2)	
Currently employed (%)	1,739 (55.0)	1,873 (51.5)	0.004	2,729 (55.9)	883 (46.1)	<0.0001	3,184 (54.9)	428 (42.7)	<0.0001
Mean inflation-adjusted household income per capita, $10,000 (SD)									
	2.7 (2.2)	2.5 (1.9)	0.0003	2.6 (2.1)	2.5 (2.0)	0.06	2.6 (2.1)	2.3 (1.9)	<0.0001
Currently married (%)	1,986 (63.8)	2,153 (59.1)	0.002	3,027 (62.0)	1,112 (57.8)	0.002	3,569 (61.6)	570 (56.4)	0.002
Health Behaviors									
Current Alcohol Use (%)	1,738 (55.0)	2,031 (55.7)	0.5	2,781 (56.9)	988 (51.3)	<0.0001	3,258 (56.2)	511 (50.4)	0.0007
Smoking Status (%)			<0.0001			0.0008			0.001
Never smoker	1,698 (53.7)	1,720 (47.4)		2,518 (51.5)	900 (47.2)		2,947 (50.8)	471 (47.3)	
Former smoker	1,106 (35.0)	1,381 (38.1)		1,766 (36.2)	721 (37.8)		2,127 (36.7)	360 (36.1)	
Current smoker	359 (11.3)	528 (14.5)		600 (12.3)	287 (15.0)		722 (12.5)	165 (16.6)	
Mean number of cigarettes smoked per day by baseline smokers (SD)	12.5 (10.7)	14.4 (19.9)	0.06	13.2 (19.0)	14.6 (10.8)	0.1	13.3 (18.0)	15.2 (9.7)	0.07

Supplemental Table 1 Continued.

Sample Characteristics	2 Mile Buffer At each person's first exam			3 Mile Buffer At each person's first exam			5 Mile Buffer At each person's first exam		
	Included	Excluded	P-value [a]	Included	Excluded	P-value [a]	Included	Excluded	P-value [a]
Neighborhood Characteristics									
Mean neighborhood socioeconomic score (SD)	1.12 (6.31)	-1.08 (6.09)	<0.0001	0.26 (6.39)	-0.76 (5.87)	<0.0001	0.08 (6.43)	-0.49 (3.88)	0.008
Study Site			<0.0001			<0.0001			<0.0001
North Carolina	403 (12.7)	674 (18.5)		596 (12.2)	481 (24.9)		819 (14.1)	258 (25.3)	
New York	581 (18.4)	521 (14.3)		908 (18.6)	194 (10.1)		1,005 (17.3)	97 (9.5)	
Maryland	294 (9.3)	792 (21.7)		629 (12.9)	457 (23.7)		923 (15.9)	163 (16.0)	
Minnesota	399 (12.6)	667 (18.3)		890 (18.2)	176 (9.1)		943 (16.3)	123 (12.1)	
Illinois	647 (20.5)	517 (14.2)		796 (16.3)	368 (19.1)		943 (16.3)	221 (21.7)	
California	839 (26.5)	480 (13.2)		1,065 (21.8)	254 (13.2)		1,163 (20.1)	156 (11.8)	

[a]p-values from chi-squared or t-tests

Supplemental Table 2. Associations between Cigarette Pack Price and Smoking Outcomes, The Multi-Ethnic Study of Atherosclerosis 2000-2010: Sensitivity Analyses using 5-mile and 2-mile Buffers

Longitudinal Models (Years 0-10)- Binary Outcomes[a]			
5 mile buffer		**2 mile buffer**	
Association of a $1 increase in cigarette pack price with:	**Risk Ratio (95% CI)**	Association of a $1 increase in cigarette pack price with:	**Risk Ratio (95% CI)**
Current smoking (current versus not current)- N=766	0.96 (0.93, 1.00)	Current smoking (current versus not current)- N=317	0.96 (0.91, 1.02)
Heavy smoking (≥10 cigarettes per day versus <10) - N=471	0.91 (0.86, 0.97)	Heavy smoking (≥10 cigarettes per day versus <10) - N=188	0.92 (0.85, 0.99)
Smoking cessation (versus not)- N=336	1.11 (0.90, 1.36)	Smoking cessation (versus not) – N=117	1.40 (1.07, 1.85)
Relapse (versus not) - N=149	0.95 (0.65, 1.41)	Relapse (versus not) - N=59	0.70 (0.50, 0.99)

Longitudinal Models (Years 0-10)- Linear Smoking Intensity Model[b]					
5 mile buffer			**2 mile buffer**		
Association of a $1 increase in cigarette price with outcome among:	Average change in ln(cigarettes smoked per day) (95% CI)	Ratio of geometric means (95% CI)	Association of a $1 increase in cigarette price with:	Average change in ln(cigarettes smoked per day) (95% CI)	Ratio of geometric means (95% CI)
All participants who smoked during follow-up- N=790	-0.27 (-0.54, 0.01)	0.76 (0.58, 1.01)	All participants who smoked during follow-up- N=358	-0.52 (-0.91, -0.13)	0.59 (0.40, 0.88)
Heavy baseline Smokers (≥10 per day)- N=412	-0.32 (-0.68, 0.05)	0.73 (0.51, 1.05)	Heavy baseline Smokers (≥10 per day)- N=186	-0.83 (-1.37, -0.29)	0.44 (0.25, 0.75)
Light baseline smokers (<10 per day)- N=378	-0.19 (-0.60, 0.21)	0.83 (0.55, 1.23)	Light baseline smokers (<10 per day)- N=172	-0.56 (-1.17, 0.05)	0.57 (0.31, 1.05)

Supplemental Table 2 footnotes

[a]Estimated using fixed effects Poisson models with robust variance estimates. Conditional fixed effects models only include participants with a change in the outcome over the follow-up period. Model adjusted for time since baseline and time-varying income, marital status, employment status, current alcohol use, and neighborhood socioeconomic status. Quadratic terms (years-squared) were retained for smoking cessation and relapse to provide more robust control for secular trends. Interactions between time-invariant covariates and time were retained if significant at the $p<0.05$ level to allow associations with the outcome to vary over time.

[b]Estimated using linear fixed effects models with natural log-transformed number of cigarettes smoked per day as the outcome, among all participants and stratified by baseline smoking intensity (heavy- ≥10 per day, versus light- <10 per day). Model adjusted for time since baseline and time-varying income, marital status, employment status, current alcohol use, and neighborhood socioeconomic status. Regression coefficients were exponentiated to reflect the ratio of geometric means, and can be interpreted as the percent change in the average number of cigarettes smoked per day associated with a $1 increase in cigarette price.

Supplemental Table 3. Sensitivity to Adjustment for Neighborhood Socio-economic Status.

Association of a $1 increase in cigarette pack price with smoking outcomes, before and after adjustment for neighborhood socio-economic status. The Multi-Ethnic Study of Atherosclerosis (MESA), 2000-2012.

	Risk Ratio[a] (95% Confidence Interval)	
	Model 1	Model 2
Current smoking (current versus not current). N=578	0.97 (0.93, 1.01)	0.97 (0.93, 1.01)
Heavy smoking (≥10 cigarettes per day versus <10). N=344	0.93 (0.87, 0.99)	0.93 (0.87, 0.99)
Smoking cessation (versus no cessation). N=238	1.19 (0.99, 1.44)	1.19 (0.99, 1.44)
Relapse (versus no relapse). N=109	0.90 (0.62, 1.31)	0.90 (0.62, 1.30)

	Average change in ln(cigarettes smoked per day) (95% CI)[b]		Ratio of geometric means (95% CI)[b]	
Association of a $1 increase in cigarette price with outcome among:	Model 1	Model 2	Model 1	Model 2
All participants who smoked during follow-up- N=632	-0.22 (-0.50, 0.06)	-0.21 (-0.49, 0.07)	0.80 (0.61, 1.06)	0.81 (0.61, 1.07)
Heavy baseline Smokers (≥10 per day)- N=326	-0.38 (-0.75, -0.01)	-0.37 (-0.74, -0.002)	0.68 (0.47, 0.99)	0.69 (0.48, 1.00)
Light baseline smokers (<10 per day)- N=306	-0.11 (-0.51, 0.29)	-0.11 (-0.51, 0.29)	0.90 (0.60, 1.34)	0.90 (0.60, 1.34)

[a]Estimated using fixed effects Poisson models with robust variance estimates. Conditional fixed effects models only include participants with a change in the outcome over the follow-up period. Model 1 adjusted for time since baseline (in years) and time-varying income, marital status, employment status, and current alcohol use. Model 2 adjusted for the variables in Model 1 + time-varying neighborhood socioeconomic status. A quadratic term (years-squared) was included for cessation and relapse models. Interactions between time-invariant covariates and time were retained if significant at the $p<0.05$ level to allow associations with the outcome to vary over time (sex*time was retained in the heavy smoking model and race*time in the cessation model)

[b]Estimated using linear fixed effects models with natural log-transformed number of cigarettes smoked per day as the outcome, among all participants and stratified by baseline smoking intensity (heavy- ≥10 per day, versus light- <10 per day). Model adjusted for time since baseline and time-varying income, marital status, employment status, current alcohol use, and neighborhood socioeconomic status. Regression coefficients were exponentiated to reflect the ratio of geometric means, and can be interpreted as the percent change in the average number of cigarettes smoked per day associated with a $1 increase in cigarette price.

Supplemental Table 4. Longitudinal Results, Within-Person Change in Smoking Using Year Dummies. Associations of Cigarette Pack Price and Exposure to Bar/Restaurant Smoking Ban Policies (Yes/No) and Within-Person Change in Smoking Outcomes, The Multi-Ethnic Study of Atherosclerosis 2000-2012.

A) Binary Smoking Outcomes

	Adjusted Risk Ratio [a]		
	(95% Confidence Interval)		
Smoking Outcomes and Exposures	**Model 1**	**Model 2**	**Model 3**
A. Current smoking (current versus not current). N=578			
$1 higher cigarette price	0.98 (0.93, 1.03)	---	0.97 (0.93, 1.02)
Smoking ban policy exposure (yes versus no) [b]	---	1.04 (0.94, 1.15)	1.05 (0.95, 1.16)
B. Heavy smoking (≥10 cigarettes per day versus <10). N=344			
$1 higher cigarette price	0.94 (0.88, 1.01)	---	0.94 (0.88, 1.01)
Smoking ban policy exposure (yes versus no) [b]	---	0.95 (0.79, 1.14)	0.97 (0.82, 1.16)
C. Smoking cessation (versus not). N=238			
$1 higher cigarette price	1.05 (0.87, 1.28)	---	1.06 (0.87, 1.28)
Smoking ban policy exposure (yes versus no) [b]	---	0.92 (0.56, 1.54)	0.92 (0.55, 1.53)
D. Relapse (versus no relapse). N=109			
$1 higher cigarette price	0.87 (0.61, 1.25)	---	0.87 (0.60, 1.25)
Smoking ban policy exposure (yes versus no) [b]	---	1.04 (0.44, 2.50)	1.06 (0.44, 2.52)

Supplemental Table 4 Continued.

B) Natural Log-Transformed Smoking Intensity

	Average change in ln(cigarettes smoked per day) (95% Confidence Interval)[c]		
Exposures	**Model 1**	**Model 2**	**Model 3**
Among all Smokers (N=632)			
$1 higher cigarette price	-0.20 (-0.53, 0.12)	---	-0.20 (-0.52, 0.12)
Smoking ban policy exposure (yes versus no) [b]	---	0.07 (-0.81, 0.67)	0.01 (-0.73, 0.74)
Among Heavy Baseline Smokers (N=326)			
$1 higher cigarette price	-0.40 (-0.81, 0.01)	---	-0.43 (-0.83, -0.03)
Smoking ban policy exposure (yes versus no) [b]	---	0.30 (-0.60, 1.20)	0.48 (-0.42, 1.37)
Among Light Baseline Smokers			
$1 higher cigarette price	-0.06 (-0.54, 0.42)	---	-0.04 (-0.52, 0.44)
Smoking ban policy exposure (yes versus no) [b]	---	-0.27 (-1.38, 0.85)	-0.25 (-1.36, 0.86)

[a] Risk ratios were estimated using fixed effects Poisson models with robust variance estimates only including participants with a change in the outcome over the follow-up period. Adjustment was for exam year (dummy coded) and time-varying income, marital status, employment status, current alcohol use, and neighborhood socioeconomic status. Additional adjustment in heavy smoking models was a sex*time interaction term; see Methods.

[b] Smoking ban exposure was lagged by 1 year to establish temporality by ensuring that policy implementation preceded outcome measurement.

[c] Estimated using linear fixed effects models with natural log-transformed number of cigarettes smoked per day as the outcome, among all participants and stratified by baseline smoking intensity (heavy- ≥10 per day, versus light- <10 per day). Model adjusted for exam year (dummy coded) and time-varying marital status, employment status, current alcohol use, and neighborhood socioeconomic status.

Supplemental Table 5. Cross-sectional Results. Associations of Cigarette Pack Price and Exposure to Bar/Restaurant Smoking Ban Policies (years) with Smoking Outcomes, The Multi-Ethnic Study of Atherosclerosis (2011-2012, Year 10)

Smoking Outcomes and Exposures	Adjusted Prevalence Ratio [a]		
	(95% Confidence Interval)		
	Model 1	Model 2	Model 3
A. Current smoking (current versus not current). N=2774			
$1 higher cigarette price	0.88 (0.77, 1.01)	---	0.89 (0.77, 1.02)
1 additional year exposed to smoking ban	---	0.91 (0.80, 1.03)	0.91 (0.80, 1.05)
B. Heavy smoking (≥10 cigarettes per day versus <10) N=343 [b]			
$1 higher cigarette price	0.77 (0.62, 0.95)	---	0.77 (0.62, 0.95)
1 additional year exposed to smoking ban	---	0.94 (0.82, 1.09)	0.94 (0.80, 1.11)
C. Relapse (versus no relapse). N=343 [b]			
$1 higher cigarette price	0.89 (0.61, 1.30)	---	0.89 (0.61, 1.32)
1 additional year exposed to smoking ban	---	0.72 (0.54, 0.94)	0.71 (0.54, 0.94)

[a] Prevalence ratios estimated using modified Poisson regression with robust variance estimates. Models 1-3 were adjusted for age, sex, race, education, marital status, income, employment, alcohol use, neighborhood socioeconomic status, and state of residence.

[b] Analyses was restricted to participants who ever smoked during follow-up.

Supplemental Table 6. Interactive Associations of Cigarette Pack Price and Bar/Restaurant Smoking Bans (yes/no) and within-person change in smoking outcomes, The Multi-Ethnic Study of Atherosclerosis 2000-2012[a,b]

	Risk Ratio (95% confidence interval)		
	Model 1	Model 2	Model 3
i) Current Smoking (N=575)			
$1 higher cigarette price	---	0.97 (0.93, 1.01)	0.97 (0.93, 1.02)
Smoking ban exposure (yes versus no)	1.01 (0.92, 1.11)	1.04 (0.94, 1.14)	1.04 (0.94, 1.16)
Price x Ban interaction	---	---	0.99 (0.92, 1.06)
Interaction p-value	---	---	**0.7**
Association of price when:			
No Smoking ban exposure	---	---	0.97 (0.93, 1.02)
Smoking ban exposure	---	---	0.96 (0.91, 1.02)
ii) Heavy Smoking (N=344)			
$1 higher cigarette price	---	0.94 (0.88, 0.99)	0.97 (0.90, 1.04)
Smoking ban exposure (yes versus no)	0.90 (0.78, 1.05)	0.95 (0.82, 1.11)	0.98 (0.83, 1.16)
Price x Ban interaction	---	---	0.94 (0.85, 1.04)
Interaction p-value	---	---	**0.2**
Association of price when:			
No Smoking ban exposure	---	---	0.97 (0.90, 1.04)
Smoking ban exposure	---	---	0.91 (0.83, 0.99)
iii) Smoking Cessation (N=238)			
$1 higher cigarette price	---	1.19 (0.99, 1.44)	1.12 (0.83, 1.52)
Smoking ban exposure (yes versus no)	0.90 (0.54, 1.49)	0.90 (0.54, 1.49)	0.88 (0.53, 1.47)
Price x Ban interaction	---	---	1.08 (0.82, 1.41)
Interaction p-value	---	---	**0.6**
Association of price when:			
No Smoking ban exposure	---	---	1.12 (0.83, 1.52)
Smoking ban exposure	---	---	1.21 (0.99, 1.46)
iv) Smoking Relapse (N=109)			
$1 higher cigarette price	---	0.89 (0.61, 1.30)	0.87 (0.47, 1.60)
Smoking ban exposure (yes versus no)	1.14 (0.50, 2.58)	1.15 (0.51, 2.64)	1.15 (0.51, 2.60)
Price x Ban interaction	---	---	1.04 (0.62, 1.76)
Interaction p-value	---	---	**0.9**
Association of price when:			
No Smoking ban exposure	---	---	0.87 (0.47, 1.60)
Smoking ban exposure	---	---	0.90 (0.62, 1.30)
	Average Change in ln(Cigarettes Smoked Per Day) (95% confidence interval)[c]		
	Model 1	Model 2	Model 3
v) Smoking Intensity (N=632)			
$1 higher cigarette price	---	-0.21 (-0.49, 0.06)	-0.20 (-0.54, 0.14)
Smoking ban exposure (yes versus no)	-0.06 (-0.76, 0.63)	0.08 (-0.60, 0.77)	0.09 (-0.64, 0.82)
Price x Ban interaction	---	---	-0.02 (-0.45, 0.40)
Interaction p-value	---	---	**0.9**
Association of price when:			
No Smoking ban exposure	---	---	-0.20 (-0.54, 0.14)
Smoking ban exposure	---	---	-0.22 (-0.56, 0.12)

Supplemental Table 6 footnotes

[a] Risk ratios estimated using fixed effects Poisson models with robust variance estimates. Conditional fixed effects models only include participants with a change in the outcome over the follow-up period. Models adjusted for time-varying years since baseline, income, marital status, employment status, current alcohol use, and neighborhood socioeconomic status. Models for cessation and relapse included a quadratic time term (years-squared). Interactions between time-invariant covariates and time were retained if significant at the $p<0.05$ level to allow associations with the outcome to vary over time (sex*time was retained in the heavy smoking model, race*time in the cessation model). Model 1 included smoking ban exposure status (yes/no) main effect only. Model 2 included both average cigarette pack price and smoking ban exposure status as main effects. In model 3, interactions between average cigarette pack price and smoking ban exposure status were added to Model 2.

[b] Smoking ban exposure was lagged by 1 year to establish temporality by ensuring that policy implementation preceded outcome measurement.

[c] Estimated using linear fixed effects models with natural log-transformed number of cigarettes smoked per day as the outcome, among all participants and stratified by baseline smoking intensity (heavy- ≥10 per day, versus light- <10 per day). Model adjusted for time since baseline and time-varying income, marital status, employment status, current alcohol use, and neighborhood socioeconomic status. Regression coefficients were exponentiated to reflect the ratio of geometric means, and can be interpreted as the percent change in the average number of cigarettes smoked per day associated with a $1 increase in cigarette price.