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RESEARCH PAPER

Effect of local restaurant smoking regulations on progression to established smoking among youths

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Background: While smoke-free restaurant laws are intended to protect the public from secondhand smoke exposure, they may also discourage smoking among adolescents. There is no evidence from longitudinal studies to test this hypothesis.
Objective: To examine the effect of local restaurant smoking regulations on progression to established smoking among adolescents.
Design, setting, and subjects: A cohort of 2623 Massachusetts youths, ages 12–17 years at baseline, was interviewed via random digit dial telephone survey in 2001–2002 and followed up two years later. A generalised estimating equations (GEE) logistic regression analysis was used and controlled for potential individual, household, and town level confounding factors.
Main outcome measure: Progression to established smoking during the two year follow up period (defined as having smoked 100 or more cigarettes in one's life).
Results: Compared to youths living in towns with weak regulations, those living in towns with strong regulations (complete restaurant smoking bans) had less than half the odds of progression to established smoking (odds ratio (OR) 0.39, 95% confidence interval (CI) 0.24 to 0.66). The association was stronger for youths in towns with strong regulations in effect for two or more years (OR 0.11, 95% CI 0.03 to 0.37), although it was still present for those in towns with strong regulations in effect for less than two years (OR 0.55, 95% CI 0.33 to 0.90). No relationship was found between living in a town with a medium restaurant smoking regulation (restriction of smoking to enclosed, separately ventilated areas) and rates of progression to established smoking.
Conclusions: Local restaurant smoking bans may be an effective intervention to prevent youth smoking.

To protect non-smokers from the hazards of secondhand smoke,[1–3] more than 300 cities have adopted clean indoor air laws: regulations or ordinances that eliminate smoking in workplaces or public places.[4 5] The strongest and most controversial of these laws prohibit smoking in restaurants and bars. More than 200 cities and nine states have adopted laws that specifically eliminate smoking in restaurants.[4 5] Although these laws are intended to protect the public from secondhand smoke exposure, some have hypothesised that they may also reduce youth smoking by altering smoking related social norms.[6–9] Clean indoor air laws may decrease the number of smokers youths see in public settings, thus decreasing the perceived prevalence of smoking.[6] In addition, these laws may send a message to youths that smoking is not socially acceptable.[6] Since restaurants are the predominant social setting in which youths may see smokers,[10] restaurant smoking regulations are hypothesised to be particularly important in influencing community norms regarding smoking.[6–8] As smoking remains the leading cause of death in the USA[11] and nearly a quarter of high school students become smokers,[12 13] it is critical to understand whether or not local restaurant smoking laws represent an effective youth smoking prevention strategy.

Despite hypotheses that smoke-free regulations may reduce smoking among youths, strong evidence is not available. The existing evidence, derived from cross sectional studies, demonstrates an association between restrictions on smoking in public places and youth smoking prevalence.[14–19] Thus, it is impossible to determine whether the regulations caused the reduced smoking or whether states and towns with lower smoking rates are more likely to adopt such regulations. These studies are also limited by their failure to control for town level factors that may confound the relationship between the presence of regulations and the observed levels of smoking. Furthermore, the measure of regulation strength used in these studies groups different smoking restriction sites (for example, worksites, schools, restaurants, public places) together and does not clearly differentiate between total and partial smoking bans, or between state and local laws.

To the best of our knowledge, this is the first longitudinal study to examine the effect of local restaurant smoking regulations on progression to established smoking among youths. Because we examine differences in smoking behaviour over time between youths with varying baseline restaurant smoking policies in their towns, the direction of any observed associations is clear. In addition, we improve upon the existing literature by: (1) examining the specific effect of local smoke-free restaurant regulations; (2) controlling for both individual level and town level factors that may confound the relationship between adoption of restaurant smoking regulations and youth smoking behaviour; and (3) investigating differences in the effect of regulations of varying strength.

METHODS

Sample

Between January 2001 and June 2002, the Center for Survey Research, University of Massachusetts Boston, obtained a probability sample of Massachusetts youths by random digit dialling. Interviewers attempted to interview all resident youths ages 12–17 years in each eligible household identified through an initial screening interview with an adult household resident. Screening interviews were completed for 66% of sampled households, yielding a sample of 6006 eligible youths. Parental permission was obtained to interview 76% of

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eligible youths and interviews were completed with 84% of those, resulting in a baseline sample of 3862 adolescents. The number of youths interviewed per household was one for 73.9% of households, two for 23.3%, and three for 2.7%.

Between January 2003 and July 2004, we attempted to re-interview all 3838 of the youths in the baseline sample for whom baseline smoking status had been obtained. Interviews were completed with 2793 subjects, for a follow up rate of 72.8%. Respondents surveyed later at baseline were surveyed later at follow up to achieve a consistent two year follow up period.

The research protocol was approved by the institutional review boards of the University of Massachusetts Boston and Boston University Medical Center. All subjects gave informed consent or assent (for youths) and a waiver of the requirement for written consent was obtained from both institutions.

Measures

Town of residence

Town of residence at baseline and follow up was obtained using the reported zip (post) code. The overwhelming majority (95.8%) of re-interviewed youths lived in the same town at baseline and follow up; 2.5% moved within Massachusetts and 1.7% moved out of state.

Strength of local restaurant smoking regulation

The strength of the local restaurant regulation in effect in each respondent's town of residence on the date of their baseline interview was recorded. We reviewed the local restaurant smoking regulations in effect during the study period for each of the 351 cities and towns in Massachusetts and categorised their stringency as follows: (1) strong regulations—no smoking allowed in restaurants and no variances allowed; (2) medium regulations—smoking restricted to enclosed, separately ventilated areas or no smoking allowed but variances allowed; and (3) weak regulations—smoking restricted to designated areas or not restricted. Details of the development of the database and coding of regulations have been published.[20] For the small number of youths who moved to a different town from baseline to follow up (4.2% of the sample), we used the regulation in the baseline town of residence.

Progression to established smoking

Following Pierce *et al*,[21] we defined progression to established smoking as having smoked 100 or more cigarettes. This measure has been formally validated[22–24] and used in previous studies.[22–27] We chose to use progression to established smoking as the measure of smoking initiation because it avoids the problem of the irregularity of smoking during adolescence.[28] It also avoids the problem of unreliable adolescent recall of smoking behaviour during the past 30 days by establishing a defined threshold of total lifetime cigarettes smoked to measure regular smoking behaviour. Furthermore, progression to established smoking is significantly predictive of becoming an addicted adult smoker.[24]

Since youths who had already progressed to established smoking at baseline were not eligible to progress to established smoking during follow up, these youths ($n = 170$) were excluded from the analysis, yielding a final sample size of 2623.

Potential individual level confounding variables

We controlled for the following individual level variables: (1) age group (12–14 years at baseline versus 15–17 years); (2) sex; (3) race (white, non-Hispanic versus other); (4) presence of at least one adult smoker in the household (at baseline); (5) presence of at least one close friend who smoked (at baseline); (6) education level of household informant (college graduate or not); (7) household income ($\leqslant$ \$50 000 *v* $>$ \$50 000); (8) exposure to anti-smoking messages at school (yes or no); and (9) baseline smoking status (non-susceptible non-smoker, susceptible non-smoker, puffer, experimenter, or current smoker).

While none of the subjects included in the analysis had smoked 100 cigarettes at baseline, some had experimented with cigarettes. We controlled for subjects' baseline predisposition to smoking by including in the analysis a set of indicator variables reflecting their baseline smoking status. For this purpose, non-smokers were defined as respondents who had never puffed on a cigarette, puffers as those who had puffed but not smoked a whole cigarette, experimenters as those who had smoked at least one whole cigarette but none within the past 30 days, and current smokers as those who had smoked at least one cigarette including one or more within the past 30 days. Non-smokers were further classified based on a measure of susceptibility to smoking that has been shown to predict progression to established smoking reliably.[21–25] Non-smokers were classified as non-susceptible to smoking if they answered "no" to the question "Do you think that you will try a cigarette soon?" and "definitely not" to the questions "If one of your best friends were to offer you a cigarette, would you smoke it?" and "At any time during the next year do you think you will smoke a cigarette?".

Potential town level confounding variables

We controlled for the following town level variables (included as continuous variables except where noted): (1) the percentage of each town's adult residents with a college degree; (2) the percentage of each town's voters who voted "yes" on Question 1, a 1992 ballot initiative that increased the cigarette tax and created a statewide tobacco control programme; (3) the percentage of white residents in each town; (4) the percentage of youth (age less than 18 years) residents in each town; (5) the number of restaurants in each town (< 5 *v* $\geqslant 5$); and (6) town population ($<$ 20 000, 20 000–50 000, $>$ 50 000). Of a large number of town level factors examined, these were most strongly related to the strength of local restaurant smoking regulations in Massachusetts towns.[29] The percentage "yes" vote on Question 1 served as a measure of the level of education in the town as well as the baseline level of anti-smoking sentiment in each town before the proliferation of local restaurant smoking regulations in the state.[30] The cut off for dichotomisation of the number of restaurants was chosen to control for potential differences in towns that had very few restaurants; the cut offs for classification of town population were based on approximate tertiles of the distribution of this variable. All town level variables were obtained from the 2000 US Census, except for number of restaurants, which was ascertained by examining yellow page restaurant listings for each town, and the Question 1 vote, which was obtained from the Division of Elections within the Massachusetts office of the Secretary of State.

Data analysis

Because respondents from the same town may be more similar than respondents from different towns, we used a generalised estimating equations (GEE) logistic regression model to examine the relationship between strength of town restaurant smoking regulations at baseline and the likelihood of progression to established smoking during the two year follow up period. This procedure accounts for correlation of data within town "clusters", avoiding a type 1 error that would be introduced if this correlation were ignored.[31]

Because more than one youth could be sampled per household, there was also some clustering of subjects within

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Table 1 Baseline characteristics of Massachusetts youth cohort* by strength† of local restaurant smoking regulation

	Total n = 2623	Weak† (%) n = 1584	Medium† (%) n = 605	Strong† (%) n = 434
Individual level variables				
Age at baseline (years)				
12–14	1405	53.9	55.4	49.8
15–17	1218	46.1	44.6	50.2
Sex				
Male	1328	50.0	52.6	50.2
Female	1295	50.0	47.4	49.8
Race/ethnicity				
Non-Hispanic white	2126	77.8	87.2	87.7
Other	478	22.2	12.8	12.3
Smoking status				
Non-susceptible non-smoker	1581	61.7	60.0	55.3
Susceptible non-smoker	453	15.3	19.3	21.4
Puffer	308	12.5	11.4	9.5
Experimenter	200	7.1	7.1	10.1
Current smoker	81	3.3	2.2	3.7
Peer smoking				
No close friend smokes	1942	73.6	76.4	72.6
At least one close friend smokes	681	26.4	23.6	27.4
Exposure to anti-smoking messages at school				
No	775	30.2	31.0	27.9
Yes	1806	69.8	69.0	72.1
Household level variables				
Household smoking				
No adult smoker in household	1804	66.9	70.2	73.5
Adult smoker in household	819	33.1	29.8	26.5
Education of adult informant				
Not college graduate	1367	56.4	49.1	45.6
College graduate	1215	43.6	50.9	54.4
Household income				
⩽$50000	568	30.0	21.9	21.0
>$50000	1565	70.0	78.1	79.0
Town level variables				
Percentage of town residents who are college graduates‡	42.9	39.1	47.7	50.3
Percentage of town "yes" vote on Question 1‡	51.2	49.2	53.2	55.6
Percentage of town residents who are white‡	87.9	85.4	91.9	91.9
Percentage of town residents who are youths‡	24.6	24.7	24.9	23.6
Number of restaurants				
⩾5	2280	83.4	94.2	89.6
<5	343	16.6	5.8	10.4
Population				
<20000	1034	38.1	44.5	37.3
20000–50000	934	29.3	42.0	49.8
>50000	655	32.6	13.5	12.9

*Cohort includes only youths who were not established smokers (that is, had smoked fewer than 100 cigarettes in their life) at baseline.
†Strength of local restaurant smoking regulation was defined as strong if it banned smoking completely in all restaurants with no variances, medium if it banned smoking but allowed variances or restricted smoking to enclosed, separately ventilated areas, and weak if it required only designated smoking areas or did not restrict smoking at all.
‡Mean percentage shown in each column.

households. Since households are nested within towns, we selected town as the clustering level. The robust, or empirical, standard errors derived from the GEE approach allow that individuals within a town may be differentially correlated.[32–35] Thus, the GEE results will be valid even though youths from the same household may be more correlated than youths from different households. We used a GEE model and the resulting robust variance estimators since the robust estimator produces consistent point estimates[32 33] and standard errors[32–35] even if the working correlation matrix is misspecified. We used a compound symmetry, or exchangeable working correlation matrix.

Data were weighted using baseline sampling weights that accounted for non-response and for number of telephone lines in the household. Ninety five per cent confidence intervals (CIs) for odds ratios (ORs) were calculated using standard errors estimated by the Wald test.[36] We used indicator variables to create a category for missing values for each covariate so that the same subset of respondents was examined in each analysis.

RESULTS

Of the 2623 youths in the sample, 1584 (60.4%) lived in a town with a weak restaurant smoking regulation at baseline, 605 (23.1%) lived in a town with a medium regulation, and 434 (16.5%) lived in a town with a strong regulation (table 1). Of the 351 towns included in the sample, the number of towns in each of the regulation categories as of the end of the baseline interview period was: weak 208 (59%); medium 73 (21%); and strong 70 (20%).[20]

While 8.0% of youths living in a town with a weak local restaurant smoking regulation and 8.2% of youths living in a town with a medium regulation progressed to established smoking during the two year follow up period, only 4.9% of youths living in towns with strong regulations progressed to established smoking (table 2). In bivariate analyses, there

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Table 2 Progression to established smoking* among Massachusetts youth cohort† by strength‡ of local restaurant smoking regulation and potential confounding variables

	Progressed* (%)	Did not progress* (%)	Unadjusted OR§ (95% CI)	Adjusted OR¶ (95% CI)
Main predictor variable				
Strength‡ of local restaurant smoking regulation				
Weak‡	8.0	92.0	1.00	1.00
Medium‡	8.2	91.8	1.04 (0.73 to 1.47)	1.06 (0.70 to 1.62)
Strong‡	4.9	95.1	0.59 (0.38 to 0.92)	0.39 (0.24 to 0.66)
Individual level variables				
Age at baseline (years)				
12–14	5.0	95.0	1.00	1.00
15–17	10.5	89.5	2.21 (1.63 to 3.00)	1.15 (0.80 to 1.66)
Sex				
Male	8.1	91.9	1.00	1.00
Female	7.0	93.0	0.86 (0.63 to 1.16)	0.73 (0.51 to 1.03)
Race/ethnicity				
Non-Hispanic white	7.4	92.6	1.00	1.00
Other	7.6	92.4	1.02 (0.63 to 1.65)	1.43 (0.81 to 2.53)
Smoking status				
Non-susceptible non-smoker	2.2	97.8	1.00	1.00
Susceptible non-smoker	6.8	93.2	3.27 (1.89 to 5.66)	3.42 (1.96 to 5.99)
Puffer	10.9	89.1	5.45 (3.19 to 9.33)	4.22 (2.40 to 7.43)
Experimenter	29.4	70.6	18.6 (11.6 to 29.7)	13.6 (8.03 to 23.0)
Current smoker	54.4	45.6	53.2 (28.8 to 98.3)	42.8 (21.1 to 86.9)
Peer smoking				
No close friend smokes	4.2	95.8	1.00	1.00
At least one close friend smokes	17.5	82.5	4.91 (3.68 to 6.54)	1.99 (1.38 to 2.89)
Exposure to anti-smoking messages at school				
No	8.9	91.1	1.00	1.00
Yes	7.1	92.9	0.79 (0.56 to 1.11)	0.70 (0.47 to 1.03)
Household level variables				
Household smoking				
No adult smoker in household	5.8	94.2	1.00	1.00
Adult smoker in household	11.2	88.8	2.04 (1.52 to 2.73)	1.47 (1.05 to 2.05)
Education of adult informant				
Not college graduate	8.6	91.4	1.00	1.00
College graduate	6.4	93.6	0.73 (0.53 to 0.99)	0.96 (0.68 to 1.36)
Household income				
⩽$50000	7.5	92.5	1.00	1.00
>$50000	7.2	92.8	0.97 (0.67 to 1.40)	1.15 (0.76 to 1.72)
Town level variables				
Percentage of town residents who are college graduates**	–	–	0.94 (0.86 to 1.02)	0.80 (0.60 to 1.06)
Percentage of town "yes" vote on Question 1**	–	–	0.95 (0.82 to 1.11)	1.33 (0.80 to 2.23)
Percentage of town residents who are white**	–	–	1.13 (1.05 to 1.22)	1.29 (1.06 to 1.56)
Percentage of town residents who are youths**	–	–	0.77 (0.54 to 1.10)	0.78 (0.52 to 1.17)
Number of restaurants				
⩾5	7.4	92.6	1.00	1.00
<5	8.3	91.7	1.13 (0.75 to 1.69)	0.71 (0.41 to 1.23)
Population				
<20000	8.8	91.2	1.00	1.00
20000–50000	6.7	93.3	0.74 (0.53 to 1.04)	0.67 (0.43 to 1.03)
>50000	6.8	93.2	0.74 (0.53 to 1.03)	0.90 (0.50 to 1.61)

*Progression to established smoking was defined as smoking 100 or more cigarettes in one's life. Data are weighted to account for baseline probability of respondent selection.
†Cohort includes only youths who were not established smokers (that is, had smoked fewer than 100 cigarettes in their life) at baseline.
‡Strength of local restaurant smoking regulation was defined as strong if it banned smoking completely in all restaurants with no variances, medium if it banned smoking but allowed variances or restricted smoking to enclosed, separately ventilated areas, and weak if it required only designated smoking areas or did not restrict smoking at all.
§Unadjusted odds ratio for progression to established smoking. Odds ratio is derived from generalised estimating equations (GEE) logistic regression model that accounts for clustering of responses within towns. Data are weighted to account for baseline probability of respondent selection.
¶Odds ratios are adjusted for all other variables in the table.
**Odds ratio corresponding to each 10 percentage point increase.
CI, confidence interval; OR, odds ratio.

was no significant relationship between medium regulations and progression to established smoking (OR 1.04, 95% CI 0.73 to 1.47), but youths living in towns with strong regulations had a little more than half the odds of progression to established smoking compared to youths living in towns with weak regulations (OR 0.59, 95% CI 0.38 to 0.92).

The significant association between strong regulations and decreased progression to established smoking persisted after controlling for potential individual, household, and town level confounding factors; youths living in towns with strong regulations had less than half the odds of progression to established smoking compared to youths living in towns with weak regulations (OR 0.39, 95% CI 0.24 to 0.66) (table 2).

The magnitude of the association between strong regulations and decreased odds of progression to established smoking increased notably with the amount of time that the regulation had been in effect. In multivariate analyses, youths living in towns with strong regulations in effect for less than two years at baseline had about half the odds of progression to established smoking compared to youths living in towns with weak regulations (OR 0.55, 95% CI 0.33 to 0.90), while youths living in towns with strong regulations in effect for two or more years had one tenth the

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Table 3 Relationship between duration of local restaurant smoking regulations and progression to established smoking* among Massachusetts youth cohort†

	OR‡ (95% CI)
Strength§ and duration of local restaurant smoking regulation	
Weak§	1.00
Medium§	1.04 (0.68 to 1.59)
Strong§—in effect <2 years	0.55 (0.33 to 0.90)
Strong§—in effect ≥2 years	0.11 (0.03 to 0.37)

*Progression to established smoking was defined as smoking 100 or more cigarettes in one's life.
†Cohort includes only youths who were not established smokers (that is, had smoked fewer than 100 cigarettes in their life) at baseline.
‡Odds ratio for progression to established smoking. Odds ratio is derived from GEE logistic regression model that accounts for clustering of responses within towns. Data are weighted to account for baseline probability of respondent selection. Odds ratios are adjusted for all other variables in the analysis.
§Strength of local restaurant smoking regulation was defined as strong if it banned smoking completely in all restaurants with no variances, medium if it banned smoking but allowed variances or restricted smoking to enclosed, separately ventilated areas, and weak if it required only designated smoking areas or did not restrict smoking at all.

odds of progression to established smoking (OR 0.11, 95% CI 0.03 to 0.37) (table 3).

The relationship between strong regulations and decreased progression to established smoking persisted when youths who moved during the follow up period were excluded from the analysis, when sample weights were excluded, when all observations with missing data were deleted, when the analysis was restricted to youths who had never puffed on a cigarette at baseline, and when the analysis was restricted to youths who had never smoked at baseline and were non-susceptible to smoking (all in multivariate models) (table 4).

DISCUSSION

In what we believe is the first longitudinal study of the effect of restaurant smoking restrictions on youth smoking behaviour, we found substantially lower rates of progression to established smoking (about a 60% reduction), after two years of follow up, among Massachusetts youths who lived in towns with restaurant smoking bans. This finding was specific to complete smoking bans and the magnitude of the effect was substantially higher with smoking bans of greater duration (about a 90% reduction in progression to established smoking among youths in towns with restaurant smoking bans in effect for two or more years).

Table 4 Analysis of robustness of main study findings: adjusted odds ratios* for effect of strong† local restaurant smoking regulations on progression to established smoking‡

	OR* (95% CI)
Primary analysis	0.39 (0.24 to 0.66)
Results when all youths who moved (from baseline to follow up) (n = 103) are excluded	0.40 (0.24 to 0.68)
Results when sample weights are excluded	0.39 (0.24 to 0.64)
Results when all observations with missing data (n = 539) are deleted (stepwise elimination)	0.34 (0.19 to 0.60)
Results when all ever smokers (at baseline), including puffers, (n = 589) are excluded	0.26 (0.10 to 0.68)
Results when all ever smokers and susceptible non-smokers (n = 1042) are excluded	0.07 (0.01 to 0.52)

*Odds ratio for progression to established smoking. Odds ratio is derived from GEE logistic regression model that accounts for clustering of responses within towns. Data are weighted to account for baseline probability of respondent selection. Odds ratios are adjusted for all other variables in the analysis.
†Strength of local restaurant smoking regulation was defined as strong if it banned smoking completely in all restaurants with no variances.
‡Progression to established smoking was defined as smoking 100 or more cigarettes in one's life.

There are several reasons why we believe these findings represent a true effect of restaurant smoking regulations, rather than a product of bias or confounding. First, the observed association is not explained by a wide range of potential individual, household, and town level confounding factors, including baseline smoking status, susceptibility to smoking, parental education, household income, peer and parental smoking, baseline educational status in each town, town population, number of restaurants in each town, and the percentage of town voters who voted for a 1992 cigarette tax initiative, a measure that controls for the baseline anti-smoking sentiment in a town, and likely reflects baseline levels of smoking prevalence as well.[6 30] Although this measure of baseline anti-smoking sentiment is based on a 1992 phenomenon, we have found it to predict strongly the adoption of smoke-free regulations through 2002.[29 30] Moreover, analyses of data collected in Massachusetts between 1993 and 1998 have demonstrated that individual support for tobacco tax increases is strongly associated with support for other kinds of tobacco control policies, even after controlling for sociodemographic characteristics and smoking status.[30]

Second, the findings are specific to strong regulations and the strength of the observed association is related, in the expected direction, to the duration of regulation. There is also a strong conceptual rationale as well as a reasonable mechanism by which smoking bans could lead to decreased smoking initiation,[6] as youths in Massachusetts towns with restaurant smoking bans have a lower perception of adult smoking prevalence and view smoking as less socially acceptable.[6]

Nevertheless, it is possible that an unidentified confounder, associated with both the adoption of smoke-free regulations and with youth smoking initiation, explains the observed findings, or that the measures we used to control for identified potential confounders—such as baseline educational status and smoking related attitudes in each town—were not adequate in controlling completely for these factors. Still, the observed association in this study is strong and robust, and it would take an extremely strong confounder to explain it.

Although the degree of enforcement of youth access regulations at the local level might be hypothesised to have a confounding effect on the observed association between local restaurant smoking bans and youth smoking initiation, this is not the case in our study. Strength of enforcement of youth access regulations was not related to progression to established smoking (data not shown).

The strong magnitude of the effect of restaurant smoking bans observed in this study is consistent with the conclusions of tobacco industry documents, which reveal that the industry views smoking bans in public places as being one of the most important threats to cigarette consumption: "What do these health claims, the heightened public sentiment for smoking restriction, increasing non-smoker annoyance toward smokers mean for this industry? Lower sales, of course. The Tobacco Merchant's Association took a look at smoking restriction legislation and cigarette consumption between 1951 and 1982. Restrictive smoking laws accounted for 2% of the variation in cigarette consumption from state to state during that time. … At a dollar a pack, even the lightest of workplace smoking restrictions is costing this industry 233 million dollars a year in revenue. How much more will it cost us with far more restrictive laws such as

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What this paper adds

While smoke-free restaurant laws are intended to protect the public from secondhand smoke exposure, some have hypothesised that by changing social norms regarding smoking, these laws may have the additional benefit of discouraging smoking among adolescents. Several cross sectional studies have reported an association between clean indoor air policies and youth smoking prevalence. Unfortunately, there is currently no evidence from longitudinal studies to test this hypothesis.

This two year longitudinal study finds that Massachusetts youths living in towns with local restaurant smoking bans were substantially less likely to progress to established smoking than youths living in towns with weaker regulations. Since the study controlled for a wide range of potential individual and town level confounding factors, we believe it provides evidence that local restaurant smoking bans may be an effective intervention to prevent youth smoking.

those in Suffolk County and Fort Collins now being enacted?''[37]

The finding that strong regulations in effect for less than two years still had an effect on progression to established smoking is plausible, since the very process of ordinance adoption may have an influence on smoking related social norms and because compliance with smoke-free ordinances has been found to be immediate.[38]

Our finding that strong, but not medium, regulations are associated with decreased progression to established smoking is consistent with our previous finding (using the baseline dataset) that strong, but not medium, regulations are associated with lower perceived adult smoking prevalence and lower perceived social acceptability of smoking among youths.[6]

These findings, if accurate and generalisable to other populations, have important public health implications. They suggest that adoption of local smoke-free regulations, while primarily intended to protect non-smokers from secondhand smoke exposure, may represent an effective intervention to prevent youth smoking. They provide further justification for state and local efforts to enact clean indoor air policies, and for state tobacco control programmes to include a substantial focus on supporting local secondhand smoke policy efforts.

The primary limitation of this research is that it is not clear whether the results are generalisable to other populations. Local clean indoor air regulations in Massachusetts were adopted under the umbrella of an aggressive statewide anti-smoking campaign that included funding for boards of health throughout the state to promote restaurant smoking regulations as well as a prominent anti-smoking media campaign that aimed to de-normalise smoking and educate the public about the hazards of secondhand smoke. It is not clear whether restaurant smoking laws would have similar effects on youth smoking behaviour in states where widespread anti-smoking programmes are not present.

A second potential limitation is the significant loss to follow up. Youths who were successfully re-interviewed were significantly more likely to be in the younger age group at baseline (54% *v* 49%), to be white (82% *v* 69%), to be non-susceptible to smoking (60% *v* 51%), not to have a close friend who smokes (74% *v* 67%), not to have a smoker in the household (69% *v* 55%), to have reported exposure to anti-smoking programmes at school (70% *v* 65%), to live in a household whose screener was a college graduate (47% *v* 28%), to live in a household with higher income (73% *v* 52%), and to live in a town with a restaurant smoking ban (17% *v* 14%).

However, these observed differences between youths who were and were not successfully re-interviewed should not bias the study results because all of these differing characteristics were controlled for in the analyses. In addition, the rate of follow up was not significantly different between youths living in towns with medium (75.2%) and strong (76.1%) regulations, even though there was a twofold difference in progression to established smoking between youths in these towns. Based on this observation, the assumption that loss to follow up is not related to probability of progression to established smoking appears reasonable. Furthermore, once household education and income were accounted for, there was no relationship between strength of local restaurant smoking regulations and the probability of being successfully followed up (data not shown).

In spite of these limitations, this paper provides the strongest evidence to date that strong, local restaurant smoking regulations (those which completely eliminate smoking in restaurants) may be associated with substantial reductions in progression to established smoking among youths. Confirmation of this finding in other settings is necessary to help rule out the possibility that the observed relationship is a spurious one. Nevertheless, we believe that the strength and robustness of the findings presented here suggest that strong, local clean indoor air regulations are an effective intervention to reduce youth smoking.

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REFERENCES

1 **US Department of Health and Human Services**. *Health effects of exposure to environmental tobacco smoke: the report of the California Environmental Protection Agency*, Smoking and tobacco control monograph 10. Bethesda, Maryland: National Cancer Institute, 1999.
2 **International Agency for Research on Cancer**. *Involuntary smoking: summary of data reported and evaluation*. Lyon, France: International Agency for Research on Cancer, 2002.
3 **US Environmental Protection Agency**. *Respiratory health effects of passive smoking: lung cancer and other disorders*. Washington DC: US Environmental Protection Agency, Office of Health and Environmental Assessment, 1992, (EPA publication 600/6-90/006F.).
4 **American Nonsmokers' Rights Foundation**. *Municipalities with local 100% smokefree laws: cumulative number effective by year 1990–2004*. Berkeley, California: American Nonsmokers' Rights Foundation, 2004, http://www.no-smoke.org/100ordgraph.pdf (Accessed Nov 4, 2004).
5 **American Nonsmokers' Rights Foundation**. *Municipalities with local 100% smokefree laws: currently in effect as of October 5, 2004*. Berkeley, California: American Nonsmokers' Rights Foundation, 2004, http://www.no-smoke.org/100ordlisttabs.pdf (Accessed Dec 8, 2004).
6 **Albers AB**, Siegel M, Cheng DM, *et al*. Relation between local restaurant smoking regulations and attitudes towards the prevalence and social acceptability of smoking: a study of youths and adults who eat out predominantly at restaurants in their town. *Tobacco Control* 2004;**13**:347–55.
7 **Jacobson PD**, Zapawa LM. Clean indoor air restrictions: progress and promise. In: Rabin RL, Sugarman SD, eds. *Regulating tobacco*. New York: Oxford University Press, 2001:207–44.

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8 **Jacobson PD**, Lantz PM, Warner KE, *et al. Combating teen smoking: research and policy strategies.* Ann Arbor, Michigan: The University of Michigan Press, 2001.
9 **Glantz SA**. Preventing tobacco use – the youth access trap [editorial]. *Am J Public Health* 1996;**86**:156–7.
10 **Schofield MJ**. Smoking bans in restaurants: who is responsible and who needs protection? *Tobacco Control* 1995;**4**:113–4.
11 **Mokdad AH**, Marks JS, Stroup DF, *et al.* Actual causes of death in the United States, 2000. *JAMA* 2004;**291**:1238–45.
12 **Centers for Disease Control and Prevention**. Cigarette use among high school students – United States, 1991–2003. *MMWR Morb Mortal Wkly Rep* 2004;**53**:499–502.
13 **Centers for Disease Control and Prevention**. Youth risk behavior surveillance – United States, 2003. *MMWR Surveillance Summaries* 2004;**53**:1–96.
14 **Chaloupka FJ**, Grossman M. *Price, tobacco control policies and youth smoking.* Cambridge, Massachusetts: National Bureau of Economic Research Working Paper 5740, 1996.
15 **Chaloupka FJ**, Pacula RL. Sex and race differences in young people's responsiveness to price and tobacco control policies. *Tobacco Control* 1999;**8**:373–7.
16 **Gruber J**, Zinman J. *Youth smoking in the U.S.: evidence and implications.* Cambridge, Massachusetts: National Bureau of Economic Research Working Paper 7780, 2000.
17 **Wakefield MA**, Chaloupka FJ, Kaufman NJ, *et al.* Effect of restrictions on smoking at home, at school, and in public places on teenage smoking: cross sectional study. *BMJ* 2000;**321**:333–7.
18 **Wasserman J**, Manning WG, Newhouse JP, *et al.* The effects of excise taxes and regulations on cigarette smoking. *J Health Econ* 1991;**10**:43–64.
19 **Giovino GA**, Tworek C, Chaloupka FJ, *et al. Smoke-free air policies and adolescent smoking – United States, 1991–2001.* Helsinki, Finland: Presented at the 12th World Conference on Tobacco or Health, August 5, 2003.
20 **Skeer M**, Siegel M. The descriptive epidemiology of local restaurant smoking regulations in Massachusetts: an analysis of the protection of restaurant customers and workers. *Tobacco Control* 2003;**12**:221–6.
21 **Pierce JP**, Choi WS, Gilpin EA, *et al.* Tobacco industry promotion of cigarettes and adolescent smoking. *JAMA* 1998;**279**:511–5.
22 **Pierce JP**, Choi WS, Gilpin EA, *et al.* Validation of susceptibility as a predictor of which adolescents take up smoking in the United States. *Health Psychol* 1996;**15**:355–61.
23 **Choi WS**, Pierce JP, Gilpin EA, *et al.* Which adolescent experimenters progress to established smoking in the United States? *Am J Prev Med* 1997;**13**:385–91.
24 **Pierce JP**, Farkas AJ, Evans N, *et al.* An improved surveillance measure for adolescent smoking? *Tobacco Control* 1995;**4**(suppl 1):S47–56.
25 **Siegel M**, Biener L. The impact of an antismoking media campaign on progression to established smoking: results of a longitudinal youth study. *Am J Public Health* 2000;**90**:380–6.
26 **Siegel M**, Biener L, Rigotti NA. The effect of local tobacco sales laws on adolescent smoking initiation. *Prev Med* 1999;**29**:334–42.
27 **Choi WS**, Ahluwalia JS, Harris KJ, *et al.* Progression to established smoking: the influence of tobacco marketing. *Am J Prev Med* 2002;**22**:228–33.
28 **Wellman RJ**, DiFranza JR, Savageau JA, *et al.* Short term patterns of early smoking acquisition. *Tobacco Control* 2004;**13**:251–7.
29 **Skeer M**, George S, Hamilton WL, *et al.* Town-level characteristics and smoking policy adoption in Massachusetts: are local restaurant smoking regulations fostering disparities in health protection? *Am J Public Health* 2004;**94**:286–92.
30 **Hamilton WL**, Biener L, Rodger CN. Who supports tobacco excise taxes? Factors associated with towns' and individuals' support in Massachusetts. *Journal of Public Health Management and Practice* (in press).
31 **Hedeker D**, Gibbons RD, Flay BR. Random-effects regression models for clustered data with an example from smoking prevention research. *J Consult Clin Psychol* 1994;**62**:757–65.
32 **Liang KY**, Zeger SL. Longitudinal data analysis using generalized linear models. *Biometrika* 1986;**73**:13–22.
33 **Pendergast JF**, Gange SJ, Newton MA, *et al.* A survey of methods for analyzing clustered binary response data. *International Statistical Review* 1996;**64**:89–118.
34 **Stata Corporation**. *Stat reference manual, release 7: volume 5 Su-Z.* College Station, Texas: Stata Press, 2001.
35 **Horton NJ**, Lipsitz SR. Review of software to fit generalized estimating equation regression models. *The American Statistician* 1999;**53**:160–9.
36 **Hosmer DW**, Lemeshow S. *Applied linear regression.* New York: John Wiley & Sons, Inc, 1989.
37 **The Tobacco Institute**. *Public smoking: the problem.* Washington DC: The Tobacco Institute, undated (probably 1985), http://www.tobaccoinstitute.com/getallimg.asp?DOCID=TIMN0014554/4565.
38 **Skeer M**, Land ML, Cheng DM, *et al.* Smoking in Boston bars before and after a 100% smoke-free regulation: an assessment of early compliance. *Journal of Public Health Management and Practice* 2004;**10**:501–7.

The most important papers in the tobacco control field, by S Chapman

What are the most important papers in the tobacco control field? In May and June 2005, authors who had papers published in *Tobacco Control* since 2001 and the journal's editorial advisory board were invited to nominate the ''most important and influential papers in tobacco control''. The nomination phase saw 658 different papers nominated. These nominations were then thrown open to an online vote, where 2966 votes were recorded for these 658 papers. *Tobacco Control* online shows the top 10 papers in each of the 12 categories that resulted from this vote. http://www.tobaccocontrol.com/cgi/content/full/14/5/e1