Effect of Local Restaurant Smoking Regulations on Environmental Tobacco Smoke Exposure Among Youths

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Objectives. We examined the effect of local restaurant smoking regulations on restaurant environmental tobacco smoke exposure among youths.

Methods. We interviewed 3863 Massachusetts youths aged 12–17 years and ascertained how often they saw smokers in restaurants in their town. We assessed the effect of local restaurant smoking regulation strength on nonexposure to environmental tobacco smoke (seeing smokers never or only rarely).

Results. Compared with youths from towns with weak regulations, youths from towns with medium-strength regulations had 1.4 times the odds (odds ratio=1.36; 95% confidence interval=1.12, 1.65) and youths from towns with strong regulations had twice the odds (odds ratio=2.03; 95% confidence interval=1.64, 2.52) of reporting nonexposure.

Conclusions. Strong local restaurant smoking regulations are associated with reduced environmental tobacco smoke exposure among youths (*Am J Public Health.* 2004;94:321–325)

Environmental tobacco smoke exposure in bars and restaurants is a health hazard for customers and employees.[1–3] To protect the public, many communities have adopted regulations restricting smoking in these establishments.[4–9] Because of the widespread adoption of these laws, it is important to evaluate whether they are effective in reducing environmental tobacco smoke exposure.

Although there is strong evidence that local workplace smoking ordinances reduce employees' environmental tobacco smoke exposure,[10–13] the evidence regarding the effect of restaurant smoking ordinances is quite limited.[2,14,15] There is evidence that smoke-free policies in specific bars and restaurants results in substantial reductions in environmental tobacco smoke exposure in those establishments.[16–21] Although these studies indicate that smoke-free bar and restaurant ordinances could be expected to result in decreased exposure, they do not demonstrate what happens in actual practice.

This study examines the relationship between Massachusetts youths' self-reported environmental tobacco smoke exposure in restaurants and the local restaurant smoking regulation in the towns in which these individuals reside. It addresses the limitations of earlier studies by evaluating the effects of local regulations in towns of varying sociodemographic characteristics, evaluating the effect of restaurant smoking regulations in actual practice, and evaluating the effect of many local 100% smoke-free bar and restaurant regulations.

METHODS

Sample

Data were from a larger longitudinal study designed to examine the effect of community-based tobacco control interventions on adult and youth smoking behavior. Between January 2001 and June 2002, the Center for Survey Research of the University of Massachusetts obtained a probability sample of Massachusetts households by random-digit dialing. After conducting a household screening interview with an adult resident, interviewers attempted to obtain parental permission and to interview all resident youths between 12 and 17 years of age. Parental permission was obtained for 76% of the 6006 eligible youths, and interviews were completed with 84% of these youths, yielding a final baseline sample of 3863 adolescents (64.3% of the eligible population contacted). Survey weights were created to reflect survey nonresponse and the number of telephone lines in the household. Because a simple random sample was obtained, with no stratification or clustering, there are no design effects.

Measures

Town of Residence. Actual town of residence was obtained using the reported zip code. However, to facilitate asking questions about the respondents' town, an attempt was made to ascertain the town of residence from the respondent. We deleted 32 cases in which the town used for questioning was not the actual town of residence, resulting in an effective sample size of 3831 youths.

Strength of Local Restaurant Smoking Regulation. We obtained the local restaurant smoking regulation for each of the 351 cities and towns in Massachusetts in force as of June 17, 2002 (the final survey date), as well as any previous regulations in force during the survey period.[22] We then classified each regulation into one of three categories based on the degree of protection from environmental tobacco smoke exposure in restaurants: strong regulations—no smoking allowed in restaurants and no variances allowed; medium regulations—smoking restricted to enclosed, separately ventilated areas or to adult-only restaurants, or smoking not permitted in restaurants but variances allowed; and weak regulations—smoking restricted to designated areas or subject only to state law (designated nonsmoking area required for restaurants with more than 75 seats).

Using the actual town of residence, we linked each respondents' survey responses to the strength of local regulation in force in their town on the date of their interview, yielding a measure of the strength of the local restaurant smoking regulation in each respondent's town on the date of their interview.

Self-Reported Exposure to Smoking in Restaurants. Youths were classified as being exposed or unexposed to smoking in restaurants based on their response to the question: "In the past 12 months, when you were eating at a restaurant in [TOWN], how often did you see someone smoking?" Respondents who answered "never" or "rarely" were

classified as being unexposed, whereas respondents who answered "sometimes," "often," or "always" were classified as being exposed. This question was asked only of the 3203 youths who reported that they at least sometimes eat out at restaurants in their town. Excluding the 34 youths who failed to answer this question and the additional 27 youths for whom there was not a match between the town used in questioning and the actual town of residence, our final sample size was 3142.

Potential Confounding Variables. From the telephone survey, we obtained the following variables: age group (12–14 y vs 15–17 y), gender, race (non-Hispanic White vs other), smoking experimentation (whether respondent ever puffed a cigarette), presence of at least one adult smoker in the household, presence of at least one close friend who smokes, education level of adult household informant (college graduate vs not college graduate), household income (<$50 000 vs ≥$50 000), and how often the respondent ate out in his or her town, as opposed to other towns. From the Elections Division in the office of the Massachusetts Secretary of State, we obtained 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 program. A dichotomous variable was defined to represent whether the percentage of town residents voting "yes" on Question 1 was >50%. This variable served as a measure of the baseline level of antismoking sentiment in each town before the proliferation of local restaurant smoking regulations in the state.

Data Analysis

We conducted logistic regression analysis to examine the likelihood of a youth's being exposed to smoking in restaurants as a function of the strength of the local restaurant smoking regulation, controlling for the potential confounding variables. To account for the correlation in responses between youths living in the same household, we used a generalized estimating equations approach[23] to model the clustering of responses within households. We used a compound symmetry working correlation matrix to model the correlation among the responses within households; this assumes that the correlation between any two youths in a household is the same. We used a logit link function to model the binary response variable. Essentially, this is a multiple logistic regression model that accounts for correlation in responses between youths living in the same household.

Weighted analyses were conducted to account for survey nonresponse and the number of telephone lines in the household. Ninety-five percent confidence intervals (CIs) for odds ratios (ORs) were calculated with standard errors estimated by the Wald test.[24] Because there were no survey design effects, all analyses were conducted with the SAS statistical package (SAS version 8; SAS Institute Inc, Cary, NC).

We first ran a full model that included all variables, regardless of their contribution to the model. We then developed a final, more parsimonious model by using a change-in-estimate confounder selection procedure.[25,26] Initially, we built a model with covariates strongly believed (based on theoretical or empirical grounds) to be independent risk factors for environmental tobacco smoke exposure in restaurants (age group and race) and then controlled for each empirical confounder by including it in the model and using a change-in-estimate confounder selection criterion.[25,26] We defined empirical confounders as variables that changed the point estimate of the odds ratio for the effect of medium or strong regulations by 2% or more.[27]

In an alternative, confirmatory model-building approach, we used an iterative model building procedure[24] to determine which variables were significant in the presence of other variables. This model-building approach yielded the same final model as the approach described above.

All variables with missing values were modeled as categorical variables, using indicator variables that included a "missing" category, so that the full dataset of youth respondents could be examined in each analysis. The regression coefficients corresponding to missing data categories are not reported in the tables as they are not of interest; however, none of the coefficients were significant.

RESULTS

The strength of local restaurant smoking regulation was significantly related to the frequency of youth exposure to smokers in restaurants ($P<.0001$ for overall χ^2 test), and there was a significant linear trend in exposure with regulation strength ($P<0.0001$ for Cochran–Armitage trend test; Table 1). There was a gradient in the proportion of youths who did not report exposure to smokers in restaurants in their towns as regulation strength increased; 40.1% of youths in towns with weak regulations reported nonexposure, compared with 49.5% of youths in towns with medium regulations and 59.0% of youths in towns with strong regulations. Compared with youths living in towns with weak regulations, youths in towns with medium regulations had about 1.5 times the odds (OR=1.45 [95% CI=1.21, 1.75]) of reporting nonexposure to smokers in restaurants in their towns, and youths in towns with strong regulations had about twice the odds (OR=2.16 [95% CI=1.75, 2.66]) of reporting nonexposure.

The relationship between regulation strength and exposure to smokers in restaurants changed little after controlling for all of the potential confounding variables (Table 2). Compared with youths living in towns with weak regulations, youths in towns with medium regulations had about 1.3 times the odds (OR=1.34 [95% CI=1.10, 1.63]) of reporting nonexposure, and youths in towns with strong regulations had about twice the odds (OR=1.98 [95% CI=1.60, 2.46]) of reporting nonexposure. The magnitude and significance of this relationship was unchanged in the final model (OR=1.35, 2.00).

We conducted a sensitivity analysis to determine whether our results were robust with respect to the duration of the town smoking regulation or to our assignment of the regulation as of the respondents' interview date rather than the regulation in effect 1 year before the interview date (note that our exposure measure ascertained exposure during the previous year). In the full model, when we excluded all respondents for which the regulation had been in force for less than 1 year, the results changed little (OR=1.36 [95% CI=1.10], 1.68) for medium regulations and OR=1.97 [95% CI=1.49, 2.61] for strong

TABLE 1—Frequency of Exposure to Environmental Tobacco Smoke in Restaurants[a] Among Massachusetts Youths and Unadjusted Odds Ratios for Nonexposure, by Strength[b] of Local Restaurant Smoking Regulation and Sociodemographic Control Variables

	No. (%)	Not Exposed, %	Exposed, %	Odds Ratio[c] for Non-Exposure (95% CI)
Main predictor variable				
Strength of local restaurant smoking regulation**				
Weak	1924 (61.2%)	40.1	59.9	1.00
Medium	705 (22.4%)	49.5	50.5	1.45 (1.21, 1.75)
Strong	513 (16.3%)	59.0	41.0	2.16 (1.75, 2.66)
Control variables				
Age, years*				
12–14	1560 (49.9%)	42.8	57.2	1.00
15–17	1567 (51.1%)	47.7	52.3	1.22 (1.06, 1.40)
Gender				
Male	1598 (50.9%)	45.0	55.0	1.00
Female	1544 (49.1%)	45.3	54.7	1.01 (0.88, 1.17)
Race/ethnicity				
Non-Hispanic White	2453 (78.9%)	44.8	55.2	1.00
Other	656 (21.1%)	47.2	52.8	1.10 (0.92, 1.31)
Smoking status				
Experimenter/smoker	937 (30.0%)	47.3	52.7	1.00
Never smoker	2188 (70.0%)	44.6	55.4	0.88 (0.75, 1.03)
Peer smoking				
No close friends smoke	2158 (68.7%)	46.1	53.9	1.00
At least one close friend smokes	981 (31.2%)	43.2	56.7	0.91 (0.78, 1.06)
Household smoking*				
No adult smoker in household	2005 (63.9%)	47.0	53.0	1.00
Adult smoker in household	1134 (36.1%)	42.0	58.0	0.82 (0.70, 0.96)
Education of adult informant				
Not college graduate	1810 (58.7%)	44.2	55.8	1.00
College graduate	1272 (41.3%)	46.6	53.4	1.11 (0.95, 1.29)
Household income*				
$50,000	818 (32.2%)	41.9	58.1	1.00
≥ $50,000	1723 (67.8%)	47.1	52.9	1.24 (1.04, 1.48)
Frequency of eating out at restaurants in town				
Rarely or sometimes	1993 (63.5%)	45.7	54.3	1.00
Often or always	1147 (36.5%)	44.1	55.9	0.94 (0.81, 1.09)
Percentage of town "yes" vote on Question 1*				
< 50%	1798 (58.2%)	40.4	59.6	1.00
≥ 50%	1344 (42.8%)	51.8	48.2	1.57 (1.35,1.83)
Total	3142 (100%)	45.2	54.8	. . .

Note. CI = confidence interval.
[a]Exposure to environmental tobacco smoke in restaurants was indicated by a respondent reporting sometimes, usually, or always having seen someone smoking in a restaurant in their town during the previous year; nonexposure was indicated by a respondent reporting having never or rarely seen someone smoking in a restaurant in their town during the previous year.
[b]Strength of local restaurant smoking regulation was "strong" if it banned smoking completely in all restaurants in which youths were permitted 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.
[c]Unadjusted odds ratio reflects the likelihood of not being exposed to environmental tobacco smoke in restaurants, based on bivariate analysis.
*$P < .05$ for overall χ^2 test (test for significance of differences in distribution of exposure between different levels of independent variable); **$P < .05$ for overall χ^2 test and for Cochran–Armitage test for linear trend in distribution of exposure between different levels of independent variable.

regulations). Similarly, the results changed little when we assigned the regulation as of 1 year before the interview date, rather than the interview date itself (OR=1.45 [95% CI=1.20, 1.77] for medium regulations and OR=1.95 [95% CI=1.48, 2.57] for strong regulations).

DISCUSSION

To the best of our knowledge, this is the first study to examine the relationship between the strength of local restaurant smoking regulations and youths' self-reported exposure to environmental tobacco smoke in restaurants in those towns. We found a significant association between the strength of local restaurant smoking regulations and self-reported environmental tobacco exposure in restaurants and a significant gradient in the magnitude of this association as regulation strength increased. For the strongest regulations, which eliminated smoking in restaurants in which youths were allowed without exception, youths had twice the odds of reporting never or only rarely seeing smokers in restaurants in their town, compared with youths living in towns with the weakest regulations. Living in a town with a strong restaurant smoking regulation was in fact the strongest predictor of nonexposure to environmental tobacco smoke in restaurants in our data.

We believe this observed effect represents a true association between local restaurant smoking regulations and environmental tobacco smoke exposure, rather than an effect caused by confounding, because it is not explained by a wide range of potential individual-level confounding variables (including demographic factors, individual smoking status, peer and household smoking, and household education and income levels), nor is it explained by a major potential town-level confounder, the percentage of town's voters who voted for a cigarette tax initiative in 1992, which likely reflects the general level of anti-smoking sentiment in a town.

There are four major limitations to this study. First, the outcome variable did not assess environmental tobacco smoke exposure directly, but asked how often youths saw smokers when they ate out in restaurants in their town. Although this is an indirect mea-

TABLE 2—Adjusted Odds Ratios for Nonexposure to Environmental Tobacco Smoke in Restaurants[a] Among Massachusetts Youths, by Strength[b] of Local Restaurant Smoking Regulation and Sociodemographic Control Variables

	Full Model[c] Adjusted Odds Ratio for Nonexposure (95% CI)	Final Model[d] Adjusted Odds Ratio for Nonexposure (95% CI)
Main predictor variable		
Strength of local restaurant smoking regulation		
Weak	1.00	1.00
Medium	1.34 (1.10, 1.63)	1.35 (1.11, 1.64)
Strong	1.98 (1.60, 2.46)	2.00 (1.61, 2.47)
Control variables		
Age, years		
12–14	1.00	1.00
15–17	1.22 (1.04, 1.43)	1.21 (1.05, 1.40)
Gender		
Male	1.00	
Female	1.01 (0.87, 1.18)	
Race/ethnicity		
Non-Hispanic White	1.00	1.00
Other	1.35 (1.11, 1.63)	1.31 (1.09, 1.58)
Smoking status		
Experimenter/smoker	1.00	
Never smoker	0.82 (0.68, 0.99)	
Peer smoking		
No close friends smoke	1.00	
At least one close friend smokes	0.81 (0.67, 0.98)	
Household smoking		
No adult smoker in household	1.00	
Adult smoker in household	0.88 (0.75, 1.05)	
Education of adult informant		
Not college graduate	1.00	
College graduate	0.91 (0.76, 1.08)	
Household income		
< $50,000	1.00	
≥ $50,000	1.16 (0.95, 1.41)	
Frequency of eating out at restaurants in town		
Rarely or sometimes	1.00	
Often or always	0.97 (0.83, 1.14)	
Percentage of town "yes" vote on Question 1		
< 50%	1.00	1.00
≥ 50%	1.42 (1.19, 1.68)	1.43 (1.22, 1.68)

Note. CI = confidence interval.
[a]Exposure to environmental tobacco smoke in restaurants was indicated by a respondent reporting sometimes, usually, or always having seen someone smoking in a restaurant in their town during the previous year; nonexposure was indicated by a respondent reporting having never or rarely seen someone smoking in a restaurant in their town during the previous year.
[b]Strength of local restaurant smoking regulation was "strong" if it banned smoking completely in all restaurants in which youths were permitted 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.
[c]Full model included all control variables, regardless of significance of contribution to the model. Odds ratios are adjusted for all other variables in the model.
[d]Final model was determined with an empirical change-in-estimate confounder selection procedure[25,26] in which potential confounding variables were included only if they changed the coefficient of interest (point estimate for the odds ratio for medium and weak regulations) by 2% or more.

sure of exposure, it has been shown that self-reported data on the number of smokers one sees in a place is highly correlated with levels of environmental tobacco smoke exposure as confirmed by ambient nicotine measurements.[28] Although our measure of assessing exposure thus appears to be a valid measure of self-reported exposure, it is well documented that actual environmental tobacco smoke exposure tends to be underestimated by self reports.[29] We would expect, however, that misclassification of exposure caused by self-report in this study would be nondifferential with respect to exposure (i.e., there is no reason to believe that the degree of misclassification depends on the strength of regulation in one's town). This would bias the results toward the null hypothesis, making it more difficult to detect an effect of restaurant smoking regulations on exposure if a true effect existed. Thus, this limitation actually strengthens our finding, indicating that we may have underestimated the magnitude of effect of smoking regulations on environmental tobacco smoke exposure.

Second, youths likely eat out in more than one town, and it is possible that they reported on exposure in towns other than their town of residence. This would tend to dampen any differential exposure effect if one existed between towns with varying strength regulations, thus biasing the results toward the null hypothesis. For example, if youths who lived in a town with a strong regulation were reporting on dining experiences in a neighboring town with a weak regulation, then (assuming a relationship between regulation strength and exposure) they would tend to report higher levels of exposure than if they reported only on their experiences in their own town. The regulation effect would therefore be underestimated.

Third, we assigned to each respondent the strength of regulation on the date of their interview, but the exposure question assessed exposure over a 1-year period before that. Thus, in some cases, a regulation may not have been in effect for most of the period about which a youth was being questioned. However, a sensitivity analysis revealed that our results are robust with respect both to the duration of regulation and to whether the reg-

ulation strength is assigned on the interview date or 1 year before the interview date.

Fourth, the survey response rate was somewhat low. Because we had basic demographic information on eligible youths who were not interviewed, we were able to compare sample youths with nonresponders. We found no significant differences in the percentages of sample youths versus nonresponders who lived in towns with weak (69.0% vs 69.6%), medium (21.5% vs 19.9%), or strong (9.4% vs 10.5%) regulations (as of January 1, 2001); who were male (50.9% vs 50.7%); who were aged 12–14 years (49.3% vs 48.9%); whose household informant was a college graduate (40.9% vs 35.7%); and whose household income was greater than $50 000 (67.3% vs 64.6%). Therefore, we have no reason to believe that nonresponders differed from the sample youths in any systematic way that would have significantly influenced the internal validity of the study or the generalizability of the findings.

We conclude that local restaurant smoking regulations that restrict smoking to enclosed, separately ventilated areas or ban smoking entirely are associated with reduced exposure to environmental tobacco smoke in restaurants among youths. There is a gradation in effect, with substantially stronger protection from exposure being associated with eliminating smoking in restaurants entirely. This study indicates that strong local restaurant smoking regulations are effective in achieving their primary purpose—protecting the public from environmental tobacco smoke exposure. ■

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Contributors

All authors contributed to the conceptualization of the research question and the design of the study. L. Biener was the principal investigator of the study and directed the survey administration and data collection. M. Siegel and A.B. Albers conducted the data analysis and prepared the article. D.M. Cheng was the statistician responsible for analytic design, statistical and methodological guidance, and data interpretation. All authors reviewed and edited the article.

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Human Participant Protection

The institutional review boards of the University of Massachusetts and the Boston University Medical Center granted approval for the inclusion of human subjects in the study.

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