Bartenders’ Respiratory Health After Establishment of Smoke-Free Bars and Taverns

Mark D. Eisner, MD; Alexander K. Smith, BS; Paul D. Blanc, MD, MSPH

Context.—The association between environmental tobacco smoke (ETS) exposure and respiratory symptoms has not been well established in adults.

Objective.—To study the respiratory health of bartenders before and after legislative prohibition of smoking in all bars and taverns by the state of California.

Design.—Cohort of bartenders interviewed before and after smoking prohibition.

Setting and Participants.—Bartenders at a random sample of bars and taverns in San Francisco.

Main Outcome Measures.—Interviews assessed respiratory symptoms, sensory irritation symptoms, ETS exposure, personal smoking, and recent upper respiratory tract infections. Spirometric assessment included forced expiratory volume in 1 second (FEV1) and forced vital capacity (FVC) measurements.

Results.—Fifty-three of 67 eligible bartenders were interviewed. At baseline, all 53 bartenders reported workplace ETS exposure. After the smoking ban, self-reported ETS exposure at work declined from a median of 28 to 2 hours per week (P < .001). Thirty-nine bartenders (74%) initially reported respiratory symptoms. Of those symptomatic at baseline, 23 (59%) no longer had symptoms at follow-up (P < .001). Forty-one bartenders (77%) initially reported sensory irritation symptoms. At follow-up, 32 (78%) of these subjects had resolution of symptoms (P < .001).

Conclusion.—Establishment of smoke-free bars and taverns was associated with a rapid improvement of respiratory health.

THE LONG-TERM health effects of exposure to environmental tobacco smoke (ETS) have been established during the past 2 decades. Strong epidemiologic evidence links ETS exposure with lung cancer1,2 and atherosclerotic cardiovascular disease.3-5 As a result, ETS has been estimated as the third leading preventable cause of death.6 By contrast, the more immediate impact of ETS exposure on adult respiratory health has received less attention.7 Although household ETS exposure is a known cause of respiratory symptoms,8-10 studies examining the effect of ETS on adult respiratory symptoms have yielded conflicting results.11-16

Recently, California statewide legislation,17 which now mandates smoke-free bars and taverns, provided an unusual opportunity to prospectively evaluate the effect of reduced ETS exposure on respiratory symptoms, sensory irritation symptoms (eye, nose, and throat), and pulmonary function in bartenders.

METHODS

Overview

California State Assembly Bill 13 amended the California Labor Code (section 6404.5) to prohibit tobacco smoking in bars and taverns starting January 1, 1998.18,19 From December 1 to 31, 1997, we interviewed and performed spirometry on participating bartenders in their workplaces (bar or tavern). Follow-up interviews and spirometry were performed from February 1 to 28, 1998, to evaluate changes in symptoms or lung function following the institution of smoke-free bars.

Recruitment of Freestanding Bars and Taverns

The present study was approved by the University of California, San Francisco, Committee on Human Research. We obtained a list of all bars and taverns (N = 306) in the city and county of San Francisco from a commercial yellow pages directory (under subject headings “bars,” “cocktail lounges,” or “taverns”). After review of the listings, we excluded businesses known to be restaurants (n = 66) or associated with hotels (n = 4). Of the 296 listings, we randomly sampled 105 freestanding establishments. Each bar or tavern proprietor was contacted by a letter describing the study and given the opportunity to prospectively evaluate the effect of reduced ETS exposure on respiratory symptoms, sensory irritation symptoms (eye, nose, and throat), and pulmonary function in bartenders.

Of the 105 freestanding bars and taverns sampled, 13 establishments were no longer in business and 9 were located in restaurants, leaving 83 eligible businesses. In 22 cases, the owner could not be reached by telephone despite 6 or more
attempts. The owners of 36 bars declined study participation; 7 returned the decline postcard and 29 declined by telephone. During telephone contact, the reasons provided for declining were disagreement with the change in the Labor Code (n = 8, 28%), inconvenience (n = 3, 11%), or not stated (n = 18, 61%). Ultimately, 25 bars and taverns (30%) still in business participated. As presented later in the “Methods” section, we found no evidence of systematic bias introduced by bar or tavern nonparticipation.

Recruitment of Bartenders

At prearranged times, a single study investigator (M.D.E.) visited each participating bar or tavern and attempted to recruit all bartenders who worked there at least 1 daytime shift per week. Because study participation required about 15 minutes per subject, we were unable to conduct the study during peak business hours. The 25 participating bars and taverns employed 124 bartenders, with 67 bartenders working at least 1 weekly daytime shift. Fifty-four of the daytime bartenders (81%) completed baseline interviews and spirometry; 53 of these subjects (98%) completed follow-up. A small number of subjects (n = 3, 6%) were no longer working in bars or taverns at the time of the follow-up interview and lung function assessment (these subjects were retained for analysis). The mean interval (SD) between baseline and follow-up interviews was 56 (9) days (median, 56 days).

The estimated annual average number of bartenders employed in San Francisco was 1910 (1994 data based on the California Employment Development Department Labor Market Information Database). Our study sample of bartenders, then, represents approximately 2.8% of all bartenders employed in San Francisco.

Interviews

All subjects underwent a standard baseline interview conducted by a single study investigator (M.D.E.) in their workplaces. Respiratory symptoms were assessed with 5 questions from the International Union Against Tuberculosis and Lung Disease (IUATLD) Bronchial Symptoms Questionnaire.34 The questions related to wheezing, dyspnea, morning cough, cough during the rest of the day or night, and phlegm production. The IUATLD instrument has been validated against the criterion of bronchial hyperresponsiveness.34,35 To evaluate change in respiratory symptoms during a short period, we modified the IUATLD questions to assess symptoms during the past 4 weeks rather than the previous 12 months. In addition to the IUATLD battery, we also assessed sensory irritation symptoms, which can result from ETS-related noxious stimulation of upper respiratory tract and corneal mucous membranes.36 Three questions ascertained the presence of red, teary, or irritated eyes; runny nose, sneezing, or nose irritation; and sore or scratchy throat during the past 4 weeks.

Personal, active cigarette smoking was measured using questions developed for the National Health Interview Survey.36 In 3 additional questions, we evaluated ETS exposure duration in work, home, and other settings during the previous 7 days (in hours per week). Several questions focused on baseline health and demographic characteristics. Using a question from the National Health and Nutrition Examination Survey (NHANES), we assessed whether subjects had physician-diagnosed asthma.37 In addition, medication use for asthma was ascertained. We evaluated whether subjects had an upper respiratory tract infection (URI) during the past 4 weeks with the following question: “In the last 4 weeks, have you had a cold?” Finally, demographic information was collected, including age, sex, race, and education.

Conducted about 8 weeks later, follow-up interviews contained the same questions about respiratory symptoms, sensory irritation symptoms, personal smoking, ETS exposure, and URIs. At the end of the second interview, we ascertained personal beliefs about the health effects of ETS exposure and attitudes about the prohibition of smoking in bars and taverns.

Spirometry

All participating bartenders underwent spirometry at both baseline and follow-up in their workplaces. We measured lung function with a portable spirometer (Creative Biomedics, San Clemente, Calif). Using a standard protocol conforming to American Thoracic Society Guidelines, we had each subject perform at least 3 forced expiratory maneuvers.38 Forced expiratory volume in 1 second (FEV1), forced vital capacity (FVC), and forced expiratory flow, midexpiratory phase (FEF25%-75%) were determined.

Participating and Nonparticipating Bars and Taverns

To assess the comparability of participating and nonparticipating establishments, we obtained information about San Francisco bars and taverns from several sources. The State of California Department of Alcoholic Beverage Control provided liquor license issuance dates and license status. We extracted data about establishment size (square meters), county health care district (either ‘yes’ or ‘no’), length of time in business (either same owner or same establishment name), and health code violations from Department of Public Health Environmental Health Section inspection records. Table 1 shows that there were no statistically significant differences between participating and nonparticipating bars (P > .25 in all cases).

To estimate how closely our sample of bartenders matched the target population of San Francisco bartenders, we reviewed demographic data for an available comparison group—unionized San Francisco bartenders (n = 462) —obtained from the Hotel and Restaurant Employees and Bartenders Union Local 2 (affiliated with the American Federation of Labor–Congress of Industrial Organizations). Compared with union members, the bartenders in our sample were younger (mean [SD], 42.2[14] vs 51.0[11.4] years; P < .001) and more likely to be female (28% vs 17%; P = .05). There was no statistically significant difference in the proportion of nonwhite bartenders in our sample compared with union members (37% vs 29%; P = .25).

Statistical Analysis

Our general analytic framework compared the respiratory health of bartenders before and after prohibition of smoking in bars and taverns. The study had 2 central hypotheses. First, respiratory and sensory irritation symptoms would improve among bartenders after reduced ETS exposure following the legislative ban. Second, bartenders’ pulmonary function would improve after reduction in workplace ETS exposure.

Interview and spirometry data were analyzed using SAS software version 6.12 (SAS Institute Inc, Cary, NC), unless otherwise noted. We compared the change in work duration (hours per week), personal smoking, and ETS exposure using the paired t test for normally distributed variables, paired Wilcoxon signed rank test for nonnormally distributed continuous variables, and McNemar χ² test for dichotomous variables.

To reduce the number of statistical comparisons, we defined 2 a priori primary symptom end points: any respiratory symptom (wheeze, shortness of breath, morning cough, cough during the rest of the day or night, or phlegm production) and any sensory irritation symptom (eye, nose, or throat). The McNemar χ² test was used to compare the observed change in each symptom end point with that expected by chance. We then performed secondary analyses to evaluate the change in each symptom type during follow-up.

To address the potential confounding effect of recent URIs, we repeated the primary analyses excluding these subjects. To control for personal smoking, we also repeated the analyses stratified by smoking status. Using Stata software version 5.0 (Stata Corp, College Station,
RESULTS

Bartender Characteristics

For the 53 participating bartenders completing follow-up interviews and spirometry, the average (SD) age was 42.5 (14.0) years. A substantial proportion of subjects were female (28%) and non-white (38%) (Table 2). The mean duration of employment at the current bar or tavern was 6.1 (SD, 7.1) years (median, 3.0 years). Other subject characteristics are summarized in Table 2.

Cigarette Smoking and ETS Exposure

Forty (76%) of the 53 bartenders reported respiratory symptoms at baseline, while only 17 (32%) were still symptomatic at follow-up (Table 4). Of the 39 bartenders reporting baseline symptoms, 23 subjects (59%) no longer indicated any respiratory symptoms after prohibition of smoking ($P<.001$). The majority of bartenders also had at least 1 sensory irritation symptom at baseline (77%), with fewer reporting symptoms at follow-up (19%). With introduction of smoke-free workplaces, sensory symptoms were no longer present in 32 (78%) of the 41 previously symptomatic subjects ($P<.001$).

Since URIs can be associated with both respiratory and sensory irritation symptoms, we repeated the analyses excluding the 8 subjects who reported a recent URI at baseline. A majority of the remaining 45 bartenders (69%) still reported respiratory symptoms at baseline, with most of these subjects (65%) indicating resolution of symptoms at follow-up ($P<.001$). Similarly, most bartenders without recent URIs noted sensory irritation symptoms at baseline (76%). At follow-up interview, the majority of these subjects (79%) no longer reported any sensory symptoms ($P<.001$).

We recognized that smoke-free bars and taverns might lead bartenders to curtail their personal smoking, which could diminish respiratory symptoms. After stratifying the analysis by smoking status, we observed similar results. Of the previously symptomatic smoking bartenders, the majority no longer reported respiratory (63%) or sensory irritation symptoms (80%) at follow-up ($P<.001$ in both cases). Similarly, most nonsmoking bartenders with baseline symptoms reported resolution of respiratory (53%) or sensory irritation symptoms (76%) ($P=.02$ and $P<.001$, respectively).

Conditional logistic regression analysis was performed to estimate the independent impact of reduced bar ETS exposure on the primary symptom end points. A 5-hour reduction in workplace ETS exposure was associated with a lower risk of respiratory symptoms at follow-up (odds ratio [OR], 0.7; 95% confidence interval [CI], 0.5-0.9), after controlling for URIs and daily cigarette consumption at both interviews. In a similar analysis, a 5-hour decrement in bar ETS exposure was associated with a reduced risk of sensory irritation symptoms at follow-up (OR, 0.5; 95% CI, 0.3-0.8). Excluding the 3 subjects no longer working as bartenders at follow-up did not appreciably affect these risk estimates.

Pulmonary Function

After prohibition of smoking, the mean FVC and FEV1 both increased at follow-up (mean [SD], 33.4 [14.9] hours) to follow-up interviews (32.2 [17.5] hours; $P=.48$). However, self-reported workplace ETS exposure sharply declined from a median of 28 to 2 h/week ($P<.001$) after the smoke-free workplace law went into effect (Table 3). We observed a parallel decrease in other (non-work) and total ETS exposure. Despite the prohibition of smoking, 29 subjects (55%) continued to report some ETS exposure ($\geq$1 h/week) while working as bartenders.

Respiratory and Sensory Irritation Symptoms

Table 1.—Comparison of Participating and Nonparticipating Bars and Taverns in San Francisco

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Participating Bars (n = 25)</th>
<th>Nonparticipating Bars (n = 58)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health center location, No. (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>5 (20)</td>
<td>13 (22)</td>
</tr>
<tr>
<td>3</td>
<td>2 (9)</td>
<td>8 (14)</td>
</tr>
<tr>
<td>4</td>
<td>7 (28)</td>
<td>14 (24)</td>
</tr>
<tr>
<td>5</td>
<td>11 (44)</td>
<td>23 (40)</td>
</tr>
<tr>
<td>Establishment size, mean (SD), m²</td>
<td>143.91 (95.76)</td>
<td>126.36 (84.06)</td>
</tr>
<tr>
<td>Years in business, mean (SD), y</td>
<td>13.6 (9.5)</td>
<td>15.3 (8.3)</td>
</tr>
<tr>
<td>Current cigarette license duration, mean (SD), y</td>
<td>9.9 (6.5)</td>
<td>9.0 (7.0)</td>
</tr>
<tr>
<td>Liquor license with active status, No. (%)</td>
<td>25 (100)</td>
<td>58 (100)</td>
</tr>
<tr>
<td>Any health code violation in past 1 year, No. (%)</td>
<td>11 (46)</td>
<td>25 (43)</td>
</tr>
</tbody>
</table>

$*P<.10$ in all comparisons of participating vs nonparticipating bars. The sources of data are the Department of Public Health Environmental Health Section inspection records (health center location, establishment size, years in business, and health code violations) and State of California Department of Alcoholic Beverage Control (liquor license information).

Table 2.—Baseline Bartender Characteristics (n = 53)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Participating Bars (n = 25)</th>
<th>Nonparticipating Bars (n = 58)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD), y</td>
<td>42.5 (14.0)</td>
<td>40 (76)</td>
</tr>
<tr>
<td>Sex, No. (%) female</td>
<td>15 (28)</td>
<td></td>
</tr>
<tr>
<td>Race, No. (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White, non-Hispanic</td>
<td>33 (62)</td>
<td>38 (63)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>10 (19)</td>
<td>18 (32)</td>
</tr>
<tr>
<td>African American</td>
<td>2 (4)</td>
<td>3 (6)</td>
</tr>
<tr>
<td>Asian/Pacific Islander</td>
<td>6 (11)</td>
<td>9 (18)</td>
</tr>
<tr>
<td>Other</td>
<td>2 (4)</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Education, highest level attained, No. (%)</td>
<td>13 (25)</td>
<td>20 (35)</td>
</tr>
<tr>
<td>High school</td>
<td>13 (25)</td>
<td>14 (25)</td>
</tr>
<tr>
<td>College or greater</td>
<td>40 (76)</td>
<td>44 (75)</td>
</tr>
<tr>
<td>Duration of current bar employment, y</td>
<td>Mean (SD)</td>
<td>6.1 (7.1)</td>
</tr>
<tr>
<td>Median (25th-75th interquartile range)</td>
<td>3.0 (1.5-8.0)</td>
<td>4.0 (2.0-10.0)</td>
</tr>
<tr>
<td>History of physician-diagnosed asthma, No. (%)</td>
<td>9 (17)</td>
<td>12 (21)</td>
</tr>
<tr>
<td>Currently receiving asthma medications, No. (%)</td>
<td>4 (8)</td>
<td>5 (9)</td>
</tr>
</tbody>
</table>

$*P<.10$ in all comparisons of participating vs nonparticipating bars.
Table 3.—Personal Smoking and Environmental Tobacco Smoke Exposure at Baseline and Follow-up Interviews (n = 53)*

<table>
<thead>
<tr>
<th>Personal (direct) smoking</th>
<th>Baseline</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ever smoked cigarettes, No. (%)</td>
<td>40 (76)</td>
<td>. . .</td>
</tr>
<tr>
<td>Currently smokes cigarettes, No. (%)</td>
<td>24 (45)</td>
<td>24 (45)</td>
</tr>
<tr>
<td>Daily smoking, mean No. of packs per day (SD)</td>
<td>1.0 (0.6)</td>
<td>1.0 (0.6)</td>
</tr>
</tbody>
</table>

Environmental tobacco smoke exposure, median (25th-75th interquartile range)

| Bar or tavern exposure, h in past 7 d | 28 (20-40) | 2 (0-10) |
| Other exposure, h in past 7 d | 7 (0-20) | 2 (0-15) |
| Total exposure, h in past 7 d | 40 (30-55) | 10 (2-30) |

*Environmental tobacco smoke exposure at follow-up excludes 3 subjects who no longer worked in bars. Including these subjects, exposure at follow-up was bar or tavern median, 2 (interquartile range, 0-9) hours; other, 2 (0-10) hours, and total, 10 (2-30) hours. Ellipses indicate data not applicable.

Table 4.—Respiratory and Sensory Irritation Symptoms in Bartenders Before and After Prohibition of Smoking in Bars (n = 53)

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Baseline</th>
<th>Follow-up</th>
<th>Change, P Value†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any respiratory symptom‡</td>
<td>39 (74)</td>
<td>17 (32)</td>
<td>23 1 29 &lt;.001</td>
</tr>
<tr>
<td>Wheezing</td>
<td>17 (32)</td>
<td>8 (15)</td>
<td>12 3 38 .02</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>10 (19)</td>
<td>4 (8)</td>
<td>8 2 43 .06</td>
</tr>
<tr>
<td>Cough, morning</td>
<td>28 (53)</td>
<td>12 (23)</td>
<td>17 1 35 &lt;.001</td>
</tr>
<tr>
<td>Cough, rest of day or night</td>
<td>26 (49)</td>
<td>6 (11)</td>
<td>21 1 31 &lt;.001</td>
</tr>
<tr>
<td>Phlegm production</td>
<td>28 (53)</td>
<td>6 (11)</td>
<td>22 0 31 &lt;.001</td>
</tr>
<tr>
<td>Any sensory irritation symptom‡</td>
<td>41 (77)</td>
<td>10 (19)</td>
<td>32 1 20 &lt;.001</td>
</tr>
<tr>
<td>Eye</td>
<td>22 (42)</td>
<td>3 (6)</td>
<td>20 1 32 &lt;.001</td>
</tr>
<tr>
<td>Nose</td>
<td>32 (60)</td>
<td>6 (15)</td>
<td>25 1 27 &lt;.001</td>
</tr>
<tr>
<td>Throat</td>
<td>13 (25)</td>
<td>7 (13)</td>
<td>9 3 41 .08</td>
</tr>
</tbody>
</table>

Reduction, symptoms at baseline but none at follow-up; increase, no symptoms at baseline and new symptoms at follow-up; and no change, either symptomatic at both interviews or asymptomatic at both interviews.

§ Any respiratory symptom or any sensory irritation symptom are primary end points. Individual symptom analyses are secondary.

McNemar χ² test, comparing observed change in symptoms over time with that expected by chance. For example, of the 39 subjects with any respiratory symptom at baseline, 23 (59%) no longer had symptoms at follow-up (P<.001).

Table 5.—Pulmonary Function in Bartenders Before and After Prohibition of Smoking in Bars (n = 53)*

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Baseline Mean (SE) [% Predicted]</th>
<th>Change, Mean (95% CI)†</th>
<th>% Change§</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEV₁, Ls</td>
<td>3.38 (0.13) [89.2 (2.4)]</td>
<td>0.19 (−0.030 to 0.107)</td>
<td>5.7</td>
</tr>
<tr>
<td>FVC, L</td>
<td>4.43 (0.15) [95.5 (2.2)]</td>
<td>0.18 (0.082 to 0.296)</td>
<td>4.2</td>
</tr>
<tr>
<td>FEF25%-75%, L/s</td>
<td>3.37 (0.19) [81.6 (3.5)]</td>
<td>−0.19 (−0.405 to 0.225)</td>
<td>−5.7</td>
</tr>
</tbody>
</table>

PVEF indicates forced expiratory volume in 1 second; FVC, forced vital capacity; FEF25%-75%, forced expiratory flow, midexpiratory phase; and CI, confidence interval.

1912 JAMA, December 9, 1998—Vol 280, No. 22
Smoke-Free Bars and Tavern’s Effect on Health of Bartenders—Eisner et al

©1998 American Medical Association. All rights reserved.

highly variable, declined during the study period.

As with symptom end points, we performed additional analyses to control for the effects of recent URIs and personal smoking. Excluding the 8 subjects who reported URIs in the 4 weeks prior to baseline, we found a statistically significant improvement in both FVC (0.283 L; 95% CI, 0.124-0.343 L) and FEV₁ (0.083 L; 95% CI, 0.015-0.151 L). After further stratification by smoking status, we observed a similar estimated improvement in FVC among smokers (0.238 L; 95% CI, 0.081-0.396 L) and nonsmokers (0.229 L; 95% CI, 0.063-0.394 L). The FEV₁, increase was also comparable among smokers (0.096 L; 95% CI, −0.013 to 0.204 L) and nonsmokers (0.070 L; 95% CI, −0.020 to 0.159 L), although the CIs did not exclude no significant change.

Compared with some continued ETS exposure in bars or taverns at follow-up, complete workplace exposure cessation was associated with improved FVC (0.267 L; 95% CI, 0.088-0.468 L) and FEV₁ (0.142 L; 95% CI, 0.020-0.264 L), after controlling for current smoking, decreased daily cigarette consumption, and recent URIs. Expressed as an adjusted mean percentage change, FVC and FEV₁ increased by 6.8% and 4.5%, respectively. After controlling for these covariates, FEF25%-75% also increased during follow-up, but the effect was not statistically significant (0.081 L; 95% CI, −0.349 to 0.511 L). A history of asthma, when added to the model, was not associated with change in pulmonary function (P>.60). Excluding the 3 subjects no longer working as bartenders at follow-up did not appreciably change the effect estimates or CIs.

To evaluate a dose-response relationship, we repeated the multivariate analysis using 3 categories of workplace ETS exposure at follow-up: none, moderate (1-6 hours), and high (>7 hours). Bartenders with complete workplace ETS exposure cessation had improved FVC (0.326 L; 95% CI, 0.009-0.565 L) and FEV₁ (0.157 L; 95% CI, 0.001-0.393 L), relative to those indicating persistent high-level workplace exposure. Compared with bartenders reporting only moderate levels of ETS exposure in bars or taverns, complete workplace exposure cessation was associated with a smaller improvement in FVC (0.244 L; 95% CI, 0.048 L) and FEV₁ (0.127 L; 95% CI, −0.024 to 0.277 L).

Relationship Between Symptoms and Pulmonary Function

We repeated the multiple linear regression analyses to evaluate whether pulmonary function improved in 2 separate strata: subjects whose respiratory symptom resolved (n = 23) and subjects with persistent or new symptoms (n = 30) at follow-up. In bartenders who reported resolution of respiratory symptoms, complete cessation of workplace ETS exposure was associated with improved FVC (0.464 L; 95% CI, 0.172-0.757 L) and FEV₁ (0.202 L; 95% CI, 0.002-0.403 L). The subjects with continued symptoms also experienced improvement in FEV₁ (0.146 L; 95% CI, −0.010 to 0.302 L) and FVC (0.139 L; 95% CI, −0.164 to 0.441 L), although the CIs overlapped no change.

Bartenders’ Attitudes About the Health Effects of ETS and the Prohibition of Smoking

Eleven (21%) of the 53 bartenders expressed the belief that ETS exposure has no adverse effect on their personal health. The remaining 42 bartenders believed that ETS has a slight effect (40%) or moderate-to-severe effect (40%) on their health.

When asked about their personal attitude toward the prohibition of smoking in bars, 24 (45%) of the 53 bartenders strongly or somewhat (19%) disagreed with the legislative ban. The remaining bartenders were neutral (35%), somewhat agreed (8%), or strongly agreed (19%). Most bartenders believed that ETS has a moderate-to-severe adverse health effect agreed with the prohibition of smoking in bars.

Downloaded From: https://jama.jamanetwork.com/ by a Non-Human Traffic (NHT) User on 03/17/2019
lower ETS levels.46 The present study particulate concentrations, suggesting exhibited in a sports tavern, investigators reflected decreased ambient ETS lev-

ers with respiratory symptoms in adults ex-
mposed to household11-14,17,18 or workplace

orses agreed with the legislation (59%) compared with those who thought smoking substantially reduced, but did not

prohibited in workplace ETS exposure. The prevalence of respiratory and sensory irritation symptoms, which initially affected the majority of bartenders, declined mark-
edly after the smoking ban. Similarly, pul-

mony function improved following re-
duction of workplace ETS exposure, after controlling for personal smoking and URIs.

In previous studies, prohibition of work-
place smoking has effectively reduced em-
ployee ETS exposure. Smoke-free work-

places have been associated with decreased personal cigarette consumption,43-46 public smoking,47 and self-reported ETS exposure.48 In addition, workplace smoking bans result in dramatic reduction of indoor airborne nicotine concentrations, reflect-
ing decreased ambient ETS levels.24,46 The efficacy of smoking prohibition in bars and taverns, however, has been less well established. After smoking was pro-
hibited in a sports tavern, investigators found decreased respiratory suspended particulate concentrations, suggesting lower ETS levels.49 The present study indicates that legislative prohibition of smoking substantially reduced, but did not eliminate, self-reported workplace ETS exposure among bartenders.

In adults, the evidence linking ETS ex-
posure with respiratory symptoms has been inconclusive. Several studies have demonstrated an association between self-reported obstructive lung disease and ETS exposure.54,55,56 A recent cross-sectional study of 4187 nonsmoking Swiss adults found an increased risk of wheeze, dyspnea, and bronchitis symptoms in subjects reporting ETS exposure during the past year.57 Similarly, workplace ETS exposure was related to increased cough, phlegm production, and dyspnea in 80 adults enrolling in a fitness program.48 Other studies, however, have not demonstrated a consistent, significant increase in respiratory symptoms in adults ex-
posed to household11,14,17,18 or workplace ETS.17 Furthermore, a smoking ban in se-

model Canadian office buildings was not as-

associated with any significant reduction in respiratory symptoms 1 year later.58 Our study, which demonstrated reduced respira-

tory symptoms after prohibition of workplace smoking, helps confirm the ad-

verse impact of ETS exposure on imme-
diate respiratory health.

Environmental tobacco smoke contains potent respiratory irritants, such as ammonia, sulfur dioxide, acrolein, and formalde-
hyde,2 that could potentially impair lung function. In several cross-sectional epi-
demiologic studies, ETS exposure was associated with small reductions in FEV1 (2.8%-6.7%)49-53 and FVC (2.6%-5.4%)49,53 compared with unexposed subjects. An-
other study found no impact of ETS expos-
ure on FEV1 or FVC, but FEV/FVC was reduced.54 A recent prospective investiga-
tion of 28 bar workers demonstrated a sig-
nificant reduction in FEV1 (0.042 L) im-
ediately following ETS exposure during a work shift.55 Not all studies, however, have found consistent pulmonary func-
tion decrements.11,56 Although the effect of ETS exposure cessation on adult lung func-
tion has not been characterized, the salu-
tary effect of personal cigarette smoking cessations is well established. Several stud-
ies demonstrated modest increases in FEV1 (1.2%-4.8%) shortly after personal smoking cessation.57-59 Our study sug-
gests that lung function may also improve, to a small degree, after cessation of heavy ETS exposure.

Although we adhered to a standard spi-
rometry protocol,50 we cannot exclude the contribution of training to the observed pulmonary function improvement. The proportionally larger increase in FVC than FEV1, in particular, could be consistent with a learning effect. The CIs, however, are broad, with overlap between the esti-
mated relative improvement in FEV1 and FVC. Also, the FEV1 improvement is simi-
lar to the acute decrements previously de-
scribed in bar workers after a work shift.55 Similarly, the unadjusted relative in-
crease in FEV1 (1.2%) is comparable with the FEV1 change described in both smok-
ing cessation studies57-61 and cross-
sectional studies of ETS.49,53 The unad-
justed FVC improvement (4.2%) also seems compatible with the ETS-related decrements described in epidemiologic studies.49,55 Finally, the unexpected trend toward decreasing FEV1/FVC was a highly variable measure, disappeared after adj-
justment for smoking and URIs. Overall, the improvement in lung function is con-
sistent with a causal effect of reduced workplace ETS exposure.

The small sample size, while unlikely to affect study generalizability, limited our power to detect differences in some aspects of respiratory health. The unad-
justed improvement of FEV1, in particu-
lar, had a CI including no change. Simi-
larly, there was limited power to detect a dose-response relationship. Although we have biased subject responses, although we attempted to maintain standard condi-
tions. Although many studies demon-
strate modest correlations between self-
reported ETS exposure and biomarker levels, such as serum cotinine,20,21,62,63 we cannot exclude some systematic misclassifi-
cation of exposure. For example, bartend-
ers with respiratory symptoms might be more likely to report ETS exposure, whereas asymptomatic subjects might un-
derreport exposure. Similarly, contro-
versy generated by the smoke-free bar and tavern legislation could have biased symptom reporting. If subjects who agreed with the smoking ban were more likely to report symptom reduction, the observed improvement in symptom status could be inflated. However, the major-
ity of subjects disagreed with the new legis-
lation, which would not be expected to favorably bias symptom reporting. Moreover, the objective measure of pul-
monary function helps validate the reduc-
tion in respiratory symptoms.

The low participation rate by bars and
taverns (30%) raises the concern of gen-
eralizability to all bars. Owner attitude to-
ward the smoking ban could have influ-
enced their decision to allow study partici-
ipation, making systematic differ-
ces between participating and nonpar-

ticipating bars possible. However, we found no differences in any characteris-
tic examined between participating and nonparticipating establishments. Impor-
tantly, business size, which is a determi-
nant of ambient ETS concentration,44 did not differ.

Similarly, differences between study participants and the entire population of San Francisco bartenders could limit the generalizability of our results. To assess how representative our sample was, we compared our subjects with an available bartender group from the same sampling area. Participating bartenders were younger and more likely to be female than unionized bartenders; there were no dif-
f erences in race. Unionized workers, how-
ever, are generally more likely to be older and male than the general working popu-
lation,46 potentially explaining these ob-
served differences. Although we found little evidence of systematic differences between our sample and the target popu-
lation, residual differences may still limit the generalizability of our findings to all bartenders in San Francisco, and more broadly, in California overall.

The small sample size, while not likely to affect study generalizability, limited our power to detect differences in some aspects of respiratory health. The unad-
justed improvement of FEV1, in particu-
lar, had a CI including no change. Simi-
larly, there was limited power to detect a dose-response relationship. Although we...


Hirayama T. Nonsmoking wives of heavy smokers have a higher risk of lung cancer: a study from Japan. BMJ. 1981;283:185-188.


