



# Archives of Environmental Health: An International Journal

ISSN: 0003-9896 (Print) (Online) Journal homepage: <https://www.tandfonline.com/loi/vzeh20>

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To cite this article: Farhang Akbar-khanzadeh , Sheryl Milz , April Ames , Sara Spino & Christopher Tex (2004) Effectiveness of Clean Indoor Air Ordinances in Controlling Environmental Tobacco Smoke in Restaurants, Archives of Environmental Health: An International Journal, 59:12, 677-685, DOI: [10.1080/00039890409602953](https://doi.org/10.1080/00039890409602953)

To link to this article: <https://doi.org/10.1080/00039890409602953>



Published online: 05 Apr 2010.



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# Effectiveness of Clean Indoor Air Ordinances in Controlling Environmental Tobacco Smoke in Restaurants

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**ABSTRACT.** Clean indoor air (CIA) ordinances in Toledo, Ohio, and Bowling Green, Ohio, regulate smoking in restaurants to protect patrons and employees. Yet complete protection is questionable because the ordinances allow for smoking in certain dining sections. Two restaurants were studied in each city, one smoking and one nonsmoking. Levels of contaminants related to environmental tobacco smoke (ETS)—determined by personal and area air monitoring—in the nonsmoking restaurants were comparable to levels in a control environment. However, levels of ETS-related contaminants in the smoking restaurants, including designated nonsmoking sections, were significantly higher than levels in the control environment. ETS-related contamination of the nonsmoking sections in the smoking restaurants is attributable to direct openings between the smoking and nonsmoking sections. Reasonable protection of employees and patrons against ETS-related contaminants requires strict enforcement of CIA ordinances. Full protection is achievable only with 100% smoke-free policies.

<Key words: environmental tobacco smoke, indoor air ordinances, restaurants>

AS OF JANUARY 2005, up to 1,903 municipalities in the United States had adopted local laws restricting where smoking is allowed.<sup>1</sup> Of those, only 358 municipalities adopted 100% smoke-free ordinances, whereas the rest, including the cities of Toledo and Bowling Green, both located in northwest Ohio, provided exemptions. The Clean Indoor Air (CIA) Ordinance #509-03 in Toledo was enacted in 2003 to restrict smoking in restaurant/bar establishments to sections that are enclosed. Bowling Green passed Clean Indoor Air Ordinance #6912 in 2002, which restricts smoking in restaurant/bar settings to those allowing smoking in a bar, provided that the bar was contained within a separate smoking section.

The smoking restriction ordinances in Toledo and Bowling Green may have been influenced by reports clearly demonstrating the harmful effects of environmental tobacco smoke (ETS)<sup>2-5</sup> and by numerous studies conducted in northwest Ohio<sup>6-9</sup> and elsewhere<sup>10-15</sup> that have been published during the past decade. Those

studies revealed that patrons dining in and employees working in designated nonsmoking sections of a smoking restaurant/bar were not completely protected against ETS-related air contaminants.

Whether the CIA ordinances of Toledo and Bowling Green fully protect patrons and employees is questionable because the ordinances allow smoking in dining lounges in certain restaurant/bar establishments. Therefore, we are evaluating the effectiveness of these two clean indoor air ordinances in this report. The main purposes of this study were to (1) measure the ETS-related contaminants in a sample of randomly selected restaurants in the cities of Toledo and Bowling Green, (2) determine whether the enacted CIA ordinances have eliminated ETS-related contaminants in both restaurants that have become smoke-free and nonsmoking sections of restaurants that still allow smoking, and (3) compare the levels of ETS-related contaminants found in the study conducted before CIA ordinances were adopted<sup>6</sup> with the levels determined in this study.

## Materials and Method

**Restaurant selection.** We compiled a list of restaurants in Toledo and Bowling Green in two databases: one for smoke-free establishments and one for smoking establishments. We ordered each database by decreasing surface area (square footage). For recruitment purposes the restaurants from the top of the list were invited to participate in the study. We selected 2 restaurants in each city, 1 that allowed smoking and 1 that did not, to participate in the study. We included a nonsmoking office building in the study as a control (referent) establishment.

We assumed that the 2 chosen nonsmoking restaurants were representative of other nonsmoking restaurants in Toledo and Bowling Green because none allowed smoking. To ensure that the 2 selected smoking restaurants were representative of other smoking restaurants in these two cities, we conducted a survey in 9 additional smoking restaurants (5 in Toledo and 4 in Bowling Green), based on the CIA ordinances of the two cities. The results of the survey indicated that the 2 smoking restaurants we sampled for this study were representative of other smoking restaurants in these two cities.

**Air monitoring.** We used standard methods<sup>16-18</sup> to determine the concentrations of ETS-related contaminants, including nicotine, 3-ethenylpyridine (3-EP), total respirable suspended particulate matter (RSP), respirable suspended particulate matter based on Solanesol, and respirable suspended ultraviolet particulate matter

(UVPM) and fluorescent particulate matter (FPM). Air monitoring included both personal and area integrated air sampling.

We used the same equipment for both personal and area air monitoring trains. For area air monitoring, we used a tripod to hold the sampling media inlet at about 1 m above the floor, which is the average height of the breathing zone of a seated patron. Two pouches were used in the personal monitoring to accommodate the 2 personal sampling pumps. One pouch had a shoulder strap to hold the sampling media in the subject's breathing zone.

Area air monitors were placed in locations where we could obtain representative samples of air in the restaurants (Figs. 1 and 2) where employees and patrons would be present. The locations of 2 air monitors at the smoking restaurant in Bowling Green were altered at the request of the manager because they were too noisy for patron comfort. These 2 air monitors were relocated to areas near the wall and the restaurant entrance. The average level of ETS-related contaminants in this restaurant most likely would have been slightly higher had the air monitors remained in the original locations.

The air monitoring train used to sample nicotine and 3-EP consisted of an XAD-4 sorbent tube (SKC #226-93, 7 × 70mm; SKC Inc., Eighty-Four, PA), Tygon® tubing, sampling pump, tripod (42 in tall with the media clipped at the top), and a tube holder (SKC Type A #222-3-1). The air monitoring train used to sample respirable suspended particulate matter consisted of a 3-stage,

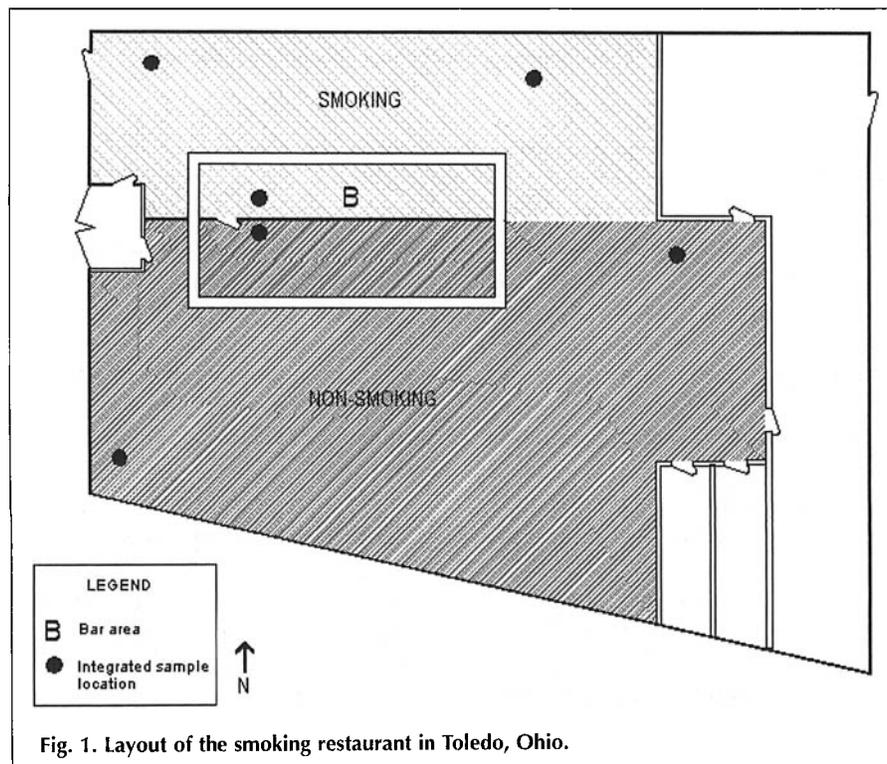


Fig. 1. Layout of the smoking restaurant in Toledo, Ohio.

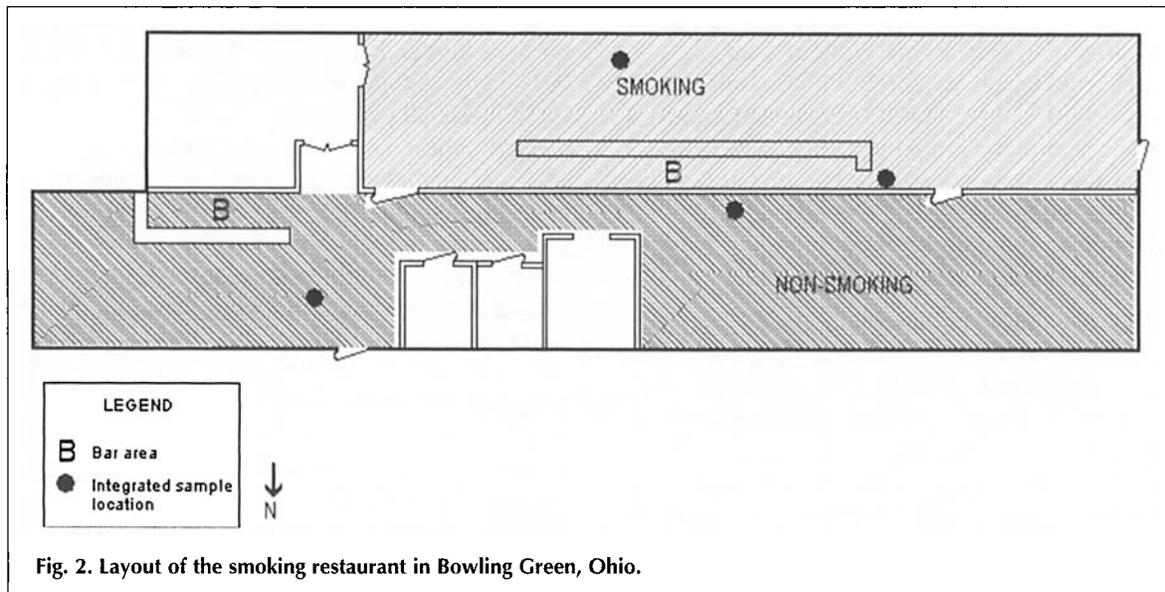


Fig. 2. Layout of the smoking restaurant in Bowling Green, Ohio.

37-mm fluoropore filter-cassette that was preweighed and supplied by an accredited analytical laboratory; a cyclone (SKC-01-02); a cassette holder (SKC #225-1); Tygon tubing; sampling pump, and a tripod (42 in tall with the media clipped at the top). The flow rate was set at 1.0 L/min for XAD-4 sorbent tubes and 2.6 L/min for fluoropore filter cassettes.<sup>16-18</sup>

Area air monitoring trains were placed in locations suitable to collect representative indoor air within each restaurant and outdoors, adjacent to the establishments. Personal monitoring trains were attached with pouches and straps to employees of nonsmoking restaurants. The start and stop times were recorded for each sample period. Each personal or area monitoring train was checked frequently to ensure that airflow rate stayed at the appropriate predetermined level.

**Quality control.** We calibrated each air monitoring train before and after the sampling period, first with a frictionless bubble tube and then with the Dry Cal Calibrator Model DC-1 (Bios International, Butler, NJ). We used a secondary standard rotameter to check the flow rate in the field. Field blanks were randomly selected out of the sampling media, with approximately 1 blank for every 9 sampling media. We handled the field blanks similarly to sampled media, except that no air was passed through them. Area samples, except for those taken outdoors, were replicated. The Institutional Review Board of the research institution reviewed and approved the involvement of human subjects in this study.

**CIA ordinances in Toledo and Bowling Green.** The existing CIA ordinance (#509-03) in Toledo was enacted on August 24, 2003, to restrict smoking in public places to enclosed areas. As it relates to restaurant/bar settings,

the ordinance requires that:

- (1) A sign shall be posted at the entrance clearly stating that smoking is not permitted except in a separate smoking lounge if available;
- (2) Ashtrays shall be removed from areas where smoking is prohibited...;
- (3) Separate smoking lounge shall: be clearly designated; completely enclosed on all sides by solid floor-to-ceiling walls; have a separate ventilation system exclusive of any seating area...and is negatively pressurized to prevent back streaming of second-hand smoke; be clearly designated as a separate smoking lounge wherein no employees shall be required to work; not contain the sole means of ingress and egress to restrooms or any other smoke-free area and shall not constitute the sole indoor waiting area of the premises; and, not exceed thirty percent of the lounges;... Exemptions: A bar with serving area of less than 245 square feet, provided that a non-smoking area is not available (p. 12-15).

Approximately 1,700 restaurant and bar owners in Toledo were affected by the new rule. As of June 9, 2004, city approval was granted to 70 establishments for smoking lounges, and 3 lounges had qualified for a permanent exemption from the ordinance because each has a serving area of less than 245 ft<sup>2</sup>.

Bowling Green passed a CIA ordinance (#6912) on February 4, 2002, regulating smoking in restaurant/bar settings:

- (1) All restaurants with bars, all dining areas, waiting areas and restrooms shall be smoke free. Smoking may be allowed in a bar area provided

that the bar area is contained within a separate smoking area; (2) Restaurants without bars may not permit smoking in any area which is at any time open to the public; and, (3) Owner of a bar may permit or prohibit smoking at his or her discretion. However, owners of bars are encouraged to promote a nonsmoking environment and may limit smoking to separate smoking rooms or may completely prohibit smoking (p. 2).

The ordinance further defines "a separate smoking room" that shall meet all of the following requirements: (1) Be clearly designated as a separate smoking room; (2) Be completely enclosed on all sides by a ceiling and permanent, immovable floor to ceiling walls, doors and/or windows which must remain closed except for entry and exit of persons to and from the room; (3) Have a separate ventilation system whereby the air from the enclosed area is immediately exhausted to the outside in such a way as to prevent the reintroduction of smoke into the enclosed area or any smoke free area; (4) Be negatively pressurized to an extent sufficient to prevent back streaming of smoke into smoke free areas; (5) Have self-closing doors that remain closed when not being used for ingress or egress; (6) Not be the sole patron waiting area; and, (7) Not be the sole means of entry or exit to the facility itself, the restrooms, or any other smoke free area (p. 1).

## Results and Discussion

**Air monitoring data.** A total of 98 integrated active air samples were collected, including 2 categories of 49 samples: the first category included 49 samples collected for nicotine and 3-EP, and a second category included 49 samples for ETS-related particulate matter. Of the 49 samples in each category, we collected 14 personal samples inside the restaurants, 30 area samples inside the restaurants (including 14 replicate and 2 single samples), 2 area samples in an office building (referent site), and 5 area samples outdoors (one outside each of the 5 study sites).

**Mathematical treatment of sampling data.** Laboratory analytical methods restrict the lowest detection limit to a quantity called the *limit of detection* (LOD), which is the level below which the sampled air contaminant cannot be determined. LOD for each sampled contaminant depends on the standard method used, and it is usually reported by the analytical laboratory. However, during statistical data analysis it is customary to assign a quantity for each nondetected level of contamination. The quantity is assigned using the formula  $LOD/2$  if the majority of samples become nondetected; otherwise the formula  $LOD/\sqrt{2} = LOD/1.414$  is applied.<sup>19</sup> LODs for nicotine, 3-EP, Solanesol, UVPM, and FPM were  $0.05 \mu\text{g}/\text{m}^3$ ,  $0.05 \mu\text{g}/\text{m}^3$ ,  $0.10 \mu\text{g}/\text{m}^3$ ,  $12 \mu\text{g}/\text{m}^3$ , and  $1.0 \mu\text{g}/\text{m}^3$ , respectively, with 49–59% of the samples (depending on the contaminant monitored) in the nondetected categories.

Therefore, the assigned quantity for nondetected samples of these contaminants were  $0.025 \mu\text{g}/\text{m}^3$ ,  $0.025 \mu\text{g}/\text{m}^3$ ,  $0.05 \mu\text{g}/\text{m}^3$ ,  $6.0 \mu\text{g}/\text{m}^3$ , and  $0.5 \mu\text{g}/\text{m}^3$ , respectively. LOD for RSP was  $30 \mu\text{g}/\text{m}^3$ , and because only 15% were nondetected, the quantity assigned for nondetected samples of this contaminant was  $21 \mu\text{g}/\text{m}^3$ . We incorporated the assigned quantities into the results of integrated samples used throughout the data analysis.

For quality control purposes, in 14 of 21 sampling locations the area samples were collected by 2 identical sampling media positioned side-by-side, less than a few centimeters (2–3 inches) apart, that ran for the same sampling period and with the same flow rate. Those 7 area samples that were not replicates included 5 area samples collected outdoors and 2 samples collected in the smoking restaurant in Toledo (1 in each of the smoking and nonsmoking sections). Data analysis showed that the levels of each set of the replicate samples for all contaminants measured were highly significantly correlated and were not different from each other. Therefore, in the subsequent data analysis the averages of replicate samples were used.

We found no significant difference between the levels of ETS-related contaminants in the office building and the levels measured outside each site. Therefore, the levels of these groups of sampling locations (office building and outdoors) were combined and called the "control environment- (nonrestaurant site)."

In data presentation, the findings on ETS-related contaminants in the smoking restaurants in Toledo and Bowling Green have been combined to represent this study's smoking restaurants. The findings on contaminants in the nonsmoking restaurants located in the two cities have also been combined to represent this study's nonsmoking restaurants.

The sampling time range for area air monitors was 324–471 min, with a mean of 383 (standard deviation [SD] 41 min). The sampling time for personal air monitors was 209–409 min, with a mean of 331 min ( $SD = 48$  min). Table 1 shows the levels of ETS-related contaminants sampled by personal and area air monitoring methods in both nonsmoking and smoking restaurants. Statistical comparison showed that the levels of ETS-related contaminants overall were not significantly different between samples collected by area air monitoring and samples collected by personal air monitoring; though, in general, the personal air monitoring levels of contaminants were lower. The lack of significant difference between the two methods of sample collection may be attributed to the small number of samples. For subsequent statistical analysis, however, the levels of ETS-related contaminants determined by both area and personal air monitoring methods were combined for each space sampled.

**Description of ETS-related contaminants.** A summary of the levels of ETS-related contaminants sampled by integrated air monitoring for this study is presented in

**Table 1.—Mean Levels of Environmental Tobacco Smoke Related Contaminants Determined by Integrated Personal and Area Air Monitoring in Nonsmoking and Smoking Restaurants**

Contaminant	Concentration of contaminants in nonsmoking restaurants ( $\mu\text{g}/\text{m}^3$ )				Concentration of contaminants in smoking restaurants ( $\mu\text{g}/\text{m}^3$ )							
	P (n = 8)		A (n = 4)		Nonsmoking section				Smoking section			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Nicotine	0.08	0.01	0.08	0.02	0.14	0.08	1.75	1.63	4.40	5.74	14.2	15.3
3-EP	0.07	0.01	0.07	0.01	0.73	0.16	0.70	0.33	4.28	1.47	5.03	1.88
Sol-PM	3.54	2.70	1.76	0.17	2.13	0.02	10.8	9.12	36.3	64.0	88.6	92.7
UVPM	6.88	0.58	6.36	0.58	7.76	0.05	28.6	21.6	61.5	67.3	134	116
FPM	2.92	4.37	1.60	2.17	4.49	1.31	26.9	23.1	56.6	52.8	116	94.8
RSP	76.5	55.4	48.5	30.7	115	67.8	71.3	17.3	120	80.6	253	122

Notes: P = personal air monitoring; A = area air monitoring; n = number of samples; 3-EP = 3-ethenylpyridine; Sol-PM = respirable suspended particles based on Solanesol; UVPM = respirable suspended particles based on ultraviolet particulate matter; FPM = fluorescent particulate matter; RSP = total respirable suspended particles

**Table 2.—Levels of Environmental Tobacco Smoke (ETS)- Related Contaminants Determined by Integrated Sampling in Four Restaurants and Control Environment**

Site	Statistic	Concentration of ETS-related contaminants ( $\mu\text{g}/\text{m}^3$ )											
		Nicotine		3-EP		Sol-PM		UVPM		FPM		RSP	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Control environment (n = 7)	Min-Max	0.07	0.01	0.07	0.01	2.1	1.4	5.9	0.96	0.56	0.18	63.3	37.9
	Mn	0.05–0.08	0.06	0.05–0.08	0.06	1.4–5.1	1.6	4.9–7.1	6.0	0.41–0.94	0.51	34.3–131	50.5
		0.08	0.01	0.07	0.01	3.0	2.3	6.7	0.61	2.5	3.7	67.1	49.0
Nonsmoking restaurants (n = 12)	Min-Max	0.06–0.11	0.08	0.06–0.08	0.07	1.6–9.2	2.0	5.8–7.6	6.9	0.49–10	0.58	20.4–162	53.3
	Mn	0.08	0.01	0.07	0.01	3.0	2.3	6.7	0.61	2.5	3.7	67.1	49.0
		1.3	1.5	0.71	0.28	8.3	8.6	23	20	21	22	83.9	37.8
Nonsmoking sections in smoking restaurants (n = 7)	Min-Max	0.07–3.4	0.20	0.29–1.1	0.78	1.7–22	2.1	6.2–52	7.8	1.9–51	5.9	54.2–163	68.1
	Mn	0.07–3.4	0.20	0.29–1.1	0.78	1.7–22	2.1	6.2–52	7.8	1.9–51	5.9	54.2–163	68.1
		9.8	13	4.7	1.7	65	81	102	99	90	81	194	122
Smoking sections in smoking restaurants (n = 9)	Min-Max	1.1–39	1.9	2.5–6.7	5.3	3.1–231	6.0	23–316	36	22–268	38	61.8–445	169
	Mn	1.1–39	1.9	2.5–6.7	5.3	3.1–231	6.0	23–316	36	22–268	38	61.8–445	169
		9.8	13	4.7	1.7	65	81	102	99	90	81	194	122

Notes: n = number of samples; SD = standard deviation; 3-EP = 3-ethenylpyridine; Sol-PM = respirable suspended particles based on Solanesol; UVPM = respirable suspended particles based on ultraviolet particulate matter; FPM = fluorescent particulate matter; RSP = total respirable suspended particles

Table 2. Comparative statistical analysis (Mann-Whitney test or *t*-test) showed that the levels of contaminants were (1) not significantly different in the control environment and the nonsmoking restaurants, (2) significantly higher in the nonsmoking sections of the smoking restaurants than in the nonsmoking restaurants, and (3) significantly higher in the smoking sections of the smoking restaurants than in the nonsmoking sections of the smoking restaurants.

**Comparison of ETS-related contaminant levels before and after CIA ordinances were adopted.** We compared the results of this study with the results of a

study conducted before the adoption of the CIA ordinances.<sup>6</sup> The current study, hereafter called the “post-CIA ordinances” study, was conducted at 4 restaurants (1 smoke-free and 1 smoking establishment each in the cities of Toledo and Bowling Green) from January 1, 2004, to June 30, 2004. The previous study, hereafter called the “pre-CIA ordinances” study, was conducted at 8 smoking restaurants in Toledo, from 1998 to 2000.<sup>6</sup>

The levels of ETS-related contaminants sampled by integrated air monitoring for the studies performed before and after CIA ordinances were established are presented and compared in Figs. 3–6. In these figures,

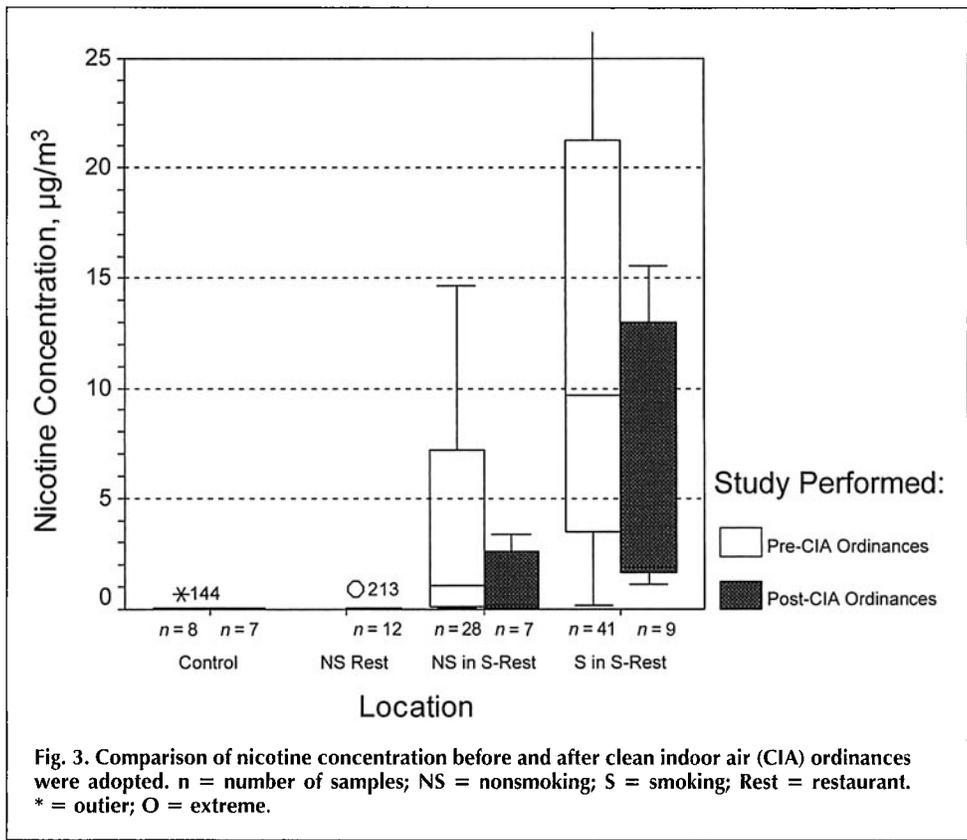


Fig. 3. Comparison of nicotine concentration before and after clean indoor air (CIA) ordinances were adopted. n = number of samples; NS = nonsmoking; S = smoking; Rest = restaurant. \* = outlier; O = extreme.

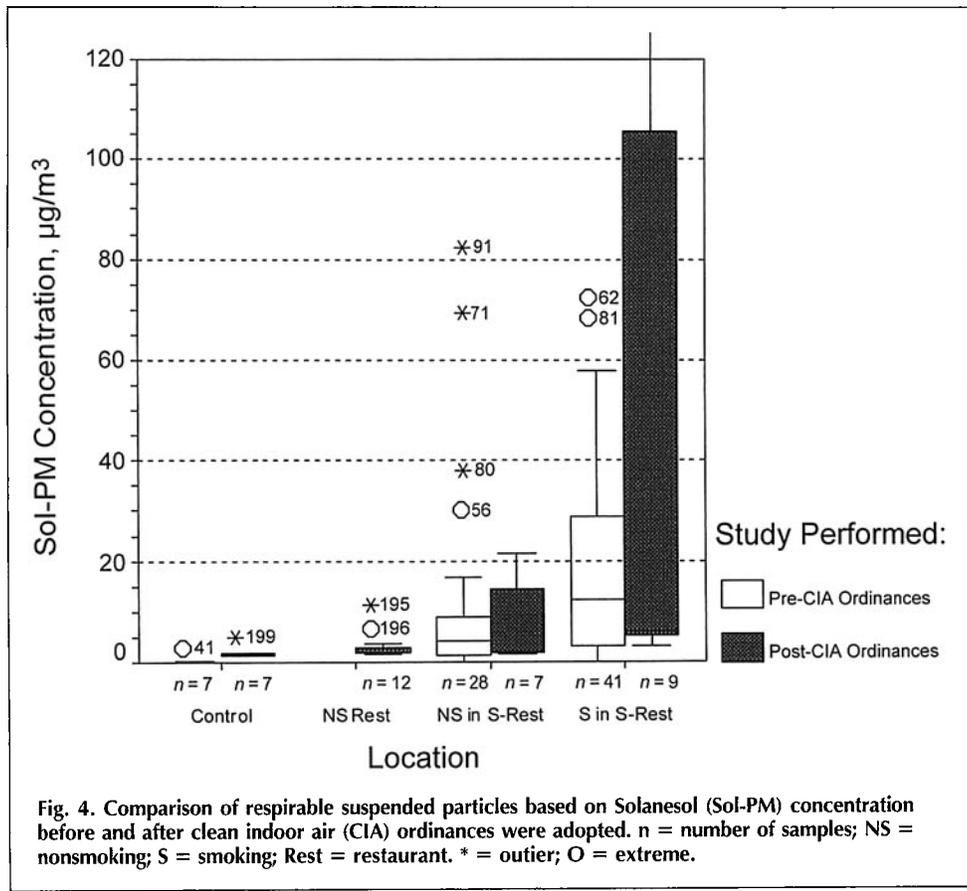


Fig. 4. Comparison of respirable suspended particles based on Solanesol (Sol-PM) concentration before and after clean indoor air (CIA) ordinances were adopted. n = number of samples; NS = nonsmoking; S = smoking; Rest = restaurant. \* = outlier; O = extreme.

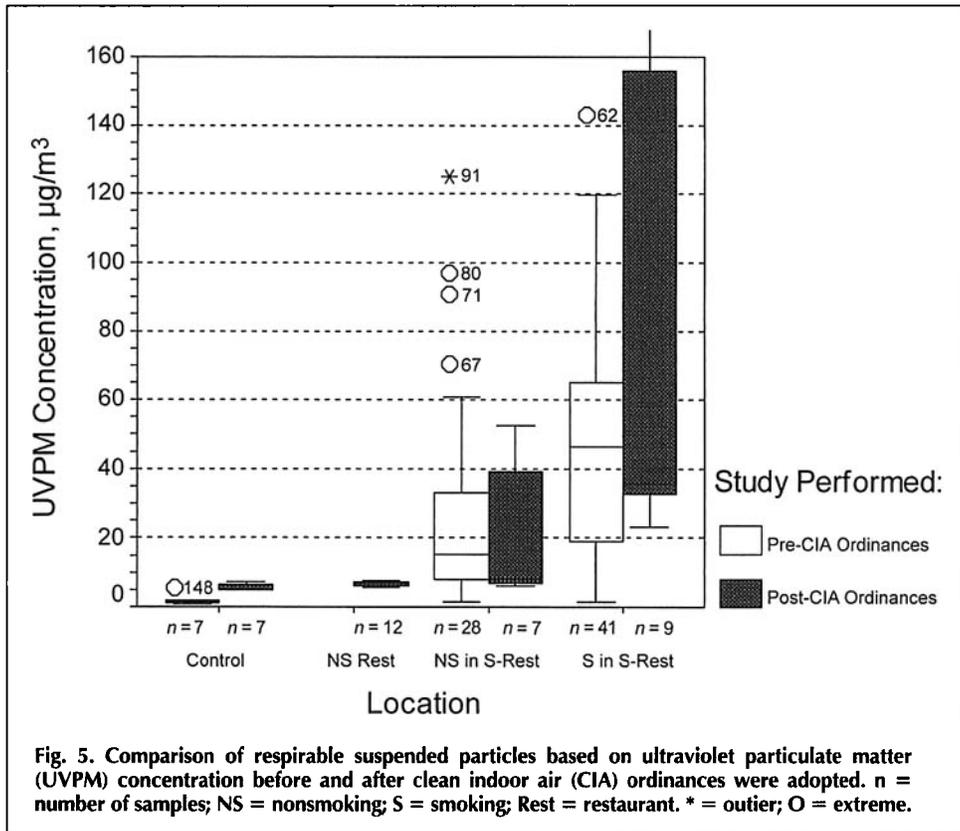


Fig. 5. Comparison of respirable suspended particles based on ultraviolet particulate matter (UVPM) concentration before and after clean indoor air (CIA) ordinances were adopted. n = number of samples; NS = nonsmoking; S = smoking; Rest = restaurant. \* = outlier; O = extreme.

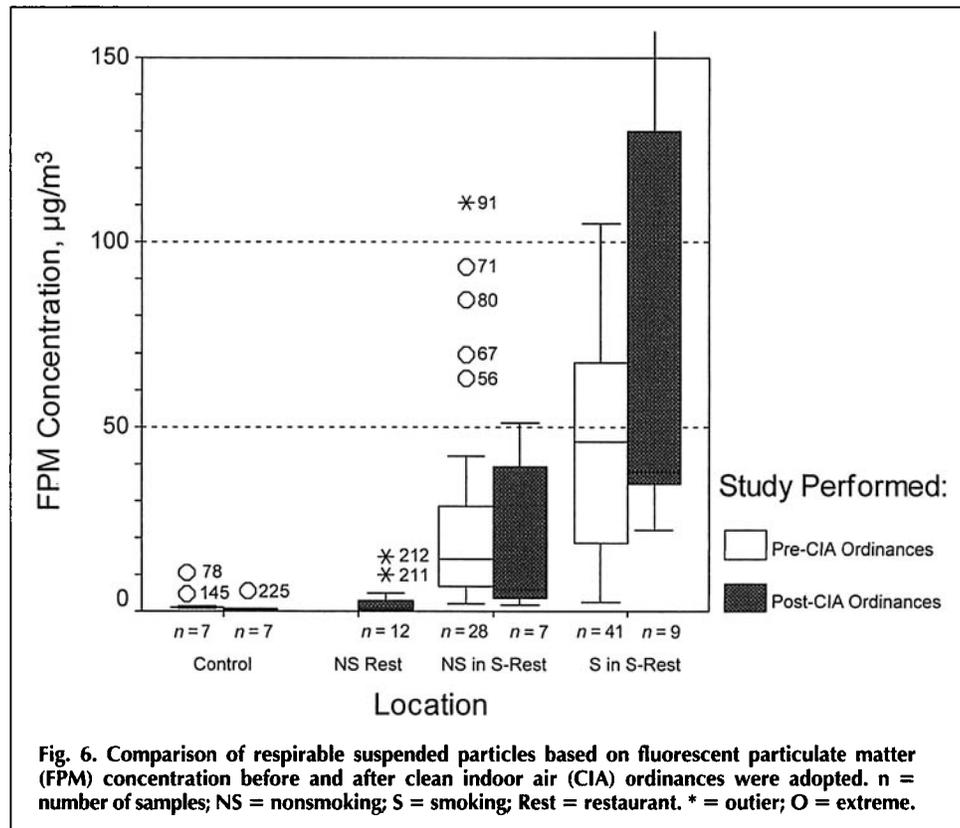


Fig. 6. Comparison of respirable suspended particles based on fluorescent particulate matter (FPM) concentration before and after clean indoor air (CIA) ordinances were adopted. n = number of samples; NS = nonsmoking; S = smoking; Rest = restaurant. \* = outlier; O = extreme.

for both pre- and post-CIA ordinances studies: (a) "Control" includes the combined referent (e.g., an office building) and outdoor areas of the restaurants; (b) "Nonsmoking restaurants" includes all locations sampled in 2 nonsmoking restaurants, 1 each in Toledo and Bowling Green; no nonsmoking restaurants were included in the study that was performed before the CIA ordinances took effect; (c) "Nonsmoking sections in smoking restaurants" includes all locations sampled in the nonsmoking sections of the smoking restaurants: 2 restaurants in the current study and 8 restaurants in the previous study;<sup>6</sup> and (d) "Smoking sections in smoking restaurants" includes all locations sampled in the smoking sections of the smoking restaurants: 2 restaurants in the current study and 8 restaurants in the previous study.<sup>6</sup> The reported values are the combination of personal and area monitoring in each section.

Comparative statistical analysis (Mann-Whitney test or *t*-test) showed that the levels of ETS-related contaminants were not significantly different in the studies performed before and after adoption of CIA ordinances in both the nonsmoking sections and the smoking sections.

**Comparison of nicotine levels in this study with those in other studies.** Exposure of American employees' exposure to ETS has recently been reviewed by Hammond,<sup>20</sup> who states that "mean concentrations measured in restaurants that allow smoking generally range from 3 to 8  $\mu\text{g}/\text{m}^3$ " (p. 11). The concentrations of airborne nicotine measured in the smoking restaurants during this study were 4.4  $\mu\text{g}/\text{m}^3$  in personal samples and 14.2  $\mu\text{g}/\text{m}^3$  in area samples, both of which are comparable to those reported by Hammond.<sup>20</sup>

**Results of survey in smoking restaurants.** The survey of 11 smoking restaurants in Toledo and Bowling Green indicated that these restaurants, including the 2 smoking restaurants studied, were not fully in compliance with the CIA ordinances. One example of a violation is that the majority of smoking restaurants surveyed had direct openings (such as active doors) between the smoking and nonsmoking sections.

The smoking and nonsmoking sections of the smoking restaurant in Toledo were separated from ceiling to floor for approximately 75% of the wall. The remaining 25% was a direct opening between the two sections, approximately 15 ft  $\times$  8 ft, and located at the end of the bar, opposite from the main entrance (Fig. 1). The partial wall contained a double door approximately 6 ft wide, located behind the bar for employee access to either side of the bar to provide service in both the smoking and nonsmoking sections. The main entrance opened to a small waiting room that had two additional doors, one leading to the smoking section and the other to the nonsmoking section, with signs designating the smoking room. An exit-only door was also present in the smoking section. The kitchen had direct access to both the smoking and nonsmoking sections.

Five air supply diffusers, two ceiling fans, and one air cleaner were present in the smoking section. An air cleaner (also called a smoke-eater) is a wall- or ceiling-mounted active carbon filter unit designed to absorb air contaminants. Nine air supply diffusers, 2 ceiling fans, and 2 air cleaners were present in the nonsmoking section. The smoking section had a separate ventilation system. However, smoke appeared to move slightly toward the nonsmoking section around the bar area. During the survey 51 patrons in the smoking section were observed smoking, and the smoking rate averaged 6.4 cigarettes per hour. The ambient temperature in the restaurant during the study was  $21.7 \pm 2.0^\circ\text{C}$  ( $n = 14$ ).

The main entrance to the smoking restaurant in Bowling Green was directly connected to the smoking section through a small waiting room. A side entrance through an alley opened to a small waiting room leading to the nonsmoking section. Two active doors connected the smoking section to the nonsmoking section (Fig. 2). No signs were present on either side of the doors to specify the smoking status of the sections.

Ventilation in the smoking section consisted of 11 air supply diffusers and 2 return air grilles. Additionally, 2 ceiling fans and 6 air cleaners were present. The smoking section had a separate ventilation system, and the space appeared to be negatively pressurized. Smoke appeared to move up and toward the back of the restaurant and toward the kitchen. Smoke also moved toward the nonsmoking section when the connecting doors between the smoking and the nonsmoking sections were open. The kitchen had direct access to both the smoking and nonsmoking sections.

The exact number of cigarettes smoked in the Bowling Green restaurant was not determined. We estimated, however, that the number was slightly less than the number smoked in the Toledo restaurant. The ambient temperature in the restaurant during the study was  $20.0 \pm 4.1^\circ\text{C}$  ( $n = 12$ ).

## Conclusion

The results of this study suggest that the levels of ETS-related contaminants in the two nonsmoking restaurants were (1) comparable to those determined in the control environment (outdoors and nonsmoking office building) and (2) significantly lower than those found in both the smoking sections and the nonsmoking sections of the two smoking restaurants. In the two smoking restaurants the levels of ETS-related contaminants were (1) significantly higher in the nonsmoking sections than those found in the control environment and (2) significantly higher in the smoking sections than those found in the nonsmoking sections.

The results of our post-CIA ordinance study in 2004 were compared with those of the pre-CIA ordinance study<sup>6</sup> conducted from 1998 to 2000. The comparison

showed that the levels of ETS-related contaminants measured in both the nonsmoking and smoking sections of the two smoking restaurants after the ordinances were adopted were not significantly different from those measured in corresponding nonsmoking and smoking sections of the 8 smoking restaurants investigated in the pre-CIA ordinance study.

We conclude that the major reason for ETS-related contamination of the nonsmoking sections in the smoking restaurants surveyed in the present study is that there were direct openings (e.g., doors) between the smoking and nonsmoking sections, which is a major violation of the CIA ordinances. To achieve reasonable protection of patrons and employees against ETS-related contaminants, strict enforcement of CIA ordinances is necessary. However, full protection will be achieved only with 100% smoke-free policies.

\* \* \* \* \*

This research project was funded by the Ohio Tobacco Use Prevention and Control Foundation (grant proposal RFP#04-2), through the Hospital Council of Northwest Ohio. The authors acknowledge and thank Dr. James H. Price, Jan Ruma, and Dr. Michael S. Bisesi for their technical assistance, and Kate Lanza for her help in data collection.

Although the data in this report are adapted from a research project funded by the Ohio Tobacco Use Prevention and Control Foundation through grant proposal RFP#04-2, it does not necessarily reflect the views of the Agency, and no official endorsement should be inferred.

Submitted for publication August 28, 2004; revised; accepted for publication June 22, 2005.

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### References

1. American Nonsmokers' Rights Foundation, 2005; Smokefree ordinance lists. <<http://www.no-smoke.org/pdf/mediaordlist.pdf>> Accessed March 2, 2005.
2. United States Department of Health and Human Services (USDHHS). The Health Consequences of Smoking: A Report of the Surgeon General. Atlanta, GA: USDHHS, 2004.
3. International Agency for Research on Cancer (IARC). Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans: Tobacco Smoke and Involuntary Smoking (vol. 83). Lyon, France: IARC, 2002.
4. California Environmental Protection Agency (Cal-EPA). Health Effects of Exposure to Environmental Tobacco

- Smoke. Sacramento, CA: Cal-EPA Office of Environmental Health Hazard Assessment, 1997.
5. United States Environmental Protection Agency (USEPA). Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders. Washington, DC: USEPA, 1992.
6. Akbar-Khanzadeh F. Exposure to environmental tobacco smoke in restaurants without separate ventilation systems for smoking and nonsmoking dining areas. *Arch Environ Health* 2003; 58(2):97-103.
7. Akbar-Khanzadeh F, Tan Y, Brown EN, et al. An evaluation of ventilation system flow rates and levels of carbon dioxide, ambient temperature and relative humidity in restaurants. *Appl Occup Environ Hyg* 2002; 17(9):640-7.
8. Vij R. Exposure to environmental tobacco smoke and determination of biomarkers in nonsmoking workers in a restaurant [thesis]. Medical College of Ohio at Toledo, 1997.
9. Akbar-Khanzadeh F, Greco T. Health and social concerns of restaurant/bar workers exposed to environmental tobacco smoke. *Med Lav* 1996; 87(2):122-32.
10. Siegel M, Skeer M. Exposure to secondhand smoke and excess lung cancer mortality risk among workers in the "5 B's": bars, bowling alleys, billiard halls, betting establishments, and bingo parlours. *Tob Control* 2003; 12(3):333-8.
11. Kjaerheim K, Andersen A. Cancer incidence among waitresses in Norway. *Cancer Causes Control* 1994; 5(1):31-7.
12. Siegel M. Involuntary smoking in the restaurant workplace. A review of employee exposure and health effects. *J Am Med Assoc* 1993; 270(4):490-3.
13. Repace JL, Lowrey AH. An enforceable indoor air quality standard for environmental tobacco smoke in the workplace. *Risk Anal* 1993; 13(4):463-75.
14. Andersen A, Bjelke E, Langmark F. Cancer in waiters. *Br J Cancer* 1989; 60(1):112-5.
15. Dimich-Ward H, Gallagher RP, Spinelli JJ, et al. Occupational mortality among bartenders and waiters. *Can J Public Health* 1988; 79(3):194-7.
16. American Society for Testing and Materials (ASTM). Standard test method for nicotine and 3-ethenylpyridine in indoor air (ASTM designation D5075). West Conshohocken, PA: ASTM, 1996.
17. American Society for Testing and Materials (ASTM). Standard test method for estimating contribution of environmental tobacco smoke to respirable suspended particles based on Solanesol (ASTM designation D 6271). West Conshohocken, PA: ASTM, 1998.
18. American Society for Testing and Materials (ASTM). Standard test method for estimating contribution of environmental tobacco smoke to respirable suspended particles based on UVP and FPM (ASTM designation D 5955). West Conshohocken, PA: ASTM, 1996.
19. Hornung RW, Reed LD. Estimations of average concentration in the presence of non-detectable values. *Appl Occup Environ Hyg* 1990; 5:46-51.
20. Hammond SK. Exposure of US employees to environmental tobacco smoke. *Environ Health Perspect* 1999; 107(suppl 2):329-40.

Decision editor: Kaye H. Kilburn, MD