New Jersey Air Monitoring Study 2006

Effect of the NJ Smoke-Free Air Act

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November 9, 2006

Executive Summary

Indoor air quality was assessed in 50 New Jersey locations, in 13 of New Jersey's 21 counties in 2005, before, and in 2006, after, the New Jersey Smoke-Free Air Act (NJ SFAA). Sites tested included 15 smoking-permitted restaurants and diners, some with alcoholic beverage service, and some with bars; 17 smoking-permitted bars, including neighborhood bars, bar clubs catering to young adults, sports bars, university-area bars, a go-go bar, and bars that had food service but were primarily bars; 8 smoking-permitted casinos; and 3 smoking-permitted bowling alleys. Seven smokefree restaurants and diners, including some with alcoholic beverage service and bars, were tested. In addition, all thirteen Atlantic City casinos were also visited twice after the law, including once during the July state government shutdown when casino gambling was suspended.

The concentration of fine particle air pollution, $PM_{2.5}$, was measured with a TSI SidePak AM510 Personal Aerosol Monitor. $PM_{2.5}$ is particulate matter in the air smaller than 2.5 microns in diameter. Particles of this size are released in significant amounts from burning cigarettes, are easily inhaled deep into the lungs, and cause a variety of adverse health effects including cardiovascular and respiratory morbidity and death.

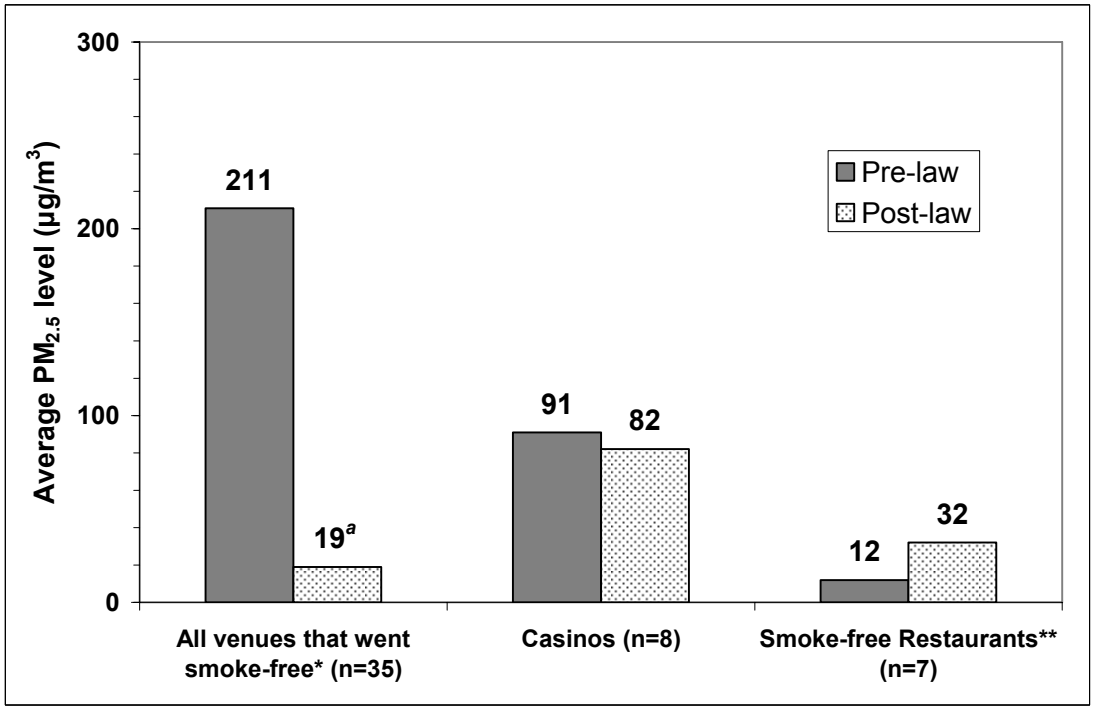
Key findings of the study include:

- The average level of fine particle indoor air pollution declined 91% after the NJ SFAA went into effect in those venues that went smokefree as a result of the law.
- The average level of fine particle air pollution in casinos remained unchanged and is still well above the safe levels required by the U.S. Environmental Protection Agency
- During the NJ state government shutdown, when there was no smoking in casinos, the level of indoor air pollution was very low. This demonstrates the good air quality that would be achieved if NJ casinos were smokefree.
- New Jersey hospitality venues, except casinos, now have fine particle exposures below EPA limits.

Before New Jersey's Smokefree Air Act, locations allowing indoor smoking were significantly more polluted than indoor smokefree sites and than outdoor air in New Jersey, with levels of pollution in excess of EPA standards. As a result of the Smoke-Free Air Act, air quality is dramatically improved for workers and patrons of all New Jersey workplaces and public places where smoking was formerly permitted, except casinos, where smoking is still permitted, and where air quality continues to be poor. This study demonstrates that exposure to indoor toxic air pollution in New Jersey has declined and this translates into improved quality of life and health outcomes for New Jersey workers and residents.

The U.S. Surgeon General has concluded there is no risk-free level of exposure to secondhand smoke, and, consistent with the results of this study, casinos are a source of high concentrations of secondhand smoke for nonsmoking workers and the public. Possible solutions to the on-going air pollution problem in New Jersey casinos include casinos adopting smokefree policies, enacting state or local legislation to make casinos smokefree, and litigation forcing casinos to provide smokefree air.

Figure 1. Indoor Air Pollution Before and After New Jersey Smoke-Free Air Act



[a] p≤0.001 for comparison of pre-law and post-law values (Wilcoxon Signed-Rank Test)

* includes bars, restaurants and bowling centers

** The change in $PM_{2.5}$ level in restaurants that were smokefree at baseline is not statistically significant. Cooking in restaurants is another source of fine particles.

Introduction

Secondhand smoke (SHS) contains at least 250 chemicals that are known to be toxic or carcinogenic, and is itself a known human carcinogen,[1] responsible for an estimated 3,000 lung cancer deaths annually in *never smokers* in the U.S., as well as more than 35,000 deaths annually from coronary heart disease in *never smokers,* and respiratory infections, asthma, Sudden Infant Death Syndrome, and other illnesses in children.[2] Although population-based data show declining SHS exposure in the U.S. overall, SHS exposure remains a major public health concern that is entirely preventable.[3, 4] Because requiring smokefree environments is the most effective method for reducing SHS exposure in public places,[5] Healthy People 2010 Objective 27-13 encourages all states and the District of Columbia to establish and to enforce smokefree air laws in public places and worksites.[6]

Currently in the U.S., 14 states, Washington, DC, and Puerto Rico have enacted strong smokefree laws that include restaurants and bars. The states are California, Colorado, Connecticut, Delaware, Hawaii, Maine, Massachusetts, Montana, New Jersey, New York, Rhode Island, Utah, Vermont, and Washington (the Hawaii law takes effect November 16, the DC law includes bars as of January 2, 2007, and the Montana and Utah laws include bars in 2009). Arkansas, Florida, and Idaho have smokefree laws that exempt only stand-alone bars. Nine Canadian provinces and territories also have smokefree air laws in effect. Hundreds of cities and counties across the U.S. have also taken action, as have whole countries including Ireland, Scotland, Uruguay, Norway, New Zealand, Sweden, Italy, Spain and England.

The first *New Jersey Air Monitoring Study*[7], conducted in 2005, was a cross-sectional study designed to show the difference in air quality between worksites and public places in New Jersey that did and did not permit indoor smoking. The baseline data from the 2005 study provided a unique opportunity to conduct a longitudinal study comparing the air quality in these same locations before and after implementation of the New Jersey Smoke-Free Air Act (SFAA). The NJ SFAA makes all workplaces and public places smokefree with only two significant exceptions; casino gambling areas may permit smoking and hotels may allow smoking in a maximum of 20% of guest rooms. For the full text of the law, summaries, information on enforcement, implementation, empirical background, and assistance, go to http://www.njgasp.org.

This *New Jersey Air Monitoring Study 2006* is a follow-up to the 2005 study. The overall purpose of this study was to evaluate the effects of the NJ SFAA on the indoor air quality in a sample of New Jersey worksites and public places, including bars, restaurants, bowling alleys, and casinos. The relation between indoor air pollution and the presence of on-premises smoking was assessed. It was hypothesized that indoor air would be less polluted in all types of venues after the implementation of the SFAA, except casinos, where no change in air quality was expected.

Methods

Overview

Fifty locations were visited both before and after the April 15, 2006 implementation of the New Jersey Smoke-Free Air Act. The results of the pre-law visits are detailed in two previous reports.[7, 8] The pre-law visits were made on April 16, 2004 and between August 18 and September 27, 2005. The post-law visits were made between June 8 and July 22, 2006. The locations were in 13 of New Jersey's 21 counties, including Atlantic (9 sites), Bergen (3), Essex (1), Hudson (9), Hunterdon (1), Middlesex (3), Monmouth (3), Morris (4), Ocean (5), Passaic (1), Somerset (3), Union (5), and Warren (3). Testing was done throughout the days of the week from early morning through midnight and later. Post-law visits occurred on the same day of the week or a similar day to the pre-law visit (e.g. weekend or weekday) if a same-day visit was not possible for logistical reasons. Post-law visits also occurred at approximately the same time of the day as the pre-law visits. Tested sites were in urban, suburban, and rural areas and included blue collar, middle class, and upscale establishments. Some sites were individually-owned establishments and some were part of local or national chain entities. Sites tested included 15 smoking-permitted restaurants and diners, some with alcoholic beverage service, and some with bars; 17 smoking-permitted bars, including neighborhood bars, bar clubs catering to young adults, sports bars, university-area bars, a go-go bar, and bars that had food service but were primarily bars; 8 smoking-permitted casinos; and 3 smoking-permitted bowling alleys. Seven smokefree restaurants and diners, including some with alcoholic beverage service and bars, were tested.

In addition to the pre- and post-SFAA visits to 50 venues, as a second part of this study, all 13 Atlantic City casinos were visited after implementation of the NJ SFAA. The air pollution levels were measured in the gambling and non-gambling areas of the casinos. According to the SFAA, smoking is permitted on the gambling floors and is prohibited in the non-gambling areas. These same thirteen casinos were visited again during the New Jersey state government shutdown in July, when casino gambling was prohibited; there was no smoking on the gambling floors during these visits.[*]

Measurement Protocol

An effort was made to spend a minimum of 30 minutes in each venue. The number of people inside the venue and the number of burning cigarettes were recorded every 15 minutes during sampling. These observations were averaged over the time inside the venue to determine the average number of people on the premises and the average number of burning cigarettes. The Zircon DM S40 Sonic Measure (Zircon Corporation, Campbell, CA) was used to measure room dimensions and hence the volume of each of the venues. The active smoker density was calculated by dividing the average number of burning cigarettes by the volume of the room in meters.

[*] In a budget dispute with the Legislature, Governor Corzine furloughed all non-essential government workers for several days. This removed the inspectors of the New Jersey Casino Control Commission from the casino gambling areas and required the casinos to suspend gambling. So the smoking-permitted areas of the casinos were empty; in response, the smoking-prohibited areas were almost completely deserted, too.

A TSI SidePak AM510 Personal Aerosol Monitor (TSI, Inc., St. Paul, MN) was used to sample and record the levels of respirable suspended particles in the air. The SidePak uses a built-in sampling pump to draw air through the device where the particulate matter in the air scatters the light from a laser to reveal the real-time concentration of particles smaller than 2.5µm (microns) in micrograms per cubic meter, or $PM_{2.5}$. The SidePak was calibrated against a laser photometer, which had been previously calibrated and used in previous studies of tobacco smoke pollution exposure.[9] In addition, the SidePak was zero-calibrated prior to each use by attaching a HEPA filter according to the manufacturer's specifications.

TSI SidePak AM510 Personal Aerosol Monitor

The equipment was set to a one-minute log interval, which averages the previous 60 one-second measurements. Sampling was discreet in order not to disturb the occupants' normal behavior. For each venue, the first and last minute of logged data were removed because they are averaged with outdoors and entryway air. The remaining data points were averaged to provide an average $PM_{2.5}$ concentration within the venue.

$PM_{2.5}$ is the concentration of particulate matter in the air smaller than 2.5 microns in diameter. Particles of this size are released in significant amounts from burning cigarettes, are easily inhaled deep into the lungs, and are associated with pulmonary and cardiovascular disease and mortality.

Roswell Park Cancer Institute staff provided the equipment, trained the New Jersey testers, and accompanied them at the initial sites for 2005 testing. Teams composed of New Jersey GASP staff members and volunteers did the 2006 post-law testing.

Statistical Analyses

The primary goal was to assess the difference in the average levels of $PM_{2.5}$ in worksites and public places before and after implementation of a smokefree air law. For venues that were required to go smokefree, the mean $PM_{2.5}$ levels are reported across all of the venues sampled before implementation of the law and these are compared with the mean levels of all venues after the implementation of the law. In addition, venues were also stratified into five different types of venues, 1) bars (required to go smokefree), 2) restaurants that allowed smoking at baseline, 3) bowling centers (also required to go smokefree), 4) casinos, which were not required to go smokefree, and 5) smokefree restaurants which were already smokefree at baseline. Statistical significance is assessed overall and among strata using the non-parametric Wilcoxon Signed-Rank Test. Descriptive statistics including the venue volume, number of patrons, and average smoker density (i.e., number of burning cigarettes) per 100 m^3 are reported for each venue and averaged for all venues.

Table 1. Summary of Each Location Visited Before and After the New Jersey Smoke-Free Air Act

					Pre-Law					Post-Law				
Venue Number	County	Type	Smoke-free?*	Size (m^3)	Date Sampled	Average # people in venue	Average # burning cigs	Active smoker density**	Average $PM_{2.5}$ level ($\mu g/m^3$)	Date Sampled	Average # people in venue	Average # burning cigs	Active smoker density**	Average $PM_{2.5}$ level ($\mu g/m^3$)
1	Union	diner	No	176	8/19/2005	28	0.7	0.38	41	6/8/2006	15	0.0	0.00	18
2	Morris	diner	No	505	8/29/2005	27	1.0	0.20	124	7/13/2006	16	0.0	0.00	9
3	Bergen	diner	No	612	9/1/2005	20	0.4	0.07	35	7/25/2006	52	0.0	0.00	12
4	Bergen	diner	No	453	9/1/2005	10	0.3	0.07	91	7/25/2006	5	0.0	0.00	36
5	Passaic	diner	No	459	9/1/2005	22	1.3	0.29	41	7/25/2006	32	0.0	0.00	12
6	Hudson	diner	No	879	9/1/2005	39	1.6	0.18	58	7/25/2006	33	0.0	0.00	13
7	Warren	diner	No	352	9/8/2005	34	3.0	0.85	213	6/15/2006	34	0.0	0.00	6
8	Union	restaurant w/ bar	No	620	8/18/2005	40	2.0	0.32	225	6/8/2006	77	0.0	0.00	44
9	Union	restaurant w/ bar	No	267	9/9/2005	13	0.5	0.19	151	8/2/2006	26	0.0	0.00	41
10	Hudson	restaurant w/ bar	No	371	4/16/2004	54	6.0	1.62	219	7/21/2006	101	0.0	0.00	33
11	Hudson	restaurant w/ bar	No	149	4/16/2004	40	2.5	1.68	221	7/21/2006	43	0.0	0.00	40
12	Somerset	restaurant w/ bar	No	2076	8/18/2005	110	3.3	0.16	50	6/8/2006	48	0.0	0.00	14
13	Union	restaurant w/ bar	No	498	8/18/2005	23	3.3	0.65	137	6/8/2006	25	0.0	0.00	29
14	Essex	restaurant w/ bar	No	934	8/29/2005	90	2.0	0.21	47	6/21/2006	.	0.0	0.00	12
15	Bergen	restaurant w/ bar	No	446	9/1/2005	17	0.8	0.17	40	7/25/2006	26	0.0	0.00	20
16	Morris	restaurant w/ bar	No	159	9/10/2005	9	0.8	0.47	58	7/11/2006	6	0.0	0.00	40
17	Ocean	restaurant w/ bar	No	833	9/16/2005	134	40.0	4.80	135	7/15/2006	77	0.0	0.00	21
18	Middlesex	bar w/ rest	No	204	9/6/2005	11	0.7	0.33	65	6/13/2006	19	0.0	0.00	11
19	Ocean	bar	No	1338	9/17/2005	87	24.0	1.79	115	7/15/2006	37	0.0	0.00	22
20	Ocean	bar	No	1407	9/26/2005	68	11.0	0.78	154	7/15/2006	110	0.0	0.00	39
21	Somerset	bar w/ food avail	No	464	8/18/2005	50	3.7	0.79	179	6/8/2006	36	0.0	0.00	10
22	Warren	bar w/ rest	No	181	9/8/2005	8	1.3	0.69	92	6/15/2006	15	0.0	0.00	8
23	Hudson	bar	No	340	8/26/2005	66	6.7	1.96	1196	6/16/2006	32	0.0	0.00	9
24	Monmouth	bar w/ food avail	No	389	8/27/2005	46	3.7	0.94	462	6/23/2006	25	0.0	0.00	14
25	Monmouth	bar, club w/ food	No	883	8/27/2005	54	2.7	0.30	388	6/23/2006	31	0.0	0.00	17
26	Middlesex	bar	No	126	9/6/2005	34	1.7	1.32	172	6/13/2006	27	0.0	0.00	14
27	Middlesex	bar	No	182	9/6/2005	22	2.3	1.28	101	6/13/2006	16	0.0	0.00	10
28	Hunterdon	bar	No	348	9/8/2005	10	1.7	0.48	196	6/15/2006	24	0.0	0.00	22
29	Hudson	bar	No	224	8/26/2005	9	1.7	0.74	929	6/16/2006	15	0.0	0.00	8
30	Monmouth	bar, club	No	2832	8/27/2005	750	37.5	1.32	827	6/23/2006	650	0.0	0.00	15
31	Hudson	bar	No	234	4/16/2004	32	4.4	1.88	197	7/21/2006	26	0.0	0.00	21
32	Hudson	bar	No	292	[a] 8/26/2005, 4/16/2004	37	4.5	1.54	206	7/21/2006	40	0.0	0.00	14
33	Warren	bowling center	No	1291	9/8/2005	85	3.8	0.29	104	6/15/2006	72	0.0	0.00	8
34	Ocean	bowling center	No	5947	9/26/2005	93	19.0	0.32	71	7/15/2006	72	0.0	0.00	11
35	Ocean	bowling center	No	3982	9/17/2005	71	1.0	0.03	49	7/15/2006	24	0.0	0.00	15
36	Atlantic	casino	No	***	9/2/2005	.	.	.	115	6/9/2006	.	.	.	117
37	Atlantic	casino	No	.	9/2/2005	.	.	.	75	6/9/2006	.	.	.	75
38	Atlantic	casino	No	.	9/2/2005	.	.	.	81	6/24/2006	.	.	.	73
39	Atlantic	casino	No	.	9/10/2005	.	.	.	75	6/9/2006	.	.	.	69
40	Atlantic	casino	No	.	9/10/2005	.	.	.	122	6/10/2006	.	.	.	90
41	Atlantic	casino	No	.	9/10/2005	.	.	.	73	6/24/2006	.	.	.	79
42	Atlantic	casino	No	.	9/11/2005	.	.	.	76	6/10/2006	.	.	.	61
43	Atlantic	casino	No	.	9/11/2005	.	.	.	110	6/10/2006	.	.	.	91
44	Morris	restaurant w bar	Yes	280	9/10/2005	22	0.0	0.00	4	6/28/2006	16	0.0	0.00	10
45	Somerset	restaurant w bar	Yes	432	8/29/2005	7	0.0	0.00	13	7/14/2006	10	0.0	0.00	5
46	Hudson	restaurant w bar	Yes	248	8/26/2005	33	0.0	0.00	17	7/21/2006	29	0.0	0.00	74
47	Union	restaurant w/o bar	Yes	267	8/18/2005	18	0.0	0.00	14	6/29/2006	18	0.0	0.00	37
48	Hudson	restaurant w/o bar	Yes	101	8/26/2005	11	0.0	0.00	8	7/21/2006	19	0.0	0.00	29
49	Atlantic	restaurant	Yes	354	9/2/2005	30	0.0	0.00	12	7/6/2006	56	0.0	0.00	60
50	Morris	diner	Yes	255	9/9/2005	12	0.0	0.00	18	7/24/2006	35	0.0	0.00	9

* Used to compare indoor air pollution levels between places that are smokefree and places that are not.

** Average number of burning cigarettes per $100m^3$.

*** Due to the massive size and large number of people in the casinos, it was not possible to determine room volumes, people counts, or burning cigarette/cigar counts.

[a] There were two pre-law visits to this venue. The pre-law data presented is an average of the two visits.

Results

Overall, 50 indoor sites were visited before and after the smokefree air law, including 7 smokefree restaurants, 3 bowling centers, 8 casinos, 17 restaurants allowing smoking, and 15 bars. A summary of each location visited is shown in Table 1. The average $PM_{2.5}$ level in the 35 locations (bars, restaurants and bowling centers) that went smokefree as a result of the smokefree air law was 211 $\mu g/m^3$ before the law and 19 $\mu g/m^3$ after the law. This decrease of 91% in indoor air pollution was highly statistically significant ($p<0.001$). The average number of burning cigarettes decreased from 5.7 cigarettes to 0 and the average active smoker density decreased from 0.83 burning cigarettes per 100 m^3 to 0 in these locations. There was no statistically significant change in $PM_{2.5}$ levels on casino gambling floors (n=8) as a result of the law (91 $\mu g/m^3$ before the law and 82 $\mu g/m^3$ after the law). There was also no statistically significant change in $PM_{2.5}$ levels in the 7 restaurants that were smokefree at baseline (12 $\mu g/m^3$ before the law and 32 $\mu g/m^3$ after the law). These results are shown in Figure 1 and Table 2.

The results, after stratifying by type of venue, including the number of locations in each group, the average size, average number of people present, average number of burning cigarettes, average active smoker density, and average $PM_{2.5}$ level, are shown in Table 2. Bars showed a dramatic improvement in air quality going from an average $PM_{2.5}$ level of 352 $\mu g/m^3$ to 16 $\mu g/m^3$ after the law, a 95% decrease in indoor air pollution ($p\leq0.001$). Restaurants showed a 78% decline in indoor air pollution as $PM_{2.5}$ levels went from 111 $\mu g/m^3$ to 24 $\mu g/m^3$ ($p\leq0.001$). Bowling centers also experienced an 85% decline in $PM_{2.5}$ levels although this result is not statistically significant, which is not unexpected due to the small sample size (n=3).

Table 2. Average Level of Indoor Air Pollution Before and After New Jersey Smoke-Free Air Act by Type of Venue

			Pre-Law				Post-Law			
Type of Venue	Sample Size	Average Size (m^3)	Average # people in venue	Average # burning cigs	Average Active smoker density*	Average $PM_{2.5}$ level ($\mu g/m^3$)	Average # people in venue	Average # burning cigs	Active smoker density*	Average $PM_{2.5}$ level ($\mu g/m^3$)
Bars	15	630	86	7.2	1.08	**352**	73	0.0 [a]	0.00 [a]	**16** [a]
Smoking Restaurants	17	576	42	4.1	0.72	**111**	38	0.0 [a]	0.00 [a]	**24** [a]
Bowling Centers	3	3740	83	7.9	0.21	**74**	56	0.0	0.00	**11**
All of the above	*35*	*870*	*63*	*5.7*	*0.83*	***211***	*55*	*0.0* [a]	*0.00* [a]	***19*** [a]
Casinos**	8	.	.	.	.	**91**	.	.	.	**82**
Smoke-free Restaurants	7	277	19	0.0	0.00	**12**	26	0.0	0.00	**32** [b]

* Average number of burning cigarettes per $100m^3$

** Due to the massive size and large number of people in the casinos it was not possible to determine room volumes, people counts or burning cigarette counts

[a] $p\leq0.001$, comparison of pre to post values within type of venue using Wilcoxon Signed-Rank Test

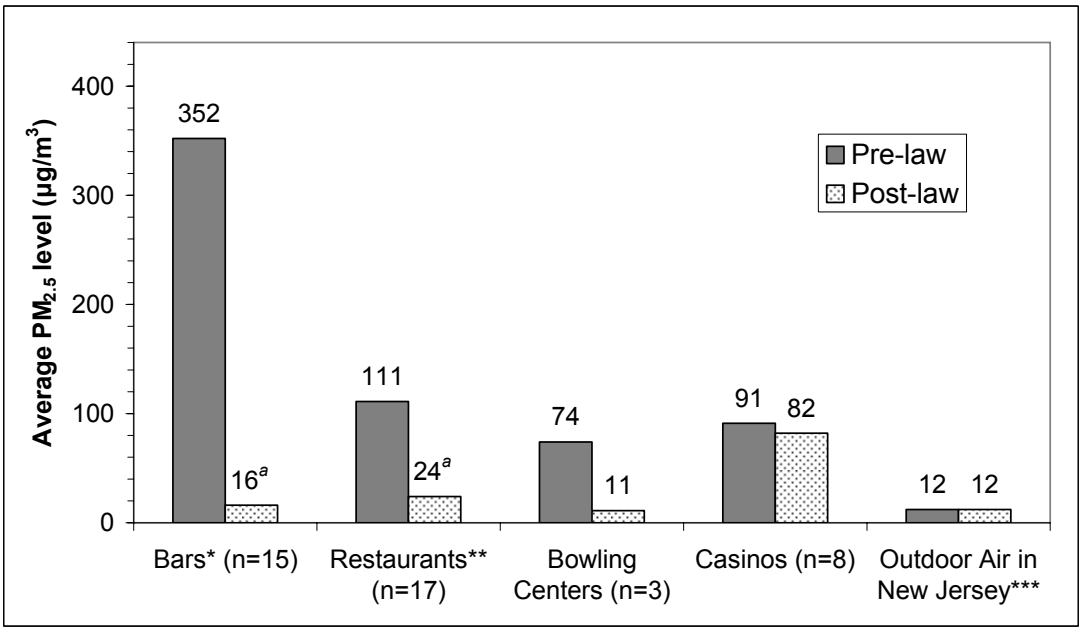
[b] The change in $PM_{2.5}$ level in restaurants that were smokefree at baseline is not statistically significant. Cooking in restaurants is another source of fine particles.

In these non-casino sites, compliance with the law was 100% as there was no observed smoking in any of the 42 locations that were required to be smokefree after the law went into effect. There were no statistically significant differences in the average number of people present before and after the law in any of the types of venues.

Figure 2 shows the average indoor air pollution levels, as determined by $PM_{2.5}$ levels, in the 4 types of locations that permitted smoking at baseline, as well as the average $PM_{2.5}$ level in outdoor air in New Jersey as a comparison. Ten of the thirteen counties in this study had at least one outdoor $PM_{2.5}$ monitoring site using the EPA's Federal Reference

Method for measuring $PM_{2.5}$. The average $PM_{2.5}$ level from each of these sites, as of October 4, 2006, was found at http://www.epa.gov/air/data/ and they were averaged to determine the average outdoor $PM_{2.5}$ level as a comparison for this study.

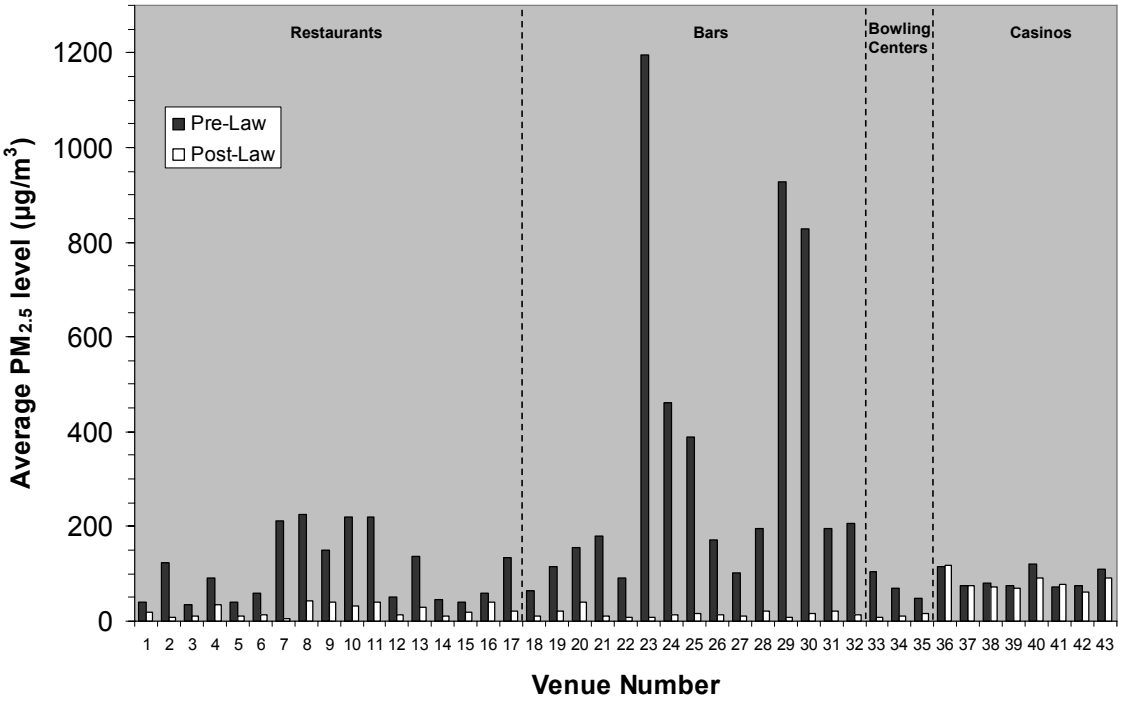
Figure 2. Indoor Air Pollution by Type of Venue Before and After New Jersey Smoke-Free Air Act



[a] p≤0.001 for comparison of pre-law and post-law values (Wilcoxon Signed-Rank Test).
* Some with food service.
** Some with alcoholic beverage service, some with bars.
*** Used for comparison purposes. Based on the 2005 and 2006 average $PM_{2.5}$ level as of 10/4/2006 in the 10 of 13 NJ counties in this study with outdoor EPA monitoring sites. http://www.epa.gov/air/data/

Figure 3 shows the average indoor air pollution level before and after the smokefree air act in each of the venues that permitted indoor smoking at baseline. The venue numbers correspond to those in Table 1. Figure 3 illustrates that there was a substantial decrease in indoor air pollution in all of the locations with smoking at baseline, except for the casinos.

Figure 3. Effect of the New Jersey Smoke-Free Air Act on Indoor Air Pollution in Previously Smoking-Permitted Venues

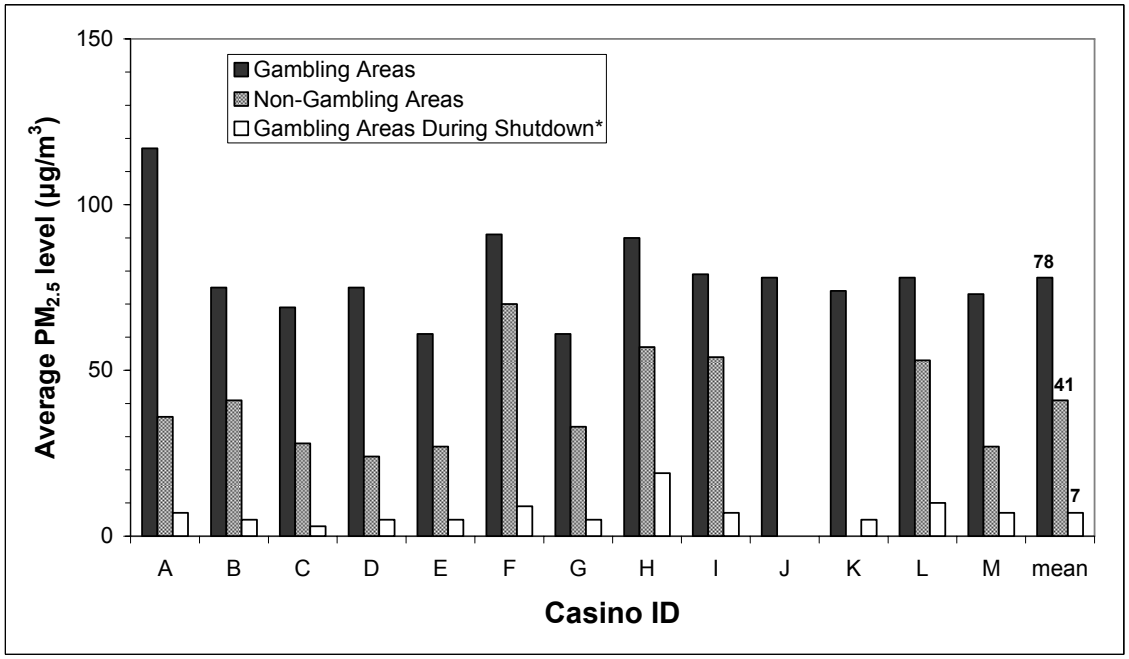


Additional Casino Evaluation

In the second part of this study, all 13 Atlantic City casinos were visited on the evenings of June 9, 10 and 24, 2006. Monitoring showed that the average $PM_{2.5}$ level on the gambling floors was 78 $\mu g/m^3$ and the average level in the non-gambling areas was 41 $\mu g/m^3$. Smoking was observed in the non-gambling areas, which are required to be smokefree under the NJ SFAA, of every casino visited, a compliance rate of 0%.

In addition, these casinos were visited again on July 6 and 7, 2006 during the New Jersey state government shutdown, when there was no gambling, hence no smoking in the gambling areas. The average $PM_{2.5}$ level on the gambling floors during these visits was 7 $\mu g/m^3$. This is very good air quality, with only about half the concentration of fine particles seen in outdoor air in New Jersey. These results are shown in Figure 4.

Figure 4. Average Level of Indoor Air Pollution in New Jersey Casinos



* There was no gambling allowed during these visits on July 6 and 7, 2006 due to a New Jersey state government shutdown. There was no observed smoking on the gambling floor during these visits.

The real-time plots showing the level of indoor air pollution in each venue sampled are presented in Figures 6 through 11, starting on page 16. The real-time $PM_{2.5}$ plots throughout the duration of sampling reveal the following results: 1) low background levels are observed outdoors; 2) much higher levels of indoor air pollution are observed in venues where smoking is permitted; 3) peak exposure levels in some venues where smoking is permitted can reach levels far in excess of the average recorded level; and 4) indoor pollution levels are much lower following implementation of the smokefree air law.

Discussion

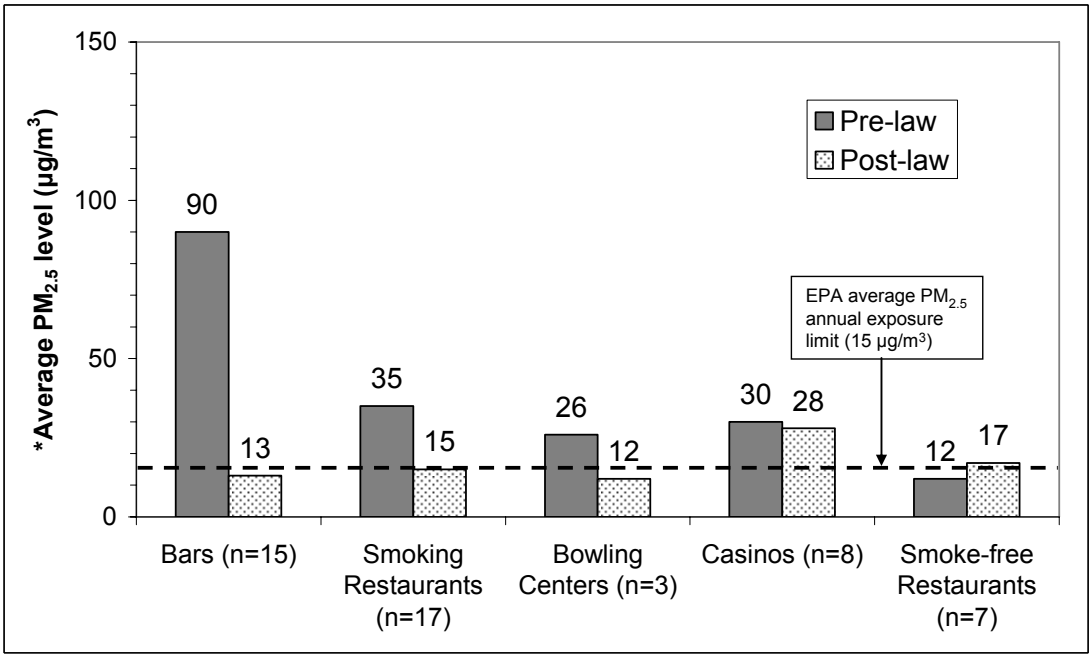
The EPA cited over 80 epidemiologic studies in creating a particulate air pollution standard in 1997.[10] The EPA has recently updated this standard and, in order to protect the public health, the EPA has set limits of 15 $\mu g/m^3$ as the average annual level of $PM_{2.5}$ exposure and 35 $\mu g/m^3$ for 24-hour exposure.[10, 11] In order to compare the findings in this study with the annual EPA $PM_{2.5}$ exposure standard, it was assumed that a full-time employee in the locations sampled that allow smoking works 8 hours, 250 days a year, is exposed to 211 $\mu g/m^3$ (the average level in all sites allowing smoking before the SFAA) on the job, and is exposed only to background particle levels of 12 $\mu g/m^3$ during non-work times. For a full-time employee their average annual $PM_{2.5}$ exposure was 57 $\mu g/m^3$ before the SFAA. The EPA average annual $PM_{2.5}$ limit was exceeded by 3.8 times due to their occupational exposure. Now that the law is in effect, these same workers are exposed to an average particle concentration of 19 $\mu g/m^3$ and, for a full-time employee in these New Jersey venues, the average annual exposure is 14 $\mu g/m^3$, a safe level according to the EPA.

Figure 5 shows the average annual exposures of employees in each of the 5 types of locations in this study as compared to the EPA annual $PM_{2.5}$ exposure limit of 15 $\mu g/m^3$. Before the NJ SFAA, employees in smoking-permitted venues were exposed to between 2 and 6 times the EPA maximum safe exposure level. After the law, bars, restaurants, and bowling centers were at or below this limit while casinos continue to be unsafe for employees. Based on the latest scientific evidence, the EPA staff currently proposes even lower $PM_{2.5}$ standards to adequately protect the public health,[12] making the high $PM_{2.5}$ exposures of people in smoking environments even more alarming.

As expected, this study demonstrates that casinos continue to be polluted after the SFAA. Not only is there exposure to tobacco smoke pollution in the gambling areas, but there is also significant exposure in the non-gambling areas which are designated non-smoking areas according to the SFAA. The tobacco smoke pollution in the non-gambling areas is a result of smoke drifting from the gambling areas and of active smoking in the non-gambling areas, observed in every casino visited, in violation of the SFAA. Active smoking densities in the non-gambling areas were much lower than in the gambling areas, so smoke drifting from the gambling areas accounts for most of the air pollution in the non-gambling areas. The air quality in the casinos during the government shutdown was dramatically improved with an average $PM_{2.5}$ level of only 7 $\mu g/m^3$. This demonstrates the good air quality that would be achieved if casinos were required to be smokefree, like all other locations under the SFAA, and if the only significant indoor source of pollution, smoking, were eliminated.

(Discussion continued on next page.)

Figure 5. Annual Employee Air Pollution Exposure Before and After NJ SFAA



*Assumes an employee works eight hours, 250 days a year, and is only exposed to background particle levels (12 µg/m3) during non-work times.

Previous studies have evaluated air quality by measuring the change in levels of respirable suspended particles (RSP) between smokefree venues and those that permit smoking. Ott et al. did a study of a single tavern in California and showed an 82% average decrease in RSP levels after smoking was prohibited by a city ordinance.[13] Repace studied 8 hospitality venues, including one casino, in Delaware before and after a statewide prohibition of smoking in these types of venues and found that about 90% of the fine particle pollution could be attributed to tobacco smoke.[9] Similarly, in a study of 22 hospitality venues in Western New York, Travers et al. found a 90% reduction in RSP levels in bars and restaurants, an 84% reduction in large recreation venues such as bingo halls and bowling alleys, and a 58% reduction even in locations where only SHS from an adjacent room was observed at baseline.[14] A cross-sectional study of 53 hospitality venues in 7 major cities across the U.S. showed 82% less indoor air pollution in the locations subject to smokefree air laws, even though compliance with the laws was less than 100%.[8]

Other studies have directly assessed the effects SHS exposure has on human health. One study found that respiratory health improved rapidly in a sample of bartenders after a state smokefree workplace law was implemented in California[15], and another study reported a 40% reduction in acute myocardial infarctions in patients admitted to a regional hospital during the 6 months that a local smokefree ordinance was in effect.[16] Smokefree legislation in Scotland was associated with significant early improvements in symptoms, lung function, and systemic inflammation of all bar workers, while asthmatic bar workers also showed reduced airway inflammation and improved quality of life.[17] Farrelly et al. also showed a significant decrease in both salivary cotinine concentrations

and sensory symptoms in hospitality workers after New York State's smokefree law prohibited smoking in their worksites.[18]

The effects passive smoking on the cardiovascular system in terms of increased platelet aggregability, endothelial dysfunction, increased arterial stiffness, increased atherosclerosis, increased oxidative stress and decreased antioxidant defense, inflammation, decreased energy production in the heart muscle, and a decrease in the parasympathetic output to the heart, are often nearly as large (averaging 80% to 90%) as chronic active smoking. Even brief exposures to SHS, of minutes to hours, are associated with many of these cardiovascular effects. The effects of secondhand smoke are substantial and rapid, explaining the relatively large health risks associated with secondhand smoke exposure that have been reported in epidemiological studies.[19]

The hazardous health effects of exposure to second-hand smoke are now well-documented and established in various independent research studies and numerous international reports. The body of scientific evidence is overwhelming: there is no doubt within the international scientific community that second-hand smoke causes heart disease, lung cancer, nasal sinus cancer, sudden infant death syndrome (SIDS), asthma and middle ear infections in children and various other respiratory illnesses. There is also evidence suggesting second-hand smoke exposure is also causally associated with stroke, low birthweight, spontaneous abortion, negative effects on the development of cognition and behavior, exacerbation of cystic fibrosis, cervical cancer and breast cancer. The health effects of secondhand smoke exposure are detailed in recent reports by the California Environmental Protection Agency[20] and the U.S. Surgeon General[21].

Conclusions

Before implementation of the New Jersey Smoke-Free Air Act, locations allowing indoor smoking were significantly more polluted than indoor smokefree sites and than outdoor air in New Jersey, with levels of pollution in excess of EPA standards. As a result of the Smoke-Free Air Act, air quality is dramatically improved for workers and patrons of all New Jersey hospitality venues where smoking was permitted, except casinos where smoking is still allowed and air quality continues to be poor. This study demonstrates that exposure to indoor toxic air pollution in New Jersey has declined and this translates into improved quality of life and health outcomes for New Jersey workers and residents.

The U.S. Surgeon General has concluded there is no risk-free level of exposure to secondhand smoke, and, consistent with the results of this study, casinos are a source of high concentrations of secondhand smoke for nonsmoking workers and the public.[21] Possible solutions to the on-going air pollution problem in New Jersey casinos include casinos adopting smokefree policies, enacting state or local legislation to make casinos smokefree, and litigation forcing casinos to provide smokefree air.

Acknowledgments

Generous support for this study was provided by the Flight Attendant Medical Research Institute.

Figure 6

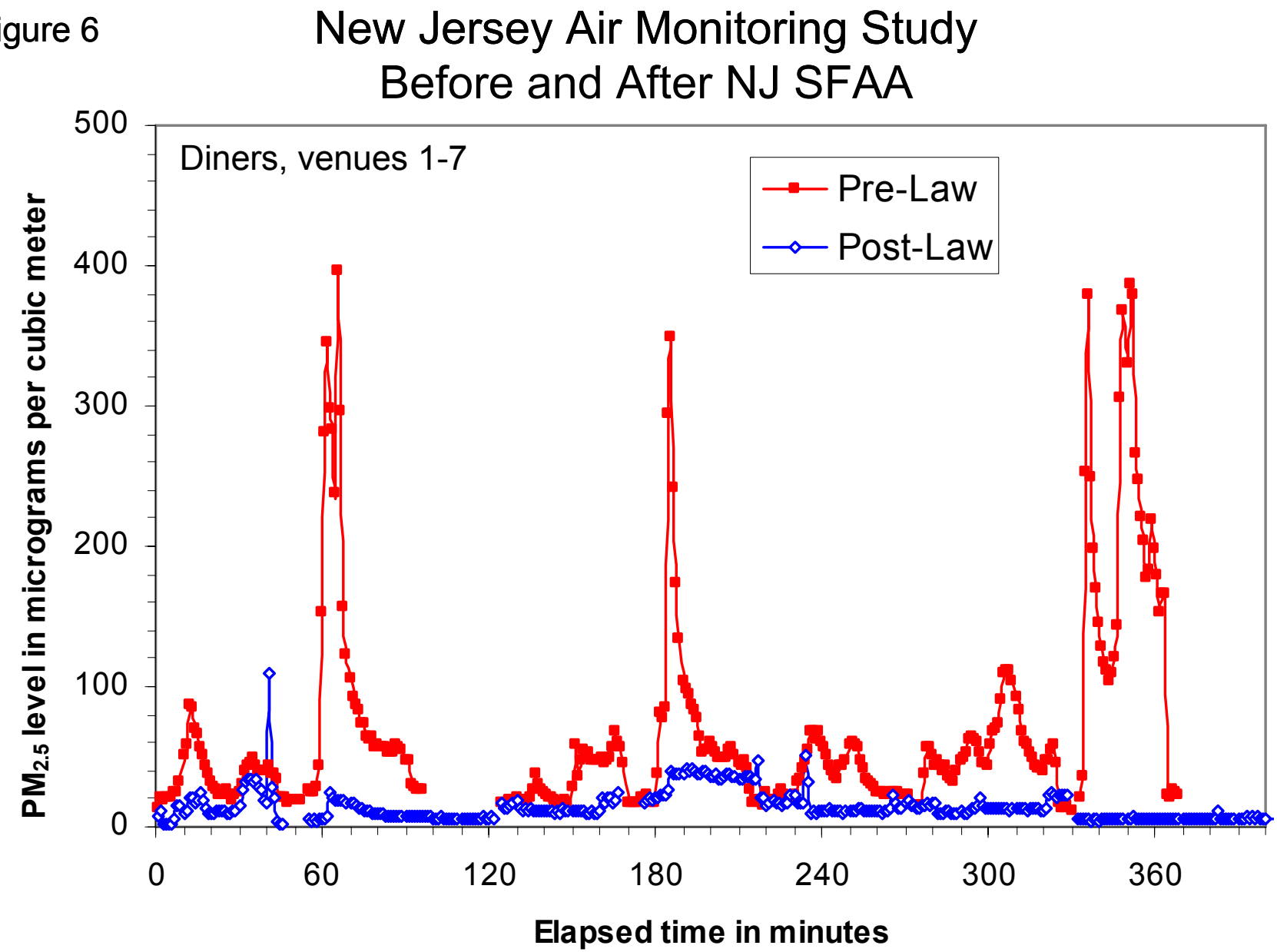

New Jersey Air Monitoring Study
Before and After NJ SFAA
Diners, venues 1-7
Pre-Law
Post-Law
PM2.5 level in micrograms per cubic meter
500
400
300
200
100
0
0
60
120
180
240
300
360
Elapsed time in minutes

Figure 7

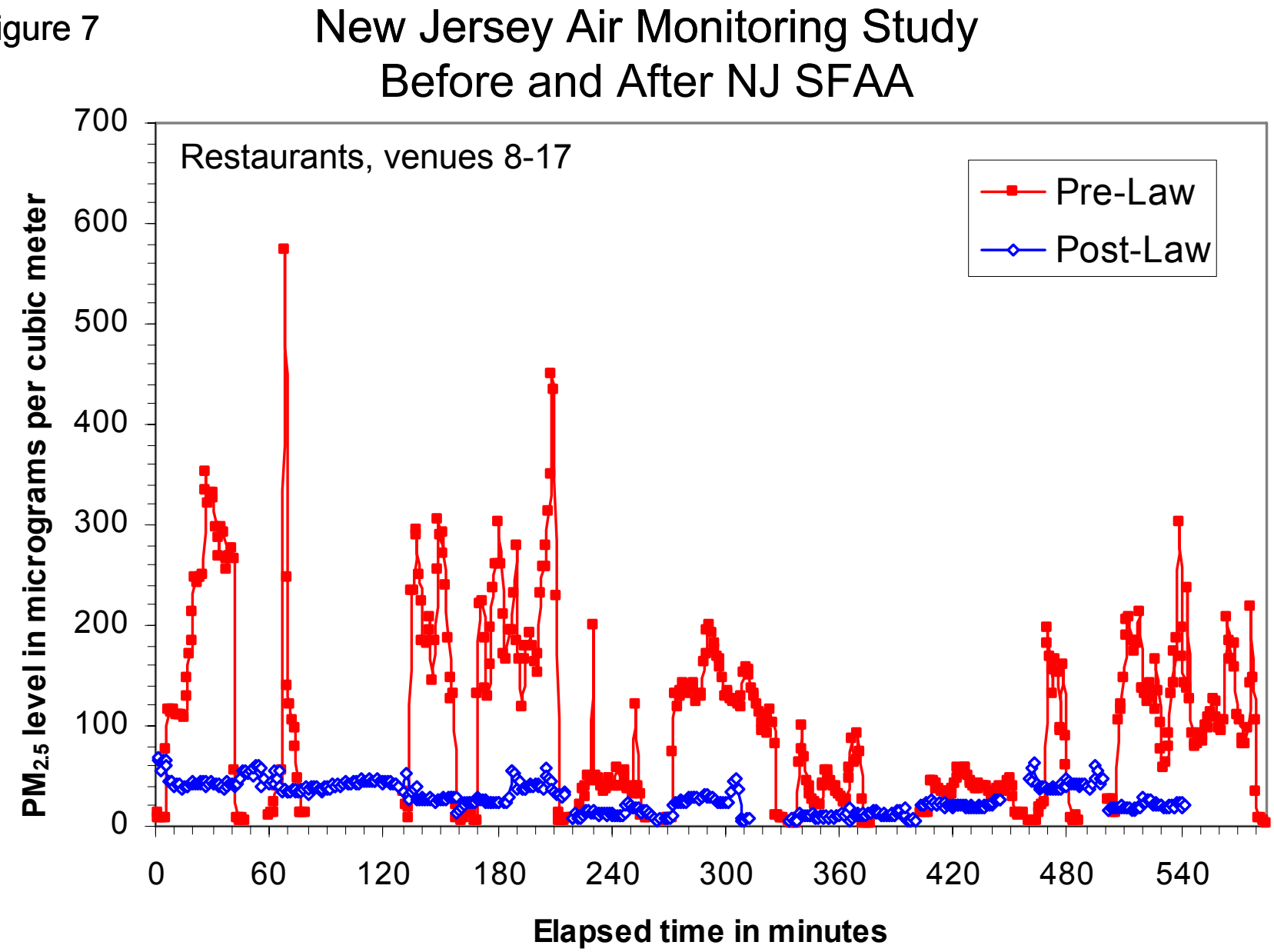

New Jersey Air Monitoring Study
Before and After NJ SFAA
Restaurants, venues 8-17
Pre-Law
Post-Law
PM2.5 level in micrograms per cubic meter
700
600
500
400
300
200
100
0
0
60
120
180
240
300
360
420
480
540
Elapsed time in minutes

Figure 8

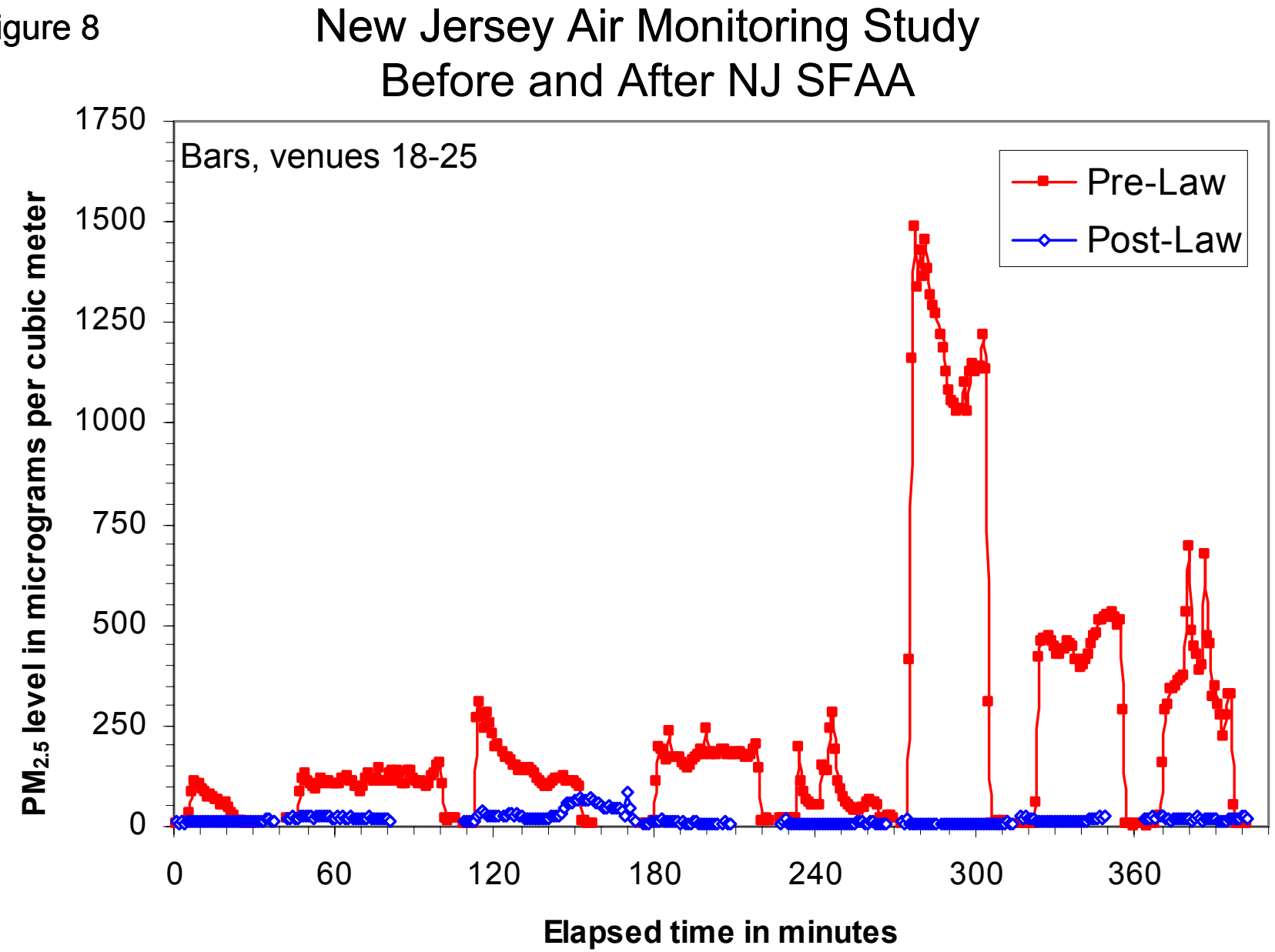

New Jersey Air Monitoring Study
Before and After NJ SFAA
Bars, venues 18-25
Pre-Law
Post-Law
PM2.5 level in micrograms per cubic meter
1750
1500
1250
1000
750
500
250
0
0
60
120
180
240
300
360
Elapsed time in minutes

Figure 9

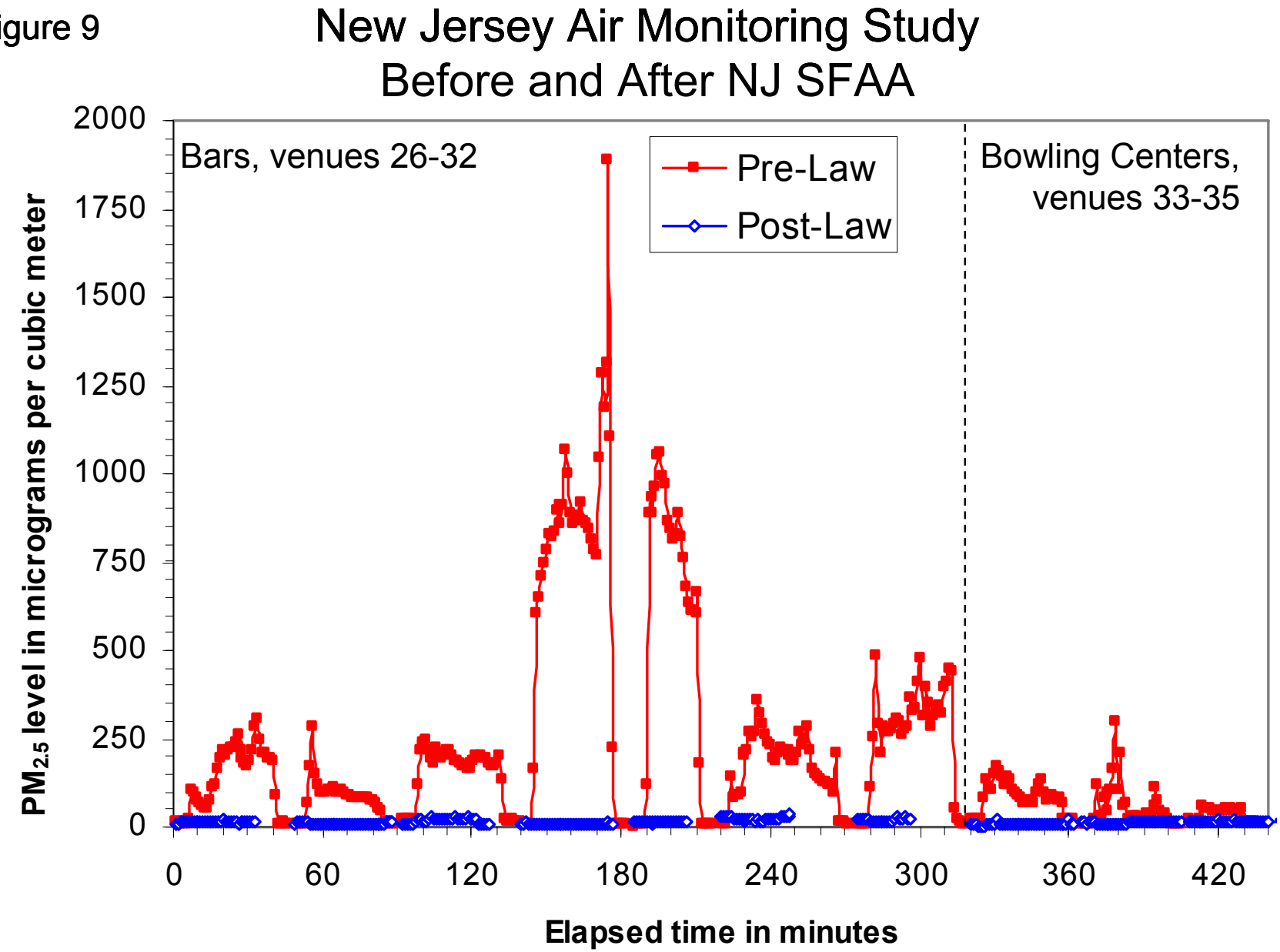

New Jersey Air Monitoring Study
Before and After NJ SFAA
Bars, venues 26-32
Pre-Law
Post-Law
Bowling Centers, venues 33-35
PM2.5 level in micrograms per cubic meter
2000
1750
1500
1250
1000
750
500
250
0
0
60
120
180
240
300
360
420
Elapsed time in minutes

Figure 10

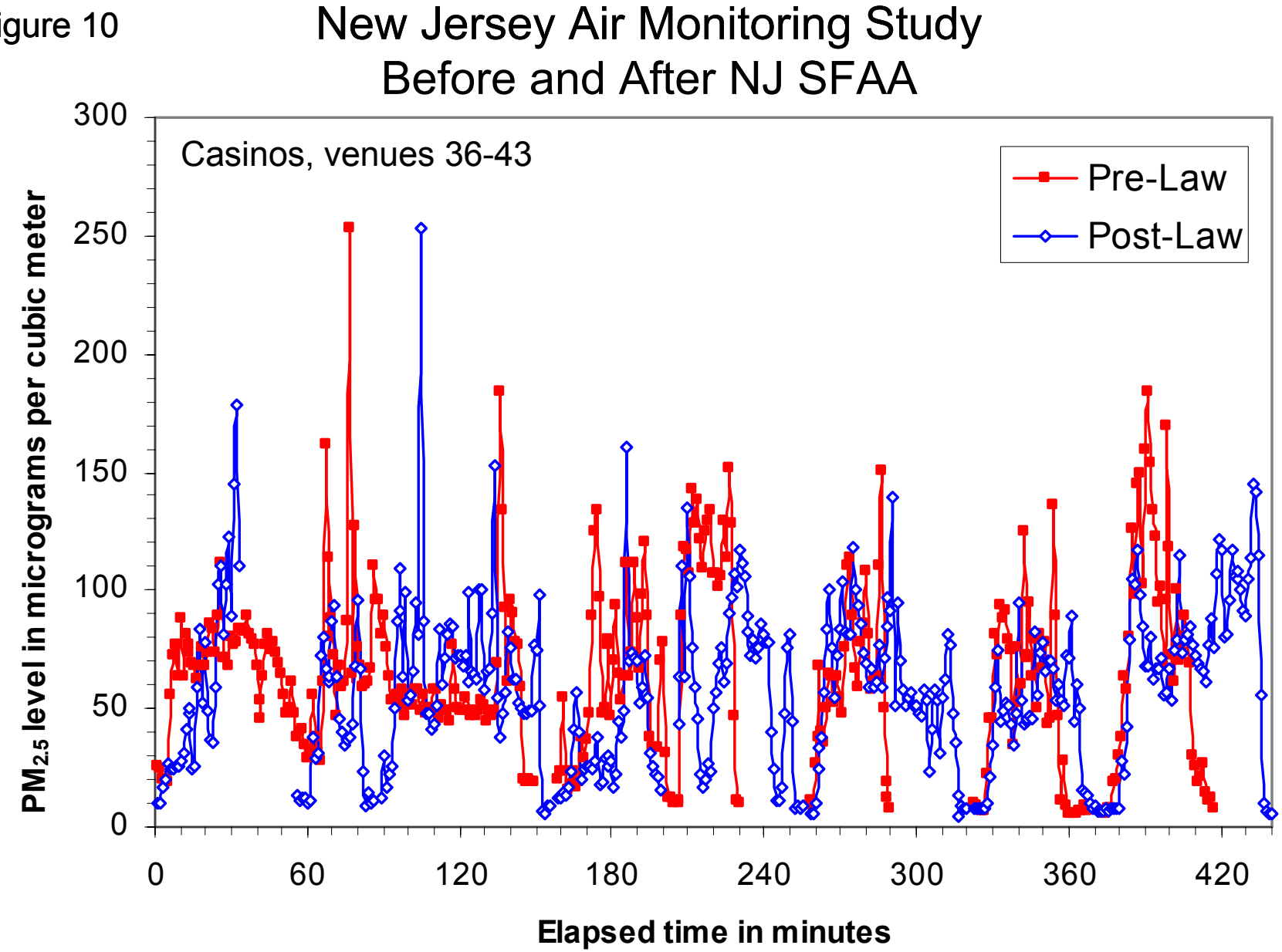
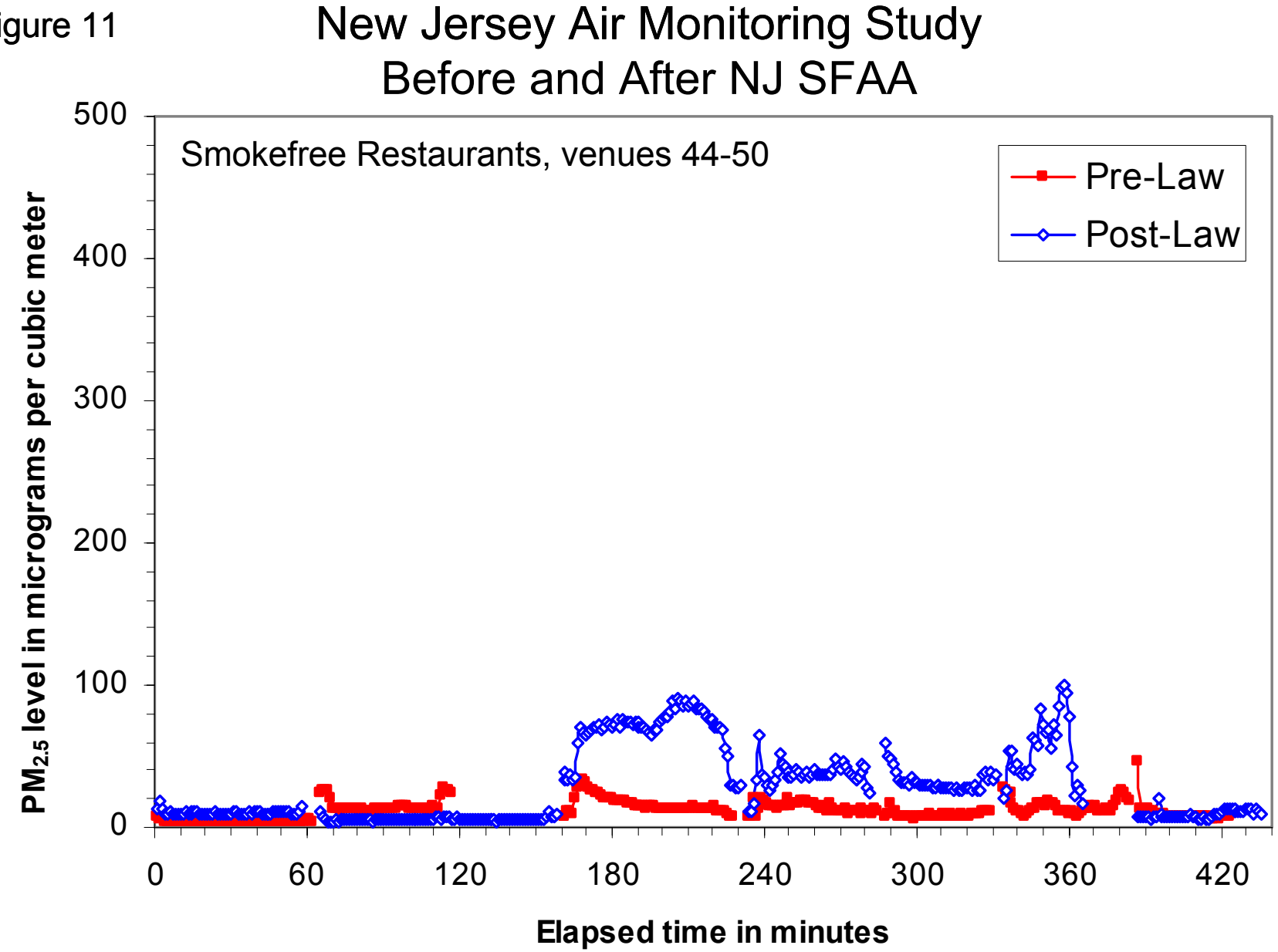

New Jersey Air Monitoring Study
Before and After NJ SFAA
Casinos, venues 36-43
Pre-Law
Post-Law
PM2.5 level in micrograms per cubic meter
0
50
100
150
200
250
300
0
60
120
180
240
300
360
420
Elapsed time in minutes

Figure 11


New Jersey Air Monitoring Study
Before and After NJ SFAA
Smokefree Restaurants, venues 44-50
Pre-Law
Post-Law
PM2.5 level in micrograms per cubic meter
500
400
300
200
100
0
0
60
120
180
240
300
360
420
Elapsed time in minutes

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