AIR QUALITY EFFECT OF THE

KANSAS INDOOR CLEAN AIR LAW

Mark J. Travers, PhD, MS

Lisa Vogl, BS

Department of Health Behavior

January 2011

EXECUTIVE SUMMARY

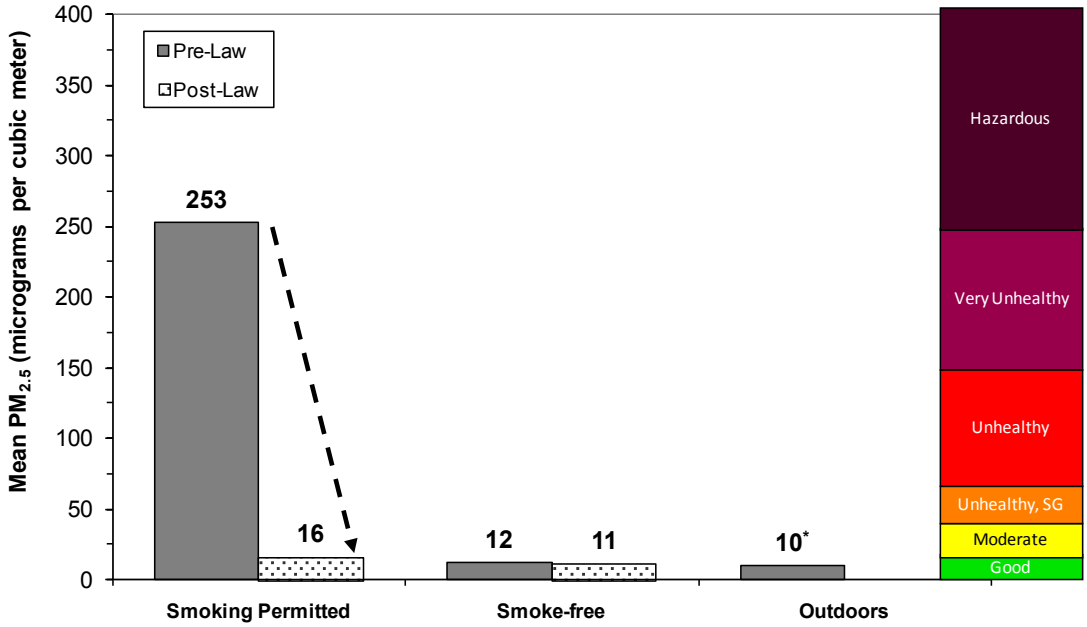
Beginning in January, 2009, through November, 2010, indoor air quality was assessed in 36 restaurants and bars in the following 6 Kansas communities: Topeka, Emporia, Pittsburg, Kansas City, Wichita and Western Kansas (Liberal and Great Bend). Prior to the Kansas Indoor Clean Air Law being implemented on July 1st, 2010, 12 of these locations were smoke-free and 24 locations permitted indoor smoking. After the law officially took effect, the 36 restaurants and bars were reassessed to observe the effect of the Kansas statewide smoke-free air law.

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:

- In the 24 locations with observed indoor smoking before the law, the level of fine particle air pollution was hazardous ($PM_{2.5}$ = 253 µg/m^3). This level of particle air pollution was 25 times higher than outdoor air in Kansas and 21 times higher than the smoke-free locations.
- Prior to the law, employees working full time in the locations with indoor smoking before the law were exposed to levels of air pollution 4.4 times higher than safe annual levels established by the U.S. Environmental Protection Agency because of their occupational exposure to tobacco smoke pollution.
- Indoor particle pollution levels declined 94% in Kansas as a result of the smoke-free air law to low levels, similar to those found in outdoor air.

Figure 1. Effect of the Kansas Clean Indoor Air Law on Indoor Air Pollution



*Used for comparison purposes. Based on the 2008 average $PM_{2.5}$ level from the EPA monitoring sites in Kansas City (http://www.epa.gov/air/data/). The color-coded EPA Air Quality Index is also shown to demonstrate the magnitude of the measured particle levels

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 establishing smoke-free environments is the most effective method for reducing SHS exposure in public places,[5] Healthy People 2020 Objective TU-13 encourages all States, Territories, Tribes and the District of Columbia to establish laws on smoke-free indoor air that prohibit smoking in public places and worksites.[6]

Currently in the U.S., 28 states, Washington D.C., and Puerto Rico have passed strong smoke-free air laws that include restaurants and bars. The states are Arizona, California, Colorado, Connecticut, Delaware, Hawaii, Illinois, Iowa, Kansas, Maine, Maryland, Massachusetts, Michigan, Minnesota, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oregon, Rhode Island, Utah, Vermont, Washington, and Wisconsin. Because of these statewide policies well over 50% of the U.S. population is now protected from secondhand smoke in all public places.[7] Nine Canadian provinces and territories also have comprehensive smoke-free 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, England and France.

The goal of this study was to determine the effect that the Kansas state smoke-free air law (effective July 1st, 2010) had on reducing the level of fine particle air pollution in bars and restaurants in 6 Kansas communities. The new Kansas state smoke-free air law prohibits smoking in most public places, places of employment, restaurants, bars, and within 10 feet of any doorway, open window or air intake of areas where smoking is prohibited. The state law exempts the gaming floors of state-owned casinos.

It is hypothesized that: 1) before the law, levels of indoor fine particle air pollution will be significantly higher in places with indoor smoking compared to those that are smoke-free; 2) particle levels will decline significantly in a cohort of establishments permitting smoking at baseline that are sampled before and after the smoke-free air law; 3) there will be no significant change in particle pollution levels in a cohort of establishments that smoke-free at baseline that are sampled before and after the law; and 4) the degree of indoor particle air pollution will be correlated with the amount smoking.

METHODS

Beginning in January, 2009, through November, 2010, indoor air quality was assessed in 36 restaurants and bars in the following 6 Kansas communities: Topeka, Emporia, Pittsburg, Kansas City, Wichita and Western Kansas. Prior to the Kansas Indoor Clean Air Law being passed by the Kansas House of Representatives on February 25th, 2010, 12 locations were smoke-free and 24 locations permitted indoor smoking. After the law officially took effect on July 1st, 2010, the 36 restaurants and bars were reassessed to observe the effect of the Kansas state smoke-free air law.

MEASUREMENT PROTOCOL

Trained volunteers followed an established air monitoring protocol and spent 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. Room dimensions were also determined using a combination of any or all of the following techniques; a sonic measuring device, counting of construction materials of a know size such as floor tiles, or estimation. Room volumes were calculated from these dimensions. The active smoker density was calculated by dividing the average number of burning cigarettes by the volume of the room in meters.

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. This portable light-scattering aerosol monitor was fitted with a 2.5 µm impactor in order to measure the concentration of particulate matter with a mass-median aerodynamic diameter less than or equal to 2.5 µm, or $PM_{2.5}$. Tobacco smoke particles are almost exclusively less than 2.5 µm with a mass-median diameter of 0.2 µm.[8] The Sidepak was used with a calibration factor setting of 0.32, suitable for secondhand smoke.[9, 10] 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. The Sidepak is about 5x4x3 inches and weighs about one pound. 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.

Statistical Analyses

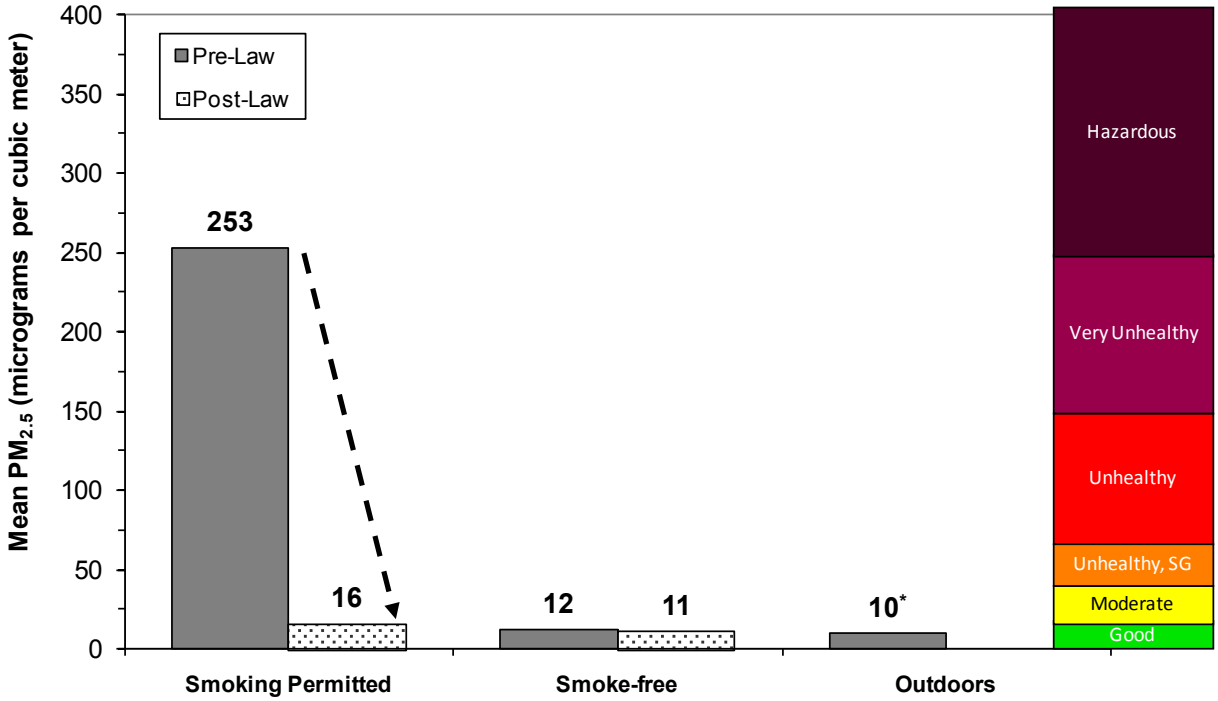
To evaluate the first hypothesis, statistical significance is assessed using the Mann-Whitney test on the $PM_{2.5}$ concentrations. The second and third hypotheses are assessed using the Wilcoxon signed-rank test to compare the difference in the average levels of $PM_{2.5}$ between establishments with observed smoking and those with no observed smoking before and after the Kansas state smoke-free air law came into effect. The fourth hypothesis is tested by using all 72 sample visits and correlating the average smoker densities to the $PM_{2.5}$ levels using the Spearman rank correlation coefficient (r_s). 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.

RESULTS

A summary of each location visited and tested is shown in Table 1. Before the statewide smokefree law, the average $PM_{2.5}$ level in the 24 locations permitting indoor smoking was 253 µg/m^3 (Figure 1). Before the law, the $PM_{2.5}$ concentrations in places with smoking were significantly higher than smoke-free locations where the mean $PM_{2.5}$ concentration was 12 µg/m^3 (U=4.00, p<0.001, r=.80). After the Kansas state smoke-free air law, the mean $PM_{2.5}$ level in the 24 locations that previously permitted smoking was 16 µg/m^3 (T=0.00, p<0.001). This is a 94% reduction in $PM_{2.5}$ levels compared to the pre-law levels. This difference is statistically significant (p<0.001). There was no significant change in $PM_{2.5}$ levels in the 12 places that were smokefree before the law (T=34.0, p=0.693).

In the 24 locations with observed smoking, before the smoke-free law was passed, the average number of burning cigarettes was 4.0 which corresponds to an average smoker density (ASD) of 0.48 burning cigarette per 100 m^3. Looking at all 72 sample visits, $PM_{2.5}$ levels are positively associated with the active smoker density indicating that the amount of indoor smoking may be the primary driver of the indoor particle pollution levels. This association was statistically significant (r_s=0.79, p<0.001).

Figure 1. Effect of the Kansas Clean Indoor Air Law on Indoor Air Pollution



*Used for comparison purposes. Based on the 2008 average $PM_{2.5}$ level from the EPA monitoring sites in Kansas City (http://www.epa.gov/air/data/). The color-coded EPA Air Quality Index is also shown to demonstrate the magnitude of the measured particle levels

Table 1. Fine Particle Air Pollution in Kansas Bars and Restaurants

Venue Number	City	Size (m^3)	Pre-Law				Post-Law			
			Average # people	Average # burning cigs	Active smoker density*	Average $PM_{2.5}$ level ($\mu g/m^3$)	Average # people	Average # burning cigs	Active smoker density*	Average $PM_{2.5}$ level ($\mu g/m^3$)
No Observed Smoking										
1	Western †	881	52	0.0	0.00	33	51	0.0	0.00	28
2	Western †	383	5	0.0	0.00	4	5	0.0	0.00	6
3	Western †	1308	47	0.0	0.00	30	51	0.0	0.00	33
4	Western †	794	15	0.0	0.00	15	12	0.0	0.00	10
5	Topeka	314	42	0.0	0.00	5	20	0.0	0.00	4
6	Pittsburg	1408	24	0.0	0.00	3	16	0.0	0.00	9
7	Pittsburg	96	14	0.0	0.00	5	11	0.0	0.00	10
8	Emporia	3154	73	0.0	0.00	5	11	0.0	0.00	6
9	Wichita	510	28	0.0	0.00	9	16	0.0	0.00	4
10	Wichita	1654	51	0.0	0.00	18	51	0.0	0.00	10
11	Kansas City	919	22	0.0	0.00	5	27	0.0	0.00	6
12	Kansas City	892	35	0.0	0.00	7	43	0.0	0.00	5
Average		**1026**	**34**	**0.0**	**0.00**	**12**	**26**	**0.0**	**0.00**	**11**
Smoking Observed										
13	Western †	2039	9	2.0	0.10	115	3	0.0	0.00	3
14	Western †	489	11	6.0	1.23	136	19	0.0	0.00	14
15	Western †	766	13	2.0	0.26	250	25	0.0	0.00	12
16	Topeka	856	66	2.0	0.23	151	77	0.0	0.00	29
17	Topeka	713	37	2.0	0.28	155	63	0.0	0.00	4
18	Topeka	877	31	5.0	0.57	156	26	0.0	0.00	12
19	Topeka	401	49	5.0	1.25	1039	39	0.0	0.00	150
20	Pittsburg	297	10	1.0	0.34	181	21	0.0	0.00	9
21	Pittsburg	233	39	1.0	0.43	58	23	0.0	0.00	6
22	Pittsburg	339	11	3.0	0.88	438	7	0.0	0.00	4
23	Pittsburg	1712	25	2.0	0.12	278	25	0.0	0.00	17
24	Pittsburg	565	63	3.0	0.53	442	73	0.0	0.00	5
25	Pittsburg	505	17	1.0	0.20	476	26	0.0	0.00	21
26	Pittsburg	1269	17	1.0	0.08	163	56	0.0	0.00	10
27	Emporia	2022	133	2.0	0.10	23	45	0.0	0.00	13
28	Emporia	400	36	6.0	1.50	753	12	0.0	0.00	7
29	Emporia	1076	26	5.0	0.46	348	22	0.0	0.00	6
30	Emporia	412	27	3.0	0.73	177	28	0.0	0.00	9
31	Wichita	726	25	5.0	0.69	55	23	0.0	0.00	9
32	Wichita	1752	31	7.0	0.40	93	27	0.0	0.00	4
33	Wichita	1439	34	9.0	0.63	308	27	0.0	0.00	4
34	Kansas City	2219	84	8.0	0.36	123	85	0.0	0.00	8
35	Kansas City	1694	13	2.0	0.12	28	62	0.0	0.00	12
36	Kansas City	2159	27	2.0	0.09	124	54	0.0	0.00	11
Average		**1040**	**35**	**3.5**	**0.48**	**253**	**36**	**0.0**	**0.00**	**16**

*Average number of burning cigarettes per 100 cubic meters.

† Western Kansas consists of Great Bend and Liberal Counties

The real-time plots showing the level of indoor air pollution in each venue sampled is presented in Figures 2-7, starting on page 11. The continuous $PM_{2.5}$ plots reveal the following results: 1) low outdoor $PM_{2.5}$ levels are observed while outside between locations; 2) high levels of indoor air pollution are observed in the venues where smoking was observed before the law went into effect; and 3) peak exposure levels in some venues where smoking was observed reached levels far in excess of the average recorded level in those venues.

DISCUSSION

The EPA cited over 80 epidemiologic studies in creating a particulate air pollution standard in 1997.[11] 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.[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 253 $\mu g/m^3$ (the average level in the sites with smoking before the law) on the job, and is exposed only to background particle levels of 10 $\mu g/m^3$ during non-work times. For a full-time employee their average annual $PM_{2.5}$ exposure is 66 $\mu g/m^3$. The EPA average annual $PM_{2.5}$ limit is exceeded by 4.4 times due to their occupational exposure. 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.

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.[14] 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 secondhand smoke from an adjacent room was observed at baseline.[15] 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%.[16]

Other studies have directly assessed the effects SHS exposure has on human health. Rapid improvements in the respiratory health of bartenders were seen after a state smokefree workplace law was implemented in California[17]. 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.[18] 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.[19] A meta-analysis of the 8 published studies looking at the effects of smokefree air policies on heart attack admissions yielded an estimate of an immediate 19% reduction in heart attack admissions associated with these laws.[20] In its 2009 report, *Secondhand Smoke Exposure and Cardiovascular Effects: Making Sense of the Evidence*, the Institute of Medicine also concludes that secondhand-smoke exposure increases the risk of coronary heart disease and heart attacks and that clean indoor air laws reduce this risk. Given the prevalence of heart attacks, and the resultant deaths, clean indoor air laws can have a substantial impact on public health.[21]

The effects of passive smoking on the cardiovascular system in terms of increased platelet aggregation, 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.[22]

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 birth weight, 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 reports by the California Environmental Protection Agency[23] and the U.S. Surgeon General[24, 25].

CONCLUSIONS

This study demonstrates that employees and patrons in Kansas bars and restaurants with observed indoor smoking, prior to the smoke-free air law, were exposed to harmful levels of indoor air pollution resulting from indoor smoking. The Kansas state smoke-free air law passed on February 25th, 2010, that currently prohibits indoor smoking in most public places, places of employment, restaurants, bars and within 10 feet of any doorway, open window or air intake where smoking is prohibited has been shown to decrease exposure to toxic tobacco smoke pollution by 94%. This reduction in exposure to toxic tobacco smoke will result in improved quality of life and health outcomes for Kansas workers and residents.

ACKNOWLEDGMENTS

This educational study was funded by the Tobacco Free Kansas Coalition.

Support for Roswell Park Cancer Institute researchers was provided by the Flight Attendant Medical Research Institute.

Roswell Park Cancer Institute (RPCI) is America's first cancer center founded in 1898 by Dr. Roswell Park. RPCI is the only upstate New York facility to hold the National Cancer Center designation of "comprehensive cancer center" and to serve as a member of the prestigious National Comprehensive Cancer Network.

Over its long history, Roswell Park Cancer Institute has made fundamental contributions to reducing the cancer burden and has successfully maintained an exemplary leadership role in setting the national standards for cancer care, research and education.

The campus spans 25 acres in downtown Buffalo and consists of 15 buildings with about one million square feet of space. A new hospital building, completed in 1998, houses a comprehensive diagnostic and treatment center. In addition, the Institute built a new medical research complex and renovated existing education and research space to support its future growth and expansion.

For more information about Roswell Park and cancer in general, please contact the Cancer Call Center at 1-877-ASK-RPCI (1-877-275-7724).

Figure 2

Topeka, Kansas Air Monitoring Study
August 2009, October 2010

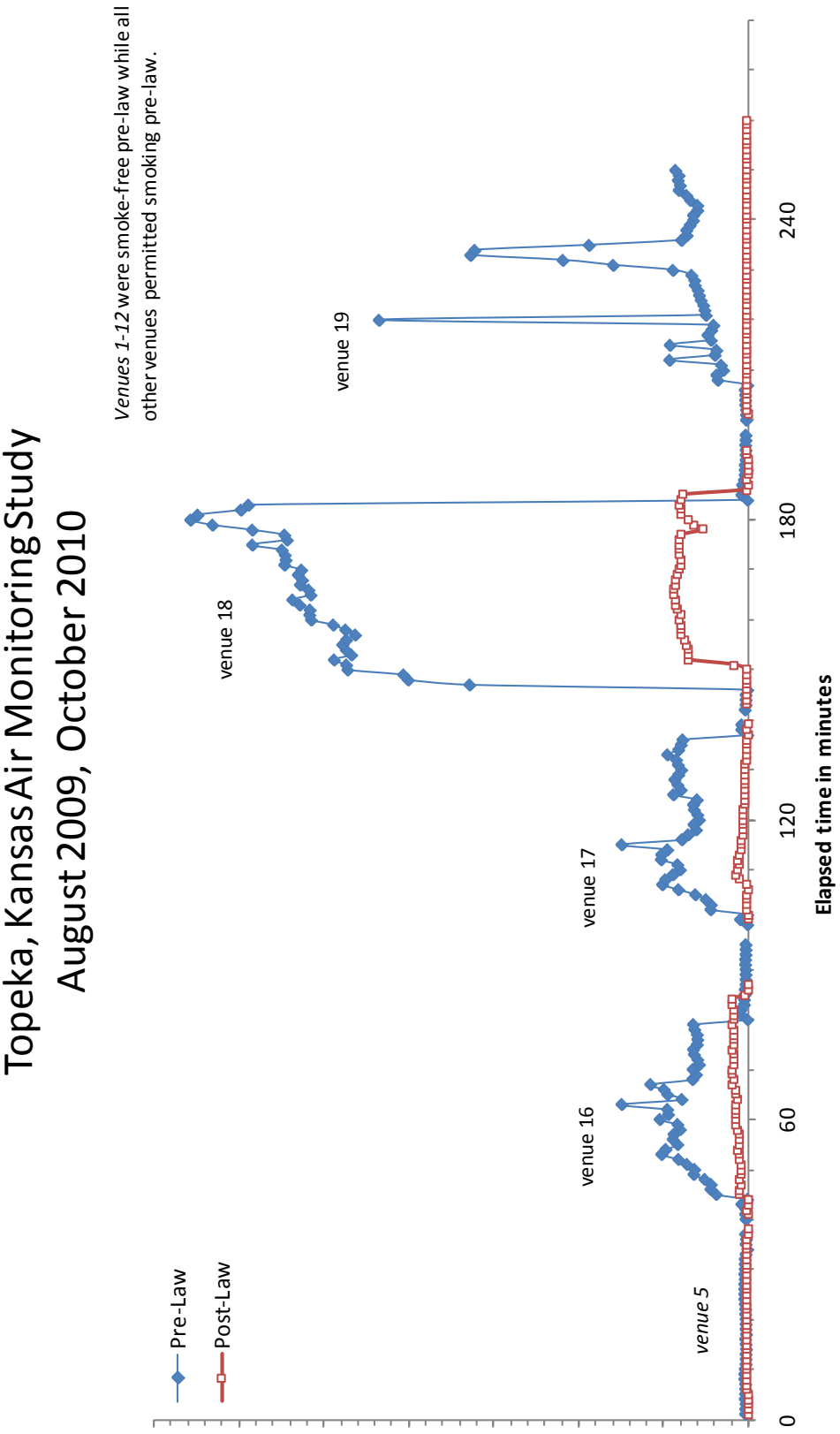


Figure 3

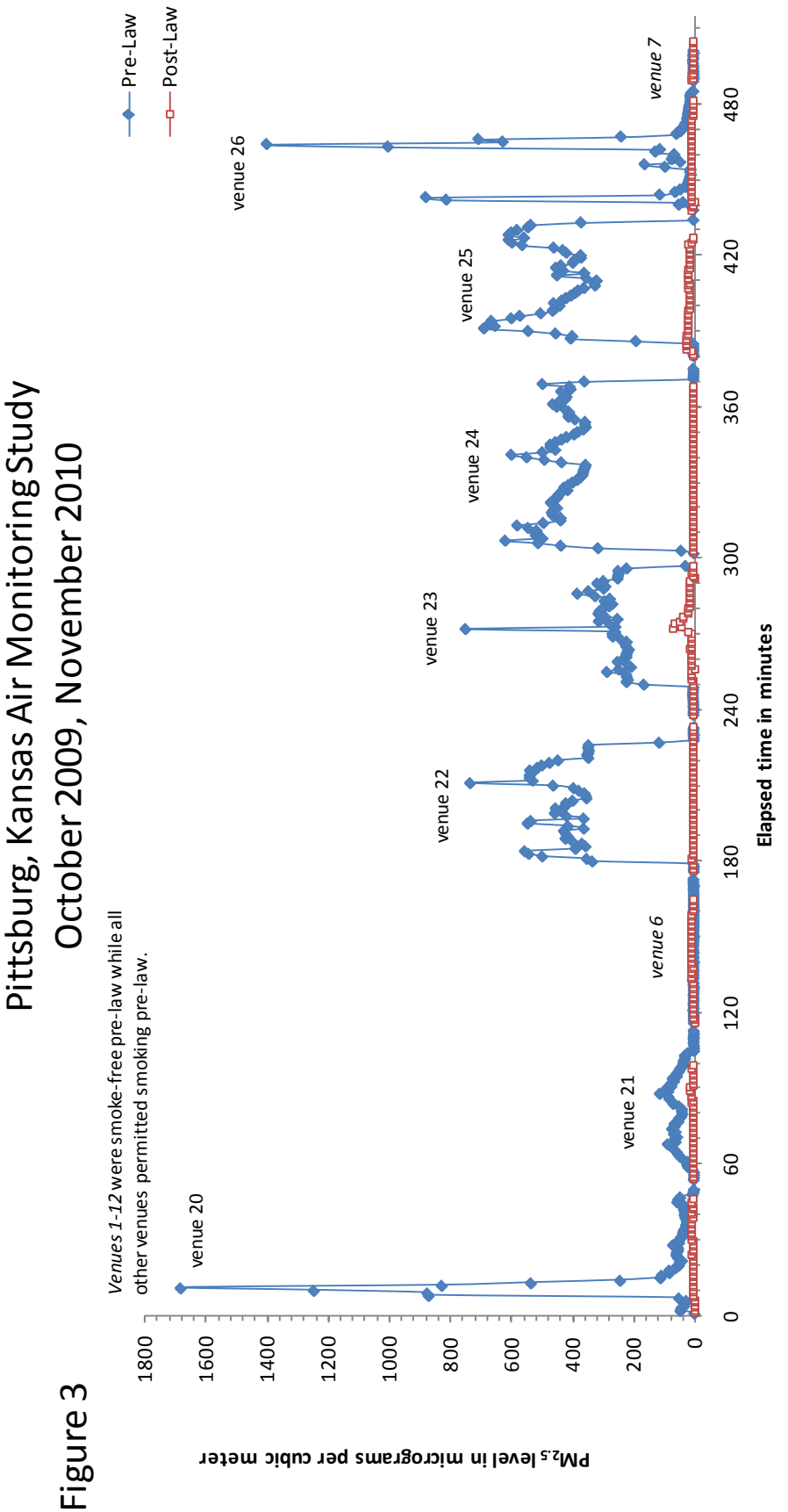

Pittsburg, Kansas Air Monitoring Study
October 2009, November 2010
Venues 1-12 were smoke-free pre-law while all other venues permitted smoking pre-law.
Pre-Law
Post-Law
PM2.5 level in micrograms per cubic meter
Elapsed time in minutes
0
200
400
600
800
1000
1200
1400
1600
1800
0
60
120
180
240
300
360
420
480
venue 20
venue 21
venue 6
venue 22
venue 23
venue 24
venue 25
venue 26
venue 7

Figure 4

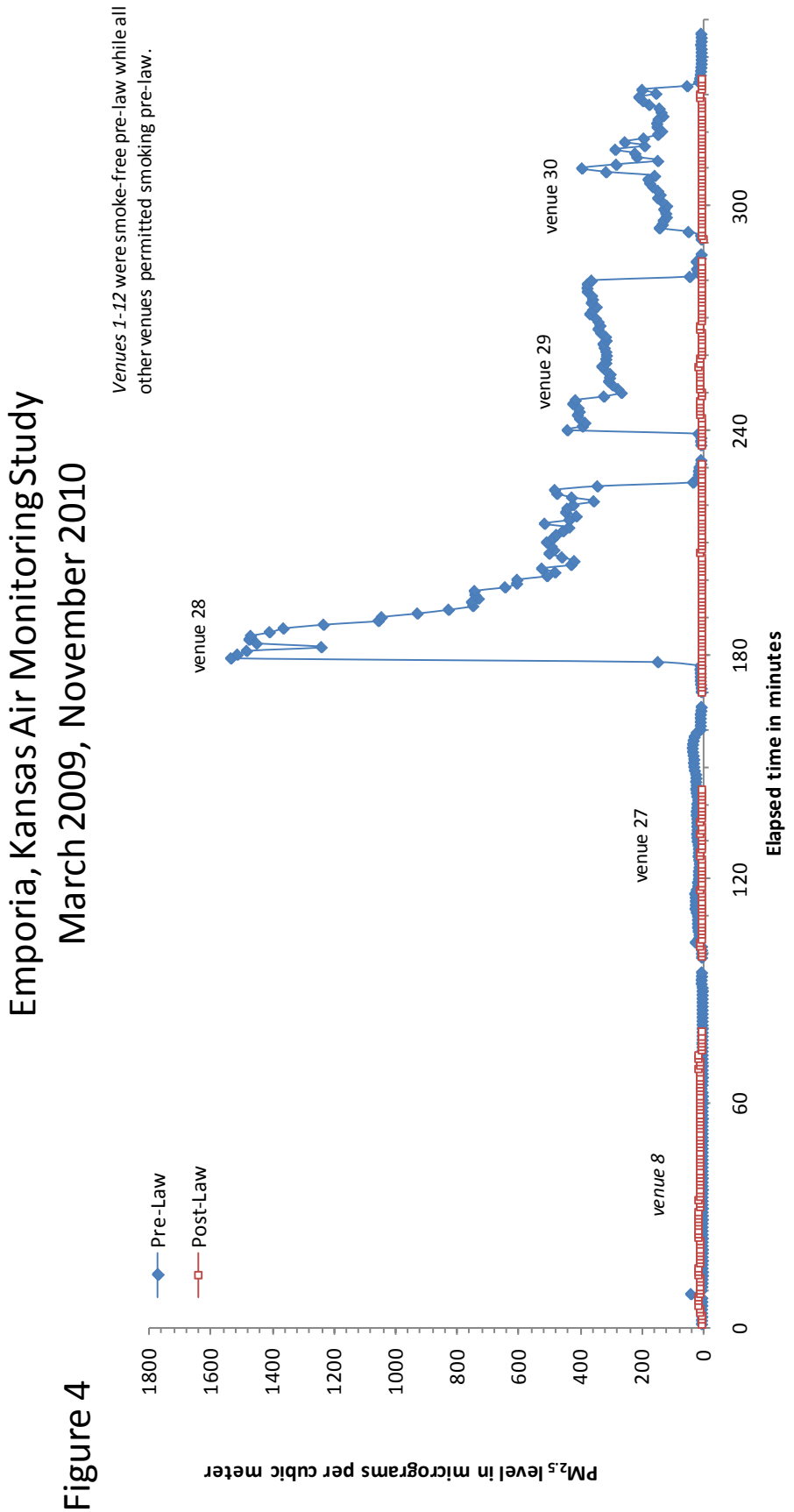

Emporia, Kansas Air Monitoring Study
March 2009, November 2010
Venues 1-12 were smoke-free pre-law while all other venues permitted smoking pre-law.
Pre-Law
Post-Law
venue 28
venue 29
venue 30
venue 27
venue 8
$PM_{2.5}$ level in micrograms per cubic meter
Elapsed time in minutes
0
200
400
600
800
1000
1200
1400
1600
1800
0
60
120
180
240
300

Figure 5

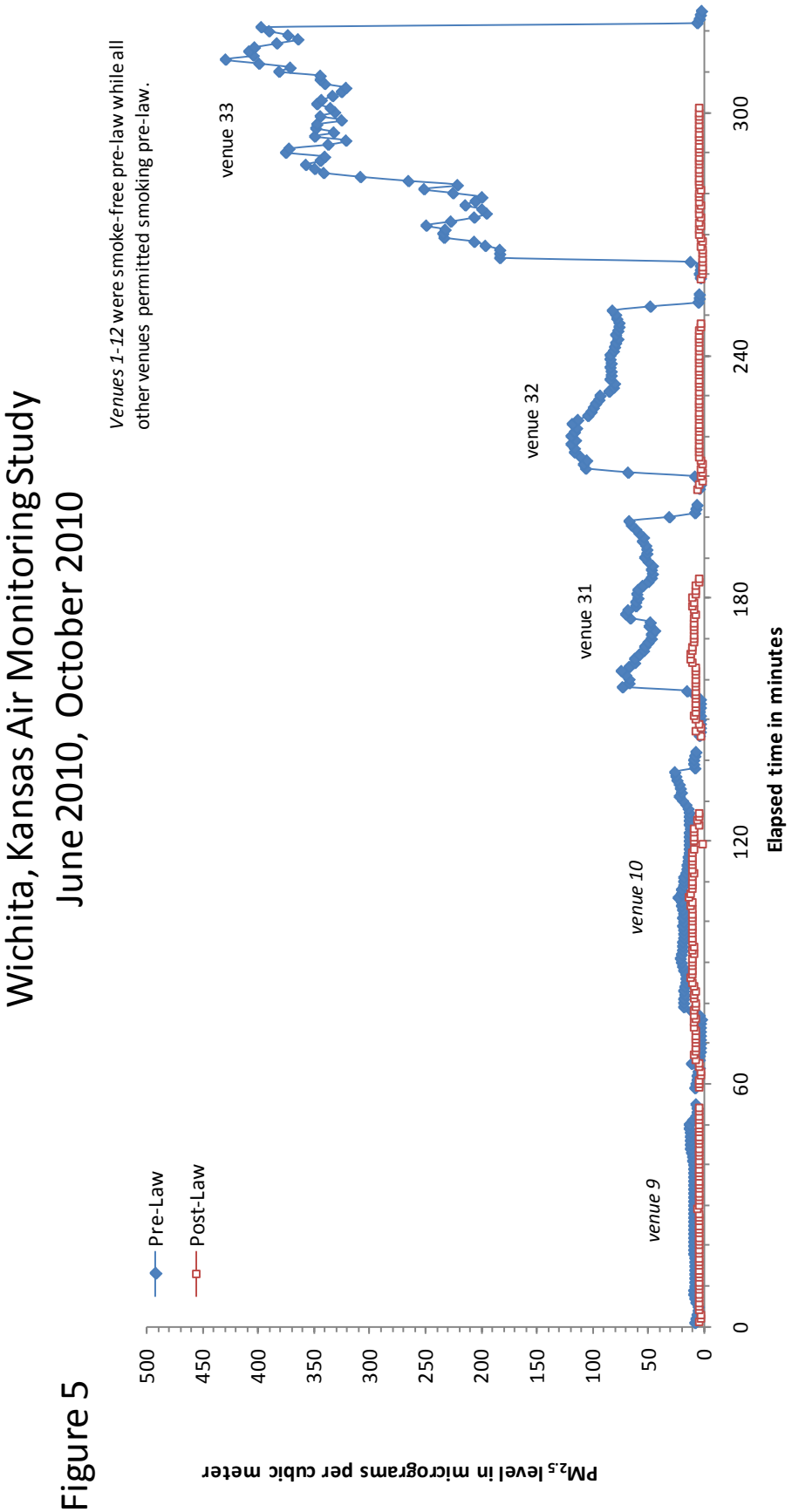
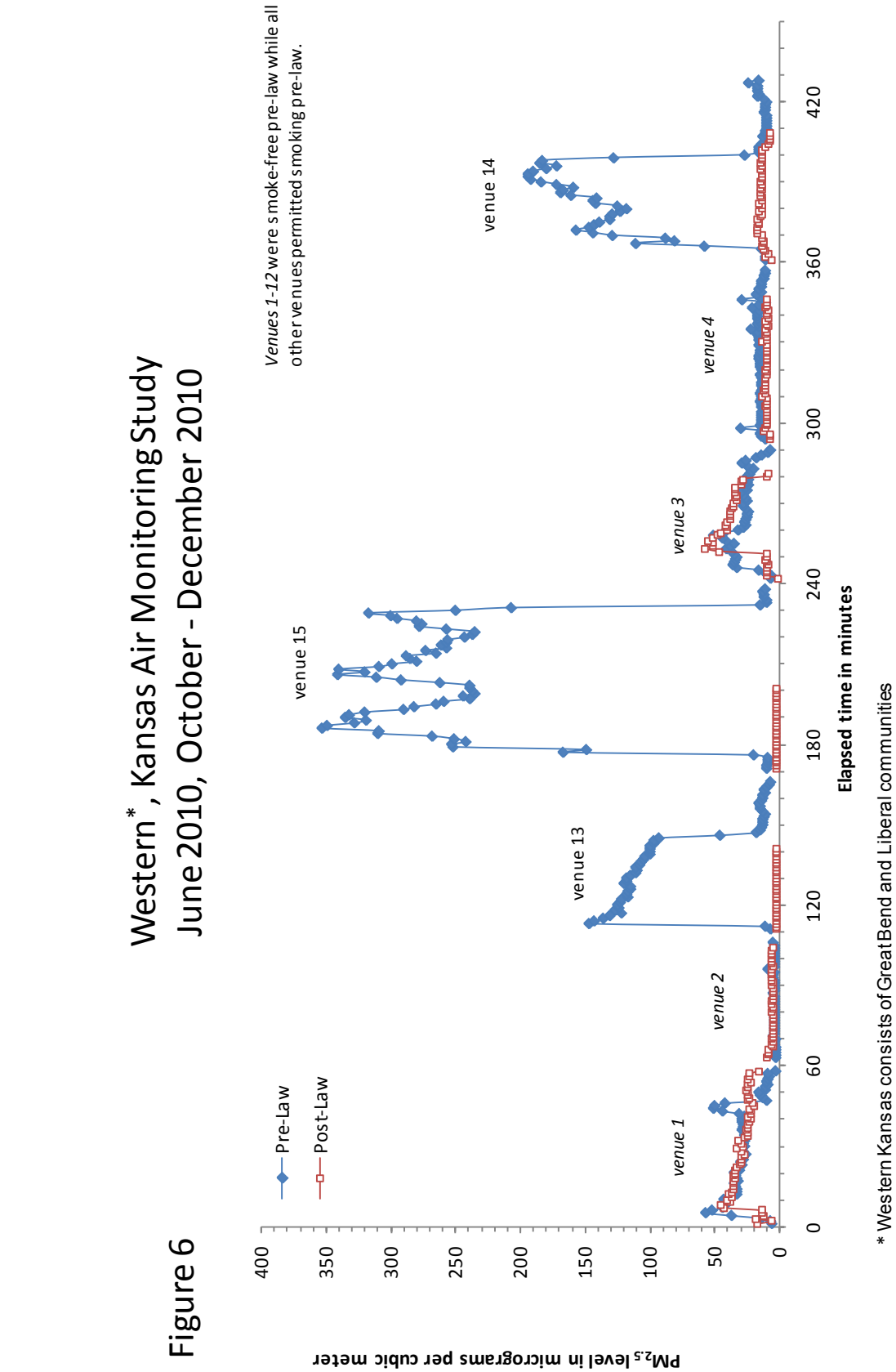

Wichita, Kansas Air Monitoring Study
June 2010, October 2010
Venues 1-12 were smoke-free pre-law while all other venues permitted smoking pre-law.
Pre-Law
Post-Law
venue 33
venue 32
venue 31
venue 10
venue 9
$PM_{2.5}$ level in micrograms per cubic meter
Elapsed time in minutes
0
50
100
150
200
250
300
350
400
450
500
60
120
180
240
300

Figure 6

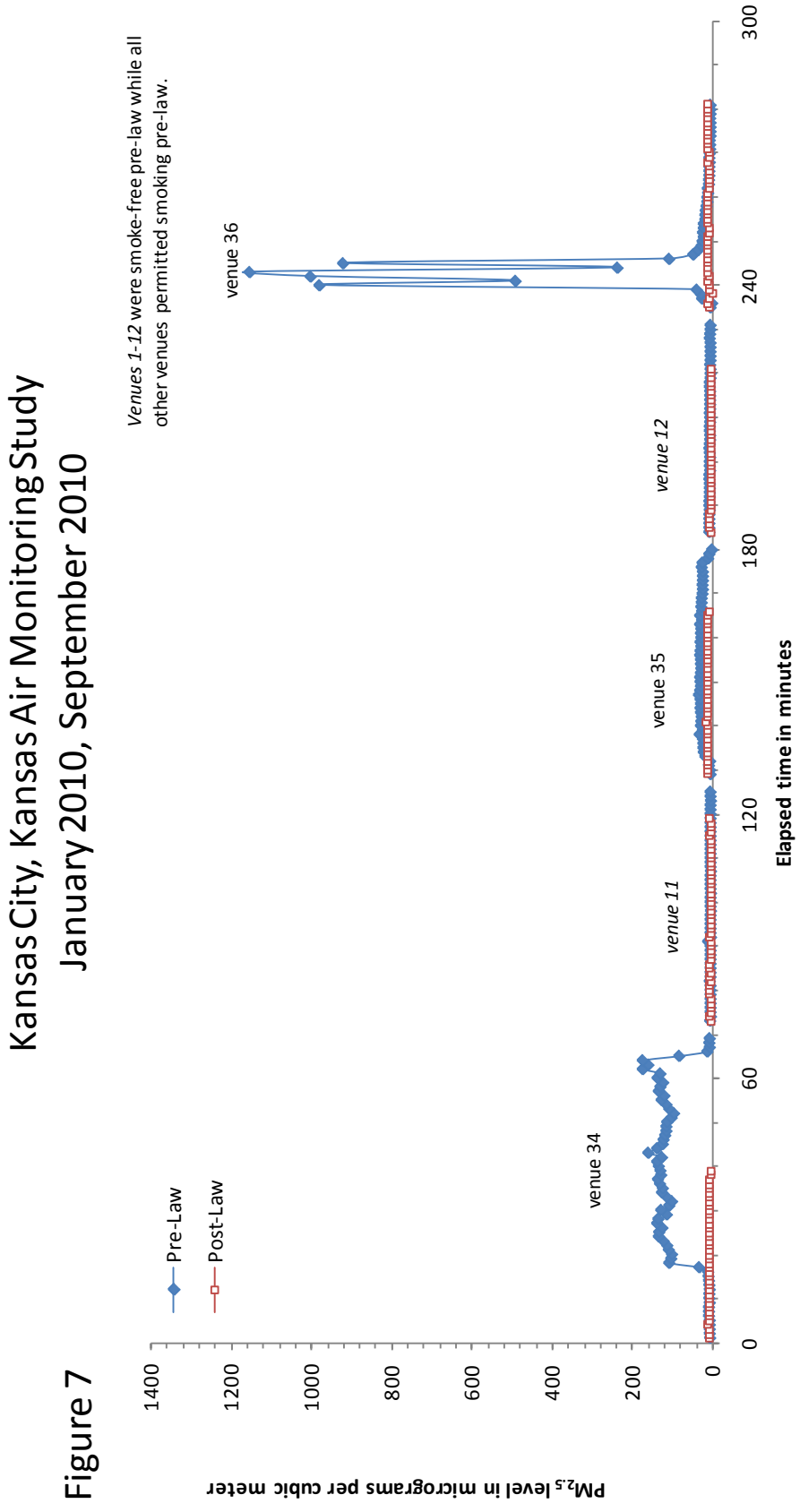
Western*, Kansas Air Monitoring Study
June 2010, October - December 2010



* Western Kansas consists of Great Bend and Liberal communities

Figure 7

Kansas City, Kansas Air Monitoring Study
January 2010, September 2010



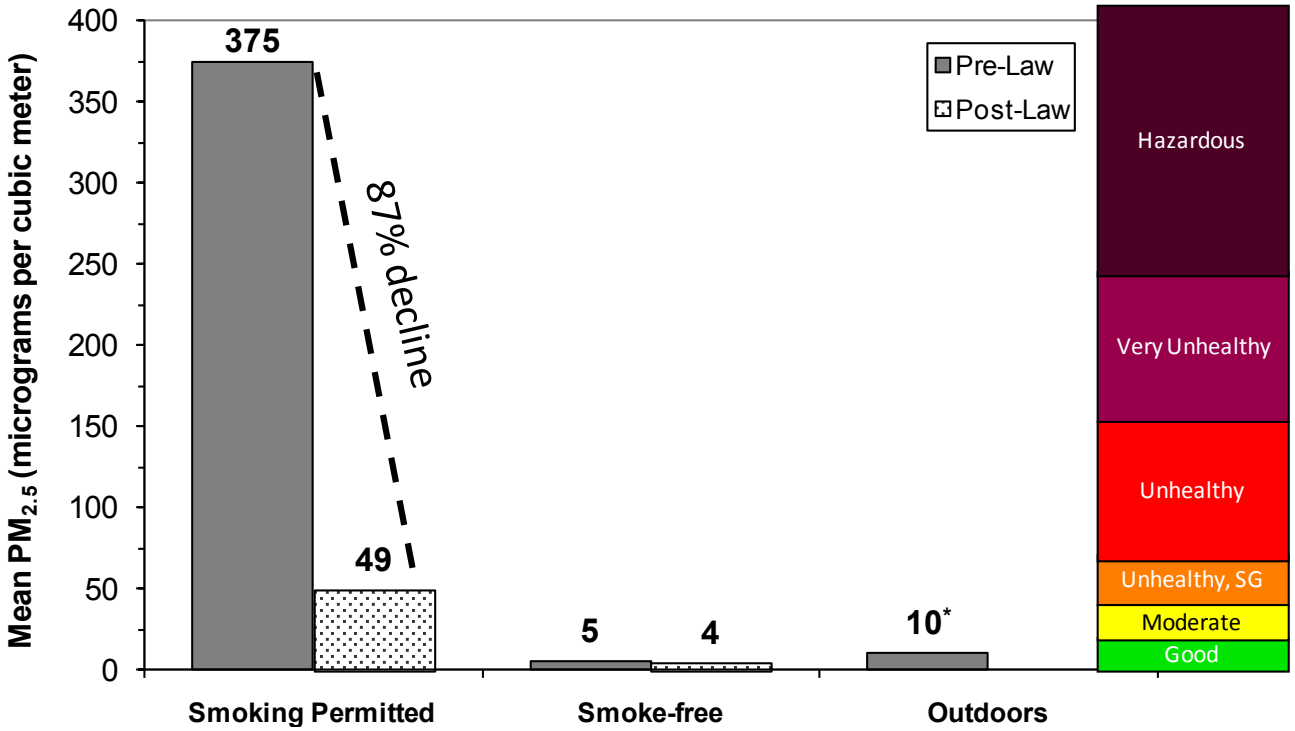
TOPEKA

Table 1. Fine Particle Air Pollution in Topeka Kansas Bars and Restaurants

Venue Number	City	Size (m^3)	Pre-Law: Average # people	Pre-Law: Average # burning cigs	Pre-Law: Active smoker density*	Pre-Law: Average $PM_{2.5}$ level ($\mu g/m^3$)	Post-Law: Average # people	Post-Law: Average # burning cigs	Post-Law: Active smoker density*	Post-Law: Average $PM_{2.5}$ level ($\mu g/m^3$)
No Observed Smoking										
5	Topeka	314	42	0.0	0.00	5	20	0.0	0.00	4
Average		**314**	**42**	**0.0**	**0.00**	**5**	**20**	**0.0**	**0.00**	**4**
Smoking Observed										
16	Topeka	856	66	2.0	0.23	151	77	0.0	0.00	29
17	Topeka	713	37	2.0	0.28	155	63	0.0	0.00	4
18	Topeka	877	31	5.0	0.57	156	26	0.0	0.00	12
19	Topeka	401	49	5.0	1.25	1039	39	0.0	0.00	150
Average		**712**	**46**	**3.5**	**0.58**	**375**	**51**	**0.0**	**0.00**	**49**

*Average number of burning cigarettes per 100 cubic meters.

Figure 8. Effect of Kansas State Smoke-free Air Law on Indoor Air Pollution in Topeka Kansas



Used for comparison purposes. Based on the 2008 average $PM_{2.5}$ level from the EPA monitoring site in Kansas (http://www.epa.gov/air/data/). The color-coded EPA Air Quality Index is also shown to demonstrate the magnitude of the measured particle levels

PITTSBURG

Table 3. Fine Particle Air Pollution in Pittsburg Kansas Bars and Restaurants

Venue Number	City	Size (m^3)	Pre-Law				Post-Law			
			Average # people	Average # burning cigs	Active smoker density*	Average $PM_{2.5}$ level ($\mu g/m^3$)	Average # people	Average # burning cigs	Active smoker density*	Average $PM_{2.5}$ level ($\mu g/m^3$)
No Observed Smoking										
6	Pittsburg	1408	24	0.0	0.00	3	16	0.0	0.00	9
7	Pittsburg	96	14	0.0	0.00	5	11	0.0	0.00	10
Average		**752**	**19**	**0.0**	**0.00**	**4**	**14**	**0.0**	**0.00**	**10**
Smoking Observed										
20	Pittsburg	297	10	1.0	0.34	181	21	0.0	0.00	9
21	Pittsburg	233	39	1.0	0.43	58	23	0.0	0.00	6
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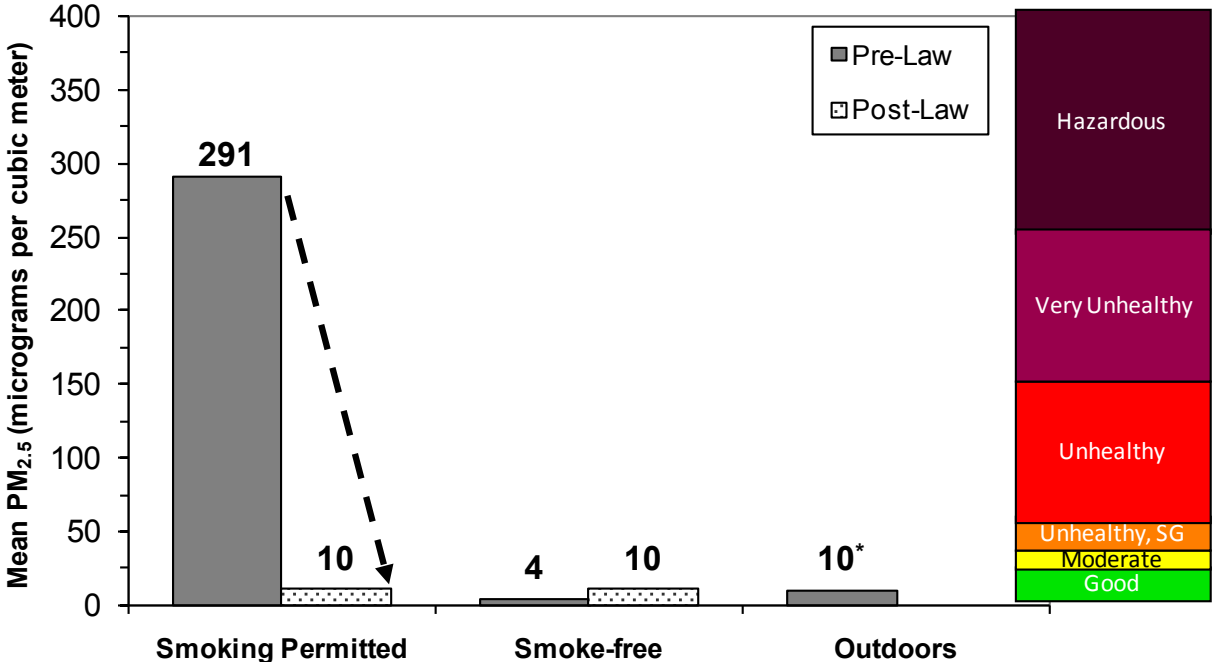
25	Pittsburg	505	17	1.0	0.20	476	26	0.0	0.00	21
26	Pittsburg	1269	17	1.0	0.08	163	56	0.0	0.00	10
Average		**703**	**26**	**1.7**	**0.37**	**291**	**33**	**0.0**	**0.00**	**10**

*Average number of burning cigarettes per 100 cubic meters.

Figure 9. Effect of Kansas State Smoke-free Air Law on Indoor Air Pollution in Pittsburg Kansas



Used for comparison purposes. Based on the 2008 average $PM_{2.5}$ level from the EPA monitoring site in Kansas (http://www.epa.gov/air/data/). The color-coded EPA Air Quality Index is also shown to demonstrate the magnitude of the measured particle levels

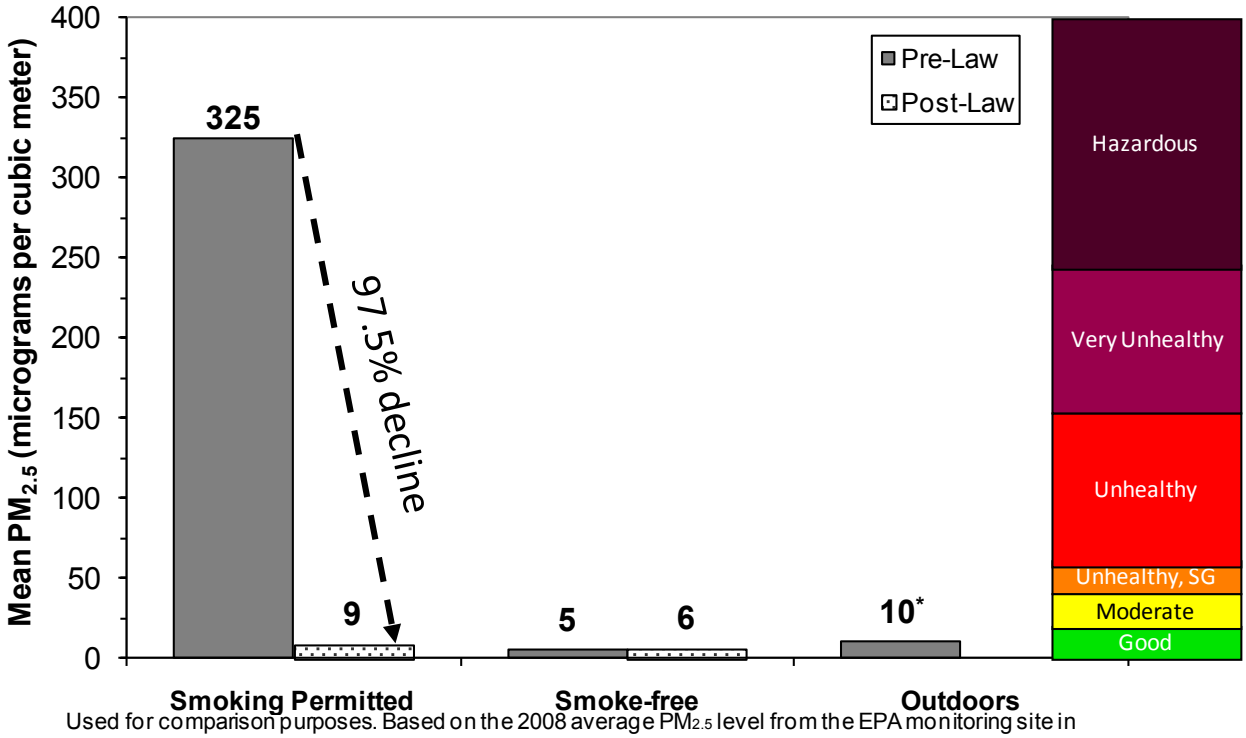
EMPORIA

Table 4. Fine Particle Air Pollution in Emporia Kansas Bars and Restaurants

Venue Number	City	Size (m^3)	Pre-Law: Average # people	Pre-Law: Average # burning cigs	Pre-Law: Active smoker density*	Pre-Law: Average $PM_{2.5}$ level ($\mu g/m^3$)	Post-Law: Average # people	Post-Law: Average # burning cigs	Post-Law: Active smoker density*	Post-Law: Average $PM_{2.5}$ level ($\mu g/m^3$)
No Observed Smoking										
8	Emporia	3154	73	0.0	0.00	5	11	0.0	0.00	6
Average		**3154**	**73**	**0.0**	**0.00**	**5**	**11**	**0.0**	**0.00**	**6**
Smoking Observed										
27	Emporia	2022	133	2.0	0.10	23	45	0.0	0.00	13
28	Emporia	400	36	6.0	1.50	753	12	0.0	0.00	7
29	Emporia	1076	26	5.0	0.46	348	22	0.0	0.00	6
30	Emporia	412	27	3.0	0.73	177	28	0.0	0.00	9
Average		**978**	**56**	**4.0**	**0.70**	**325**	**27**	**0.0**	**0.00**	**9**

*Average number of burning cigarettes per 100 cubic meters.

Figure 10. Effect of Kansas State Smoke-free Air Law on Indoor Air Pollution in Emporia Kansas



Used for comparison purposes. Based on the 2008 average $PM_{2.5}$ level from the EPA monitoring site in Kansas (http://www.epa.gov/air/data/). The color-coded EPA Air Quality Index is also shown to demonstrate the magnitude of the measured particle levels

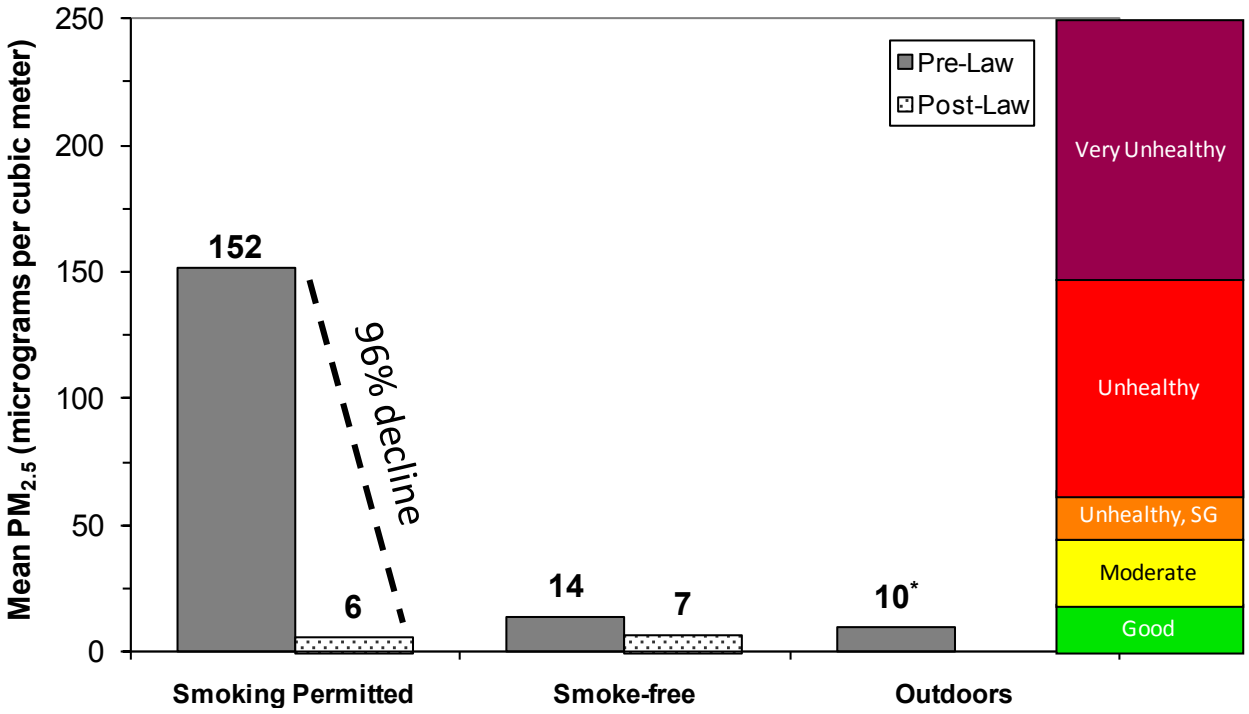
WICHITA

Table 5. Fine Particle Air Pollution in Wichita Kansas Bars and Restaurants

Venue Number	City	Size (m^3)	Pre-Law				Post-Law			
			Average # people	Average # burning cigs	Active smoker density*	Average $PM_{2.5}$ level ($\mu g/m^3$)	Average # people	Average # burning cigs	Active smoker density*	Average $PM_{2.5}$ level ($\mu g/m^3$)
9	Wichita	510	28	0.0	0.00	9	16	0.0	0.00	4
10	Wichita	1654	51	0.0	0.00	18	51	0.0	0.00	10
Average		**1082**	**40**	**0.0**	**0.00**	**14**	**34**	**0.0**	**0.00**	**7**
Smoking Observed										
31	Wichita	726	25	5.0	0.69	55	23	0.0	0.00	9
32	Wichita	1752	31	7.0	0.40	93	27	0.0	0.00	4
33	Wichita	1439	34	9.0	0.63	308	27	0.0	0.00	4
Average		**1306**	**30**	**7.0**	**0.57**	**152**	**26**	**0.0**	**0.00**	**6**

*Average number of burning cigarettes per 100 cubic meters.

Figure 11. Effect of Kansas State Smoke-free Air Law on Indoor Air Pollution in Wichita Kansas



Used for comparison purposes. Based on the 2008 average $PM_{2.5}$ level from the EPA monitoring site in Kansas (http://www.epa.gov/air/data/). The color-coded EPA Air Quality Index is also shown to demonstrate the magnitude of the measured particle levels

WESTERN KANSAS (LIBERAL AND GREAT BEND)

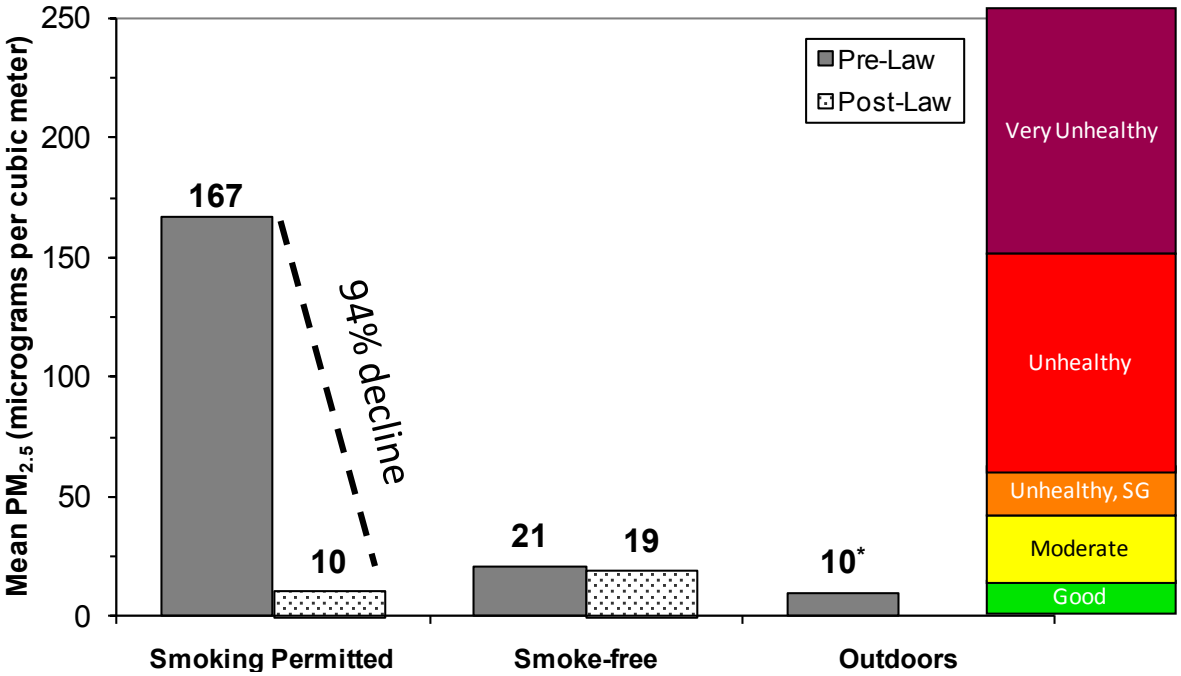
Table 6. Fine Particle Air Pollution in Western Kansas Bars and Restaurants

Venue Number	City	Size (m^3)	Pre-Law				Post-Law			
			Average # people	Average # burning cigs	Active smoker density*	Average $PM_{2.5}$ level ($\mu g/m^3$)	Average # people	Average # burning cigs	Active smoker density*	Average $PM_{2.5}$ level ($\mu g/m^3$)
No Observed Smoking										
1	Western †	881	52	0.0	0.00	33	51	0.0	0.00	28
2	Western †	383	5	0.0	0.00	4	5	0.0	0.00	6
3	Western †	1308	47	0.0	0.00	30	51	0.0	0.00	33
4	Western †	794	15	0.0	0.00	15	12	0.0	0.00	10
Average		**842**	**30**	**0.0**	**0.00**	**21**	**30**	**0.0**	**0.00**	**19**
Smoking Observed										
13	Western †	2039	9	2.0	0.10	115	3	0.0	0.00	3
14	Western	489	11	6.0	1.23	136	19	0.0	0.00	14
15	Western	766	13	2.0	0.26	250	25	0.0	0.00	12
Average		**1098**	**11**	**3.3**	**0.53**	**167**	**16**	**0.0**	**0.00**	**10**

*Average number of burning cigarettes per 100 cubic meters.

† Western Kansas consists of Great Bend and Liberal Counties

Figure 12. Effect of Kansas State Smoke-free Air Law on Indoor Air Pollution in Western Kansas



Used for comparison purposes. Based on the 2008 average $PM_{2.5}$ level from the EPA monitoring site in Kansas (http://www.epa.gov/air/data/). The color-coded EPA Air Quality Index is also shown to demonstrate the magnitude of the measured particle levels

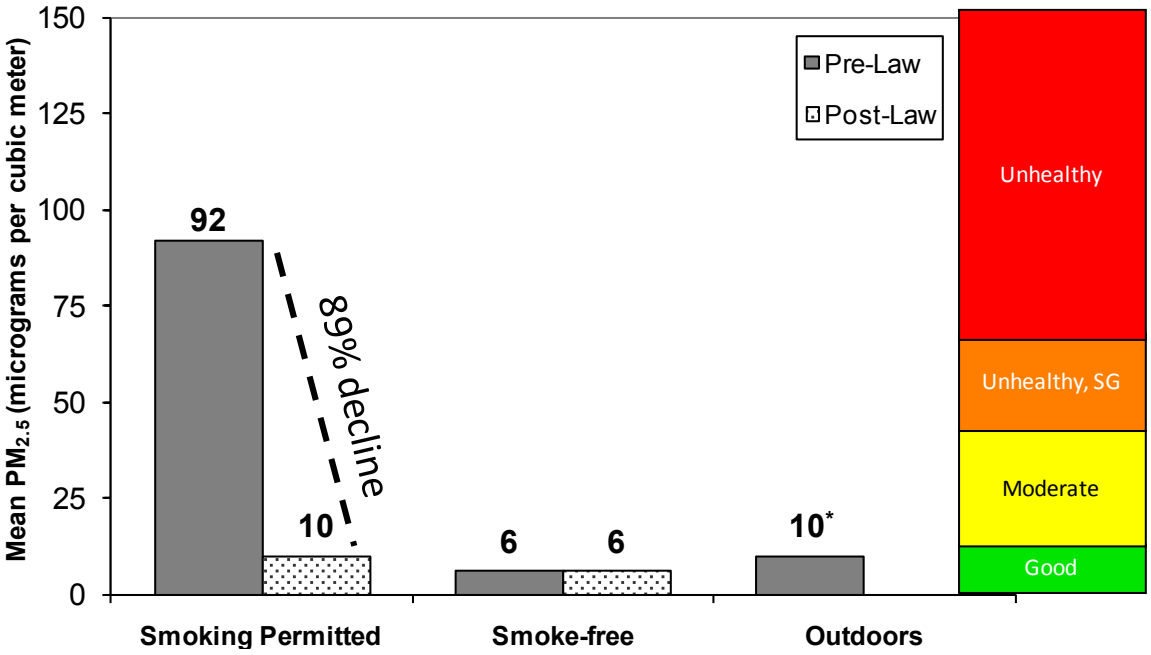
KANSAS CITY

Table 7. Fine Particle Air Pollution in Kansas City Kansas Bars and Restaurants

Venue Number	City	Size (m^3)	Pre-Law				Post-Law			
			Average # people	Average # burning cigs	Active smoker density*	Average $PM_{2.5}$ level ($\mu g/m^3$)	Average # people	Average # burning cigs	Active smoker density*	Average $PM_{2.5}$ level ($\mu g/m^3$)
No Observed Smoking										
11	Kansas City	919	22	0.0	0.00	5	27	0.0	0.00	6
12	Kansas City	892	35	0.0	0.00	7	43	0.0	0.00	5
Average		**906**	**29**	**0.0**	**0.00**	**6**	**35**	**0.0**	**0.00**	**6**
Smoking Observed										
34	Kansas City	2219	84	8.0	0.36	123	85	0.0	0.00	8
35	Kansas City	1694	13	2.0	0.12	28	62	0.0	0.00	12
36	Kansas City	2159	27	2.0	0.09	124	54	0.0	0.00	11
Average		**2024**	**41**	**4.0**	**0.19**	**92**	**67**	**0.0**	**0.00**	**10**

*Average number of burning cigarettes per 100 cubic meters.

Figure 13. Effect of Kansas State Smoke-free Air Law on Indoor Air Pollution in Kansas City Kansas



Used for comparison purposes. Based on the 2008 average $PM_{2.5}$ level from the EPA monitoring site in Kansas (http://www.epa.gov/air/data/). The color-coded EPA Air Quality Index is also shown to demonstrate the magnitude of the measured particle levels

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