Indoor Air Quality After Implementation of Daviess County's Smoke-free Ordinance

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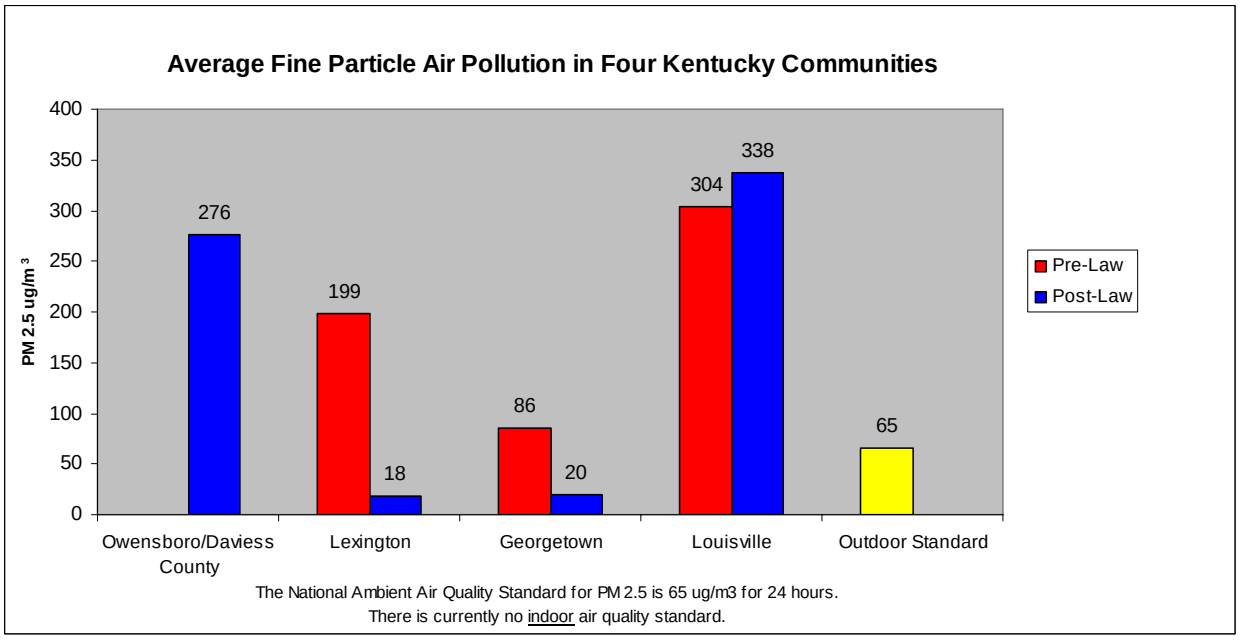
Executive Summary

Indoor air quality was assessed in 10 venues in Owensboro/Daviess County, KY, including six restaurants, three bars, and one other entertainment venue after a countywide smoke-free law was implemented. Two restaurants were smoke-free by law. The remaining 8 venues qualified for an exemption and they allowed smoking per the ordinance. Venues were sampled from May 31, 2006, to June 6, 2006, using the TSI SidePak AM510 Personal Aerosol Monitor. The average $PM_{2.5}$ levels from all 10 venues including the smoke-free venues is compared to the average $PM_{2.5}$ levels in Lexington, Georgetown, and Louisville pre- and post-law, as well as the National Ambient Air Quality Standard for 24 hours. Key findings of the study are:

- The level of indoor air pollution in Owensboro/Daviess County, Kentucky, post-law as measured by average $PM_{2.5}$ (276 $\mu g/m^3$) was 15.3 and 13.8 times higher than Lexington's and Georgetown's post-law average $PM_{2.5}$ levels, respectively (see Figure 1). Workers and patrons in Owensboro/Daviess County venues sampled in this study are exposed to air pollution over four times the National Ambient Air Quality Standard.

- The two smoke-free restaurants had an average $PM_{2.5}$ level of 42 $\mu g/m^3$, compared to335 $\mu g/m^3$ for the eight that allowed smoking by law (see Figure 3). The four restaurants, three bars, and other entertainment venue that allowed smoking had average $PM_{2.5}$ levels ranging from 26 $\mu g/m^3$ to 848 $\mu g/m^3$, and all except one venue without smoking during the monitoring period exceeded the National Ambient Air Quality Standard. In hospitality venues that allowed smoking by law, the air pollution was nearly eight times higher than in the smoke-free venues.

Figure 1



Introduction

Secondhand smoke (SHS) contains at least 250 chemicals that are known to be toxic or carcinogenic.[1,2] There is no safe level of exposure to SHS.[2] SHS exposure is the third leading cause of preventable death in the United States.[3] SHS is a mixture of the smoke from the burning end of tobacco products (sidestream smoke) and the smoke exhaled by smokers (mainstream smoke) and is known to cause cancer in humans.[1,2,3] SHS exposure causes lung cancer and heart disease in nonsmoking adults.[1-4] An estimated 3,000 nonsmokers die from lung cancer annually and over 35,000 nonsmokers die from heart disease annually in the U.S.[5] It is estimated that approximately 60% of people in the United States have biological evidence of SHS exposure.[6]

Currently in the U.S., there are 17 states that have enacted statewide laws restricting smoking in workplaces, restaurants, and/or bars, with six of these states eliminating smoking in virtually all workplaces.[7] It is estimated that approximately 44.5% of the U.S. population are protected by clean indoor air regulations that cover virtually all indoor worksites including bars and restaurants. There are over 2,300 local ordinances or regulations that restrict smoking to some extent in workplaces across the United States and Washington, D.C.[8] The extent of protection provided by these laws varies widely from community to community.

Currently in Kentucky, seven communities have enacted and implemented smoke-free laws. The most comprehensive ordinances, 100% smoke-free workplace *and* 100% smoke-free enclosed public place laws, have been implemented in Georgetown and Morehead. The next most comprehensive ordinances, 100% smoke-free enclosed public place laws, have been implemented in Lexington, Letcher County, and Frankfort. Two communities have enacted partial smoke-free laws, protecting workers and patrons in some public venues: Louisville and Daviess County. The Daviess County ordinance prohibits smoking in all enclosed public places that allow persons under age 18 to enter. Two additional communities are in the process of enacting 100% smoke-free workplace and 100% smoke-free enclosed public place ordinances, both due to go into effect October 1, 2006 (Ashland and Henderson).

The purpose of this study was to (a) assess air quality in 10 Owensboro/Daviess County hospitality venues five months after implementation of their partial smoke-free law on January 1, 2006; and (b) compare the results to Lexington, Georgetown, and Louisville air quality data before and after their smoke-free laws took effect. It was hypothesized that the level of indoor air pollution in Daviess County hospitality venues would be significantly higher than Georgetown and Lexington post-law levels and higher than the National Ambient Air Quality Standard.

Methods

Between May 31 and June 6, 2006, indoor air quality was assessed in 10 indoor venues including six restaurants, three bars, and one other entertainment venue in Owensboro/Daviess County. Sites were of various sizes; some sites were individually owned establishments and some were local or national chain establishments. Two restaurant venues were smoke-free by law, and we selected them for comparison purposes.

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, and the particulate matter in the air scatters the light from a laser to assess the real-time concentration of particles smaller than 2.5µm in micrograms per cubic meter, or $PM_{2.5}$. The SidePak was calibrated against a light scattering instrument, which had been previously calibrated and used in similar studies. 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 two minutes 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. The Kentucky Center for Smoke-free Policy (KCSP) staff trained staff from the Green River District Health Department, who did the sampling and sent the data to KCSP for analysis.

Statistical Analyses

Descriptive statistics including the venue volume, number of patrons, number of burning cigarettes, and smoker density (i.e., average number of burning cigarettes per 100 m^3) were reported for each venue and averaged for all venues.

Results

The six restaurants, three bars, and one other entertainment venue were visited on Wednesday, Thursday, Friday, Saturday, Monday and Tuesday for an average of 48 minutes (range 40-60 minutes) per venue. Visits occurred at various times of the day from 8:05 a.m. to 11:00 p.m. The average size of the Owensboro/Daviess County venues was 292 m^3 (range 92-795 m^3). On average, 41 people were present per venue, and five burning cigarettes per venue were observed. The smoker density was 1.69 #bc/100 m^3. Descriptive statistics for each venue are shown in Table 1.

As depicted in Figure 1, the average level of indoor air pollution in the 10 Owensboro/Daviess County venues (276 µg/m^3) was 15.3 times higher than Lexington's average level post-law (18 µg/m^3) and 13.8 times higher than Georgetown's average level post law (20 µg/m^3). Daviess County's average level of indoor air pollution in the venues sampled was 4.2 times higher than the National Ambient Air Quality Standard (65 µg/m^3) for 24 hours.

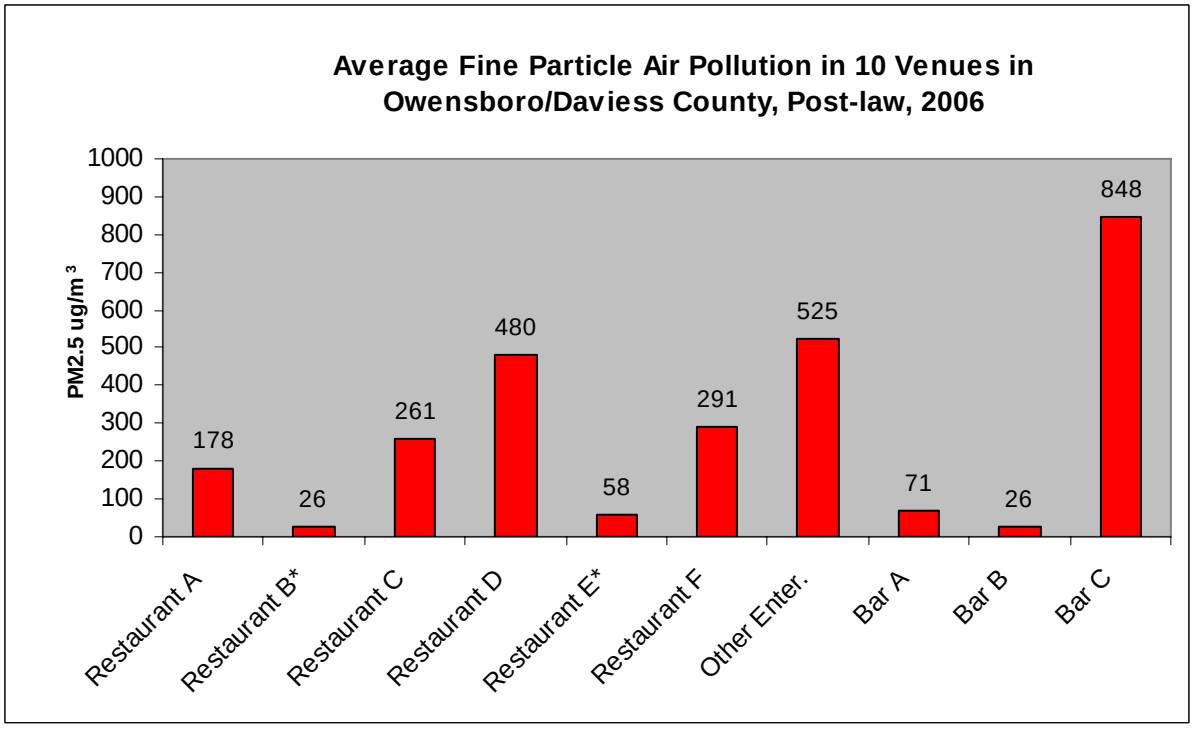
Table 1. Air Quality Data for 10 Venues in Owensboro/Daviess County, Kentucky 2006

Venue	Date Sampled	Size (m^3)	Average # people	Average # burning cigs	Smoker density (#bc/100m^3)	Average $PM_{2.5}$ level
Restaurant A	5/31/2006	92	20	2.16	2.34	178
Restaurant B*	6/1/2006	279	41	0	0	26
Restaurant C	6/2/2006	128	11	3.5	2.73	261
Restaurant D	6/5/2006	237	43	6.5	2.74	480
Restaurant E*	6/6/2006	167	19	0	0	58
Restaurant F	6/6/2006	129	8	1	0.77	291
Other Enter.	6/3/2006	438	190	27.4	6.25	525
Bar A	6/3/2006	141	23	1.42	1	71
Bar B	6/6/2006	407	2	0	0	26
Bar C	6/6/2006	795	54	8.75	1.10	848

*Smoke-free venues

Figure 2 shows the average level of indoor air pollution in each of the 10 sampled venues. The average $PM_{2.5}$ levels ranged from 26 µg/m^3 to 848 µg/m^3. Restaurants B and E were smoke-free venues by law, and they had average levels of 26 µg/m^3 and 58 µg/m,^{3} respectively. Bar B was the only venue allowing smoking that had an average $PM_{2.5}$ (26 µg/m^3) below the National Ambient Air Quality Standard. Bar B, a large venue in which smoking was allowed by law, was measured during the daytime when there were few people and no burning cigarettes observed. Bar C, the other entertainment venue, and Restaurant D had the highest air pollution levels: 848, 525, and 480 µg/m,^{3} respectively.

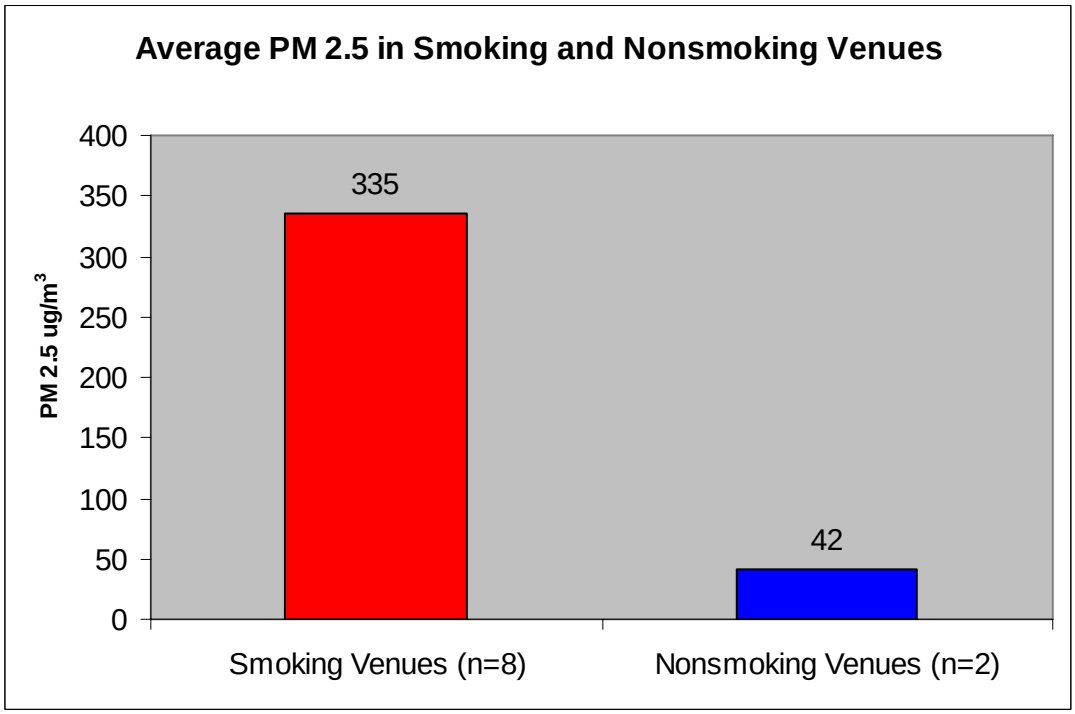
Figure 2



*Denotes smoke-free venues

Figure 3 shows that when smoke-free laws are applied to hospitality venues, air pollution is dramatically lower. Average $PM_{2.5}$ in the two smoke-free establishments was 42 µg/m,[3] compared to 335 µg/m^3 in the venues that allowed smoking by law.

Figure 3



Discussion

To protect the public health, the Environmental Protection Agency (EPA) sets a limit of 65 µg/m^3 as the average level of *outdoor* exposure over 24-hours. There is no indoor air standard. The average $PM_{2.5}$ level in 8 smoking Owensboro/Daviess County, Kentucky venues after implementation of their partial smoke-free law was 335 µg/m^3, 5.2 times higher than the National Ambient Air Quality Standard. The two smoke-free venues did not exceed the national air quality standard.

Two Kentucky air quality studies have demonstrated significant improvements in air quality as a result of implementing 100% smoke-free laws. Hahn et al. showed a 91% decrease in indoor air pollution after Lexington, Kentucky implemented a 100% smoke-free enclosed public place law on April 27, 2004.[9] The average level of indoor air pollution was 199 µg/m^3 pre-law and dropped to 18 µg/m^3 post-law. Similarly, average levels of indoor air pollution dropped from 86µg/m^3 to 20 µg/m^3 after Georgetown, Kentucky implemented a 100% smoke-free workplace and enclosed public place law on October 1, 2005. Other studies have shown similar significant improvements in air quality after implementing 100% smoke-free laws. One California study showed an 82% average decline in air pollution after smoking was prohibited.[10] When indoor air quality was

measured in 20 hospitality venues in western New York, average levels of respirable suspended particle (RSP) dropped by 84% after a smoke-free law took effect.[11]

After a partial smoke-free law was implemented in Louisville, Kentucky, the average $PM_{2.5}$ level rose slightly from pre-law levels to 338 $\mu g/m^3$, even though 3 of the 10 venues sampled were smoke-free as a result of the ordinance (see Figure 1).[12] As with the Louisville ordinance, the Daviess County partial smoke-free law is not effective in reducing fine particle air pollution for all workers and patrons. In Daviess County venues not covered by the law, the air pollution is nearly eight times higher than in the venues that are covered by the law.

Other studies have been conducted to assess the effects of SHS on human health. Hahn et al. found a 56% drop in hair nicotine levels in a sample of workers after Lexington implemented a smoke-free law.[13] Workers were also less likely to report colds and sinus infections after the law went into effect. Similarly, Farrelly et al. showed a significant decrease in both salivary cotinine concentrations and sensory symptoms in hospitality workers after New York State implemented a smoke-free law in their worksites.[14]

Conclusions

The findings from this study demonstrate that the Daviess County smoke-free ordinance is protecting only some workers and patrons in hospitality venues and many are still exposed to harmful levels of SHS. Nearly all establishments that allowed smoking by law had levels of indoor air pollution above the National Ambient Air Quality Standard. On average, workers and patrons in Daviess County are exposed to indoor air pollution levels approximately 4.2 times the National Ambient Air Quality Standard. In Daviess County venues not covered by the law, the air pollution is nearly eight times higher than in the smoke-free venues. Further, the fine particle air pollution from secondhand smoke in hospitality venues in Daviess County is significantly higher than in comparable establishments in Lexington and Georgetown that have 100% smoke-free laws. The health of workers and patrons of all ages in Daviess County would greatly benefit from a 100% smoke-free law with no exemptions that completely prohibits smoking in all workplaces and enclosed public places.

References

1. National Toxicology Program. *10th Report on Carcinogens.* Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program, December 2002.
2. United States Department of Health and Human Services. The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General. Atlanta, GA: Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Chronic Disease and Prevention and Promotion, Office of Smoking and Health; 2006.
3. National Cancer Institute. Health Effects of Exposure to Environment Tobacco Smoke. Smoking and Tobacco Control Monograph No. 10 (PDF – 71k). Bethesda, MD: U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute; 1999. NIH Pub. No. 99-4645.

4. U.S. Environmental Protection Agency. Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders. Washington, DC: U.S. Environmental Protection Agency; 1992. Pub. No. EPA/600/6-90/006F.
5. Centers for Disease Control and Prevention. Annual smoking-attributable mortality, years of potential life lost, and economic costs—United States, 1995-1999, MMWR, 2002;51(14):300-320.
6. Centers for Disease Control and Prevention. Second National Report on Human Exposure to Environmental Chemicals: Tobacco Smoke. Atlanta, GA: U.S. Department of Health and Human Services, CDC, National Centre for Environmental Health; 2003:80. NCEH Pub No. 03-0022.
7. Americans for Nonsmokers' Rights. Summary of 100% smokefree state laws and population protected by state and local laws. July 1, 2006. Retrieved August 11, 2006 from http://www.no-smoke.org/pdf/SummaryUSPopList.pdf.
8. Americans for Nonsmokers' Rights. (2006b). Overview list – how many smoke-free laws? July 1, 2006. Retrieved August 11, 2006 from http://www.no-smoke.org/pdf/mediaordlist.pdf.
9. Hahn, E, Lee, K, Okoli, Z, Troutman, A, Powell, R. Smoke-free laws and indoor air pollution in Lexington and Louisville. Louisville Medicine, 2005; 52(10): 391-392.
10. Ott, W, Switzer, P, Robinson, J. Particle concentrations inside a tavern before and after prohibition of smoking: Evaluating the performance of an indoor air quality model. Journal of the Air and Waste Management Association, 1996; 46:1120-1134.
11. Centers for Disease Control and Prevention. Indoor air quality in hospitality venues before and after implementation of a clean indoor air law—Western New York. MMWR, 2004, 53(44); 1038-1041.
12. Hahn, E.J., Lee, K., Peiper, N.C., Troutman, A. Indoor air quality before and after Louisville's smoke-free ordinance. June 20, 2006. Report to the Greater Louisville Medical Society. Available at: http://www.mc.uky.edu/tobaccopolicy/SummaryLouisvilleAQSummary-Final.pdf.
13. Hahn, E, Rayens, M, York, N, Dignan, M, Al-Delaimy, W. Effects of a smoke-free law on hair nicotine and respiratory symptoms of restaurant and bar workers. Journal of Occupational and Environmental Medicine, 2006; 48: 1-7.
14. Farrelly, M, Nonnemaker, J, Chou, R, Hyland, A, Peterson, K, Bauer, U. Change in hospitality workers' exposure to secondhand smoke following the implementation of New York's smoke-free law. Tobacco Control, 2005; 14: 236-241.