Indoor Air Quality in Bowling Green, Kentucky Hospitality Venues, 2008

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Executive Summary

Indoor air quality was assessed in 11 locations in Bowling Green, Kentucky including 6 restaurants, 3 bars and 2 entertainment venues. Fine particulates were measured from January 31 to February 3, 2008, using the TSI SidePak AM510 Personal Aerosol Monitor. The average $PM_{2.5}$ level from the 11 locations was compared to the average $PM_{2.5}$ levels in Lexington and Louisville before and after implementation of their smoke-free laws, as well as the National Ambient Air Quality Standard (NAAQS; 35µg/m^3) for 24 hours.

Key findings of the study are:

- The level of indoor air pollution in hospitality venues measured in Bowling Green (average $PM_{2.5}$ = 166 µg/m^3) was approximately 9.2 times higher than Lexington's post-law and 18 times higher than Louisville after implementation of their comprehensive smoke-free law (see Figure 1). Further, the level of indoor air pollution in Bowling Green hospitality venues was 4.7 times higher than the National Ambient Air Quality Standard for outdoor air.

- The 6 restaurants, 3 bars and 2 entertainment venues had average $PM_{2.5}$ levels ranging from 11 to 613 µg/m^3 (see Figure 2). Air pollution in 9 of the 11 venues exceeded the National Ambient Air Quality Standard for outdoor air.

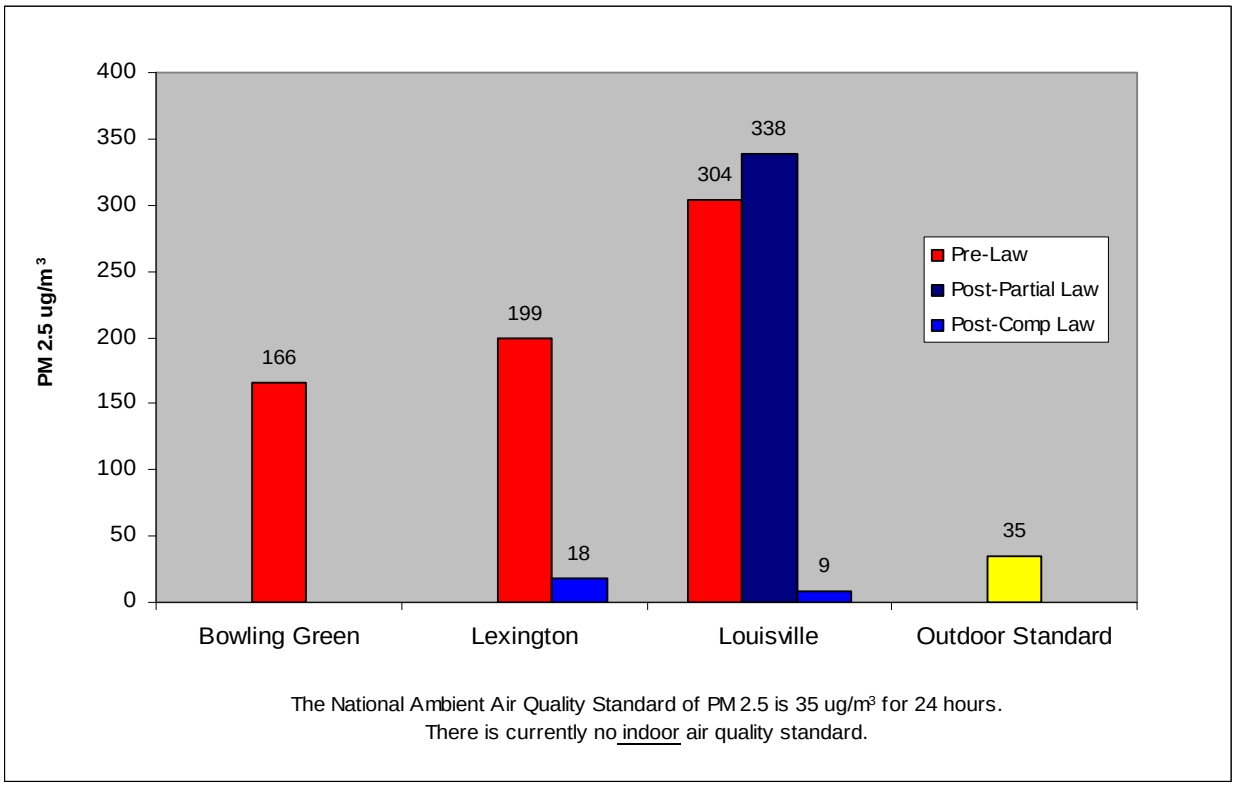

Figure 1. Average fine particle air pollution in three Kentucky communities, pre- and post-law

Introduction

Secondhand smoke (SHS) contains at least 250 chemicals that are known to be toxic.[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 is a cause of heart disease and lung cancer in nonsmoking adults.[1-4] An estimated 3,000 nonsmokers die from lung cancer[5] annually and over 46,000 nonsmokers die from heart disease[2] every year in the U.S due to secondhand smoke exposure. It is estimated that approximately 60% of people in the United States have biological evidence of SHS exposure.[6]

Currently in the U.S., 12,724 local municipalities are covered by either local or state 100% smoke-free laws in workplaces and/or restaurants and/or bars.[7] It is estimated that approximately 64.3% of the U.S. population are protected by clean indoor air regulations that cover virtually all indoor worksites including bars and restaurants. There are 2,791 local ordinances or regulations that restrict smoking to some extent in workplaces across the United States and Washington D.C.[7] The extent of protection provided by these laws vary widely from community to community.

Currently in Kentucky, 16 communities have enacted and implemented smoke-free laws or regulations. The most comprehensive ordinances/regulations, 100% smoke-free workplace *and* 100% smoke-free enclosed public place laws, have been implemented in Georgetown, Morehead, Ashland, Elizabethtown, Hardin County (unincorporated areas), Madison County (Board of Health regulation) and Louisville. The next most comprehensive ordinances, 100% smoke-free enclosed public place laws, have been implemented in Lexington, Letcher County, Frankfort and Paducah. Five communities have enacted partial smoke-free laws, protecting workers and patrons in some public venues: Daviess County, Henderson, Oldham County, Paintsville and Pikeville.

In Louisville, Kentucky, two different types of smoke free laws have been enacted and implemented since 2005. In November 2005, a smoke-free law covering most buildings open to the public but with significant exemptions was implemented in Louisville Metro. In July 2007, Louisville Metro strengthened their ordinance to cover all workplaces and all buildings open to the public.

The purpose of this study was to (a) assess air quality in 11 Bowling Green, Kentucky hospitality venues; and (b) compare the results to Lexington and Louisville, Kentucky air quality data before and after their smoke-free laws took effect.

Methods

Between January 31 and February 3, 2008, indoor air quality was assessed in 11 indoor locations including 6 restaurants, 3 bars and 2 entertainment venues in Bowling Green. Sites were of various sizes; some sites were individually owned establishments and some

TSI SidePak AM510 Personal Aerosol Monitor

were part of local or national chain entities. 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. 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 outdoor and entryway air. The remaining data points were summarized to provide an average $PM_{2.5}$ concentration within each venue. The Kentucky Center for Smoke-free Policy (KCSP) staff trained researchers from various local agencies, 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 6 restaurants, 3 bars and 2 entertainment venues were visited Thursday through Sunday for an average of 64 minutes (range 42-100 minutes). Visits occurred at various times of the day from 12: 41 PM to 11: 05 PM. The average size of the Bowling Green venues was 1,281 m^3 (range 258-4,310 m^3) and the average smoker density was 0.74 #bc/100 $m.^3$ On average, 83 patrons were present per venue and 5.2 burning cigarettes per venue were observed. Descriptive statistics for each venue are summarized in Table 1.

Table 1. Air Quality Data for 11 Venues in Bowling Green, Kentucky, Jan-Feb 2008

Venue	Date Sampled	Size (m^3)	Average # people	Average # burning cigs	Smoker density (#bc/100m^3)	Average $PM_{2.5}$ level
Restaurant A	1/31/2008	258	23	3.4	1.32	86
Restaurant B	2/1/2008	482	57	6.3	1.31	249
Restaurant C	2/1/2008	1650	99	5.3	0.32	228
Restaurant D	2/2/2008	367	24	2.2	0.60	104
Restaurant E	2/2/2008	1357	225	1.1	0.08	11
Restaurant F	2/3/2008	732	41	1.9	0.26	72
Bar A	2/1/2008	382	66	9.1	2.38	613
Bar B	2/2/2008	1173	45	5.6	0.48	189
Bar C	2/2/2008	814	60	8.0	0.98	96
Enter. A	2/2/2008	2565	115	3.2	0.12	19
Enter. B	2/2/2008	4310	159	11.0	0.26	162
Averages		1281	83	5.2	0.74	166

As depicted in Figure 1, the average level of indoor air pollution in the 11 Bowling Green venues (166 µg/m^3) was approximately 9.2 times higher than Lexington's post-law and 18 times higher than Louisville after implementing their comprehensive smoke-free law. Further, the level of indoor air pollution in Bowling Green hospitality venues was 4.7 times higher than the National Ambient Air Quality Standard (35 µg/m^3) for 24 hours.

It is important to note that after a partial smoke-free law was implemented in Louisville, the average $PM_{2.5}$ level rose slightly to 338 µg/m^3 (see Figure 1). Only 3 of the 10 venues were smoke-free as a result of the partial ordinance. After the comprehensive smoke-free law was implemented, the average $PM_{2.5}$ level dropped substantially to 9 µg/m,^{3} with all 10 venues being smoke-free.

Figure 2 shows the average level of indoor air pollution in each of the 11 tested venues. The average $PM_{2.5}$ levels ranged from 11 µg/m^3 to 613 µg/m^3. Air pollution in 9 venues exceeded the National Ambient Air Quality Standard for outdoor air (NAAQS; 35 µg/m^3).

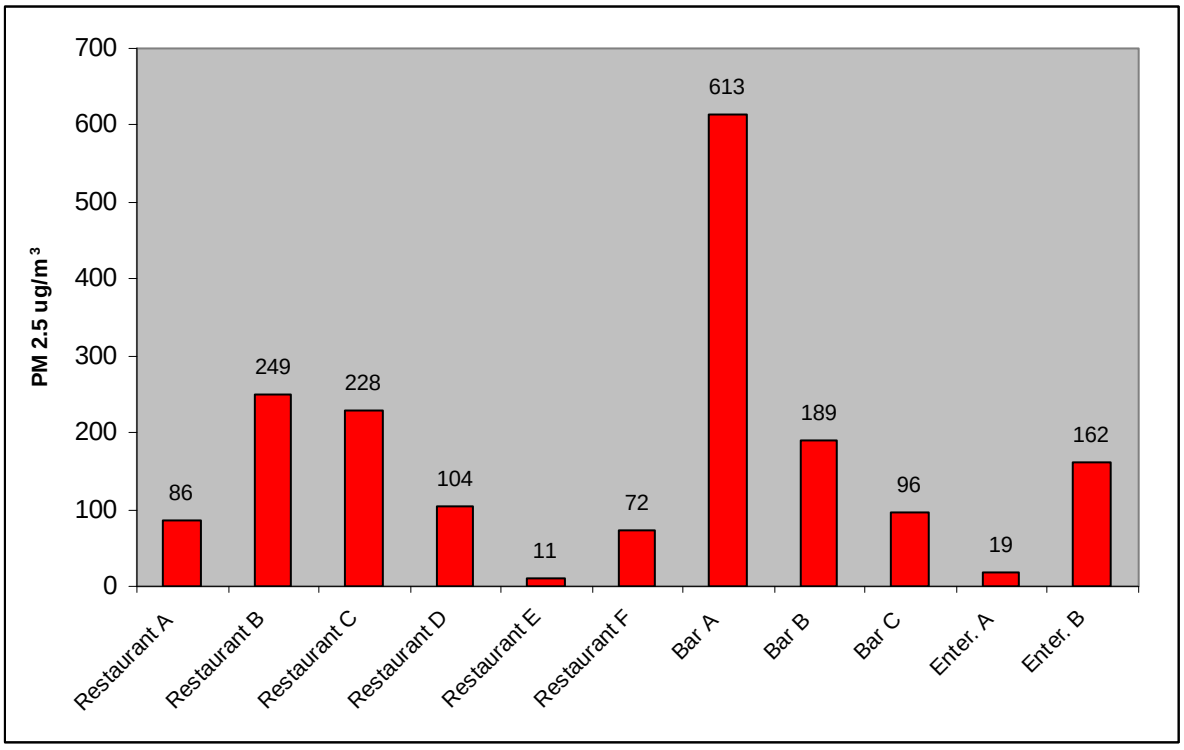

Figure 2. Average indoor fine particle concentration in 11 Bowling Green, Kentucky venues, 2008

Discussion

The average $PM_{2.5}$ level in 11 Bowling Green, Kentucky venues was 166 μg/m,[3]which is 4.7 times higher than the National Ambient Air Quality Standard for outdoor air set by the EPA. There were over 80 EPA cited epidemiologic studies in creating a particulate air pollution standard in 1997.[8] To protect the public's health, the EPA set a new limit of 35 $\mu g/m^3$ on December 17, 2006 as the average level of exposure over 24-hours in *outdoor environments*. There is no EPA standard for indoor air quality.

Two Kentucky air quality studies have demonstrated significant improvements in air quality as a result of implementing a comprehensive smoke-free law. Hahn et al. showed a 91% decrease in indoor air pollution after Lexington, Kentucky implemented a comprehensive smoke-free law on April 27, 2004.[9] The average level of indoor air pollution was 199 $\mu g/m^3$ pre-law and dropped to 18 $\mu g/m^3$ post-law. Average levels of indoor air pollution dropped from 86 $\mu g/m^3$ to 20 $\mu g/m^3$ after Georgetown, Kentucky implemented a comprehensive smoke-free law on October 1, 2005.[10] Similarly, other studies show significant improvements in air quality after implementing a smoke-free law. One California study showed an 82% average decline in air pollution after smoking was prohibited.[11] 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.[12]

Other studies have assessed 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, regardless of whether workers were smokers or nonsmokers.[13] Workers were also less likely to report colds and sinus infections after the law went into effect. Similarly, Farrelly et al. also 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] Smoke-free legislation in Scotland was associated with significant improvements in symptoms, spirometry measurements, and systemic inflammation of bar workers. The significant improvement of respiratory health was reported in only one month after smoke-free law.[15]

There is no longer any doubt in the medical or scientific communities that SHS is a significant public health problem. In 2006, U.S. Surgeon General Carmona, said "The scientific evidence is now indisputable: secondhand smoke is not a mere annoyance. It is a serious health hazard that can lead to disease and premature death in children and nonsmoking adults." [2] SHS causes coronary heart disease, lung cancer, other cancers, and lung disease in nonsmoking adults.

Many millions of Americans, both children and adults, are still exposed to secondhand smoke in their homes and workplaces. Approximately 60% of people in the United States have biological evidence of SHS exposure.[6] U.S. Surgeon General Carmona said, "Eliminating smoking in indoor spaces fully protects nonsmokers from exposure to secondhand smoke. Separating smokers from nonsmokers, cleaning the air, and ventilating buildings cannot eliminate exposure of nonsmokers to secondhand smoke."[2]

Conclusions

This study demonstrated that workers and patrons in Bowling Green hospitality venues are exposed to harmful levels of SHS. On average, workers and patrons in Bowling Green were exposed to indoor air pollution levels approximately 4.7 times the National Ambient Air Quality Standard, and the level of indoor air pollution in these venues was 9.2 times higher than Lexington's post-law and 18 times higher than Louisville's average $PM_{2.5}$ level after implementation of their comprehensive smoke-free law. Partial smoke-free laws do not protect workers and patrons from harmful indoor air pollution. However, when smoking is completely prohibited as with Louisville's comprehensive smoke-free ordinance, air quality is significantly improved.

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