Indoor Air Quality in Boone County Hospitality Venues, October 2007

Ellen J. Hahn, DNS, RN[1]
Kiyoung Lee, ScD, CIH[2]
Heather E. Robertson, MPA[1]
Suzann Vogel, MPA[1]
Seongjik Lee, MS, EdS[1]

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[1]University of Kentucky, College of Nursing
[2]University of Kentucky, College of Public Health, Department of Environmental Health

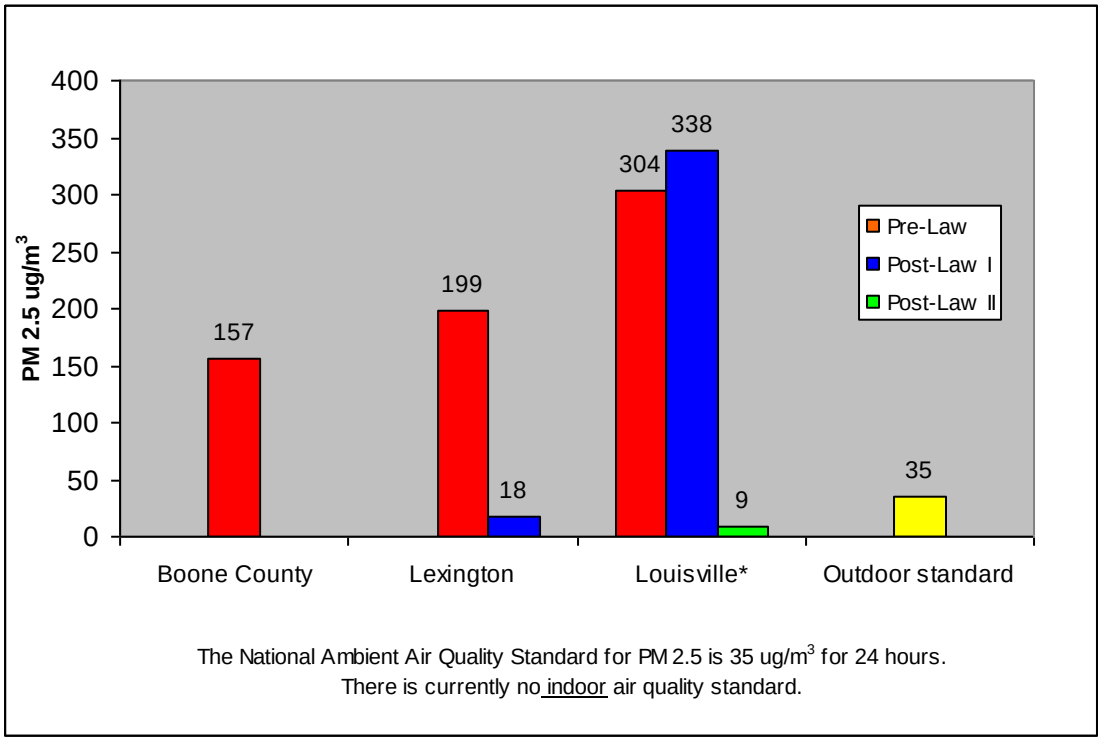
Executive Summary

Indoor air quality was assessed in 20 locations in Boone County, including 11 restaurants and 9 bars. Fine particulates were measured from October 11 to October 13, 2007, using the TSI SidePak AM510 Personal Aerosol Monitor. The average $PM_{2.5}$ level from the 20 locations was compared to the average $PM_{2.5}$ levels in Lexington and Louisville pre- and post-law, 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 Boone County (average $PM_{2.5}$ = 157 µg/m^3) was 8.7 times higher than Lexington's post-law and 17 times higher than Louisville's average $PM_{2.5}$ level post-comprehensive law (see Figure 1). Further, the average $PM_{2.5}$ level in Boone County locations (157 µg/m^3) was nearly 4.5 times higher than the National Ambient Air Quality Standard (NAAQS; 35µg/m^3) for outdoor air.

- The 11 restaurants and 9 bars had average $PM_{2.5}$ levels ranging from 15 to 384 µg/m^3 (see Figure 2). Air pollution in 16 venues exceeded the NAAQS for outdoor air.



Note: Post-Law I in Louisville reflects air quality following implementation of a partial smoke-free law and Post-Law II reflects the results of a comprehensive smoke-free law.

Figure 1. Average fine particle air pollution in three Kentucky communities

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 20 Boone County, 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 October 11 and October 13, 2007, indoor air quality was assessed in 20 indoor locations including 11 restaurants and 9 bars in Boone County. Sites were of various sizes; some sites were individually owned

TSI SidePak AM510 Personal Aerosol Monitor

establishments and some 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 the Northern Kentucky 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 11 restaurants and 9 bars were visited Thursday through Saturday for an average of 45 minutes (range 35-63 minutes). Visits occurred at various times of the day from 6:06 PM to 12: 09 PM. The average size of the Boone County venues was 1520 m^3 (range 357-4119 m^3) and the average smoker density was 0.48 #bc/100 $m.^3$ On average, 59 patrons were present per venue and 5.6 burning cigarettes per venue were observed. Descriptive statistics for each venue are summarized in Table 1.

As depicted in Figure 1, the average level of indoor air pollution in the 20 Boone County venues (157 $\mu g/m^3$) was 8.7 times higher than Lexington's post-law and 17 times higher than Louisville's post-comprehensive law average $PM_{2.5}$ levels (18 and 9 $\mu g/m^3$, respectively). Boone County's average level of indoor air pollution was approximately 4.5 times higher than the National Ambient Air Quality Standard (35 $\mu g/m^3$) 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 $\mu g/m^3$ (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 $\mu g/m,^3$ with all 10 venues being smoke-free.

Table 1. Air Quality Data for 20 Venues in Boone County, Kentucky, October 2007

Venue	Date Sampled	Size (m^3)	Average # people	Average # burning cigs	Smoker density (#bc/100m^3)	Average $PM_{2.5}$ level
Restaurant A	10/11/2007	497	105	1.3	0.26	28
Restaurant B	10/11/2007	1206	282	8.3	0.69	199
Restaurant C	10/11/2007	400	8	0.3	0.08	15
Restaurant D	10/11/2007	1242	13	1.8	0.14	86
Restaurant E	10/12/2007	520	10	0.8	0.15	44
Restaurant F	10/12/2007	3609	13	0.2	0.01	90
Restaurant G	10/13/2007	3061	8	0	0.00	22
Restaurant H	10/13/2007	3263	80	14	0.43	169
Restaurant I	10/13/2007	556	48	0.3	0.05	32
Restaurant J	10/13/2007	850	111	1.2	0.14	45
Restaurant K	10/13/2007	1206	178	2.6	0.22	74
Bar A	10/11/2007	1193	16	3.5	0.29	137
Bar B	10/11/2007	965	18	2	0.21	242
Bar C	10/11/2007	1489	42	14.2	0.95	209
Bar D	10/11/2007	357	26	7	1.96	358
Bar E	10/12/2007	382	26	7.4	1.94	132
Bar F	10/12/2007	1275	32	4.2	0.33	239
Bar G	10/12/2007	1913	50	12	0.63	384
Bar H	10/12/2007	4119	38	12	0.29	349
Bar I	10/13/2007	2296	77	19	0.83	276
Averages	-	1520	59	5.6	0.48	157

Figure 2 shows the average level of indoor air pollution in each of the 20 tested venues. The average $PM_{2.5}$ levels ranged from15 µg/m^3 to 384 µg/$m.^3$ Air pollution in 16 venues exceeded the National Ambient Air Quality Standard for outdoor air (NAAQS; 35 µg/m^3).

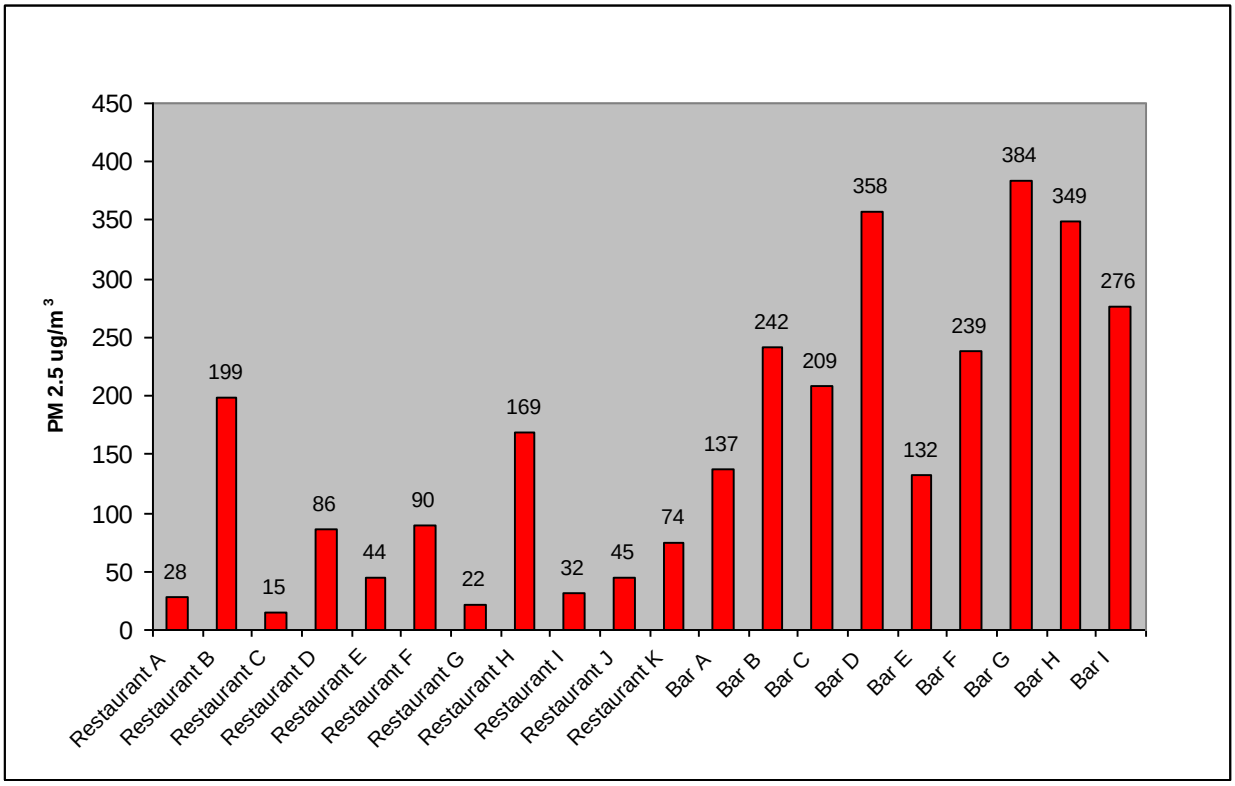


Figure 2. Average indoor fine particle concentration in 20 Boone County, Kentucky venues, October 2007

Discussion

The average $PM_{2.5}$ level in the 20 venues in the Boone County was 157µg/m^3, which was approximately 4.5 times higher than the National Ambient Air Quality Standard for 24 hours (35µg/m^3). 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 µg/m^3 for $PM_{2.5}$ 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 µg/m^3 pre-law and dropped to 18 µg/m^3 post-law. Average levels of indoor air pollution dropped from 86 µg/m^3 to 20 µg/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 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, 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."

Conclusions

This study demonstrated that workers and patrons in Boone County hospitality venues are exposed to harmful levels of SHS. On average, workers and patrons in Boone County were exposed to indoor air pollution levels approximately 4.5 times the National Ambient Air Quality Standard, and the level of indoor air pollution in these venues was 8.7 times higher than Lexington's post-law and 17 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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