

**Indoor Air Quality in Ohio County, Kentucky Public Venues, 2009**

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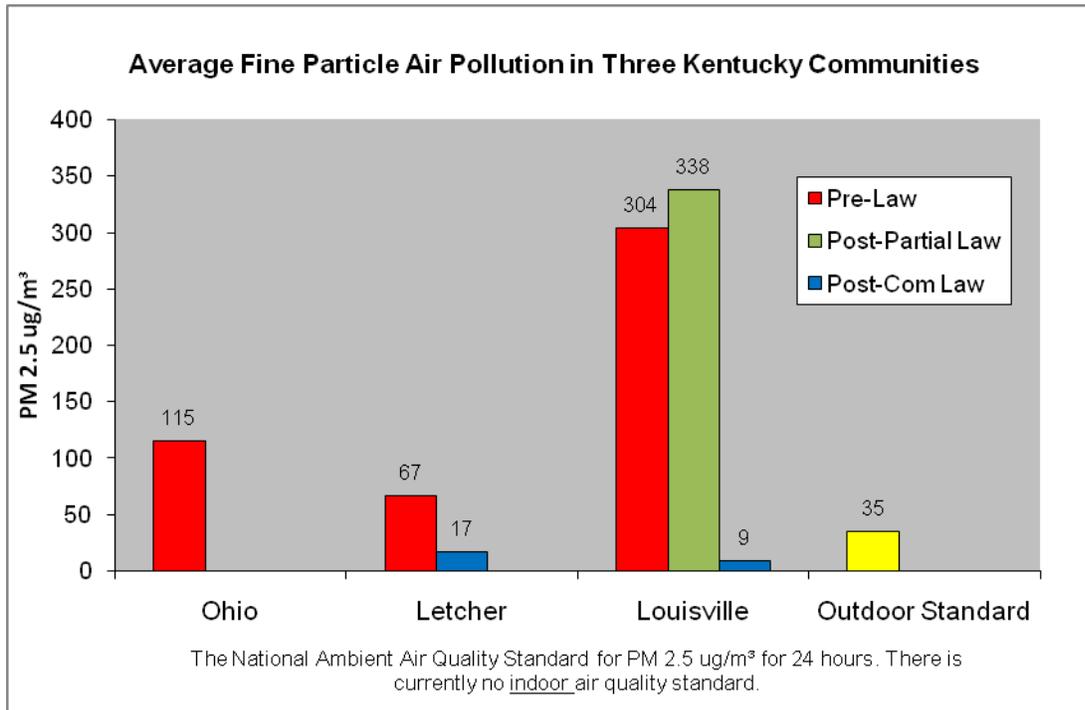
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## Executive Summary

Indoor air quality was assessed in 10 hospitality venues in Ohio County, Kentucky. Fine particulates were measured from May 8 to May 17, 2009, using the TSI SidePak AM510 Personal Aerosol Monitor. The average PM<sub>2.5</sub> level from the 10 locations was compared to the average PM<sub>2.5</sub> levels in Letcher County and Louisville before and after implementation of their smoke-free laws, as well as the National Ambient Air Quality Standard (NAAQS; 35µg/m<sup>3</sup>) for 24 hours.

Key findings of the study are:

- The level of indoor air pollution in hospitality venues measured in Ohio County (average PM<sub>2.5</sub> = 115 µg/m<sup>3</sup>) was approximately 6.8 times higher than Letcher County and 12.8 times higher than Louisville after implementation of their comprehensive smoke-free laws (see Figure 1). Further, the level of indoor air pollution in Ohio County's public venues was 3.3 times higher than the National Ambient Air Quality Standard for *outdoor* air.
- The ten hospitality venues had average PM<sub>2.5</sub> levels ranging from 4 to 369 µg/m<sup>3</sup> (see Figure 2). Air pollution in eight of the 10 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**

*Note: Post-Partial Law in Louisville reflects air quality following implementation of a law covering some venues and Post-Comp Law reflects the results of a comprehensive smoke-free law covering all venues.*

## Introduction

Secondhand smoke (SHS) contains at least 250 chemicals that are known to be toxic.<sup>1,2</sup> There is no safe level of exposure to SHS.<sup>2</sup> SHS exposure is the third leading cause of preventable death in the United States.<sup>3</sup> 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.<sup>1,2,3</sup> SHS exposure is a cause of heart disease and lung cancer in nonsmoking adults.<sup>1-4</sup> An estimated 3,000 nonsmokers die from lung cancer<sup>5</sup> annually and over 46,000 nonsmokers die from heart disease<sup>2</sup> every year in the U.S due to secondhand smoke exposure. It is estimated that 46.4% of people in the United States have biological evidence of SHS exposure.<sup>6</sup>

Currently in the U.S., 17,059 local municipalities are covered by either local or state 100% smoke-free laws in workplaces and/or restaurants and/or bars.<sup>7</sup> It is estimated that approximately 40.3% of the U.S. population is protected by clean indoor air regulations that cover virtually all indoor worksites including bars and restaurants. There are 3,091 local ordinances or regulations that restrict smoking to some extent in workplaces across the United States and Washington D.C.<sup>7</sup> The extent of protection provided by these laws vary widely from community to community.

As of August 17, 2009, 24 Kentucky communities had enacted smoke-free laws or adopted smoke-free regulations. The most comprehensive ordinances/regulations, 100% smoke-free workplace *and* 100% smoke-free enclosed public place laws, have been enacted in 14 communities: Georgetown, Morehead, Ashland, Elizabethtown, Hardin County (unincorporated areas), Madison County (Board of Health regulation), Louisville, Danville, Woodford County (Board of Health regulation), Lexington-Fayette County, Clark County (Board of Health regulation), Campbellsville, London, and Prestonsburg, Kentucky. The next most comprehensive ordinances, 100% smoke-free enclosed public place laws, have been implemented in three communities: Letcher County, Frankfort and Paducah. Seven communities have enacted partial smoke-free laws, protecting workers and patrons in some public venues: Daviess County, Henderson, Oldham County, Paintsville, Pikeville, Beattyville, and Hopkins County.

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 10 Ohio County, Kentucky hospitality venues; and (b) compare the results to Letcher County and Louisville, Kentucky air quality data before and after their smoke-free laws took effect.

## Methods

Between May 8 to May 17, 2009, indoor air quality was assessed in 10 indoor hospitality venues located in Ohio County. Sites were of various sizes; some sites were individually owned 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  $2.5\mu\text{m}$  in micrograms per cubic meter, or  $\text{PM}_{2.5}$ . 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 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  $\text{PM}_{2.5}$  concentration within each venue. The Kentucky Center for Smoke-free Policy (KCSP) staff trained researchers from the Ohio County Smoke-Free Coalition 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  $100\text{ m}^3$ ) were reported for each venue and averaged for all venues.

## Results

The 10 hospitality venues were visited Friday through Sunday for an average of 57 minutes (range 45-69 minutes). Visits occurred at various times of the day from 7:55 AM to 8:34 PM. The average size of the Ohio County venues was  $753\text{ m}^3$  (range  $181\text{-}2551\text{ m}^3$ ) and the average smoker density was  $0.5\text{ #bc}/100\text{ m}^3$ . On average, 24 patrons were present per venue and 1.6 burning cigarettes per venue were observed. Descriptive statistics for each venue are summarized in the Table.

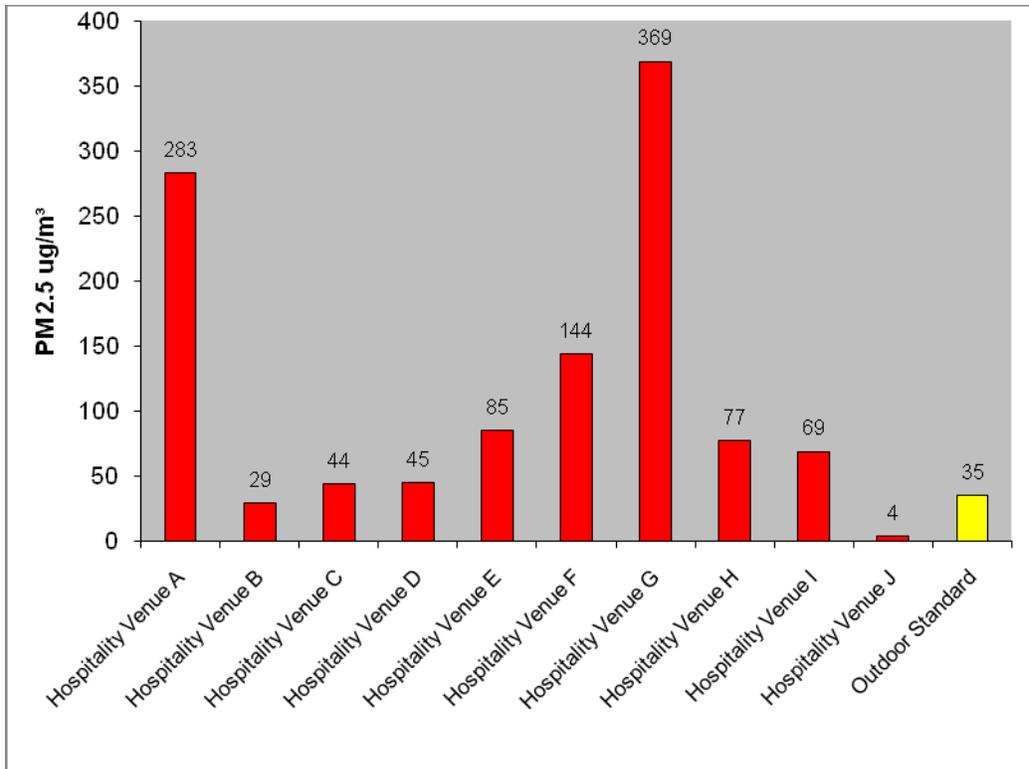
**Table. Air Quality Data for Ten Venues in Ohio County, Kentucky, May 2009**

Venue	Date Sampled	Size (m <sup>3</sup> )	Average # people	Average # burning cigs	Smoker density (#bc/100m <sup>3</sup> )	Average PM <sub>2.5</sub> level
Hospitality Venue A	5/8/2009	381	28	4.4	1.15	283
Hospitality Venue B	5/8/2009	435	21	1.4	0.32	29
Hospitality Venue C	5/15/2009	425	25	1.2	0.28	44
Hospitality Venue D	5/15/2009	425	17	1	0.24	45
Hospitality Venue E	5/15/2009	163	10	1.3	0.96	85
Hospitality Venue F	5/15/2009	2551	36	2.6	0.1	144
Hospitality Venue G	5/16/2009	612	8	1.2	0.2	369
Hospitality Venue H	5/16/2009	181	31	2.8	1.56	77
Hospitality Venue I	5/16/2009	999	24	0.5	0.05	69
Hospitality Venue J	5/17/2009	1358	38	0	0	4
Averages		753	24	1.6	0.5	115

As depicted in Figure 1, the average level of indoor air pollution in the 10 Ohio County venues (115  $\mu\text{g}/\text{m}^3$ ) was approximately 6.8 times higher than Letcher County's post-law and 12.8 times higher than Louisville after implementing their comprehensive smoke-free laws. Further, the level of indoor air pollution in Ohio County hospitality venues was 3.3 times higher than the National *outdoor* Ambient Air Quality Standard (35  $\mu\text{g}/\text{m}^3$ ) for 24 hours.

It is important to note that after a partial smoke-free law was implemented in Louisville, the average PM<sub>2.5</sub> level rose slightly to 338  $\mu\text{g}/\text{m}^3$  (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<sub>2.5</sub> level dropped substantially to 9  $\mu\text{g}/\text{m}^3$ , with all 10 venues being smoke-free.

Figure 2 shows the average level of indoor air pollution in each of the 10 tested Ohio County venues. The average PM<sub>2.5</sub> levels ranged from 4  $\mu\text{g}/\text{m}^3$  to 369  $\mu\text{g}/\text{m}^3$ . Air pollution in eight venues exceeded the National Ambient Air Quality Standard for *outdoor* air (NAAQS; 35  $\mu\text{g}/\text{m}^3$ ).



**Figure 2. Average indoor fine particle concentrations in 10 Ohio County venues, 2009**

## Discussion

The average PM<sub>2.5</sub> level in 10 Ohio County, Kentucky venues was 115 µg/m<sup>3</sup>, which is 3.3 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.<sup>8</sup> To protect the public's health, the EPA set a new limit of 35 µg/m<sup>3</sup> 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.<sup>9</sup> The average level of indoor air pollution was 199 µg/m<sup>3</sup> pre-law and dropped to 18 µg/m<sup>3</sup> post-law. Average levels of indoor air pollution dropped from 86 µg/m<sup>3</sup> to 20 µg/m<sup>3</sup> after Georgetown, Kentucky implemented a comprehensive smoke-free law on October 1, 2005.<sup>10</sup> 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.<sup>11</sup> 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.<sup>12</sup>

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.<sup>13</sup> 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.<sup>14</sup> 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.<sup>15</sup>

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.”<sup>2</sup> 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 46.4% of people in the United States have biological evidence of SHS exposure.<sup>6</sup> 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.”<sup>2</sup>

## Conclusions

This study demonstrated that workers and patrons in Ohio County hospitality venues are exposed to harmful levels of SHS. On average, workers and patrons in Ohio County were exposed to indoor air pollution levels approximately 3.3 times the National Ambient Air Quality Standard, and the level of indoor air pollution in these venues was 6.8 times higher than Letcher’s and 12.8 times higher than Louisville’s average PM<sub>2.5</sub> levels after implementation of their comprehensive smoke-free laws. 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 improves significantly.

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