

**Indoor Air Quality in Floyd County After Implementation of  
Prestonsburg's Smoke-free Ordinance**

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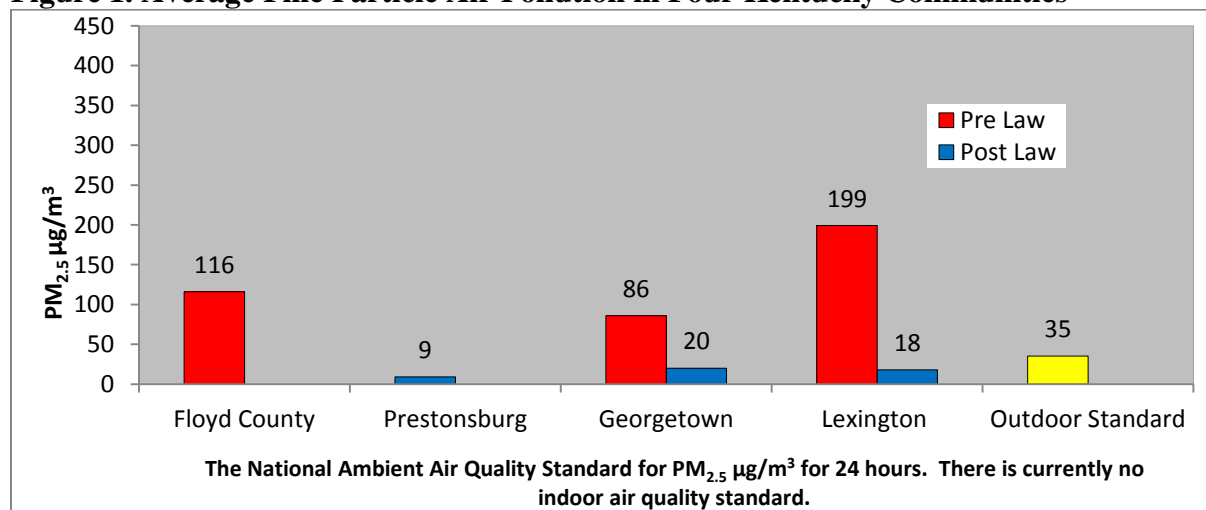
## Executive Summary

Indoor air quality was assessed in 14 locations in Floyd County after the city of Prestonsburg's smoke-free workplace ordinance was implemented on November 1, 2009. Of the 14 venues tested after Prestonsburg's law went into effect, six were located within Prestonsburg city limits, and eight were in Floyd County outside Prestonsburg city limits and not covered by the ordinance. Locations were sampled using the TSI SidePak AM510 Personal Aerosol Monitor from July 12, 2012 to October 18, 2012. We compared the air quality in venues covered by Prestonsburg's law to those located in Floyd County and not covered by the smoke-free law. We also compared Prestonsburg's average PM<sub>2.5</sub> levels to Georgetown and Lexington pre- and post-law and to the National Ambient Air Quality Standard (NAAQS) for 24 hours.

Key findings of the study are:

- The average fine particle air pollution in the six Prestonsburg venues was 9 µg/m<sup>3</sup> and the levels ranged from 5 to 16 µg/m<sup>3</sup>. Fine particle air pollution in all Prestonsburg venues after the smoke-free ordinance was well below the National Ambient Air Quality Standard for *outdoor* air.
- Of the eight venues tested outside Prestonsburg city limits in Floyd County, the average PM<sub>2.5</sub> was 116 µg/m<sup>3</sup>, approximately 12.9 times higher than Prestonsburg, 5.8 times higher than Georgetown, and 6.6 times higher than Lexington after implementation of their smoke-free laws (see Figure 1). Further, the level of indoor air pollution in Floyd County's public venues was 3.3 times higher than the National Ambient Air Quality Standard for *outdoor* air.
- The eight venues tested in Floyd County outside the Prestonsburg city limits had average PM<sub>2.5</sub> levels ranging from 3 to 386 µg/m<sup>3</sup>. Air pollution in 6 of the 8 venues exceeded the National Ambient Air Quality Standard for *outdoor* air.

**Figure 1. Average Fine Particle Air Pollution in Four Kentucky Communities**



*Note.* Data for Floyd County is outside Prestonsburg city limits.

## Introduction

Secondhand smoke (SHS) contains at least 250 chemicals that are known to be toxic.<sup>1</sup> There is no safe level of exposure to SHS.<sup>2,3</sup> SHS damages the DNA, blood vessels, and lung tissue, causing cancer, heart, and lung disease.<sup>3</sup> SHS exposure is the third leading cause of preventable death in the United States.<sup>2</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). An estimated 3,000 nonsmokers die from lung cancer and over 46,000 nonsmokers die from heart disease<sup>2</sup> every year in the U.S due to SHS exposure. It is estimated that 40.1% of nonsmokers in the United States have biological evidence of SHS exposure.<sup>4</sup>

Currently in the U.S., 22,465 local municipalities are covered by either local or state 100% smoke-free laws in workplaces and/or restaurants and/or bars.<sup>5</sup> It is estimated that approximately 48.9% of the U.S. population is protected by clean indoor air regulations that cover virtually all indoor worksites including bars and restaurants. There are 3,671 local ordinances or regulations that restrict smoking to some extent in workplaces across the United States and Washington D.C.<sup>5</sup> The extent of protection provided by these laws varies widely from community to community.

As of January 2, 2013, 35 Kentucky communities had implemented 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 implemented in 21 Kentucky communities: Ashland, Bardstown, Bowling Green, Campbellsville, Clark County (Board of Health regulation), Corbin, Danville, Elizabethtown, Georgetown, Glasgow, Hardin County (unincorporated areas), Lexington-Fayette County, London, Louisville, Madison County (Board of Health regulation), Manchester, Morehead, Prestonsburg, Radcliff, Somerset, and Woodford County (Board of Health regulation). Bullitt County's Board of Health has adopted a comprehensive regulation but it is delayed pending court action (upheld by Kentucky Court of Appeals, 12/7/12). The next most comprehensive ordinances, 100% smoke-free enclosed public place laws, have been implemented in three communities: Frankfort, Letcher County, and Paducah. Eleven communities have enacted partial smoke-free laws, protecting workers and patrons in some public venues: Beattyville, Daviess County, Franklin County, Henderson, Hopkins County, Hopkinsville, Kenton County, Oak Grove, Oldham County, Paintsville, and Pikeville.

The purpose of this study was to (a) assess air quality in Prestonsburg, Kentucky venues after implementation of their comprehensive smoke-free workplace ordinance on November 1, 2009; (b) compare air pollution in Prestonsburg's venues after the smoke-free ordinance to Floyd County venues outside the Prestonsburg city limits which are not covered by the smoke-free ordinance; and (c) compare the results to Georgetown and Lexington, Kentucky air quality data before and after their smoke-free laws took effect. It was hypothesized that the average level of indoor air pollution sampled post-ordinance in Prestonsburg venues would be significantly lower than venues outside the city limits, and lower than the National Ambient Air Quality Standard (NAAQS).

## Methods

Between July 12 and October 18, 2012, indoor air quality was assessed in 14 indoor public venues located in Floyd County. Six venues were tested within the city limits of Prestonsburg after their smoke-free ordinance took effect. Eight venues were tested in Floyd County outside the city limits of Prestonsburg which are not covered by the smoke-free ordinance. Sites were of various sizes; some sites were individually owned establishments and some were part of local or national chains.

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.

Aerosol TSI SidePak AM510 Personal 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 Clean Indoor Air Partnership (CIAP) staff trained researchers from the Floyd County Health Department who conducted the sampling. CIAP analyzed the data.

### 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

Prestonsburg city venues were visited for an average of 59 minutes (range = 48-81 minutes) per venue. Visits occurred at various times of the day from 11:00 AM to 10:00 PM. On average, 27 people were present per venue. Descriptive statistics for the six city venues covered by Prestonsburg's smoke-free ordinance are shown in Table 1.

The remaining eight venues were located in Floyd County outside Prestonsburg city limits and were not covered by a smoke-free ordinance. These venues were visited for an average of 75 minutes per venue (range of 54-139 minutes). On average, 28 people were present per venue.

Descriptive statistics for the eight venues outside city limits and not covered by the smoke-free ordinance are shown in Table 2.

**Table 1. Air quality data for six venues located within Prestonsburg city limits, post-ordinance, July 2012 –October 2012**

Venue	Date Sampled	Size	Average # of People	Average # burning cigs	Smoker density (#bc/100m <sup>3</sup> )	Average PM <sub>2.5</sub> level (µg/m <sup>3</sup> )
Venue E	8/20/12	816	56	0.0	0.00	6
Venue F	8/21/12	520	11	0.0	0.00	7
Venue H	8/23/12	261	20	0.0	0.00	8
Venue I	8/23/12	688	9	0.0	0.00	16
Venue J	8/24/12	294	18	0.0	0.00	9
Venue M	9/17/12	1675	45	0.0	0.00	5
<b>Averages</b>		709	27	0.0	0.00	9

**Table 2. Air Quality Data for Eight Venues in Floyd County Outside Prestonsburg City Limits, July 2012 – October 2012**

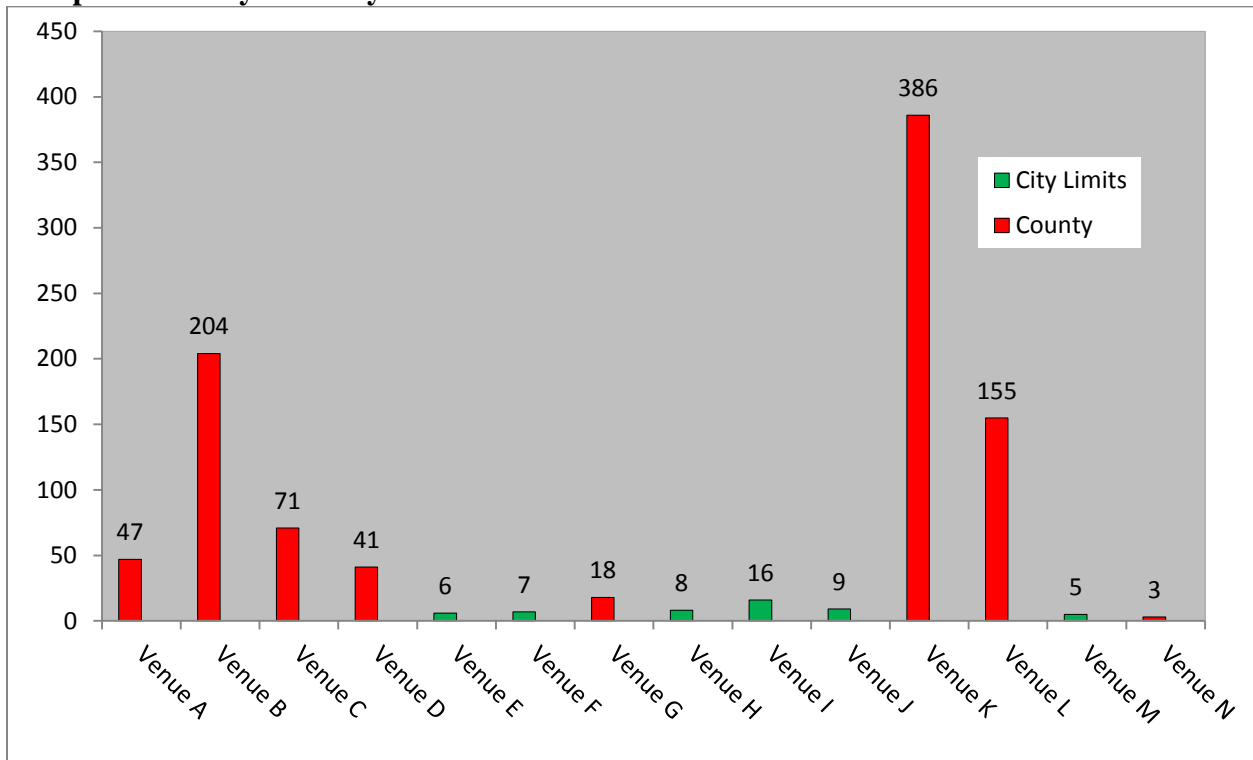
Venue	Date Sampled	Size (m <sup>3</sup> )	Average # people	Average # burning cigs	Smoker density (#bc/100m <sup>3</sup> )	Average PM <sub>2.5</sub> level (µg/m <sup>3</sup> )
Venue A	7/12/2012	251	18	1.6	0.65	47
Venue B	7/13/2012	319	7	0.6	0.18	204
Venue C	7/30/2012	302	16	3.0	0.99	71
Venue D	8/14/2012	255	11	1.0	0.39	41
Venue G	8/22/2012	340	7	0.3	0.08	18
Venue K	8/24/2012	3398	124	89.3	2.63	386
Venue L	9/14/2012	816	26	8.4	1.03	155
Venue N*	10/18/2012	857	12	0.0	0.00	3
<b>Averages</b>		817	28	13.0	0.74	116

\**Note.* Voluntarily smoke-free

As depicted in Figure 1, the average PM<sub>2.5</sub> in the six Prestonsburg venues covered by a smoke-free ordinance was 9 µg/m<sup>3</sup>, well below the National Ambient Air Quality Standard (35µg/m<sup>3</sup>). By contrast, the average level of indoor air pollution outside Prestonsburg city limits in the Floyd County venues (116 µg/m<sup>3</sup>) was approximately 12.9 times higher than Prestonsburg, 5.8 times higher than Georgetown, and 6.6 times higher than Lexington after implementing their smoke-free laws. Further, the level of indoor air pollution in Floyd County public venues was 3.3 times higher than the National Ambient Air Quality Standard (35µg/m<sup>3</sup>) for *outdoor* air for 24 hours.

Figure 2 shows the average level of indoor air pollution in the 6 tested venues in Prestonsburg and the 8 tested venues in Floyd County. The average PM<sub>2.5</sub> levels in the eight Floyd County venues ranged from 3 to 386 µg/m<sup>3</sup> and the average PM<sub>2.5</sub> levels in Prestonsburg ranged from 5 to 16 µg/m<sup>3</sup> post-ordinance. However, air pollution in six of the 8 tested venues in Floyd County exceeded the National Ambient Air Quality Standard for *outdoor* air (NAAQS; 35µg/m<sup>3</sup>).

**Figure 2. Air Pollution in Prestonsburg Post Smoke-free Ordinance by Venue and Location Compared to Floyd County with No Smoke-free Ordinance**



*Note.* Venue N was voluntarily smoke-free

## Discussion

The average PM<sub>2.5</sub> level (9 µg/m<sup>3</sup>) in Prestonsburg was well below the National Ambient Air Quality Standard (35 µg/m<sup>3</sup>) for *outdoor* air set by the EPA. In the Floyd County venues located outside the city limits and not covered by the smoke-free ordinance, the average PM<sub>2.5</sub> was 116 µg/m<sup>3</sup>, 3.3 times higher than the National Ambient Air Quality Standard (35 µg/m<sup>3</sup>). There were over 80 EPA cited epidemiologic studies in creating a particulate air pollution standard in 1997.<sup>6</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.

At least 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 smoke-free law on April 27, 2004.<sup>7</sup> The average level of indoor air pollution was 199 µg/m<sup>3</sup> pre-law and dropped to

18  $\mu\text{g}/\text{m}^3$  post-law. Average levels of indoor air pollution dropped from 86  $\mu\text{g}/\text{m}^3$  to 20  $\mu\text{g}/\text{m}^3$  after Georgetown, Kentucky implemented a comprehensive smoke-free law on October 1, 2005.<sup>8</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>9</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>10</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>11</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>12</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>13</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> In 2010, U.S. Surgeon General Benjamin reported that tobacco smoke causes immediate blood vessel, lung tissue, and DNA damage causing heart disease, lung disease, and cancer.<sup>3</sup>

Many millions of Americans, both children and adults, are still exposed to secondhand smoke in their homes and workplaces. Approximately 40.1% nonsmokers in the United States have biological evidence of SHS exposure.<sup>4</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**

The level of indoor air pollution in Prestonsburg venues post-ordinance was well below the NAAQS and similar to Georgetown and Lexington  $\text{PM}_{2.5}$  levels after implementation of their comprehensive smoke-free laws. These findings show better air quality in the venues covered by Prestonsburg’s smoke-free ordinance, compared to Floyd County venues outside the city limits.

The average level of indoor air pollution in the Floyd County venues outside the Prestonsburg City Limits ( $116\mu\text{g}/\text{m}^3$ ) was approximately 12.9 times higher than Prestonsburg, 5.8 times higher than Georgetown, and 6.6 times higher than Lexington after implementing their smoke-free laws. Further, the level of indoor air pollution in Floyd County public venues was 3.3 times higher than the National Ambient Air Quality Standard ( $35\mu\text{g}/\text{m}^3$ ) for *outdoor* air for 24 hours.

This study demonstrates that Floyd County workers and patrons outside the city limits of Prestonsburg are exposed to harmful levels of SHS. Extending Prestonsburg's smoke-free protections to the entire county (and the entire state) would significantly improve indoor air quality for all workers and patrons.

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