

Indoor Air Quality Before and After Implementation of Letcher County's Smoke-free Ordinance

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Executive Summary

Indoor air quality was assessed in nine venues in Letcher County, KY, including six restaurants, the bingo hall, and two other venues before and after a countywide smoke-free law was implemented on July 1, 2006. Venues were sampled from June 9, 2006 to June 12, 2006 for pre-law air quality measurements and from July 21, 2006 to July 25, 2006 for post-law measurements, using the TSI SidePak AM510 Personal Aerosol Monitor. The average PM_{2.5} levels in Letcher County establishments are compared to the average PM_{2.5} levels in Lexington and Georgetown pre- and post-law. Key findings of the study are:

- Of the nine venues sampled before and after the law, eight (89%) were in compliance with the law. The average PM_{2.5} in the eight compliant venues decreased from 67 µg/m³ before the law to 17 µg/m³ after implementation of the law. **There was a 75% drop in indoor air pollution as a result of compliance with the 100% smoke-free law.**
- After the law took effect, average PM_{2.5} levels in the eight compliant venues ranged from 5 µg/m³ to 46 µg/m³. **The average PM_{2.5} in the eight compliant Letcher County venues post-law (17 µg/m³) was similar to post-law levels in Lexington (18 µg/m³) and Georgetown (20 µg/m³).**
- The bingo hall was the only violator of the smoke-free ordinance. The average PM_{2.5} in the bingo hall was 635 µg/m³ before the law took effect and 249 µg/m³ after the law took effect. **Air pollution in the bingo hall was nearly 15 times higher than in the eight venues that did not allow smoking after the law took effect.**

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 cancer⁵ annually and over 46,000 nonsmokers die from heart disease² every year in the U.S. 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 and/or 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 vary widely from community to community.

Currently in Kentucky, nine 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, Morehead, and Ashland. The next most comprehensive ordinances, 100% smoke-free enclosed public place laws, have been implemented in Lexington, Letcher County, and Frankfort. Henderson, Kentucky has implemented a smoke-free law covering most workplaces and public places. Two communities have enacted partial smoke-free laws, protecting workers and patrons in some public venues: Louisville and Daviess County.

The purpose of this study was to (a) assess air quality in nine Letcher County, Kentucky hospitality and other public venues before and after implementation of their smoke-free law on July 1, 2006; and (b) compare the results to Lexington and Georgetown 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-law in Letcher County venues would be significantly lower than pre-law levels.

Methods

Between June 9, 2006 and June 12, 2006 before the smoke-free law took effect, indoor air quality was assessed in nine indoor venues including six restaurants, one bingo hall, and two other venues in Letcher County. Sites were of various sizes and types; some sites were individually owned establishments and some were national chain establishments. All nine venues allowed smoking before the law went into effect. Between July 21, 2006 and July 25, 2006 after the law took effect, indoor air quality was assessed again in the same nine venues.

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 previously been 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 $\text{PM}_{2.5}$ concentration within the venue. The Kentucky Center for Smoke-free Policy (KCSP) trained volunteers from Letcher County and Staff Associates from the UK Center for Rural Health, who conducted 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

For the first phase (before the smoke-free law), six restaurants, the bingo hall, and two other venues were visited June 9-12, 2006 (Friday, Saturday, Sunday, and Monday) for an average of 48 minutes (range 40-60 minutes) per venue. Visits occurred at various times of the day from 7:12 AM to 8:25 PM. The average size of the Letcher County venues was 2182 m^3 (range $305\text{-}8501\text{ m}^3$). On average, 23 patrons were present per venue and 2.33 burning cigarettes per venue were observed. The smoker density was $0.13\text{ \#bc}/100\text{ m}^3$. Descriptive statistics for each venue is shown in Table 1. The second phase was conducted in the same nine venues assessed 20 days after the countywide smoke-free law took effect. On average, 55 people were present per venue. An average of five burning cigarettes was observed in the bingo hall and the remaining venues did not have any burning cigarettes post-law. The smoker density was $0.05\text{ \#bc}/100\text{ m}^3$ in the bingo hall as shown in Table 2.

Table 1. Air Quality Data for Nine Venues in Letcher County, Kentucky 2006, Pre-Law

Venue	Date Sampled	Average # people	Average # burning cigs	Smoker density (#bc/100m ³)	Average PM2.5 level
Restaurant A	6/10/2006	11	0	0	2
Restaurant B	6/10/2006	14	0.6	0.07	37
Restaurant C	6/10/2006	48	0.7	0.01	77
Restaurant D	6/11/2006	9	1.8	0.47	84
Restaurant E	6/11/2006	25	0	0	28
Restaurant F	6/12/2006	8	0	0	10
Other Venue A	6/11/2006	6	1.4	0.41	22
Other Venue B	6/12/2006	4	0.8	0.04	278
Bingo Hall	6/10/2006	86	15.7	0.18	635

Table 2. Air Quality Data for Nine Venues in Letcher County, Kentucky 2006, Post-Law

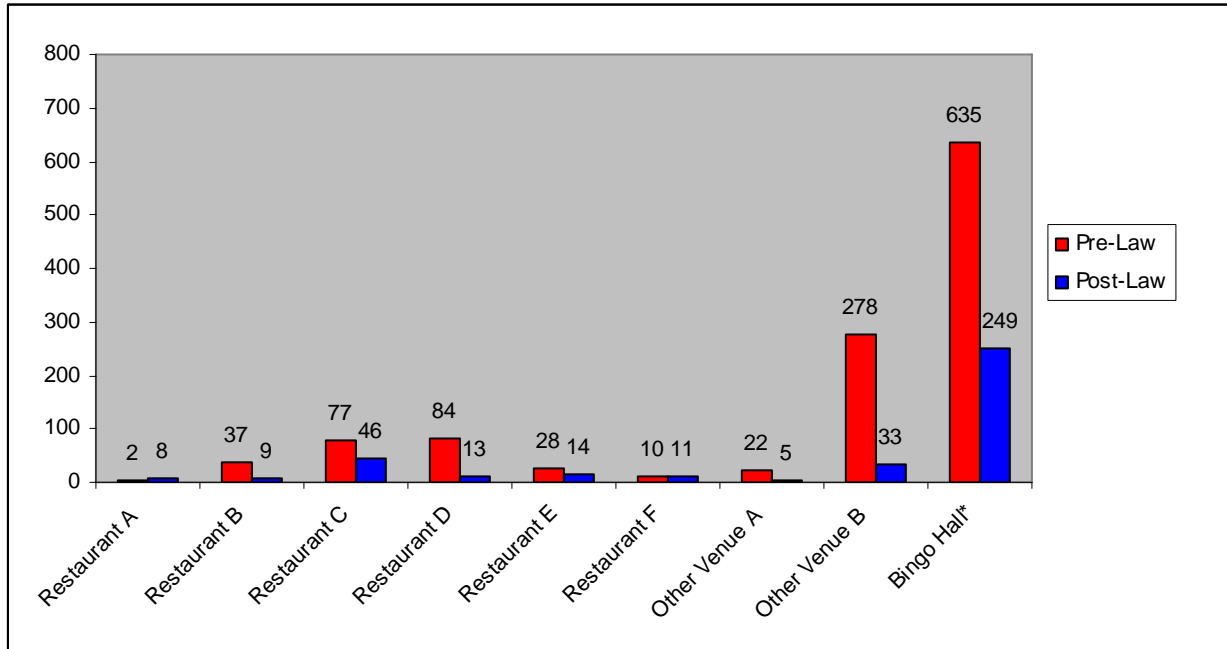
Venue	Date Sampled	Average # people	Average # burning cigs	Smoker density (#bc/100m ³)	Average PM2.5 level
Restaurant A	7/22/2006	19	0	0	8
Restaurant B	7/22/2006	15	0	0	9
Restaurant C	7/21/2006	110	0	0	46
Restaurant D	7/23/2006	28	0	0	13
Restaurant E	7/23/2006	28	0	0	14
Restaurant F	7/24/2006	8	0	0	11
Other Venue A	7/23/2006	7	0	0	5
Other Venue B	7/25/2006	80	0	0	33
Bingo Hall	7/21/2006	198	5	0.05	249

Figure 1 shows the average level of indoor air pollution in each of the nine sampled venues from pre- to post-law. After the law took effect, the bingo hall (249 $\mu\text{g}/\text{m}^3$) continued to allow smoking. For the eight compliant venues, the average PM_{2.5} levels ranged from 2 $\mu\text{g}/\text{m}^3$ to 278 $\mu\text{g}/\text{m}^3$ pre-law and from 5 to 46 $\mu\text{g}/\text{m}^3$ post-law.

Figure 2 shows that there was a 75% reduction in fine particle air pollution from pre-law (67 $\mu\text{g}/\text{m}^3$) to post-law (17 $\mu\text{g}/\text{m}^3$) in the eight Letcher County venues that were complying with the law.

Figure 3 shows that air pollution in the bingo hall was nearly 15 times higher than in the eight venues that did not allow smoking after the law took effect.

Figure 1



* Note: The Bingo Hall was in violation of the law at the post-law period.

Figure 2

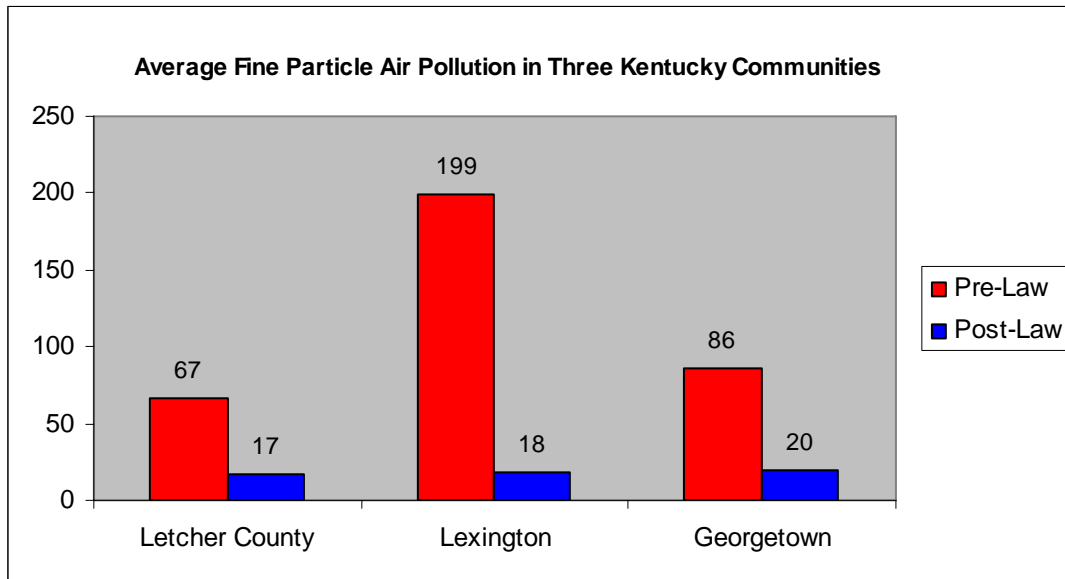
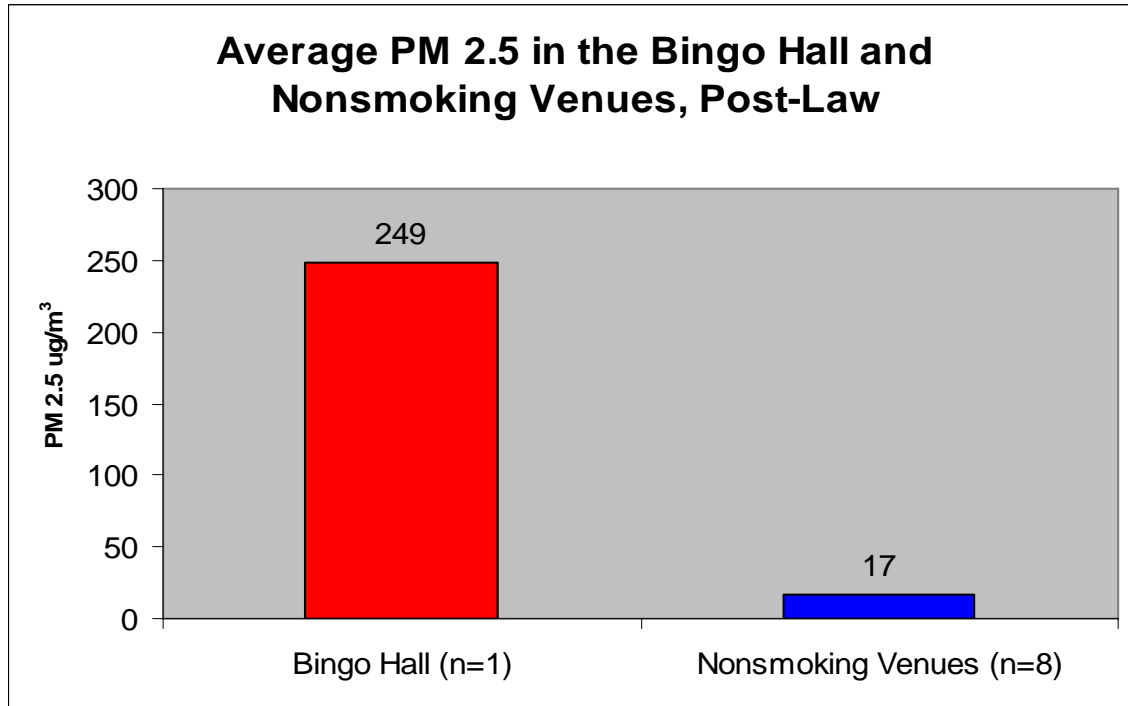


Figure 3



Discussion

The average PM_{2.5} levels in eight Letcher County, Kentucky hospitality and other public venues decreased 75% as a result of compliance with the smoke-free law, from 67 $\mu\text{g}/\text{m}^3$ to 17 $\mu\text{g}/\text{m}^3$.³ The dramatic decline in air pollution in Letcher County as a result of compliance with the smoke-free law is similar to the declines observed in the Lexington and Georgetown. The bingo hall did not comply with the law, and air pollution was nearly 15 times higher than in the nonsmoking venues.

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 $\mu\text{g}/\text{m}^3$ pre-law and dropped to 18 $\mu\text{g}/\text{m}^3$ post-law. Similarly, 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 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 $\mu\text{g}/\text{m}^3$, even though 3 of the 10 venues sampled were smoke-free as a result of the ordinance.¹² In Louisville, bars and many restaurants are exempt and enclosed smoking rooms are allowed.

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 hospitality 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 Letcher County smoke-free ordinance is protecting workers and patrons in hospitality and other public venues. However, the bingo hall was in violation of the law and people who visit and work there are still exposed to harmful levels of SHS. The reduction in air pollution in compliant Letcher County venues was similar to declines in Lexington and Georgetown after their 100% smoke-free laws were implemented. The health of all workers and patrons in Letcher County would greatly benefit from adequate enforcement of the smoke-free law in the bingo hall.

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