

Indoor Air Quality in Bullitt County, Kentucky Public Venues, 2010

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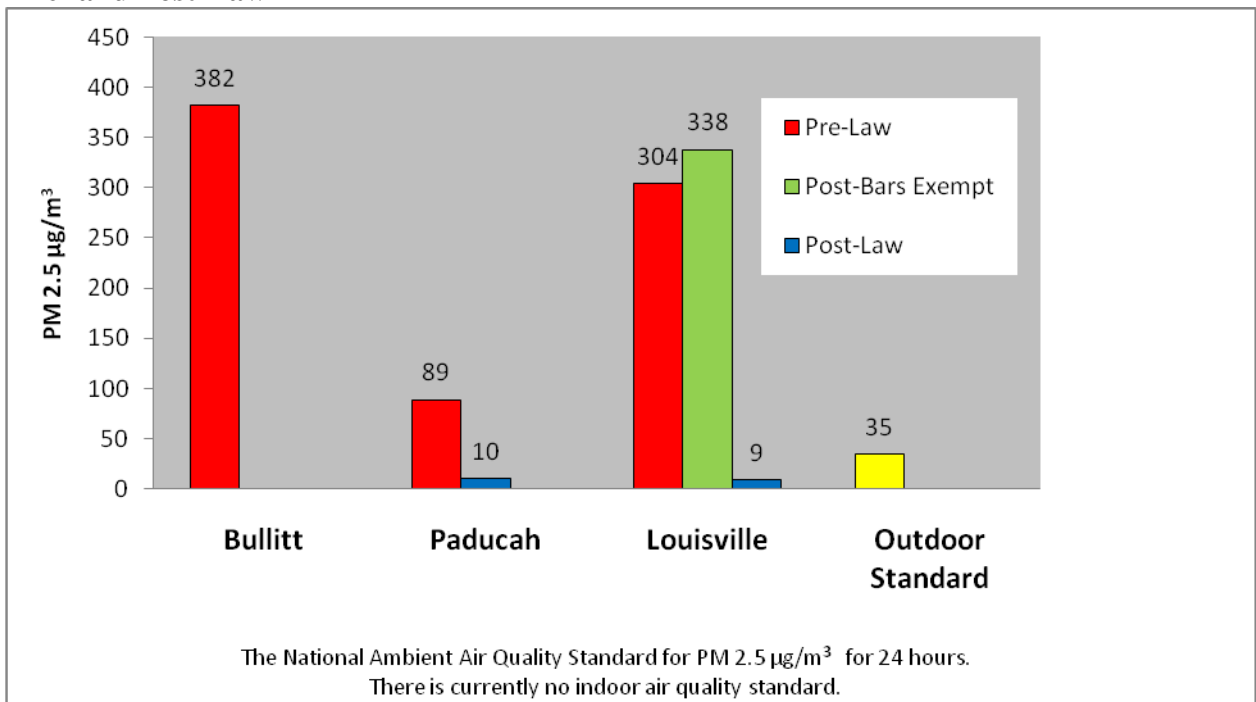
Executive Summary

Indoor air quality was assessed in eleven hospitality venues in Bullitt County, Kentucky. Fine particulates were measured from January 22 to February 27, 2010, using the TSI SidePak AM510 Personal Aerosol Monitor. The average PM_{2.5} level from the eleven locations was compared to the average PM_{2.5} levels in Paducah and Louisville before and after implementation of their smoke-free laws, as well as the outdoor National Ambient Air Quality Standard (NAAQS; 35µg/m³) for 24 hours.

Key findings of the study are:

- The level of indoor air pollution in hospitality venues measured in Bullitt County (average PM_{2.5} = 382 µg/m³) was approximately 38.2 times higher than Paducah and 42.3 times higher than Louisville after implementation of their comprehensive smoke-free laws (see Figure 1). Further, the level of indoor air pollution in Bullitt County's public venues was 10.9 times higher than the National Ambient Air Quality Standard for *outdoor* air.
- The eleven hospitality venues had average PM_{2.5} levels ranging from 59 to 1640 µg/m³ (see Figure 2). Air pollution in all eleven 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. After the Louisville law was changed to cover all workplaces including bars, the air quality improved dramatically.

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 due to secondhand smoke exposure. It is estimated that 46.4% of people in the United States have biological evidence of SHS exposure.⁶

Currently in the U.S., 17,628 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 41.0% of the U.S. population is protected by clean indoor air regulations that cover virtually all indoor worksites including bars and restaurants. There are 3,117 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.

As of June 1, 2010, 27 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 17 communities: Ashland, Bardstown, Campbellsville, Clark County (Board of Health regulation), Danville, Elizabethtown, Georgetown, Glasgow, Hardin County (unincorporated areas), Lexington-Fayette County, London, Louisville, Madison County (Board of Health regulation), Morehead, Prestonsburg, Radcliff, and Woodford County (Board of Health regulation), Kentucky. The next most comprehensive ordinances, 100% smoke-free enclosed public place laws, have been implemented in three communities: Frankfort, Letcher County, and Paducah. Seven communities have enacted partial smoke-free laws, protecting workers and patrons in some public venues: Beattyville, Daviess County, Henderson, Hopkins County, 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 (i.e., venues serving a certain amount of alcohol) was implemented in Louisville Metro. In July 2007, Louisville Metro strengthened their ordinance to cover all workplaces (including bars) and all buildings open to the public.

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

Methods

Between January 22 and February 27, 2010, indoor air quality was assessed in eleven indoor hospitality venues located in Bullitt 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 Bullitt County Smoke-Free 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 eleven hospitality venues were visited Friday through Saturday for an average of 72.2 minutes (range 43-229 minutes). Visits occurred at various times of the day from 12:06 PM to 12:25 AM. The average size of the Bullitt County venues was 1085 m^3 (range $350\text{--}2000\text{ m}^3$) and the average smoker density was $1.6/100\text{ m}^3$. On average, 82 patrons were present per venue and 16.3 burning cigarettes per venue were observed. Descriptive statistics for each venue are summarized in Table 1.

Table 1. Air Quality Data for Eleven Venues in Bullitt County, Kentucky, January – February 2010

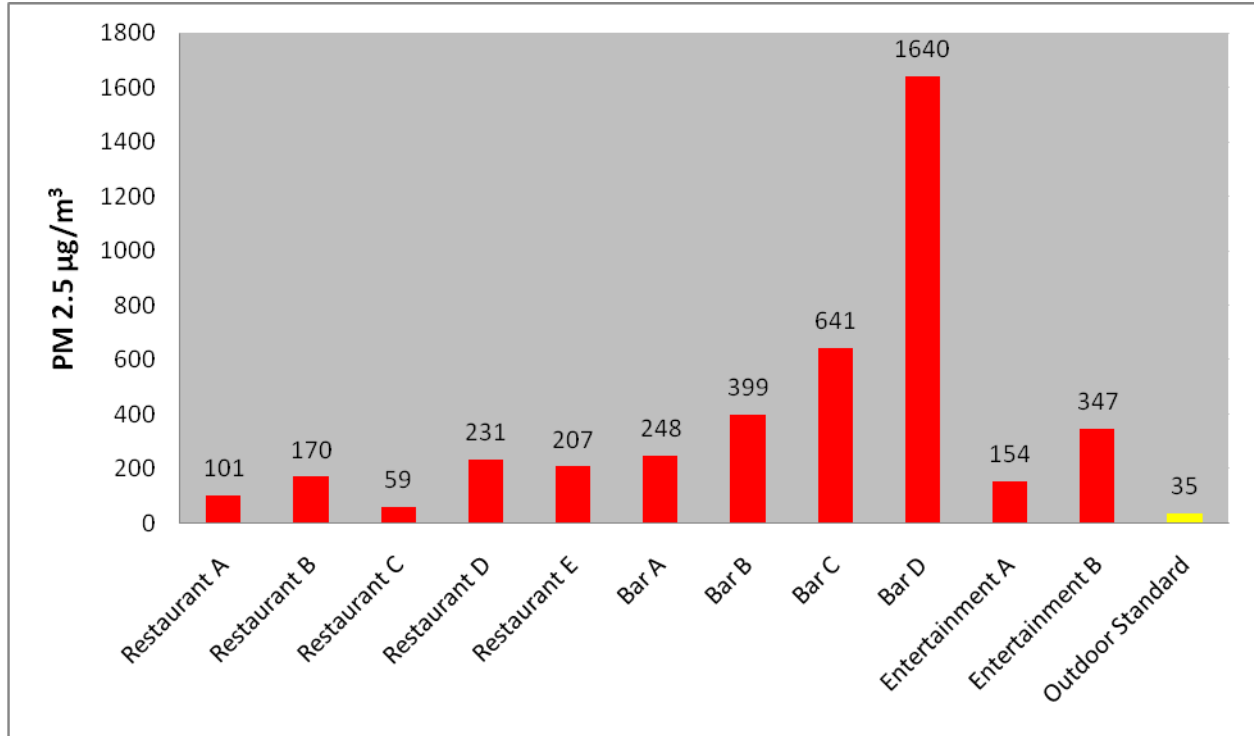
Venue	Date Sampled	Size (m ³)	Average # people	Average # burning cigs	Smoker density (#bc/100m ³)	Average PM _{2.5} level
Restaurant A	1/22/2010	1826	24	1.8	0.10	101
Restaurant B	1/23/2010	571	69	1.8	0.32	170
Restaurant C	2/21/2010	1772	49	4.8	0.27	59
Restaurant D	2/27/2010	546	75	6.6	1.21	231
Restaurant E	2/27/2010	219	21	3.2	1.46	207
Bar A	1/22/2010	464	48	5.1	1.10	248
Bar B	1/23/2010	350	73	10	2.86	399
Bar C	1/23/2010	1244	54	9.5	0.76	641
Bar D	1/23/2010	1225	282	118.8	9.70	1640
Entertainment A	1/23/2010	983	134	4	0.41	154
Entertainment B	1/26/2010	2000	78	13.3	0.67	347
Averages		1018	82	16.3	1.71	382

As depicted in Figure 1, the average level of indoor air pollution in the 11 Bullitt County venues (382µg/m³) was approximately 38.2 times higher than Paducah’s post-law and 42.3 times higher than Louisville after implementing their comprehensive smoke-free law. Further, the level of indoor air pollution in Bullitt County public venues was 10.9 times higher than the National *outdoor* Ambient Air Quality Standard (35 µg/m³) 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 338µg/m³ (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 9µg/m³, with all 10 venues being smoke-free.

Figure 2 shows the average level of indoor air pollution in each of the eleven tested venues. The average PM_{2.5} levels ranged from 59µg/m³ to 1640µg/m³. Air pollution in all eleven venues exceeded the National Ambient Air Quality Standard for *outdoor* air (NAAQS; 35µg/m³).

Figure 2. Average Indoor Fine Particle Concentration in Eleven Bullitt County Venues, 2010



Discussion

The average PM_{2.5} level in eleven Bullitt County, Kentucky venues was 382 $\mu\text{g}/\text{m}^3$, which is 10.9 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 $\mu\text{g}/\text{m}^3$ 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 $\mu\text{g}/\text{m}^3$ 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, 2005.¹⁰ 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 46.4% 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 Bullitt County public venues are exposed to harmful levels of SHS. On average, workers and patrons in Bullitt County were exposed to indoor air pollution levels approximately 10.9 times the National Ambient Air Quality Standard, and the level of indoor air pollution in these venues was 38.2 times higher than Paducah and 42.3 times higher than Louisville’s average PM_{2.5} levels after implementation of their comprehensive smoke-free laws. It is important to note that four of the 11 Bullitt County venues (40%) had PM_{2.5} levels that were 10 times higher than NAAQS. 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 significantly improves.

References

1. National Toxicology Program. *10th Report on Carcinogens*. Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program, December 2002.
2. United States Department of Health and Human Services. *The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General*. Atlanta, GA: Department of Health and Human Services, Public Health Service, Centers for Disease Control

and Prevention, National Center for Chronic Disease and Prevention and Promotion, Office of Smoking and Health; 2006.

3. National Cancer Institute. *Health Effects of Exposure to Environment Tobacco Smoke*. Smoking and Tobacco Control Monograph No. 10 (PDF – 71k). Bethesda, MD: U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute; 1999. NIH Pub. No. 99-4645.

4. U.S. Environmental Protection Agency. *Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders*. Washington, DC: U.S. Environmental Protection Agency; 1992. Pub. No. EPA/600/6-90/006F.

5. Centers for Disease Control and Prevention. Annual smoking-attributable mortality, years of potential life lost, and economic costs—United States, 1995-1999, *MMWR*, 2002;51(14):300-320.

6. Centers for Disease Control and Prevention. Disparities in Secondhand Smoke Exposure -- United States, 1988-1994 and 1999-2004, *MMWR*, 2008; 57(27): 744-747.

7. Americans for Nonsmokers' Rights. *Overview list: How many smoke-free laws*. April 1, 2010. Retrieved April 26, 2010 from <http://no-smoke.org/pdf/mediaordlist.pdf>.

8 U.S. Environmental Protection Agency. National Ambient Air Quality Standards for Particulate Matter; Final Rule. *Federal Register* 1997; 62(138): 38651-38701.

9. Hahn, E, Lee, K, Okoli, Z, Troutman, A, Powell, R. Smoke-free Laws and Indoor Air Pollution in Lexington and Louisville. *Louisville Medicine* 2005; 52(10): 391-392.

10. Lee, K., Hahn, E.J., Riker, C., Head, S. Seithers, P. Immediate impact of smoke-free laws on indoor air quality. *Southern Medical Journal* 2007; 100(9): 885-889.

11. Ott, W, Switzer, P, Robinson, J. Particle concentrations inside a tavern before and after prohibition of smoking: Evaluating the performance of an indoor air quality model. *Journal of the Air Waste Management Association* 1996; 46:1120-1134.

12. Centers for Disease Control and Prevention. Indoor air quality in hospitality venues before and after implementation of a clean indoor air law—Western New York, *MMWR*, 2003, November 12, 2004, 53(44); 1038-1041.

13. Hahn, E.J., Rayens, M.K., York, N., Okoli, C.T.C., Zhang, M., Dignan, M., Al-Delaimy, W.K. Effects of a smoke-free law on hair nicotine and respiratory symptoms of restaurant and bar workers. *Journal of Occupational and Environmental Medicine*, 2006; 48(9): 906-913

14. Farrelly, M, Nonnemaker, J, Chou, R, Hyland, A, Peterson, K, Bauer, U. Change in hospitality workers' exposure to secondhand smoke following the implementation of New York's smoke-free law. *Tobacco Control* 2005; 14: 236-241.

15. Menzies, D, Nair, A, Williamson, P, Schembri, S, Al-Khairalla, M, Barnes, M, Fardon, T, McFarlane, L, Magee, G, Lipworth, B. Respiratory symptoms, pulmonary function, and markers of inflammation among bar workers before and after a legislative ban on smoking in public places. *JAMA*. 2006; 296: 1742-1748.