Indoor Air Quality in Pulaski County's Hospitality and Entertainment Venues

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Executive Summary

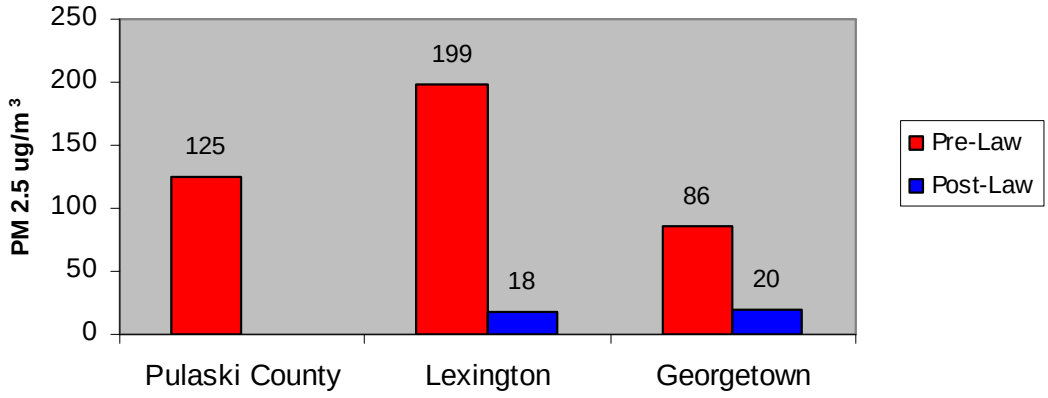
Indoor air quality was assessed in six locations in Pulaski County, Kentucky, including four restaurants, the bingo hall, and one other entertainment venue. Locations were sampled from January 19, 2007 to January 26, 2007, using the TSI SidePak AM510 Personal Aerosol Monitor. The average $PM_{2.5}$ level from all six locations is compared to the average $PM_{2.5}$ levels in Lexington and Georgetown, Kentucky 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 Pulaski County as measured by average $PM_{2.5}$ was more than 6 times higher than Lexington and Georgetown's post-law average $PM_{2.5}$ levels (see Figure 1). The data also suggest that average air pollution in the Pulaski County locations (125 µg/m^3) was approximately 3.6 times higher than the National Ambient Air Quality Standard for outdoor air.

- The average $PM_{2.5}$ levels ranged from 32 to 379 µg/m^3 in the sampled Pulaski County venues. Air pollution in five of the six venues met or exceeded the National Ambient Air Quality Standard for outdoor air.

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. It is estimated that approximately 60% of people in the United States have biological evidence of SHS exposure.[6]

Currently in the U.S., 570 local municipalities and 21 states plus the District of Columbia have enacted 100% smoke-free laws in workplaces and/or restaurants and/or bars.[7] It is estimated that approximately 52.9% 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, 11 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, Ashland, and Elizabethtown. The next most comprehensive ordinances, 100% smoke-free enclosed public place laws, have been implemented in Lexington, Letcher County, and Frankfort. Four communities have enacted partial smoke-free laws, protecting workers and patrons in some public venues: Louisville, Daviess County, Paintsville, and Henderson.

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

Methods

Between January 19 and January 26, 2007, indoor air quality was assessed in six indoor locations including restaurants, the bingo hall, and an entertainment venue in Pulaski County, Kentucky. 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

TSI SidePak AM510 Personal Aerosol Monitor

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 outdoors and entryway air. The remaining data points were averaged to provide an average $PM_{2.5}$ concentration within each venue. The Kentucky Center for Smoke-free Policy (KCSP) staff trained researchers from the Pulaski County Medical Society, 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

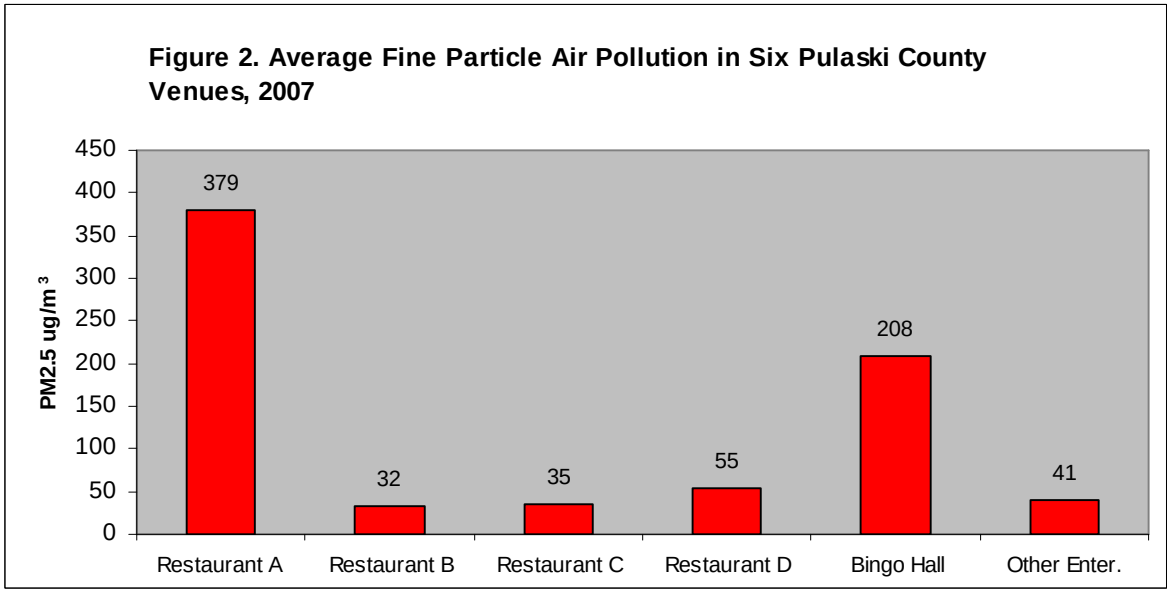
The four restaurants, one bingo hall, and one other entertainment venue were visited Wednesday through Saturday for an average of 59 minutes (range 47-68 minutes). Visits occurred at various times of the day from 11:13AM to 7:54 PM. The average size of the Pulaski County venues was 1777 m^3 (range 133-6732 m^3) and the smoker density was 0.36 #bc/100 m^3. On average, 48 patrons were present per venue and 4.9 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 six Pulaski County venues (125 μg/m^3) was more than 6 times higher than Lexington and Georgetown's post-law average $PM_{2.5}$ levels (18 and 20 μg/m^3, respectively). Pulaski County's average level of indoor air pollution was approximately 3.6 times the National Ambient Air Quality Standard (35 μg/m^3).

Table 1. Air Quality Data for Six Venues in Pulaski County, Kentucky 2007

Venue	Date Sampled	Size (m^3)	Average # people	Average # burning cigs	Smoker density (#bc/100m^3)	Average PM2.5 level
Restaurant A	1/19/2007	294	30	4	1.36	379
Restaurant B	1/24/2007	990	56	0.5	0.05	32
Restaurant C	1/26/2007	133	9	0.3	0.22	35
Restaurant D	1/26/2007	390	14	0.6	0.15	55
Bingo Hall	1/25/2007	6732	155	23	0.34	208
Other Enter.	1/26/2007	2125	29	1.2	0.05	41

Figure 2 shows the average level of indoor air pollution in each of the six tested venues. The average $PM_{2.5}$ levels ranged from 32 µg/m^3 to 379 µg/m^3. Restaurant B and C showed average levels at or below the National Ambient Air Quality Standard (NAAQS; 35 µg/m^3). The remaining venues were well above the National Ambient Air Quality Standard. Restaurant A and the Bingo Hall had average $PM_{2.5}$ levels that were 10.8 and 5.9 times higher than the NAAQS.



Discussion

The average $PM_{2.5}$ level in the six venues in Pulaski County, Kentucky was 125 µg/m^3, approximately 3.5 times higher than the National Ambient Air Quality Standard for outdoor air (35µg/m^3). There were over 80 EPA cited epidemiologic studies in creating a particulate air pollution standard in 1997.[9] To protect the public's health, the EPA will 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.

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.[10] 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. 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]

The body of literature showing SHS's negative effects is compelling. Surgeon General Carmona, vice admiral of the U.S. Public Health Service 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." SHS has been shown to cause cancer and is associated with an increased risk for lung cancer and coronary heart disease in nonsmoking adults. Approximately 60% of people in the United States have biological evidence of SHS exposure.[16]

Conclusions

This study demonstrated that workers and patrons in Pulaski County are exposed to harmful levels of SHS. On average, workers and patrons in Pulaski County were exposed to indoor air pollution levels approximately 3.6 times the National Ambient Air Quality Standard, and more than 6 times higher than Lexington and Georgetown's post-law average $PM_{2.5}$ level (18 and 20 $\mu g/m^3$, respectively).

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. *Second National Report on Human Exposure to Environmental Chemicals: Tobacco Smoke*. Atlanta, GA: U.S. Department of Health and Human Services, CDC, National Centre for Environmental Health; 2003:80. NCEH Pub No. 03-0022.

7. Americans for Nonsmokers' Rights. *Summary of 100% smokefree state laws and population protected by state and local laws.* January 12, 2007. Retrieved March 13, 2007 from http://www.no-smoke.org/pdf/SummaryUSPopList.pdf.

8. Americans for Nonsmokers' Rights. (2006b). *Overview list – how many smoke-free laws?* July 1, 2006. Retrieved August 11, 2006 from http://www.no-smoke.org/pdf/mediaordlist.pdf.

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

10. 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.

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. *J Air Wast Manag Assoc* 1996; 46:1120-1134.

12. Morbidity and Mortality Weekly Report, Indoor Air Quality in Hospitality Venues Before and After implementation of a Clean Indoor Air Law—Western New York, 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. (2006). Effects of a smoke-free law on hair nicotine and respiratory symptoms of restaurant and bar workers. *Journal of Occupational and Environmental Medicine*, 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.

16. CDC. *Second National Report on Human Exposure to Environmental Chemicals: Tobacco Smoke*. Atlanta, GA: U.S. Department of Health and Human Services, CDC, National Centre for Environmental Health; 2003:80. NCEH Pub No. 03-0022.