Indoor Air Quality in Pike County, Kentucky Workplaces, 2014

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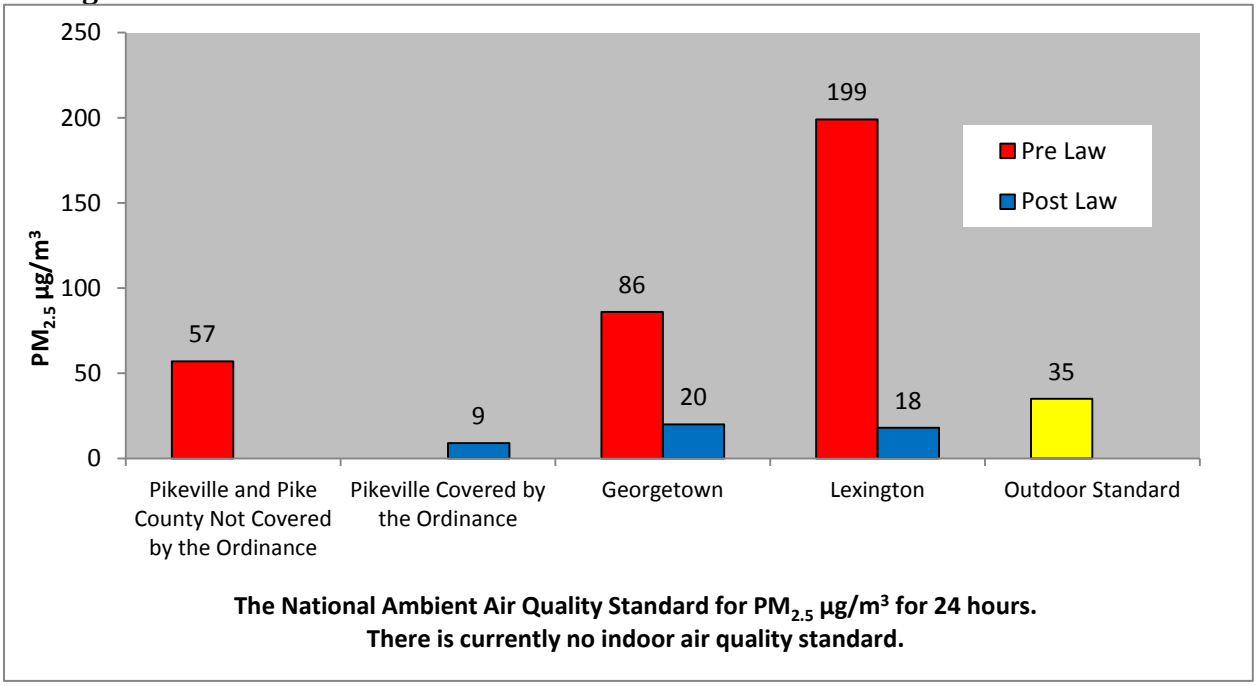
Executive Summary

Indoor air quality was assessed in 15 workplaces in Pike County, Kentucky, 7 years after Pikeville's partial smoke-free ordinance was passed on October 9, 2007. Of the 15 workplaces tested, five were located within Pikeville city limits and were covered by the ordinance, and 10 were either exempt or not covered by the ordinance (five within city limits and 5 in the county outside Pikeville city limits). Fine particulates were measured from June 5 to July 17, 2014, using the TSI SidePak AM510 Personal Aerosol Monitor. The average $PM_{2.5}$ level from the 15 workplaces in Pike County was compared to the average $PM_{2.5}$ levels in Georgetown and Lexington, Kentucky before and after implementation of their smoke-free laws, as well as the outdoor National Ambient Air Quality Standard (NAAQS; 35µg/m^3) for 24 hours.

Key findings of the study are:

- The level of indoor air pollution measured in the five workplaces covered by Pikeville's ordinance was well below the National Ambient Air Quality Standard for *outdoor* air (average $PM_{2.5}$ = 9 µg/m^3).
- The level of indoor air pollution measured in the 10 workplaces exempt or *not* covered by the smoke-free ordinance in Pikeville (average $PM_{2.5}$ = 57 µg/m^3) was approximately 6.3 times higher than workplaces covered by Pikeville's ordinance, 2.6 times higher than Georgetown, 3.2 times higher than Lexington after implementation of their smoke-free laws, and 1.6 times higher than the National Ambient Air Quality Standard for *outdoor* air (see Figure 1). The 10 workplaces *not* covered by Pikeville's ordinance had average $PM_{2.5}$ levels ranging from 4 to 155 µg/m^3. Air pollution in 3 of the 10 workplaces exceeded the National Ambient Air Quality Standard for *outdoor* air.

Figure 1. Average Fine Particle Air Pollution in Pike County compared to Georgetown and Lexington



Introduction

Secondhand smoke (SHS) contains at least 250 chemicals that are known to be toxic.[1] There is no safe level of exposure to SHS.[2,3] SHS damages the DNA, blood vessels, and lung tissue, causing cancer, heart and lung disease,[3] and stroke.[4] SHS exposure is the third leading cause of preventable death in the United States.[2] 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 7,333 U.S. adults died from lung cancer and an estimated 33,951 from heart disease in 2006[5] due to SHS exposure. It is estimated that 40.1% of nonsmokers in the United States have biological evidence of SHS exposure.[6]

Currently in the U.S., 22,536 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 49.3% of the U.S. population is protected by clean indoor air regulations that cover virtually all indoor worksites including bars and restaurants. There are 4,177 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 varies widely from community to community.

As of January 1, 2015, 41 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 23 Kentucky communities: Ashland, Bardstown, Berea, Bowling Green, Campbellsville, Corbin, Danville, Elizabethtown, Georgetown, Glasgow, Hardin County (unincorporated areas), Lexington-Fayette County, London, Louisville, Manchester, Midway, Morehead, Prestonsburg, Radcliff, Richmond, Somerset, Versailles, Williamsburg, and Woodford County. The next most comprehensive ordinances, 100% smoke-free enclosed public place laws, have been implemented in three communities: Frankfort, Letcher County, and Paducah. Fourteen communities have enacted partial smoke-free laws, protecting workers and patrons in some workplaces: Beattyville, Daviess County, Elkhorn City, Franklin County, Henderson, Hopkins County, Hopkinsville, Kenton County, Mayfield, Oak Grove, Oldham County, Owensboro, Paintsville, and Pikeville.

The purpose of this study was to (a) assess air quality in workplaces covered by Pikeville's partial smoke-free ordinance; (b) compare the results to workplaces exempt or *not* covered by the Pikeville ordinance as well as in Pike County workplaces located outside the city limits; and (c) compare the results to Georgetown and Lexington, Kentucky air quality data before and after their smoke-free laws took effect.

Methods

Between June 5 and July 17, 2014, indoor air quality was assessed in 15 indoor workplaces located in Pike County, Kentucky. Of the 15 workplaces tested, five were located within Pikeville city limits and were covered by the smoke-free ordinance, and 10 were either exempt or *not* covered

TSI SidePak AM510 Personal Aerosol Monitor

by the ordinance (five within city limits and 5 in the county outside Pikeville city limits). Of the 15 workplaces, 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 2.5μm 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. 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 $PM_{2.5}$ concentration within each venue. The Kentucky Center for Smoke-free Policy (KCSP) staff trained local data collectors who did the sampling and sent the data to KCSP for analysis. Sampling was discreet in order not to disturb the occupants' normal behavior.

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 workplaces by group.

Results

Workplaces covered by the city ordinance were visited Monday through Saturday for an average of 50 minutes (range 42-74 minutes). Visits occurred at various times of the day from 11:35 to 7:43 PM. The average size of the workplaces was 540 m^3 (range 163-796 m^3) and the average smoker density was 0.00/100 m^3. On average, 24 patrons were present per workplace and 0.0 burning cigarettes per workplace were observed. Descriptive statistics for the five workplaces covered by the Pikeville ordinance are summarized in Table 1.

Workplaces that were either exempt or *not* covered by the smoke-free ordinance were visited for an average of 55 minutes (range 44-63 minutes). The average size of the workplaces was 896 m^3 (range 169-3,151 m^3) and the average smoker density was 0.08/100 m^3. On average, 30 patrons were present per workplace, and 1.7 burning cigarettes per workplace were observed. Descriptive statistics for the ten workplaces *not* covered by the ordinance in Pikeville are summarized in Table 2.

Table 1. Air quality data for five workplaces located within Pikeville city limits and covered by the smoke-free ordinance, June 2014–July 2014

Workplace	Date Sampled	Size (m^3)	Average # people	Average # burning cigs	Smoker density (#bc/100m^3)	Average $PM_{2.5}$ levels (µg/m^3)
Workplace A	6/5/14	796	39	0.0	0.0	8
Workplace B	6/7/14	733	18	0.0	0.0	4
Workplace C	6/7/14	214	13	0.0	0.0	5
Workplace D	6/12/14	163	8	0.0	0.0	4
Workplace E	6/6/14	795	40	0.0	0.0	23
Averages		540	24	0.0	0.0	9

Table 2. Air quality data for 10 workplaces in Pike County exempt or *not* covered by the Pikeville smoke-free ordinance, June 2014–July 2014

Workplace	Date Sampled	Size (m^3)	Average # people	Average # burning cigs	Smoker density (#bc/100m^3)	Average $PM_{2.5}$ levels (µg/m^3)
Workplace F	7/17/14	3151	20	0.6	0.02	137
Workplace G	6/16/14	472	13	0.3	0.07	29
Workplace H	6/17/14	447	16	0.2	0.04	34
Workplace I	6/24/14	257	7	0.0	0.00	155
Workplace J	6/20/14	2886	75	15.8	0.55	130
Workplace K*	6/9/14	701	149	0.0	0.00	28
Workplace L*	6/26/14	219	9	0.2	0.08	17
Workplace M*	6/26/14	185	4	0.0	0.00	31
Workplace N*	6/20/14	471	4	0.0	0.00	4
Workplace O*	6/20/14	169	4	0.0	0.00	4
Averages		896	30	1.7	0.08	57

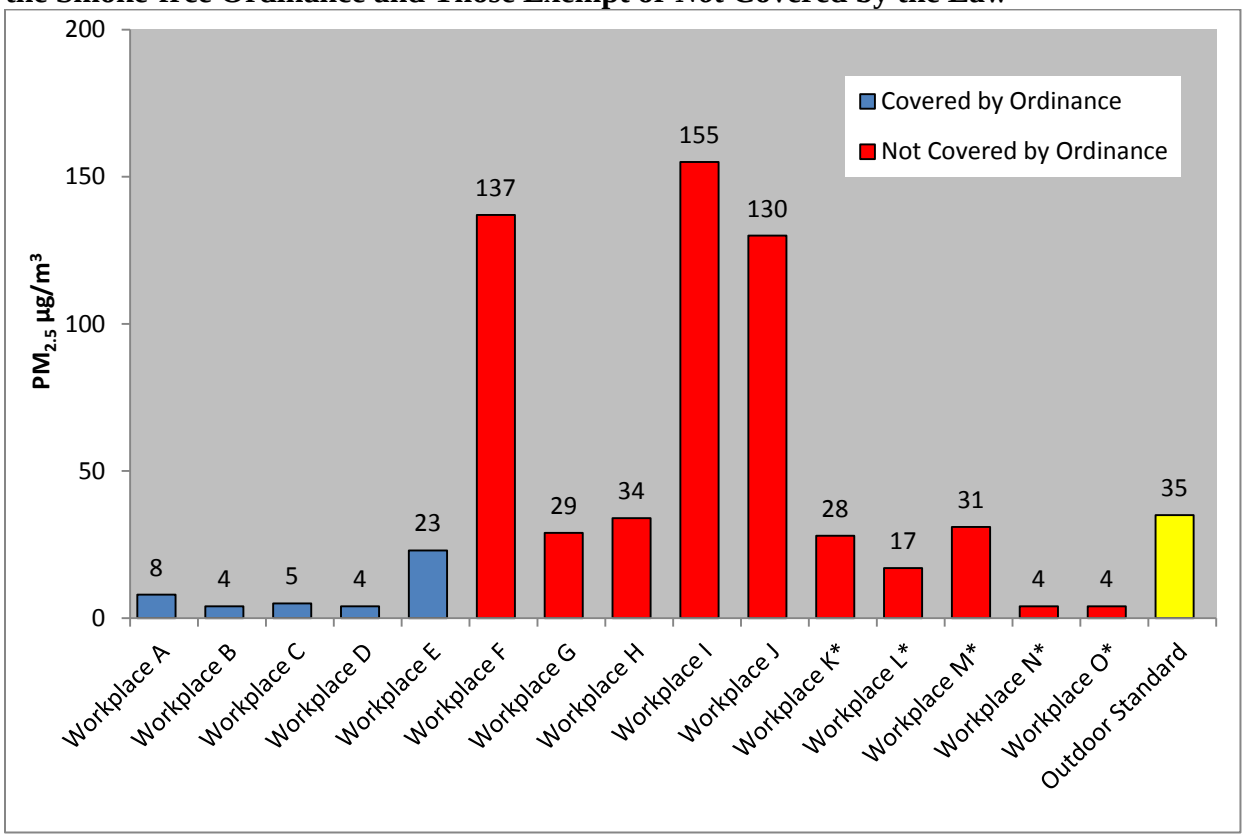
**Workplaces were located in Pike County outside Pikeville city limits*

As depicted in Figure 1, the average $PM_{2.5}$ level of indoor air pollution measured in the five workplaces covered by the smoke-free ordinance in Pikeville was 9 µg/m^3. By contrast, the average $PM_{2.5}$ level of indoor air pollution measured in the 10 workplaces exempt or *not* covered by the ordinance (average $PM_{2.5}$ = 57 µg/m^3) was approximately 6.3 times higher than workplaces in Pikeville that are covered by the ordinance, 2.6 times higher than Georgetown and 3.2 times higher than Lexington after implementation of their smoke-free laws. Further, the level of indoor air pollution in Pikeville workplaces that are exempt or not covered by the ordinance

was 1.6 times higher than the National Ambient Air Quality Standard (35µg/m^3) for *outdoor* air for 24 hours.

Figure 2 shows the average level of indoor air pollution in each of the 15 tested workplaces in Pike County. The average $PM_{2.5}$ levels in the five workplaces covered by the ordinance in Pikeville ranged from 4 to 23 µg/m;[3] the average $PM_{2.5}$ levels in the 10 workplaces exempt or *not* covered by the ordinance ranged from 4 to 155 µg/m^3. Air pollution in three of the10 workplaces *not* covered by the smoke-free ordinance within Pikeville city limits exceeded the National Ambient Air Quality Standard for *outdoor* air (NAAQS; 35µg/m^3).

Figure 2. Average Indoor Fine Particle Concentration in Pikeville Workplaces Covered by the Smoke-free Ordinance and Those Exempt or *Not* Covered by the Law



**Workplaces located in Pike County outside Pikeville city limits*

Discussion

The average $PM_{2.5}$ level in the five workplaces covered by the Pikeville ordinance was 9 µg/m^3. The average $PM_{2.5}$ level of indoor air pollution measured in the 10 workplaces exempt or *not* covered by the ordinance was 57 µg/m,[3] 1.6 times higher than the National Ambient Air Quality Standard (NAAQS) 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 µg/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.

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.[9] The average level of indoor air pollution was 199 $\mu g/m^3$ pre-law and dropped to 18 $\mu g/m^3$ post-law. Average levels of indoor air pollution dropped from 86 $\mu g/m^3$ to 20 $\mu g/m^3$ 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] Tobacco smoke causes immediate blood vessel, lung tissue, and DNA damage, causing heart disease, lung disease, cancer,[3] and stroke.[4]

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.[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] The 2014 Surgeon General's report recommends that comprehensive smoke-free indoor protections be extended to the entire U.S. population.[4]

Conclusions

This study demonstrated that many workers and patrons in Pike County workplaces remain exposed to harmful levels of SHS despite Pikeville's partial smoke-free ordinance. The level of indoor air pollution in Pikeville workplaces that are covered by the smoke-free ordinance are well below the NAAQS and similar to Georgetown and Lexington $PM_{2.5}$ levels after implementation of their comprehensive smoke-free laws. These findings show better air quality in the workplaces covered by Pikeville's smoke-free ordinance, compared to those that are exempt or *not* covered by the ordinance.

On average, workers and patrons in the 10 workplaces exempt or *not* covered by the smoke-free ordinance are exposed to indoor air pollution levels approximately 1.6 times higher than the National Ambient Air Quality Standard for *outdoor* air, 6.3 times higher than workplaces covered by Pikeville's ordinance, 2.6 times higher than Georgetown and 3.2 times higher than Lexington after implementation of their smoke-free laws. When smoking is completely prohibited, air quality significantly improves for all workers and patrons.

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