Indoor Air Quality in Caldwell County, Kentucky Public Venues, 2013-2014

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Executive Summary

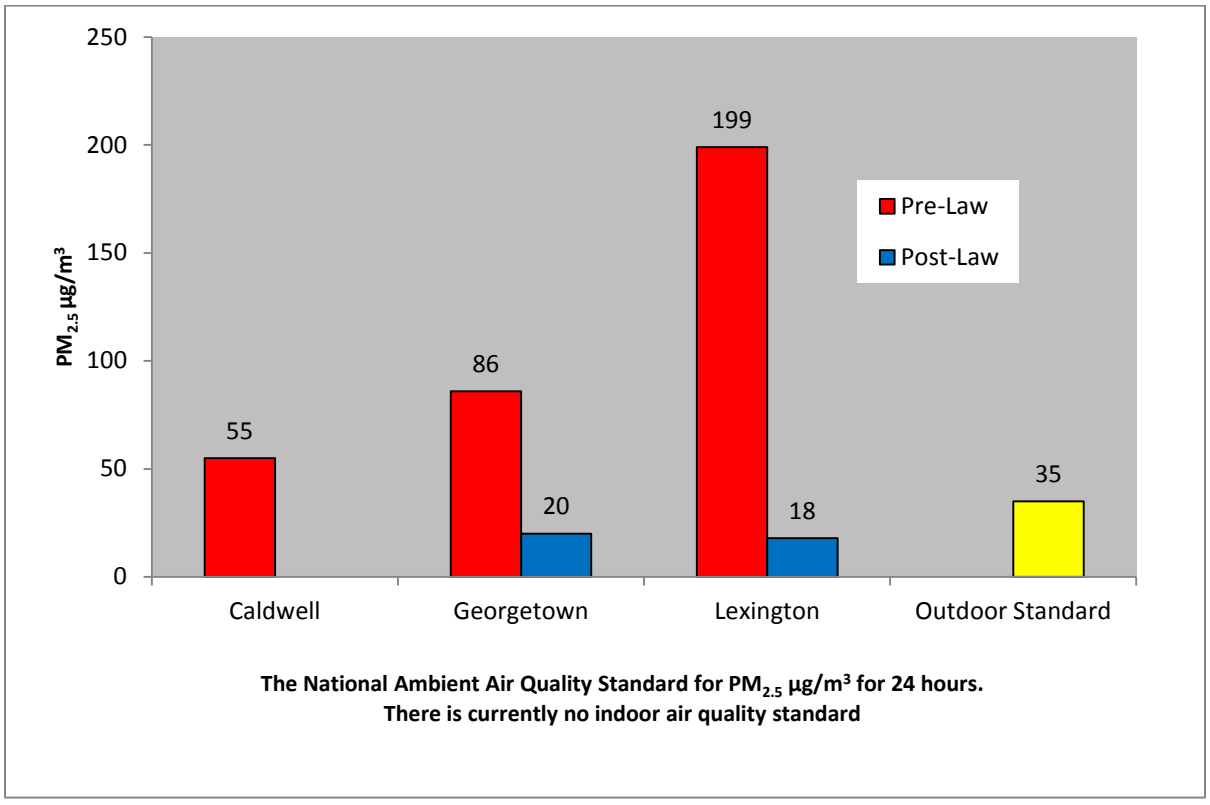
Indoor air quality was assessed in six workplaces in Caldwell County, Kentucky. Fine particulates were measured from November 21, 2013 to April 3, 2014, using the TSI SidePak AM510 Personal Aerosol Monitor. The average $PM_{2.5}$ level from the six workplaces was compared to the average $PM_{2.5}$ levels 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 in workplaces measured in Caldwell County (average $PM_{2.5}$ = 55 µg/m^3) was approximately 2.8 times higher than Georgetown and 3.1 times higher than Lexington after implementation of their smoke-free laws (see Figure 1). Further, the level of indoor air pollution in Caldwell County workplaces was 1.6 times higher than the National Ambient Air Quality Standard for *outdoor* air.

- The six workplaces had average $PM_{2.5}$ levels ranging from 12 to 200 µg/m^3 (see Figure 2). Air pollution in three of the six workplaces was equal to or 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



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., 22,504 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 49.1% of the U.S. population is protected by clean indoor air regulations that cover virtually all indoor worksites including bars and restaurants. There are 3,997 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 July 1, 2014, 35 Kentucky communities had implemented smoke-free laws or regulations. The most comprehensive ordinances/regulations, 100% smoke-free workplace and 100% smoke-free enclosed public place laws, have been implemented in 19 Kentucky communities: Ashland, Bardstown, Bowling Green, Campbellsville, Corbin, Danville, Elizabethtown, Georgetown, Glasgow, Hardin County (unincorporated areas), Lexington-Fayette County, London, Louisville, Manchester, Morehead, Prestonsburg, Radcliff, Somerset, and Williamsburg. The next most comprehensive ordinances, 100% smoke-free enclosed public place laws, have been implemented in three communities: Frankfort, Letcher County, and Paducah. Thirteen 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, Paintsville, and Pikeville.

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

Methods

Between November 21, 2013 and April 3, 2014, indoor air quality was assessed in six indoor workplaces located in Caldwell County, Kentucky. Of the six workplaces, sites were of various sizes; some sites were individually owned establishments and some were part of local or national chains.

TSI SidePak AM510 Personal Aerosol Monitor

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 researchers from the Pennyrile District Health Department 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.

Results

The workplaces were visited Monday through Friday for an average of 56 minutes (range 52-63 minutes). Visits occurred at various times of the day from 7:00 AM to 1:00 PM. The average size of the Caldwell County workplaces was 723 m^3 (range 340-1,019 m^3) and the average smoker density was 0.13/100 m^3. On average, 14 patrons were present per workplace and 0.8 burning cigarettes per workplace were observed. Descriptive statistics for each workplace are summarized in the Table.

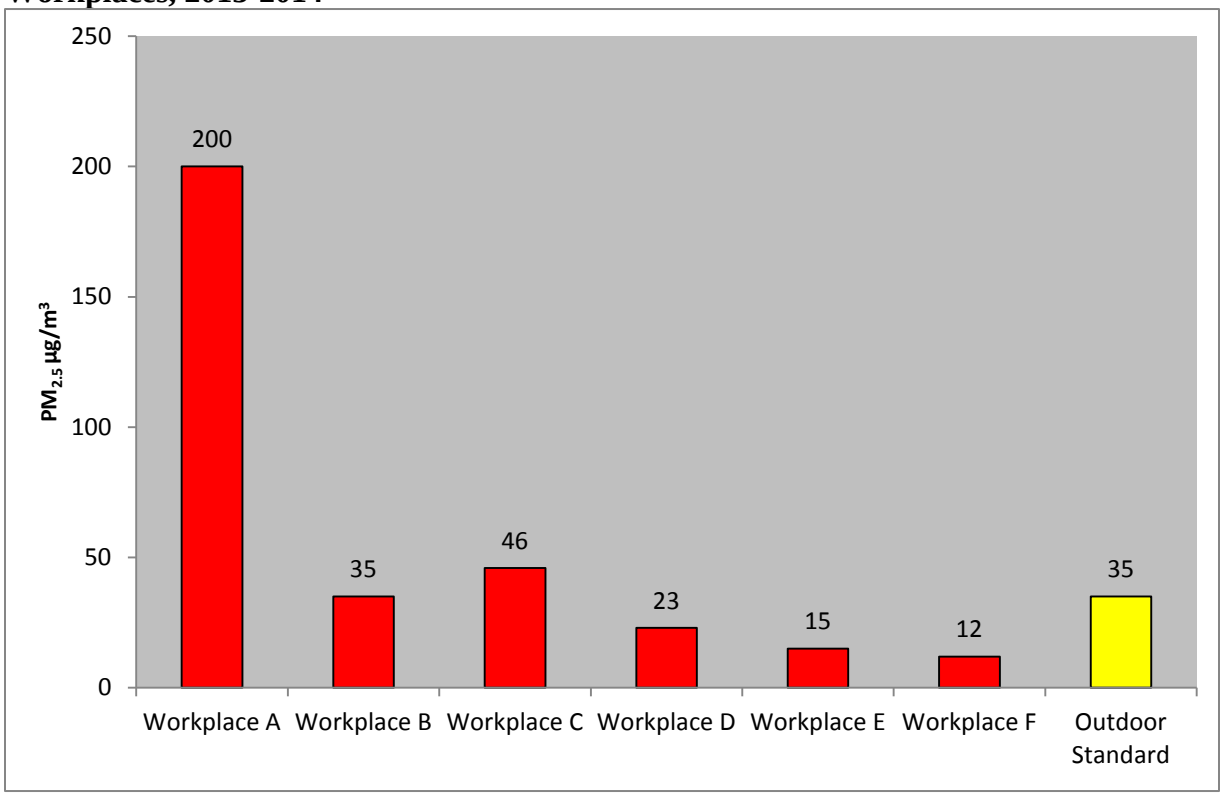
As depicted in Figure 1, the average level of indoor air pollution in the Caldwell County workplaces (55 $\mu g/m^3$) was approximately 2.8 times higher than Georgetown and 3.1 times higher than Lexington after implementing their smoke-free laws. Further, the level of indoor air pollution in Caldwell County workplaces was 1.6 times higher than the National Ambient Air Quality Standard (35$\mu g/m^3$) for *outdoor* air for 24 hours.

Figure 2 shows the average level of indoor air pollution in each of the six tested workplaces in Caldwell County. The average $PM_{2.5}$ levels ranged from 12 to 200 $\mu g/m^3$. Air pollution in three workplaces equaled or exceeded the National Ambient Air Quality Standard for *outdoor* air (NAAQS; 35$\mu g/m^3$).

Table. Air Quality Data for Six Workplaces in Caldwell County, Kentucky, Nov 2013 - April 2014

Venue	Date Sampled	Size (m^3)	Average # people	Average # burning cigs	Smoker density (#bc/100m^3)	Average $PM_{2.5}$ levels ($\mu g/m^3$)
Workplace A	11/21/2013	544	16	2.2	0.40	200
Workplace B	11/21/2013	1019	26	1.4	0.14	35
Workplace C	11/22/2013	340	16	0.5	0.15	46
Workplace D	11/22/2013	850	12	0.9	0.10	23
Workplace E	12/10/2013	680	7	0.1	0.02	15
Workplace F	4/3/2013	906	6	0.0	0.00	12
Averages		723	14	0.8	0.13	55

Figure 2. Average Indoor Fine Particle Concentration in Six Caldwell County, Kentucky Workplaces, 2013-2014



Discussion

The average $PM_{2.5}$ level in six Caldwell County, Kentucky workplaces was 55 $\mu g/m^3$, which is 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 $\mu g/m^3$ 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 workers and patrons in Caldwell County workplaces are exposed to harmful levels of SHS. On average, workers and patrons in Caldwell County were exposed to indoor air pollution levels approximately 1.6 times the National Ambient Air Quality Standard for *outdoor* air, and the level of indoor air pollution in these workplaces was 2.8 times higher than Georgetown and 3.1 times higher than Lexington's average $PM_{2.5}$ levels after implementation of their comprehensive smoke-free laws. When smoking is completely prohibited, air quality significantly improves for all workers and patrons.

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