Indoor Air Quality in Harlan County, Kentucky Workplaces, 2011

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Executive Summary

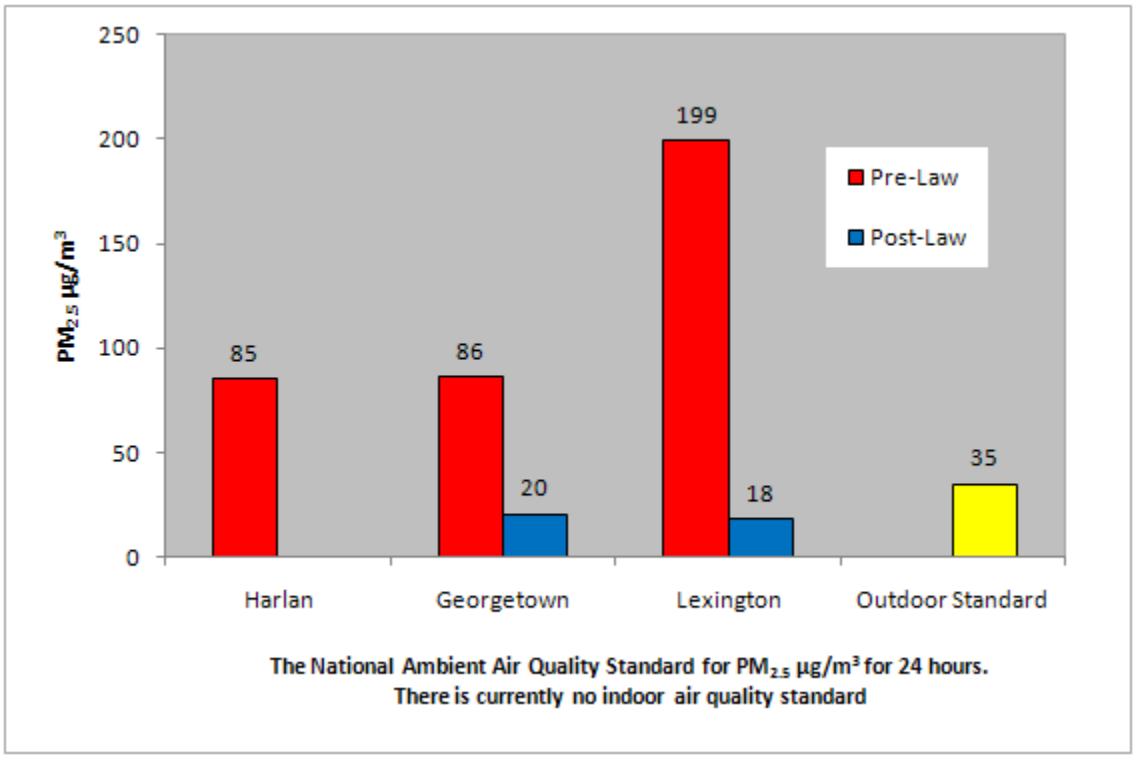
Indoor air quality was assessed in 10 workplaces in Harlan County, Kentucky. Fine particulates were measured from May 23 to June 23, 2011, using the TSI SidePak AM510 Personal Aerosol Monitor. The average $PM_{2.5}$ level from the 10 locations was compared to the average $PM_{2.5}$ levels in Georgetown 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 Harlan County (average $PM_{2.5}$ = 85 µg/m^3) was approximately 4.3 times higher than Georgetown and 4.7 times higher than Lexington after implementation of their smoke-free laws (see Figure 1). Further, the level of indoor air pollution in Harlan County's workplaces was 2.4 times higher than the National Ambient Air Quality Standard for *outdoor* air.

- The 10 workplaces had average $PM_{2.5}$ levels ranging from 17 to 398µg/m^3 (see Figure 2). Air pollution in 8 of the 10 workplaces exceeded the National Ambient Air Quality Standard for *outdoor* air.

Figure1. 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] 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 3,000 nonsmokers die from lung cancer and over 46,000 nonsmokers die from heart disease[2] every year in the U.S due to SHS exposure. It is estimated that 40.1% of nonsmokers in the United States have biological evidence of SHS exposure.[4]

Currently in the U.S., 22,487 local municipalities are covered by either local or state 100% smoke-free laws in workplaces and/or restaurants and/or bars.[5] 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 3,964 local ordinances or regulations that restrict smoking to some extent in workplaces across the United States and Washington D.C.[5] The extent of protection provided by these laws varies widely from community to community.

As of January 15, 2014, 38 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 22 Kentucky communities: Ashland, Bardstown, Bowling Green, Campbellsville, Clark County (Board of Health regulation), Corbin, Danville, Elizabethtown, Georgetown, Glasgow, Hardin County (unincorporated areas), Lexington-Fayette County, London, Louisville, Madison County (Board of Health regulation), Manchester, Morehead, Prestonsburg, Radcliff, Somerset, Williamsburg, and Woodford County (Board of Health regulation). Bullitt County's Board of Health has adopted a comprehensive regulation but it is delayed pending court action (upheld by Kentucky Court of Appeals, 12/7/12). The next most comprehensive ordinances, 100% smoke-free enclosed public place laws, have been implemented in three communities: Frankfort, Letcher County, and Paducah. Twelve 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 Harlan County, Kentucky workplaces; and (b) compare the results to Georgetown and Lexington, Kentucky air quality data before and after their smoke-free laws took effect.

Methods

Between May 23, and June 23, 2011, indoor air quality was assessed in 10 indoor workplaces located in Harlan County. Sites were of various sizes; some sites were

TSI SidePak AM510 Personal Aerosol Monitor

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 researchers from the Cumberland Valley 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 53 minutes (range 45-72 minutes). Visits occurred at various times of the day from 8:40 AM to 7:20 PM. The average size of the Harlan County workplaces was 1413 m^3 (range 291-3396 m^3) and the average smoker density was 0.12/100 m^3. On average, 21 patrons were present per venue and 0.9 burning cigarettes per venue were observed. Descriptive statistics for each venue are summarized in the Table.

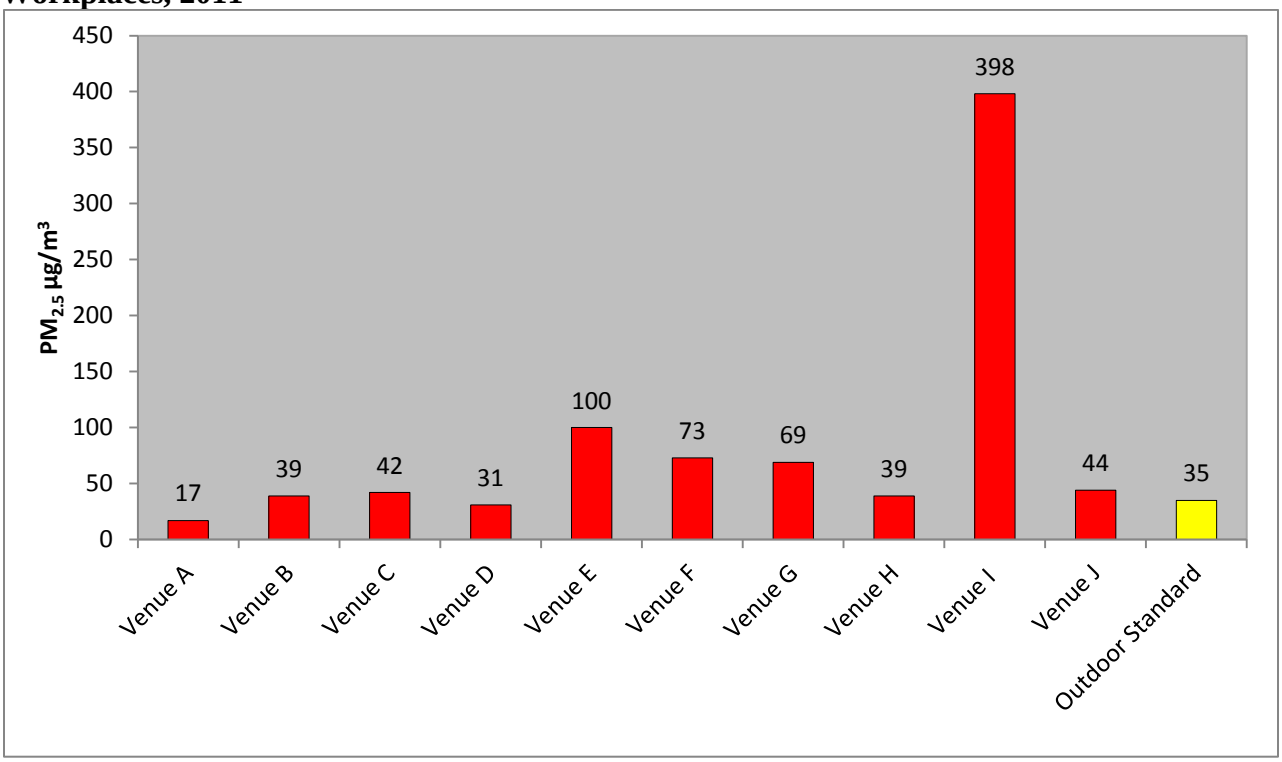
As depicted in Figure 1, the average level of indoor air pollution in the Harlan County workplaces (85μg/m^3) was approximately 4.3 times higher than Georgetown and 4.7 times higher than Lexington after implementing their smoke-free laws. Further, the level of indoor air pollution in Harlan County workplaces was 2.4 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 10 tested workplaces in Harlan County. The average $PM_{2.5}$ levels ranged from 17 to 398μg/m^3. Air pollution in 8 workplaces exceeded the National Ambient Air Quality Standard for *outdoor* air (NAAQS; 35μg/m^3).

Table. Air Quality Data for 10 Workplaces in Harlan County, Kentucky, May-June, 2011

Venue	Date Sampled	Size (m^3)	Average # people	Average # burning cigs	Smoker density (#bc/100m^3)	Average $PM_{2.5}$ levels ($\mu g/m^3$)
Venue A	5/23/2011	291	8	1.8	0.63	17
Venue B	5/25/2011	1119	10	0.8	0.07	39
Venue C	5/25/2011	797	12	1.0	0.13	42
Venue D	5/25/2011	1356	12	1.5	0.11	31
Venue E	5/25/2011	2442	63	0.6	0.02	100
Venue F	5/27/2011	1132	19	1.2	0.10	73
Venue G	5/31/2011	2034	60	0.5	0.02	69
Venue H	6/2/2011	1017	10	0.1	0.01	39
Venue I	6/2/2011	541	12	0.3	0.06	398
Venue J	6/23/2011	3396	10	1.6	0.05	44
Averages		**1413**	**21**	**0.9**	**0.12**	**85**

Figure 2. Average Indoor Fine Particle Concentration in 10 Harlan County, Kentucky Workplaces, 2011



Discussion

The average $PM_{2.5}$ level in 10 Harlan County, Kentucky workplaces was 85µg/m^3, which is 2.4 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.[6] 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.[7] 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.[8] 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.[9] 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.[10]

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.[11] 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.[12] 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.[13]

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] In 2010, U.S. Surgeon General Benjamin reported that tobacco smoke causes immediate blood vessel, lung tissue, and DNA damage causing heart disease, lung disease, and cancer.[3]

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.[4] 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 Harlan County workplaces are exposed to harmful levels of SHS. On average, workers and patrons in Harlan County were exposed to indoor air pollution levels approximately 2.4 times the National Ambient Air Quality Standard, and the level of indoor air pollution in these workplaces was 4.3 times higher than Georgetown and 4.7 times higher than Lexington's average $PM_{2.5}$ levels after implementation of their smoke-free laws. When smoking is completely prohibited, air quality significantly improves.

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