Indoor Air Quality in Jessamine County, Kentucky Workplaces, 2017

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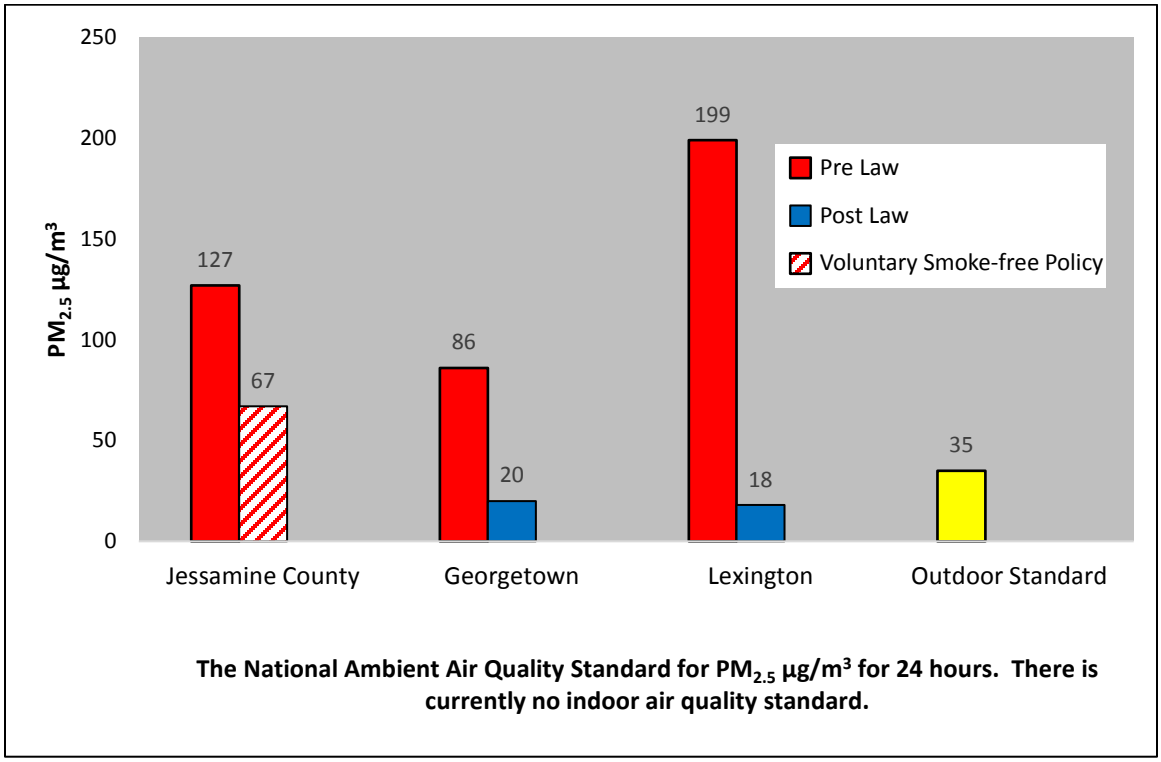
Executive Summary

Indoor air quality was assessed in 10 workplaces in Jessamine County, Kentucky; five of these workplaces allow smoking, and five have voluntary smoke-free policies, meaning that the business owner decided to prohibit smoking. Fine particulates were measured from February 25 to April 3, 2017 using the TSI SidePak AM510 Personal Aerosol Monitor. The average $PM_{2.5}$ level from the 10 workplaces was compared to the average $PM_{2.5}$ levels in Lexington and Georgetown, 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:

- On average, the level of indoor air pollution in the five Jessamine County workplaces that allow smoking (average $PM_{2.5}$ = 127 µg/m^3) was 3.6 times higher than the National Ambient Air Quality Standard (NAAQS) for *outdoor* air. The level of air pollution in the five workplaces that voluntarily prohibit smoking (average $PM_{2.5}$ = 67 µg/m^3) also exceeded the NAAQS for outdoor air (see Figure 1). Further, the average level of air pollution in all 10 Jessamine County workplaces (average $PM_{2.5}$ = 97 µg/m^3) was 5.4 times higher than Lexington and 4.9 times higher than Georgetown after implementation of their smoke-free laws (see Figure 1).
- The 10 workplaces in Jessamine County had average $PM_{2.5}$ levels ranging from 3 to 428 µg/m^3 (see Figure 2). Air pollution in four of the 10 workplaces 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., 22,650 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 58.3% of the U.S. population is protected by clean indoor air regulations that cover virtually all indoor worksites including bars and restaurants. There are 4,924 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 October 1, 2017, 45 Kentucky communities had implemented smoke-free laws. The most comprehensive ordinances/regulations, 100% smoke-free workplace and 100% smoke-free enclosed public place laws, have been implemented in 26 Kentucky communities: Ashland, Bardstown, Berea, Bowling Green, Campbellsville, Clarkson, Corbin, Danville, Elizabethtown, Georgetown, Glasgow, Hardin County (unincorporated areas), Lexington-Fayette County, London, Louisville, Manchester, Middlesborough, 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 four communities: Frankfort, Leitchfield, Letcher County, and Paducah. Fifteen communities have enacted partial smoke-free laws, protecting workers and patrons in some workplaces: Beattyville, Daviess County, Elkhorn City, Franklin County, Hazard, 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 Jessamine County workplaces; (b) compare air quality in Jessamine County workplaces with and without voluntary smoke-free policies; and (c) compare the results to Georgetown and Lexington, Kentucky air quality data before and after their smoke-free laws took effect.

Methods

Between February 25 and April 3, 2017, indoor air quality was assessed in 10 indoor workplaces located in Jessamine County, Kentucky. Of the 10 workplaces tested, five allow smoking, and five have voluntary smoke-free policies, meaning that the business owner decided to prohibit smoking. Of the 10 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 local data collectors who did the sampling and sent the data to KCSP for analysis. Data collectors made observations throughout the entire data collection period, but information on the number of people and burning cigarettes were recorded every 10 minutes. 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

Jessamine County workplaces that allow smoking were visited Monday through Saturday for an average of 64 minutes (range 48-102 minutes). Visits occurred at various times of the day from 12:03 PM to 10:36 PM. The average size of the workplaces was 836 m^3 (range 411-1,739 m^3) and the average smoker density was 0.35/100 m^3. On average, 36 patrons were present per workplace and 2.2 burning cigarettes per workplace were observed. Descriptive statistics for the five Jessamine County workplaces that allow smoking are summarized in Table 1.

Jessamine County workplaces that voluntarily prohibit smoking were visited for an average of 61 minutes (range 52-68 minutes). The average size of the workplaces was 569 m^3 (range 108-1,223

m^3), the average smoker density was 0.0/100 m^3, and on average, 29 patrons were present per workplace. There were no burning cigarettes observed in Workplaces I and J, but both venues have openings to the kitchen that may have partially accounted for the air quality results; however, secondhand smoke is the primary factor associated with $PM_{2.5}$. Descriptive statistics for the five workplaces with voluntary smoke-free policies are summarized in Table 2.

Table 1. Air quality data for five Jessamine County workplaces that allow smoking, March, 2017

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	03/01/2017	411	12	0.2	0.04	12
Workplace B	03/03/2017	695	51	0.0	0.00	11
Workplace C	03/06/2017	1,739	30	0.0	0.00	8
Workplace D	03/04/2017	757	75	4.0	0.53	428
Workplace E	03/03/2017	577	12	6.9	1.20	177
Averages		**836**	**36**	**2.2**	**0.35**	**127**

Table 2. Air quality data for five Jessamine County workplaces that voluntarily prohibit smoking, February – April, 2017

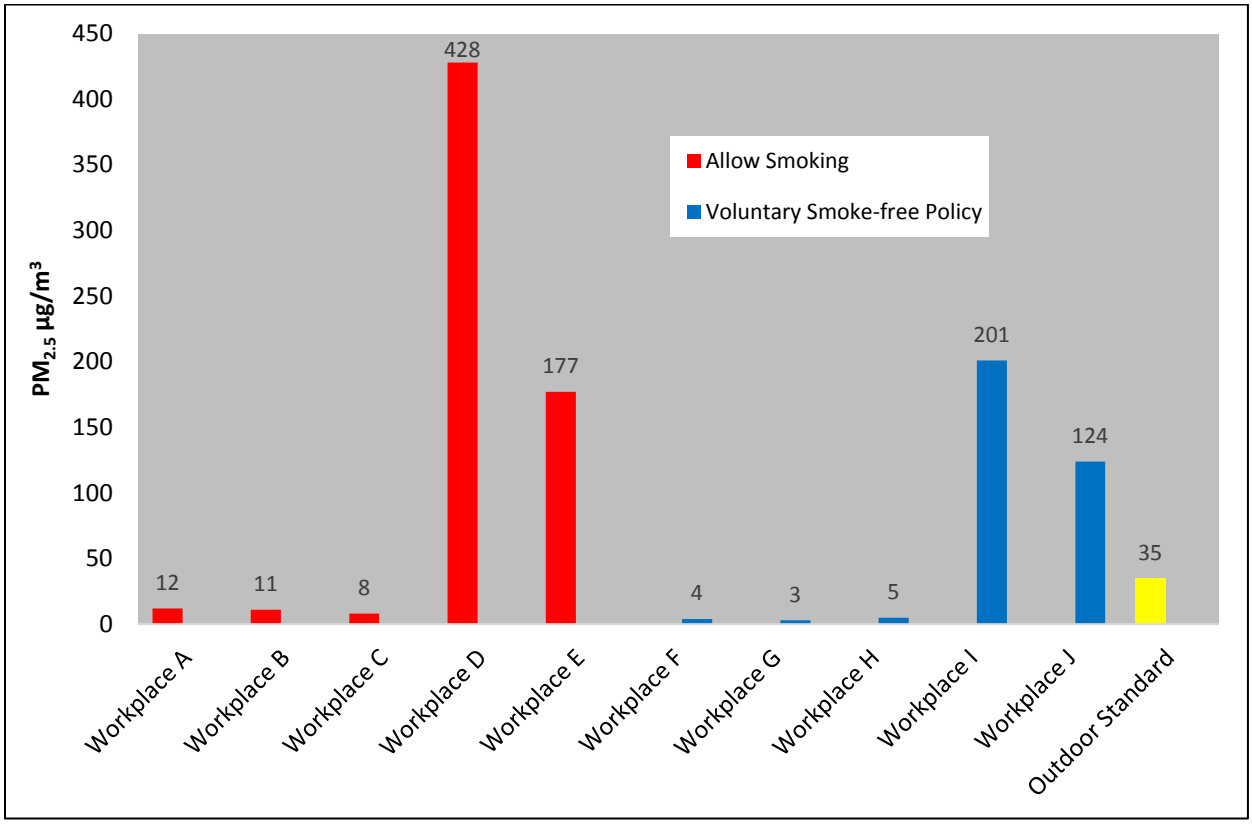
Workplace	Date Sampled	Size (m^3)	Average # people	Average # burning cigs	Smoker density (#bc/100m^3)	Average $PM_{2.5}$ levels (µg/m^3)
Workplace F	02/25/2017	327	18	0.0	0.00	4
Workplace G	02/25/2017	1,223	15	0.0	0.00	3
Workplace H	03/04/2017	920	67	0.0	0.00	5
Workplace I	02/27/2017	266	27	0.0	0.00	201
Workplace J	04/03/2017	108	20	0.0	0.00	124
Averages		**569**	**29**	**0.0**	**0.00**	**67**

Note. Workplaces I and J have openings to the kitchen that may have partially accounted for the air quality results; however, secondhand smoke is the primary factor associated with $PM_{2.5}$.

As depicted in Figure 1, on average, the level of indoor air pollution in the five Jessamine County workplaces that allow smoking (average $PM_{2.5}$ = 127 µg/m^3) was 3.6 times higher than the National Ambient Air Quality Standard (NAAQS) for outdoor air. The level of air pollution in the five workplaces that voluntarily prohibited smoking (average $PM_{2.5}$ = 67 µg/m3) also exceeded the NAAQS for outdoor air. On average, air pollution in the 10 Jessamine County workplaces (average $PM_{2.5}$ = 97 µg/m^3) was 5.4 times higher than Lexington and 4.9 times higher than Georgetown after implementation of their smoke-free laws.

Figure 2 shows the average level of indoor air pollution in each of the 10 tested workplaces in Jessamine County. The average $PM_{2.5}$ levels in the five Jessamine County workplaces that allow smoking ranged from 8 to 428 µg/m^3; the average $PM_{2.5}$ levels in the five workplaces with voluntary smoke-free policies ranged from 3 to 201 µg/m^3. Air pollution in four of the 10 workplaces exceeded the National Ambient Air Quality Standard for *outdoor* air (NAAQS; 35 µg/m^3).

Figure 2. Average indoor fine particle concentration in Jessamine County workplaces that allow smoking and those with a voluntary smoke-free policy



Discussion

The average $PM_{2.5}$ level of indoor air pollution measured in the five workplaces that allow smoking was 127 µg/m.[3] The average $PM_{2.5}$ level in the five Jessamine County workplaces with voluntary smoke-free policies was 67 µg/m.[3] On average, air pollution in the 10 Jessamine County workplaces was 2.8 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 a 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 Jessamine County workplaces remain exposed to harmful levels of SHS. These findings show that when businesses voluntarily prohibit smoking, the community is not protected from SHS. On average, workers and patrons in the 10 Jessamine County workplaces are exposed to indoor air pollution levels approximately 2.8 times higher than the National Ambient Air Quality Standard for *outdoor* air, 4.9 times higher than Georgetown and 5.4 times higher than Lexington after implementation of their smoke-free laws. When smoking is completely prohibited indoors by law, air quality significantly improves for all workers and patrons.

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