

# Columbia Air Quality Monitoring Study



**C A S E**

Campus-Community Alliances for Smoke-Free Environments

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## Executive Summary

Secondhand smoke (SHS) was classified in 1992 by the U.S. Environmental Protection Agency (EPA) as a cause of cancer in humans. It contains more than 4,800 chemicals of which more than 250 are known to be toxic. For such a substance, there is no minimum safe level of exposure. The 2006 U.S. Surgeon General's Report, reviewing thousands of research studies, finds SHS is a cause for stroke, emphysema, bronchitis, asthma, respiratory infections, Sudden Infant Death Syndrome and other illnesses. SHS is responsible for almost 50,000 deaths per year from heart disease and lung cancer in nonsmokers. The 2006 Surgeon General's Report concluded that policies for smokefree environments are the most effective method of reducing SHS exposure in public places and workplaces.

The purpose of this study was to sample the air quality in public places that have smokefree policies and those that permit smoking, and compare results to the EPA Air Quality Index. Indoor air quality for fine particulate matter pollution (PM<sub>2.5</sub> particles) was sampled for 5 Columbia restaurants and bars that allowed smoking in January of 2007, before the city's enhanced smokefree ordinance went into effect; and again in December of 2007 after the ordinance was in effect for almost a year.

Key findings of this study include:

- Before the Columbia smokefree ordinance went into effect, fine particulate matter air pollution in restaurants and bars averaged 87  $\mu\text{g}/\text{m}^3$  (EPA rating of "unhealthy") even though an average of fewer than 3 cigarettes were being smoked at any given time. After the ordinance was in effect, this type of air pollution was reduced by 92% to an average of 7  $\mu\text{g}/\text{m}^3$  (EPA rating of "good").
- On average, only 6% of people were actively smoking in the public places where smoking was permitted. This is less than half the 17% adult smoking prevalence in Columbia and refutes the commonly held misperception that a high percent of employees or customers in restaurant and bars smoke.

The findings of this study are consistent with those of similar previous studies that found that about 90% of the fine particle pollution could be attributed to SHS.

## Introduction

Secondhand smoke (SHS) contains more than 4,800 chemicals, of which more than 250 are known to be toxic or carcinogenic, and by itself was classified in 1992 by the U.S. Environmental Protection Agency as a human carcinogen. Exposure to SHS is responsible for an estimated 35,000 deaths per year from heart disease and lung cancer in nonsmokers.<sup>1</sup> The U.S. Surgeon General issued reports in 1984 and 2006 concluding SHS was also a cause for stroke, emphysema, bronchitis, asthma, respiratory infections, Sudden Infant Death Syndrome and other illnesses. The Surgeon General also concluded there is no safe level of exposure to SHS.<sup>2,3</sup>

Current Missouri law allows for smoking in most indoor workplaces. Policies prohibiting smoking are the most effective method for eliminating SHS exposure in public places and workplace environments. While many businesses voluntarily establish smokefree policies, the hospitality industry (bars, restaurants, bowling alleys, etc.), representing approximately 10-14% of workplaces, has been slow to enact smokefree policies. Consequently, workers and patrons are exposed to SHS. An increase in state- and city-wide smokefree ordinances across the United States has resulted in declining SHS exposure among the overall U.S. population,<sup>4</sup> but a majority of Missouri municipalities remain without comprehensive smokefree laws.

To protect public health, the U.S. Environmental Protection Agency (EPA) issued National Ambient Air Quality Standards which included fine particulate matter as one of the criteria pollutants. The EPA first issued standards for daily exposure to pollution consisting of particulate matter of 2.5 microns in size (PM<sub>2.5</sub>) in 1971 with periodic revisions, the latest in 2006 and currently in a public comment period. Current EPA standards based on review of thousands of peer-reviewed scientific studies recommend exposure during a 24-hour period to be not greater than 35 µg/m<sup>3</sup>. Further, over the period of a year a person's exposure should not have a daily average of more than 15 micrograms per cubic meter (µg/m<sup>3</sup>). EPA assigned levels for PM<sub>2.5</sub> ranging from "good" to "hazardous" with accompanying health advisories as presented in Table 1.<sup>5</sup> Because the impact on health is the same regardless of whether the air is in an outdoor or indoor environment, the EPA index is a valuable measure of health risk.

**Table 1. U.S. Environmental Protection Agency – Air Quality Index**

Air Quality	PM <sub>2.5</sub> (µg/m <sup>3</sup> )	Health Advisory
Good	≤ 15	None
Moderate	16-35	Unusually sensitive people should consider reducing prolonged or heavy exertion
Unhealthy for Sensitive Groups	36-55	People with heart or lung disease, older adults and children should reduce prolonged or heavy exertion
Unhealthy	56-150	People with heart or lung disease, older adults and children should avoid prolonged or heavy exertion. Everyone else should reduce prolonged or heavy exertion
Very Unhealthy	151-250	People with heart or lung disease should avoid all physical activity outdoors. Everyone else should avoid prolonged or heavy exertion.
Hazardous	≥ 251	People with heart or lung disease, older adults, and children should remain indoors and keep activity levels low. Everyone else should avoid all physical activity outdoors.

The Columbia Air Quality Monitoring Study examined indoor air quality in a sampling of restaurants and bars before and after the implementation of an ordinance for smokefree workplaces and public places, to assess the relation between smoking and indoor air pollution. Air quality findings were compared to the EPA Air Quality Index.

## **Methods**

### Overview

Indoor air quality for fine particulate matter pollution was sampled for five Columbia restaurants and bars that allowed smoking in January of 2007, before the city's enhanced smokefree ordinance was implemented; and again in December of 2007 after the ordinance had been in effect for almost a year. Particulate matter smaller than 2.5 micrograms (PM<sub>2.5</sub>) was measured. The PM<sub>2.5</sub> particles are easily inhaled deep into the lungs, are associated with pulmonary and cardiovascular disease and mortality. SHS is a major source of PM<sub>2.5</sub> pollution.

### Measurement Protocol

A minimum of 44 minutes was spent in each public place to monitor air for data collection. The number of people inside the venue and the observed number of burning cigarettes were recorded every 15 minutes during the air quality sampling period. Active smoker density was calculated by dividing the average number of burning cigarettes by the volume of the room in meters. The number of burning cigarettes was divided by the number of people at the venue in 15-minute intervals to determine the percent of people smoking within a venue at any particular time.

A TSI Sidepak AM510 Personal Aerosol Monitor (TSI, Inc., St. Paul, MN) was used to sample and record the levels of particulate matter pollution in the air. The Sidepak uses a built-in sampling pump to draw air through the device, where the particulate matter in the air scatters the light from a laser to assess the real-time concentration of particulate matter smaller than 2.5 micrograms to be recorded as PM<sub>2.5</sub>. The concentrations of particulate matter were recorded as micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ). The Sidepak was zero-calibrated prior to each use by attaching a HEPA filter according to the manufacturer's specifications. The Sidepak was set to a one-minute log interval, which averages the previous 60 one-second measurements.

Air quality sampling was conducted discreetly in order to not disturb the normal behavior of workers or other patrons. Study staff ordered food or beverages and assumed standard seating positions in a venue. If a venue had both smoking and nonsmoking sections, the air monitoring was conducted in the smoking section. The monitor was generally located on a table so the air being sampled was within the sitting occupants' normal breathing zone. For each public place, the first and last minute of logged data were removed because they were averaged with outdoor and entryway air. The remaining data points were averaged to provide an average PM<sub>2.5</sub> concentration within the public place.

Descriptive data including the venue volume in cubic meters ( $\text{m}^3$ ), number of people, number of burning cigarettes, and smoker density (number of burning cigarettes per 100  $\text{m}^3$ ) were recorded for each public place and averaged for all public places. Additionally, the results are compared to the EPA Air Quality Index.

## Results

The five venues were visited for an average of 73 minutes per visit at pre-ordinance and 68 minutes per visit for post-ordinance samplings. Return visits occurred at similar times: early afternoon lunch times; early evening supper and later evening.

The average level of PM<sub>2.5</sub> for the five locations pre-ordinance was 87.4 µg/m<sup>3</sup> (range: 9.0 – 374.2 µg/m<sup>3</sup>). On average, 2.8 cigarettes (range: 0 to 9.8 cigarettes) were burning during the pre-ordinance monitoring, representing an overall average of 6% of patrons. No smoking was observed in the post-ordinance monitoring. The average PM<sub>2.5</sub> level post-ordinance was 7.0 µg/m<sup>3</sup> (range: 1.1 – 21.2 µg/m<sup>3</sup>). The pre-ordinance PM<sub>2.5</sub> level was 12.5 times higher than post-ordinance. This shows a 92% reduction in PM<sub>2.5</sub> after the smokefree ordinance was in effect. Table 2 provides additional details of the monitored venues.

On average there were 47 persons per establishment pre-ordinance and 53 persons per establishment post ordinance.

**Table 2. Air Quality Before and After Columbia Smokefree Ordinance**

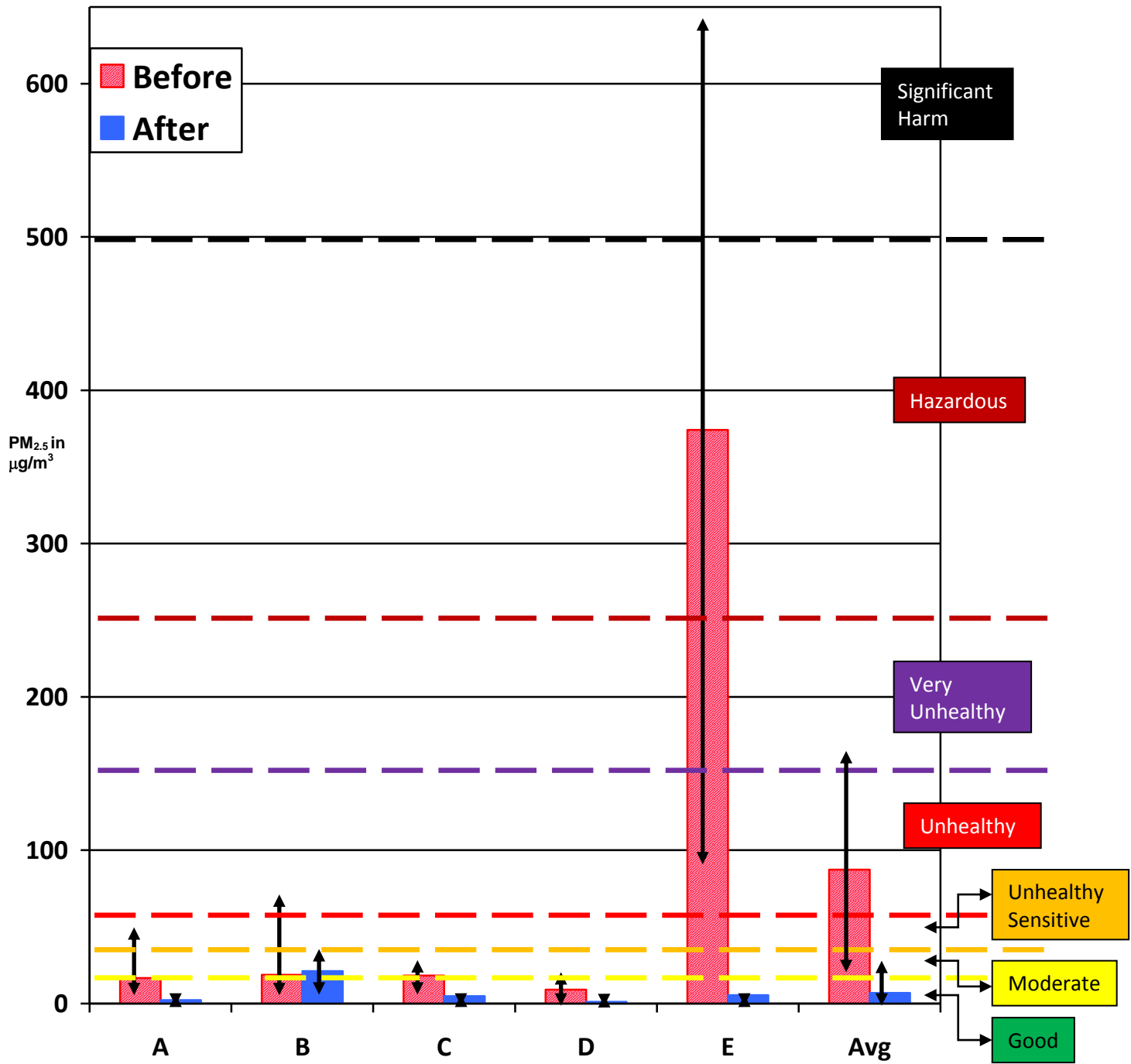
Venue	Volume m <sup>3</sup>	Before Ordinance						After Ordinance		
		Average # people	Average # burning cigarettes	Active smoker density	% burning cigarettes to # people	Average PM <sub>2.5</sub> level (µg/m <sup>3</sup> )	EPA AQI*	Average # people	Average PM <sub>2.5</sub> level (µg/m <sup>3</sup> )	EPA AQI*
A	5,220	108	2.25	0.04	2.1	16.7	M	99	2.3	G
B	1,152	46	1.50	0.13	3.3	18.8	M	56	21.2	M
C	468	22	0.00	0.00	0.0	18.2	M	22	4.9	G
D	1,260	5	0.25	0.25	5.0	9.0	G	30	1.1	G
E	1,920	54	9.80	0.51	18.6	374.2	H	56	5.5	G
Avg	2,004	47.0	2.76	0.19	6.1	87.4	U	52.6	7.0	G

\* EPA Air Quality Index category:

G = Good; M = Moderate; U = Unhealthy' VU = Very Unhealthy; H = Hazardous

Figure 1 is a graphic presentation comparing the air quality data of the five restaurants and bars before and after the city smokefree ordinance with correlation to the EPA Air Quality Index standards.

Figure 1 – Air Quality Measures for Columbia – January 2007 vs. December 2007



## Discussion

Particulate matter pollution is a complex mixture of extremely small particles that when breathed in can reach the deepest regions of the lungs. Exposure to PM<sub>2.5</sub> is linked to a variety of significant health problems, ranging from aggravated asthma to premature death in people with heart and lung disease. This study found PM<sub>2.5</sub> pollution to be 12.5 times higher in restaurants and bars before the smokefree ordinance was in effect compared to afterward (87.4 µg/m<sup>3</sup> vs. 7.0 µg/m<sup>3</sup>). Air quality before the ordinance was classified as “unhealthy” and after the ordinance as “good” by the EPA Air Quality Index.

Counts of the number of people and of the number of burning cigarettes conducted every 15 minutes revealed that on average only 6.1% of the people in these public places were actively smoking at any given time, less than half the 16.6% adult smoking prevalence in Columbia.<sup>6</sup> Despite commonly held misperceptions that a high percent of employees or customers in bars or public recreational venues smoke, this study finds on average less than 3 cigarettes were burning at any given time; and yet, these few cigarettes create levels of pollution to the degree to be rated as “unhealthy” by the EPA.

The findings of this study are consistent with those of similar previous studies. A study of eight hospitality venues in Delaware before and after a statewide smokefree law was implemented found about 90% of the fine particle pollution could be attributed to tobacco smoke.<sup>7</sup> Similarly, a study of 22 hospitality venues in western New York found a 90% reduction in PM<sub>2.5</sub> levels in bars and restaurants and an 84% reduction in large recreation venues (e.g., bingo halls, bowling alleys).<sup>8</sup> Similar findings of reductions of more than 90% of PM<sub>2.5</sub> levels in public places were reported after several communities in Kentucky implemented smokefree workplace ordinances.<sup>9</sup> The current study in Columbia finds 92% lower particulate matter pollution after the ordinance was in effect.

Other studies have directly assessed the effects of SHS exposure on human health. One study found that respiratory health improved rapidly in a sample of bartenders after a state smokefree workplace law was implemented in California, as well as after national smokefree laws were implemented in Ireland and Scotland.<sup>10,11,12</sup> Additional studies found a significant reduction in cotinine (a metabolic byproduct of nicotine) and of polycyclic aromatic hydrocarbons (a known human carcinogen found in SHS) in the bodies of hospitality industry workers or customers.<sup>13,14</sup> Experimental studies examining blood chemistries of smokers and nonsmokers find negative effects of even brief (minutes to hours) exposures to SHS on the cardiovascular system.<sup>15,16</sup>

Additional studies report an average of a 17% reduction in hospital admissions for acute myocardial infarctions (heart attacks) within the first year after implementation of a smokefree ordinance or law in the communities; followed by an incremental 26% reduction for subsequent years.<sup>17,18,19,20,21,22,23,24,25,26</sup> Of note are reports in which hospitalizations for heart attacks were reduced by 28% in Pueblo, Colorado, 18 months after their smokefree ordinance was implemented; and that the decline continued to a 41% reduction 36 months after the time the ordinance was implemented. However, rates in surrounding Pueblo County and adjacent El Paso County, which had no smokefree ordinances, remained virtually flat for the same periods.<sup>27,28</sup> A recurring theme is demonstrated by a growing body of evidence showing that smokefree policies are proven to provide health benefits for both smokers and nonsmokers.

## Conclusions

Columbia restaurants and bars that allowed smoking had more than 12 times the fine particulate matter air pollution when compared to air quality samples taken after the smokefree ordinance was in effect. Air quality was rated “unhealthy” by EPA standards before the ordinance and “good” after the ordinance.

This study demonstrates when smoking was allowed in Columbia restaurants and bars, employees and customers were exposed to harmful levels of an air pollutant known to cause heart disease, cancer and other diseases. Implementation of the smokefree ordinance significantly lowered the level of this air pollutant to a level considered as not harmful. This finding is similar to other studies that demonstrated policies prohibiting smoking in public places and workplaces dramatically reduce SHS exposure and improve employee and public health.

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