

# Branson

# Air Quality Monitoring Study



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## Executive Summary

Secondhand smoke was classified in 1992 by the U.S. Environmental Protection Agency (EPA) as a cause of cancer in humans. It contains more than 7,000 chemicals of which more than 250 are known to be poisonous. 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 secondhand smoke is a cause for stroke, emphysema, bronchitis, asthma, respiratory infections, Sudden Infant Death Syndrome and other illnesses. Secondhand smoke 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 secondhand smoke exposure in public places and workplaces.

Smokefree policies are becoming the social norm and have been associated with reduced rates of hospitalizations for heart attacks, strokes, emphysema, asthma, bronchitis and pneumonia.

This study compared air quality in Branson public places and workplaces to the EPA Air Quality Index. Indoor air quality for fine particulate matter pollution (PM<sub>2.5</sub> particles) was sampled in 9 public places on February 25, 2014. Six locations had smoking indoors; the other three did not. The EPA determined that even short term exposure to PM<sub>2.5</sub> air pollution can aggravate irregular heartbeat, set the stage for heart attacks and, for those with heart disease, can cause a heart attack with no warning symptoms.

Key findings of this study include:

- Particulate matter air pollution for –
  - The 6 smoking locations averaged 243 µg/m<sup>3</sup> (EPA rating of “very unhealthy”).
  - The 3 non-smoking locations averaged 3 µg/m<sup>3</sup> (EPA rating of “good”).

The level of particulate matter air pollution was over 67 times higher in places where smoking occurred compared to those where smoking did not occur.

- Due solely to their occupational exposure, a full-time employee in a Branson public place that allows smoking would be exposed to 370% the EPA's average annual limit for particulate matter air pollution during an 8-hour workshift.
- On average, only 11.3% of people were actively smoking in the locations where smoking was permitted. This is slightly greater than 1/3<sup>rd</sup> the adult smoking prevalence of 31.5% for Taney County. This refutes a commonly held misperception that a high percent of hospitality industry customers or employees smoke.

The findings of this study are consistent with those of similar previous studies that found that approximately 90% or more of the fine particle pollution could be attributed to secondhand smoke.

## Introduction

Secondhand smoke contains more than 7,000 chemicals, of which more than 250 are known to be either toxic and/or carcinogenic, and by itself was classified in 1992 by the U.S. Environmental Protection Agency as a human carcinogen.<sup>1</sup> Exposure to secondhand smoke is responsible for an estimated 35,000 deaths per year from heart disease and lung cancer in nonsmokers.<sup>2</sup> The U.S. Surgeon General issued reports in 1984 and 2006 concluding secondhand smoke 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 secondhand smoke.<sup>1,3,4</sup>

With specified exemptions, Missouri state law requires all public places to prohibit smoking unless designated smoking areas are provided. Such designated areas are not to exceed 30% of its entire space. Missouri state law does not preempt local governments from enacting more stringent smokefree ordinances.

Branson currently has two city ordinances related to smoking in public places and workplaces.

Section 26-245–(e) prohibits drivers of taxi cabs from smoking while carrying passengers.

Section 46-235–(1) prohibits patrons and operators of body art establishments from smoking during the procedure or in the room(s) where the body art takes place.

Policies prohibiting smoking are the most effective method for eliminating secondhand smoke exposure in public places and workplace environments. While many businesses voluntarily establish smokefree policies, the hospitality industry (including restaurants, bars, bowling alleys, etc.), representing approximately 10-14% of workplaces, has been slow to enact smokefree policies. Consequently, workers and patrons are exposed to secondhand smoke. An increase in state and local smokefree ordinances across the United States has resulted in declining secondhand smoke exposure among the overall U.S. population,<sup>5</sup> but a majority of Missouri municipalities and populations remain without comprehensive smokefree laws.

To protect public health, the U.S. Environmental Protection Agency (EPA) issued National Ambient Air Quality Standards which include 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>6</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**

<b>Air Quality</b>	<b>PM<sub>2.5</sub> (µg/m<sup>3</sup>)</b>	<b>Health Advisory</b>
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.

## Methods

### Overview

Particulate matter smaller than 2.5 micrograms (PM<sub>2.5</sub>) was measured. Particles of this size are easily inhaled deep into the lungs, can pass into the bloodstream, and are associated with pulmonary and cardiovascular disease and mortality.

Indoor air quality for fine particulate matter pollution was sampled for 9 public places in Branson on February 25, 2014. Six of the locations had smoking indoors, the other three locations did not.

### Measurement Protocol

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 (µg/m<sup>3</sup>). 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.

Locations were visited between 5:30 p.m. and 9 p.m. A minimum of 45 minutes was spent in each location to monitor air for data collection. The number of people and the observed number of burning cigarettes were recorded during the air quality sampling period. A sonic measuring device was used to measure room dimensions, enabling unobtrusive calculation of the volume of each location. 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 location to determine the percent of people smoking.

Air quality sampling was conducted discreetly in order to not disturb the normal behavior of workers or patrons. For each location, the first and last minute of logged data were removed because they were averaged with outdoor and/or entryway air. The remaining data points were averaged to provide an average PM<sub>2.5</sub> concentration within the location.

Descriptive data including the location volume in cubic meters (m<sup>3</sup>), number of people, number of burning cigarettes, and smoker density (number of burning cigarettes per 100 m<sup>3</sup>) were recorded for each location and averaged for all locations. Additionally, the results are compared to the EPA Air Quality Index.

## Results

The average PM<sub>2.5</sub> level for the 6 sampled smoking locations was 242.8 µg/m<sup>3</sup> (range: 3.2 – 670.1 µg/m<sup>3</sup>). The 3 smokefree locations had an average PM<sub>2.5</sub> level of 3.1 µg/m<sup>3</sup> (range: 2.1 – 4.7 µg/m<sup>3</sup>). The level of particulate matter air pollution was 67.1 times higher in those locations that allowed smoking compared to those prohibiting smoking. An average 11.3% of patrons were smoking at any given time. Table 2 provides additional details of the monitored venues.

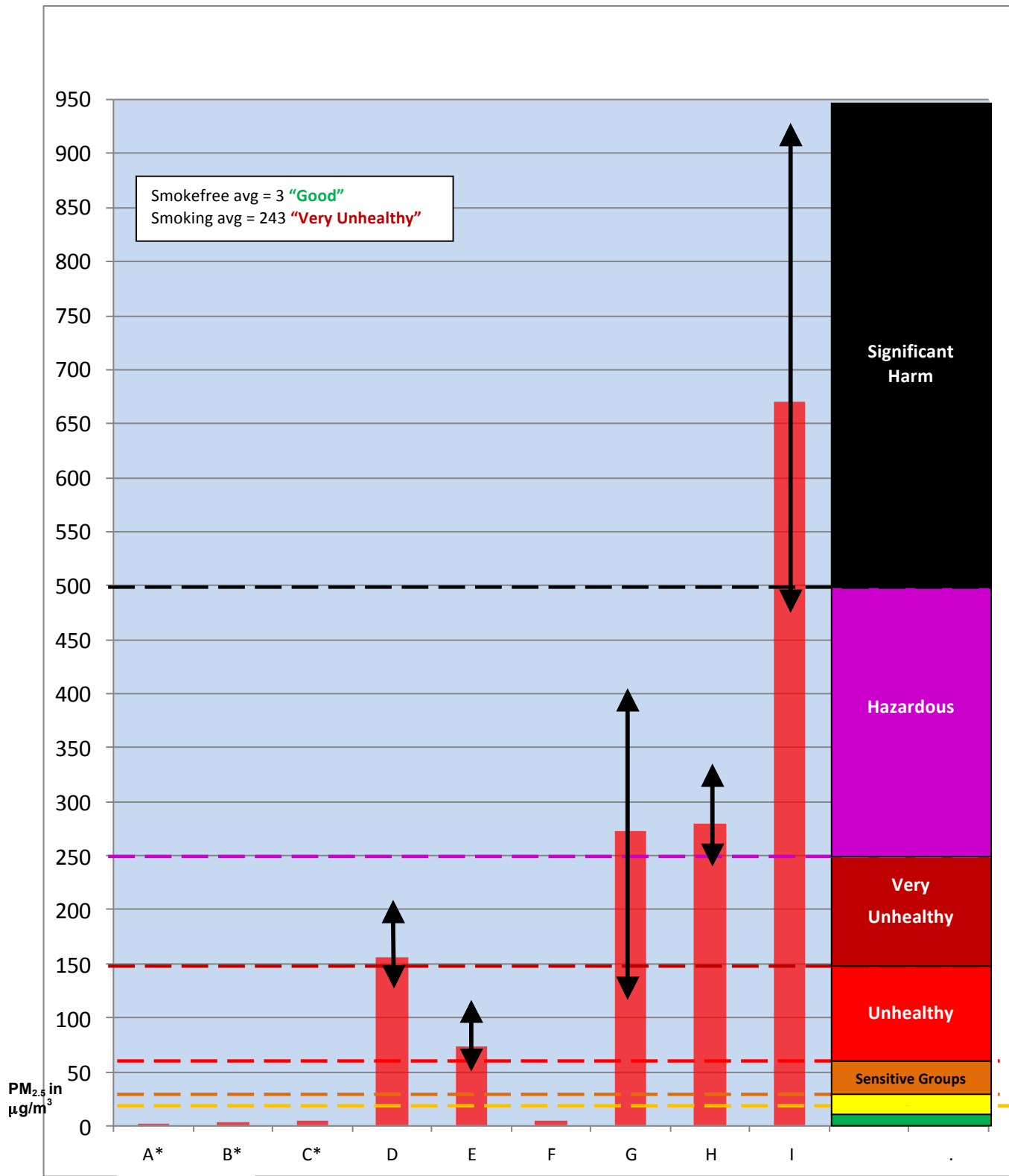
**Table 2. Air Quality Details for Monitored Public Places in Branson**

Location	Number burning cigarettes	% burning cigarettes to # people	Active smoker density	Average PM <sub>2.5</sub> level (µg/m <sup>3</sup> )	EPA Air Quality Index category
A*		-	-	2.1	Good
B*		-	-	2.5	Good
C*		-	-	4.7	Good
<b>Average</b>		-	-	<b>3.1</b>	<b>Good</b>
D	1.3	9.1	0.35	155.9	Very Unhealthy
E	2.0	6.2	0.42	73.6	Unhealthy
F	0.5	8.1	0.21	4.2	Good
G	1.8	21.6	0.52	273.4	Hazardous
H	4.3	15.1	1.50	279.8	Hazardous
I	1.2	15.6	0.54	670.1	Significant Harm
<b>Average</b>	<b>1.9</b>	<b>11.3</b>	<b>0.57</b>	<b>242.8</b>	<b>Very Unhealthy</b>

\*smokefree venues

Figure 1 provides details of monitored locations with comparison to the EPA Air Quality Index standards. The ▼ indicates lowest and highest readings for each location.

Figure 1 – Air Quality Measures for Branson Public Places – February 2013



\* smokefree

## 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 67.1 times higher in public places where smoking occurred compared to those without smoking (3  $\mu\text{g}/\text{m}^3$  vs. 243 $\mu\text{g}/\text{m}^3$ ). Average air quality of sampled smokefree locations was classified as “good” by the EPA Air Quality Index with all three each being “good”. The six smoking locations had an average classification of “very unhealthy” with one classified as “good”, one as “unhealthy”, one as “very unhealthy”, two as “hazardous” and one as “significant harm”.

Full-time employees in public places with smoking were exposed to 370% the established annual EPA exposure limit to protect human health from fine particle air pollution.

Counts of the number of people and of the number of burning cigarettes revealed that on average only 11.3% of the people in these public places were actively smoking. This is slightly more than 1/3<sup>rd</sup> the adult smoking prevalence of 31.5% for Taney County.<sup>7</sup> This refutes the commonly held misperception that a high percent of hospitality industry customers or employees smoke.

An anomaly was noted for Location F, which allowed smoking, yet measured only 4.2  $\mu\text{g}/\text{m}^3$ . This location had only four to eight people present during the monitoring and the only observed smoking was one employee at an area distantly located from the customers. If Venue F were removed from the calculations, the results for smoking locations would increase from 243  $\mu\text{g}/\text{m}^3$  “very unhealthy” to 291  $\mu\text{g}/\text{m}^3$  “hazardous”.

The findings of this study are consistent with those of similar previous studies regarding numbers of smokers among customers and employees, and levels of particulate matter air pollution.

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>8</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.<sup>9</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>10</sup>

Air quality tested in smoking-allowed public places and workplaces in 19 Missouri communities was rated as “unhealthy” according to EPA standards. Employees in these places were exposed to 250% the EPA’s average annual daily limit for this pollution. Re-testing of air quality in these same workplaces after 9 communities implemented smokefree ordinances saw an 88% reduction in air pollution and employee exposure was reduced to only 1/4<sup>th</sup> the EPA limit.<sup>11</sup>

Other studies have directly assessed the effects of secondhand smoke 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>12,13,14</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 secondhand smoke) in the bodies of hospitality industry workers or customers.<sup>15,16</sup> Examination of blood chemistries of smokers and nonsmokers found harmful effects on the cardiovascular system after even brief exposures of only minutes to hours.<sup>17,18</sup>

A “66 casino” study by Repace found that incremental PM<sub>2.5</sub> pollution from secondhand smoke in approximately half of the smoking-allowed casinos exceeded a level known to impact cardiovascular health in nonsmokers after less than 2 hours of exposure, posing acute health risks to patrons and workers.<sup>13</sup>

The EPA determined that even short term exposure to PM<sub>2.5</sub> air pollution can aggravate irregular heartbeat, set the stage for heart attacks and, for those with heart disease, can cause a heart attack with no warning symptoms. Older adults are at greater risk as they may have undiagnosed heart disease.<sup>19</sup> This is worrisome as the most common first symptom of heart disease is a heart attack; and about half of first-time heart attacks are fatal.

Still additional studies found a significant reduction in cotinine (a metabolic byproduct of nicotine) and of polycyclic aromatic hydrocarbons (a known human carcinogen found in secondhand smoke) in the bodies of bar and/or casino employees or customers.<sup>20,21</sup> A study of air quality in Pennsylvania casinos found that despite low smoking prevalence and with ventilation rates 50% higher than those previously recommended by engineers for smoking-permissible casinos, levels of polycyclic aromatic hydrocarbons and particulate matter were 4 and 6 times respectively that of outdoor air and cotinine levels increased among customers. This study estimated 6 Pennsylvania casino workers’ deaths annually per 10,000 at risk; a risk 5 times greater than that of Pennsylvania mining disasters.<sup>22</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.<sup>23,24,25,26,27,28,29,30,31,32,33</sup> Of note in Figure 2 are reports in which hospitalizations for heart attacks were reduced by 28% in Pueblo, Colorado, within the first 18 months after their smokefree ordinance was implemented; and that the decline continued to a 41% reduction within the first 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>34,35</sup>

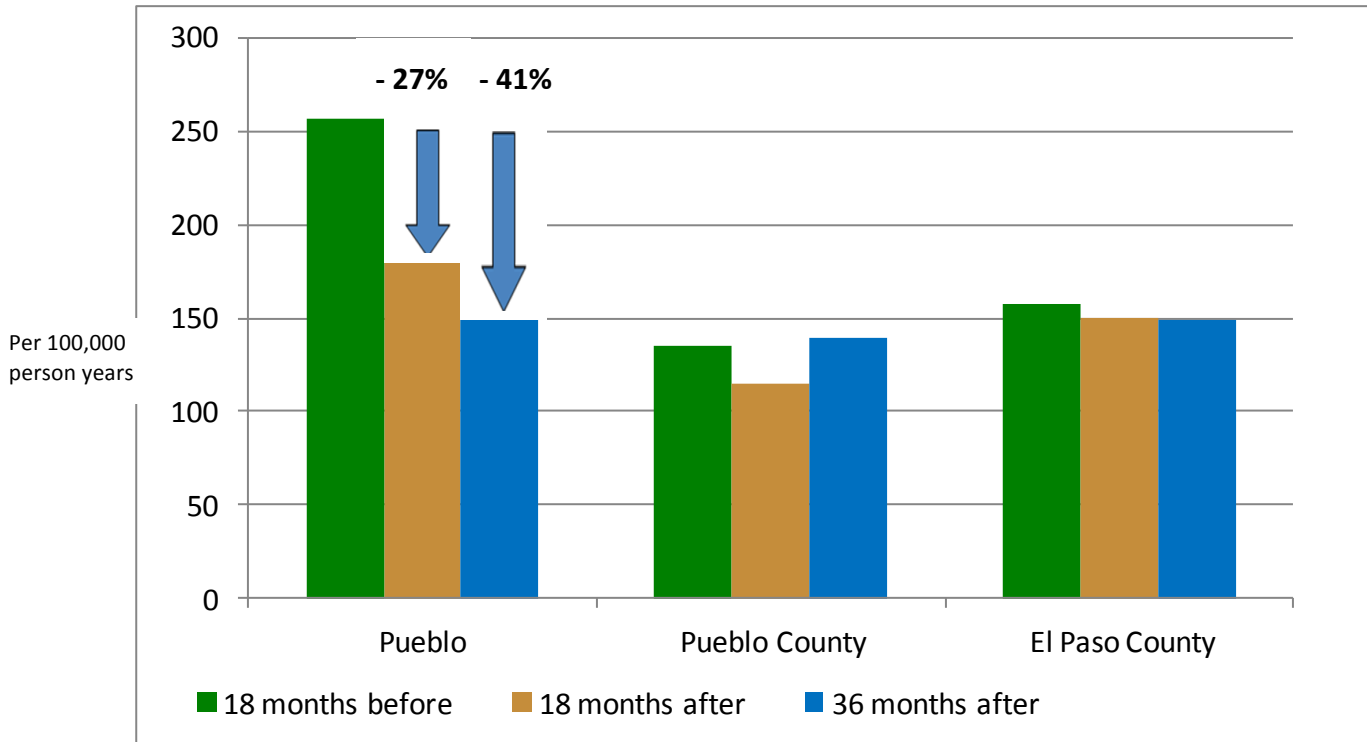
A recurring theme is demonstrated by a growing body of evidence showing that smokefree policies are proven to provide health benefits for both smokers and nonsmokers. Health benefits are especially greater among non-smokers as seen in studies that found reductions of 30% - 60% among non-smokers for hospitalization for heart attack within the first year of law for smokefree workplaces and public places.<sup>19,36</sup> A Swiss study found a 50% reduction for such hospitalizations among people previously diagnosed with coronary heart disease.<sup>30</sup>

Such evidence reinforces the Centers for Disease Control & Prevention recommendation that physicians advise their patients at risk of or with known coronary heart disease to avoid places where they may be exposed to secondhand smoke.<sup>37</sup>

Smokefree policies have also been associated with reductions of medical emergencies. The Colorado state smokefree law went into effect July 2006 for all public places and workplaces except for casinos. The state law was amended to include casinos effective January 2008. A review of ambulance calls for Gilpin County with its 26 casinos (Black Hawk and Central City) found when the 2006 law went into effect, there was a 23% drop in ambulance calls for non-casino locations and the rate for casino locations remained steady. When the 2008 law went into effect, the rate for calls to non-casino locations (which have already been smokefree for 1 ½ years) remained steady; and the rate for casino locations decreased 19%. This indicates a strong correlation between policies for smokefree public places and an approximately 20% decrease in medical emergencies.<sup>38</sup>



**Figure 2 – Hospitalizations for Heart Attacks; Pueblo, Colorado 2002-2006**



**Conclusions**

Public places with smoking in Branson had over 67 times the fine particulate matter air pollution of the smokefree public places. Average air quality for a smokefree public place was rated “good” by EPA standards, while that of smoking locations was “very unhealthy”.

Full-time employees in public places that allow smoking are exposed to 370% the established annual EPA exposure limit to protect human health from fine particle air pollution.

Employees and patrons in public places in Branson where smoking occurred were exposed to very unhealthy levels of an air pollutant known to cause heart disease, cancer and other diseases.

Peer-reviewed studies have demonstrated that policies prohibiting smoking in public places and workplaces dramatically reduce secondhand smoke exposure and improve employee and public health.

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