

Sedalia

Air Quality Monitoring Study



CASE

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 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 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.

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.

The purpose of this study was to sample the air quality in Sedalia public places and workplaces and compare results to the EPA Air Quality Index. Indoor air quality for fine particulate matter pollution (PM_{2.5} particles) was sampled in 8 public places on before and after the city smokefree ordinance went into effect. Five locations allowed smoking indoors and three locations were smokefree.

Key findings of this study include:

- Before the ordinance was in effect:
 - Particulate matter air pollution for –
 - The 5 smoking-allows locations averaged 66 $\mu\text{g}/\text{m}^3$ (EPA rating of “unhealthy”).
 - The 3 smokefree locations averaged 25 $\mu\text{g}/\text{m}^3$ (EPA rating of “moderate”).
 - The level of particulate matter air pollution was over 2½ times higher in places that allowed smoking compared to those where smoking was not allowed.
 - Due solely to their occupational exposure, a full-time employee in one of those Sedalia public place that allowed smoking was exposed to 136% the EPA's average annual limit for particulate matter air pollution.
 - On average, about 2.8% of people were actively smoking in the locations where smoking was permitted. This is about 1/8th the adult smoking prevalence of 23.6% for Pettis County, and refutes the commonly held misperception that a higher percent of hospitality industry customers or employees smoke.
 - After the ordinance was in effect:
 - No incidents of smoking were observed in any of the monitored public places, indicating high compliance with the ordinance.
 - Particulate matter air pollution for the public places that previously allowed smoking averaged 10 $\mu\text{g}/\text{m}^3$ (EPA rating of “good”) and represents an 84% reduction for this pollutant.
 - A full-time employee in one of these Sedalia public places that previously allowed smoking would be exposed to only about ½ the EPA's average annual limit for particulate matter air pollution.

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 SHS.

Introduction

Secondhand smoke (SHS) 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.¹ Exposure to SHS is responsible for an estimated 35,000 deaths per year from heart disease and lung cancer in nonsmokers.² 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.^{1,3,4}

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.

On June 17, 2013, the Sedalia City Council adopted an ordinance for all public places and workplaces to be smokefree effective September 1, 2013.

Policies prohibiting smoking have been shown as an effective method for eliminating SHS 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 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,⁵ but unlike Sedalia, 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_{2.5}) 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/m³. 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/m³). EPA assigned levels for PM_{2.5} ranging from "good" to "hazardous" with accompanying health advisories as presented in Table 1.⁶ 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 _{2.5} (µg/m ³)	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.

Methods

Overview

Particulate matter smaller than 2.5 micrograms (PM_{2.5}) 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 8 public places in Sedalia on April 23, 2010 when no smokefree ordinance was in place. Five of the locations allowed smoking indoors, three locations did not. The same locations were sampled again on November 1, 2013 after a smokefree ordinance was in place for two months.

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_{2.5}. 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.

Locations were visited between 6 p.m. and 9 p.m. A minimum of 40 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_{2.5} concentration within the location.

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

Results

Samplings prior to the smokefree ordinance saw average PM_{2.5} levels for the 5 locations that allowed smoking at 66.0 $\mu\text{g}/\text{m}^3$ (range: 23.1 – 107.7 $\mu\text{g}/\text{m}^3$). The 3 smokefree locations had an average PM_{2.5} level of 24.8 $\mu\text{g}/\text{m}^3$ (range: 6.1 – 39.0 $\mu\text{g}/\text{m}^3$). The level of particulate matter air pollution was 2.7 times higher in those locations that allowed smoking compared to those prohibiting smoking. On average, 1.7 cigarettes (range: 0.2 – 1.8 cigarettes) were burning during the monitoring time frame at smoking venues. This represents an overall average of 2.8% of patrons smoking at any given time. Tables 2 and 3 provide additional details of the monitored venues.

Table 2. Sedalia Air Quality Data before ordinance

Location	Average # burning cigarettes	Active smoker density	% burning cigarettes to # people	Average PM _{2.5} level (µg/m ³)	EPA Air Quality Index category
A*	-	-	-	29.4	Moderate
B*	-	-	-	39.0	Unhealthy to Sensitive Groups
C*	-	-	-	6.1	Good
Average	-	-	-	24.8	Moderate
D	0.2	0.10	2.6	107.7	Unhealthy
E	1.8	0.69	2.4	23.1	Moderate
F	0.8	0.22	1.5	77.4	Unhealthy
G	0.8	0.04	0.6	45.3	Unhealthy to Sensitive Groups
H	4.8	0.38	20.5	76.5	Unhealthy
Average	1.7	0.29	2.8	66.0	Unhealthy

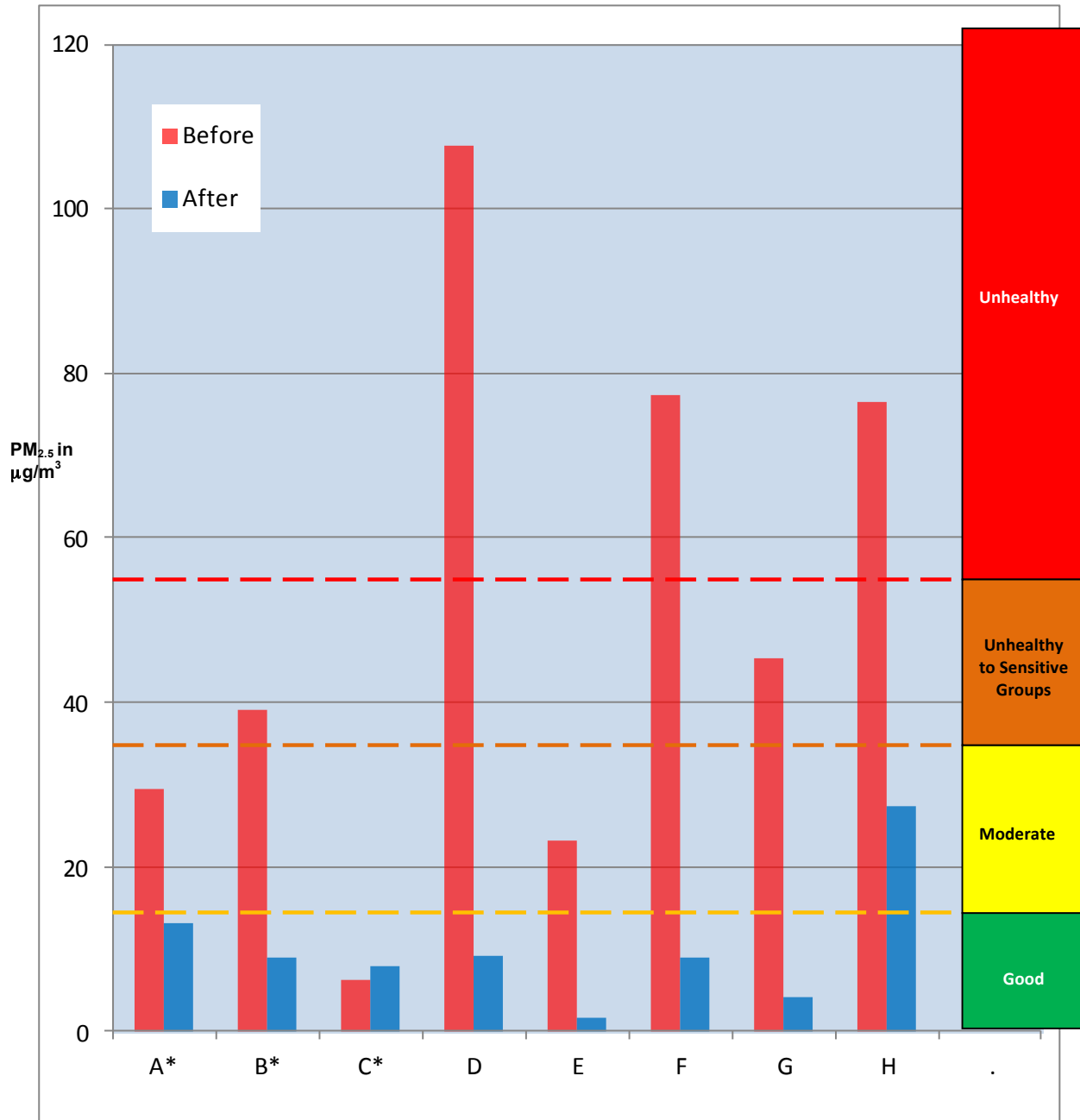
*smokefree venue
^no smoking observed

Samplings after the smokefree ordinance saw decreases for every one of the 5 locations that previously allowed smoking. The average PM_{2.5} levels for these locations was 10.3 µg/m³ (range: 1.6 – 27.4 µg/m³) for an overall reduction of 84.5% for fine particulate matter pollution (see Table 3 for details).

Table 3. PM_{2.5} Levels in Sedalia Public Places that previously allowed smoking

Public Place	Before Ordinance		After Ordinance		% PM _{2.5} change
	Average PM _{2.5} level (µg/m ³)	EPA Air Quality Index category	Average PM _{2.5} level (µg/m ³)	EPA Air Quality Index category	
D	107.7	Unhealthy	9.1	Good	-91.6%
E	23.1	Moderate	1.6	Good	-93.1%
F	77.4	Unhealthy	9.0	Good	-88.4%
G	45.3	Unhealthy to Sensitive Groups	4.1	Good	-90.9%
H	76.5	Unhealthy	27.4	Moderate	-64.2%
Average	66.0	Unhealthy	10.3	Good	-84.5%

Figure 1 presents air quality data of the 3 smokefree and 5 previously smoking-allowed places with comparison to the EPA Air Quality Index standards.



NOTE: *A,B,C smokefree before ordinance

Figure 1 – Air Quality Measures for Sedalia Public Places – Before/After Ordinance

Discussion

Fine particulate matter pollution is composed of extremely small particles that when inhaled can reach the deepest regions of the lungs. Exposure to PM_{2.5} is linked to a variety of significant health problems, ranging from aggravated asthma to premature death in people with heart and lung disease.⁷ In indoor environments, secondhand smoke from burning tobacco accounts for 85% to 95% of fine particulate matter pollution. As such, this type of air pollution can be viewed as an indicator of the presence of the more than 7,000 other chemicals found in secondhand smoke, of which over 250 are toxic and at least 60 are known causes for cancer in humans.⁸

Pre-Ordinance

Before the Sedalia smokefree ordinance was in effect PM_{2.5} pollution was 2.7 times higher in public places that permitted smoking compared to the smokefree public places (66 µg/m³ vs. 24.8 µg/m³).

Of the 5 smoking-allowed venues:

- 1 had air quality classified as “moderate”
- 1 as “unhealthy for sensitive groups” (such as asthmatics)
- 3 as “unhealthy”

The average air quality in the sampled smoking-allowed public places was classified as “unhealthy” while the average air quality for the smokefree public place was classified as “moderate”.

Due solely to occupational exposure, a full-time employee in one of these smoking-allowed public places was 136% the EPA’s average annual daily limit for particulate matter air pollution.

Counts of the number of people and of the number of burning cigarettes revealed on average 2.8% of the people in these public places were actively smoking, which is about 1/8th the adult smoking prevalence of 26.3% for Pettis County.⁹

Post-Ordinance

Average particulate matter air pollution for the 5 public places that previously allowed smoking was 10.3 µg/m³, a decrease of 84.5% compared to the 66 µg/m³ average seen before the ordinance was in effect. Of these 5 previously smoking-allowed venues that became smokefree under the city ordinance:

- 4 now had air quality classified as “good”
- 1 as “moderate”

Occupational exposure to this type of air pollution was found to be only about half (52%) of the EPA average annual daily limit rather than the 136% noted prior to the ordinance.

Health Considerations

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.¹⁰ Similarly, a study of 22 hospitality venues in western New York found a 90% reduction in PM_{2.5} levels in bars and restaurants and an 84% reduction in large recreation venues.¹¹ Similar findings of reductions of more than 90% of PM_{2.5} levels in public places were reported after several communities in Kentucky implemented smokefree workplace ordinances.¹²

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 1/4th the EPA limit.¹³

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.^{14,15,16} 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.^{17,18} Examination of blood chemistries of smokers and nonsmokers found harmful effects on the cardiovascular system after even brief exposures of only minutes to hours.^{19,20}

A “66 casino” study by Repace found that incremental PM_{2.5} 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.¹³

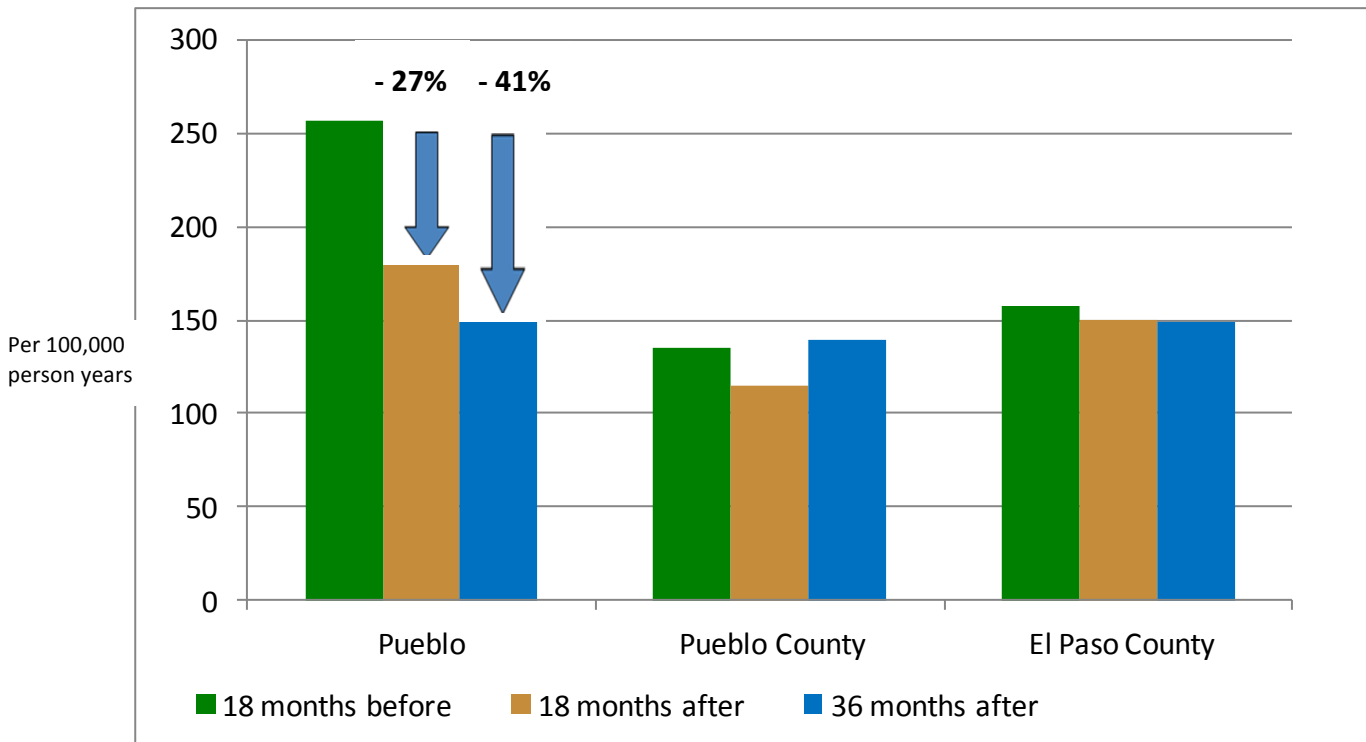
The EPA determined that even short term exposure to PM_{2.5} air pollution can aggravate irregular heartbeat, set the stage for heart attacks and, for those with heart disease, can cause a heart attack with no warning symptoms. Older adults are at greater risk as they may have undiagnosed heart disease.²¹ 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 SHS) in the bodies of bar and/or casino employees or customers.^{22,23} 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.²⁴

With such evidence becoming more established and recognized by policymakers, a resolution was adopted on January 10, 2009 by the Executive Committee of the National Council of Legislators from Gaming States to support 100% smokefree gaming venues as a prerequisite for issuing/renewing gaming licenses.²⁵ To date, 19 out of the 40 states that have casinos or racinos also have laws requiring non-tribal casinos to be smokefree.²⁶ Over 500 state-regulated non-tribal gambling facilities are required to be smokefree by law.²⁷

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.^{28,29,30,31,32,33,34,35,36,37,38} 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.^{39,40}

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



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.^{19,41} A Swiss study found a 50% reduction for such hospitalizations among people previously diagnosed with coronary heart disease.³⁰

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.⁴²

Smokefree policies have also been associated with reductions of medical emergencies. The Colorado state smokefree law went into effect January 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 two 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.⁴³

Conclusions

Prior to the enactment of the Sedalia smokefree ordinance, smoking-allowed public places in the city had about 2½ times the fine particulate matter air pollution of the smokefree public places. Average air quality for a smokefree public place was rated “moderate” by EPA standards, while that of smoking-allowed locations was “unhealthy”.

After the ordinance, fine particulate matter air pollution was reduced 84% for places that previously allowed smoking and air quality improved to a rating of “good”.

Before the ordinance, full-time employees in public places that allow smoking were exposed to 136% the established average annual daily EPA exposure limit to protect human health from fine particle air pollution. After the ordinance these same places saw a decline to only about half (52%) the EPA exposure standard.

Employees and patrons in public places in Sedalia where smoking had been allowed were exposed to unhealthy levels of an air pollutant known to cause heart disease, cancer and other diseases. Air quality in regard to fine particulate matter pollution in formerly smoking-allowed public places is no longer considered a threat to the health of employees or the public.

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