

THE POTENTIAL HEALTH IMPACTS OF RESIDENTIAL WOOD BURNING



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Air Resources Board



California Environmental Protection Agency

Thank you Mr. Goldstene. Good morning, Chairman Nichols and members of the Board. In this health update, I am going to discuss potential health impacts associated with residential wood burning. This presentation will focus on several studies examining exposure to wood smoke and associated health effects.

Wood Smoke Emissions

Background

- **Can be from 20% to 80% of ambient wintertime particulate matter (PM)**
- **Is a complex mixture of health damaging pollutants**
- **Readily penetrates other households throughout neighborhoods and regions**



2

Concern over the health effects from residential wood burning has been increasing over the past several years. In some California communities, wood smoke can comprise 20 to 80 percent of ambient particulate pollution. Wood smoke consists of several pollutants, including: carbon monoxide, nitrogen dioxide, particulate matter (or PM), and other irritating and toxic components. Residential wood burning affects ambient and indoor air quality locally, throughout neighborhoods and regionally. In addition to the smoke that can be released inside the home, studies show that up to 70 percent of smoke from chimneys can actually reenter the home and other neighborhood dwellings (1). In the winter, we often have weather conditions that cause stagnant air. As a result, wood smoke is trapped close to the ground. To illustrate this point, the photograph in this slide shows wood smoke lingering in the San Joaquin Valley.

1. Pierson, W.L., Koenig, J.K., & Bardana Jr, E.J. 1989. Potential adverse health effects of wood smoke. *West J Med.* 151(3): 339–342.

Panel and Chamber Studies

- **Decreased lung function in asthmatic children with exposures to combustion generated components of ambient PM_{2.5}¹**
- **Increases in airway inflammatory markers with ambient exposure to local combustion in adult asthmatics²**
- **Increases in inflammatory markers and in blood-clotting markers in healthy adults from wood smoke exposure³**



1. Allen R, et al. 2008. *Inhal Toxicol* 20(4):423-433.
2. Jansen, K., et al. 2005. *Environ. Health Perspect.* 113(12):1741-1746.
3. Barregard L, et al. 2006. *Inhal Toxicol* 18(11):845-853.



3

Although many studies have shown that exposure to the components that are found in wood smoke are associated with adverse health effects, few recent studies have tried to parse out effects specifically related to wood smoke. In a panel of asthmatic children in Seattle, Allen and colleagues found lung function decreases with exposure to the combustion generated components of PM_{2.5}, particularly wood smoke (1). In this same Seattle panel, Jansen and colleagues monitored a group of adult asthmatics and evaluated the relationship between inflammatory markers and PM_{2.5} sources. Local combustion, including wood smoke, was the particle source most consistently associated with increases in these markers (2). In one of the few wood smoke chamber studies, researchers found substantial increases of inflammatory markers associated with cardiovascular disease and markers associated with the ability of the blood to clot properly when compared to clean air exposure among healthy volunteers (3).

1. Allen, R.W., Mar, T., Koenig, J., Liu, L.-J.S., Gould, T., Simpson, C., Larson, T. 2008. Changes in lung function and airway inflammation among asthmatic children residing in a woodsmoke-impacted urban area. *Inhal Toxicol.* 20(4):423-33. Supported by the USEPA.
2. Jansen, K.L, Larson, T.V., Koenig, J.K, et al. 2005. Associations between health effects and particulate matter and black carbon in subjects with respiratory disease. *EHP* 113(12):1741-1746. Supported by the USEPA.
3. Barregard L, Sallsten G, Gustafson P, Andersson L, Johansson L, Basu S, et al. 2006. Experimental exposure to wood-smoke particles in healthy humans: effects on markers of inflammation, coagulation, and lipid peroxidation. *Inhal Toxicol.* 18(11):845-853. Supported by the Swedish EPA.

Population Based Study

- **10% increase in asthma hospital admissions among children associated with wood and agricultural burning**
- **8% increase in respiratory and 4% increase in cardiovascular hospital admissions among seniors associated with wood and agricultural burning**



1. Anderson, Z., et al. 2007. *J. Expos. Sci. Environ. Epidemiol.* 17(7):625–636.

4

In a population based study in Copenhagen, Anderson and colleagues reported that of several particulate matter sources, wood and agricultural burning showed the strongest association with respiratory hospital admissions among children and senior adults. Hospital admissions for asthma among children increased 10% in association with wood and agricultural burning. In seniors, risk of respiratory admissions increased 8% and cardiovascular admissions increased 4% for every 5.4 micrograms per cubic meter increase in particulate matter attributed to wood and agricultural burning (1).

1. Anderson, Z. J., Wahlin, P., Raaschou-Nielsen, O., Scheike, T., and Loft, S. 2007. Ambient particle source apportionment and daily hospital admissions among children and elderly in Copenhagen. *J. Expos. Sci. Environ. Epidemiol.* 17(7):625–636. Supported by the Danish Research Council.

Current ARB-Funded Projects

- **Effects of wood smoke exposure on cardiopulmonary responses in healthy and asthmatic adults (UCSF)**
- **Exposure assessment of residential wood smoke sources (Cal Poly)**



5

While published reports have shown some adverse health effects of wood smoke exposure, gaps in our knowledge still exist. To help fill these gaps, ARB has an active research program on wood smoke exposure and health. We are providing funding to the University of California, San Francisco to examine the effects of controlled wood smoke exposure on cardiopulmonary responses in both healthy and asthmatic adults. We are also providing funding to Cal Poly researchers to clarify the nature of wood smoke exposures in a community with active residential wood burning.

Current In-House Projects

- **Potential effects of residential wood burning regulations and reductions in pollution and health impacts in the San Joaquin Valley**
 - Preliminary results show decreases in cardiovascular and respiratory hospitalization and deaths
- **Comparison of emissions from wood burning devices**



6

ARB has two in-house projects related to residential wood smoke. The first is examining the health impacts in the San Joaquin Valley following a strengthening of residential wood burning regulations. Not only did ambient air pollution decrease substantially after implementation of the regulation, we found that cardiovascular and respiratory hospitalizations and deaths decreased significantly, as well. These results were recently presented at the International Society for Environmental Epidemiology. The Central Valley Health Policy Institute has also performed a similar in-depth analysis using different methodologies and found comparable results.

The second study examined indoor emissions from different types of wood burning devices.

We have recently completed data collection in this study and the findings will be released later this year.

Conclusions

- **Negative health effects are associated with wood smoke exposure**
- **Wood smoke can dominate ambient air pollution**
- **Several air districts implementing regulations to meet standards and protect health**



7

Exposure to wood smoke is associated with adverse health effects. Wood smoke can be the dominant component of wintertime ambient air pollution. Concern over air quality has prompted several air districts and municipalities to initiate various degrees of residential wood burning restrictions when air quality is forecasted to be poor. Implementation of these regulations has been coupled with public education and there are indications that some of these campaigns have been successful in improving air quality and health. This will help us meet our air quality standards and protect the health of all Californians. This concludes my presentation. We will be happy to answer any questions you may have.