

# Women and Long-Term Air Pollution Impacts

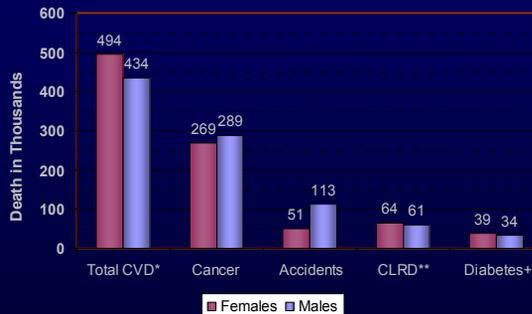


Air Resources Board  
California Environmental Protection Agency

Thank you Ms. Witherspoon and good morning Dr. Sawyer and members of the Board. Today's health update will focus on the results of an important new study that evaluates the possible link between the long-term fine particulate matter air pollution and cardiovascular mortality and disease in women. Before discussing the study, I would like to briefly provide you with some background information.

## Women & Cardiovascular Disease

### Leading Causes of Death in the United States: 2002



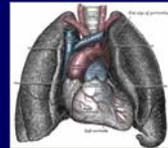
Cardiovascular Deaths (CVD)  
Chronic Lower Respiratory Diseases (CLRD),  
Diabetes Mellitus (Diabetes)

Source: CDC/NCHS

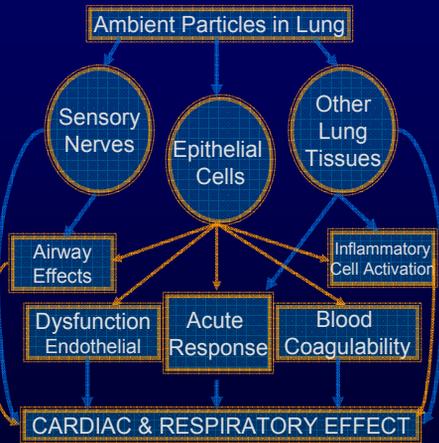
- Almost 1 in 2 women die of CVD vs. 1 in 25 women who die of breast cancer
- CVD kills ~500,000 American women each year (60,000 more than men)
- Studies suggest women are more at risk
  - Kunzli et al., Air Pollution and Atherosclerosis in LA, 2005 (Univ. of Southern CA)
  - Chen et al., Fatal CHD & Air Pollution, 2005 (Loma Linda Univ.)

Let me first begin with what we know from death statistics. Cardiovascular disease, which includes coronary heart disease and stroke, is the leading cause of death in the US. We know that approximately 40% of all female deaths in America occur from cardiovascular disease. In other words, almost one in two women die of heart disease or stroke, compared with one in 25 women who die of breast cancer. This means that cardiovascular disease kills approximately half a million American women each year nation wide which is 60,000 more women than men. In addition, some epidemiological studies suggest that the increased risk from fine particles may be gender specific with postmenopausal women being more susceptible. Two of these studies were previously presented to the board on September and December of 2005: the Kunzli et al. study on Air Pollution and Atherosclerosis from the University of Southern California and the Chen et al., study on Fatal Coronary Heart Disease and Air Pollution from Loma Linda University.

## Biological Mechanisms of PM Health Effects



### Possible Mechanism for PM Health Effects

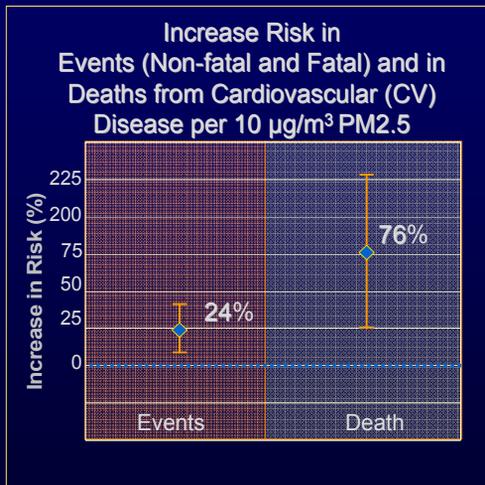


- Women may be more susceptible to coronary disease than men due to life style and other factors
- Mechanisms may involve a number of pathways
- US EPA's PM Centers and others are currently investigating mechanisms

Today we know that particles are clearly and consistently associated with adverse health impacts. Epidemiologic and experimental investigations support the association of ambient particulate matter exposure to cardiovascular disease. However, the biological mechanisms for PM health effects are not clearly understood and less understood are the mechanisms that may be causing the observed gender effects seen nationwide. In addition, women may be more susceptible to coronary disease than men due to life style choices and other factors that increase the risk of vascular disease such as hypertension, diabetes, obesity, and inactivity, all of which are seen more frequently in postmenopausal women than in men.

The figure to your left highlights the complex pathways in which particulate matter exposure can lead to cardiovascular disease. These can involve sensory nerve effects, inflammation of lung tissues, the impacts on epithelial cells and other lung tissues, and mechanisms for blood coagulability. These possible biological mechanisms are currently being investigated by the US EPA's PM Centers and others.

## Women's Health Initiative Study of PM2.5



- ~65,000 older women from 36 US cities
- PM<sub>2.5</sub> measurements for the year 2000
- Risk estimated for first CV event
- Results: for a 10  $\mu\text{g}/\text{m}^3$  increase in PM<sub>2.5</sub>
  - 24% increase risk in CV events
  - 76% increase risk in death from CV disease

Miller et al., "Long-Term Exposure to Air Pollution and Incidence of Cardiovascular Events in Women", *The New England Journal of Medicine*, vol. 356 no. 5, February 2007

I will now summarize what we've learned from the study being highlighted today titled "Long-Term Exposure to Air Pollution and Incidence of Cardiovascular Events in Women" published in February, 2007.

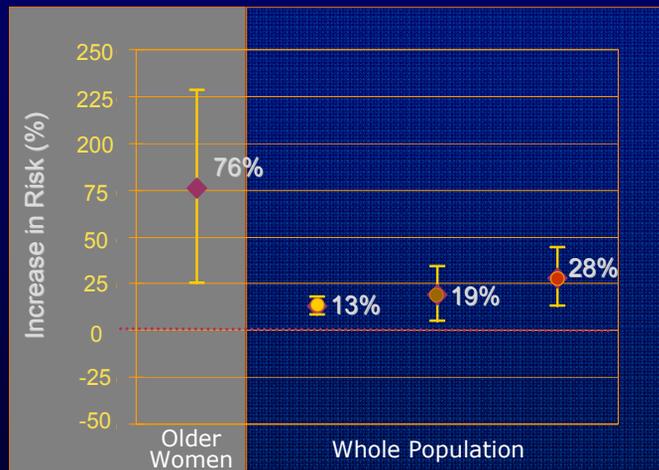
The participants of this study were part of the fifteen-year Women's Health Initiative. The scientists analyzed the medical records of about 65,000 postmenopausal women from 36 US cities. The average age of the women in this study was 63 years. PM<sub>2.5</sub> measurements from the year 2000 were used. The closest monitored PM<sub>2.5</sub> values was assigned to the participant's home zip code.

Risk was estimated for the first cardiovascular event confirmed by a review of the medical records. An event consisted of non fatal and fatal cardiovascular event such as heart attack, stroke, arterial or cerebrovascular disease. This study included controls for a comprehensive list of potential confounding factors such as age, smoking status, obesity, presence or absence of diabetes and hypertension.

As seen in this graph the results from this women's study indicate that for each 10  $\mu\text{g}$  per cubic meter increase in PM 2.5 there is a 24% increase risk of a cardiovascular event and the risk of dying from heart attack or stroke is increased by 76%.

The next slide will compare these results to other well known general population US studies.

## Risk for Death from Cardiovascular Disease per 10 $\mu\text{g}/\text{m}^3$ Increase in PM2.5



◆ Miller et al. 2007, Women's Health Initiative Study  
● Krewski et al. 2000, American Cancer Society's Study  
● Krewski et al. 2000, Six Cities Study  
● Laden et al. 2006, Harvard Six Cities Study

This slide shows that the risk of death associated with PM2.5 in the Women's Health Initiative Study was larger than that reported in previous well known general population U.S. studies. As mentioned previously the investigators estimated an overall 76% increase in risk of death from heart attack and stroke with long-term PM2.5 exposure, however, one must note that the confidence bounds are much greater than previous studies likely because of a smaller sample size. Previous general US population studies estimated an increase risk of 13% for death from all cardiovascular causes associated to long-term PM2.5 exposure in the American Cancer Society's study and 19% in the Six Cities Study. The more recent analysis of the six cities study by Laden et al. resulted in a higher estimated risk for cardiovascular disease of 28%, but it is still less of an estimated risk than that for Women's Health Initiative study.

The larger effect sizes observed for levels of PM2.5 in this study could be due to the characteristics of the study population. For example, in this study only post menopausal women without diagnosed CV disease were included, while the previous, larger studies included men and women who may have had previously diagnosed cardiovascular disease.

## Conclusion



- Women's Health Initiative study is especially relevant because it found a stronger effect from PM<sub>2.5</sub> on premature cardiovascular death, one of the leading causes of women's mortality in the US
- ARB's California Teachers Cohort Study will further our understanding of women's susceptibility to PM<sub>2.5</sub>
  - Preliminary results show a high association between PM<sub>2.5</sub> and CVD
  - Additional analysis will include exposure timeframes, never smokers, and PM<sub>2.5</sub> constituents
- The WHI study supports the Board's future regulatory and policy decisions that affect the health of California's women

What makes the Women's Health Initiative study especially relevant is that the investigators studied postmenopausal women and found a stronger effect than previously reported of fine particulate matter exposure on premature cardiovascular death, which is one of the leading causes of women's mortality in the US.

Although the results presented today do not answer why women's risk might be higher, the ARB has funded a study, the California's Teacher cohort study, which should further add to our understanding of women's susceptibility to PM fine. Preliminary results show a high association between PM<sub>2.5</sub> and Cardiovascular Disease. Additional analysis will include investigations into the effects of different accumulated years of PM<sub>2.5</sub> exposure and the effects of PM<sub>2.5</sub> on postmenopausal women that have never smoked. Also investigated will be the effects of certain PM<sub>2.5</sub> constituents such as ammonium nitrate and sulfate, organic carbon and elemental carbon.

In summary, the study highlighted today supports the Board's regulatory activities and policy decisions that affect the health of California's women and it provides stronger justification for attaining the ambient air quality standards.

This concludes my presentation. We will be happy to answer any questions.  
Thank you very much.