

PARTICULATE AIR POLLUTION AND INFANT MORTALITY



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AIR RESOURCES BOARD
CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

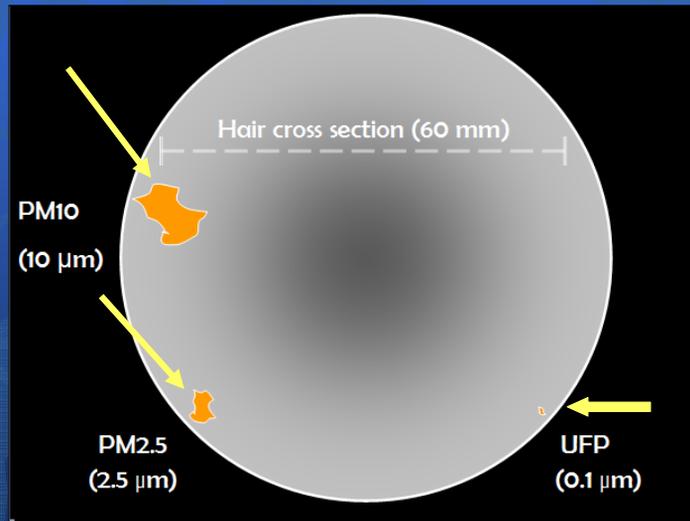
SLIDE 1

Thank you Ms. Witherspoon. Good morning Dr. Sawyer and members of the Board. In today's Health Update I will discuss the results of two studies evaluating the possible association between particulate air pollution and infant mortality in California.

As we know, several studies have reported increased risks of premature death in adults and especially in the elderly due to particulate pollution. However, much less information exists on the adverse effects of particulate pollution on infant death. Understanding the relationship between particulate pollution and infant health is very important, since infants may be especially vulnerable to air pollution. Compared to adults, infants have increased breathing frequency, their lungs are developing and their detoxification pathways may be underdeveloped.

RELATIVE SIZES OF PARTICLES

PM in the air has 3 size ranges



PM10 = Coarse + Fine + Ultra-Fine

PM2.5 = Fine + Ultra-Fine 2

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The studies being presented to you today investigate the effects of two different particle size fractions, PM10 and PM2.5. PM10 is composed of particles in three size ranges, coarse, fine and ultra fine, which exist mixed together in the ambient air. PM2.5 includes only fine and ultra-fine particles. This picture is a cross section of a human hair; drawn inside is the size of PM10, PM2.5 and ultra fine to help put in perspective the size distributions of these particulate measures.

WHY ARE WE CONCERNED WITH PARTICLES?



- Attaining the State PM_{2.5} standard would prevent ~8,200 adult premature deaths annually in California
- Substantial evidence that PM exposure is associated with cardiovascular deaths in adults
- Evidence that PM exposure is associated with respiratory-related deaths in infants
- Californians have a disproportionate share of PM exposure

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Why are we concerned with particles? We've estimated that attaining the State PM_{2.5} annual average standard would prevent approximately 8,200 adult premature deaths annually in California.

We know from previous research findings that particulate matter exposure is associated with cardiovascular death in adults. Where as, in infants, particulate matter seems to be more associated to respiratory-related death.

In addition, Californians have a disproportionate share of the national exposure to particulate pollution. Californians receive more than 60% of the population-weighted exposure to PM_{2.5} values above the National annual average standard of 15 ug/m³.

Less Known are the Effects of PM on Children Especially Infants



- London, England 1952 - increase in infant death due to the "Great Fog"
- Sao Paulo, Brazil - 7% increased risk of respiratory death in children less than 5 years old due to PM10
- Seoul, South Korea - 102% increased risk of respiratory death in infants compared to 6.3% increased risk in those over 65 due to PM10
- United States - 20% increased risk of respiratory death among normal birth weight infants due to PM10
- Gaps in knowledge - Infant/Birth Outcome
 - The next two California studies help close the gap

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Less known are the effects of PM on Children especially infants. A few studies around the world and in the US have related PM to infant death.

Evidence of PM's deadly effects was dramatically illustrated by the infamous "Great Fog" that gripped London in 1952, officially killing 4,000 people. A later review of infant death during the Great Fog found that in the week before, 15 newborns died. During the Fog, that number jumped to 28, an 87 percent increase.

Brazilian scientists linked childhood death under the age of 5 to PM10 and determined a seven percent increased risk of death.

In Seoul, South Korea, investigators found PM10 associated with a 102% increased risk of respiratory death in infants as compared to 6.3% increased risk in individuals over 65.

In the United States, Woodruff and colleagues conducted a study to evaluate the relationship between infant death and particulate pollution in several metropolitan areas across the United States. They found a 20% increased risk in infant respiratory death among normal birth weight infants associated with PM10 exposures.

There still exists a gaps in our knowledge due to the difficulty in carrying out these types of studies. The low numbers of infant deaths are good news, however, it makes studying the effects from environmental factors challenging.

The next two studies I'll discuss not only help close some of the gap in our knowledge, but more importantly provide us with the effects of particulate matter on infant death within California.

METHODS - PM10 & Infant Death



"Air Pollution and Infant Death in Southern California, by Ritz et al. 1989–2000, PEDIATRICS Volume 118, Number 2, August 2006

- South Coast Air Basin
- Postneonatal = infant between 28 days and 1 yr. old
- 1989 to 2000, birth and death certificates
 - 11 years of data and 19,664 deaths
- Zip codes within 16 km of a PM10 station
- PM10 averages of 2-weeks through a 6-month period
- Controlled for maternal confounding effects

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The first study is titled, "Air Pollution and Infant Death in Southern California, 1989 to 2000" by Professor Ritz and colleagues. The objective of this study was to evaluate the influence of outdoor air pollution on postneonatal infant death in the South Coast Air Basin in California. These are infants between 28 days old and 1 year old.

The investigators in this study linked birth and death certificates for infants who died between 1989 and 2000. There was a total of 19,664 infant deaths for these 11 years of data. They selected maternal zip codes within a 16 km radius of a PM10 monitoring station. For all subjects, they calculated average PM10 exposures for a 2-week, 1-month, 2-month, and 6-month period before the infant's death. Investigating the effects from these different exposure averages allowed the investigators to determine the most critical window of exposure responsible for deaths due to all causes, respiratory-related, and sudden infant death syndrome. The investigators controlled mother's demographic factors, such as race, education, age, marital status, and smoking.

RESULTS - PM10 & Infant Death



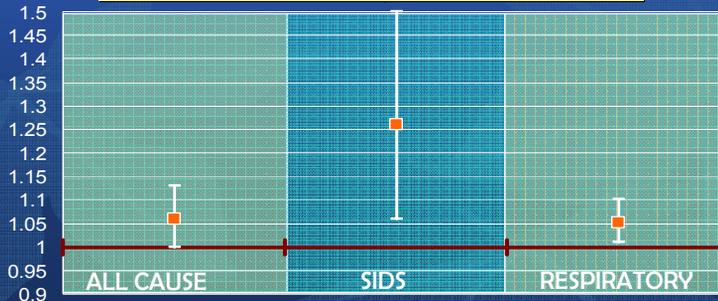
Preterm or Low Birth Weight - 2 month avg. PM10

- A 6% increased risk in all cause of death [1%–13%]
- A 26% increase risk in SIDS [6% – 50%]

Includes all infants regardless of weight - 2 week avg. PM10

- A 5% increase risk in respiratory-related death [1%–10%]

Death Associated Per 10 $\mu\text{g}/\text{m}^3$ Increase in PM10



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Ritz et al, "Air Pollution and Infant Death in Southern California, 1989–2000, PEDIATRICS Volume 118, Number 2, August 2006

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The results of this study adds further evidence of a PM10 air pollution effect on all-cause, respiratory-related infant death and sudden infant death syndrome, or SIDS. For preterm birth infants or low birth weight infants, the investigators found a 6% increased risk in all cause deaths and a 26% increased risk in SIDS associated with a 10 $\mu\text{g}/\text{m}^3$ increase of PM10 exposure averaged over two-months prior to death. On a shorter window of exposure and for all infants regardless of birth weight, the investigators found that a 5% increased risk in respiratory-related death due to PM10 exposures averaged over the two-weeks prior to death.

METHODS - PM 2.5 & Infant Death



“Fine Particulate Matter (PM 2.5) Air Pollution and Selected Causes of Postneonatal Infant Mortality in California” by Woodruff et al. Environmental Health Perspectives, volume 114, Number 5, May 2006

- All of California
- Postneonatal = infant between 28 days and 1 yr. old
- 1999 to 2000, births & death certificates
 - 2 years of data and 1,606 deaths
- Maternal addresses within 5 miles of a PM2.5 monitor
- Life Exposure = PM2.5 average (birth to death)
- Controlled for maternal confounding factors

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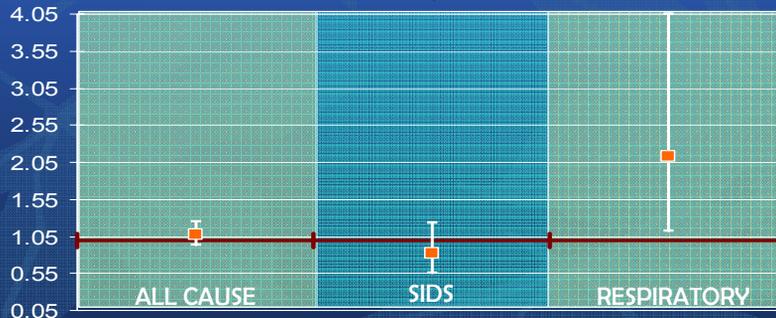
The second study is titled “Fine Particulate Matter Air Pollution and Selected Causes of Postneonatal Infant Mortality in California” by Dr. Woodruff and colleagues. Researchers examined the relationship between long-term exposure to PM2.5 air pollution and postneonatal infant death in all areas of California. They linked monitoring data for PM2.5 to infants born in California in 1999 and 2000 using maternal addresses for mothers who lived within 5 miles of a PM2.5 monitor stations. The total number of infant deaths for these 2 years is 1,606 deaths. Researchers investigated each infant’s death by birth weight category and date of birth. This method allowed the investigators to control for potential effects due to birth weight a known contributing factor to infant death. They calculated exposure as the average PM2.5 concentration over the period of life for the infant who died. As in the previous study, they controlled for maternal demographic factors, such as race, education, age, and marital status. However, in this study, maternal smoking was not controlled for.

RESULTS - PM 2.5 & Infant Death



- A 213% increase risk for respiratory-related death [1.12 - 4.05]
- A 7% increase risk for all cause of death [0.93 - 1.24] (close but not significant)
- SIDS not significant [0.55 - 1.23]

Death Associated Per 10 $\mu\text{g}/\text{m}^3$ Increase in PM_{2.5}



Woodruff et al., "Fine Particulate Matter (PM_{2.5}) Air Pollution and Selected Causes of Postneonatal Infant Mortality in California", Environmental Health Perspectives, volume 114, Number 5, May 2006

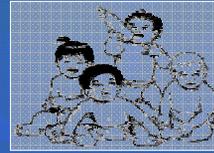
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The strongest association found in this study related to respiratory-related postneonatal infant death. Researchers found a 213% increased risk for respiratory-related infant death associated to a 10 $\mu\text{g}/\text{m}^3$ increase in lifetime PM_{2.5} exposure. The investigators also found a 7% increased risk for all cause death, however the lower end of the range was not statistically significant. The investigators found no significant findings for SIDS.

The large confidence intervals observed for respiratory-related infant deaths is due to the much smaller number of data points the investigators had to work with. There were only 51 cases of respiratory-related infant deaths recorded over the two year period, which coincides with the beginning of PM_{2.5} monitoring in California in 1999.

SUMMARY



- Ritz and Woodruff studies corroborate and add further evidence of a PM effect on infant death
- Not only adults but especially children and infants benefit from PM controls
- Better accounting of maternal tobacco smoke and of indoor exposure in future infant studies
- More studies are needed to fill the gap for the remaining unanswered questions

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In Summary, both studies corroborate previous findings on PM air pollution effects on infant death and add further evidence of an effect in exposures in California. These studies support the observations that not only adults but especially children and infants benefit from PM controls and air quality improvements.

One of the problems encountered most often during the infant studies is controlling for maternal tobacco smoke and indoor PM exposures. Although, birth certificates now include maternal tobacco smoke, this field may not be reliable.

More studies are needed to fill the gap of knowledge for remaining unanswered questions about the consequences of environmental exposure to PM and to provide us with a better understanding of children and infants vulnerability to air pollution.

This concludes my presentation, I will be happy to answer any questions.
Thank you.