Risk Assessment of Air Contaminants

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OEHHA Assessments Support CalEPA Environmental and Public Health Activities

CalEPA Mission:
To restore, protect and enhance the environment, to ensure public health, environmental quality and economic vitality.

OEHHA Mission:
To protect and enhance the health of Californians and our state’s environment through scientific evaluations that inform, support and guide regulatory and other actions.
Outline

- Background: risk, toxicity, and exposure
- How OEHHA determines toxicity
- Factors that influence toxicity
- How OEHHA determines Health Guidance Values for use in estimating risk
- Health concerns associated with some of the chemicals being measured
- How risk is determined from air monitoring data
- How do improvements in air quality affect health?
Risk = Toxicity \times Exposure

How dangerous is the chemical?

Health Guidance Values

Does chemical contact or enter our body?

Air monitoring data
What is Exposure?

https://commons.wikimedia.org/wiki/File:Diesel-smoke.jpg
How do we determine the toxicity of chemicals?

OEHHA develops benchmarks for toxicity called Health Guidance Values:

Noncancer: Reference Exposure Levels (RELs)
The amount of chemical in the air that is not likely to cause noncancer health effects (like asthma) even in sensitive populations like children and pregnant women.

Cancer: Unit risks or cancer potency factors
Describe increase in cancer risk per unit of exposure.

http://clipart-library.com/clipart/163895.htm
What influences toxicity?

- Amount
- Length of exposure (time)
- Sensitivity

https://www.meadindoor.com/for-physicians/
Health effects can become more serious as the amount someone is exposed to increases.
Toxicity depends on the amount of time someone is exposed to a chemical

OEHHA develops Reference Exposure Levels for specific amounts of time

- Brief exposure (acute): occasional 1-hour exposures
- Moderate exposure: repeated 8-hour exposures over a significant fraction of a lifetime
- Constant exposure (chronic): continuous exposures from 1 year to a lifetime

https://accesspharmacy.mhmedical.com/content.aspx?bookid=2462&sectionid=194918140
More people are affected as the amount of chemical they are exposed to increases.

People differ – some are more sensitive than others (like children and pregnant women), while others are less sensitive (resistant).
How are health guidance values developed?

- Review health effects information
- Identify most sensitive effects
- Determine relationship between amount of chemical and effect
- Determine amount that causes a specific effect
- Adjust amount for route, species, length of exposure
- Adjust amount for uncertainty (time differences, missing information, species)
- Adjust amount for differences in sensitivity between people

**Health Guidance Value**

**Hypothetical example**

- 1000 parts per billion (ppb) (rat)
- 100 ppb (human)
- $\div 10$ (no developmental study)
- $\div 10$ (asthmatic children)
- 1 ppb
Particulate Matter

HUMAN HAIR
50-70 μm
(microns) in diameter

PM$_{2.5}$
Combustion particles, organic compounds, metals, etc.
< 2.5 μm (microns) in diameter

PM$_{10}$
Dust, pollen, mold, etc.
< 10 μm (microns) in diameter

90 μm (microns) in diameter
FINE BEACH SAND

https://www.epa.gov/pm-pollution/particulate-matter-pm-basics
Health Concerns: PM$_{2.5}$

- Can reach deep into the lung
- Short-term exposure: respiratory irritation, ↓ lung function, asthma attacks, irregular heartbeat, ↑ respiratory symptoms like coughing, wheezing, shortness of breath
- Short- and long-term exposure: premature death, cardiovascular mortality and hospitalizations, respiratory and asthma hospitalizations
- Sensitive populations
  - Elderly
  - Those with emphysema, asthma, chronic heart/lung disease
  - Infants/children (↑ childhood illnesses, ↓ lung function)
  - Pregnant women (↓ birth weight, preterm birth)

https://www.masters.tw/wp-content/uploads/2015/07/pm2_52.jpg
Health Concerns: Diesel Exhaust

Noncancer
- Respiratory irritation, cough, allergies, lung inflammation
- ↑ hospitalizations, ER visits, asthma attacks, premature deaths

Sensitive populations
- Those with respiratory and cardiovascular conditions
- Children
- Elderly

Cancer
- Increased cancer risk
- ~70% of average Californian’s cancer risk from air pollution (CARB)
Health Guidance Values for Diesel Exhaust

Non-cancer
Chronic REL: 5.0 μg/m³
Effect: Changes in rat lung

Cancer
Unit risk: 0.0003 per μg/m³
Inhalation Cancer Potency Factor: 1.1 (mg/kg-day)^{-1}
Effect: Lung tumors in workers

Health Concerns: Wood Smoke

Contains thousands of chemicals, most concerning are:

- PM\(_{10}\) and PM\(_{2.5}\)
- Carbon monoxide
- Irritants (nitrogen dioxide, sulfur oxides, aldehydes like acrolein and formaldehyde)
  - May play a role in smoke-triggered asthma attacks
- Carcinogens, including polyaromatic hydrocarbons (PAHs), benzene, 1,3-butadiene, formaldehyde

Contributes to indoor air pollution, particularly for PAHs

SJVAPCD program requiring reduction of residential wood burning associated with decreased hospitalization for cardiovascular disease (Yap & Garcia, 2015)

https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQr9ByO6ixDAA_fKV5QxeuMOKWnIcKCGqf6A-yly5nCpBOUQAAdz2w
Health Concerns: Metals

Lung cancer (arsenic, beryllium, cadmium, cobalt, hexavalent chromium, nickel)

Adrenal cancer (cobalt)

Kidney cancer (lead)

Nervous system (arsenic, lead, manganese, selenium)

Respiratory system (beryllium, cadmium, cobalt, hexavalent chromium, nickel)

Liver (selenium)

Kidney (cadmium)

Immune system (beryllium, nickel)

Reproduction and development (arsenic)

Blood (selenium)

Hair, skin, nails (selenium)

https://www.istockphoto.com/in/photo/human-organs-gm497303869-41750622
Health Concerns: Volatile Organic Compounds (VOCs)

- **Nasal tumors** (formaldehyde, naphthalene)
- **Kidney cancer** (ethylbenzene)
- **Leukemia** (benzene)
- **Nervous system** (benzene, hexane, styrene, toluene, xylenes)
- **Respiratory system** (acrolein, formaldehyde, naphthalene, styrene, toluene, xylenes)
- **Liver** (ethylbenzene)
- **Kidney** (ethylbenzene)
- **Reproduction and development** (benzene, ethylbenzene, toluene)
- **Blood** (benzene)

https://www.istockphoto.com/in/photo/human-organs-gm497303869-41750622
Health Concerns: Ammonia

Colorless gas with a sharp and very irritating odor
Contributes to PM$_{2.5}$
Acute REL
• 3200 μg/m$^3$
• Effect: respiratory and eye irritation in humans
Chronic REL
• 200 μg/m$^3$
• Effect: symptoms of exposure and effects on lung function in workers
Susceptible populations
• Persons with asthma and other respiratory conditions, including cardiopulmonary disease

Ammonia sources in San Joaquin Valley (2013)

- Dairy: 125 tons, 38%
- Fertilizer: 118 tons, 36%
- Non-Dairy Livestock: 61 tons, 19%
- Waste Disposal: 10 tons, 3%
- On-Road Motor Vehicles: 4 tons, 1%
- Fuel Combustion: 2 tons, 1%
- Other: 8 tons, 2%

How do we determine the risk from the amount of a chemical measured in air?

**Noncancer**

How does the amount in air compare to the Reference Exposure Level?

- Higher? May be some concern
- Reference Exposure Level
- Lower? Little concern

**Cancer**

How much does the amount in air increase cancer risk by?

- Higher? Concern
- Lower? Less concern
Reduced PM exposures linked with clear health improvements

- Utah Valley - Steel mill shutdown reduced PM and respiratory hospital admissions
- Dublin, Ireland - Coal sale ban reduced PM and death from heart and lung disease
- So. California - Children who moved to less polluted areas had improved lung function growth; those who moved to more polluted areas had decreased growth rates
- Review of cardiovascular mortality and PM in 51 U.S. metro areas shows PM reductions increased life expectancy
- Reduced diesel PM expected to decrease cancer risk
Questions?
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https://cityofshafterpublicart.wordpress.com/public-art/