

# Use of Biomonitoring to Assess Human Exposure to Environmental Contaminants

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# Overview

- Biomonitoring California
- Background
  - Environmental sampling vs biomonitoring
- Basics of biomonitoring
- Biomonitoring for environmental contaminants
  - Mercury
  - Bioaccumulative contaminants
    - Polychlorinated biphenyls (PCBs)
    - Organochlorine pesticides
    - Polybrominated diphenyl ethers (PBDEs)
- Providing information to study participants

# Biomonitoring California

- Established by the State Legislature (SB 1379) in 2006
- Tri-departmental program
  - **California Department of Public Health (CDPH)** Health and Human Services
  - **Office of Environmental Health Hazard Assessment (OEHHA)** California EPA
  - **Department of Toxic Substances Control (DTSC)** California-EPA
- Scientific Guidance Panel
- Public Involvement

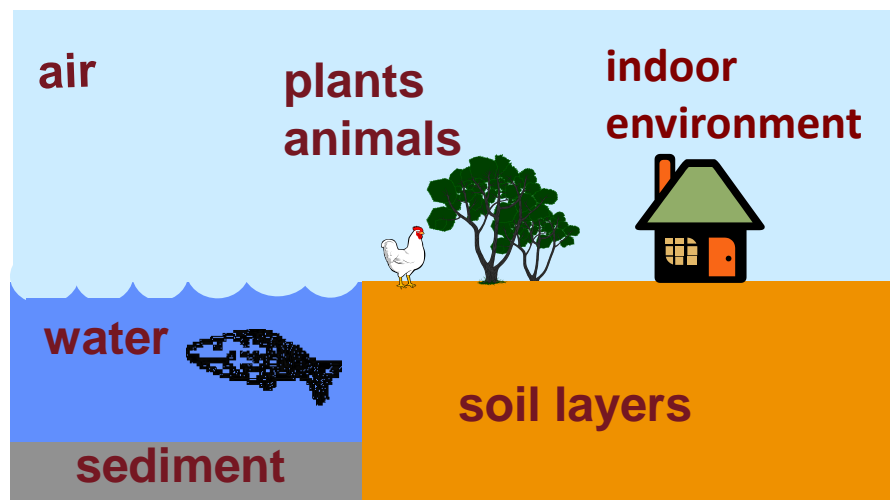
# Biomonitoring California Goals

- Determine levels of environmental contaminants in California residents
- Examine trends in contaminant levels over time
- Help assess and inform regulatory programs & public health efforts

# Traditional Environmental Monitoring Framework

Directly measure chemicals in environmental media

Chemical Source



Mathematical Modeling  
(Lots of assumptions)  
- Dose  
- Pharmacokinetics



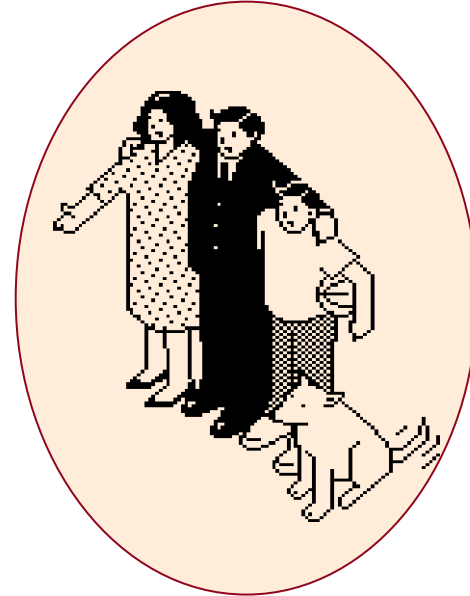
Predicted  
chemical levels  
in people

# What is biomonitoring?

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**Collect blood, urine, or  
other biological  
specimens**



**Directly measure levels of  
environmental contaminants**

# Biomonitoring Environmental Contaminants – Factors to Consider

- Is the chemical absorbed into the human body?
- How fast is it eliminated and by what route (e.g., urine, feces)?
- Is there a biomarker (target chemical analyzed) specific to the contaminant?
  - Parent compound
  - Metabolite
  - Environmental breakdown product
- Can the chemical be measured in blood, urine or other biological matrices?

# Bioaccumulative contaminants

- Absorption – generally well-absorbed
- Elimination - In general, slow elimination. Generally poorly metabolized and stored in adipose tissue.
- Biomarker specific to the contaminant
  - Parent compound – most likely
  - Metabolite – may be present at low levels, but sometimes analyzed
  - Environmental breakdown product (e.g., DDE)
- Commonly measured in blood
  - Also, breast milk and adipose tissue



# Non-persistent contaminants

- Many metabolized and excreted quickly
  - Single or intermittent exposures can be hard to detect
- “Pseudo-persistent” chemicals
  - Non-persistent contaminants with ongoing exposures
  - Examples include BPA and phthalates
- Biomarker: often metabolite
- Commonly measured in urine

# Mercury Contamination in Fish

- Methylmercury
  - Formed by action of bacteria in water, soil and sediment
  - Biomagnifies up the food chain
- Biomonitoring for mercury
  - blood: total mercury
    - Usually dominated by organic mercury compounds, primarily methylmercury
    - Generally, elevated total blood mercury reflects methylmercury exposure
  - urine: inorganic mercury

# Examples of Mercury Findings from Biomonitoring California Studies



Firefighter Occupational  
Exposures Study (FOX)



Maternal Infant Environmental Exposure Project  
(MIEEP)

# FOX Project Overview

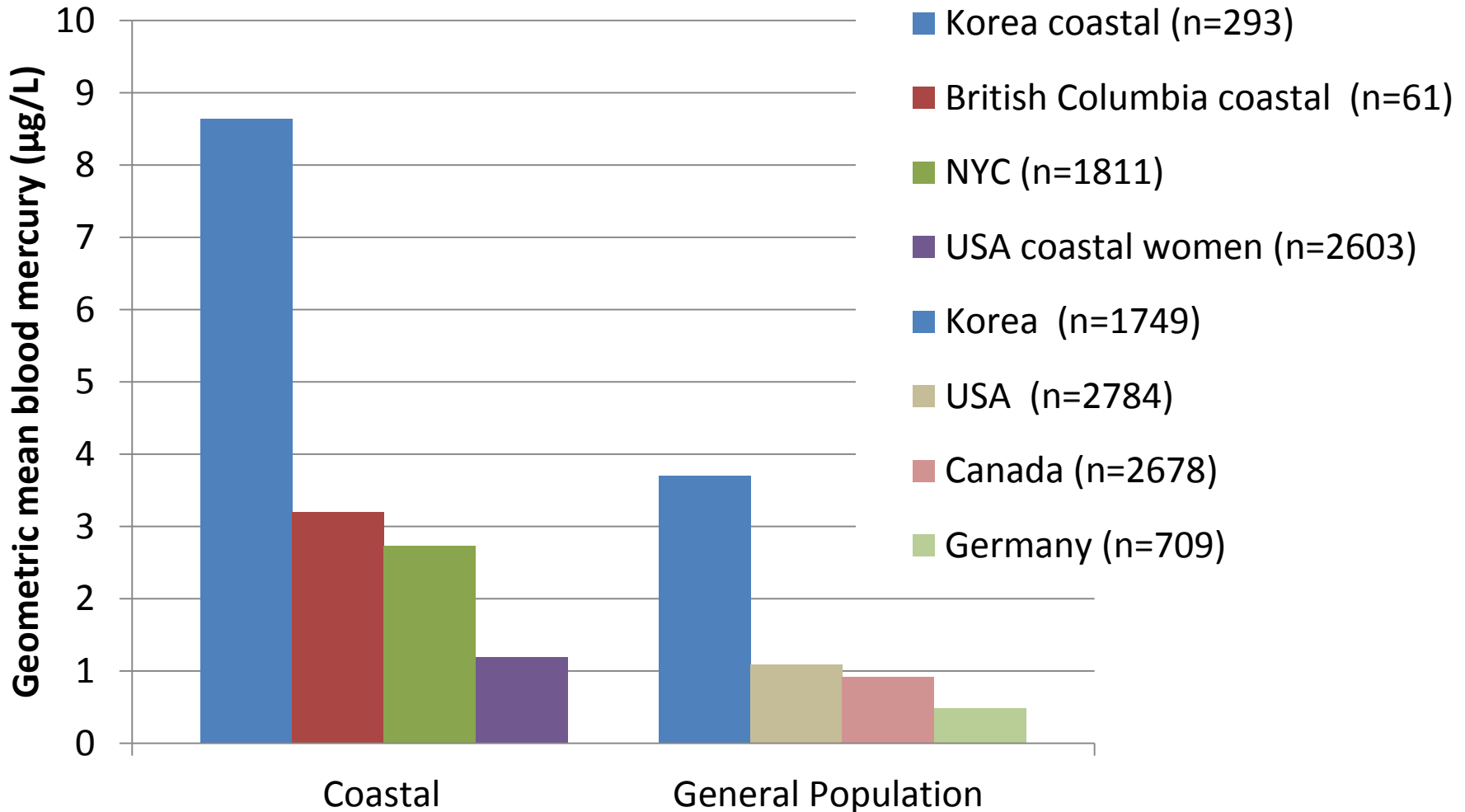
- Collaboration with UC Irvine
- 101 firefighters in Orange County participated
- Blood & urine samples collected Oct 2010 - Feb 2011
- Contaminants measured include:
  - Some heavy metals
  - PBDEs
  - PCBs
  - Perfluorinated chemicals (e.g., PFOA, PFOS)
  - Pesticides
  - Phthalates
  - Polycyclic aromatic hydrocarbons (PAHs)
- Laboratory analyses in progress

# FOX Project: Blood mercury findings

- Average blood mercury was higher in FOX participants compared to levels reported in the National Health and Nutrition Survey (NHANES).
  - NHANES 2009-2010: median blood level, 0.98  $\mu\text{g}/\text{L}$
  - FOX: ~ 3 times higher than NHANES
- Blood mercury has been shown to be higher in individuals living in coastal regions.
  - Associated with higher fish consumption

# Blood mercury levels:

## Studies in coastal and general populations\*



\* Blood mercury values are for adult men and women, except for: US coastal adult women and Canadian population (includes ages 6-79).

# Maternal Infant Environmental Exposures Project (MIEEP)

- Collaboration with UCSF and UC Berkeley
- 92 pregnant women, mainly Latina
  - Maternal urine & blood, umbilical cord blood
- Elevated mercury levels in one mother-infant pair

Maternal blood: 15.16  $\mu\text{g/L}$

Cord blood: 7.43  $\mu\text{g/L}$

- Both were higher than the CDC early reporting threshold of 5.8  $\mu\text{g/L}$  for women of childbearing age and children.
- High mercury levels were found to be the result of exposure to face cream imported from Mexico.
- Blood mercury level was unrelated to fish consumption.

# Bioaccumulative contaminants: PCBs

- Multiple sources of PCBs in environment
  - Diet is likely the primary source of exposure (e.g, fatty fish; and some high-fat meat and dairy products)
  - Other possible sources include old caulk, paint, floor finish, fluorescent light ballasts
- Biomonitoring has demonstrated declining levels in people
- However, PCBs are still commonly detected
  - Selected detection frequencies from Biomonitoring California collaborations\*

	N	Detection Frequency
PCB-118	237	73%
PCB 138	237	94%
PCB 153	237	96%
PCB 180	226	96%



# Bioaccumulative contaminants: Organochlorine pesticides

- Organochlorine pesticides (OCPs) that Biomonitoring California is measuring are no longer used in the U.S.
- OCPs are still found in some fatty fish, and some high-fat meat and dairy products.
- Biomonitoring has demonstrated declining levels in people.
  - Selected detection frequencies from Biomonitoring California collaborations\*

	N	Detection frequency
DDT	199	51%
DDE	212	99.5%
Hexachlorobenzene	236	98%
Oxychlorane	237	80%
trans-Nonachlor	136	88%

\*Presented at November 8, 2012 Biomonitoring California Scientific Guidance Panel meeting

# Bioaccumulative contaminants: PBDEs

- Indoor dust is currently the primary source of exposure
- Exposure is greater in California
- PBDE blood levels in Californians are among the highest in the world
  - Selected detection frequencies from Biomonitoring California collaborations\*

	N	Detection Frequency
BDE-47	237	95%
BDE-99	236	79%
BDE-100	203	95%
BDE-153	236	94%
BDE-154	203	18%
BDE-209	203	38%

\*Presented at November 8, 2012 Biomonitoring California Scientific Guidance Panel meeting

# Other bioaccumulative contaminants

Biomonitoring California is also measuring

- Perfluorinated compounds (PFCs), such as:
  - PFOA
  - PFOS
  - Perfluorohexane sulfonic acid
  - Perfluorononanoic acid
  - Perfluorobutane sulfonic acid

# Biomonitoring California Fact Sheets

Each chemical fact sheet describes

- Where the chemical is found
  - e.g., consumer products, food, dust
- Possible health effects
- Possible ways to reduce exposure
- Links for more information

*Chemical fact sheets will be posted on the Biomonitoring California website ([www.biomonitoring.ca.gov](http://www.biomonitoring.ca.gov)), in early 2013*

## Frequently Asked Questions about Mercury

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### Where is mercury found?

- Certain types of fish and seafood – this is the most common source of exposure to mercury
- Some imported face creams used for skin lightening, anti-aging, or acne
- Silver-colored dental fillings
- Glass thermometers, older barometers, and blood pressure gauges
- Fluorescent lights, including compact fluorescent light (CFL) bulbs

### What are possible health concerns?

#### Mercury:

- Can affect brain development and cause learning and behavior problems in infants and children who were exposed in the womb.
- Can harm the nervous system and kidneys.
- May affect the heart.

### What are possible ways to reduce exposure?

- Choose fish that are lower in mercury, such as salmon, tilapia, trout, canned light tuna, sardines, anchovies, and oysters.
- Avoid fish that are high in mercury, such as shark, swordfish, orange roughy, bluefin, and bigeye tuna.
- Do not use imported skin lightening, acne treatment, or anti-aging creams unless you are certain that they do not contain mercury.
- Properly clean up broken thermometers, CFL bulbs, and other items containing mercury. Do not let children play with silver liquid from items like mercury thermometers.

### For more information:

Guide for choosing fish that are lower in mercury: [www.oehha.ca.gov/fish/pdf/2011CommFishGuide\\_color.pdf](http://www.oehha.ca.gov/fish/pdf/2011CommFishGuide_color.pdf)

Advice on mercury in fish that you catch: [www.oehha.ca.gov/fish/hg/index.html](http://www.oehha.ca.gov/fish/hg/index.html) or call (510) 622-3218

Concerns about mercury exposure – contact the California Poison Action Line:

[www.calpoison.org/home.html](http://www.calpoison.org/home.html) or 1-800-222-1222

Cleaning up mercury spills, such as from broken thermometers or CFL bulbs: <http://www.epa.gov/mercury/spills/>

# Biomonitoring supports public health action

Measure selected chemicals in California residents



Identify chemical exposures of concern



Inform environmental and health policies to reduce exposure to toxic chemicals

