

Use of Biomonitoring to Assess Human Exposure to Environmental Contaminants

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Biomonitoring California



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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

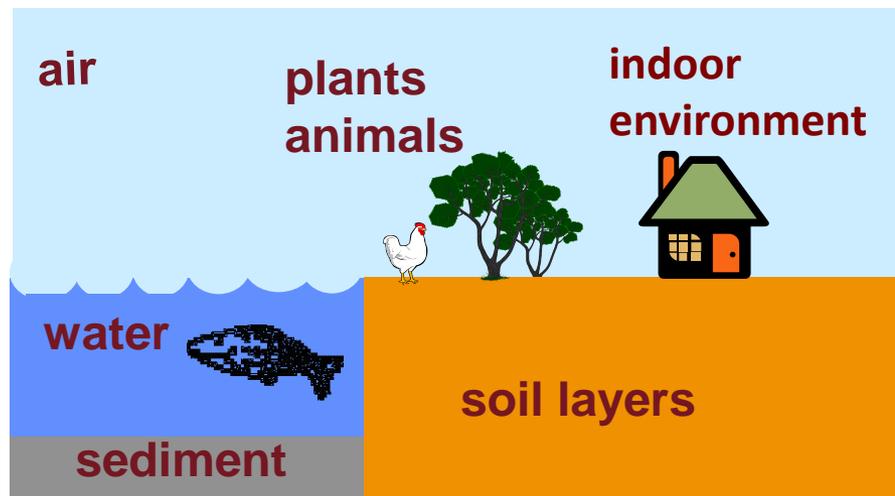
Biomonitoring California Goals

- 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

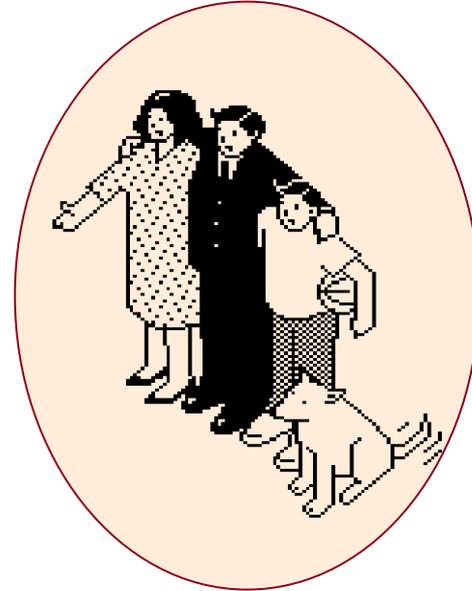


**Predicted
chemical levels
in people**

What is biomonitoring?



**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

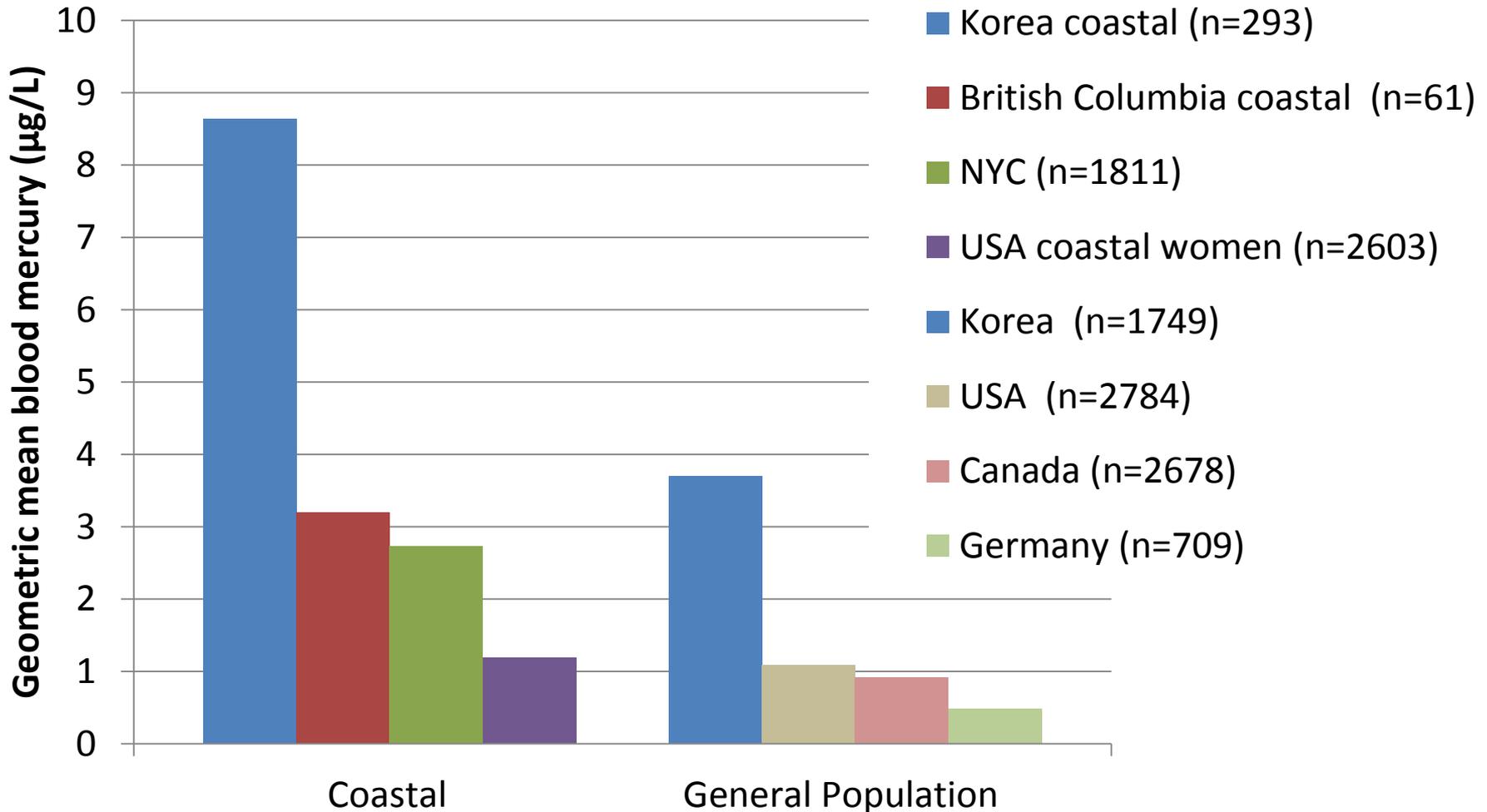
- Collaboration with UC Irvine
- 101 firefighters in Orange County participated
- Blood & urine samples collected Oct 2010 - Feb 2011
- Contaminants measured include:
 - Some heavy metals
 - PBDEs
 - PCBs
 - Perfluorinated chemicals (e.g., PFOA, PFOS)
 - Pesticides
 - Phthalates
 - Polycyclic aromatic 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), in early 2013

Frequently Asked Questions about Mercury

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

Advice on mercury in fish that you catch: 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 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

