
Dodge this: do environmental chemicals impact your health?

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My journalist-as-guinea-pig experiment is taking a disturbing turn. A Swedish chemist is on the phone, talking about flame retardants, chemicals added for safety to just about any product that can burn. Found in mattresses, carpets, the plastic casing of televisions, electronic circuit boards, and automobiles, flame retardants save hundreds of lives a year in the United States alone. These, however, are where they should not be: inside my body.

—David Ewing Duncan¹
“The Pollution Within”

Not only are flame retardants detectable in Duncan’s body, he’s swimming in them: his flame retardant level is 10 times the average U.S. resident, and 200 times the average Swede. Is there any consolation in this? Perhaps—if Duncan catches fire, he should not burn...

Who are these chemicals?

Anthropogenic, or man-made, chemicals began appearing on the scene with regularity in the late 19th century. Their production limped along until the 1960s, at which time production exploded exponentially—pesticides, dyes, medicines, flavorings, perfumes, plastics, solvents, plasticizers, preservatives. They have made our life better and easier—medicines to fight disease, plasticizers to create tubing that delivers intravenous fluids, preservatives that prevent wood from rotting. We are now exposed to more than 100,000 chemicals in our daily lives.

We use 2.5 million tons of pesticides each year to prevent diseases like yellow fever, malaria, and West Nile virus. Our use of pesticides has increased 50-fold since the 1950s, and estimates are that not using pesticides would lead to a rise in food prices, a loss in jobs, and an increase in world hunger. But as scientists observed the chemical world around them, especially in the latter half of the 1900s, they discovered two things. The first was that pesticides were harmful to life. Originally developed to kill mosquitoes that carry malaria, DDT

was highlighted in Rachel Carson’s *Silent Spring*² as the culprit responsible for thinning eggshells and reducing survival of the bald eagle, peregrine falcon, and osprey.

The second thing scientists learned was that once we stopped producing pesticides—DDT production was halted in the U.S. in 1972—they didn’t go to that mythological place called “away.”³ They persisted—for decades.^{4,5} In a 2009 survey of 500 U.S. kitchen floors for 24 pesticides, DDT showed up in 41 percent and chlordane (another banned pesticide) in 74 percent of the households.⁶ How unfortunate is it that our children take the brunt of this, being low to the ground and quick to pop curious gravity-bound morsels into their mouths.

Another burgeoning category of chemicals is pharmaceuticals. Ever wondered what happens to the chemicals in a birth control pill? Once the synthetic estrogen prevents pregnancy and is eliminated from the body, it, too, goes “away,” into wastewater, past the treatment plant, and into our waterways. Do these estrogens contribute to the increasing phenomenon of male fish becoming female?⁷ Triclosan, the antibacterial chemical in liquid soaps,⁸ not only skips past wastewater treatment plants and arrives in estuaries and coastal waters of South Carolina and Florida, it gets into the bodies of bottlenose dolphins.⁹ Does that mean these chemicals can get into us?

Enter: Biomonitoring

Biomonitoring is assessing human exposures to natural and synthetic chemicals by analyzing samples of a person's tissues and/or fluids.¹⁰ Chemicals that have entered the body leave their mark—the chemical itself, its breakdown product, or its aftereffects. Blood, urine, breast milk, even hair and nails are common media for biomonitoring.

The U.S. Centers for Disease Control and Prevention conducts a national biomonitoring program and publishes their findings in the National Report on Human Exposure to Environmental Chemicals.¹¹ Blood and urine samples from a random sample of people ages 1–80 across the country are analyzed for chemicals and their metabolites. In their third report, covering 2001–2002, 148 chemicals were measured. What do they find?

First, they find there's no escape. If chemicals are in our soil, air, dust, or water—even if they are not in our food supply—they are in us. Second, they find that biomonitoring data can tell us if situations are getting better or worse. For example, in 1994, 4.4 percent of young children had dangerously high levels of lead in their blood. By 2000, this decreased to 2.2 percent. So our efforts to reduce lead exposure for children are working.

What about locally? We recently completed a biomonitoring study of forty lactating women in the Seacoast area of New Hampshire.¹² We wanted to know the breast-milk levels of flame retardants—the same compounds in David Ewing Duncan's body. Given that the breastfed infant is at the top of the food chain, just what are we inadvertently feeding our children?

Our sample population had levels of flame retardants that were 10–100 times that of breast milk from European women. There was no association between a woman's breast-milk level of flame retardants and her living environment, her age, her body size, and even what she ate, with one exception: the more fruit a woman ate during pregnancy, the lower the flame retardant levels in her milk. So there's pollution within. So what?

What me, worry?

In 1989, Theo Colborn observed that offspring of animals around the Great Lakes were afflicted with abnormalities in reproduction, metabolism, thyroid function, and sexual development—all systems that are driven by hormones. Colborn's work spawned an historic meeting of scientists in 1991 at the Wingspread Conference Center and gave birth to the endocrine disruptor hypothesis: a large number of man-made chemicals released into the environment, as well as a few natural ones, have

the potential to disrupt the endocrine system of animals, including humans.^{13, 14}

Because hormones are the most powerful biochemicals in our bodies, what happens when their actions are disrupted? Can chemicals that masquerade as estrogen cause an earlier start of menstruation in girls?¹⁵ Can chemicals that interfere with thyroid hormones lower a person's metabolism and cause obesity?¹⁶

Research on endocrine disrupting compounds, or EDCs, is thriving,¹⁷ with some 20,000 scientific papers published to date on the topic. UNH is contributing to this effort.¹⁸ Our lab and that of our colleagues has documented that flame retardants given to rats disrupt fat cell response to hormones,¹⁹ promote preference for sweet beverages,²⁰ and cause weight gain.²¹ These data suggest that flame retardants could be obesogens—chemicals that promote obesity.

And that's just the tip of the iceberg. We know that factors like the age, mixture, and dose of chemicals to which you are exposed will determine how your body responds. Note, however, that our experiments are on rats; we can't do these experiments on people. But we can observe, like scientists in Denmark, who have correlated a decline in sperm count with a rise in environmental chemicals. Scientists recognize, however, that correlation is not cause and effect. Case in point: the number of sunbathers at Hampton Beach directly correlates with the number of sunny days. Do sunbathers cause sunny weather? No. So a broader question is: how certain do we need to be about this cause and effect?

Scientists love certainty, or at least knowing the probability of being certain. For example, we know that administering a flame retardant to a rat will reduce its thyroid hormone levels to 20 percent of normal. We can say this with 95 percent certainty (that is, $P < 0.05$), admitting that there's a 5 percent chance that the flame retardant has no effect on thyroid hormone levels. Alas, even in the best of worlds, there's no such thing as complete certainty.

The European Union gets this. It subscribes to the Precautionary Principle: When the health of humans and the environment is at stake, it may not be necessary to wait for scientific certainty to take protective action. So in June 2007, the EU signed REACH—Registration, Evaluation, Authorisation, and Restriction of Chemical substances—into law.²² REACH aims to improve the protection of human health and the environment through the better and earlier identification of the intrinsic properties of chemical substances. Industry is required to gather information on the properties of their chemical substances and register the information

in a central database in Helsinki. What are Americans doing?

Can we dodge this?

Our planet has become our toilet bowl, our “away.” But in a closed system, “away” is “here.” So do we continue to ask “what do these chemicals do to us?” and wait until all the evidence is in and we are certain? Or should we follow the Precautionary Principle and not allow monetary cost (as opposed to human health cost) to drive our moral fiber? American scientists say it’s time to act.²³ But can we? It means choosing health—not only of people, but of the planet—over the status quo.

Individually, environmental chemicals are impossible to dodge. David Ewing Duncan knows this firsthand. He saw his level of phthalates in his urine increase after showering and washing his hair (today’s personal care products are a great source of chemicals), and the level of mercury in his blood double after eating halibut and swordfish caught just beyond the San Francisco Bay.²⁴ It is only collectively—through engaged activism and lobbying for regulation that will decrease human exposure to endocrine-disrupting chemicals—that we can dodge this.

References

1. Duncan, D.E. (2006) The Pollution Within. *National Geographic*, October 2006. Author David Ewing Duncan writes of his experience as a guinea pig. He donated 14 vials of blood to be tested for 320 chemicals. <http://ngm.national-geographic.com/2006/10/toxic-people/duncan-text.html>
2. Carson, R. (1962) *Silent Spring*, Houghton Mifflin Co., Boston.
3. Hirshberg, G. (2009) Commencement address, University of New Hampshire. http://www.unh.edu/president/markhuddleston/speeches/commencement2009_hirshberg.htm
4. Interested to know what pesticides are in your food? Visit a database compiled by the Pesticide Action Network at <http://www.whatsonmyfood.org>
5. Interested to know what chemicals are in your environment? The Environmental Protection Agency, EPA, can be visited at <http://www.epa.gov>. Click on My Environment, and enter your zip code to learn about My Air, My Health, My Water, and My Land.
6. Stout, D.M. et al. (2009) American healthy homes survey: a national study of residential pesticides measured from floor swipes. *Environmental Sciences and Technology* 43: 4294-4300.
7. Gross-Sorokin, M.Y., Roast, S.D. and Brighty, G.C. (2006) Assessment of feminization of male fish in English rivers by the environment agency of England and Wales. *Environ Health Perspectives* 114 (suppl 1):147-151 (2006).
8. Although first introduced into soaps, detergents, and other cleaning and health care products, today antibacterials may also be impregnated into sponges, cutting boards, carpeting, upholstery, and even children’s toys.
9. Fair, PA, et al. (2009). Occurrence of triclosan in plasma of wild Atlantic bottlenose dolphins (*Tursiops truncatus*) and in their environment. *Environmental Pollution* doi:10.1016/j.envpol.2009.04.002.
10. Sexton, K., Needham, L.L. and Pirkle, J.L. (2004) Human Biomonitoring of Environmental Chemicals. *American Scientist*, 92:38-45.
11. U.S. Centers for Disease Control and Prevention (CDC; <http://www.cdc.gov/biomonitoring>) National Report on Human Exposure to Environmental Chemicals.
12. Dunn, R. (2008) Biomonitoring polybrominated diphenyl ethers in lactating women. Ph.D. Dissertation, University of New Hampshire, Durham, N.H.
13. The Wingspread Conference’s official title was “Chemically Induced Alterations in Sexual and Functional Development: The Wildlife/Human Connection.” <http://www.fao.org/agris/search/display.do?f=/1996/v2206/US9545328.xml;US9545328>

14. Colborn, T., vom Saal, F.W. and Soto, A.M. (1993) Developmental effects of endocrine disrupting chemicals in wildlife and humans. *Environmental Health Perspectives* 101: 378–383.
15. Colborn, T., Dumanoski, D. and Myers, J.P. (1996) *Our Stolen Future. Are We Threatening Our Fertility, Intelligence, and Survival? A Scientific Detective Story*. Plume, N.Y.
16. Baillie-Hamilton, P.F. (2002) Chemical toxins: a hypothesis to explain the global obesity epidemic. *Journal of Alternative and Complementary Medicine* 8: 185–192.
17. Krimsky, S. (2000) *Hormonal Chaos: The Scientific and Social Origins of the Environmental Endocrine Hypothesis*. The Johns Hopkins University Press, Baltimore.
18. UNH's Environmental Research Group was founded in 1987. Its mission is to conduct applied and fundamental environmental engineering and science research. Its 15 full and associate faculty members come from three departments (Civil Engineering, Microbiology, Chemical Engineering), reflecting the necessary interdisciplinary team approach to problem solving in today's world.
19. Hoppe, A.A. and Carey, G.B. (2007) Polybrominated diphenyl ethers (PBDEs) as endocrine disruptors of adipocyte metabolism. *Obesity* 15: 2942–2950.
20. Hennigar, S.R., Mirando, A.C., Ronan, A.M, and Tagliaferro, A.R.. (2008) Exposure to flame retardants promotes increased consumption of simple sugars. *FASEB J.* 22: 888.7.
21. Allgood, E.L. and Carey, G.B. (2009) The effect of diet and polybrominated diphenyl ether exposure on adipocyte and whole body metabolism in male Wistar rats. *FASEB J.* 23: 505.3.
22. Visit the REACH web site at http://ec.europa.eu/environment/chemicals/reach/reach_intro.htm
23. Diamanti-Kandarakis, E. et al. (2009) Endocrine-Disrupting Chemicals: An Endocrine Society Statement. *Endocrine Reviews* 30 (4):293–342.
24. Duncan's mercury level reached 12 micrograms/liter. Children suffer IQ losses at 5.8 micrograms/liter.