

Polytoxicity – The Wild World of Chemical Exposure

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STORY AT-A-GLANCE

- › There are about 85,000 chemicals registered under the Toxic Substances Control Act (TSCA), but even the EPA is largely in the dark about what that actually means for people's health and the environment
- › Combining chemicals often magnifies their toxic effects; in the case of bisphenol A (BPA), using hand sanitizer prior to handling a BPA-containing receipt may increase skin absorption 100-fold
- › About 1 in 11 public schools in the U.S. are located within 500 feet of highways, truck routes and other roads with heavy traffic, leaving millions of school kids breathing polluted air

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Have you ever wondered how many chemicals you're exposed to on any given day? How about your kids? It's really anyone's guess. The Toxic Substances Control Act (TSCA) requires that the U.S. Environmental Protection Agency (EPA) compile and keep a current list of chemical substances manufactured or processed in the U.S.

That list includes about 85,000 chemicals,¹ but even the EPA is largely in the dark about what that actually means for people's health and the environment. As noted in Chemical & Engineering News, "The agency is struggling to get a handle on which of those chemicals are in the marketplace today and how they are actually being used."²

Very few chemicals on the market are tested for safety, but even those that are, are not necessarily safe. Part of this is because safety testing is typically done on just one chemical at a time, and under laboratory conditions.

The way you're actually exposed to chemicals – in combination and under countless different real-world scenarios – may increase their toxicity exponentially.

The Toxic Reality of Using Hand Sanitizer, Eating and Holding a Receipt

A revealing example of just how toxic our world has become is the bisphenol A (BPA) used in thermal paper (the type many receipts are made out of).

BPA is an [endocrine-disrupting chemical](#) linked to a number of health concerns, particularly in pregnant women, fetuses and young children, but also in adults, including high blood pressure, heart disease,³ obesity, fertility problems and more.

BPA is most often associated with plastics, personal care products and canned goods but, according to a 2014 study published in PLOS One, "Free BPA is applied to the outer layer of thermal receipt paper present in very high (~20 mg BPA/g paper) quantities as a print developer."⁴

This in itself is unsettling, considering very few people think twice about handling receipts (or handing one to a child). However, the study revealed that a very common scenario – using hand sanitizer prior to handling a receipt – maximizes the risk.

Using Hand Sanitizer Prior to Handling a Receipt May Increase Your BPA Absorption 100-Fold

They noted that many hand sanitizers, as well as other skin care products, contain penetration-enhancing chemicals that may increase the absorption of BPA through your skin by up to 100-fold. Worse still, when eating out, the BPA is then easily transferred to your food.

The resulting elevated levels of BPA found in study subjects have been linked to developmental abnormalities and diseases in adults. According to the study:⁵

"We found that when men and women held thermal receipt paper immediately after using a hand sanitizer with penetration-enhancing chemicals, significant free BPA was transferred to their hands and then to French fries that were eaten ...

[T]he combination of dermal and oral BPA absorption led to a rapid and dramatic average maximum increase (Cmax) in unconjugated (bioactive) BPA of ~7 ng/mL in serum and ~20 µg total BPA/g creatinine in urine within 90 min."

When regulatory agencies test chemicals for safety, they do not take into account this type of skin absorption, or the absorption that may occur in your mouth (prior to making it to your gastrointestinal tract).

Both of these exposure routes bypass first-pass liver metabolism, the researchers noted, which could increase the health risks further.⁶ A study published in *Analytical and Bioanalytical Chemistry* in 2010 found that of 13 thermal printing papers analyzed, 11 contained BPA.⁷

Holding the paper for just five seconds was enough to transfer BPA onto a person's skin, and the amount of BPA transferred increased by about 10 times if the fingers were wet or greasy (such as if you've just applied lotion or eaten greasy food).

Because receipts are often stored next to paper currency in people's wallets, paper currency may also be contaminated with BPA. In a study published in *Environmental Science and Technology*, researchers analyzed paper currencies from 21 countries for the presence of BPA, and the chemical was detected in every sample.⁸

The fact of the matter is that even when we know the chemical is out there, we've only scratched the surface of what kind of interactions can occur.

'Vapor Intrusion' May Be Making People Sick in Minnesota

Chemicals often exist in the environment invisibly, meaning you can't see them or smell them, and have little way of knowing when they're there.

Such is the case in Minnesota, where volatile organic compounds (VOCs) such as dry-cleaning fluids and metal degreasers — tossed out or spilled by industry — are contaminating soil across the state.

The chemicals don't stay in the soil, however. Toxic vapors rise up into the air in a process known as "vapor intrusion." Exposure to even low levels of these vapors over a long period is dangerous, potentially leading to cancer or problems with fetal development among pregnant women.⁹

The state has already cleaned up close to 300 state-managed sites, but there are more than 1,400 sites that still need to be investigated, including dry cleaners, auto repair shops, gas stations and more.

Starting in 2017, owners of potentially contaminated land will also be required to conduct soil vapor testing — and fix the problem if vapors exist — before selling it to a new owner.

Since the vapors enter the air, surrounding areas may also be affected, making cleanup issues complex. It's yet another example of how difficult, if not impossible, it is to factor in compound and long-term exposures when it comes to chemical exposures. According to the Star Tribune:

"... [V]apor moves. It can penetrate a building's foundation slab, and then concentrate inside a basement or building — and other homes and buildings nearby — multiplying the problem and raising tangled questions about liability and who should pay for the fix."

4.4 Million School Kids Breathe in Toxic Air Pollution

There are chemicals found in food, soil, water and also in the air — even in areas where you may not think air pollution is a problem, like rural locales and small cities.

A report from the Center for Public Integrity and The Center for Investigative Reporting revealed that about 1 in 11 public schools in the U.S. are located within 500 feet of highways, truck routes and other roads with heavy traffic.

This means that about 4.4 million students may be exposed to toxic air while they're at school (and the study only included public schools; many private schools also lie close to high-traffic roads).^{10,11}

George Thurston, a population health professor at the New York University School of Medicine, told the Center for Public Integrity, "The expectation of every parent is that they're sending their child to a safe environment ... And with this kind of pollution, they're not."¹²

The risks of air pollution to health are many – asthma attacks, heart disease and cancer, just to name a few.

However, breathing toxic air is also linked to health problems you might not expect, like **dementia** and slower cognitive development (the latter of which was found in students exposed to high levels of traffic-related air pollution¹³).

While the EPA warned school districts to reconsider building new school buildings near busy roads in 2011 because of the air-pollution risks, the Center for Public Integrity reported that nearly 1 in 5 schools that opened in 2014 were near heavily trafficked roadways.¹⁴

Fish Are Swimming in Industrial Chemicals

Chemicals permeate our waterways, too, which has major implications for the fish and other marine life living in them. The Wheeler basin on the Tennessee river in northern Alabama, for instance, used to be home to a diverse variety of marine life, including mussels and stripe bass, which have now largely disappeared.

The industrial chemicals **perfluorooctanoic acid** (PFOA, also known as C8) and the related PFOS (perfluorooctane sulfonate) are among the potential culprits. Decatur Daily

reported:¹⁵

"The Alabama Department of Public Health has issued advisories regarding the consumption of fish based on the accumulation of one of the chemicals, PFOS, in fish species.

The public should limit their consumption of all fish species taken from Baker's Creek to one meal per month, ADPH said in its advisory ... Lawsuits allege Baker's Creek is where 3M discharged wastewater containing PFOS and PFOA."

In another example, smallmouth bass in the Susquehanna River, Pennsylvania, are showing signs of exposure to endocrine-disrupting compounds and herbicides – signs that include lesions and tumors.¹⁶ In the Potomac River, meanwhile, 85% of male smallmouth bass are also growing immature eggs in the area of their body where their testes should be – a sign that their sex is being altered by hormone-disrupting chemicals.¹⁷

Chemical Industry Helps Make Your Cat Flame Retardant

Even the family cat is not safe from the realities of modern-day chemical exposures, according to a study that suggested, rightly so, that pet cats (especially those who spend most of their time indoors) may be used as a biomarker for assessing exposure to certain chemicals, such as brominated flame retardants, adsorbed to household dust.¹⁸

Significant correlations were found between the levels of the chemicals in the cats and those found in household dust, which suggests that the exposure to the dust is a significant route of exposure to such chemicals for cats.

The implications are huge, since it's not only pet cats that are exposed to household dust – all family members are, especially young children who crawl on the floor much like your cat. The Washington Toxics Coalition has previously tested household dust and also found flame-retardant chemicals in all samples tested.¹⁹

Higher exposures to flame retardants called polybrominated diphenyl ethers, or PBDEs, have been linked to **decreased fertility**, which could be in part because the chemicals may mimic your thyroid hormones.²⁰

A study by researchers at the University of California, Berkeley, also revealed that both in utero and childhood PBDE exposures were associated with neurodevelopmental delays, including poorer attention, fine motor coordination and cognition in school-age children²¹ — and these chemicals are probably lingering in your house dust right now, along with others.

Combining Chemicals May Make Them More Dangerous

It's not enough to simply assume that chemicals in combination behave the way they do on their own. For instance, an assessment by the National Food Institute at the Technical University of Denmark found that even small amounts of chemicals can amplify each other's adverse effects when combined. As reported by the Institute:²²

"A four-year research project on cocktail effects in foods ... has established that when two or more chemicals appear together, they often have an additive effect. This means that cocktail effects can be predicted based on information from single chemicals, but also that small amounts of chemicals when present together can have significant negative effects."

Research published in the journal *Carcinogenesis* also found that chemicals deemed "safe" on their own can cause cancer when combined, even at low doses, with researchers noting, "Our analysis suggests that the cumulative effects of individual (non-carcinogenic) chemicals acting on different pathways, and a variety of related systems, organs, tissues and cells could plausibly conspire to produce carcinogenic synergies."²³

Experts agree that in order to gauge the true risk of a chemical, it should be tested in combination with others to more closely replicate real-world exposures. Yet, U.S.

National Toxicology Program data suggests testing the interactions between just 25 chemicals for 13 weeks would require 33 million experiments and cost \$3 trillion.²⁴

Jonathan Latham, Ph.D., co-founder and executive director of the Bioscience Resource Project, pointed out that even if such experiments were possible, it's likely that no chemical would be deemed truly "safe."²⁵

Your Body Is Not a Chemical Dumping Ground

Considering all the potential sources of toxic chemicals, it's virtually impossible to avoid all of them, but that doesn't mean you have to sit silently by while corporations use your home, your water, your air, your food and your body as a convenient chemical dumping ground. Until change occurs on a global scale, you can significantly limit your exposure by keeping a number of key principles in mind.

Eat a diet focused on locally grown, fresh and ideally organic whole foods. Processed and packaged foods are a common source of chemicals, both in the food itself and the packaging. Wash fresh produce well, especially if it's not organically grown.

Choose pastured, sustainably raised meats and dairy to reduce your exposure to hormones, **pesticides** and fertilizers. Avoid milk and other dairy products that contain the genetically engineered recombinant bovine growth hormone (rBGH or rBST).

Buy products that come in glass bottles rather than plastic or cans, as chemicals can leach out of plastics (and plastic can linings), into the contents; be aware that even "**BPA-free**" **plastics** typically leach endocrine-disrupting chemicals that are just as bad for you as BPA.

Store your food and beverages in glass, rather than plastic, and avoid using plastic wrap.

Use glass baby bottles.

Replace your nonstick pots and pans with ceramic or glass cookware.

Filter your tap water for both drinking and bathing. If you can only afford to do one, filtering your bathing water may be more important, as your skin readily absorbs contaminants. **Most tap water toxins, including fluoride**, can be filtered out using a reverse osmosis filter.

Look for products made by companies that are Earth-friendly, animal-friendly, sustainable, certified organic, and GMO-free. This applies to everything from food and personal care products to building materials, carpeting, paint, baby items, furniture, mattresses and others.

Use a vacuum cleaner with a HEPA filter to remove contaminated house dust. This is one of the major routes of exposure to flame-retardant chemicals.

When buying new products such as furniture, mattresses or carpet padding, consider buying chemical-free varieties containing naturally less flammable materials, such as leather, wool, cotton, silk and Kevlar.

Avoid stain- and water-resistant clothing, furniture and carpets to avoid **perfluorinated chemicals** (PFCs).

Make sure your baby's toys are BPA-free, such as pacifiers, teething rings and anything your child may be prone to suck or chew on – even books, which are often plasticized. It's advisable to avoid all plastic, especially flexible varieties.

Use natural cleaning products or make your own. Avoid those containing 2-butoxyethanol (EGBE) and methoxydiglycol (DEGME) – two toxic glycol ethers that can compromise your fertility and cause fetal harm.

Switch over to organic toiletries, including shampoo, toothpaste, antiperspirants and cosmetics. EWG's Skin Deep database can help you find personal care products that are free of **phthalates** and other potentially dangerous chemicals.²⁶

Replace your vinyl shower curtain with a fabric one or use glass doors.

Replace **feminine hygiene products** (tampons and sanitary pads) with safer alternatives.

Look for fragrance-free products. One **artificial fragrance** can contain hundreds – even thousands – of potentially toxic chemicals. Avoid **fabric softeners** and dryer sheets, which contain a mishmash of synthetic chemicals and fragrances.

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