Protecting Children from Environmental Toxicants through Policy

Every day, we are exposed to dozens, perhaps hundreds, of chemicals. The extent of such exposures is relatively new. Since World War II, thousands of new, primarily synthetic, chemicals have been discovered and introduced into commerce and our environment. In 1940, the production of synthetic chemicals was 1.3 billion pounds; in 1980, it was 320 billion pounds.\(^i\) Chemicals are ubiquitous; traces of synthetic compounds are found in all humans and animals around the world.\(^ii\)

Both synthetic and natural chemicals such as lead, once released into the environment, can harm the health of humans and wildlife.

The diverse and growing range of chemicals to which we are exposed means that today’s children live in an environment vastly different from previous generations. Currently more than 70,000 chemicals are in use. For the majority of these chemicals, little is known about their health effects on children.\(^iii\)

**Children Are Not Just "Little Adults"**

Children, from the fetal stage through adolescence, are in a dynamic state of growth as their immature nervous, respiratory, reproductive, and immune systems develop. Because of these developing systems, growing organisms can be more vulnerable to permanent and irreversible damage from toxicants than mature organisms. Children experience the world differently than adults, meaning that children's exposures to environmental toxicants and their levels of exposure can vary dramatically from those of adults.

**The Delicate Choreography of Children's Growth**

The primary task of infancy and childhood is growth and development. If growth and development are hampered, the chances of a healthy adulthood are dramatically decreased. Many different kinds of insults have the potential to damage these natural processes, potentially leading to lifetime harm. It is often impossible to repair damages that occur in childhood.
Studious of the impact of exposure to environmental toxicants on development make clear that not just the degree and route of exposure but also the timing of the exposure affects the response. For instance, at a given dose, intrauterine exposure to lead or polychlorinated biphenyls (PCBs) appears to be more damaging than later life exposure. Also, the type of defect seen is highly dependent on the timing of the exposure.

**Example: Nervous System Development.** One of the critical organ systems to be considered in evaluating the effect of environmental toxicants on the fetus, infant, and child is the nervous system. Its anatomic and functional development is complex, intricate, and dependent on a precise sequence of events that occur at specific points in the development of the child. This exquisitely scripted pattern of development can be disrupted and irreparably injured by various agents at various stages, resulting in very specific alterations of neurologic and behavioral development. Key stages in the anatomical development of the central nervous system, beginning in utero and continuing into adult life, include:

- **Formation of the neural tube**, an embryonic structure that leads to all further brain development.
- **Neuron proliferation**, the growth of functional brain cells.
- **Cell migration**, the process by which cells move from one place to another to form the complex structure of the brain.
- **Synaptogenesis**, the process by which connections between neurons occur. Both the numbers and complexity of these interconnections affect the functioning of the brain.
- **Cell death**. The nervous system initially produces more neurons than it needs. The process of brain maturation requires the retention of some neurons and the natural loss of other neurons.
- **Pruning of synapses**. Synaptogenesis, which peaks at two years of age, creates more connections between neurons than are needed. Subsequently, there is an orderly process of loss of some connections and retention of others.
- **Myelination**, the process by which the communicating structures of neurons are covered to protect them and improve their function. Myelin functions like the insulation on an electrical cord.

Each one of these vital steps to a healthy brain and nervous system can be disrupted by environmental agents, resulting in permanent injury or impairment.

The structural growth of the nervous system is just one example of the delicate nature of human development. What we don’t know about these effects and potential effects is far more than what we do know, not just for the nervous system but also for our reproductive, immune and other critical systems, as well as our state of knowledge for carcinogenic, endocrine and other health effects.

Children are different from adults in other ways. Because biochemical systems are still developing in the fetus and the child, their ability to detoxify and excrete toxins differ from adults. This difference is sometimes to their advantage, but more frequently children are not as able to excrete toxins and thus are more vulnerable to them.
**Children Experience The World Differently**

Children's exposures to environmental toxicants, and their levels of exposure, can vary dramatically from those of adults.

An infant more than doubles its weight in the first four months of life. Young children breathe more rapidly and take in more air, have higher metabolic rates, and have higher proportionate food and liquid intakes than do adults.\(^v\) Pound for pound, children eat more food, drink more water, and breathe more air than adults do. When an infant drinks six ounces of formula or breast milk per kilogram of body weight daily, it is equivalent to an adult male drinking 35 cans of soda in a day.\(^v\) The average one-year-old eats two to seven times more grapes, bananas, pears, carrots, and broccoli than an adult does.\(^vii\) Because children eat more fruits and vegetables and drink more liquids, potential exposure to toxins such as lead, pesticides, and nitrates is greater.

Exposure differences are also a result of locations where children spend time, the activities in which children indulge, and children's level of personal hygiene. Thus, in identifying how children may be exposed to a chemical and the level of exposure, it is inadequate to simply extrapolate from adult exposure.

Behavioral differences, because of age and developmental stages, means that opportunities for exposure to environmental chemicals such as pesticides also differ. These differences exist both between adults and children as well as between children of different ages.

Some examples of children's behavior and activities that lead to exposure differences include:

- **Infants** may mouth or lick any object, surface, or body part that they can reach. Their hygiene and access to the areas within their home are controlled by the parent or caretaker.
- **Very young children** spend hours close to the ground where there may be more exposure to toxins in dust, soil, and carpets as well as to low lying vapors such as radon or pesticides.
- **Toddlers and primary school children** may spend many hours sitting or lying on the floor while watching TV or playing games (2-3 hours/day). They place their fingers in their mouth frequently (9-10 times/hour); they are constantly touching their clothes (65 times/hour), objects (118 times/hour) and surfaces (97 times/hour). Whatever they touch, they swallow.
- **Children** often eat snacks while sitting on the floor, thus whatever environmental chemicals are on the floor can adhere to both their hands and food and will be ingested through hand to mouth activities and through contamination of the food with dirty hands.
- **Primary school children** are likely to spend more time outdoors than toddlers or infants, typically in contact with soil or grass and are also more likely to be outside barefoot than either older or younger children. They roll on the grass, tumble, and play games. They typically do not wash their hands after coming indoors and before eating. Whatever is on the grass may be absorbed through the skin on the body and feet or ingested when they put their hands in their mouth.
- **Older children** also spend a lot of time outdoors, typically playing organized games such as soccer or football, or hanging out. Their activities may include dermal contact with soil or grass.\(^viii\)
This type of behavior/exposure data do not exist for children older than 12, yet older children may have exposures similar to adults -- through their part time jobs cutting grass or working on farms -- in addition to sources of exposure through their play activities.

The data that do exist show that children are more heavily exposed than adults to toxicants such as pesticides. For example, studies that looked at biomarker levels for a commonly used organophosphate pesticide, chlorpyrifos, in children and adults found that the levels of the pesticide in children were substantially higher than in the adult population.

**Summary**

In brief, a child's metabolism, physiology, diet, exposure patterns, and behavior are different than those of an adult.

A child is exposed to multiple toxicants in the course of her/his life, sometimes simultaneously, sometimes sequentially. Children have a longer life span than adults so they have more time to develop diseases with long latency periods that may be triggered by earlier environmental exposures, such as cancer or Parkinson’s disease. The effects of multiple and/or cumulative exposures and their potential synergistic effects are not known.

Experience with a variety of chemicals, from alcohol to environmental toxicants like lead and mercury, has shown us that what is safe for the adult is not necessarily safe for the fetus, infant or child. Exposure levels that for an adult would have no impact or a transitory impact can have life-long negative consequences for a child.

**For More Information:**

Contact the Children’s Environmental Health Network at 202-543-4033 or visit the Network's web site: www.cehn.org.

**About the Network**

The Network is a non-partisan and multi-disciplinary national project whose mission is to protect the developing child from environmental health hazards and promote a healthy environment. The Network’s three areas of concentration are education, research and policy.

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