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Voices for Vermont's Children

Promoting public policy that enhances the lives of children and youth in Vermont

Children and Environmental Toxins

Chemicals pervade our modern life. Countless natural and synthetic substances are present in our air, our soil, our water, our food, and the products we buy. We don't know if everything we come into contact with is safe, but we do know that certain substances are toxic and we suspect that many more have detrimental health effects. The research on environmental toxins that has been done in recent decades has allowed us to identify many substances as harmful, better understand their effects, and protect against exposures. Legislative acts have banned toxins and sought to address the damage they have done and are doing. But many toxins remain present in our environment, and today's children—our future—are especially at risk.

Why toxins are more harmful to children

Their small, growing bodies make children more vulnerable than adults to toxins in a number of ways. The same absolute amount of a toxic substance poses a more significant health threat to children because of their relatively smaller size. Moreover, to fuel growth and development, children take in more food, liquids and oxygen than adults, relative to their weight. Children therefore absorb a proportionately higher toxic dose through digestion and respiration when exposed. Additionally, the ratio of surface area to body volume is higher for children than for adults, on average, meaning that children have proportionately more skin through which to absorb any toxins they touch directly. Finally, behavioral tendencies such as crawling close to the floor and putting hands and objects in mouths put children in contact with toxic sources that adults usually avoid.

Children inhale twice as much oxygen as adults, proportionate to body weight.

- Institute for Children's Environmental Health [1]

"[C]hildren in the first six months of life drink seven times as much water per pound as does the average American adult."

- Philip J. Landrigan and Joy E. Carlson [2]

Once the toxins are absorbed, children's immature metabolisms are not as well equipped to process and expel them as adults' metabolisms are. Children also react differently to toxins than adults: their developing organs and biological systems are uniquely susceptible to the influence of toxic substances, with serious, irreversible health effects possible. With so many years ahead of them, children face the prospect of developing medical conditions that will stay with them for the rest of their lives. As children are at risk even before they are born—the placenta can transfer toxins from the mother to the fetus in the womb—it is important to understand both the many factors that contribute to their particular vulnerabilities at specific developmental stages as well as the properties and dangers of relevant toxic substances.

PO Box 261, Montpelier, VT 05601
802-229-6377 • vtkids@voicesforvtkids.org
www.voicesforvtkids.org

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Endnotes

1 Institute for Children's Environmental Health. "Children's Environmental Health Fact Sheet." <http://www.iceh.org/pdfs/HFP/CEHFactSheet.pdf>. Accessed September 18, 2008.
2 Landrigan, Philip J. and Joy E. Carlson. "Environmental Policy and Children's Health." Future of Children. 1995. <http://www.futureofchildren.org/usr_doc/vol5no2ART4.pdf>. Accessed October 28, 2008.
3 US Environmental Protection Agency: Office of Research and Development. A Decade of Children's Environmental Health Research: Highlights from EPA's Science to Achieve Results Program. < es.epa.gov/ncer/publications/research_results_synthesis/ceh_report_508.pdf >. Accessed December 20, 2007.
4 Institute for Children's Environmental Health, "Children's Environmental Health Fact Sheet."
5 Agency for Toxic Substances & Disease Registry (ATSDR). "Health Consultation: Phillipsburg Community Park." 2008. <http://www.atsdr.cdc.gov/HAC/pha/PhillipsburgCommunityPark/Phillipsburg%20Community%20Park%20LHC%207-29-2008.pdf>. Accessed September 20, 2008
6 A. Sherriff, A. Farrow, J. Golding, and J. Henderson, "Frequent Use of Chemical Household Products Is Associated with Persistent Wheezing in Pre-School." Thorax 60 (2005): 45–49.
7 Institute for Children's Environmental Health, "Children's Environmental Health Fact Sheet."
8 EPA. "Radon." <http://www.epa.gov/radon>. Accessed September 16, 2008.
9 Cell migration: neurons originate in a structure near the center of the brain then migrate out to a predestined location in one of the many layers of the brain (Bearer, "Environmental …")
10 Neuron myelination: allows information to travel faster along a neuron (Bearer)
11 Neuron synapses: transmit information from one part of the brain to the other (Bearer)
12 Alveoli: allow gas exchange with the blood (oxygen and carbon dioxide) (Bearer)
13 Institute for Children's Environmental Health, "Children's Environmental Health Fact Sheet."
14 Allergic sensitization: a child becomes increasingly allergic to a substance by repeated exposure to that substance (EPA, A Decade …)
15 Dendritic trimming: removal of some synapses to make neuron network more efficient (Bearer)
16 Specific synapse formation: occurs in conjunction with learning, slower than previous neural developments (Bearer)
17 California Office of Environmental Health Hazard Assessment. "Guidelines for the Safe Use of Art and Craft Materials." <http://www.oehha.org/education/art/artguide.html>. Accessed September 16, 2008.
18 Health Care Without Harm. Aggregate Exposure to Phthalates in Humans. <http://www.noharm.org/us/pvcDehp/issue>. Accessed September 18, 2008.
19 Ibid.
20 National Institute of Environmental Health Sciences. "New Directions in Children's Environmental Health Research." <http://www.niehs.nih.gov/health/scied/documents/Childrens%20Environm%20Health%20factR2.pdf>. Accessed October 17, 2008.
21 Ibid.
22 US Environmental Protection Agency, A Decade of Children's Environmental Health Research: Highlights from EPA's Science to Achieve Results Program.
23 Northwest Coalition for Alternatives to Pesticides. "Chapter 3: Breathing Touching, Tasting: How Children Can Inhale, Absorb, or Ingest Pesticide Residues and Vapors." Unthinkable Risk: How children are Exposed and Harmed When Pesticides are Used at School. <http://www.pesticide.org/Chapter3.pdf>. Accessed September 18, 2008.
24 National Institute of Environmental Health Sciences, New Directions in Children's Environmental Health Research.
25 National Toxicology Program. Report on Carcinogens, 11th. <http://ntp.niehs.nih.gov/ntp/roc/toc11.html>. Accessed October 20, 2008.
26 O'Connor, John C. and Robert E. Chapin. "Critical evaluation of observed adverse effects of endocrine active substances on reproduction and development, the immune system, and the nervous system." Pure Applied Chemistry 75 (11–12): 2099–2123. <http://www.iupac.org/publications/pac/2003/pdf/7511x2099.pdf>. Accessed October 20, 2008.

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Prenatal exposure to lead has been implicated as a precursor of ADHD in children accounting for possibly 1/3 of cases.

-US Environmental Protection Agency [3]

"As testing procedures advance, we learn that lower and lower [lead] doses are harmful. For example, the initial 'safe' blood lead level was set at 60 micrograms/deciliter (ug/dl) in 1960. This was revised down to 10 ug/dl in 1990. Current studies suggest that lead may have no identifiable exposure level that is safe to the developing brain."

- Institute for Children's Environmental Health [4]

"While adults will absorb only a few percent of the lead that they may swallow, children absorb about 50% of ingested lead."

- Agency for Toxic Substances & Disease Registry [5]

Developmental Vulnerabilities

AGE GROUP	DEVELOPMENTAL CHARACTERISTICS	BEHAVIORAL VULNERABILITIES	VULNERABILITIES DUE TO PHYSICAL LOCATION
Prenatal	The brain is beginning to develop; the liver and kidneys (which break down toxins) are immature; poor ability to repair damaged DNA	Associated with the mother's activities and behaviors	Associated with the mother's physical location; many compounds, including lead, mercury, PCBs, pesticides, phthalates and dichlorobenzene can be transferred from mother to fetus via the placenta
Neonatal (0 - 3 months)	Developments in the brain, including: cell migration[9], neuron myelination[10], creation of neuron synapses[11]; developing alveoli[12]; rapid growth/hardening of bones; rapid growth and weight gain; immature immune system functions; immature detoxification capacity of liver, kidney and digestive system; highly permeable skin with large surface-to-volume ratio	Can't walk, not able to remove themselves from noxious or dangerous environments; hand-to-mouth activity (oral toxic exposure hazard); wearing baby clothes that often leave more skin exposed than typical adult-style clothing (dermal exposure hazard); consuming breast milk that may contain toxins such as lead, mercury, PCBs or pesticides, if mother was exposed[13]	Indoor air with potential pollutants; tap/well water in the home may contain lead or radon (particularly significant for babies fed with infant formula that requires water for mixture)
Infant/Crawler (3 - 12 months)	Continued creation of synapses in brain and development of alveoli in lungs; rapid growth and weight gain; deficiencies in liver enzymes; immature immune system functions; risk of allergic sensitization[14]	Introduction of solid food and expanded food consumption; increased object- and hand-to-mouth activity (increased oral toxic exposure hazard); wearing baby clothes that often leave more skin exposed than normal adult-style clothing	Increased floor mobility resulting in extensive contact with surfaces such as rugs, floors, and lawns and associated toxins such as formaldehyde (rugs, pressed wood) and pesticides (lawns); breathing zone close to the floor, hazardous because of possible presence of lead dust as well as the "layering effect" in indoor air, where some substances (including radon) accumulate closer to the floor
Toddler (1 - 2 years)	Continued creation of synapses in brain and development of alveoli in lungs; most immune system functions are mature	Walking upright, running and climbing; oral exploration; more time away from parents; cessation of breast- and bottle-feeding and consumption of full range of food, accompanied by toxic exposure risk through contaminated food; curiosity accompanied by poor judgment; play with toys that may contain phthalates or lead	Moving through wider variety of breathing zones, multiplying the possible sources of toxins the toddler may come into contact with; home and child care are both significant environments with numerous potential toxic sources, including air, water, floors, toys, and arts and craft supplies
Preschooler (2 - 6 years)	Dendritic trimming[15]; developing alveoli and expanding lung volume; relatively stable weight gain and skeletal growth	Decreased hand-to-mouth activity; growing independence; group and individual play	Hazards associated with home, child care and preschool (see above); increased time outdoors with possible exposure to pesticides and airborne pollutants; furniture and playground structures may be constructed with wood treated with formaldehyde; carpeting may also be treated
School age (6 - 11 years)	Specific synapse formation in the brain[16]; lung volume expansion	School-related activities; playground activities and sports	Potential hazards at school: lead or radon in drinking fountain water, arts and crafts supplies that contain lead, phthalates or other toxins[17], formaldehyde-treated furniture, playground structures or carpeting, pesticides used on school fields, dichlorobenzene vapors from toilet odor blocks
Adolescent (12-18 years)	Continued lung volume expansion; rapid skeletal growth; rapid reproductive and hormone systems changes, including puberty	Self-determination; development of abstract thinking (i.e. cause and effect analysis): this is acquired slowly, hence adolescents will more frequently place themselves in hazardous environments/situations; onset of wearing jewelry and cosmetics that may contain lead or phthalates	School-related hazards (see above); possible employment with associated workplace hazards, for example pesticide exposure while working on a farm, dichlorobenzene exposure during janitorial work, or lead exposure while working as contractor

Sources: Compiled from tables in Cynthia F. Bearer's "Environmental Health Hazards: How Children are Different from Adults" (1995, http://www.futureofchildren.org/usr_doc/vol5no2ART2.pdf) and the US Environmental Protection Agency's A Decade of Children's Environmental Health Research: Highlights from the EPA's Science to Achieve Results Program (2007, http://es.epa.gov/ncer/publications/research_results_synthesis/ceh_report_508.pdf) unless otherwise cited

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Toxins

ENVIRONMENTAL TOXIN	PROPERTIES	FOUND IN	EXPOSURE	HEALTH EFFECTS
Lead	Bluish-grey soft, malleable metal	Old paint, toys, plumbing and construction materials, jewelry, cosmetics	Dust from lead-based paint; contaminated drinking water; transferred from mother to fetus or nursing child	In children, low level exposure can cause learning disabilities, reduced IQ and attention span, and impaired growth, among other intellectual and behavioral effects; high level exposure can cause mental retardation, comas, and even death
Radon	Invisible, odorless, tasteless radioactive gas	Natural decay of uranium in soils produces gas	Gas seeps into homes, concentrates near floor (where small children walk and crawl); can be present in well water	Associated with lung disease and cancer
Phthalates	Man-made plastic-softening chemical	Food packaging and containers, cosmetics, toys, medical products	Ingested through contaminated food; can be absorbed through the skin from contact with toys and cosmetics; during medical procedures; transferred from mother to fetus or nursing child[18]	Suspected to harm reproductive development[19]; possible carcinogen
Formaldehyde	Colorless, pungent-smelling gas; component of glues and adhesive; sometimes used as a preservative	Low-cost furniture and wooden building materials – doors, windows, playground structures; carpeting; industrial and car emissions; second-hand smoke	Released as gas and inhaled	Allergic reactions and possible carcinogenic effects
Mercury (elemental, inorganic, methylmercury and ethylmercury)	Silver liquid metal at room temperature; colorless and odorless as gas	Naturally exists in rock and soil; released with burning of fossil fuels; discarded products (thermometers and some medical and dental products)	Through consumption (i.e. of large predatory fish with mercury buildup); inhalation of emissions; transferred from mother to fetus or nursing child	In conjunction with PCBs, methylmercury affects neurological functions[20]; high exposures over long periods may cause kidney and heart problems; developing fetuses are particularly sensitive
Polychlorinated Biphenyls (PCBs)	Varies from thin, light colored liquid to yellow or black waxy substance; electrical insulator	Transformers, cables, paints, plastics, rubber products, dyes, carbonless copy paper (banned in 1979)	Plants and foods can be contaminated by leaks from waste sites; transferred from mother to fetus or nursing child	In conjunction with methylmercury, affects neurological functions [21]; carcinogenic and immune, reproductive, nervous and endocrine systems effects
Organophosphates (OPs)	Family of pesticides	Pesticides used in urban and rural contexts	Ingested through treated food products; inhaled as vapor; skin exposure to residue or dust; transferred from mother to fetus or nursing child; farm children are at special risk[22]	Can harm brain development, immune and reproductive systems[23]; newborns whose mothers were exposed exhibit poor motor reflexes, smaller-than-normal head size, and lighter birth weight[24]
Decabromodiphenyl ether (decaBDE, deca-BDE, DBDE, "deca")	Member of Polybrominated diphenyl ether (PBDE) family; man-made flame retardant	A variety of consumer products including furniture and electronics	PBDEs enter air, water, and soil during their manufacture and use in consumer products, then contaminate food	Animal testing suggests thyroid and liver effects, and at high levels neurobehavioral alterations and immune system and reproductive system effects; suspected carcinogen
Perfluorooctyls (PFOs, Teflon)	Synthetic chemicals used in production of compounds that prevent adhesion	"Non-stick" cookware and food packaging	Through contact with treated products	Suspected carcinogen
2-Butoxyethanol (BE, EGBE	Clear, colorless liquid; highly soluble	Cleaning products, thinners and strippers	Through direct skin contact and inhalation of vapors	Suspected to harm liver, kidney, nervous system, cardiovascular system, and to affect development
1,4 Dichlorobenzene (1,4 DCB, paradichlorobenzene, "para")	Strong odor	Toilet deodorant blocks and mothballs	Inhalation of vapors; transferred from mother to fetus or nursing child	Allergic reactions; suspected liver, kidney, cardiovascular, nervous system effects; reasonably anticipated carcinogen[25]
Bisphenol A (BPA)	Used in production of plastic products	Baby and water bottles, sports equipment, medical and dental devices and household electronics	Contaminated water; inhalation of industrial emissions	Disrupts hormones[26]; possible carcinogen

Sources: Environmental Protection Agency (www.epa.gov) and Agency for Toxic Substances & Disease Registry (http://www.atsdr.cdc.gov/toxfaq.html) unless otherwise cited

Prenatal exposure to the use of disinfectants, bleach, carpet cleaner, window cleaner, air fresheners, paints, dry cleaning fluid, aerosols, and pesticides were found to increase the risk that a young child would have persistent wheezing, which can be a precursor to asthma; the more frequently the chemicals were used, the greater the risk.

- Thorax [6]

"[A]bout 1.16 million women in the U.S. of childbearing years eat sufficient amounts of mercury-contaminated fish to risk damaging their children's brain development."

- Institute for Children's Environmental Health [7]

"Radon is the leading cause of lung cancer among non-smokers. Radon is the second leading cause of lung cancer in America and claims about 20,000 lives annually."

- US Environmental Protection Agency [8]

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