

### Children's Special Vulnerabilities

#### Preconception

The volume of environmental chemicals known or suspected to be reproductive toxicants can overwhelm parents because such toxicants are found in common consumer products they bring into their home e.g. paint, solvents, lead, pesticides, alcohol, tobacco smoke, personal care products such as fragranced products and hair treatments. In the USA, the American Society for Reproductive Medicine claim that almost 10% of couples desiring children have difficulty achieving pregnancy, while 35-50% of pregnancies are not successful at reaching full term. Around 3% of babies are born with major birth defects.

There is now widespread concern amongst parents, health professionals, scientists and advocacy groups that exposure to some common environmental agents may contribute to human reproductive and developmental disorders. Information on reproductive toxicants can be found from many sources. However, in the USA the National Toxicology Program (NTP) and the National Institutes of Environmental Health Sciences (NIEHS) have established the Center for the Evaluation of Risks to Human Reproduction (CERHR), which serves as a clearinghouse for current information on environmental toxicants that can affect human reproduction and development. CERHR has introduced a monograph series on reproductive toxicants, which can be found on the Web. Their homepage can be found at <http://cerhr.niehs.nih.gov> .

#### During Pregnancy.

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Mother's exposure to chemicals can affect the development of the child dependent on the stage of the pregnancy. Exposure to certain chemicals during the early months of pregnancy is associated with an increased risk of mental retardation and learning disorders.

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Women have more body fat than males and can store more toxins that affect a developing fetus.

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During the normal hormonal fluctuations associated with menstrual cycles and pregnancy there is an increased susceptibility to toxins.

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Toxins of special concern to women of child bearing age include industrial pollutants such as mercury (primary source fish consumption) and common ingredients in Personal Care Products.

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### **Child's Life Cycle.**

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- Pregnancy Fetal development
- Infancy and Early childhood, then to
- School Age and finally
- Adolescence.

During each of these stages children will be in contact with and exposed to a vast array of chemicals. Different chemicals or chemical classes can affect different organs, hormonal systems and biochemical pathways. Those chemicals that act as endocrine disruptors will have a variable effect depending on the age and stage of hormonal development. Children's 'dose' per body weight is likely to be much higher than adults and children are not uniformly exposed to environmental risk factors.

## **Increased Exposures in Children**

### 1. Diet.

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Eat and drink more than adults for their body weight.

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Young children eat a limited food range (milk and milk products)

### 2. Behaviours

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Young children hand to mouth

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Swim more

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Different activities

### 3. Stature

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Closer to the ground and exposed to more dense vapours, car exhausts, house dust and chemicals leaching from floor coverings

#### 4. Enhanced Absorption

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Dermal absorption. Higher skin surface area and more permeable, especially newborns – dermal absorption high

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Gastrointestinal tract absorption. Immature and leads to greater absorption in children

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Respiratory absorption. Young children breath approximately twice that of adults

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Blood-brain barrier (BBB). Age dependent maturing of BBB during childhood and results in higher permeability to chemicals. BBB also more permeable to lipid soluble compounds

#### 5. Distribution in the body.

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Difference to adults in the composition of the body and blood, and organ size means that children are less able to handle toxins. Low body fat combined with proportionally larger organs in children leads to greater distribution and storage of toxins.

## 6. Metabolism

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Higher metabolic rate

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Greater food and air intake

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More active than adults – higher respiration rate and energy metabolism

## 7. Biotransformation of chemicals

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Chemical compounds are broken down in the body to metabolites, some of which are more toxic than the parent compound.

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In children these pathways are immature and can result in an inability to metabolise a chemical OR in different types of metabolites to that found in adults.

## 8. Excretion and Elimination

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The liver and kidney in newborns is not fully developed and results in slower elimination of chemical compounds (2-9X slower)

### **Routes of Exposure: Inhalation, ingestion and dermal penetration.**

1. Food.

#### **Primary Sources**

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Direct contamination of animals or plants during growth

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Bioaccumulation along the food chain. Eg accumulation of Flame Retardants in fish and shellfish

#### **Secondary Sources**

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1. During manufacture, processing and storage. For example

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Bisphenol A can migrate from plastic and rubber products into foods during dishwashing, boiling and brushing and is found in 80 – 85% of canned foods.

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Organotins can migrate into foods from products such as baking parchment, kitchen gloves, dishwashing sponges and cellophane film wrap.

### 2. Air. Indoor and Outdoor air pollution

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Compounds in indoor air include alkylphenols, bisphenol A and phthalates. These can be released from cleaning products, personal care products and cosmetics vapours, degraded materials leach from carpets, paint, computers, furniture and toys and adhere to aerosol particles (house dust)

### 3. Water.

May contain pesticides, heavy metals, nitrates & disinfection by-products. Chlorine used in disinfection forms organic chlorine compounds (disinfection byproducts). Epidemiological studies indicate that there maybe an increased risk of miscarriage in women and developmental; effects to the fetus of pregnant women exposed to high levels of disinfection by products.

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Chemical contamination via sewage, industry waste water, or leaching from landfill

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Contamination via drinking water pipes

## 4. Medical Sources

Medical devices containing plastics including blood bags, mechanical ventilators, hemodialysis machines, feeding equipment and infusion lines

There are distinct stages that children go through that have unique characteristics, for example:

Stage

Physiological

Social/Age Activity Related

Pregnancy

Fetal lungs immature

Placental transfer

Prolific cell growth

Totally dependent on mother's activities.



Infancy & Early Childhood

## **NEWBORNS**

Lungs immature

Highly permeable GI

Highly permeable skin

## **TODDLERS**

Nervous system development

Immature metabolic pathways (& less able for detoxification)

## **INFANTS AND TODDLERS**

Breast Feeding:

Crawling Stage: Close to ground – flooring, lawns, grounds

## Why Are Children More Vulnerable to Chemical Pollutants

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Mouthing: Hand to mouth

Eat & drink more than adults (in body wt)

Eat different proportions of food (more fruits, juices, milk)

School Age

Maturing organs and systems especially reproductive system, skeleton and muscles

New environments

School grounds & classrooms

Classroom ventilation

Arts and crafts

Chemical Usage in schools

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Cleaning Products

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Solvent based textas, whiteboard markers, liquid paper etc.

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Perfumes, aftershaves, deodorants

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Toilets – Air fresheners

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Pesticide applications

Adolescence

Maturing organs and systems especially reproductive, hormonal system. Developing skeleton and muscle

New environments

Personal Care products, especially high use of deodorants and scents

Occupational exposures

### Exposure assessments in children

Following a literature review of articles and reports from the US EPA to identify age categories used in childhood exposure risk, Thompson found significant data gaps in children's exposure risk. (Thompson K.M. 2004. Changes in Children's Exposure as a Function of Age and the Relevance of Age Definitions for Exposure and Health Risk Assessment. *Medscape General Medicine* 6(3), 2004.)

*These gaps included information on:*

breast milk consumption by infants, and children over 1 year

children' food handling practices – how they lead to exposures (eating with hands, food falling on the floor)

fish intakes for young children (and children of families that rely on caught fish)

incidental and intentional soil intake by children

soil adherence for dermal exposure

relationship between various microactivities, macroactivities, and microenvironments where children spend time

correlation between exposure factors and growth (changing exposure behaviours)

longitudinal studies for data needed to track exposures over time and to assess the impacts of early exposure and/or events on children's developmental trajectories

*Risk Assessment Data needs to take account of:*

a. The continuous changes from infancy to adulthood. Everyday behaviours and child specific activity patterns alter the amount of exposure.

b. Variability of individuals. Interindividual variability (the extent to which the observed differences in daily exposure represents difference between children) and, Intraindividual variability (the extent to which the observed differences in daily exposure represents differences for each child)

c. Aggregate exposures (multiple pathways for exposure and dose) and cumulative risks

d. Eating habits and practices have changed

- increased ability to source foods once only available seasonally
- ever increasing percent of food eaten away from home
- children's diets shifting from fresh produce and tap water to including larger amounts of processed food and bottled water

### Reference Articles and websites:

Children's Health and The Environment: Environmentally Healthy Homes and Communities CE. Authors: Barbara Sattler, RN, DrPH; Brenda M. Afzal, RN, MS; Marian E. Condon, RN, MS; Erin K. Belka, BS; Tonya M. McKee, BA. 2003. [www.medscape.com](http://www.medscape.com) Clinical Update 2003.

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Bruce P. Lanphear\*, Charles V. Vorhees, David C. Bellinger. Protecting Children from Environmental Toxins. Toxicity testing of pesticides and industrial chemicals is a crucial step. PLoS Medicine | [www.plosmedicine.org](http://www.plosmedicine.org) March 2005 | Volume 2 | Issue 3 | e61

IPEN Community Monitoring Handbook. Information on Body Burden of chemicals - POPs and PTSs. <http://www.oztoxics.org/cmwg/index.html>

'Children in the New Millennium: Environmental Impact on Health. 2002. United Nations Environment Programme (UNEP), United Nation's Children's Fund (UNICEF) and World Health Organisation (WHO). [www.unep.org](http://www.unep.org) , [www.unicef.org](http://www.unicef.org) and [www.who.int](http://www.who.int)

Changes in Children's Exposure as a Function of Age and the Revelance of Age Definitions for Exposure and Health Risk Assessment. Kimberly M. Thompson. Medscape General Medicine 6(3), 2004.

[www.medscape.com/viewarticle/480733](http://www.medscape.com/viewarticle/480733)

IPEN Community Monitoring Handbook. Information on Body Burden of chemicals - POPs and PTSs. <http://www.oztoxics.org/cmwg/index.html>

1. There are stages throughout a child's life where they are particularly vulnerable to the harmful effect of chemicals. A child's exposure to environmental chemicals is insidious and may begin during the prenatal phase (pregnancy) and continue during infancy from direct ingestion of breast milk, other dietary sources, as well as house dust and soil.

Chemicals have a high affinity for fatty tissues resulting in significant exposure through food.

2. A child's lifecycle may be described in the following stages from