Developmental Exposure to Environmental Toxicants

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KEYWORDS

• Toxicant • Environmental exposure • Fetus • Child

KEY POINTS

- Susceptibility to environmental toxicants depends on a child's developmental stage and interactions within the physical, biological, and social environment.
- Critical stages of growth and cellular differentiation that occur in fetuses, newborns, infants, and children represent periods of greatest vulnerability to the adverse effects of environmental toxicants.
- The floor inside the home represents an important microenvironment for young children, because their breathing zones are lower than those of adults, and many chemicals are concentrated near the floor. Ingestion, inhalation, and dermal absorption can occur.
- Toxicants are widely dispersed in the environment. It is important for pediatricians to understand the potential routes of exposure, toxic effects, and strategies for prevention of exposure in order to provide anticipatory guidance to children and their families.

OVERVIEW AND DEVELOPMENTAL ASPECTS

Introduction

Toxicants are ubiquitous in the human environment, and children are often inadvertently exposed. Infants and children are a uniquely vulnerable population, especially during early stages of growth and development. Exposure to environmental toxicants is affected by children's physical, biological, and social environment. Children and adults experience the physical environment differently. The physical environment can be more hazardous for children, especially those who are preambulatory and lack control of their surroundings. The physical environment changes as

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children gain independence and spend time away from the home.[1] The biological environment is determined by genotypic and metabolic responses to interactions with the physical environment. Routes of absorption, metabolism, distribution, and health effects vary, and are influenced by the developmental stage in which exposure occurs.[1,2] A toxicokinetic diagram illustrates how environmental toxins interact with the biological environment (**Fig. 1**). The social environment is determined by lifestyle preferences and societal regulations and policies that influence the physical environment.[3]

The Epigenome

The epigenome refers to biochemical interactions that regulate expression of the genome without modification of DNA sequence. The epigenome is heritable, and highly vulnerable to toxicants during periods of rapid growth, such as fetal embryogenesis.[4] DNA methylation is a well-described epigenetic mechanism that affects DNA expression. When the promoter region of DNA is methylated, it remains tightly coiled, affecting DNA transcription. Impaired DNA methylation in children is associated with exposure to toxicants, such as lead and polycyclic aromatic hydrocarbons (PAHs) found in cigarette smoke and motor vehicle exhaust.[4,5]

Preconception

Even before conception, environmental toxins can influence future offspring. Oogonia differentiate during fetal life and therefore become vulnerable to toxicants during fetal development. Spermatogenesis begins at puberty; thus sperm become susceptible after puberty, in the periconceptual period. Because sperm lack DNA repair mechanisms and differentiate rapidly, they are highly vulnerable to toxins.[1,6] Impaired

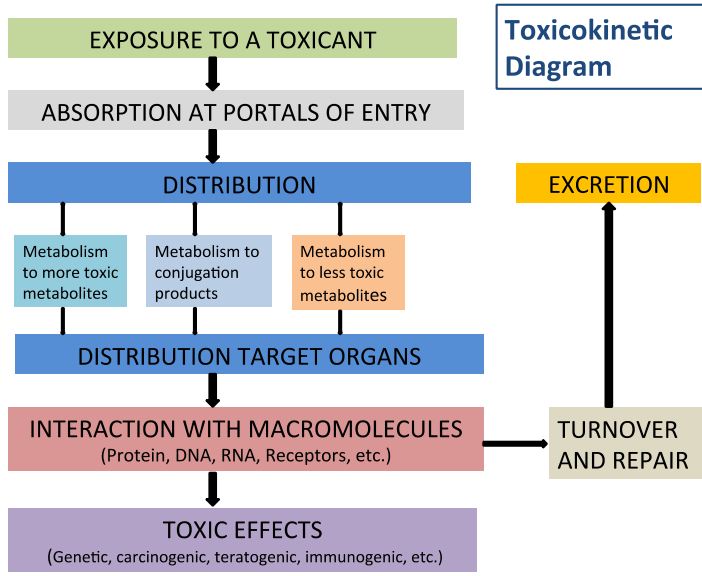

Fig. 1. How chemicals in the physical environment interact with the biological environment. Absorption, distribution, metabolism, interaction with target organs, and toxic effects vary with developmental stage. Genetic polymorphism affects metabolism and excretion of toxic metabolites.