DIFFERENCES IN EXPOSURE AND METABOLIC RESPONSE OF INFANTS AND ADULTS TO LEAD, CADMIUM AND ZINC

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ABSTRACT

Substantial differences exist between infants and adults in their exposures to lead, cadmium and zinc and in the sources of these exposures. In addition, metabolic responses of infants and children to environmental levels of these metals are different from those of adults. The toxicity of lead and cadmium to all age groups has been recognized for a number of years. Nonindustrial lead toxicity occurs principally among young children, whereas the toxic effects of cadmium in bone and kidney are thought to be manifested only after decades of exposure have produced a substantial body burden of cadmium. In contrast, zinc deficiency has been reported to occur among infants and children far more commonly than has zinc toxicity. Despite differences in the likelihood that modern human populations will develop toxicity or deficiency of these metals, several general physiological and behavioral characteristics converge to modify metal exposure during infancy and early childhood.

EXPOSURE DURING INFANCY AND EARLY CHILDHOOD

The various sources of environmental exposure to lead (Mahaffey, 1978), cadmium (Nriagu, 1982), and zinc (Hambidge, 1981) are reviewed elsewhere. Pediatric exposure to metals differs from exposure of adults. Infants and very young children can greatly increase their ingestion of metals through pica and mouthing of objects. Mouthing of hands and objects is considered to be normal in infants, and nearly all infants under one year of age exhibit this behavior. In a survey of children 12 to 72 months of age, Barltrop (1966) reported that 78 percent mouthed objects and 35

percent ingested the objects. Pica, defined as the habitual ingestion of nonfood substances, occurs among young children; depending on the type of objects ingested, e.g., paint, colored newspapers or magazines, pica can greatly increase the intake of lead and occasionally cadmium.

Among children, acute lead intoxication is characterized by pronounced central nervous system (CNS) damage in which cerebral edema, coma and convulsions occur; in the most severe cases, death results (Lin-Fu, 1980). Acute oral exposure to cadmium can cause acute gastrointestinal poisoning manifested by vomiting, diarrhea and crampy abdominal pain of sudden onset (Chisolm, 1980). Symptoms of poisoning due to ingestion of high levels of zinc are described as nausea, vomiting, abdominal cramps, diarrhea and fever (Li and Vallee, 1980).

Because of the high concentration of lead and, under some circumstances, cadmium in sources such as paint or urban street dirt, consumption of only small quantities may produce toxicity. In contrast, modest elevations in the concentration of lead or cadmium in food and beverages can have toxicologic significance because of the relatively large quantities of fluid and food consumed. For example, infants living in an area with acidic water and water-supply pipes or lead-lined water-storage cisterns received most of their lead exposure from water used to dilute powdered infant formula or other beverages such as juice (Sherlock et al., 1982).

In the absence of metabolic abnormalities, zinc deficiency in infants is secondary to low levels of zinc in food, poor bioavailability of dietary zinc, and a high requirement for zinc for growth. The relative importance of these factors is not fully understood.

CONTRAST BETWEEN INFANTS AND ADULTS IN LEVELS OF CADMIUM, LEAD AND ZINC EXPOSURE

Exposure from Dust and Dirt

Under specific environmental conditions, an individual source of metals may dominate all other sources contributing to exposure. Clinically evident, severe poisonings among children due to high-lead dirt are secondary to sporadic ingestion of these sources via pica or mouthing of hands and objects. However, discussion of severe pediatric lead toxicity is outside the scope of this paper.

Increased exposure to cadmium and lead through mouthing of hands and objects is common among infants and young children. Estimates of the quantities of lead transferred to the child via the hands have been published. Sayre et al. (1974) reported an increase