TRACE ELEMENTS IN NUTRITION DURING CHILDHOOD AND ADOLESCENCE

ESSAY

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By

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بسم الله الرحمن الرحيم

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TO MY WIFE

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An element is considered to be trace element when it constitutes less than 0.01% of total body weight.

Although iron and iodine are trace elements, the present survey is devoted to the other 11 trace elements thought to be nutritionally important for higher animals.

These 11 trace elements are, in order of importance to children: zinc, copper, fluoride, Manganese, selenium, chromium, cobalt, molybdenum, nickle, silicon, and vanadium.

The purpose of the survey is to describe the physiology and pathophysiology of these elements in a short account followed by an account of the present state of our knowledge about the effects of deficiency and excess of these elements in dietary intake of children and adolescents (American Academy of Pediatrics, 1985).

ZINC

ZINC

The trace element zinc only recently has been established as a nutrient essential for health and growth in humans **(Butrimoritz and Purdy; 1978).**

Zinc comprises 0.0033% of the body's mass, making it the third most abundant trace element after iron and fluorine **(Schroeder and Nason; 1971).**

The first human zinc responsive syndrome was reported in 1961, by Prasad and Coworkers at the **U.S. Naval Medical Research Unit (NAMRU)** in Cairo, when they showed that zinc would cause increases in growth and sexual maturation in patients with dwarfism and hypogonadism.

PHYSIOLOGY AND BIOCHEMISTRY:

Zinc is found in the biologic state, as loosely or firmly bound fractions, complexed to organic ligands, rather than free in solution as metalic ion.

Approximately 50% of plasma zinc is freely exchangeable and loosely bound to albumin, 7% is bound to amino acids and the remainder is bound to macroglobulin and other serum proteins. Zinc also binds to specific sites on insulin but the biologic significance of this is unclear **(Walravens; 1979)**.

On the cellular level zinc is involved in nearly all aspects of metabolism. Zinc is essential for the function of at least 70 enzymes such as carbonic anhydrase, carboxypeptidase A and B, alkaline phosphatase, aldolases and is involved in a variety of metabolic processes. The activity and formation of these metalloenzymes is regulated by the level of zinc in tissue **(Prasad; 1979)**.

Zinc exerts its primary biologic effect through the zinc dependent enzymes responsible for the regulation of RAN and DNA metabolism. Therefore, zinc depletion will inhibit the formation of nucleic acids consequently alteration of protein synthesis leading to limitation of cell replication and decreasing metabolic processes involved in tissue growth, repair and maturation **(Arlette; 1983)**.

Zinc was found to be important for the mobilization of vitamin A from the liver **(Smith et al., 1974)**.

Zinc is believed to have an action in maintaining the stability of cellular membranes by decreasing membrane lipid peroxidation. The observation that zinc prevents the release of histamine from mast cells and inhibits macrophage migration are examples of such an action **(Chrapil., 1976)**.

It was found that zinc has an immunoregulatory influence as it decreases lymphocyte response in high responders and conversely has an enhancing effect on low responders **(Duchateau et al; 1981)**.

SOURCES:

Zinc is available from a wide variety of dietary sources. Animal food sources are richer in absorbable zinc than plants because the phytates contained in the latter, complex with zinc reducing its bioavailability (table 1). **(National Academy of Science., 1980)**.

Table (1).

Classification of dietary zinc sources based on nutrient energy density (Solomons and Shrimpton., 1984)

Zinc category (mg/ 1,000 KCal.)	Foods
Very poor 0-2	Fats, oils, butter, cream cheese sweets, chocolates, soft drinks, alcoholic drinks, sugars, jams, and preserves.
Poor 1-5	Fish, fruits, refined cereal products, pastries, biscuits, cakes, puddings, tubers, plautains, sausages chips.
Rich 4-12	Whole grains, pork, poultry, milk low fat cheese, yogurt, eggs, nuts.
Very rich	Lamb, leavy and root vegetables, crustacea, beef, kidney, liver, heart Mollusks.

ABSORPTION:

Dietary zinc is absorbed in the duodenum and proximal small intestine **(Solomons and Cousins., 1984)**.

The perfusion studies from Mayo Clinic raised the issue of an entero-pancreatic circulation in man suggesting that each meal represents two meals of zinc; one from the ingested food and the other from the meal stimulated exocrine secretions into the duodenum. Thus, exposing the endogenous zinc to the same inhibitory substances from the diet to which exogenous zinc is exposed **(Matseshe et al., 1980).**

In the intestinal lumen, dietary zinc mixes with zinc from pancreatic secretions and with zinc-containing breakdown products from intestinal desquamation. After cellular uptake the metal may be transported to the serosal surface and actively secreted into the portal circulation where it binds to albumin. This mechanism is reversible, and uptake of portal zinc by intestinal cells also occurs. In cases of zinc sufficiency, an increasing zinc pool will trigger synthesis of intestinal cell metallothionine, which can bind excess intracellular zinc. With desquamation this excess zinc will again become available for absorption, and zinc attached to low molecular weight protein fragments may adhere preferentially to the brush border. The luminal zinc binding site also has the capacity of increasing active transport of zinc in cases of zinc deficiency.**(Solomons and Cousins., 1984).**

FACTORS AFFECTING ZINC BIOAVAILABILITY:

In 1971, Reinhold speculated that the dietary basis for zinc deficiency syndrome was the high phytate content of the diet. **Davis and Olpiu., (1979)** recently showed that adjusting the phytate/zinc molar ratio through a range of 0:1 to 40:1 had comparable effects on weight gain, plasma or hair zinc concentration. **Morris and Ellis (1980)** have recently suggested that phytate/zinc ratio is not an immutable determinant of zinc bio-availability. Manipulating the dietary calcium content from 0.75 to 1.75% at a fixed phytate/zinc molar ratio can cause profound decrease in growth. **Reinhold et al., (1976)** suggested that dietary fiber had also an inhibitory effect on zinc absorption. Thus, it is safe to conclude that phytates and fibers occurring together in whole grain and leguminous food stuffs, contribute for the reduction of zinc bio-availability from these foods.

There has been a suggestion that oxalates reduce apparent zinc absorption in human subjects **(Kelsay and Prather., 1981)**. Moreover, minerals of sufficiently similar chemical properties often exhibit