CC/NUMBER 45
NOVEMBER 6, 1989

This Week's Citation Classic®

Sandstead H H. Zinc nutrition in the United States. *Amer. J. Clin. Nutr.* 26:1251-60, 1973.
[USDA Human Nutrition Laboratory, Grand Forks, ND]

Zinc is essential for all complex forms of life. Among its functions is the activation of many enzymes including some that mediate synthesis of nucleic acids and protein. In humans, effects of zinc deficiency include growth retardation and delayed sexual development, signs that led to the discovery of zinc deficiency among adolescents in the Middle East, in American adolescents with severe intestinal malabsorption syndrome, and in infants with "failure to thrive." The bioavailability of dietary zinc is an important determinant of human zinc nutriture. Factorial estimates of human zinc requirements and the zinc content of some American diets suggest that marginal or deficient zinc nutriture occurs in some Americans because of economic deprivation and/or requirements that exceed the amount of bioavailable zinc in the diet. Individuals at risk include pregnant women, infants, children, adolescents, and the elderly. [The *SCI*® indicates that this paper has been cited in over 250 publications.]

Human Zinc Requirements

Harold H. Sandstead
Department of Preventive Medicine
and Community Health
University of Texas Medical Branch
Galveston, TX 77550-2779

June 1, 1989

In 1971 I was invited to participate in the 1972 American Institute of Nutrition/Federation of American Societies for Experimental Biology Symposium on "Marginal Mineral Nutrition in Man." My assignment was to review knowledge of "Human Zinc Nutrition in the United States." Based on experience with zinc-deficient adolescent boys in Egypt[1] and the well-described inhibition of zinc absorption by phytate,[2] it seemed likely that the bioavailability of zinc from the diet was a major determinant of human zinc nutriture. At the time of my review, human requirements for zinc had not been determined. Therefore, I calculated the probable zinc requirements factorially using published data. I then related my estimates of requirements to bioavailability and examined the adequacy of published diets. My findings suggested that some pregnant women, infants and young children, adolescents, and elderly in the US are at potential risk of zinc deficiency and that diets reported to be consumed by some groups were probably marginal or deficient. These findings led me to conclude that marginal or deficient zinc nutriture is probably more frequent in the US than previously suspected.

My review was timely because there was considerable interest among researchers at several centers, and at our own laboratory, in human trace-element requirements and the effects of dietary constituents on bioavailability of zinc and other trace elements. This interest prompted the World Health Organization (WHO) to convene a panel of experts to review knowledge of trace-element requirements of humans. I was fortunate to be a member of the panel. The background data and my factorial calculations of probable human requirements for zinc that were published in this paper provided the basis for the provisional estimates of human zinc requirements that were published in the WHO report.[3]

My interest in zinc began in 1961 when I was assigned as a Public Health Service officer to the US Naval Medical Research Unit Number 3 (NAMRU-3) in Cairo, Egypt, where I was introduced to zinc by Dr. Ananda S. Prasad and Dr. William J. Darby. Prasad and Dr. James A. Halsted had hypothesized that dwarfism and hypogonadism associated with geophagia and iron deficiency in Iranian adolescent village boys was caused by zinc deficiency. Prasad had joined Darby's research team at NAMRU-3 where he initiated research on the problem. The experience of being a member of this research team focused my research interests and molded my subsequent career.

I am pleased this article has been a useful contribution to the advancement of knowledge on zinc.[4] Many students and colleagues have mentioned to me that it provided a perspective they found helpful. Few rewards in science are more gratifying.

1. **Sandstead H H, Prasad A S, Schulert A R, Farid Z, Miale A, Bassilly S & Darby W J.** Human zinc deficiency, endocrine manifestations and response to treatment. *Amer. J. Clin. Nutr.* 20:422-42, 1967. (Cited 215 times.) [See also: **Sandstead H H.** Zinc deficiency: growth stunting and hypogonadism. Citation Classic. *Current Contents Clinical Medicine* 17(16):16, 17 April 1989 and *CC/Life Sciences* 32(16):17, 17 April 1989.]
2. **O'Dell B L.** Effect of dietary components upon zinc availability. A review with original data. *Amer. J. Clin. Nutr.* 22:1315-22, 1969. (Cited 150 times.)
3. **World Health Organization.** *Trace elements in human nutrition: proceedings of the WHO Expert Committee, Geneva, 1973.* Geneva, Switzerland: WHO, 1973. Technical Report No. 532. (Cited 150 times.)
4. **Hambidge K M, Casey C E & Krebs N F.** Zinc. (Mertz W. ed.) *Trace elements in human & animal nutrition.* New York: Academic Press, 1986. Vol. 2. p. 1-137.

/A-16

CC/CM