Normal Hair Zinc Levels of Children

Are They Affected by Drinking-Water Hardness?

J. P. VAN WOUWE,1,2,* C. J. A. VAN DEN HAMER,1 AND J. J. M. DE GOEIJ1

1Department of Radiochemistry, Interuniversity Reactor Institute, Mekelweg 15, 2629 JB Delft, The Netherlands; and 2Department of Pediatrics, Leiden State University, P.O. Box 9600, 2300 RC Leiden, The Netherlands

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ABSTRACT

From literature data, a negative correlation was derived between the normal average hair zinc levels of 5-yr-old children and the calcium levels in their drinking water (hair zinc level in mg/kg = -(0.158 ± 0.003) calcium level in mg/L + 134; r = 0.993, n = 6, p = 0.0006). Exposure of hair samples of a 5-yr-old child to water with different levels of calcium and zinc did not provide evidence for an exogenous effect of calcium in drinking water on hair zinc levels. Thus, these results support Gibson's hypothesis that calcium in hard drinking water interferes with Zn absorption.

Index Entries: Zinc; hair zinc, in children; hair zinc, and water hardness; calcium, in drinking water; hair zinc, exogenous effect of calcium on.

INTRODUCTION

The recognition of a variety of symptoms in which deficiency of zinc plays a pathophysiological role—chronic diarrhea, impaired immune function, anorexia, dysgeusia, growth retardation, delayed maturation, and subfertility in males—stresses the need to diagnose effectively zinc...

*Author to whom all correspondence and reprint requests should be addressed.
deficiency. Hair analysis has been promoted for this purpose (1). However, reported normal hair zinc values vary considerably from author to author. Apart from systematic differences in sampling and/or analysis, these variations may be attributed to a variety of factors, such as environmental effects (hair care, occupational exposure, geographic location), differing growth rates, health, drug use, age, and gender.

Gibson et al. (2) pointed toward drinking water hardness as a possible cause of regional differences in normal hair zinc levels. Using the data of Gibson et al. and additional data we observed a negative linear dependency of hair zinc levels with drinking water calcium levels in 5-yr-old children (3). The nature of this relation is unknown. It is conceivable that the effect of calcium is purely exogenous, i.e., a result of washing of the hair. On the other hand, the effect may be of endogenous origin, i.e., the result of an influence of calcium in hard drinking water upon zinc absorption, as suggested by Gibson et al. (2).

The aim of this study is twofold. First, we searched for additional literature data on hair zinc levels in 4-6-yr-old children as a function of the calcium level in drinking water to check the negative correlation mentioned above. Second, we investigated whether exposure of childrens’ hair to calcium-containing water may change hair zinc levels, i.e., by impeding zinc uptake in hair from water or by exchange between calcium from the water with zinc in the hair. Since the proton concentration may affect the interaction between calcium and zinc, the influence of the pH of the water was investigated.

METHODS AND MATERIALS

The data evaluated earlier for the groups from Halifax, Guelph, Denver, and Leiden were taken from refs. (2-4). Additional data were obtained for groups of 4-7-yr-old children from Bangkok, Thailand (5), and Frankfurt, FRG (6). All data were converted into arithmetically averaged zinc levels and associated standard error of the mean. Since average values were available for the groups from Bangkok and Frankfurt only, we have estimated the standard error of the mean on the basis of the standard deviation in the four other groups (ranging from 30 to 45 mg/kg). The data for drinking water hardness in the 3 yr preceeding the publication were obtained upon inquiry from the local drinking water supply authorities. Calcium levels were averaged and converted into the U mg/L. The data are presented in Table 1.

Hair of a 4.5-yr-old healthy girl, with normal height and weight, was cut for samples. The child used no medication and her dietary habits were normal. Her hair had never been exposed to dye or bleach prior to the taking of the samples. All hair was cut in sections of 2 cm, mixed, and divided into strands of 50 mg. Variation in hair zinc was measured in 10 samples and also used for comparison in an equal number of keratin (Merck, Darmstadt, FRG) samples.