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Zinc in urban infants and children from Brasilia

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SUMMARY. Zinc in urban infants and children from Brasilia. The substandard living conditions of the poor families in the fast growing urban population of Brazilian cities puts children in the more vulnerable group of micronutrient deficiency. The chemical analysis of milk diets consumed by infants showed that zinc is insufficiently provided in bottle-fed infants, and possibly a first-limiting nutrient in breast-fed babies, at least during the first 6 months of life.

INTRODUCTION

The rapid growth of Brazilian cities is a new phenomenon in the urbanization process particularly over the last three decades. Such phenomenon has brought about dramatic changes in our human ecology. The traditional way of life of a rural and agricultural society has made way for the urban and proletarian manner of living of the migrating masses. The consumption of a variety of locally grown foods has been displaced by mass production and income dependent types of food, typical of large urban centers. Such subtle but nonetheless fundamental changes in the process of food provision has raised questions such as: "What are the nutritional consequences of this process in the urban population" ? We hope that this initiative will open the debate, and some light will be shed on this contemporary issue of human ecology, in order to guide future research in human nutrition.

ZINC IN URBAN INFANTS AND CHILDREN

The case which I bring to this meeting is similar for all large Brazilian cities. The last twenty years of our research activity in the Nutrition Laboratory at University of Brasilia has focused on micronutrient nutritional status (zinc in particular) of children of the migrant population, mostly, but not exclusively, shanty town dwellers. Choices had to be made as to the best methods of assessing the zinc nutritional status. In the seventies hair zinc content was our choice, but then, as today reliable indicators are hard to find.

Since zinc is a component of a few hundred enzymes its deficiency may sometime be confounded by, or with, general malnutrition to the untrained clinician. In spite of finding differences in hair zinc distribution between studies we never could find a direct relationship between hair zinc concentrations and anthropometric data (1,2).

In our early studies (2) we found that among children of poor families 72% were found normal, 16% stunted, 8% wasted and 3% stunted and wasted. Almost all children were infected with intestinal parasites, and 20% were positive for two or more parasites. The families were characteristically low income, large number of members (including children) and substandard living conditions. In such children we could not find a significant association between anthropometric assessment of nutritional status and hair zinc levels. Under conditions of a heavily parasitic load and inadequate nutrition it would be difficult to find, through hair, that zinc was the only or primary micronutrient associated with anthropometric deficits.

Our suspicion that zinc is an important contributor of poor nutritional performance appeared during our studies of diets of infants and pregnant and lactating mothers. In surveys of poor families (3), we found that in children and lactating mothers the requirements for zinc, vitamin A and riboflavin were less likely to be met than for macronutrients.

The feeding practices of poor families (4), unveiled certain characteristics of important nutritional consequences. The milk based diets of infants less than one year of age were also low in zinc, vitamin A, and thiamin and recommended daily allowance (RDA) were only marginally met for vitamin C. Thus revealing that in this case also micronutrient deficits were more likely to cause poor nutritional performance than those of macronutrients.

The situation of urban infants becomes more complicated when we consider the working mother and the weaning process. It is not just a question of quality of bottle milk *vis a vis* breast-milk, but also the regularity of feedings, contamination of bottles and the preparatory process. Studying infant feeding practices among the poor urban families in shanty towns we (4) found that breast- and mixed-fed infants were likely to receive more milk feedings that non-breast fed infants. The disadvantages of less feeding *per se*, in the case of bottle-fed infants, is exacerbated by the nutritionally unbalanced diets or preparations. This may lead to nutritional inadequacies especially micronutrients imbalances/deficiencies, as a consequence of practices involved in the process used to prepare bottle-milks.

During the first year of life, milk feeding, with either breast- or bottle-milk, is the principal determinant of nutritional support. As a consequence, the development of malnutrition in infancy, in some circumstances, can be a direct result of faulty nutritional practices in milk feedings. The breast-fed infant receives more feedings (and perhaps attention from mothers), while bottle-fed babies receive less feedings, maybe from caretakers, if mothers are at work (4).

First, let's look at the types of food consumed by these infants in the first year of life. It is clear that economic limitations will place constrains on acquisition of certain food items, and, in consequence, on the provision of key nutrients. This situation is aggravated by the introduction of bottle-milks. Sugar and liquids such as teas, fruit juices and soft drinks were introduced at an early age. With such food consump-

tion, Fe and vitamin A were estimated to be below the RDA in the group that was not receiving breast-milk (4).

In spite of the importance of milk feedings among poor families, information on milk composition has been based mainly on breast milk, and, in fewest instances, on industrially produced powdered milks or formula as marketed. The information on zinc concentration in these foods was obtained after laboratory reconstitution of known commercially powdered cow's milk or formulae according the manufacturer's instructions. Reconstitution of powdered milk products by mothers under home conditions may result in improper dilution or in nutritionally unbalanced milks.

Among "favelados" (shanty town dwellers), 84% of children were fed either breast-milk plus cow's milk (44%) or only cow's milk (40%). In these children 44% of the mixed feed group and 47% of the cow-milk fed were malnourished (5). The milk prepared at home, either from formulas or dilution of cow's milk as powdered or fluid and the addition of sugar always end up with a hyperosmolar solution. This is an aspect grossly neglected in food surveys of very young children (5). Such a concentrated diet in itself could favor osmotic diarrhea, however the nutritional imbalance is an additional matter of concern.

The essential role that zinc plays in growth results in an infant's requirements being higher than those of older children and adults. At the beginning of lactation, when growth is at its peak, the zinc:calorie ratio is at its highest. When breast-fed, infants have access to a higher zinc:calorie ratio diet in the first three months of lactation (6). The peculiar rate of secretion of zinc in human milk during the first month of lactation makes this milk unique in the provision of zinc during a fast-growing period. Regardless of the different ways of expressing zinc concentration, i.e. Zn mass/volume, or as either mass of zinc/total mineral mass or total calorie, there is always a higher proportion of zinc than any other micronutrient during the first three months of lactation (6).

In the case of home preparations based on cow's milk, no such adjustments exist and bottle milks may provide less than the minimum requirement for the majority of poor children (7). Our studies consistently point to the specific nutrient deficits in cow's milk-based diet of young children. The analytical data obtained from chemical analysis of milk preparations done by mothers and caretakers from shanty towns (7) showed that based on minimum recommendations for formulae, 55% of bottle milks had zinc below 3.2 mg/L. Owing to added sugar and high calorie preparations, metal:calorie ratios were below the minimum recommendations in 72.5% of cases (7).

Growth failure is a common and essential feature of protein, energy, and zinc deficiency in the growing organism. Adequacy of weight gain in exclusively breast-fed infant has varied from 3 to 6 months in developing and developed countries respectively. Assuming that changes in milk composition can modulate total nutrient utilization, multiple regression was used to interpret the dependence of growth on nutrients in milk. The length and weight gain of infants during the first 6 months of lactation and concentrations of zinc, nitrogen, and fat in human milk were analyzed by multiple regression. Using this method we assessed the effects of macronutrients (protein and energy) and zinc (micronutrient) concentrations in human milk and we found that concentration of milk zinc and nitrogen but not fat, were significant predictors of weight gain in breast-fed infants. Zinc concentration, however, was the strongest predictor of weight gain of breast-fed infants, thus indicating zinc as a first limiting nutrient in human milk (8).

CONCLUSIONS

The substandard living conditions of the fast growing urban population puts children in the more vulnerable group of micronutrient deficiency. In the case of Brasilia, the micronutrient deficits may come from many different causes. The chemical analysis of milk diets consumed by infants showed, indeed, that zinc is insufficiently provided in bottle-fed infants and possibly a first-limiting nutrient in breast-fed babies, at least during the first 6 months of life.

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