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Zinc Nutritional Status of Preschool Children in Riyadh City

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Abstract: Zinc (Zn) status of 178 children was evaluated using biochemical and dietary measure. Dietary zinc intake ranged between 2.15 and 10.7 mg/day at age 2-3 years, and 1.21 and 15.6 mg/day at age 4-6 y with an overall sample mean of 5.6 and 5.8 mg/day, respectively. Dietary zinc intake assessment showed that 22 % of the studied sample consumed less than the dietary reference intake at age 2-3 y, and 40 % at age 4-6 y. Plasma zinc ranged between 6.7 and 18.7 $\mu\text{mol/L}$ with an overall sample mean of 12.1 $\mu\text{mol/L}$. Moreover, nearly eighteen (18.3) percent of all of children had serum zinc concentrations below 10.0 $\mu\text{M/L}$ (65 $\mu\text{g/dL}$) and only 3.3 % had serum zinc concentrations below 7.7 $\mu\text{M/L}$. The dietary records and the concentrations of Zn in plasma used in this study suggesting there is risk of Zn deficiency in pre-school children. To improve zinc status in pre-school children, zinc fortified food may be an effective approach. Zinc supplementation is recommended, mainly for individuals who are at risk of zinc depletion.

Key words: Zinc, zinc deficiency, pre-school children, serum zinc

Introduction

The American dietetic association (ADA) has reported the importance of optimal nutrition for physical and mental growth of pre-school children (ADA, 1987). Malnutrition of pre-school children was documented to depressed growth, impaired intellectual development and altered behavioral responsiveness (Birch, 1972; Read, 1973). Zinc essential trace elements for normal growth, is essential for maintaining health throughout life (Brown and Pollit, 1996). Mainly, Zn deficiency is associated with deficient growth, sexual maturation, fertility, immunity, taste, and appetite. The clinical signs of marginal zinc deficiency are decreased immunity, impaired taste and smell, onset of night blindness, impairment of memory and depressed spermatogenesis (Rodriguez *et al.*, 1984). Marginal and moderate zinc deficiencies in children with impairment in their growth have been documented in both developed and developing countries (Black, 1998; Brown and Pollit, 1996). In human, Zn deficiency has always been a nutritional problem in the Middle East. Moreover, Zn deficiency was first reported in 1960 from Iran, Egypt and turkey, and (Prasad, 1985). Malnutrition is prevalent in Saudi Arabia (Al-Jassir and EL Bashir, 2002); however, there are no enough data about zinc status in Saudi Arabia. The status of zinc deficiency in preschool children in Saudi Arabia is still unknown; therefore the aim of this study is to evaluate the zinc nutritional status of preschool children.

Materials and Methods

178 children were randomly chosen from the 3 primary health centers in Riyadh city. Each subject attended a primary health center in Riyadh city. The subjects of this study were health in age 2 to 6 years. Mothers accepted

the participation of their children by freely signing a written informed consent.

The children were evaluated according to the following parameters: weight, by using a digital SECA balance with a precision of 0.1 kg; length, as measured by a Physician Scale (Health meter, USA) with a precision of 0.1 cm. 24-h dietary history of children was obtained from their mothers. Food-processor software was used, to calculate daily nutrient intakes. The Zn intakes were compared with Dietary Reference intake (DRI, 2001). A blood samples were drawn from the antecubital vein of each subject into trace element-free tubes. Serum was determined by an atomic absorption spectrophotometer. The statistical analysis included means; standard deviations, were analyzed by SSPS version 10.

Results

The study groups included 178 Saudi children in age range 2 to 6 years. According to their requirements, children were divided into two groups. Characteristics of the children in the study are presented in Table 1. There were no significant gender differences in mean height and weight for all age group. The mean height for boys and girls at age 2-3 y was 92.1 and 89.3 cm, respectively, whereas, the mean height for boys and girls at age 4-6 y was 107.8 and 108.2, respectively. Boys and girls are presented together as there were very few differences. Energy, protein and zinc intake are presented in Table 2. Energy intakes of 2-3 and 4-6 years old were 86 and 78.1 kcal/ kg/day, meanwhile a protein intake were 3.8 and 3 g/kg/day, respectively. Dietary zinc intake ranged between 2.15 and 10.7 mg/day at age 2-3 years, and 1.21 and 15.6 mg/day at age 4-6 y with an overall sample mean of 5.6 and 5.8 mg/day, respectively (Table 2, 3). Notably, 22 % of the

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studied sample consumed less than the dietary reference intake at age 2-3 y, and 40% at age 4-6 y (Table 3). The mean ratio of Zn to energy was 5.3 and 4.3 at age 2-3 and 4-6, respectively. Hambidge *et al.* (1976) have defined hypozincemia as plasma zinc levels less than 68 µg/dL (10.5 µmol/L) while, Rivera *et al.* have defined low serum zinc (zinc deficiency) as serum zinc levels less than 10.0 µmol/L (65 µg/dL) (Rivera *et al.*, 2001; Rivera-Dommarco *et al.*, 2001). whereas, Serum zinc concentration < 7.7 µmol/L have been considered sever zinc deficiency (Prasad, 1985; AL-Timimi, 2005). Taken together, serum zinc levels less than 10.0 µmol/L have been considered low serum zinc (hypozincemia) and serum zinc concentration < 7.7 µmol/L have been considered sever zinc deficiency. In this study, serum zinc, determined in 120 children, ranged between 6.7 and 18.7 µmol/L with an overall sample mean of 12.1 µmol/L (Table 4). Moreover, nearly eighteen percent (18.3%) of all of children had serum zinc concentrations below 10.0 µmol/L (65 µg/dL) and only 3.3% (n= 4) had serum zinc concentrations below 7.7 µmol / L.

Discussion

The mean zinc intake was 5.6 and 5.8 mg/day at age 2-3 years and 4-6 y, respectively. These intakes are adequate if compared with the current Dietary Reference Intake (DRI, 2001), but they are lower than the Dietary recommended Allowance (RDA, 1989). Several studies found similar results. In united States, By using dietary intake data from the third National Health and Nutrition Examination Survey (NHANES III, 1988-1994), Briefel *et al.* (2000) found that the mean zinc intakes were 6.4 mg/d for 1-3-y-olds and 7.7 mg/d for 4-6-y-olds (Briefel *et al.*, 2000). In Baghdad, the mean zinc intakes were 5.2 mg/d for children at age 2-10 year (Al-Timimi *et al.*, 2005). In Beirut, the intakes of zinc were very low in low class and high class preschool children. The mean zinc intake of day car pre-school children was 1 and 2 mg/day for low class and high class children, respectively, whereas The mean zinc intake of home based pre-school children was 1 mg/day for both low class and high class pre-school children (Baba *et al.*, 1996). Notably, dietary zinc intake assessment showed that 22 % of the studied sample consumed less than the dietary reference intake at age 2-3 y, and 40 % at age 4-6 y (Table 3). Data from NHANES III shown that 81% of 1-3-y-old and 48% of 4-6-y-old children had inadequate zinc intakes (Briefel *et al.*, 2000). In AL-Timimi study only 36 of children at age 2-10 years had adequate zinc intake. In recent study in United Stats, Arsenault and Brown found that less than 1% of children had usual zinc intakes below the estimated average requirement (Arsenault and Brown, 2003). However, results, in this study, were compared with DRI which is higher than estimated average requirements. Moreover, In Arsenault study, fortified foods contributed 24% and 25% of total zinc for 1-3-y-old and 4-5-y-old children, respectively.

Table 1: Characteristics of children studied

	Boys		Girls	
	5±0.88 (n=40)	2.5y±0.5 (n=53)	2-6y±0.5 (n=38)	4.9±0.9 (n=47)
Height (cm)	92.1±8.2	107.8±9	89.3±6.5	108.2± 8.9
Weight (kg)	13.1±2.5	17.1±2.8	12.7±1.8	18.3±3.8

Values are mean ± standard deviation

Table 2: Intakes of energy, protein, and zinc by age group

	2-3 y (n = 78)	4-6 y (n = 100)
Energy (kcal/kg/d)	86±27	78.1±26
Protein (p/kg/d)	3.8±1.5	3±1.2
Zinc (mg/d)	5.6±2.4	5.8±2.7
Zinc density (mg/1000 kcal)	5.3±1.5	4.3±1.5

Values are mean ± standard deviation

Table 3: Zinc intake and its recommendation for pre-school children

	Intake average (mg/day)	Intake mean (mg/day)	DRI (mg/day)	percent deficient
2-3 y (n = 78)	2.15-10.7	5.6±2.4	3	22
4-6 (n = 100)	1.21-15.6	5.8±2.7	5	40

DRI; Dietary Reference Intake (2001)

Moreover, Berner *et al.* (2001) found that fortified foods contributed 13% and 17% of total zinc intake for 1-3-y-old children for 4-5-y-old children, respectively. Data presented in Table 4 indicated that plasma zinc ranged between 6.7 and 18.7 µmol/L with an overall sample mean of 12.1 µmol/L. Moreover, low serum (zinc was observed in 15% of children and 3.3% had sever zinc deficiency zinc concentrations below 7.7 µmol/L. Recent national data from Mexico show 25% of all children between ages 0 and 11 y to have serum concentrations <10 µmol/L (65 µg/dL). Rural areas had a higher incidence of zinc deficiency (40%) than did urban areas (18%) (Rivera-Dommarco *et al.*, 2001; Rivera *et al.*, 2001). In addition. data from survey conducted in Australia indicated that the incidence of hypozincemia was greater than 50% between the age 5 to 15y (Holt *et al.*, 1980). Moreover, Bahi *et al.*, 1998, found that 32% of children at age 1-6 y had low zinc plasma concentration (≤8.4 µmol/L). In recent study, Al-Timimi *et al.* (2005) reported that 7.5 of children at age 2-10 y had serum zinc concentrations below 7.7 µmol/L and 72% had serum zinc concentrations between 7.7 and 12.3 µmol/L (Al-Timimi *et al.*, 2005). In this study, serum zinc in 54.4% of children was no greater than 12.3 µmol/L. This finding is very closed to Torrajón's finding, who found that plasma Zn in 54.8% of children was no greater than 12.3 µmol/L (Torrejon *et al.*, 2004). We could attribute the low serum zinc to sub-optimal zinc intake found in 32% of study sample. Moreover, zinc deficiency has been attributed to the low intake of zinc-rich foods, as well as to the low bioavailability of zinc, especially in foods of vegetable origin (Brown *et al.*, 2001). Silva *et al.*, 2006 found that serum zinc deficiency zinc levels were restored after supplementation in children who had serum zinc deficiency. Zinc

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Table 4: Plasma zinc concentrations of pre-school children

	Plasma zinc ($\mu\text{mol/L}$)	% of plasma Zn $\geq 10 \mu\text{M/L}$	% of plasma Zn $< 10 \geq 7.7 \mu\text{M/L}$	% of plasma Zn $< 7.7 \mu\text{M/L}$
Mean \pm SD	12.1 \pm 2.6	81 (98)	15 (18)	3.3 (4)
Range	6.7 - 18.7			

$<10.0 \mu\text{mol/L}$ (65 $\mu\text{g/dL}$); zinc deficiency (Rivera-Dommarco *et al.*, 2001). $< 7.7 \mu\text{M/L}$ - sever zinc deficiency (Prasad, 1998 and Al-Tamimi, 2005)

supplementation is recommended, mainly for individuals who are at risk of zinc and other mineral depletion. To improve zinc status in pre-school children, zinc fortified food may be an effective approach.

In summary, the dietary records and the concentrations of Zn in plasma used in this study suggesting pre-school children are at risk of Zn deficiency. These results are important because this is the first study conducted on zinc nutritional status in preschool children in Riyadh city. However, further studies are necessary in order to confirm this finding thus, it is necessary to study it further so as to establish a safe and appropriate intake of zinc among preschool children. In future studies we will assess whether a low-zinc diet has any adverse effect on growth or health in Saudi population.

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