Zinc deficiency among a healthy population in Baghdad, Iraq

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ABSTRACT

Objectives: To determine the prevalence of zinc deficiency and the current zinc status among a sample selected from the healthy population in Baghdad, Iraq.

Methods: We carried out a community-based study in Baghdad City, Iraq from November through June 2002. We selected a sample of 2090 healthy subjects (aged 1 month to 85 years). We used a pre-tested questionnaire, designed to obtain information on gender, birth dates, height, weight, residence, habitual food consumption patterns, and social status. We performed laboratory assessment of serum zinc level, dietary assessment of food frequency and usual zinc intake. We considered subjects with serum zinc concentration of <7.7 µmol/l zinc deficient and ≥7.7 to 12.3 µmol/l mild to moderately zinc deficient.

Results: The prevalence of zinc deficiency among the studied sample was 2.7%. We found mild to moderate zinc deficiency among 55.7% of the study sample. Dietary zinc intake assessment showed that 74.8% of the studied sample consumed less than the recommended intake, and in 62.3%, the intakes were deficient and grossly deficient. Mean daily zinc ranged from 5.2 mg in children to 8.5 mg in adults.

Conclusions: We observed a high prevalence of mild to moderate zinc deficiency, with inadequate dietary zinc intake among a considerable proportion of the studied sample. Zinc supplementation may be an effective public health intervention means to improve the zinc status of the population.

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Zinc is an essential trace element for human health and wellbeing.[1] Consequences of severe zinc deficiency have been documented in several populations worldwide.[2] The most widely used approach for the assessment of zinc status, particularly in a large population study, is the determination of circulating concentration of either serum or plasma zinc.[3] Mild to moderate zinc deficiency is common in several developing countries, as the commonly stable foods have low zinc contents and are rich in phytates. We know that the high phytate content of cereal proteins decreases the availability of zinc, thus, the prevalence of mild to moderate zinc deficiency is likely to be high in a population consuming large quantity of cereal proteins.[4,5] The Iraqi population, and the Arab world populations, is thought to be at high risk of mild to moderate zinc deficiency, due to an increase preference to cereal proteins.[6] Thus, we largely directed this work to determine the prevalence of zinc deficiency among a healthy population, in an attempt to identify population groups for whom zinc status may be a concern.

Methods. From November through June 2002, 2,090 healthy subjects (1,114 males and 976 females) aged 1 month to 85 years were studied.

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Subjects included in the present study were selected from the following localities in Baghdad City: 2 Primary Health Care Centers (90 infants and 80 children were selected randomly from these centers), 4 intermediate and 4 secondary schools for boys, and the same number of school for girls (1,050 adolescents were selected randomly from these schools), main blood bank (700 adults aged ≤ 50 years were selected), and Consultation Clinics of Baghdad Teaching Hospital (170 subjects aged >50 years). Selection of Primary Health Care Centers, and schools were carried out randomly from lists of centers and of schools provided by the Ministry of Health and by the Directorate General of Education, selection of subjects from these localities was carried out by the use of the systematic random sampling method. A pre-tested questionnaire was used, which was designed to obtain information on gender, birth date, height, weight, residence, habitual food consumption patterns, and socio-economic status. The inclusion criteria were the absence of chronic diseases or recent infection. None of the studied sample received mineral supplementation. Venous blood sample was drawn from each subject and used for determination of serum zinc level (Flame Atomic Absorption Spectrophotometry, Pye Unicam 2900) according to the data published by Pye Unicam Ltd.[7] To exclude the impact of sub-clinical disease status on zinc status of the subject, C-reactive protein (CRP) rapid test for qualitative and semi-qualitative determination of CRP by agglutination of latex particles on slide was used (Biokit, France instrumentation laboratory). Subjects with serum CRP >10 mg/l were considered positive. Subjects whose serum sample is sero-positive for CRP were excluded from the study. Dietary intake of zinc and phytic acid were estimated using Food Composition for Iraqi Foods,[8] and Food Composition Table by Hand's.[9] A 24-hour recall procedure was used to assess dietary intake of the studied sample. Dietary intakes were compared with the recommended intake values by age and gender.[10] Laboratory analysis of food intake was carried out for 72 subjects. Atomic Absorption Spectrophotometer was used to analyze the zinc and phytic acid content of foods consumed as outlined before.[11] Zinc deficiency and sub-optimal zinc status in subjects studied were calculated according to the cutoff values stated by others.[12,13] Zinc deficiency among healthy people is defined as zinc levels below 7.7 µmol/l (<50 µg/100 ml), mild to moderate deficiency as zinc levels ≥7.7-12.3 µmol/l (≥50-80 µg/100 ml). Nutritional status was assessed for adolescent and adults only, underweight among adolescents is defined as body mass index ≤5th age specific percentile while overweight as body mass index >85th age specific percentile.[14] Adults with body mass index <18.5 were considered as underweight while normal and overweight (or obese) were defined as body mass index of 18.5–24.99 and >25.[15]

Statistical analysis. Data were analyzed using the Statistical Packages for Social Sciences (SPSS version 10). Unpaired t-test was used to assess the significance of difference between mean values.

Ethical considerations. The study was approved by the scientific committee in the Department of Physiological Chemistry, College of Medicine, University of Baghdad. Verbal consent was obtained from the study subjects or from their parents before enrollment in the study.

Results. Mean and standard deviation of serum zinc concentrations according to age and gender are shown in **Table 1**. Significantly lower mean values of serum zinc concentration was demonstrated in younger (infants, children), and older age groups compared to the other groups. There was no significant gender difference in mean serum zinc concentration for all groups studied. Distribution of subjects in the studied groups according to serum zinc levels is given in **Table 2.** Which showed that among the studied participants, 2.7% (n=57) had serum zinc concentration below 7.7 µmol/l and 54.7% (n=1,143) had serum zinc concentration between 7.7 and 12.3 µmol/l. Infant, children and older groups had a higher prevalence of zinc deficiency than adolescents and adults. Mean ± SD serum zinc concentration values by residency and nutritional status are shown in **Table 3.** Significantly lower mean serum zinc concentration values were noted in subjects with lower nutritional status and in

Table 1 - Mean ± SD values for serum zinc concentrations of the studied subjects by age and gender.

Subjects	N	Age group	Serum Mean ± SD	Zinc µmol/l 95% CI
Infants	**90**	1-12 months	10.40 ± 0.84*	8.80 - 12.18
Male	40		10.53 ± 0.87	
Female	50		10.46 ± 0.8	
Children	**80**	2-10 years	10.66 ± 0.85*	8.96 - 12.35
Male	41		10.70 ± 0.89	
Female	39		10.60 ± 0.83	
Adolescents	**1050**	11-19 years	12.23 ± 1.56	9.09 - 15.36
Male	450		12.41 ± 2.01	
Female	600		12.09 ± 1.4	
Adults	**700**	20-50 years	12.03 ± 1.81	6.86 - 15.66
Male	488		12.05 ± 1.84	
Female	212		11.80 ± 1.69	
Older age	**170**	>50-80 years	9.78 ± 1.04*	7.69 - 11.8
Male	95		9.66 ± 1.2	
Female	75		9.70 ± 1.26	

*Significantly different from adult and adolescent, *p*<0.01,
N - number, SD - standard deviation, CI - confidence interval

Table 2 - Distribution of subjects in the studied groups based on serum zinc levels.

Subjects	Serum zinc levels (µmol/l) <7.7 N (%)	7.7-12.3 N (%)	>12.3 N (%)
Infants	12 (13.4)	78 (86.6)	0 (0)
Children	6 (7.5)	72 (89.9)	2 (2.6)
Adolescents	11 (1.1)	462 (43.9)	577 (55)
Adults	12 (1.7)	377 (53.9)	311 (44.4)
Older age	16 (9.4)	154 (90.6)	0 (0)
All	57 (2.7)	1143 (54.7)	890 (42.6)

<7.7 µmol/l - severe zinc deficiency,[16]
7.7-12.3 µmol/l - mild-moderate zinc deficiency.[11]

Table 3 - Mean ± SD of serum zinc by residency and nutritional status.

Subjects by residency and nutritional status	N	Serum zinc µmol/l Mean ± SD
Residency		
Urban	1788	12.33 ± 2.07*
Rural	302	10.90 ± 1.52
Nutritional status		
BMI-for-age (adolescents)		
Under weight	275	11.07 ± 1.23*
Normal	700	12.92 ± 1.87
Over weight	75	13.16 ± 1.73
BMI (adults)		
Under weight	140	11.32 ± 1.38*
Normal	385	12.76 ± 1.61
Over weight	175	12.93 ± 1.56

**p*<0.01

Table 4 - Distribution of subjects on various level of the recommended intake (RI) for energy, protein and zinc (n=2000).

Subjects by intake	Adequate intake (≥100%RI) N (%)	(80-<100%RI) N (%)	Deficient (40-<80%RI) N (%)	Grossly deficient (<40%RI) N (%)
Energy (Kcal)*	551 (27.5)	463 (23.1)	908 (45.5)	78 (3.9)
Protein (gm)*	1394 (69.7)	312 (15.6)	268 (13.4)	26 (1.3)
Zinc (mg)**	505 (25.2)	249 (12.4)	745 (37.3)	501 (25.1)

*Recommended intake (RI) for energy and protein[8]
** Recommended intake for zinc[14]

Table 5 - Dietary intake of zinc and phytate, phytate- to- zinc molar ratio and percentage of subjects on inadequate zinc intake (n=72).

Subject	N	Zinc intake (mg/day) Mean ± SD	Phytic acid intake (mg/day) Mean ± SD	Phytate/zinc ratio	% of subjects on adequate zinc intake*
Children	10	5.2 ± 1.6	796 ± 250	16	36
Adolescents	25	6.9 ± 2.3	300 ± 240	6	2
Adults	25	8.3 ± 3.3	460 ± 324	5	4.7
Older age	12	6.6 ± 1.7	1890 ± 600	25	56

*Inadequate intake: less than 2/3 of the recommended intake for zinc those living in rural areas. Distribution of subjects on various levels of the recommended intake for energy, protein, and zinc (**Table 4**) shows that 72.5% of subjects were not consuming their recommended intake values for energy, 30.3% for protein and 74.8% for zinc. Moreover, in 49.4% of subjects the intake for energy was deficient or grossly deficient, with 14.7% for protein and 62.8% for zinc deficient or grossly deficient. Dietary analysis was carried out for 72 subjects, and **Table 5** shows the average dietary intake of zinc and phytic acid, and the percentage of subjects in the studied groups who had inadequate zinc intake. Average zinc intake was lower in children and older age groups compared to adolescents and adults, whereas the phytate intake was higher. The molar ratio of phytate to zinc was also higher in children and older age groups compared to other groups. The percentage of subjects taking less than two-thirds of the recommended zinc values was higher in the older age group (56%) and children (36%) compared to the other groups.

Discussion. Several experts recognize zinc insufficiency as an important public health issue, especially in developing countries.[16] The magnitude of marginal zinc deficiency in developing countries is unknown, but recent data show that zinc deficiency is wide spread among children.[17] In this study we found the mean serum zinc concentration values markedly lower than values from adults and children in Western countries,[13,18] but favorably comparable with values from the developing countries.[19,20] The present results show that infant, children and older age individuals have lower mean serum zinc concentrations and a higher prevalence of zinc deficiency compared with adults and adolescents. Several studies documented similar findings. In the United States, analysis of serum zinc data from NHANES II showed lowest serum zinc concentrations in young children, increased steadily between 18-25 years of age, decreased slowly during adulthood and dropped off after 65-70 years of age.[21] In Mexico, a national survey showed that 25% of children less than age of 11 years had plasma zinc concentration below 10 µmol/L (65 µg/dl).[17] Reported data from New Zealand, shows that zinc status is suboptimal in older women.[22] It is worrying to find a high prevalence of zinc deficiency among the studied Iraqi infants and children, since zinc deficiency has been associated with growth faltering,[23] an increased prevalence of infection,[24] and impaired neurobehavioral functions in children.[25] We could attribute the high prevalence of zinc deficiency to sub-optimal zinc intake found in a large proportion of the studied sample. Moreover, analysis of dietary intake showed that the intake of phytic acid and phytic acid/zinc molar ratio is high, especially among children and older age groups, which may affect zinc status in these groups. We know that phytic acid/zinc molar ratio is an important determinant for the availability of dietary zinc, and the World Health Organization[12] suggested an algorithm for estimating zinc bioavailability based on zinc intake and an availability factor (percentage of available dietary zinc). The availability factor is projected to be 10%, if the phytic acid/zinc molar ratio is 15-30, 30% if the ratio is 5-5 and >50% if the ratio<5. Accordingly, we can see that zinc availability in the studied children and older groups is on the lower scale. We need a comprehensive program that includes dietary education, and perhaps zinc supplementation to improve the zinc status of the Iraqi population, with special emphasis on children and elderly individuals.

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