JCHR (2023) 13(2), 275-281

Journal of Chemical Health Risks

www.jchr.org

ORIGINAL ARTICLE

Adult Normal Value and Deficiency Percentage of Serum Zinc in both Sexes Iraqi Healthy Population, using Atomic Absorption Spectrophotometer (AAS)

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(Received: 10 October 2021 Accepted: 3 March 2022)

KEYWORDS

Determination;
Atomic Absorption Spectrometery;
Trace elements;
Zinc

ABSTRACT: The essential trace elements were very significant for the life of humans, and the imbalance in blood serum lead to so serious diseases. In this study, zinc (Zn) has been measured in the serum of 2005 samples (1305 male and 700 female) apparently healthy Iraqi persons aged 20-70 years using a flame atomic absorption spectrophotometer (FAAS). The mean concentration of Zn was (0.96 – 1.12 mg ml^{-1}) in males and slightly lower (0.8 – 1.02 mg ml^{-1}) in females. The concentration of Zinc was slightly increased by age, especially in the groups of 31-40 years, and slightly reduced in the group of 51-61 years. The concentration of zinc in all groups of the study seems to be stable. The study showed that there is a deficiency in Zn value (Zn concentration below 0.5 mg ml^{-1}) in the male and females healthy populations by 22.9% and 18.85%, respectively.

INTRODUCTION

The plan for establishing a database for each essential trace element reference values in the healthy human population of both sexes and different ages serves as a significant indicator of the health status of the common population in the specified city. These values of essential trace elements vary from one country to another and might be among various conservative in the same country, these depend on their availability in soil, drinking water, and comprehensively nutrients lifestyle of each place [1]. Since the essential trace elements are highly important needed to enhance good health and early diagnosis and treated large extents of diseases and illnesses through re-imbalance of these elements in humans? Its valuable goal is to determine the early deficiency status of these essential trace elements in the establishment database for reference values of these elements. Therefore, it is possible to establish a basis for a database that is more comprehensive and acceptable for each city [2]. The main objective of this data is to interpret the observed values for a doctor in the laboratory, depending on providing the relevant values in an appropriate and practical form. It was established in the population of western Pakistan, but can be questioned due to differences in diet, genetic load, and lifestyle [3-4].

Zinc is an important necessary trace element, which is required as a coenzyme to activate more than 300 enzymes and metalloproteins, as a structural component of about 2500 transcription parameters, and to regulate the gene expression of thousands of genes [5, 6].

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DOI: 10.22034/jchr.2022.695108

Generally, in humans, mild and moderate zinc deficiency might cause dwarfish growth delayed puberty rate, hypogonadism in males, dermatitis, reduced appetite, mental lethargy, and delayed wound healing process [7]. Reaching normal adult Zinc level in the plasma of pregnant, lactating women and breastfed infants are necessary to supply the infant with physiologic zinc demands [8]. Establishing zinc nutritive reference value is challenging because zinc homeostasis is tightly regulated. The Biomarkers of Nutrition for improvement Zinc Expert Panel and the International Zinc Nutrition Consultative Group recommend plasma or serum zinc concentration as a biomarker of Zn status [9]. However, Zn serum is the only indicator of status zinc for that data adequate as a reference and suggested lower cutoff values are available. The suggested lower cutoffs of zinc serum are as follows—children aged <10 y: morning/no fasting, 0. 65 µg ml^{-1}; afternoon 0. 57µg ml^{-1}; females aged ≥10 y: morning/fasting, 0.70µg ml^{-1}; morning/nonfasting, 0. 66µg ml^{-1}; afternoon, 0.5µg ml^{-1}; and males aged ≥10 y: morning/fasting, 0.74 µg ml^{-1}; morning/nonfasting, 0.70µg ml^{-1}; afternoon, 0.61µg ml^{-1} [9]. Thus, when interpreting serum concentrations of Zn, several parameters should be taken into account that slightly reduced serum Zn status, like meal consumption [10-12], time of day [13, 14], and inflammation and infection [15].

The metal zinc has amphoteric nature and has the ability to ionize in both acidic and alkaline forms. The average adult body content of Zn is about 2-3g [16]. Zn gluconate supplements have been found to protect against cadmium accumulation in various organs [17]. The plasma Zn level is reported to be low in patients with Leukemia, Hodgkin's disease, and bronchial cancer, myocardial infarction, and infections [18, 19]. Zn deficiency is the main cause of acrodermatitis enteropathic inflammation of the eye, photophobia, steatorrhea, malabsorption syndrome, and corneal opacity [20, 21]. Patients with chronic renal failure have a low concentration of Zn in plasma, and leucocytes, which is accompanied by an increase in the level of plasma ammonia and an increase in the activities of plasma ribonuclease [22-24].

The objective of this study was to establish the reference range and deficiency percentage of Zinc in the Iraqi population aged from 20 to 70 years of both sexes.

MATERIALS AND METHODS

Healthy subjects (20-70 years) were selected from the adult population of Iraqi from different six Iraqi cities; the samples were obtained from different people in factories, primary, and secondary schools, universities, and the general population from Baghdad, Tikrit, Mosul, Najaf, Babylon, and Diyala. These volunteers were apparently healthy subjects who were assessed by the questioner; they were clinically no permanent diseases. So a total of 2005 samples were collected from middle and southern Iraqi cities (1305 male and 700 female) from the above cities.

Instrumentation

A Shimadzu AA-670/G U-7 (FAA) has been used for measurement of zinc in serum of volunteers, using calibration standard curve of zinc concentration from 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8 and 2.0µg ml^{-1}.

Reagent

All water utilized to dilute standards and samples was deionized. Acids utilized were B.D.H "Analar" grade. Standard Zn 1000 µg ml^{-1} used in this study were purchased from Aldrich. All glassware, pipettes, micropipette tips, and autosampler cups were acid washed before utilization.

Collection of serum samples

Informed consent was taken from the individuals participating in the study. The samples were collected from different people in factories, primary, and secondary schools, universities, and the general population from Baghdad, Tikrit, Mosul, Najaf, Babylon, and Diayla, via a plastic cannula in the vein. The blood was transferred to an acid-washed centrifuge tube and allowed to stand. After centrifugation of 3000g for 10 minutes, the serum was transferred into an acid-washed sample tube. Sample pre-treated consists only of dilution (2X) directly into autosampler cup. The standards are prepared in HNO_3 0.1 M the instrumental setting for zinc which is shown in Table 1.

Table 1. Shimadzu instrument setting for measurements of Zn.

Element	Wave length	Flue air-acetylene	Slit nm	mA
Zn	213.9	2.0	0.5	4.0

RESULTS AND DISCUSSION

The serum level of Zinc was determined by AAS for 1305 males and 700 females aged 20 to 76 years old. The result observed that the mean serum level in males was between 0.92 - 1.16 g ml^{-1} as shown in Table 1, while the mean adult Zn concentration level increased with increased age in both sexes and then decrease for adults above 60 years old. The result observed that 209 adults out of 1305 males (22.9%) have zinc deficiency in which serum concentration is below 0.5 g ml^{-1}, while 132 adult women out of 700 (18.85%) have zinc deficiency, as in Table 2. This might be due to chelating agents such as phytate, oxalate, and phosphate which are found in large amounts in food mainly based on cereals protein, and dried food, such food form insoluble complexes with zinc and iron leading to a decrease in their absorption [25]. Zinc deficiency is a general feature of infections and illnesses including leprosy [26], breast cancer [27, 29 and 30], and digestive tract cancer [28]. It’s reported that immunological dysfunctions are resisted in patients with head and neck cancer [29]; they also reported that the cell-mediated immune function (interleukin-1 production by mononuclear cells, natural cell killer lytic activity, and interleukin-1 production by mononuclear cells are zinc-dependent. The efficiency of the serum Cu/Zn ratio for differential diagnosis of patients with and without lung cancer was reported [30]. Many diseases have been observed with Zn deficiencies, such as liver disease, pernicious anemia, thalassemia, malignant disease, acute and chronic infections, hypertension, and hypercholesteremia [31, 32]. It was reported [33] that the serum zinc level in mentally retarded children is 0.3 g ml compared with healthy control children (0.92 + 0.09 g ml^{-1}), however, they get improvement by oral zinc sulfate therapy. In contrast, asthma is found to be associated with a significant rise in serum zinc, however, the cure of the disease was associated with reduce in the concentration of zinc to a normal value. The present study projects the concept of the diagnostic and preventive role of Zn in various diseases. Even small change alteration in serum zinc level affects physiological function leading to various disease processes thus alarming us against the imbalance of these important elements. In our study about 22.9% of Iraqi male volunteers (1305) have zinc deficiency, while 18.85% of female volunteers (700) have Zn deficiency, we believed that zinc deficiency is probably due to the that most population consumes primarily cereal proteins which contain complex agent phytate, oxalate in these cases a zinc supplementation should be recommended, e.g (zinc acetate, zinc gluconate, zinc aspartate, or zinc glycinate) to get high bioavailability the zinc acetate due to complete ionization to zin^{+2} cation will be the best supplements. The concentration of Zinc ranges in male and female blood serum of different healthy volunteers was shown in Table 2 and Table 3. Also, a comparison of Zn concentration in blood serum of both sexes in adult healthy volunteers was shown in Table 4 and Figure 1.

Table 2. The concentration of Zinc ranges in male blood serum of different healthy volunteers.

Age	No.	Range (g ml^{-1})	Mean ± SD	No. of Zn deficient volunteers	% deficiency
20 –30	580	0.40 – 1.89	0.96 ± 0.18	125	21.5
31 – 40	360	0.38 – 1.96	1.12 ± 0.16	95	26.4
41 – 50	200	0.38 – 2.30	1.01 ± 0.15	60	30
51 – 60	140	0.45 – 1.60	0.92 ± 0.21	14	23
Over 60	25	0.4 – 1.50	0.98 ± 0.13	5	25
	1305			299	Mean=22.91

Table 3. The concentration of Zinc ranges in female blood serum of different volunteers.

Age	No.	Range (g ml^{-1})	Mean ± SD	No. of Zn deficient volunteers	% deficiency
20 –30	350	0.42 – 1.82	0.89 ± 0.19	60	25.7
31 – 40	260	0.41 – 1.78	1.02 ± 0.21	53	18.0
41 – 50	50	0.39 – 1.89	0.85 ± 0.16	11	22.0
51 – 60	30	0.38 – 1.70	0.82 ± 0.185	6	20.0
Over 60	10	0.35 – 1.48	0.80 ± 0.21	2	20.0
	700			132	Mean=18.85

Table 4. Comparative of Zn conc. in blood serum of both sexes adult healthy volunteers

Age	Male (mean) g ml^{-1}	Female (mean) g ml^{-1}	P value
20 –30	0.96 ± 0.18	0.89 ± 0.19	< 0.001
31 – 40	1.02 ± 0.016	1.02 ± 0.21	n.s
41 – 50	1.01 ± 0.15	0.85 ± 0.16	> 0.05
51 – 60	0.92 ± 0.21	0.82 ± 0.185	> 0.05
Over 60	0.98 ± 0.13	0.80 ± 0.21	> 0.05

P.N.: Zn deficiency was considered when the blood serum concentration was 0.5g l or below.

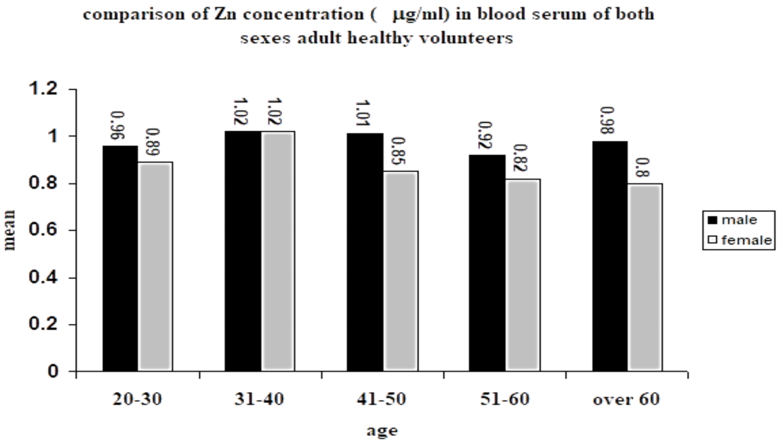

Figure 1. Comparison of mean zinc concentration (g ml^{-1}) values between males and females in the Iraqi population.

Many factors are required to activate the immune system. One of the important essential trace elements is Zn which makes structural, catalytic, and regulatory functions in the human body and action is necessary for proper body functioning [30]. Zinc is associated with several metalloenzymes: cytoplasmic enzymes, Superoxide dismutase, cytochrome oxidase, enzymes mitochondrial, DNA and RNA polymerase, pyruvate carboxylase; phosphodiesterase nuclear enzymes, mannosidase, peptidase, and enzymes of the Golgi apparatus [34].

The process of autophagy is the second kind of programmed cell death [35]. Endogenous zinc is considered indispensable for autophagy induction depending on oxidative stress. After the autophagy process, the zinc level rises in the cytosol and the cell nucleus. It was found that the process of removing zinc metal from zinc can by inhibiting the activity of lysosomes and also depends on reducing their passage during cell membranes, thus preventing the secretion of acid hydrolyses that break down nucleic acids, proteins, fats, and carbohydrates, and this leads to their self-digestion. Prison cell. Zn is a mediator of tamoxifen-mediated autophagy in breast cancer cells [36]. Also, by the tumor microenvironment, the Zn level can be modified. Mast cells that present in the modified tissues in large quantities release granules with an amount of Zn. Therefore, there are large amounts of growth factors and cytokines present in the cancerous tissues that stimulate the expression of zinc transporters [37]. The immune system consists of the thymus (improvement and selection of T-lymphocytes) and bone marrow (maturation of B-lymphocytes) [38]. Also, it consists of lymph nodes, immune system, spleen, and various mucous membrane-associated lymphoid tissues, such as skin-associated lymphoid tissue (SALT), nasal-associated lymphoid tissue (N.ALT), mucosal-associated lymphoid tissue (MALT), and intestinal-associated lymphoid tissue (MALT). GALT), and bronchoalveolar-associated lymphoid tissue (BALT) [35, 36]

It plays a significant and essential part in changing the level of Zn in the body, as it acts as a catalyst, as interferes with non-specific and specific immunity in different methods. Zn deficiency in vitro impairs granulocyte recruitment, (R.O.S) generation, phagocytosis, and chemotaxis [33, 34] phagocytosis, through which pathogens are destroyed via active (N.A.D.P.H). That zinc-dependent (inhibitor in both deficiencies (and an excess of zinc) Zinc is of significant importance in the functioning of the central nervous system and the immune system. It is an essential element in the action of antioxidants through which the importance of integrity of the blood-brain barrier is determined as well as its protection from all the harmful side effects of oxidative stress. It also has a clear effect on brain cells on the state of oxidation and reduction, in addition to that, it can inhibit N-methyl D-aspartate (N.M.D.A) receptors, which have a clear intracellular effect on calcium levels and also a clear role in regulating the activity of enzymes like (N.A.D.P.H) oxidase and nitric oxide synthesis, and is a source of reactive oxygen species in a lot of human tissues [37]. Usually, zinc deficiency in the blood is associated with affective disorders, the most important of which is depression. Depressive symptoms and pathophysiology is associated with elevated glutamate transmission through N.M.D.Receptors and by an imbalance among pro- and anti-apoptotic parameters. The NMDA receptors are the basis for the action of zinc, which is both inhibitory and specific Normally needed to activate NMDA receptors, found glutamic acid, glycine, or closely related D-serine - interacts with it [33]. The action of zinc is to flow ions at (N.M.D.A) receptors, thus reducing the affinity of glycine with receptors. An essential factor is a histidine, which stimulates the (N.M.D.A) receptor. Without it, the flow of ions would not occur, apart from the amount and strength of circulating substances that stimulate these receptors. The process of releasing zinc from glutamatergic neurons with glutamate has the potential to modify their activity. It is considered one of the main essentials of zinc as an antidepressant.4parizadeh SM et al in 2011 concluded that the mean Zn level status (0.765 µg ml^{-1}) was a common feature in Persian peoples. The mean value for Zn in people of Austria by the mean age of 25 years was (1.570µg ml^{-1}) and in Lahore Pakistan, the mean serum zinc concentration was (1.582µg ml^{-1}). A study conducted in Italy showed that the mean Zn concentration in adults was (0.8755 µg ml^{-1}). The results of our study in Iraq observed that the mean normal adult Zn values (0.96 – 1.12 µg ml^{-1}) in males and slightly lower in females, was about (0.8 – 1.02 µg ml^{-1}). In the comparison of this study with previous studies carried out in the above countries, this variation in reference values level was mainly attributed to many factors including, their abundance in soil, water, population habits, living standards, sex, number of samples, age, working environments and pattern of diseases [38-40].

CONCLUSIONS

According to the findings of the present study, zinc is fundamental for the stabilization of the structure of a wide number of enzymes and transcription parameters, and also depends on antioxidants, immune response, and mental health. Conceder supplements and the best consumption of zinc reduce the risk of infection and increase the body's natural immune response. However, the optimal dose of zinc to increase the body's immunity has not been determined. At the same time, excessive intake of zinc poses a risk that affects the immunosuppressant.

ACKNOWLEDGEMENTS

Not applicable.

Conflict of interest

The authors declared no conflicts of interest.

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