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Copper and Zinc Status in Healthy Volunteers Living in Saudi Arabia

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The present study aimed to evaluate copper (Cu) and zinc (Zn) status in Saudi population. A total of one hundred subjects (50 males and 50 females) of healthy adults Saudi volunteers of 20 years or more were selected. The serum copper and zinc concentrations (μg dL^{-1}) were determined by using flame atomic absorption spectrometry. Food processor plus computer program software were used to analyze the food intakes and to calculate the mean daily intakes of copper and zinc (mg day^{-1}). The effect of sex, age, education, occupation socioeconomic status were also evaluated. The mean dietary intakes and serum levels of copper in women were significantly ($p<0.05$) higher than that found in men. Whereas, the mean dietary intakes and serum levels of zinc in men were significantly ($p<0.05$) higher than that found in women. Also, there were positive and statistically significant correlations between these trace elements and their serum levels ($r = 0.31$, 0.28 for copper and $r = 0.29$, 0.27 for zinc in men and in women respectively, $p<0.05$). There were no significant variations in dietary intakes or serum concentrations of copper and zinc due to differences in age, education, occupation and socioeconomic status.

Key words: Copper, zinc, status, Saudi, sex

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INTRODUCTION

Trace heavy metals are significant in nutrition, either for their essential effects or their toxicity. Copper (Cu) and zinc (Zn) are known to be essential and the blood levels depend on certain factors such as, age, sex, physiological and pathological conditions (Malave *et al*., 1990; Versieck and Cornelis, 1989). In general, geographical location also seems to be an important factor in determining blood levels of trace elements as it can be linked to the influences of geochemical characteristics, food and water supply, social and environmental conditions, lifestyle, dietary habits and other factors (Versieck and Cornelis, 1989; Tobberecht and Deelstra, 1994).

The normal adult human body contains about 1.5-2 ppm of copper (Kies, 1989), which is essential as a constituent of some metalloenzymes and Cu is also required in hemoglobin synthesis and in the catalysis of metabolic oxidation (Shis *et al*., 2005).

Symptoms of copper deficiency in human body include bone demineralization, depressed growth, depigmentation and gastro-intestinal disturbances among other. While toxicity due to excessive Cu intake has been reported to cause liver cirrhosis, dermatitis and neurological disorders (Shis *et al*., 2005). Zinc constituents about 33 ppm of the normal adult body weight and it is essential as a constituents of many enzymes involved in a number of physiological functions such as protein synthesis and energy metabolism. Zinc deficiency, resulting from poor diet and malabsorption causes, dwarfism, hypogonadism and dermatities. While toxicity of zinc due to excessive intake may lead to electrolyte imbalance, nausea, anemia and lethargy (Fairweather-Tait, 1988; Prasad, 1984).

Both Cu and Zn constitute integral important parts of certain enzymes such as superoxide dismatase, lycyloxidase and ceruloplasmin, which protect cells from oxidative degradation (Yucet *et al*., 1994; Zowcza *et al*., 2001; Ho, 2004).

Apart from their role in cancer treatment, a large number of studies have shown that copper and zinc are implicated in cardiovascular disease, rheumatoid arthritis and other degenerative diseases (Madaric *et al*., 1994; Silverio Amancio *et al*., 2003).

In most studies Cu and Zn status have been assessed directly by measuring these elements mainly in plasma and/or in serum. Although, various studies concerning the Cu and Zn levels in serum of healthy individuals have been carried out in several countries (Schuhmacher *et al*., 1994; Songchitsomboom and Komindr, 1996). Similar studies have been done to determine Cu and Zn concentrations in dietary intakes of healthy individuals in other countries (Diaz Romero *et al*., 2002; Onianuwa *et al*., 2001; Manual *et al*., 2004; Biego *et al*., 1998).

There is a lack of published data on the dietary intakes of Cu and Zn and their concentrations in the blood of Saudi population. The present study has been initiated to provide a data on dietary intakes of Cu and Zn and to establish baseline levels of Cu and Zn in the blood of healthy Saudi population. Also, the correlation between the dietary intakes of Cu and Zn and their concentrations in the blood of healthy individuals is still poorly investigated either in Saudi Arabia or other countries, thus a considerable interest has been focused to investigate the correlation between dietary intakes of Cu and Zn and their levels in serum of healthy individuals. The serum Cu and Zn values are compared with literature data obtained from other countries. The effects of sex, age, education, occupation and socioeconomic status on Cu and Zn status are also evaluated.

MATERIALS AND METHODS

Selection of volunteers: The study was conducted on One hundred volunteers healthy adults (50 males and 50 females) ranging in age from 20-54 years old, from Riyadh City, the capital of Saudi Arabia. Volunteers on medication, dietary supplements and those who smoke were excluded from this current study.

A written informed consent was signed from all volunteers after doing careful explanation for the purpose of the study.

Dietary intakes of Cu and Zn and demographic information: Each volunteer was interviewed by well-trained nutritionist and provided demographic information form and dietary intake. The demographic information collected included, a) age divided into four categories: 20-29, 30-39, 40-49 and >49, b) sex into two (male and female), c) education status into three categories: low (illiterate or elementary), medium (intermediate or secondary) and high (college or higher), d) occupation status into four: employees, students, households and unemployed or retired. e) The socioeconomic status score was based on volunteers' education (low, medium and high) and family income per year which were divided into three categories low (≤16000 $), medium (>16000 $ and < 32000 $) and high (≥32000 $), giving score 1 for low, 2 for medium and 3 for high. Socioeconomic status score was calculated for each volunteer and scores ranging between 2 and 6. These scores were divided into three categories: low (2-3), medium (4-5) and high (6). The demographic information was obtained by the nutritionist during the interview.

During the interview, the nutritionist provided instructions on estimating serving size by using plastic food models. One 24 h food recall was completed during the interview and volunteers were instructed to complete two-day food records, so that three non-consecutive days of intake were obtained. Food intakes of the two food records were collected later. Food records were reviewed by the nutritionist after completion to maximize accuracy. The food processor plus computer program software (ESHA version 0.7, Salem, Oregon, 2003) was used to analyze the food record and to calculate the mean daily intake of zinc (mg day^{-1}) and copper (mg day^{-1}).

The most recent version of Dietary Reference Intake (DRI) (Dietary Reference Intake, 2001) was adapted to standardize the copper and zinc intakes, as there are no published data on recommendation of Saudi population. Some traditional meals which are not included in the above program were included with regard to Arabian Gulf table of traditional foods (Musaiger, 1993).

Collection of serum samples and determination of Cu and Zn: Volunteers fasted in the preceding 10 h. Then, venous blood samples were withdrawn in the morning from fasting subjects. Blood Samples were left to spontaneous coagulation and then centrifuged at 3000×g for 15 min at room temperature to obtain serum. Hemolyzed samples were excluded then serum samples were stored at -18°C. In order to exclude the possibility of contamination with copper or zinc extremely, all glassware and bottles used for the isolation of serum and for analysis were previously soaked in diluted nitric acid (20% V/V) for 48 h and rinsed six times with deminralized water.

Serum copper and serum zinc were determined after dilution with a 6% 1-butanol solution by flame atomic absorption spectrometer (model Analyst 300, Perkin-elemer, USA) equipped with deuterium (D_2) lamp background correction system (Pizent and Telisman, 1996).

Statistical analysis: Analysis of data was performed using Statistical Package for the Social version 11.0 (SPSS) computer software. Descriptive statistics were adapted to display data in percentages and means±SD. The statistical method of t-test and one way analysis of variance (ANOVA) used to compare the mean values obtained among the different groups. Differences were considered significant whenever the p-value is ($p<0.05$). A partial person's correlation analysis was used to detect association between copper and zinc intakes and their serum concentrations. Correlations were considered significant whenever the p-value is ($p<0.05$).

RESULTS

One hundred healthy adult volunteers were participated in this study, half of them were women. Sixty percent of those volunteers aged between 30-49 years and 20% of them aged between 20-29 years. Approximately two third the volunteers had a high education status and more than half of them were employees. Sixty percent of the subjects had a medium socioeconomic status.

The mean serum copper and zinc concentrations for the overall volunteers were 117.2±18.45 μg dL^{-1} and 79.12±15.43 μg dL^{-1} respectively. The mean serum copper concentration in women (120.68±25.10 μg dL^{-1}) was significantly ($p<0.05$) higher than that in men (112.80±19.81 μg dL^{-1}). While the mean serum zinc concentration in men (80.28±14.50 μg dL^{-1}) was significantly ($p<0.05$) higher than that in women (76.31±15.80 μg dL^{-1}). There were no significant differences in serum copper and zinc concentrations due to age, education, occupation and socioeconomic status (Table 1).

The mean dietary copper and zinc intakes for overall studied volunteers were 1.04±0.06 and 9.40±0.26 mg day^{-1} respectively. The mean copper intakes in women (1.02±0.04 mg day^{-1}) were significantly ($p<0.05$) higher than that in men (0.99±0.03 mg day^{-1}). Whereas, the mean zinc intakes in men (10.50±0.31 mg day^{-1}) were significantly ($p<0.05$) higher than that in women (7.80±0.20 mg day^{-1}). There were no significant variations in dietary copper and zinc intakes due to age, education, occupation and socioeconomic status (Table 2).

Table 1: Serum copper and zinc concentrations of Saudi healthy adult volunteers grouped by sex, age, education, occupation and socioeconomic status

Parameter	n	Copper (μg dL^{-1}) $\bar{X}$ ±SD	Zinc (μg dL^{-1}) $\bar{X}$ ±SD
Overall Sex	100	117.21±18.45	79.12±15.43
Men	50	112.80±19.81	80.28±14.50
Women	50	120.68±25.10*	76.31±15.80*
Age (years)			
20-29	20	115.47±22.20	77.71±13.10
30-39	25	116.22±21.20	78.21±12.00
40-49	35	116.42±20.67	79.23±12.60
>49	20	118.81±21.22	79.27±11.60
Education status			
Low	5	117.10±21.20	77.81±15.40
Medium	25	118.23±22.20	79.31±14.40
High	70	114.66±21.19	79.25±13.70
Occupation status			
Employees	55	117.30±20.19	79.21±15.80
Students	20	114.95±21.14	79.39±15.55
Households	25	118.35±20.12	77.22±13.24
Socioeconomic status			
Low	15	117.20±25.09	77.81±15.20
Medium	60	118.25±22.21	79.25±13.40
High	25	115.35±20.21	79.41±13.30

*Significant compare to male ($p<0.05$)

Table 2: Dietary copper and zinc intakes of Saudi healthy adult volunteers grouped by sex, age, education, occupation and socioeconomic status

		Copper (mg day^{-1})		Zinc (mg day^{-1})	
Parameter	n	$\bar{X}$ ±SD†	RDA (%)	$\bar{X}$ ±SD†	RDA (%)
Overall	100	1.04±0.06		9.40±0.26	
Sex					
Men	50	0.99±0.03	110.80%	10.50±0.31	95.50%
Women	50	1.02±0.04*	112.40%	7.80±0.20*	97.50%
Age (years)					
20-29	20	0.99±0.04		9.00±0.35	
30-39	25	1.00±0.04		9.10±0.29	
40-49	35	1.01±0.03		9.31±0.25	
>49	20	1.01±0.02		9.40±0.20	
Education status					
Low	5	1.07±0.03		9.00±0.41	
Medium	25	1.09±0.02		9.51±0.32	
High	70	0.99±0.05		9.22±0.35	
Occupation status					
Employees	55	1.06±0.04		9.21±0.29	
Students	20	1.03±0.06		9.40±0.27	
Households	25	1.08±0.03		9.11±0.35	
Socioeconomic status					
Low	15	1.05±0.02		9.10±0.41	
Medium	60	1.06±0.01		9.32±0.32	
High	25	1.02±0.0 4		9.60±0.22	

†Values are average of three non consecutive days *Significant compare to male ($p<0.05$)

Table 3: Correlation between copper and zinc intakes and their serum concentrations of Saudi healthy adult volunteers

Parameter	Men n = 50	Women n = 50
Dietary copper-Serum copper	0.31*	0.28*
Dietary zinc-Serum zinc	0.29*	0.27*

-Values are correlation (r). * Significant correlation ($p<0.05$)

There were positive and statically significant correlation between dietary copper and serum copper concentration in both men ($r = 0.31$, $p<0.05$) and women ($r = 0.28$, $p<0.05$). Also there were positive and statistically significant correlation between dietary zinc and serum zinc in both men ($r = 0.29$, $p<0.05$) and women ($r = 0.27$, $p<0.05$) (Table 3).

Table 4 and 5 show some literature data on serum copper and zinc concentrations of healthy subjects in various countries, respectively.

DISCUSSION

There is a lack of published data on the dietary intakes of copper and zinc and their concentrations in the blood of Saudi population. The present study has been initiated to provide a data on dietary intakes of Cu and Zn and to establish baseline levels of Cu and Zn in the blood of healthy Saudi population, which may be useful for similar other Arab Gulf countries. The mean serum copper value in women was significantly ($p<0.05$) higher than that in men which agrees with the findings of most authors (Schuhmacher *et al*., 1994; Diaz Romero *et al*., 2002; Helgeland *et al*., 1982; Johnson *et al*., 1992; Kouremenou-Dona *et al*., 2006), but contrast data reported by others (Lukaski *et al*., 1988; Rukgauer *et al*., 1997; Terres-Martos *et al*., 1997) who found similar serum copper concentrations for both sexes. These findings may be explained by differences in dietary intakes or efficiency of absorption (Johnson *et al*., 1992).

The mean serum zinc has an opposite trend; its concentration in men was significantly ($p<0.05$) higher than that in women. This difference is smaller than the one observed for copper, which agrees with the results of Kouremenou-Dona *et al*., 2006, whereas Diaz Romero *et al*. (2002) have found no significant differences between the mean serum zinc concentrations in both sexes. However, Schuhmacher *et al*. (1994) have found a higher serum zinc concentration in females.

The mean serum zinc concentration (79.12±15.43 μg dL^{-1}) for the overall samples in the present study was lower than that cited from some literature data in different countries (Schuhmacher *et al*., 1994; Kouremenou-Dona *et al*., 2006; Rukgauer *et al*., 1997; Bales *et al*., 1990; Gonzalez-Revalderia *et al*., 1990; Paz deMoncada *et al*., 1989; Cesur *et al*., 2005; Hotzc peerson and Brown, 2003; Vural *et al*., 2000) as shown in Table 5, except that from Greek study (Kouremenou-Dona *et al*., 2006) and North Ireland study (McMaster *et al*., 1992), which was nearly similar to our results. While, the comparison between the mean serum copper concentration, for the overall samples (117.21±18.45 μg dL^{-1}) in the present study, with that of healthy subjects from various countries as cited from some literature data on, Table 4 shows that the mean serum copper in this study was nearly similar to the mean serum copper values on healthy subjects from Greek study (Kouremenou-Dona *et al*., 2006) and North Ireland study (McMaster *et al*., 1992) but, higher than that cited from other countries (Schuhmacher *et al*., 1994; Songchitsomboom and Komindr, 1996; Diaz Romero *et al*., 2002; Bales *et al*., 1990; Gonzalez-Revalderia *et al*., 1990; Paz deMoncada *et al*., 1989; Komleh *et al*. ,1990; Mira *et al*., 1989; Hinks *et al*., 1983; Pizent *et al*., 2003; Cesur *et al*., 2005; Hotzc peerson and Brown, 2003; Vural *et al*., 2000).

Generally, the mean serum concentration of copper and zinc for both sexes in this study Table 1 fit quite well into the reference intervals of serum copper concentration (70-140 μg dL^{-1} for men) and (80-155 μg dL^{-1} for women) and for serum zinc concentration (60-150 μg dL^{-1}) as reported by Lyengar (1985).

The mean serum Cu and Zn in the current study is confirmed by the data of dietary Cu and Zn intakes by men and women in Table 2 which shows that the mean dietary Cu intakes of men (0.99±0.03 mg day^{-1}) is

Table 4: Some literature data on serum copper concentrations (μg dL^{-1}) of healthy subjects in various countries

Country	Sex	Cu concentration $\bar{X}$ ±SD	Age (year)	References
Greek	M+F	115.50±23.50	18-60	Kouremenou-Dona *et al.* (2006)
	M	112.90±21.90	18-60	Kouremenou-Dona *et al.* (2006)
	F	129.70±27.10	18-60	Kouremenou-Dona *et al.* (2006)
Turkey	M+F	90.80±14.30	26-32	Cesur *et al.* (2005)
Croatia	M	111.60 (80.6-148.7)*	20-55	Pizent *et al.* (2003)
Spain	M+F	110.00±25.00	6-75	Diaz Romero *et al.* (2002)
	M	102.00±20.00	6-75	Diaz Romero *et al.* (2002)
	F	118.00±27.00	6-75	Diaz Romero *et al.* (2002)
Turkey	M+F	85.54±15.80	18-70	Vural *et al.* (2000)
Portugal	M	115.00±19.00	20-60	Viegas-Crespo *et al.* (2000)
	F	138.00±40.00	20-60	Viegas-Crespo *et al.* (2000)
Spain	M	111.00±25.00	20-70	Terres-Martos *et al.* (1997)
	F	109.00±36.00	20-70	Terres-Martos *et al.* (1997)
Germany	M+F	104.00±27.00	22-75	Rukgauer *et al.* (1997)
UK	M	93.66±2.03 **	20-70	Bailey *et al.* (1997)
	F	111.17±2.15 **	20-70	Bailey *et al.* (1997)
Bangkok	M	108.00±18.00	20-80	Songchitsomboom and Komindr (1996)
	F	118.00±17.00	20-80	Songchitsomboom and Komindr (1996)
Spain	M+F	84.00±2.00	16-65	Schuhmacher *et al.* (1994)
	M	77.70±3.00	16-65	Schuhmacher *et al.* (1994)
	F	94.30±3.00	16-65	Schuhmacher *et al.* (1994)
Slovakia	M	110.00±19.31	19-59	Magalova *et al.* (1994)
	F	117.62±21.03	19-59	Magalova *et al.* (1994)
Slovakia	M	115.00±17.00	8-89	Madaric *et al.* (1994)
North -Ireland	M	109.00±19.00	25-64	McMaster *et al.* (1992)
	F	123.00±25.00	25-64	McMaster *et al.* (1992)
USA	M+F	101.03 (52.7-183.01)*	18-39	Bales *et al.* (1990)
	M	94.04 (57.82-149.96)*	18-39	Bales *et al.* (1990)
	F	108.02(52.7-183.01)*	18-39	Bales *et al.* (1990)
Spain	M+F	91.00±11.00	25-40	Gonzalez-Revalderia *et al.* (1990)
Australia	F	98.49 (77.52-154.41)*	22-38	Mira *et al.* (1989)
USA	M	98.49±12.07	21-57	Hinks *et al.* (1983)
	F	123.91±29.86	21-57	Hinks *et al.* (1983)

-Data organized according to publish year and expressed as mean±SD unless indicated, * Data are expressed as median with rang in parentheses, ** Data are expressed as Mean±SE

significantly ($p<0.05$) lower than that of dietary women intakes (1.02±0.04 mg day^{-1}), but the mean dietary Zn intakes of men (10.50±0.31 mg day^{-1}) is significantly ($p<0.05$) higher than that of dietary women intakes (7.80±0.20 mg day^{-1}). Similar results were reported by Ghayour-Mobartian *et al.* (2005) who have found that women have a lower dietary intakes of zinc than men ($p<0.05$) but, dietary copper intakes were higher in women than that in men and of a similar order as previously reported Diaz Romero *et al.* (2002).

On the other hand, the highly significant mean serum zinc and the lower serum copper concentrations in men than that in women indicates that the higher amounts of zinc in men diet interfere with the uptake and metabolism of copper. These results are consistent with Hill and Martone (1990) who have reported that zinc supplementation, e.g., 2.3 mmol (150 mg day^{-1}) for adults, has been used as a therapeutic agent for the treatment of Wilson's disease, an inherited, autosomal recessive disease of copper accumulation (Brewer, 2000). Thus, there is no question that high amount of zinc are antagonistic to copper metabolism. Also, the data in Table 3 confirms these results which, shows that there are weak significant correlation ($r = 0.31$ and $r = 0.28$; $p<0.05$) between dietary intakes of copper and serum copper levels for men and women respectively and dietary intakes of zinc and serum zinc levels ($r = 0.29$ and $r = 0.27$; $p<0.05$) for men and women, respectively. These results are in consistent with the results of Ghayour-Mobartian *et al.* (2005) who have mentioned that there were weak but significant association between the dietary intakes of specific trace elements and their respective serum concentration in 189 healthy men and women volunteers with mean age of 49 years, Zn ($r = 0.18$, $p<0.05$), Cu ($r = 0.17$, $p<0.05$).

Dietary zinc intakes (9.40±0.26 mg day^{-1}) is considerably low for overall sexes when compared with data obtained from industrialized countries (FAO/WHO/IAEA, 1996; Hunt and Meacham, 2001; Pennington *et al.*, 1996; Wright *et al.*, 1991; Bailey *et al.*, 1997; Schulze *et al.*, 2001; Laryea *et al.*, 1995; Ma and Betts, 2000; Moser-Veillon, 1990), but higher than the results reported for Santiago, Chile study (Manual *et al.*, 2004).

Table 5: Some literature data on serum zinc concentrations (μg dL^{-1}) of healthy subjects in various countries

Country	Sex	Zn concentration $\bar{X}$±SD	Age (year)	References
Greek	M+F	77.11±17.67	18-60	Kouremenou-Dona *et al.* (2006)
	M	78.38±17.76	18-60	Kouremenou-Dona *et al.* (2006)
	F	71.11±17.76	18-60	Kouremenou-Dona *et al.* (2006)
Turkey	M+F	94.41±19.00	26-32	Cesur *et al.* (2005)
Croatia	M	107.10 (75.10-135.10)*	20-55	Pizent *et al.* (2003)
USA	M+F	85.60±0.10 **	6-74	Hotzc Peerson and Brown (2003)
	M	88.40±0.20 **	6-74	Hotzc Peerson and Brown (2003)
	F	83.30±0.20 **	6-74	Hotzc Peerson and Brown (2003)
Spain	M+F	116.00±52.00	6-75	Diaz Romero *et al.* (2002)
	M	118.00±49.00	6-75	Diaz Romero *et al.* (2002)
	F	114.00±55.00	6-75	Diaz Romero *et al.* (2002)
New -Zealand	F	81.07±9.15	70-80	De Jong *et al.* (2001)
Turkey	M+F	81.65±16.40	18-70	Vural *et al.* (2000)
Portugal	M	108±15.00	20-60	Viegas-Crespo *et al.* (2000)
	F	102±16.00	20-60	Viegas-Crespo *et al.* (2000)
Germany	M+F	108±17.00	22-75	Rukgauer *et al.* (1997)
UK	M	90.61±1.50 **	20-70	Bailey *et al.* (1997)
	F	86.95±1.56**	20-70	Bailey *et al.* (1997)
Bangkok	M	83.00±14.00	20-80	Songchitsomboom and Komindr (1996)
	F	79.00±15.00	20-80	Songchitsomboom and Komindr (1996)
Spain	M+F	113.90±11.21	16-65	Schuhmacher *et al.* (1994)
	M	106.30±9.32	16-65	Schuhmacher *et al.* (1994)
	F	123.10±10.11	16-65	Schuhmacher *et al.* (1994)
Slovakia	M	93.00±14.00	8-89	Madaric *et al.* (1994)
Slovakia	M	104.28±17.32	19-59	Magalova *et al.* (1994)
	F	96.95±13.72	19-59	Magalova *et al.* (1994)
North Ireland	M	78.00±11.00	25-64	McMaster *et al.* (1992)
	F	75.00±9.00	25-64	McMaster *et al.* (1992)
USA	M+F	86.95 (54.26-126.83)*	18-39	Bales *et al.* (1990)
	M	90.22 (56.22-115.06)*	18-39	Bales *et al.* (1990)
	F	84.99 (54.26-126.83)*	18-39	Bales *et al.* (1990)
India	M	101.50±35.10	18-45	Komleh *et al.* (1990)
Spain	M+F	86.80±13.00	25-40	Gonzalez-Revalderia *et al.* (1990)
Venezuela	M+F	84.00±20.00	30-70	Paz deMoncada *et al.* (1989)
Australia	F	78.45 (62.11-94.80)*	22-38	Mira *et al.* (1989)
USA	M	86.95±14.38	21-57	Hinks *et al.* (1983)
	F	81.07±9.80	21-57	Hinks *et al.* (1983)

-Data organized according to publish year and expressed as mean±SD unless indicated, * Data are expressed as median with rang in parentheses, **Data are expressed as Mean±SE

By comparing the mean dietary zinc intakes for men (10.50±0.30 mg day^{-1}) and women (7.8±0.20 mg day^{-1}) in this study with DRI, the results conform only 95.50 and 97.50%, respectively. The average daily intake estimated in this study for both sexes equal to 9.40±0.26 mg day^{-1}, which is nearly comparable to the intakes determined in other countries (Buchet *et al.*, 1983; Gartrell *et al.*, 1985; Smith, 1988; Van Dokkum *et al.*, 1989) which vary from 9 to 18 mg day^{-1}. Whereas, the mean dietary copper intakes estimated from the analyzed diet of the overall samples equal 1.04±0.06 mg day^{-1}. This value is between the literatures data, which varies from 1-4.8 mg day^{-1} (world Health Organzition, 1994; Spring *et al.*, 1979; Standstead, 1982; Abdulla and Chmielnicka, 1990).

The mean dietary copper intakes for men (0.99±0.03 mg day^{-1}) and women (1.02±0.04 mg day^{-1}) in the present study conform 110.80 and 112.40% from DRI values, respectively.

Several reports were focused on age dependence of serum zinc and copper have been published (Schuhmacher *et al.*, 1994; Malvy *et al.*, 1993; Wastney *et al.*, 1992; Davies *et al.*, 1968; Lindeman *et al.*, 1981), however, their results are controversial.

The majority of authors are in agreement only about the positive correlation of high serum copper concentration with age in men and women.

In the present study, the evaluation of serum Cu and Zn concentrations with the age of the individual in overall the sample is shown in Table 1.

The mean serum Cu and Zn concentrations are slightly increased without statistically significant differences among the different age intervals. These results are in agreement with some authors (Malvy *et al.*, 1993; Wastney *et al.*, 1992; Davies *et al.*, 1968). Other authors have reported a decrease, with (Lindeman *et al.*, 1981) and without (Diaz Romero *et al.*, 2002) statistically significant differences among groups or a decrease in males but not in females.

On the other hand, Magalova *et al.* (1994) have reported that there was a significant correlation of both elements with age, except serum zinc in women (r = 0.072). Serum zinc in men was inversely correlated with age (r = 0.162, p<0.001), serum concentrations of copper increased with increasing age in both sexes (r = 0.215, p<0.001).

No relation to education, occupation and socioeconomic status, are found with respect to serum or dietary intakes of Cu and Zn concentrations. These results are partially agreed with Diaz Romero *et al.* (2002) who have mentioned that there was no relation to educational and socioeconomic status was found with respect to the serum Cu and Zn concentrations of 395 individuals living in Canary Island. However, there is a lack in information about the relation between education, occupation and socioeconomic status with dietary Cu and Zn intakes in the literature, thus the present study is considered one off the first investigations which pointed to this relation.

In conclusion, there are few studies about status of essential trace elements including copper and zinc among Saudi population. So the present study was designed to evaluate dietary intakes of Cu and Zn and their serum concentrations and their associations with sex, age, education, occupation and socioeconomic status in selected adult volunteers aged 20 years and above.

The current study shows that they are at the highest concentrations range for copper and at the lowest concentrations for zinc compared to literature data on copper and zinc levels for various investigated countries.

The mean serum zinc concentration in men is significantly (p<0.05) higher than that in women, while the mean serum copper values in men is significantly (p<0.05) lower than that in women. There is slightly increase in copper and zinc concentrations as a function of age.

There are no significant variations in dietary intakes or serum concentrations of copper and zinc due to differences in education, occupation and socioeconomic status. Also, dietary intakes of copper and zinc concentrations are weakly significant correlated with serum copper and zinc, respectively.

Finally, because there is a lack of published data on levels of Cu and Zn in blood of Saudi population, the present study was originally initiated to establish baseline levels of Cu and Zn in blood of healthy Saudi population and provides an image of dietary intakes of Cu and Zn of Saudi population which may be useful for similar other Arab Gulf countries.

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