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Zinc and copper status in childbearing age Tunisian women: Relation to age, residential area, socioeconomic situation and physiologic characteristics

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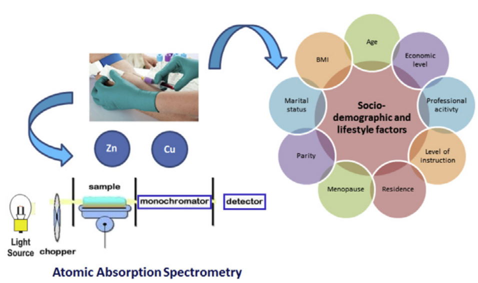
HIGHLIGHTS

- The zinc and copper status of Tunisian women was assessed.
- A high prevalence of low plasma zinc and copper concentrations was observed.
- The living area and professional activity affected plasma levels of both metals.
- Plasma copper levels increased with BMI and parity and decreased with increasing schooling level and economic score.
- The multiple regression analysis showed significant differences between professional activity and parity for copper levels.

GRAPHICAL ABSTRACT



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ABSTRACT

Plasma zinc and copper status of 1689 non pregnant Tunisian women, aged 20–49 years old, was determined by flame atomic absorption spectrometry. A multiple regression was run to predict plasma trace element concentrations from age, BMI, marital status, menopause, education level, professional activity, economic level and area of living. The mean zinc and copper values were similar to those measured among comparable populations in earlier studies. However, a high prevalence of low plasma zinc and copper concentrations was observed assuming that women at childbearing age are at high risk of zinc and copper deficiencies and specific intervention may be considered. In univariate analysis, the mean values of plasma zinc and copper were associated with sitting areas and professional activity. For only plasma copper levels, there was an increase with BMI and parity, and a decrease with increasing schooling level and economic score. After adjustment for all variables, profession and parity showed a significant relationship between plasma levels copper.

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1. Introduction

Like iron, iodine and other micronutrients, the understanding of zinc and copper status is important for optimum health. In fact, zinc is required for catalytic activity of nearly 300 enzymes implicated in intermediary metabolism. It is involved in various biological processes like immune function, growth, antioxidant role or reproduction (Shankar and Prasad, 1998; Cole and Lifshitz, 2008; Song et al., 2009; Omu et al., 2015). Copper is considered as an important cofactor in several biochemical reactions and a part of many metalloenzymes performing as oxygen reductases like ceruloplasmin, dopamine oxygenase and superoxide dismutase (Milne, 1998; Harvey et al., 2009). Actually, copper and zinc imbalance is associated to chronic diseases such as coronary heart disease resulting from a lower copper plasmatic concentration (Klevay, 2000).

Several countries have evaluated the prevalence of zinc and copper in general population by measuring these elements mainly in serum or plasma (Fischer et al., 1990; Rukgauer et al., 1997; Boonsiri et al., 2006; Kouremenou-Dona et al., 2006). However, few studies have attempted to assess zinc and copper status among childbearing age women in North African region, which is at the forefront of lifestyle changes related to nutritional transition and a growing burden of malnutrition (Lachili et al., 2001; Nwagha et al., 2011). In Tunisia, a previous research study performed by Sfar et al. (2009), reported an increase of zinc deficiency prevalence with age, while no significant variation was noticed for copper levels. Extrapolation of the obtained results on Tunisian population was not possible as the number of participants was too small.

The main objective of this study was to assess zinc and copper status among Tunisian women of childbearing age and its variation according to socio-demographic, environmental and economic characteristics.

2. Material and methods

2.1. Study area

Tunisia is an upper-middle-income North African country (ranked 81st out of 169 on the Human Development Index in 2010) (UNDP, 2010). The survey was carried out in the Great Tunis (GT) region, a mainly urban area around the capital city (2.5 million inhabitants of whom 92% live in urban areas and 8% in rural areas).

2.2. Design and sampling

A cross-sectional survey was conducted in 2009–2010. The sampling scheme was designed by the National Institute of Statistics. The national population and employment survey database of 1999 was used to select a two stage random cluster sampling design: 76 census districts were randomly selected with probability proportion to size. In each district, 20 households were randomly selected and all persons aged 6 mo to 49 y were included: The target population for the present study was the subsample of 20–49 y old non-pregnant women. All the expected 1520 households were surveyed and comprised 1817 eligible women. A large sample size was selected as the zinc and copper status of women were unknown.

2.3. Socio-demographic

Data on age, parity, marital status, menopause, level of education and occupation were collected by questionnaire. A household economic score was computed by multiple correspondence analyses from the matrix of binary variables coding for six variables describing the characteristics of the dwelling and eleven variables coding household ownership of appliances. Households were classified as “high”, “medium” and “low” according to tertiles of this index (El Ati et al., 2012; Traissac and Martin-Prevel, 2012).

2.4. Anthropometry

All anthropometric measurements were performed by personnel trained according to standard procedures (WHO, 1995) and following standard procedures (Lohman et al., 1988) to ensure accuracy. Height was measured to the nearest 0.1 cm with a stadiometer. Weight was measured to the nearest 0.1 kg. Body corpulence was assessed by BMI (weight (kg)/height^2 (m^2)).

2.5. Blood sampling

After a 12 h overnight fast, 5 mL of blood was collected from each woman and placed in tubes with heparin as anticoagulant. All samples were kept at 4–5 °C and sent to the Clinical Biology Laboratory of the National Institute of Nutrition and Food Technology. After centrifugation of samples (4000 rpm for 15 min), plasma was separated and aliquoted in 2 × 1.5 mL Eppendorf tubes and frozen at −80 °C until the day of analysis. A special attention has been taken during collection and in vitro to avoid hemolytic phenomenon.

2.6. Zinc and copper analysis

All laboratory equipment was washed with nitric acid to avoid contamination. Plasma samples were diluted (1:2) with double distilled water and analyzed in triplicate using an air/acetylene flame atomic absorption spectrophotometer (Perkin Elmer 305 B), equipped with a deuterium lamp for background correction. Hollow cathode lamps were operated at wavelengths of 324.7 and 213.9 nm, respectively for zinc and copper determination and a spectral band pass of 0.7 nm. The method accuracy was evaluated with analysis of the certified reference material SeronormTM serum level 1. Results (1750 ± 50) and (1700 ± 50) (μg L^{-1}) (n = 3) were in good agreement with certified values (1738 ± 71) and (1691 ± 84) (μg L^{-1}), respectively for zinc and copper. All concentrations were determined in double assay. The criteria for zinc and copper deficiencies were values below 70 μg dL^{-1}and 63.7 μg dL^{-1}, respectively (International Zinc Nutrition Consultative et al., 2004; Murray et al., 2011).

2.7. Data management and statistical analysis

EpiData Software version 3.1 was used for data entry, quality checks and validation by double entry and Stata 11 for statistical analysis (Lauritsen and Bruus, 2004; StataCorp, 2007). Results are presented as median, mean and standard error of the mean for continuous variables and as percentages for categorical variables. Because distribution of plasma zinc concentrations and plasma copper concentrations were typically skewed toward large values, we used natural log of these concentrations, a summary of which is