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Trace Element Status in Women of Childbearing Age in Kisangani, Democratic Republic of the Congo

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Abstract

Introduction: Trace element deficiency is a major nutritional problem worldwide, affecting more than two billion people, or around a quarter of the world's population. This situation is even more acute in developing countries than in developed countries. In sub-Saharan Africa, research and recent data on trace elements (micronutrients) are scarce. The aim of this study was to determine the serum status of calcium (Ca^{+}), copper (Cu), magnesium (Mg), selenium (Se) and zinc (Zn) in women of childbearing age in Kisangani. **Methods:** We have conducted a descriptive cross-sectional study in Kisangani, Democratic Republic of the Congo. Our sample consists of 596 women of childbearing age in apparent good health. The data collection has been prospective. Concentrations of trace elements in serum were analysed using an inductively coupled plasma mass spectrophotometer (ICP-MS Agilent 7700X). **Results:** The mean and median concentrations were: Calcium: 2.35 mmol/l and 2.31 mmol/l, Copper: 13.55 and 13.49 µmol/l, Magnesium: 0.85 and 0.81 mmol/l, Selenium: 0.99 and 0.76 µmol/l, and Zinc: 13.85 and 13.79 µmol/l. Respondents aged 20 - 34 had mean serum concentrations of 2.4 mmol/l for calcium, 13.7 µmol/l for copper, 0.9 mmol/l for magnesium, 1.1 µmol/l for selenium and 14.0 µmol/l for zinc. **Conclusion:** The trace element status of women of childbearing age in Kisangani was lower than that observed by other researchers, which suggests the need for a general nutritional intervention in our environment.

Keywords

Status, Calcium, Copper, Magnesium, Selenium, Zinc, Women,

Childbearing Age, Kisangani

1. Introduction

Trace elements are chemical elements present in very small quantities in the human body, only a few tenths of a gram, but they are essential to the metabolism of the human body. Most often obtained from food, they are a group of nutrients necessary for various biochemical functions in the living human being [1] [2].

Trace elements are ubiquitous in nature. Their nutritional status in the human body varies according to trace element intake, sex, age, bioavailability and other factors [3]-[5].

An insufficient intake of trace elements can lead to the appearance of deficiency symptoms, just as an excessive intake could lead to symptoms of intoxication in an apparently healthy individual. There is an interval between intakes that are clearly insufficient, leading to deficiency-related illnesses, and those that exceed the body's metabolic capacity, which can lead to signs of toxicity. Between these two extremes lies the correct intake for good health and the maintenance of metabolic integrity [1] [2] [6] [7].

Inadequate dietary intake, malabsorption or other conditions causing intestinal loss in an individual are thought to be at the root of a deficit or significant deficiency in trace elements [8]. Deficiencies in these minerals are widespread throughout the world and contribute to morbidity and mortality in vulnerable populations (women of childbearing age, children, pregnant and breastfeeding women) [8] [9].

Micronutrient deficiency is a major nutritional problem worldwide, affecting more than two billion people, or around a quarter of the world's population [3] [10]. This situation is even more acute in developing countries than in developed countries [11].

In a woman's life, childbearing age is of great importance because of its impact on a series of major changes and transitions. At this age, there are major fluctuations in trace elements, and mastering them requires up-to-date knowledge of their status to better help or support this growing organism in the event of any imbalance observed. What's more, the world is currently undergoing a nutritional transition, and this is happening faster in the female population than in the male population [4].

Given the higher micronutrient deficiencies among adolescent girls and adult women of childbearing age worldwide, UN experts recommend that all countries have accurate data on micronutrient status and dietary behaviour for this population group, despite the resources required for this task. This effort could contribute to a reduction in poverty and food insecurity, thus helping to achieve the Sustainable Development Goals (SDGs) [12] [13] by developing dietary guidelines based on the diet and status or level of different micronutrients in this target population [4].

The high nutritional burden among women has been recognised by the United

Nations Sustainable Development Goals, which aim to meet the nutritional needs of adolescent girls, as well as pregnant and lactating women, by 2030 [7]. In order to develop public health strategies and monitor programmes aimed at achieving these goals, data on the status and intake of trace elements in women of childbearing age and pregnant women are sorely needed. In developed countries, these parameters have already been established (or are in the process of being established), but this is not the case in most African (developing) countries, where these parameters are absent and, for the most part, obsolete [4].

In some parts of the world, the trace elements status of a large proportion of the population is known, making it easier to manage a number of deficiency diseases in vulnerable groups (children, women in reproductive activity and pregnant women) [13].

In sub-Saharan Africa, research and recent data on trace elements (micronutrients) are scarce or almost non-existent. Logistical resources and funding for several scientific studies are still lagging behind. This forces researchers or governments to refer to old, almost obsolete data, or to data from other countries that do not have the same living conditions as those being researched and sometimes, more often than not, to the standards set by the United Nations (WHO), for example [14]-[17].

In the Democratic Republic of the Congo, data on trace element status are scarce**.** We thought it appropriate to carry out this study to determine the levels of certain trace elements in women of childbearing age in the city of Kisangani, in order to understand the effects of their deficiency on pregnant women in our area.

This research will provide reference values for trace elements in the serum of women of childbearing age, giving us benchmark data for our environment. We asked ourselves the following question: What are the levels or thresholds of trace elements in women of childbearing age in Kisangani?

This study aims at improving the management of patients with trace element disorders or deficiencies in the city of Kisangani, determining the status and average concentration of each trace element (calcium, copper, magnesium, selenium and zinc), and leveling of trace elements as a function of age and socio-economic level in women of childbearing age in Kisangani.

2. Methods

2.1. Environment, Population and Type of Study

This research took place in the city of Kisangani, the capital of Tshopo province, in the north-east of the Democratic Republic of the Congo. In fact, this was a multi-site study, conducted within 8 health structure in Kisangani. These were the Kisangani University clinics, the Kabondo general referral hospital, the Foyer referral health centre, the Saint Joseph health centre, the Matete referral health centre, the Mangobo general referral hospital, the Lubanga general referral hospital, the Makiso-Kisangani general referral hospital.

The study population consisted of women of childbearing age (aged 15 - 45) living

in the city of Kisangani. The study ran from 10 July 2023 to 10 November 2023.

We have conducted a descriptive cross-sectional study with prospective data collection at all the sites selected for this research.

2.2. Sample and Sampling

To calculate the sample size for our study, we used the following formula [18]:

$$n = \frac{2\alpha^2 \times S^2}{\alpha^2}$$

- $Z\alpha$ for a 95% confidence interval is 1.96;
- S = Standard deviation;
- α = Level of accuracy or margin of error.

In our study, we used the standard deviation of copper calculated by Komarova Tatiana *et al.* [19], in their study in Australia in 2021. This standard deviation was 5.0 and we used a precision level of 0.5 mg/dl. By replacing these values in our formula, we have:

$$n = \frac{1.96^2 \times 5^2}{0.5^2} = 384.16 \text{ individus}$$

Adding 10% of those lost to follow-up, we would have 384.16 + 38 = 422 individuals. Ultimately, our sample should be ± 422 subjects. Our sampling was non-exhaustive or of convenience.

Case selection: To be a woman of childbearing age living in the city of Kisangani; To be in apparent good health; To have voluntarily consented to participate in the study by signing the informed consent form; To have agreed to the blood sample being taken, and personal data being recorded (Noted).

2.3. Data Collection Process

Data collection was prospective in the outpatient departments of the selected hospitals. After a 24-hour training session with the research team (doctors, head nurses of the outpatient departments, laboratory technicians and a community liaison officers).

The community outreach worker's role was to mobilise women of childbearing age in the neighbourhood and avenues; the doctor helped us receive the clients, explain the benefits of this activity, record their personal details and present them with the informed consent form for signature after verbal consent; the nurse took the vital signs and parameters. The laboratory technician drew blood from consenting women. Activities (from reception to sampling) took place every working day from 8 am to 12 pm, depending on the arrival of clients. At 12.30 p.m., the principal investigator came round to assess the day's activities (filling in the forms and checking the blood samples). Once the respondent had finished with the doctor and nurse, she was received for the blood test. Using a 5 ml syringe, a venipuncture was made in the forearm or the back of the hand, where 4 - 5 ml of blood was taken. From the syringe, the blood was injected into a dry vacutainer tube,

which was placed vertically while waiting for the samples to be taken to the laboratory in an isothermal box.

2.4. Sample Processing and Trace Element Analysis

Once the samples had been taken, they were sent to the laboratory of the Kisangani university clinics for analysis. The tubes containing the blood were centrifuged at 5000 rpm for 5 minutes. Then the sera were collected and placed in cryotubes. 160 microliters of serum from10 respondents were randomly collected for immediate analysis of trace elements (calcium, copper, magnesium, selenium and zinc) before hypercold storage. This was to reassure us that the values of trace elements would not be modified by our storage conditions (preservation) of the sera. The values found were recorded and the tubes of cases collected identified to be used for comparison with the values of these same samples during the analyses of all the preserved samples. The rest of the serum was divided into 3, placed in 3 different cryotubes, marked (each cryotube had a code identifying the woman in our collection form, *i.e.* each woman had three cryotubes bearing her identifier or code). The cryotubes were stored in the Hub-Kisangani at −80˚C. One third of the cryotubes were sent to the large biochemistry laboratory of the University of Strasbourg's Faculty of Life Sciences, in collaboration with the laboratory of the Chemistry and Biochemistry Section of the University of Geneva's Faculty of Science, for comparative trace element assays. The sera were transported in a liquid nitrogen container to the laboratory at the University of Strasbourg.

After digestion, the samples were diluted with 2 cc of deionised water, then diluted 5-fold and 20-fold before being analysed using an inductively coupled plasma mass spectrophotometer (ICP-MS Agilent 7700X).

We did not note significant variations between the values of trace elements measured before freezing and those after hypercold storage.

2.5. Data Processing and Analysis Plan

- Manual data processing and categorisation;
- Data analysis.

The data were entered on computer using Microsoft Excel 2021. Statistical analysis of the data was carried out using R software version 4.3.0.

We used percentage calculations for qualitative variables, mean, median, standard deviation, variance, minimum, maximum, first and third quartile, and mode for quantitative variables. We used the Kruskal Wallis Test and the Wilcoxon Mann-Whitney Test to compare the means between the different groups.

2.6. Ethical Considerations

The research protocol has been first validated by the Gynaecology-Obstetrics Department of the Faculty of Medicine at the University of Kisangani, then validated by the Faculty Council after presentation at the doctoral day organised by the Faculty of Medicine and Pharmacy at UNIKIS.

Finally, the research ethics committee of the University of Kisangani has given us its approval in letter No. UNIKIS/CER/025/2022 of 26/12/2022 to start collecting data.

Anonymity was guaranteed during data collection and analysis. Data were only collected once the woman had signed the informed consent form in the language she spoke.

3. Results

3.1. Socio-Demographic Characteristics of Respondents

Table 1 shows that 65.4% of the respondents were aged between 20 and 34, with an average age of 26.18 ± 7.50, and extremes of 15 and 45. Housewives accounted for 46.1% of our sample, and civil servants for 8.7%. 70.5% of these women were married; 68.1% had secondary education. The poor were 39.9% and the rich 24.7% (Table 1).

3.2. Trace Element Status

Table 2 shows that the mean blood calcium level was 2.35 ± 0.71 mmol/l. The lowest was 1.19 mmol/l and the highest 3.37 mmol/l. The 25th percentile was 2.20 mmol/l, the median 2.31 mmol/l and the 75th percentile 2.47 mmol/l. The most repeated level was 2.31 mmol.

The mean for cupraemia was 13.55 ± 2.67 µmol/l. The minimum was 0.53 µmol/l and the maximum 24 µmol/l. The 25th percentile was 11.20 µmol/l, the median 13.49 µmol/l and the 75th percentile 15.45 µmol/l. The mode was 11.10 µmol/l.

The mean magnesium level was 0.85 ± 0.31 mmol/l. The lowest magnesium level was 0.30 mmol/l and the highest 2.01 mmol/l. The 25th percentile was 0.75 mmol/l, the median 0.81 mmol/l, and the 75th percentile 0.89 mmol/l. The mode was 0.81 mmol/l.

With regard to selenium levels, the mean was 0.99 ± 2.96 µmol/l. The lowest level was 0.20 µmol/l and the highest was 1.13 µmol/l. The 25th percentile was 0.64 µmol/l, the median 0.76 µmol/l, the 75th percentile 0.83 mol/l. The most repeated level was 0.79 µmol/l.

In relation to zinc, the mean level was 13.85 ± 1.99 µmol/l. The minimum was 2.41 µmol/l and the maximum 18.4 µmol/l. The 25th percentile was 12.64 µmol/l, the median 13.79 µmol/l, and the 75th percentile 15.33 µmol/l. The mode was 13.42 µmol/l (Table 2).

3.3. Age of Respondents and Trace Element Status

Table 3 shows that the mean serum calcium, copper, magnesium and zinc levels differed significantly by age (p-values of 0.032, < 0.001, 0.01 and 0.018 respectively), with the mean calcium, copper and magnesium levels being higher in the 20 - 34 age group. For serum zinc levels, the mean was higher in the 20 - 34 and 35+ age groups. However, the mean serum selenium levels did not differ according to age (Table 3).

Table 1. Socio-demographic characteristics.

Socio-demographic characteristics	Frequency N = 596	%
Age (years)		
15 to 19	113	19.0
20 to 34	390	65.4
≥35	93	15.6
Profession		
Housekeeper	275	46.1
Student	101	17.0
Retailer	55	9.2
Student	52	8.7
State agent	30	5.0
Seamstress	24	4.0
Private sector	18	3.0
Nurse	15	2.5
Teacher	14	2.4
Grower	12	2.0
Marital status		
Married	420	70.5
Single	176	29.5
Level of education		
No	3	0.5
Primary	19	3.2
Secondary	406	68.1
Higher/University	168	28.2
Socio-economic level		
The poorest	14	2.4
Medium	238	39.9
Second or poor	143	24.0
Fourth or rich	147	24.7
The richest	54	9.1

Table 2. Trace element status.

Trace elements	Average	Variance	Standard deviation	Minimum	P 25	Median	P 75	Maximum	Mode
Calcium (mmol/l)	2.35	0.50	0.71	1.19	2.20	2.31	2.47	3.37	2.31
Copper (µmol/l)	13.55	7.15	2.67	0.53	11.20	13.49	15.45	24.00	11.10
Magnesium (mmol/l)	0.85	0.10	0.31	0.30	0.74	0.81	0.89	2.01	0.81
Selenium (µmol/l)	0.99	8.74	2.96	0.20	0.64	0.76	0.83	1.13	0.79
Zinc (µmol/l)	13.85	3.96	1.99	2.41	12.64	13.79	15.33	18.70	13.42

Table 3. Association between age of respondents and trace element status.

		Age in years			p-value
Trace elements		**15 to 19**	**20 to 34**	**35 to 45**	
Calcium (mmol/l)	Avg (ET)	2.2 (0.2)	2.4 (0.9)	2.3 (0.2)	**0.032**
Copper (micromol/l)	Avg (ET)	12.6 (2.4)	13.7 (2.8)	13.9 (2.1)	**<0.001**
Magnesium (mmol/l)	Avg (ET)	0.8 (0.1)	0.9 (0.4)	0.8 (0.1)	**0.01**
Selenium (micromol/l)	Avg (ET)	0.7 (0.2)	1.1 (3.6)	0.7 (0.1)	0.2
Zinc (micromol/l)	Avg (ET)	13.4 (2.1)	14.0 (2.1)	14.0 (1.4)	**0.018**

3.4. Socio-Economic Level and Trace Element Status

Table 4 shows that there was a statistically significant difference between the means of serum copper, magnesium and zinc levels in relation to socio-economic level (p-value respectively, <0.001, 0.004, and <0.001); the mean being higher in the richest people. Mean serum calcium and selenium levels did not differ by socio-economic status (Table 4).

Table 4. Relationship between socio-economic level and serum trace element levels.

Trace elements		Socio-economic level					p-value
		The Poorest	Poor	Medium	Rich	The richest	
Calcium (mmol/l)	Avg (ET)	2.0 (0.3)	2.2 (0.2)	2.4 (1.1)	2.4 (0.2)	2.4 (0.2)	0.062
Copper (µmol/l)	Avg (ET)	11.4 (1.6)	12.6 (2.1)	13.4 (2.9)	14.5 (2.4)	14.8 (2.9)	<0.001
Magnesium (mmol/l)	Avg (ET)	0.7 (0.1)	0.8 (0.1)	0.8 (0.5)	0.9 (0.2)	0.9 (0.2)	0.004
Selenium (µmol/l)	Avg (ET)	0.6 (0.1)	0.9 (1.5)	1.2 (4.5)	0.8 (0.2)	0.8 (0.2)	0.6
Zinc (µmol/l)	Avg (ET)	12.9 (1.6)	13.4 (1.7)	13.5 (2.2)	14.5 (1.6)	15.1 (1.7)	<0.001

4. Discussion

4.1. Trace Element Status

In this research, we determined the status of 5 trace elements including calcium, copper, magnesium, selenium and zinc in women of childbearing age.

Calcium status ranged from 1.19 to 15.30 mmol/l, with an average of 2.35 ± 0.71 mmol/l. Most of these women had a blood calcium level of 2.31 mmol. The 75th

Percentile was 2.47 mmol/l. Our lower limit of calcium status is well below those found by Onyekwelu AC *et al*., in Abuja, Nigeria: 2.18 mmol/l [20]; Probha K *et al*., in Kuwait: 2.25 mmol/l [21]. And Zhang H *et al*. [22], in China: 2.27 mmol/l, Rustad P *et al*.: 2.17 mmol/l [23].

The upper limit of our calcium status of 3.37 mmol/l, is higher than the limits or highest threshold of several authors or studies found in the literature [17] [24]-[27].

The mean serum calcium in our study was much higher than that observed by Annour M. Alalem *et al*. in Wadi Etba, Libya: 0.220 ± 0.023 mmol/l (8.5 ± 0.9 mg/dl) [28]; and 0.236 ± 0.006 mmol (9.14 ± 0.24 mg/dl) observed by Mohaddesi *et al*. in Iran [5]. Nevertheless, our mean was close or not very far from those observed by Yang, J *et al*. in China: 2.66 mmol/l [29]; and Mahdieh A F *et al*. in Iran: 2.22 ± 0.18 mmol/l [30].

Copper status ranged from 0.53 to 24.00 µmol/l, with an average of 13.55 ± 2.67 µmol/l. Most of these respondents had a cupremia of 11.10 µmol. The 75th Percentile was 15.45 µmol/l. This copper status is much lower than those observed by Raba'a M Jumaan in Yemen: 9.02 - 29.96 µmol/l [31]; Tasrina RC *et al*. in Bangladesh: 10.87 - 31.70 µmol/l (690.89 - 2014.45 µg/l) [32]; and Duncan A *et al*. in the USA: 13.5 - 30.0 µmol/l [33].

Our mean cupraemia was close to that observed by Hyun SB *et al*. in Seoul: 12.92 ± 1.69 µmol/l (82.12 ± 10.73 µg/dl) [34]; but lower than those found by Flavia F-M *et al*. in Sydney (Australia): 16.0 ± 5.9 µmol/l [35]; and Susan Darroudi *et al*. in Iran: 16.38 ± 5.71 µmol/l [36].

Magnesium status was 0.30 - 2.01 mmol/l, with an average of 0.85 ± 0.31 mmol/l. Most of these respondents had a magnesium level of 0.81 mmol/l. The 75th Percentile was 0.89 mmol/l. Our lower threshold of magnesium status remains low compared to those found by Zhang's *et al*. [22]; Yang J *et al*. [30]: 0.75 mmol/l in China. However, the upper limit of magnesium status in our research was higher than theirs [22] [29]: 1.14 and 1.13 mmol/l.

The mean magnesium levels observed in the sera of our respondents were close to those found by Mahdieh M F *et al*. in Iran [30]: 0.87 ± 0.11 and 0.97 ± 0.22 mmol/l; and Yang J *et al*.: 0.91 mmol/l [29] and Lowenstein FW *et al*. in the United States: 0.85 mmol/l [37]. However, our mean was much higher than that observed by Mahaddesi *et al*. in Iran at 0.054 ± 0.0034 mmol/l (*i.e*. 2.07 ± 0.13 mg/dl) [5].

Selenium status was found to be 0.20 - 1.13 µmol/l. Mean selenium was 0.99 ± 2.96 µmol/l. The selenium mode was 0.79 µmol/l. Our 25th percentile was 0.64 µmol/l and the 75th at 0.83 µmol/l.

Our selenium status remains lower than those found by other researchers around the world, including Cao Yang *et al*.: 1.16 - 2.22 µmol/l (73.81 - 140.75 µg/l) in Chinese mainland [29]; Hoet P *et al*. in Belgium: 0.97 - 1.94 µmol/l (61.6 - 122 µg/l) [38]; Stojsavljevic, A *et al*. in Serbia: 0.59 - 1.53 µmol/l (37.4 - 97.5 µg/l) [17]; Chiou-Jong Chen, *et al*. in Taiwan region [39]: 0.64 - 2.92 µmol/l; Flavia F-M *et al*.: 0.75 - 1.35 µmol/l in Sydney, Australia [35].

The mean selenium level was low compared with the various means found in Kim Hyun-Jun *et al*. in South Korea: 1.73 ± 0.31 µmol/l [40], Li, N *et al*. in Beijing: 1.24 µmol/l (78.85 µg/l) [41]; and Hoet P *et al*.: 1.44 µmol/l (91.7 µg/l) [37].

Serum zinc status in our women of childbearing age was 2.41 - 18.70 µmol/l. The average was 13.85 µmol/l. Most of our respondents had a status of 13.42 µmol/l. The 75th percentile was 15.33 µmol/l. The lower limit of our zinc status was lower than those found by other authors [36] [42]-[44], while the upper bound was similar and close to those observed in Australia by Flavia F-M *et al*.: 10 - 18 µmol/l [35]; in Yemen by Raba'a M J: 10.26 - 16.44 µmol/l [31]; and Duncan A *et al*. [33] in the USA: 9.5 - 16.5 µmol/l.

The mean serum zinc level in our study was similar to those observed by Kim H-J *et al*. in South Korea: 13.91 ± 3.34 µmol/l (884.1 ± 212.04 µg/l) [8]; and Susan D *et al*. in Iran: 13.66 ± 3.26 µmol/l [36]. Our mean was higher than that observed in Vietnam by Vinh Quang Nguyen *et al*.: 8.6 ± 2.6 µmol/l [42].

Overall, the status of different trace elements is not uniform or the same in different countries. Within the same population, there are variations from region to region and from place to place. This difference could be explained by the varied diets that differ from one people to another, or by the sufficient and/or insufficient intake of trace elements in food and drinking water. There may also be a lack of these micronutrients in the soil used for farming, and in the oils used for cooking.

In analysing the research carried out by Edward J.M.J *et al*. [45] on dietary intakes of minerals in Africa, we have found that most of our respondents had similar trace element statuses and averages to subjects classified in different countries as trace element deficient or non-deficient.

4.2. Age and Socio-Economic Level of Respondents and Trace Element Status

In this study, the majority of our respondents were aged between 20 - 34 years (65.4%), with an average age of 26.16 ± 7.50 years. 39.9% of the women were of average socio-economic status, with the poor at 24.0% and the rich at 24.7%. The average levels of micronutrients in these majority respondents were as follows: 20 - 34 age group: Calcium: 2.4 ± 0.9 mmol/l; Copper: 13.7 ± 2.8 µmol/l; Magnesium: 0.9 ± 0.4 mmol/l; Selenium: 1.1 ± 3.6 µmol/l and Zinc: 14.0 ± 2.1 µmol/l. This average was higher among the rich and middle-income respondents than among the poor and poorest.

James P.W *et al*. [46] found in their research a majority of women aged 20 - 34 years, with an average age similar to ours. Our mean age was close to or slightly lower than those observed by Cao Y *et al*. [47]: 28.6 years; Zhang H *et al*. [22]: 27.98 years in China. It was above the mean age of Hyun S B *et al*. in Seoul, South Korea: 20.54 ± 1.43 years [34]. It was below the averages found by Alalem AM *et al*. in Libya (southern region): 32.5 ± 5.45 years [28] and Mohaddesi H *et al*. in Iran: 31.41 ± 7.86 years [5].

In relation to socio-economic levels, several data in the literature and research

[39] [47]-[50] have found data concordant with our own. We agree with the observation made by the team of Nina A.C *et al.* in Canada, who noted that social status or socio-economic level had a positive influence on the mean and trace element status of wealthier women compared with poorer women [51]; as did Dartey E *et al.* [52] in Ghana, where trace element deficiency was more marked in women from poor or disadvantaged backgrounds.

It has also been observed that trace element status varies with age, with a much higher average in adolescence and during the period of genital activity in a population with a well-balanced diet [53] [54].

The difference in average age in the various studies could be explained by the selection of cases, and the difference in age of the respondents, where in some environments the population is younger rather than older.

5. Conclusion

At the end of this research, we noted that the trace element statuses of women of childbearing age in apparent good health in our environment were not uniform with those observed by other researchers. Copper, selenium and zinc statuses were lower than those observed in other environments. However, calcium and magnesium levels were similar and/or close to those found in other countries or regions of the world. Serum averages for calcium, magnesium and zinc were found to be high or higher and sometimes close to those observed in developing countries. Selenium and copper had lower serum averages than those found elsewhere. Averages for all trace elements were high in women aged 20 - 34. Serum levels of micronutrients were highest in subjects at the Rich (high) and Middle (medium) socio-economic levels, while they were low in the Poor and Poorest.

Study Limitations

The results reported in this study cannot be generalised to other towns in the Democratic Republic of the Congo because of the size of our sample. The samples were taken only once from each woman, making it difficult to assess daily or even seasonal variations in these various trace elements in women of childbearing age.

Conflicts of Interest

The authors have declared no conflicts of interest.

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