

Blood Cu/Zn Ratio in Children of School Age, Living in Malaria Endemic Area in Abidjan (Côte D'Ivoire)

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Abstract: *Background:* Food intake contains various nutrients which the loss or destruction are exogenous factors of oxidative damages in our body, aggravated by infectious diseases. Blood ratio Cu/Zn is an indicator about the pool of defenses anti oxidizing to measure damage oxidative. The present study aimed to investigate the blood ratio Cu/Zn an indicator of pool of oxidative stress and eating risk factors in children school age, living in malaria endemic area.

Methods: A total of 113 participants, aged 5-14 years with a mean age about 9.5 ±2 were submitted to the study. Malaria diagnosis was based on clinical grounds as the feverish condition (axillary temperature ≥ 37°C) and confirmed by laboratory test. A survey was conducted to screen children eating habits, and conjointly blood ratio Cu/Zn analyzed by atomic absorption spectrometry.

Results: We have noted a high value of the Cu/Zn ratio in malarial children, as compared to controls (p < 0.001). This ratio in both groups was highest compared to the normal values (< 1), and showed an acute value in course of parasitemia. Elsewhere, it was identified eating risk factors in all children.

Conclusion: Children of school age in high endemic zone of malaria in Côte d'Ivoire are exposed to the damage of stress oxidative. Thus, eating habits and their interaction with the parasite growth should be analyzed, to correct the states of stress by monitoring down the ratio copper/zinc.

Keywords: Blood Cu/Zn ratio, children, school age, malaria endemic area, Côte d'Ivoire.

INTRODUCTION

Malaria is an endemo epidemic parasitic disease caused by protozoa of the genus of *Plasmodium*. *falciparum* specie remains one of the major causes in morbidity and mortality of children under the age of five years [1, 2].

The entry in the body of a foreign agent induces an immune response, but also the production of activated oxygen species (AOS), that allow to activate transcription factors (NFkB, p38 - MAP kinase,...), responsible for the activation of genes involved in the response immune [3]. Production in sufficient quantity of AOS, creates significant cell damage brought by breaks and mutations in DNA, inactivation of proteins and enzymes, oxidation of sugars (glucose) and lipid peroxidation of cell membrane [3, 4].

Nutrition plays a major role in maintaining health, and malnutrition appears to generate vulnerability to a wide variety of diseases and general ill health [5, 6]. Food intake contains various nutrients which the loss or destruction are exogenous factors about the exposition of oxidative damages in our body. These nutrients

include fatty acids, polyphenols components, vitamins and minerals.

Blood ratio Cu/Zn is an indicator about the pool of defenses anti oxidizing to measure damage oxidative; a normal value of this ratio was estimated in less than one, to prevent oxidative damages [7, 8].

It is important to assess the blood Cu/Zn ratio to prevent oxidative damages in malaria endemic zone for the good health in children population.

The study concerned children of school age living in Abobo (Abidjan district in Côte d'Ivoire), a malaria endemic area. The aim of this study was to assess this ratio in course of malaria compared to controls and identify the food risk factors.

METHODS

Study Site and Population

Study involved one hundred and thirteen (113) children (59 boys and 54 girls) living in Anokoua Kouté, a village located in the district of Abobo which lies 15 km to the north of Abidjan (Côte d'Ivoire). Malaria is hyper-endemic, with transmission reaching its peak during the rainy season (June, July, and September). Two categories of children whose age varies between 5 and 14 with a mean age about 9.5 ±2 were studied

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from 2009 to 2010: a control group (n= 57) recruited in an educational institution whose gout thick found no trace of *Plasmodium* in blood, and cases (malarial subjects) (n = 56) recruited in a hospital (Fsu com anonkoi kouté) near the area of our investigation. They met the following criteria: regular resident in the village, no intestinal parasite infection, no micronutrients supplementation. However, only children infected with *P. falciparum*, with an axillary temperature of at least 37.5°C and not having received antimalarial treatments before enrolment were included in the study. The uninfected children by *Plasmodium* constituted the control population. Patients with viral or bacterial infections, severe malnutrition and/or the signs and symptoms of severe and complicated malaria were excluded.

Parents were informed of the project, gave their consent for the involvement of their children in this study. They have also agreed to provide if necessary any information about their children.

Research of Plasmodium Species

One of the classic technical methods of research of malaria parasites has been applied. Blood samples of children were collected and thick blood smears stained with Giemsa for the *P. falciparum* research. Blood slides were stained with 5% Giemsa stain. The asexual parasites densities were estimated by counting parasites against 200 white blood cells, assuming a standard leukocyte count of 8000/ μ L [9].

Determination of the Blood Ratio Copper/Zinc

Blood samples collected on dry tube (without anticoagulant) allowed us to obtain the serum. Cu and Zn were quantified by atomic absorption spectrophotometry (Varian AA20 Pattern®, France) using an air/acetylene flame [10]. To this end, serum samples previously thawed with no signs of hemolysis, was diluted with nitric acid solution (0.03 M) in specific assay tubes [11]. The determination of the concentration of each trace element was achieved by calibration curves from a multi-standard solution of 1000 ppm [12]. Measurements were realized in triplet, and the copper/zinc ratio was determined.

Food Habits Survey

A survey about eating habits of children was conducted to identify food risk factors related to the Cu/Zn ratio. To this end, households were visited to

screen eating habits and their frequency of consumption in children.

Statistical Analysis

Statistical analysis were performed using Graph Pad Prism 5 Demo software. The paired t-test was used for the means comparison. A p-value < 0.05 was considered as statistically significant.

RESULTS

The blood ratio Cu/Zn increased in malarial children as compared to subject controls, with a significant difference (p < 0.001); this value given 2.69±0.12 in malarial subjects against 1.2±0.3 in controls (Figure 1). However no significant difference was noted some either sex in each group (children malarial and control). We have obtained in children with malaria: 2.78±0.19 for the female against 2.71±0.16 for the male; and in controls: 1.16±0.2 for the female against 1.34±0.17 for the male (Figure 2). Elsewhere the blood Cu/Zn ratio measured in both groups was highest compared to normal values (less than 1). This ratio showed an acute value in course of parasitemia : 2.35±0.18 (DP<2000) < 2.8±0.21(DP [2000-40000]) < 3.5±0.02 (DP >40000) Figure 3.

We have noted a low consumption of animal protein and high consumption of energy foods including cereals (Table 1). Rice is the basic food of populations. It was noted by elsewhere a low consumption of fruits, and vegetables in children.

Table 1: Level of Consumption About Animal Protein, Energy Foods, Fruits and Vegetables

Animal protein	Energy intake	Fruits and Vegetables
Pork (+)	Rice (+++)	
Beef (+)	Maize (+++)	
Fish (++)	Bean (+++)	(+)
Sheep (+)	Groundnut (+++)	
Chicken (+)	Cassava (+++)	
	Banana (+)	
	Yam (+)	

(+) Low consumption.

(++) Moderate consumption.

(+++) High consumption.

DISCUSSION

Blood Cu/Zn ratio increased in course of malaria in children is in agreement with works of some authors

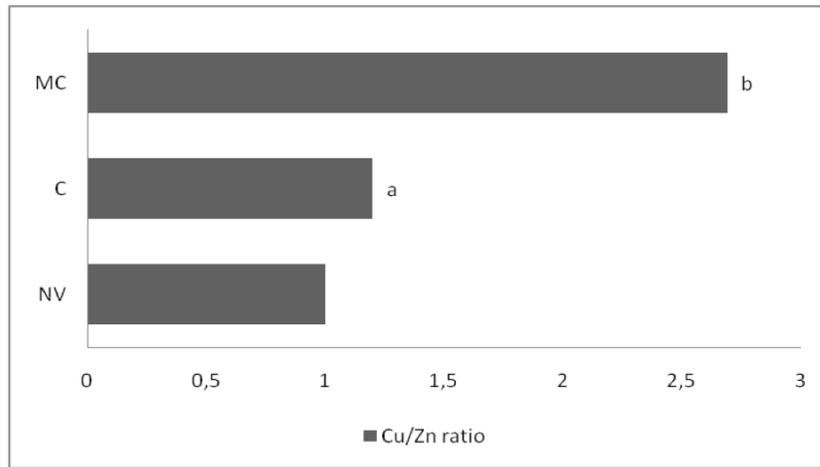


Figure 1: blood Cu/Zn ratio in children school age. The difference is significant between a and b; ($p < 0.001$). NV: normal value; C: control; MC: malarial children.

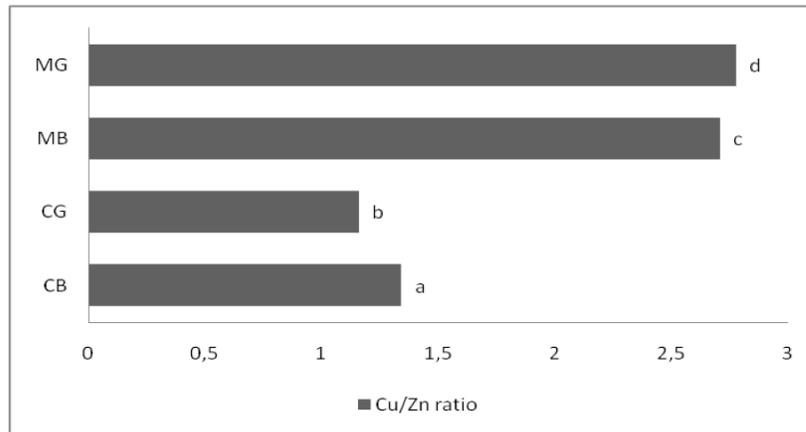


Figure 2: Blood Cu/Zn ratio in children in both sex groups. The difference is no significant between a and b; c and d ($p > 0.05$).

MB: malarial boys; MG: malarial girls; CB: control boys; CG: control girls; NV: normal value.

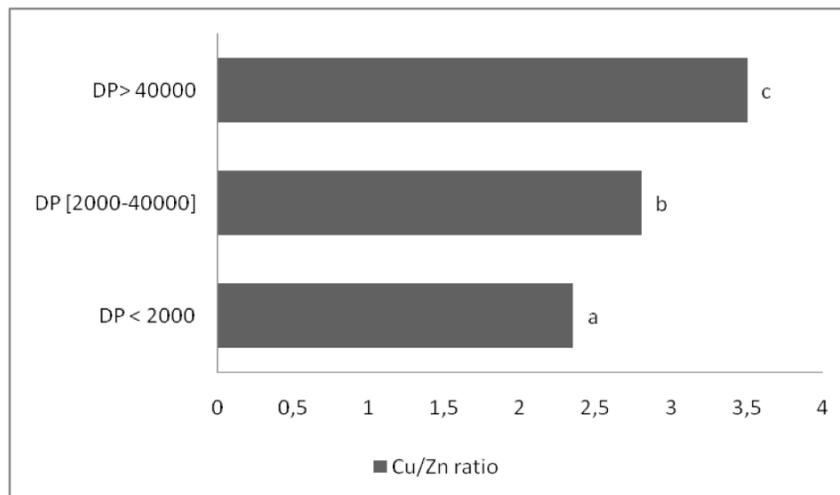


Figure 3: Blood Cu/Zn ratio in children with malaria.

DP: (Parasitemia density).

who have established relationships between oxidative stress, infections and others diseases [3, 7, 13]. Indeed

the entry in the body of a foreign agent induces an immune response with the intervention of white blood

cells which activation would be an important source of production of activated oxidative species (AOS). In effect, under the action of these foreign agents, these cells would pass a state quiescent to a status of enabled with the increasing about 400% of the oxygen consumed [13]. Thus, various enzyme systems would transform almost all oxygen in activated oxidative species, which can then attack healthy tissue (phenomenon of inflammation) [13, 14]. The AOS production related to the white blood cells activation, could explain the high value in the ratio blood copper/zinc in course of malaria; Cu/Zn ratio is an indicator of oxidative stress [8]. The action of the AOS would be to destroy the integrity of cells in the organism and weaken the immune system [3, 4].

Zinc is an essential trace element for the growth and cell differentiation, which deficiency causes impaired immune function, and therefore a reduction in the resistance to infections [15, 16]. Copper and zinc are the essential cofactors of superoxide dismutase (SOD) an antioxidant enzyme in the same way as the selenium, which is a cofactor of Glutathione peroxidase. Like iron, copper is a transition metal which plays an important role in triggering reactions leading to the formation of activated oxygen species [17]. Thus, high copper value (excess) or reduction zinc value would justify the blood copper/zinc ratio observed. This ratio measuring the pool of our anti oxidizing defenses, superior to the normal plasma value, more face the adverse effects of oxidative stress and therefore a greater susceptibility to infections [18]. The protection of the body against the harmful effect of AOS requiring the presence of antioxidant molecules, it is important with a diet appropriated and controlled of these trace elements and others antioxidant molecules to correct the state of stress in course of malaria. This action would further improve the state of health of the subject [19, 20].

The diminishing of nutrients plasma concentration in some particular infectious diseases, could be explained either by coverage of the needs of parasite for its metabolism [21], a deficit of food intake and the poor nutrients in foods.

The inadequacy of consumption of fruits and vegetables would reduce the dietary intake of vitamins and mineral salts.

The ratio phytic acid/Zinc is important for the determination of the bioavailability of zinc element in foods. A high value of this ratio in food intake

decreases the zinc bioavailability [22, 23]. The high consumption of cereals (rich in phytic acid) and the low consumption of animal protein (rich in zinc element) would explain a decrease in food intake in zinc of this nutrient in children [24].

Thus, eating habits should be analyzed about the quality and quantity of nutrients, their interaction with the parasite growth, to correct the states of stress by monitoring down the ratio copper/zinc.

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