Asian Journal of Research in Medical and Pharmaceutical Sciences

5(2): 1-7, 2018; Article no.AJRIMPS.44564
ISSN: 2457-0745

Assessment of the Levels of Serum Zinc and Copper among Sudanese Patients with Sickle Cell Anaemia in Khartoum State

Ghada Musa Eisa[1], Nuha Eljaili Abubaker[2] and Mariam Abbas Ibrahim[2*]

[1]Department of Clinical Chemistry, Faculty of Medical Laboratory Sciences, Al-Neelain University, Khartoum, Sudan.
[2]Department of Clinical Chemistry, College of Medical Laboratory Science, Sudan University of Science and Technology, Khartoum, Sudan.

Authors' contributions

This work was carried out in collaboration between all authors. Author GME designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors NEA and MAI managed the analyses of the study. Author MAI managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJRIMPS/2018/44564
Editor(s):
(1) Dr. Lokendra Bahadur Sapkota, Assistant Professor, Department of Biochemistry, Chitwan Medical College, Bharatpur, Nepal.
Reviewers:
(1) Mohammad Nadeem Khan, School of Studies in Biotechnology, Bastar University, India.
(2) Kwabena Nsiah, Kwame Nkrumah University of Science and Technology, Ghana.
(3) Priscila Bacarin Hermann, Universidade Federal do Paraná, Brazil.
(4) Leila Chaouch, Tunisia Pasteur Institute of Tunis, Tunisia.
Complete Peer review History: http://www.sciencedomain.org/review-history/27148

Original Research Article

Received 18 September 2018
Accepted 02 November 2018
Published 10 November 2018

ABSTRACT

Background: Sickle cell anaemia (SCA) is associated with increased risks of multiple micronutrient deficiencies. Zinc deficiency has been observed in patients with sickle cell anaemia, due to chronic haemolysis with subsequent loss of zinc from red blood cells.
Objectives: The aim of this study was to assess the level of zinc and copper among Sudanese patients with sickle cell anaemia.
Methods: A cross-sectional study was conducted from March to April 2018, involving forty Sudanese Patients who had been diagnosed of sickle cell anaemia, and had been admitted to Albuluk Hospital, in Khartoum State, like cases, forty age-matched healthy individuals with normal haemoglobin (HbA) were recruited as controls. The ages from 4 months to 16 years).Blood

**Corresponding author: E-mail: mariamabbas81@yahoo.com;*

samples were collected and the levels of zinc and copper were measured, using atomic absorption spectrophotometer. Data analysis was carried out, using SPSS version, 21. Mean values were calculated and independent t-test was used to compare mean values in case versus the control group. Pearson's correlation was used to find the relationship between zinc and copper and age.

Results: There was significant decrease in the mean levels of zinc and copper in patients with sickle cell anaemia, compared to control groups. The mean ± SD: 0.137±0.079 versus 0.705±0.138 mg/l, p, value= 0.00) for zinc. The values for copper were 0.512±0.290 versus 0.923±0.214 mg/l, p, value =0.00. There was no significant difference between males and females in the mean levels of zinc (p = 0.345) and copper (p = 0.656).There was weak correlation between levels of zinc, copper and ages, (r=0.052, p, value=0.750); for zinc, (r=0.122, p, value=0.452) for copper.

Conclusion: The levels of zinc and copper were decreased in patients with sickle cell anaemia, compared to healthy individuals. There was also a negative correlation between the levels of zinc and copper and age of patients.

Keywords: Sickle cell anaemia; zinc; copper; micronutrient and Sudanese.

1. INTRODUCTION

Sickle cells anaemia is a haemoglobinopathy, characterised by chronic haemolysis, chronic inflammation, immune deficiency, a heterogeneous clinical picture and organ damage [1]. SCA is associated with increased risks of multiple micronutrient deficiencies; these deficiencies may have a significant impact on SCA severity indices including growth retardation, cell-mediated immune dysfunction, and cognitive impairment with a negative impact on morbidity and mortality [2]. Also, these nutrients have a major role in the protection of the red cell membrane against damage through free radical-mediated oxidation in SCA [3] Sickle cell disease is common especially in Africa and among Negroid race. In sickle cell disease, there are deficiencies of some essential elements which are vital in the maintenance of red cell integrity, body growth and development [4].

The sickle haemoglobin is known to interact with diverse genes and environmental factors, producing a multi-systemic disease with several phenotypes [5].

Minerals are inorganic substances, present in all body tissues and fluids and they are necessary for the maintenance of certain physicochemical processes which are essential to life [6,7]. They are important for human, [8,9] so deficiencies or disturbances in the nutrition can cause a variety of diseases, which can arise in several ways [10]. Two most common trace metal imbalances are elevated copper and depressed zinc in SCA. Therefore, this study aimed to assess the level of serum zinc and copper among Sudanese patients with sickle cell anaemia.

2. MATERIALS AND METHODS

Study design: This was a cross-sectional case-control study.

Study area and period of study: Blood samples were collected from Albuluk Hospital, in Khartoum State, from March to April 2018.

Study population: Forty Sudanese sickle cell anaemic patients, aged between 4 months and 16 years (six patients were with the crisis), were recruited as cases and forty normal children with normal haemoglobin were enrolled as controls. The cases and control were age-matched; 17 of sickle cell anaemic patients were females and 23 were males, and 16 of controls were females, and 24 of them were males.

Inclusion criteria: Albuluk Hospitalin-patients with sickle cell anaemia, who were being treated with hydroxyurea, were included.

Exclusion criteria: Any patients taking long-term zinc supplements and patients with other chronic diseases (liver disease, renal disease and heart diseases), were excluded.

Ethical consideration: The study was approved by the ethical committee of Medical Laboratory Science, Clinical Chemistry Department– Alneelain University. Informed consent was obtained from the parents of all the participants, who were minors.

Data collection: Demographic data was collected by using questionnaire.

Sampling: About 2.5 ml of random venous blood was collected from each participant (from the arm), into plain sample tubes. After formation of

clot at room temperature, the samples were centrifuged for 10 minutes at 3000 rpm. Then, the serum was obtained and analyzed.

Method of the assay of zinc and copper: The levels of serum zinc and copper were measured by using atomic absorption spectrophotometer (BUCK SCINTIFIC 210/211 VGP VER3.94C).

Quality control: Pathological and normal control sera were also used for the measurement of the metals, to assure accuracy and precision of results.

Data analysis: Data was analysed using SPSS, version 21. The results were expressed as percentages, mean and SD. Independent t-test was used to compare mean values in case versus the control group. Pearson's correlation test was done to study the relationship between zinc and copper and age, p-value less than 0.05 was considered significant.

3. RESULTS

Eighty participants were enrolled in this study; 40 SCD patients (17 females and 23 males) with mean age ±SD 6.67±4.16 years and 40 controls (16 females and 24 males) with mean age ±SD 6.37±4.16 years.

Six patients were with crisis; the level of copper and zinc for these patients were as follow: (Cu level: 0.706, 0.415, 0.263, 0350, 0.260 and 0.328 mg/l) (zinc level: 0.084, 0.081, 0.20, 0.150, 0.138 and 0.372 mg/l).

There was a significant decrease in the levels of zinc and copper among patients with sickle cell anaemia (SCA), when compared to healthy individuals (Table 1). There was no significant difference in the mean levels of zinc and copper between male and female patients with sickle cell anaemia (Table 2). There was no correlation between the level of zinc and copper with ages among patients with sickle cell anaemia, (Figs. 1 and 2).

There was a positive correlation between copper with ages and no correlation between the level of zinc with age and among controls, (Figs. 3 and 4).

Table 1. Comparison of the levels of zinc and copper in cases versus controls

Parameters	Case (Mean ± SD)	Control (Mean ± SD)	*P-value*
Copper mg/l	0.512 ± 0.290 (0.122 -1.154)*	0.923 ± 0.214 (0.704 -1.346)*	0.000
Zinc mg/l	0.137 ± 0.079 (0.03 -0.372)*	0.705 ± 0.138 (0.474 -1.01)*	0.000

*P-values less than 0.05 were considered as significant. * indicates the range of values (lowest and highest) of copper and zinc*

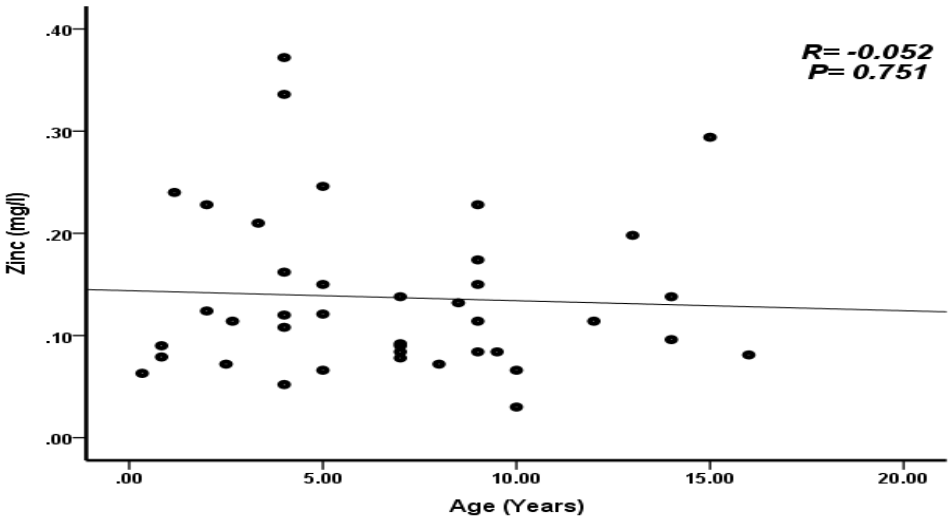

Fig. 1. Correlation between zinc levels and ages (among patients)
p-value less than 0.05 considered as significant

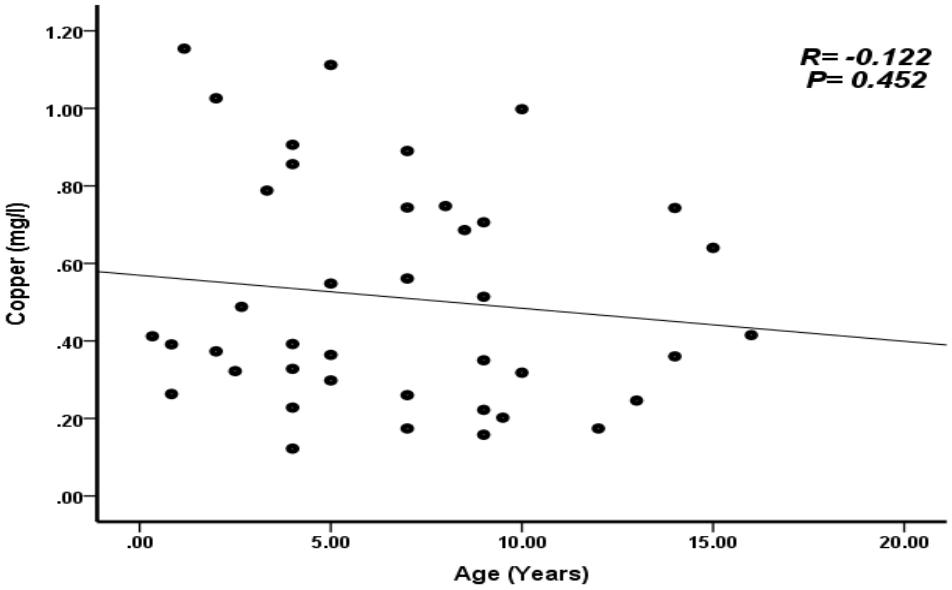

Fig. 2. Correlation between copper levels and ages (among patients)
p-value less than 0.05 considered as significant

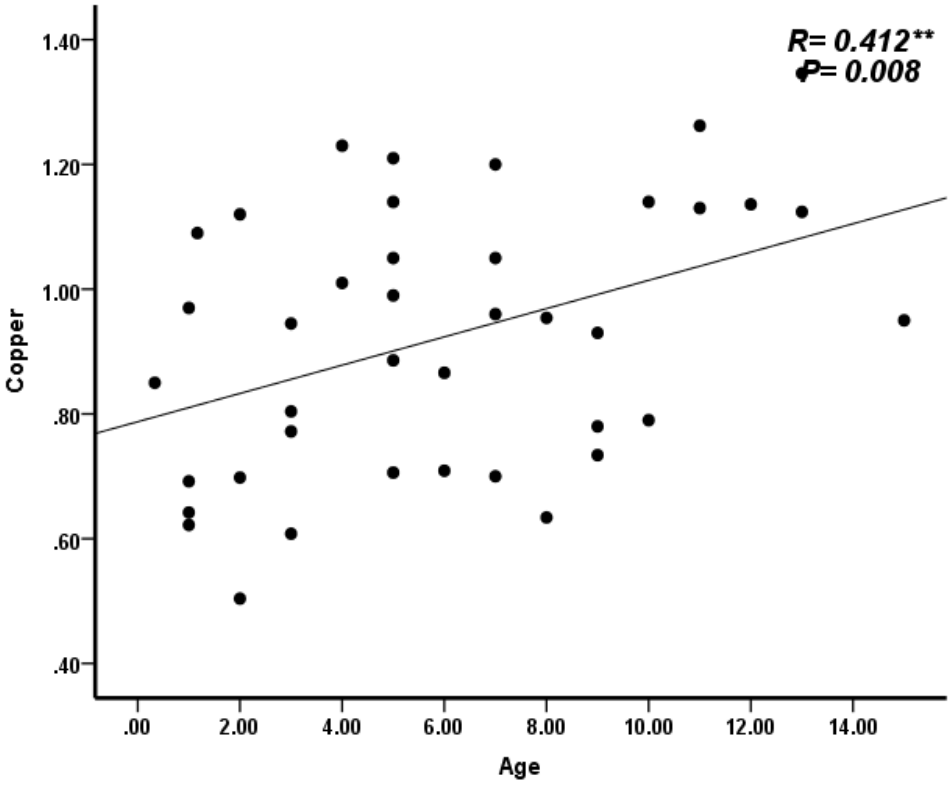

Fig. 3. Correlation between copper levels and ages (among the control group)
p-value less than 0.05 considered as significant

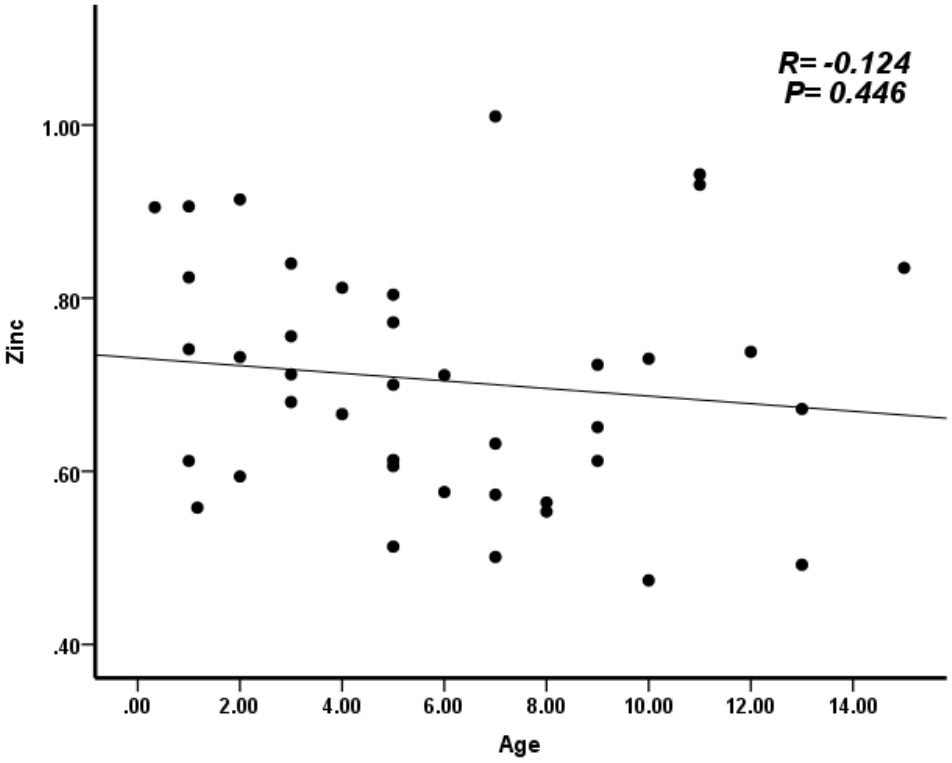

Fig. 4. Correlation between zinc levels and ages (among the control group)
p-value less than 0.05 considered as significant

Table 2. Comparison of the levels of copper and zinc in cases according to gender

Parameters	Male (Mean ± SD)	Female (Mean ± SD)	*P-value*
Copper mg/l	0.502 ± 0.271	0.525 ± 0.321	0.656
Zinc mg/l	0.144 ± 0.079	0.127 ± 0.080	0.345

P-values less than 0.05 were considered as significant

4. DISCUSSION

In sickle cell anaemia, there are deficiencies of some essential elements which are vital in the maintenance of red cell integrity, body growth and development. In the current study, the levels of zinc and copper showed a significant decrease in patients with sickle cell anaemia, compared to healthy individuals (p-value 0.000). This might have occurred due to chronic haemolysis with subsequent loss of zinc from RBCs. Zinc deficiency can also be the result of the adverse effect of hydroxyurea which increases zinc excretion [11].

This finding was in agreement with results of some previous studies [12,13,14] in Central Africa and Nigeria, which related zinc deficiency in sickle cell disease to manifestations such as growth retardation, hypogonadism in males, hyperammonaemia, abnormal dark adaptation and cell-mediated immune disorder. Similarly, the biochemical evidence for zinc deficiency in patients with SCA includes low zinc concentrations in plasma, erythrocytes, hair, lymphocytes and granulocytes [15]. This biochemical difference appears to be due to various mechanisms such as chronic haemolysis, renal loss due to repeated sickling, leading to abnormal renal tubular reabsorption of zinc, abnormal binding of zinc to tissue proteins, and disturbed metabolism of zinc metalloenzymes [14]. Bot et al. in 2015 denoted that "*People with sickle cell disease suffer from micronutrients deficiency but preliminary research on dietary habits, show that food and nutrients intake by sickle cell patients meet or exceed recommendation and is not significantly*

different from healthy controls. This suggests that higher rates of nutrients deficiency may be due to increased needs of many nutrients in sickle cell patients" [16].

Also, the results revealed that there was a non-significant difference between males and females, in the levels of zinc and copper in patients with sickle cell anaemia. Furthermore, there was negative correlation between levels of zinc and copper and age of the patients (r= -0.603, p-value= 0.000) and (r= -0.443 p- value= 0.004) respectively.

5. CONCLUSION

The levels of blood zinc and copper were decreased in patients with sickle cell anaemia, compared to healthy individuals. There was also a negative correlation between the levels of zinc and copper and age of patients.

CONSENT

Informed consent was obtained from the participants.

ETHICAL CONSIDERATION

The study was approved by the ethical committee of Medical Laboratory Science, Clinical Chemistry Department–Alneelain University.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Silva DG, Belini Junior E, de Almeida EA. Oxidative stress in sickle cell disease: An overview of erythrocyte redox metabolism and current antioxidant therapeutic strategies. Free RadicBiol Med. 2013;65: 1101–1109.
2. Al-Saqladi AWM, Cipolotti R, Fijnvandraat K. Growth and nutritional status of children with homozygous sickle cell disease. Ann Trop Paediatr. 2008;28:165–189.
3. Hierso R, Waltz X, Mora P. Effects of oxidative stress on red blood cell rheology in sickle cell patients. Br J Haematol. 2014; 166:601–606.
4. Okpuzor J, Okochi VI. Micro-nutrients as theurapeutic tools in the management of sickle cell anaemia. Afr. J. Biotechnol. 2009;7(5):416-420.
5. Driss A, Kwaku A, Hibbert J, Adamkiewicz T, Stiles JK. Sickle cell disease in the post genomic era: A monogenic disease with a polygenic phenotype. Genomic Insights. 2009;2:23–48.
6. Halfdanarson TR, Kumar N, Li CY, Phyliky RL, Hogan WJ. Hematological manifestations of copper deficiency: A retrospective review. Eur J Haematol 2008; 80:523-531.
7. Eruvbetine D. Canine nutrition and health. A paper presented at the seminar organized by Kensington Pharmaceuticals Nig. Ltd. August 2003 . 21.
8. Arinola OG, Olaniyi JA, Akiibnu MO. Evaluation of antioxidant level and trace element status in Nigerian sickle cell disease patients with Plasmodium parasitaemia. Pakistan Journal of Nutrition. 2008;7:766-769.
9. Bot YS, Benjamin A, Nyango DY, Ventmack DT, Eunice CB. Analyses of Cu and Zn in serum of sickle cell disease patients in Jos. African Journal of Biochemistry. 2013;1:001-004.
10. Idonije BO, Iribhogbe OI, Okogun GRA. Serum trace element levels in sickle cell disease patients in an urban city in Nigeria. Nature and Science. 2011;9:67-71.
11. Manafa PO, Okocha CE, Nwogbo SC, Chukwuma GO, Ihim AC. Status of some trace elements in sickle cell homozygous and heterozygous subjects attending NnamdiAzikiwe University Teaching Hospital NAUTH, Nigeria. Archives of Basic and Applied Medicine. 2013;1:73-75.
12. Bashir NA. Serum zinc and copper level in sickle cell anaemia and beta-thallassaemia in North Jordan. Ann Trop Paediatr. 1995; 15(4):291-293.
13. Digban AK, Okogun GRA, Adu Matthew, Jemikalajah JD. Evaluation of some micronutrients in sickle cell disease. International Journal of Innovative Research and Development. 2016;5(8): 309-313.
14. Sungu JK, Mukuku O, Mutombo AM, Mawaw P, Aloni MN, Luboya ON. Trace elements in children suffering from sickle

cell anemia: A case–control study. J Clin Lab Anal. 2018;32:1-3.

15. Garba N, Ifeanyichukwu OM, Amilo GI, Audu I. Evaluation of trace elements in adult sickle cell anaemia patients in Zaria, North Western Nigeria. J Blood Disord Transfus. 2016;7:347.

16. Bot YS, Benjamin A, Nyango DY, Ventmack DT, Eunice CB, Etukudu NS, Obeta MU. Analyses of Cu and Zn in serum of sickle cell disease patients in Jos. International Journal of Medicine and Medical Sciences. 2015;3(3):207-209.

© 2018 Eisa et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/27148