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BRIEF REPORT

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# Trace elements in children suffering from sickle cell anemia: A case–control study

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**Background:** Information on serum albumin and trace elements among children suffering from Sickle Cell Anemia (SCA) was poorly documented in Africa. The aim of this study was to describe and to compare different values of trace elements with published reports from other parts of the world.

**Methods:** We carried out a case–control study. Seventy-six steady state children suffering from SCA (Hb-SS). One hundred and fifty-two children were recruited with 76 (cases, Hb-SS) and 76 (control, Hb-AA) to compare the data.

**Results:** The mean age was 10.0 years (SD=5.4) in SCA children and 9.2 years (SD=4.7) in the control group. The mean level of zinc and magnesium were slightly lower in the Hb-SS group than in the Hb-AA group ($P<.001$).

**Conclusion:** The first literature about trace elements in SCA is briefly reported in Central Africa. In our midst, zinc, magnesium, and selenium deficiencies underline the need for their systematic among all children with SCA to identify patients with these deficiencies and provide early management.

KEYWORDS

children, Democratic Republic of Congo, Lubumbashi, sickle cell anemia, trace elements

## 1 | INTRODUCTION

SCA is an hemoglobinopathy characterized by chronic hemolysis, 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] In addition, these nutriments have a major role in the protection of the red cell membrane against stress free radical mediated by oxidation in SCA.[3] The objective of this study was to investigate and determine the trace elements levels among SCA children in steady state living in Kasumbalesa, the DRC. The findings could mean that the current general public health and preventive policies in place to tackle these deficiencies in our sickle cell population and to be a starting point for future research.

## 2 | METHODS

We consecutively recruited SCA children (Hb-SS) between the age of 2 and 15 years after written informed consent provided by their legal guardians in the Muhona Hospital of Kasumbalesa, which is situated in the southeastern part of the DRC. All SCA children were free of pain for at 1 month and had not been hospitalized or transfused for at least 100 days before the study.[4] We excluded subject (i) under iron therapy (ii) under chronic transfusion program. For each case, one control patient (Hb-AA) matched for age, sex, and place of residence were recruited into the study.

### 2.1 | Data collection procedure and blood analysis

Ten milliliter of venous blood sample was drawn from each study participant into an EDTA tube, used to determine laboratory parameters.

  

Five milliliter of venous blood sample was drawn from each study participant into an EDTA tube, used to determine hemoglobin electrophoresis. Sickle cell screening was performed using isoelectric focusing method.

Trace elements were estimated in blood using a Perkin Elmer Model 2380 Atomic absorption Spectrophotometer (Norwak, Connecticut, USA).

Trace elements were performed at Mineralogy Laboratory of the Société de développement industriel et minier du Congo (SODIMICO) Society at Kasumbalesa, the DRC.

A total of 152 children, 76 SCA children and 76 normal were recruited into the study over the 6 months. The mean age of the Hb-SS group was 10.0 (SD=5.4) years while that of the HB-AA group was 9.2 (SD=4.7) years. The sex-ratio male to female in the SCA group and control group was, respectively, 1:1.8 and 1:1.1.

### 2.2 | Ethics statement

All of the participants were minors and their legal guardians provided written consent for them to take part in the study. This consent procedure and the study were reviewed and approved by the National Ethical Committee of the Public Health School of the University of Lubumbashi, Lubumbashi, the DRC (UNILU/CEM/048/2015), in compliance with the principles of the Helsinki Declaration II. The aim and the procedures of the study were explained to the participants. The participants were informed that they could withdraw anytime without further obligation.

### 2.3 | Data management and analysis

Results were analyzed using the Epi Info 7.1 (CDC, Atlanta, GA, USA) and they were exported on STATA 12 for further analysis. Data are represented as means±SD when the distribution was normal and median with range when the distribution was not normal. The analysis of Student's *t*-test was used for comparisons of means. Statistical significance level was set at $P$=.05.

## 3 | RESULTS

The mean level of zinc was slightly lower in the Hb-SS group (0.27±0.58 mg/L) than in the Hb-AA group (1.64±0.14 mg/L) with statistically significant difference observed. The level of magnesium was significantly lower in the Hb-SS group (3.21±0.39 mg/L) than in the Hb-AA group (10.28±1.35 mg/L). Overall mean selenium values were significantly higher (31.57±6.42 μg/L vs 5.00±1.38 μg/L; $P$<.001) for Hb-AA than the Hb-SS group (Table 1).

**TABLE 1** Profile of trace elements in studied population

| Variable | Hb-SS (n=76) | Hb-AA (n=76) | *P* |
|---|---|---|---|
| Selenium (μg/L) | 31.57±6.42 | 5.00±1.38 | <.001 |
| Magnesium (mg/L) | 3.21±0.39 | 10.28±1.35 | <.001 |
| Zinc (mg/L) | 0.27±0.58 | 1.64±0.14 | <.001 |

## 4 | DISCUSSION

Our study is the first to look at the trace elements and albumin values in SCA children living in the Central Africa.

In Hb-SS group, zinc level was slightly lower in comparison with control group. These results are in consonance with previous studies.[5-10] This biochemical difference appears to be due to various mechanisms such as chronic hemolysis, renal lost due to repeated sickling leading to abnormal renal tubular reabsorption of zinc, abnormal binding of zinc to tissue proteins, disturbed metabolism of zinc metalloenzymes.[11] A recent paper shows a primarily relation between renal loss of zinc and the increased bone degradation.[12]

In SCA, there is an oxidative stress resulting from an imbalance between the production of reactive oxygen species and antioxidant substances. Zinc has an antioxidant action by inhibition of lipid peroxidation in red blood cells and its deficiency has been associated with the risk to increase severe vaso-occlusive crisis in SCA patients.[13] Several worldwide studies have demonstrated the reduction in pain crises and incidence of infection, the acceleration of growth in SCA children who received a zinc supplementation.[10,11]

Magnesium plays a major role in cell dehydration by inhibition of $K^+$-$Cl^-$ cotransport, leading to the reduction in $K^+$ loss and to modulate endothelial inflammation in SCA.[14] Furthermore, magnesium deficiency is associated with increased levels of the inflammatory cytokines, and increased expression of endothelial adhesive molecules such as vascular cell adhesion molecule (VCAM).[14] In this report, the level of magnesium was significantly lower in the Hb-SS group than in the Hb-AA group. The laboratory feature reported in this study was similar to that described by Zehtabchi et al.[15] in United States. However, these results are in contrast with those reported by Akenami et al.[5] in Nigeria. We therefore speculate that genetic factors as difference of haplotype between Congolese and Nigerian suffering from SCA, environment factors may explain this difference. Furthermore, Nigerian study investigated an adult population.

Selenium plays an important role in the prevention of the oxidative modification of lipids, reducing inflammation and preventing platelets from aggregating.[16] In this study, the selenium level was significantly higher for Hb-SS group than the Hb-AA group. The findings reported in our cohort were similar to those reported by previous studies.[17-19]

## 5 | CONCLUSION

The first literature about trace elements in SCA is briefly reported in Central Africa. In our midst, zinc, magnesium, and selenium deficiencies underline the need for their systematic among all children with SCA to identify patients with these deficiencies and provide early management. Further investigations will focus on data about relation of decreased elements specially zinc and symptoms as frequency

of crises, Hb levels, frequency of previous hospitalization, and blood transfusion, in our midst.

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## AUTHORS' CONTRIBUTIONS

JS, OM, AM, PM, and ONL conceived, designed, deployed and directed the case–control study at the Muhona Hospital and at the Faculty of Medicine of University of Lubumbashi. JS, PM, and OM carried out patient recruitment and follow-up, sample collection, storage, and transport. OM and MNA wrote the manuscript. MNA brought some precious corrections. OM, JS, AMM, PMM, MNA, and ONL analyzed data. OM and MNA edited the English and made corrections. All authors read and approved the final manuscript.

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