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Factors Associated with Variation in Zincemia and Acute Clinical Manifestations of Sickle Cell Disease in Cameroonian Children

WETE KAMGUENG E[1,2,5,*], KIMESSOUKIE OMOLOMO E[1], ELANDI ELANDI JR[6], NKOUANANG J[1], ALIMA YANDA AN[5], CHENDJOU KAMELA A[4], KOKI NDOMBO P[2,3]

[1]*Catholic University of Central Africa, Cameroon*
[2]*Mother and Child Center of the Chantal Biya Foundation, Cameroon*
[3]*Faculty of Medicine and Biomedical Sciences, University of Yaounde 1, Cameroon*
[4]*European Institute for Cooperation and Development, Delegation of Cameroon, Cameroon*
[5]*Cameroon Sickle Cell Study Group, Cameroon*
[6]*Institute of Demographic Training and Research, Cameroon*

[*]**Corresponding author:** WETE KAMGUENG E, Catholic University of Central Africa, Cameroon

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Abstract

The clinical observation made in the pediatric sickle cell population of the Mother and Child Centre of the Chantal BIYA Foundation (CME / FCB) reveals a spacing of acute clinical events in this group when they receive zinc supplementation. This guides the formulation of the general hypothesis according to which the lowering of zincemia in children with sickle cell disease is accentuated by a combination of factors including personal factors, environmental factors, acute clinical manifestations of sickle cell disease and the eating habits of the patient. The general objective of the present study was to study the relationship between the risk factors for zinc deficiency, the acute clinical manifestations of sickle cell disease and the zinc status of Cameroonian sickle cell children. To this end, a mixed sequential study was carried out within the CME / FCB. In its quantitative part, the study used a predictive correlational design with zincemia as dependent variable and the independent variables being the child's age, sex, number of blood transfusions, number of vaso-occlusive seizures (cvo), the number of infectious episodes, the social class to which they belong and the tutor's level of education. She saw the participation of 54 sickle cell children. Binomial logistic regression identified factors that may alter the zinc level. In its qualitative part, the study used the case study. It was attended by 16 guardians of children with sickle cell disease. The content analysis of the interviews allowed to categorize their eating habits into 2: good and bad. The results show that 67% of the participants zinc deficient. Overall, the child's age and the number of blood transfusions were the main risk factors for zinc deficiency in this population. Although no environmental risk factor has been correlated with zinc deficiency, a high proportion of population found in families with parents of primary education and low socioeconomic status. Furthermore, the use of the data collected reveals that the eating habits of children with sickle cell disease, bad for the most part, contribute to the occurrence of zinc deficiency. Awareness campaigns in communities should prioritize education on good dietary practices to help reduce the disease burden of sickle cell disease.

Keywords: Sickle cell disease; Zincemia; Associated factors; Child; Cameroon

Introduction

Sickle cell disease, also known as sickle cell anemia is the most widespread hemoglobinopathy throughout the world [1]. It is a public health priority in Africa with a prevalence of sickle cell trait between 10-40% depending on the region [2]. The history of Sickle cells disease is punctuated by acute and chronic complications on the one hand but also by nutritional deficiencies

on the other hand including zinc deficiency. Zinc is a trace element involved in numerous biological functions and whose global deficiency is 20%. This deficiency state impairs the physical and mental development of the child, but also contributes to a worsening of the clinical manifestations observed during sickle cell anemia. In Cameroon, as in most sub-Saharan African countries, food insecurity contributes to the alteration of health indicators within vulnerable populations, in which sickle cell children are found [3]. Despite the political will in place [4], optimal care for sickle cell patients continues to be delayed [5]. Even if numerous studies show a benefit from zinc supplementation in sickle cell patients [6,7], current practice is quite different. National documentation relating to zinc deficiency is in fact very sparse even if this trace element is low in more than 69% of the population in certain localities [8]. Which somewhat justifies the reluctance of medical personnel to integrate the practice of zinc supplementation into their prescribing habits with regard to sickle cell patients. The contribution to the improvement of these medical practices undoubtedly involves the identification of the factors associated with zinc deficiency making it possible to construct the clinical profiles most at risk of evolving towards a deficiency state within the sickle cell population. The following research question therefore arises: “what are the factors associated with zinc deficiency in the Cameroonian pediatric sickle cell population?” To provide some answers, the specific objectives formulated for this purpose were as follows:

- Estimate the prevalence of zinc deficiency in Cameroonian children with sickle cell disease;
- Identify the acute clinical manifestations contributing to an alteration of the zincemia of the latter;
- Determine the personal factors associated with an alteration of zincemia in Cameroonian children with sickle cell disease;
- Highlight the environmental factors associated with an alteration of zincemia in this category of children;
- Identify eating behaviors that contribute to altered zinc levels in children with sickle cell disease.

Methodology

In order to achieve the various objectives assigned to it, this research is based on a mixed approach including quantitative and qualitative approaches while resorting to documentary exploitation on the main subject of interest.

Quantitative phase

In its quantitative aspect, the study was prospective with an analytical aim. The target population corresponded to children with sickle cell disease received by the CME/FCB during the collection period. Inclusion in the study was conditioned by a certain number of criteria:

- Have come in consultation with at least one tutor;
- Be clinically stable for at least 2 weeks;
- Have in your possession a hemoglobin electrophoresis;
- Be between 6 months and 18 years old;

The inclusion criterion was obtain written or verbal informed consent from the guardian and the assent of the child with sickle cell disease who is old enough to give it. The only exclusion criterion was current zinc supplementation. The study used non-probability (consecutive) sampling. Given the exploratory part of the study, the high cost of the zincemia test and budgetary restrictions, the sample size was determined by convenience and set at 54 participants. The following parameters were collected: data on identification (age, sex) and sociodemographic data (city of residence, province of origin, educational level), personal history (coexistence or not of another chronic illness, number of blood transfusions during the last 12 months, number of CVOs during the last 12 months, number of infectious episodes during the last 12 months) and environmental aspects of the patient (relationship with the guardian, marital status of the guardian, level of education of the guardian, profession of the guardian, religious affiliation of the guardian), the patient's biological data (haemoglobin level, reticulocyte level, plasma zinc level) and elements of the physical examination (anthropometric parameters: weight, height , weight for height, weight for age, height for age), temperature, presence of jaundice, presence of organomegaly (hepatomegaly, splenomegaly). The data collected were entered into the Epi-Info software version 7.2.3.1 then imported for analysis into the SPSS 25 software. The bivariate descriptive analysis consisted of crossing the plasma zinc level with each of the independent variables retained in the context of this study. The linear correlation coefficient and the associated p value (< 5%) made it possible to determine the existence or not of a link between the 2 quantitative variables. The Pearson correlation coefficient made it possible to assess the direction of the correlation (positive or negative correlation) between the continuous variables of the study. The decision rule consisted of rejecting the null hypothesis when the associated p-value was less than 5% and accepting it otherwise. In its explanatory part, the study used binary logistic regression to identify the factors likely to alter the zinc level in children with sickle cell disease. Forward stepwise modelling was used for this analysis.

Qualitative phase

In its qualitative aspect, this work used the case study. The target population consisted of parents of children with sickle cell disease who had previously taken part in the quantitative part of the study. To take part in this phase, parents had to:

- Give their informed consent;

- Being able to mobilize information from memories;
- Have a level of understanding that allows them to understand the questions asked.

The only exclusion criterion was non-compliance with the appointment made with the principal investigator. The study used convenience sampling. The sample size was determined by the saturation threshold reached after 16 interviews. Data collection was carried out using an interview guide formulated around 6 open questions in particular:

- What relationship do you see between health and food?
- How do you organize your child's meals per day (number of meals, snack, and composition of meals)?
- What are the dietary requirements for children with sickle cell disease (food restrictions, supplements)?
- What are your child's food preferences?
- How do you go about selecting among your preferences those to include in your diet?
- On what basis do you compose your child's meals (assessment of parents' knowledge of the trace element intake provided by the foods offered to their children)?

The data analysis is done manually following 3 phases: data reduction, transcription and rearrangement of the data and finally data reconstruction during which the described data was analyzed.

Operational Definition of Study Variables

The plasma zinc level in this study is a categorical variable that has two modalities (low and normal). Any child whose zinc level is less than 0.7 mg/l is therefore classified as zinc deficient, compared to those who have a normal level (≥ 0.7 mg/l). The children's data on weight, height, and age were used to calculate three anthropometric indices used to assess their nutritional status defined from z-scores. These include height-for-age, weight-for-height and weight-for-age. Each of these indices provides different information on growth based on the global growth standards developed by the CDC (Centers for Disease Control and Prevention) in 2000. Children are thus categorized according to whether they are chronically malnourished (or stunted growth), acute (or wasting) or underweight (combination of chronic and acute malnutrition). These indicators of malnutrition will prove to be moderate or severe if the z-scores calculated are respectively located below -2 standard deviations and -3 standard deviations, from the median of the reference population. The number of infectious episodes is categorized into none (for children who have not had infectious episodes), 1-3 episodes, and more than 3 infectious episodes. The children admitted to the study were also grouped into three to distinguish those who had no CVO (vaso-occlusive crisis) with or without hospitalization, from their counterparts who had 1-3 CVO and more than 3 CVO respectively. The haemoglobin level was used to distinguish sickle cell children with severe anemia (haemoglobin level < 7 g/dl) from those with moderate anemia (≥ 7 g/dl). The socio-economic level (NSE) of the parents or the person in charge of the child is measured based on the child's profession. It is classified into three categories: low (pupils, students, domestic workers, artisans, unemployed, parents with irregular income, farmers), medium (middle managers in the private and public sector, traders, military and paramilitary), and high (senior managers, economic operators). The educational level of the child's parent or guardian was measured based his last class attended. It is categorized into three groups: Primary, secondary and higher

Ethical Considerations

This study benefited from research authorization n°2020/02016/CEIRSH/ESS/MSP from the institutional ethics committee of the Catholic University of Central Africa in its session of September 9, 2020. Research authorization was obtained from of the Director of CME/FCB. Informed consent from participants' parents/guardians was required as well as assent from participants old enough to give it. The anonymity of the data collection sheets, interviews and blood samples was rigorous.

Results

The presentation of the results was organized into 2 parts. The first concerns the presentation of quantitative results in relation to the achievement of specific objectives 1, 2, 3 and 4. The second concerns the presentation of qualitative results in relation to the achievement of specific objective 5.

Quantitative results

Description of the profile of the study participants

The study recruited as many participants of both sexes (27 participants each). The participants admitted to the study were mostly from the Central (44%) and Western (33%) regions. Their guardians were mainly with a secondary level of education (63%), followed by those with a higher level of education (25.9%). These children, who mostly live in households of low (37%) and high (46.3%) socio-economic levels, reside with their biological parents (83.3%). The average age of the participants was 95.5 months ±53.35 (or approximately 8 years ± 4). Among them, 50% were aged less than 86.5 months (around 7 years). The zinc dosage in these children revealed that the average plasma zinc level was 0.7 mg/l ±0.18 for the entire population studied. Children admitted to the study had a mean haemoglobin level of 8.04 g/dl±1.07. These children had presented on average 1.78±2.51 CVO; and on average 1.53±1.53 infectious episodes. They had received an average of 0.83 ±1.15 blood transfusions.

Among children with sickle cell disease, 57.1% who had zinc deficiency were underweight as shown in (Table 1). However, all children who had normal zinc levels were severely underweight (100%).

Prevalence of zinc deficiency

The prevalence of zinc deficiency within the study sample was found to be 67%.

Distribution of zinc deficiency according to the main characteristics of the study

Table 2 presents the distribution of Pearson's linear correlation coefficients and the associated significance between zincemia and the main individual characteristics measured in children with sickle cell disease. This indicates that the age of the child and the number of infectious episodes are negatively correlated with zincemia. It also indicates that among the individual characteristics retained in the study, only the number of blood transfusions is significantly correlated with the variation in zincemia in children with sickle cell disease (significance >0.05) (Table 2).

Risk Factors for the Occurrence of Zinc Deficiency in Children with Sickle Cell Disease

The analysis of the saturated model (final model) at each level of analysis makes it possible to identify the risk factors for the occurrence of zinc deficiency in children with sickle cell disease who were followed at the CME/FCB, to the extent that it highlights the marginal effect of each variable depending on the other explanatory variables retained for the study. Influence of age on the occurrence of zinc deficiency. The age of the child influences the occurrence of zinc deficiency at the threshold of 5%. This influence is revealed to be significant after taking into account acute clinical manifestations. Children under 5 years old are 91% less likely to have a zinc deficiency compared to their 5-9 year old counterparts (reference category). The evolution of the relative risks allows us to see that the risk of occurrence of zinc deficiency between the different categories of children with sickle cell disease clearly decreases when taking into account the number of blood transfusions, the number of CVOs and the number of infectious episodes. (M6 to M8). Influence of the number of blood transfusions on the occurrence of zinc deficiency. The number of blood transfusions received during the last 12 months preceding the study significantly influences the risk of occurrence of zinc deficiency at the threshold of 5%. It appears from the overall model that children who had had at least 3 blood transfusions had 97% less risk of having a zinc deficiency than their colleagues who had never received a blood transfusion (reference). This suggests an improvement in the zincemia of the sickle cell patient by the zincemia of the transfused blood (Table 3).

Qualitative results

Data analysis was carried out based on information received from parents during the interviews in accordance with the guidelines set by the interview guide.

Relationship between health and food

The answers to this question could be classified into 3 categories. For most parents, health is under the control of diet. This is illustrated when P1 states that “food determines health”. For others, as is the case for P4 when he declares " health influences diet or it is the opposite, both for and against ", there is a reciprocal influence between diet and health. The third category of parents does not have any answers to provide for this question. This is well illustrated through the words of P5 when he responds by saying “I don’t know”. This suggests that children from this last category of parents would be most at risk of presenting nutritional deficiencies and consequently a zinc deficiency.

Daily organization of meals for sickle cell patients

To answer this, two dimensions of the child's diet were evaluated: the frequency of meals and their composition.

Regarding the frequency of meals in households with children with sickle cell disease, it appears that most of these children eat on average three meals per day. For these parents, breakfast is the most important meal and particular emphasis is placed on the quantity of breakfast. They say in this sense that: " Well he eats 4 times a day: in the morning he takes his two cups of milk with the sandwich, at midday he takes a plate of vegetables, sometimes raw vegetables too, in the afternoon he can have a yogurt or a bergere and in the evening he has yet another meal. » (P1). Another parent attests that: “well in the morning she has her breakfast, I insist a lot on that because she doesn't eat too much, I insist a lot on her breakfast in the morning, it often even happens that I feed her” (P5). From the analysis of the composition of meals, the most consumed foods were: bread (9 occurrences), vegetables and fruits (9 occurrences), milk (8 occurrences), rice (7 occurrences), fried plantains (5 occurrences), fried eggs (5 occurrences). The rest of the foods had an occurrence count less than 5. A parent said in this sense : “she drinks her milk after milk and for school she likes plantain chips with eggs she takes her plantain chips in the evening, maybe rice with fish mam even meat mama prepares the meat mama I want to eat the ero mama the sanga we put the sugar no For the vegetables already I rely on the fact that it also strengthens its iron strength there and all that the vegetables and the fruits also the fruits I know already there is vitamin D and all the multiple vitamins that help a lot for the body, bones and blood ” (P4). Another states in the same sense

that: " I try to include a lot more fruits and vegetables compared to carbohydrates and other things, he doesn't like to eat too much in the morning, he takes a glass of milk first thing in the morning, after that he can eat bread and chocolate or with omelettes then at noon or at 2-3 p.m. there he can eat vegetables with yams or rice and in the evening he often eats fish, chicken or meat and often he there are times when he eats fried rice in the evening " (P5).

Dietary requirements for children with sickle cell disease

Some parents said they did not have the knowledge about this. This is the case for this parent when he responds by saying "I don't know them" (P1). For other parents, the emphasis should be on good hydration and eating plenty of fruits and vegetables. This category of parents declares that:

"I think that sickle cell patients have particular needs in the case of water because we ask them to consume a lot of water every day" (P3);

"In my opinion there are fruits first, after water of course" (P 4);

"As we said earlier that diet is the basis of health, I think that a child with sickle cell disease should eat a lot more fruit and vegetables and drink a lot of water" (P6). Other parents include the sickle cell patient's dietary requirements the different prophylaxes and the quality of their medical follow-up. They state thus:

"She must eat well, take lots of fruit, take her medicine and she must be well-monitored" (P 9);

"He needs to drink and give him folic acid and antibiotics bactox 250 there" (P.13).

Food preferences of children with sickle cell disease

Children with sickle cell disease have a wide range of food preferences. Among other things, we find: fish, meat; vegetables (kwem and zom) and fruits combined. We also have rice, couscous, okra which are very popular with these children. The respondents stated the following to this effect:

P 4: "she likes rice any kind of sauce that I can make with rice";

P 7: "cassava potato fried rice tomato sauce rice peanut sauce with couscous and okra";

P 9: " She likes yogurt she likes juice she likes sweets good for sweets I told her dad that he must no longer keep sweets for her because it's not good for her good by the way he also understood he left she likes fish when you make fried fish on the pan ";

P 12: "he is a carnivore and loves meat".

Process for integrating the food preferences of sickle cell patients into their diet

When it comes to the rate of integration of the food preferences of sickle cell patients into menus, different arguments guide parents' behaviour. In some families we adapt to the tastes of the child with sickle cell disease. It's the case for:

P 1: "well his meals I, well I make my menus at home only based on him. Everyone adapts"

P 4: "At home I prepare according to her, she says what she wants, it could be rice with fish, mama doesn't fry the fish today, she makes the fish in the sauce, mama fries tomorrow »

P 13: "These are the requirements that I gave to his mother: we can sleep hungry but he must prepare what he likesso that he can eat"

In other families, we avoid making differences. This is perceptible through the following statements:

P 2: "No generally at home I don't act indifferent so at home everything we eat she eats so even when she refuses I try to explain that no you have to eat what the others have eaten so there are foods where we prepare she refuses to eat but we insist that she eats even before doing what she is going to eat but we insist so we don't do we don't say that no she doesn't like this is for the child this is this no";

P 12: " In fact as I said earlier there is no eating habits because of him so he is subjected to what the house has so he is not particularly taken care of in terms of food is not easy, we don't do it, we perhaps think that what we eat at home is good for him. "

P14: "I don't cook at home according to his preferences, I don't give in to that because I have 4 children"

In other families, it is essentially income that guides the parents' choice:

P 9: "when she says that mama well I need such if there is no money I can't go and fly to come she has to eat what I made".

Elsewhere, the child's preferences are not completely set aside. We include them a few times a week in the weekly menu. This is perceptible through the words of this parent who declares: "generally I try to introduce this at least twice a week at least once a week what she wants" (P2).

Tools guiding the composition of meals for sickle cell patients

Different parameters guide parents in choosing foods to include in their children's meals. For some, it is beliefs that define eating behaviours. P 2 thus states "just because I know that soy is nutritious, she must consume it in large quantities". Other parents let their children's food preferences guide them when putting together their household menus. This is perceptible through these words: "I ask him what he wants to eat and on the basis of what I prepare". Alongside these, some parents are content to assemble what is available in the household: "E: What there is you offer them to eat, P 9: Yes". Which is very close to the words of these parents when they declared: "It depends on financial means" (P16). ; " I prepare at home, I don't look at it too much, I also prepare according to my means " (P11).

Discussion of Results

Prevalence of zinc deficiency

The prevalence of zinc deficiency within the study sample is 67%, or approximately 7 out of 10 children with sickle cell disease have a zinc deficiency. This result is superimposable with a few exceptions to those found by Sunghu and colleagues (2016) in the Democratic Republic of Congo and Hasanato (2005) in Saudi Arabia who both carried out comparative studies between sickle cell patients and healthy people respectively on population pediatric and adult. Their work demonstrated a lowering of serum zinc levels in the sickle cell population compared to their non-sickle cell counterparts, although the prevalence of the deficiency was not presented in the two studies. Zinc deficiency appears to be a permanent pathological condition in sickle cell patients regardless of their age.

Table 1: *Anthropometric indices and plasma zinc levels.*

	Weight for age		**Weight for height**	
Plasma zinc level	Percentage below -2 SD	Percentage below -3ET	Percentage below -2 SD	Percentage below -3ET
Weak	57.14	0.00	100.00	0.00
Normal	42.86	100.00	0.00	0.00

Table 2: *Distribution of the Pearson correlation coefficient and significance of individual characteristics.*

Individual characteristics	**Zincemia**	**Sig. (Bilateral)**
Number of blood transfusions	0.071	0.609
Age (months)	-0.210	0.128
Hemoglobin level	0.132	0.347
Number of CVOs	0.016	0.908
Number of infectious episodes	-0.068	0.627

Table 3: *Gross and marginal effects of independent variables on zinc deficiency*.

Variables	**Raw effects**	**Marginal effects**							
		M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**
Age of child									
Less than 5 years old	0.32 ns	0.22 ns	0.22 ns	0.22 ns	0.22 ns	0.23 ns	0.12 **	0.11 **	0.09 **
5-9 years	1.00	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*
10 years and over	0.71 ns	2.18 ns	2.31 ns	2.43 ns	2.57 ns	3.87 ns	4.59 ns	6.12 ns	6.58 ns
Gender of child									
Feminine	1.00		*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*
Male	1.00 ns		1.22 ns	1.25 ns	1.25 ns	1.33 ns	0.96ns -	1.22 ns	1.28 ns
Educational level									
Primary	3.50ns -			3.04ns -	2.93 ns	3.04ns -	6.46 ns	7.52 ns	7.35 ns
Secondary	1.00			*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*
Superior	1.26ns -			1.64 ns	1.38 ns	1.45 ns	1.76ns -	1.28 ns	1.23 ns
Socioeconomic level									
Down	1.83 ns				1.78 ns	1.85 ns	1.81 ns	2.13 ns	1.89 ns
AVERAGE	1.00				*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*
Weak	1.57 ns				1.27 ns	1.22 ns	7.89 ns	9.72 ns	9.36 ns
Anemia									
Severe anemia	0.69 ns					0.53 ns	0.71 ns	0.57 ns	0.69 ns
Moderate anemia	1.00					*Ref.*	*Ref.*	*Ref.*	*Ref.*
Number of blood transfusions									
None	1.00						*Ref.*	*Ref.*	*Ref.*
Less than 3	1.00 ns						1.57 ns	1.48 ns	1.49 ns

More than 3	0.25 ns						0.03 **	0.03 **	0.03 **
Number of CVOs									
No CVO	1.00							*Ref.*	*Ref.*
Less than 3 CVOs	1.28 ns							2.43 ns	2.64 ns
3 CVOs and more	0.53 ns							0.77 ns	0.67 ns
Number of infectious episodes									
None	1.10ns –								1.17 ns
Less than 3 episodes	1.00								*Ref.*
3 episodes and more	0.96ns –								1.97 ns
Comments	-	54	54	54	54	54	54	54	54
Chi2	-	3.87	3.98	5.28	5.99	6.52	13.26	14.96	15.47

Clinical manifestations contributing to the alteration of zincemia

There is a positive correlation between the number of blood transfusions and Zincemia (p=0.071). Indeed, from a number of blood transfusions greater than or equal to 3, only half (50%) of these children have a lowered zinc level. This can be explained by the fact that the latter manage to normalize their zincemia based on the zinc contained in the blood of the donor (healthy person) which is higher than that of the sickle cell patient, which is in accordance with the result found by Hasanato (2005) in Saudi Arabia among the adult population. In addition, the correction of the sickle cell patient's anemia is essentially achieved through blood transfusions which require hospitalization of the latter, the frequency of stays in a hospital environment allows the sickle cell patient to benefit from better attention from his parents. Dietary point of view which could also contribute to an improvement in the zincemia of the latter. P7 supports him when he declares: “from time to time when he is in a crisis situation where he has a somewhat particular diet when he is sick we are obliged to see some small supplements that we can provide him”.

Personal factors associated with altered zincemia

Analyzes show that there is a correlation between the age of the child with sickle cell disease and the risk of developing zinc deficiency. In fact, children under 5 years old have 91% less risk of having zinc deficiency compared to their counterparts whose age was between 5-9 years old. These results are similar to those of Zemel and colleagues (2002). For the latter, children of pre-pubescent age (5-10 years) were more at risk of presenting a zinc deficiency and the recommendation for zinc supplementation at this age had been made.

Environmental Factors Associated with Zinc Deficiency

Tutor's educational level

The distribution of zinc deficiency within the study population was not influenced by the level of education of the parents of sickle cell children even if all (100%) of the sickle cell patients whose guardians were at the same level primary education presented a zinc deficiency. Even if the level of education taken as a whole seemed not to be correlated with a deficiency state in children, the level of primary education posed a problem. This was incriminated by Pondy in 2016 during his work on “nutritional status and anemia in children aged 6 to 59 months in Salapoumbé, forest zone in Cameroon”.

Socio-economic level

Using the parents' profession, the study participants were distributed into social classes. Despite the absence of significance between social class and zincemia, it was among children from households with a low socio-economic level that we found the highest proportion of sickle cell patients deficient in zinc (75%). Indeed, the disadvantaged social classes in Cameroon are greatly affected by food insecurity; the diet of most of these households is monotonous and essentially vegetarian (Tanang Tchouala, 2009). However, vegetarian diets have low zinc bioavailability, preventing their consumers from meeting their daily needs (Wilson, 2017). In addition, these are rich in phytates and oxalates, both substances which reduce the absorption of zinc in their consumers and expose them to developing a deficiency (Musimwa et al., 2018).

Eating habits

Most children with sickle cell disease consumed an average of 3 meals per day with an emphasis on breakfast. The parents of the latter declare in this sense: "in the morning she eats her breakfast which I insist a lot on" Breakfast is in fact the most important meal of the day offering its consumer the daily energy and nutritional intake enough. Its presence among daily meals often allows consumers to be linked to advantaged socio-economic classes (Bédard et al., 2014). In the context of this work, the small size of the sample does not allow us to comment on this aspect.

The food preferences of children with sickle cell disease as an individual determinant represent an important indicator of their food consumption. Indeed, in many households, the diet of children with sickle cell disease is designed according to their preferences. Their parents declare to back it up: “I make my menus at home only according to him, everyone adapts”. It is in fact the food preferences of children with sickle cell disease which determine the eating habits of the households in which these children live. These habits were mainly organized around products of plant origin with a low consumption of proteins of animal origin. Products of plant origin indeed contain a high content of phytates which inhibit the absorption of dietary zinc (Lestienne, 2004). The eating habits of these children, described as bad habits, expose them to the development of zinc deficiency. By transposing all of these results to the theoretical analysis model which is the production model of the disability process, the idea emerges according to which there is a reciprocal influence between the zincemia of the sickle cell child with the personnal factors (age of the sickle cell patient) and the lifestyle habits (represented here by the child's eating habits) of the sickle cell child. It remains difficult to comment on the relationship between zincemia and environmental factors (which in the context of this work are represented by the educational level of the parent and the socio-economic level of the latter), the correlation between the two variables could not be highlighted.

Conclusion

The present work aimed to study the risk factors for zinc deficiency, the acute clinical manifestations of sickle cell disease and the zinc status of Cameroonian children with sickle cell disease. For this, a sequential mixed exploratory study was carried out. In its quantitative part, the study obtained 54 participants compared to 16 interviews for its qualitative part. The results were analyzed using bivariate analysis and logistic regression in its quantitative part and content analysis in its qualitative part. The results found a prevalence of zinc deficiency of 67% within our sample. There is a positive correlation between the number of blood transfusions and zincemia. The age of the child influences the occurrence of zinc deficiency at the threshold of 5%, with children aged 5-9 being most at risk. A high proportion of children with zinc deficiency is found in families whose guardian has a primary level of education as well as in households with a low socio-economic level even if none of these environmental factors is in reality correlated with zinc deficiency. As for the eating habits of sickle cell patients, they are for the most part oriented towards vegetarian diets providing a low quantity of zinc to the latter and exposing them to the development of a zinc deficiency state. Community awareness must take into account education on good dietary practices for sickle cell patients.

Limitations of the Study

The main limitation of this study lies in its exploratory aspect. Indeed, the non-robust results obtained do not allow their generalization to the entire Cameroonian pediatric sickle cell population.

Conflicts of Interest

The authors declare that there is no conflict of interest raised by the conduct of this study.

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