Evaluation of the Nutritional and Hematological Status of Sickle Cell Children Monitored in the Pediatric Department of the University Hospital Center of Yalgado Ouedraogo

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Abstract: *Objective*: To assess the nutritional and hematological status of sickle cell children followed in the department of pediatrics of the Yalgado Ouédraogo University Hospital Centre (CHU-YO).

Methodology: This was a cross-sectional study conducted from September 1, 2017, to February 28, 2018. All children with major sickle cell syndrome followed in the department of pediatrics at the CHU-YO and following their follow-up appointments were included in the study.

Results: We included 230 children aged 11 months to 16 years with an average age of 8.5 years. The sex M/F ratio was 1.09. The SC heterozygotes were the most represented with 56.52%. The average hemoglobin level was 9.39 g/dl. The prevalences of wasting, stunting and underweight were respectively 23.04%, 15.65%, and 13.89%. In univariate analysis, the factors associated with emaciation was hyperleukocytosis (p=0.002).The factors associated with stunting were leukocytosis (p=0.01), severe anemia (p=0.01), SS phenotype (p=0.002), age range of 5-10 years (p=0.007), Secondary (P=0.007) and higher level (p=0.001) of father's education, secondary (p=0.027) and higher level (p=0.034)of mothers'education , farmer(p=0.003) trader (p=0.042), and informal occupation of father (p = 0.002),and breastfeeding duration after 24 months (p=0.006). For underweight associated factors in univariate analysis were SS phenotype (p=0.003) and severe anemia (p=0.01).

Conclusion: The prevalence of different types of malnutrition deficiency of sickle cell children followed at CHU-YO was high. It is important to strengthen the nutritional monitoring of children with sickle cell disease for better management of the disease.

Keywords: Nutrition, Children, Sickle Cell Disease, Hematology, CHU-YO.

INTRODUCTION

Sickle cell disease is a very common hemoglobinopathy in Africa. It constitutes a real public health problem and its prevalence is very high, from 15% to 30% in Central and West Africa [1,2]. In Burkina Faso, the prevalence of this disease reaches 30% and its major syndromes affect 8.42% of the patients in the hospital [2, 3]. In addition to the many acute and chronic complications, poor nutritional status and stunting are particularly associated with the homozygous form of this disease [4-8]. Malnutrition is also responsible for anemia leading to an increased vulnerability to infections. The study of nutritional status in these children helps to monitor their development, detect disturbances and better plan treatments. In Burkina Faso, many studies have been conducted on sickle cell disease. However, the nutritional complications of this pathology have not been studied to our knowledge. However, there is increasing evidence in pediatric consultation that sickle cell children are generally underweight. It seemed important to us to initiate the present study in order to provide data on the nutritional status of sickle cell children to help improve the care and follow-up of these children.

METHODOLOGY

This is a prospective cross-sectional analytical study that was conducted in the pediatric department of the CHU-YO from 1 September 2017 to 28 February 2018. All of the children with major sickle cell disease were enrolled in the study (homozygous SS, heterozygous SC, S beta-thalassemia, SO Arab, SD Punjab, SE) aged 6 months to 192 months followed in the pediatric department of CHU-YO and whose parents consented. Children who did not come to their follow-up appointment were not included. Several variables were taken into account in our study: socio-

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demographic (children age sex, and place of residence, parental occupation and education level), anthropometric calculated according to the child's age (the Z-scores of the weight-for-height indices (W/ H) or Body Mass Index for age (BMI / A), height for age (H / A) and weight for age (W / A)), clinical parameters (type of sickle cell disease, vaccination status, dietary habits), para-clinical parameters (hemoglobin electrophoresis and hemogram). The information was collected by means of an individual card addressed to the mother and / or child and analyzed by Stata software version 12, Excel 2013 and WHO ANTHRO (version 3.2.2). For underweight, the WHO ANTHRO software (version 3.2.2) does not calculate W / A for children older than 120 months. The quantitative variables were expressed as mean with their standard deviation (± SD) and qualitative variables as number (n) and percentage (%). A univariate logistic regression analysis was performed to test the link between each explanatory variable and the 3 criteria for judgments (wasting, stunting and underweight). The results were expressed as odds ratio (OR) and their 95% confidence intervals (95% CI). For all statistical analyses, the significance level was set at $p < 0.05$. In multivariate analysis, 03 multi-variable logistic regressions were performed to determine the factors associated with the three types of malnutrition. The food diversification variable was our main independent variable and was forced into the models. The overall adequacy of each multi-variable model was estimated by the Hosmer and Lemeshow test.

For ethical considerations, parents were informed about the different aspects of the study. Their oral consent was collected prior to the collection of information. Anonymity was guaranteed in the processing and analysis of the data.

RESULTS

Socio-Demographic Characteristics of our Study Population

This study involved 230 children aged 11 months to 16 years. The average age was 8.5 years, the median age was 9 years. Children aged 10-16 were the most represented, ie 44.78% of the sample. The sex ratio M / F was 1.09. Table **1** summarizes the socio-demographic characteristics of the population.

Clinical Characteristics of Patients

Among the 230 sickle cell children, composite Heterozygous SC were the most numerous with 130 or 56.52% followed by homozygous SS 38.26% and other type 5.22% : S beta-thalassemia (n = 10), SE (n = 1); SO Arab (n = 1).

The rate of exclusive breastfeeding was 35.65%. The average age of ablactation was 20 months with extremes of 2 to 36 months. The minimum recommended dietary diversification as recommended by the WHO was only 41.74% (134/230), while the good minimum meal frequency was 91.74% (211/230).

Biological Characteristics of Patients

The average hemoglobin level was 9.5 g / dl. The average leukocyte count was 10.8/ mm3. Table **2** presents the biological characteristics of children.

Assessment of Nutritional Status

The prevalence of different types of malnutrition was 23.04%, 15.65% 13.89%, respectively for wasting, stunting and underweight. Among the 230 children, the mean z-score was -0.90 ± 1.52 for wasting and -0.59 ± 1.46 for stunting. Among 144 children, the mean z-score was -0.65 ± 1.26 for underweight. Table **3** summarizes the types of malnutrition by age group and sex.

Factors Associated with Malnutrition in Sickle Cell Disease

Factors Associated with Emaciation

In the univariate analysis, socio-demographic characteristics were not associated with emaciation. On the other hand, at the biological level, children with leukocytosis had 2.82 (95% CI 1.45, 5.50 p = 0.002) more likely to be emaciated than the others (normal and leukopenia).

In the multi-variable analysis of factors associated with wasting, children with leukocytosis had 2.79 (95% CI 1.42, 5.46) times more likely to be emaciated than other children (normal and leukopenia).

Factors Associated with Stunting

In univariate analysis, the occupation (p = 0.003, shopkeeper p = 0.042, informal p = 0.002) of father, SS (p = 0.002), severe anemia (p = 0.02), leukocytosis (p = 0.01), breastfeeding duration after 24 months (p = 0.006) were associated with the risk of stunting.

The age group 5-10 years (p = 0.007), father's education (secondary p = 0.007, higher p = 0.001), mother's education (secondary p = 0.027, higher

Table 1: Socio-Demographic Characteristics of the Population

Socio-demographic variables	N	%
Age range (year)	**230**	
[0-4]	39	16.96
[5-9]	88	38.26
[10-17]	103	44.78
Gender	**230**	
Female	110	47.83
Male	120	52.17
Place of residence	**230**	
Rural	19	8.26
Urban	211	91.74
Educational level of father	**230**	
≤Primary*	93	40.44
Secondary	70	30.43
Higher-level	67	29.13
Occupation of father	**230**	
Other**	3	1.31
Farmer	28	12.17
Trader	29	12.61
Informal	50	21.74
Employee	120	52.17
Educational level of the mother	**230**	
≤Primary*	119	51.74
Secondary	79	34.35
Higher-level	32	13.91
Occupation of mother	**230**	
Other**	11	4.79
Housewife	107	46.52
Trader	21	9.13
Informal	15	6.52
Employee	76	33.04
Number of brother and sister	**230**	
≤2 brothers or sisters	93	40.43
>2 brothers or sisters	137	59.57
Number of brother and sister with CSA* **	**229**	
0 brother or sister	159	69.43
≥1 brother or sister	70	30.57

*Other occupation of fathers: Koranic master, retired.
*Other occupation of mothers: student.
≤ Primary= any instruction + instruction in primary.
***Sickle cell anemia (SCA).

Table 2: Biological Characteristic of Children

Biologics parameters	N	%
Hg	**211**	
Normal*	55	26.07
Moderate anemia	115	54.50
severe Anemia	41	19.43
MCV	**211**	
Normocytic	120	56.87
Microcytic	62	29.38
Macrocytic	29	13.75
MCHC	**211**	
Normochromia	196	92.89
Hypochromia	15	7.11

(Table 2). Continued.

Biologics parameters	N	%
WBC (× 103)	**211**	
Normal*	152	72.04
Leucocytosis	59	27.96
Plt (×10^3)	**211**	
Normal	122	57.82
Thrombocytopénia	3	1.42
Thrombocytosis	86	40.76

Normal Hb* = Normal Hb Rate + Mild Anemia.
Normal white blood cell= Normal leukocyte rate + Leukopenia.
Abbreviations: Hb, hemoglobin; MCHC, mean cell hemoglobin concentration; MCV, mean cell volume; MPV, PLT, platelets; WBC, white blood cells.

Table 3: Breakdown of Sickle Cell Children by Sex and Age by Nutritional Status

Variables	(W/H*) or BMI/A		(H/A**)		(W/A**)	
	<-2zscore n(%)	≥-2zscore n(%)	<-2zscore n(%)	≥-2zscore n(%)	<-2zscore n(%)	≥-2zscore n(%)
Age range (year)	102.67	101.11	109.97	100.88	75.95	74.81
[0-4]	12(22.64)	27(15.25)	9(25.00)	30(15.46)	7 (35.00)	29 (23.39)
[5-9]	16(30.19)	72(40.68)	5(13.89)	83(42.78)	9 (45.00)	79 (63.71)
[10-17]	25(47.17)	78(44.07)	22(61.11)	81(41.75)	4 (20.00)	16 (12.90)
Gender	53	177	36	194	20	124
Male	30(56.60)	90(50.85)	24(66.27)	96(49.48)	8(43.55)	54(43.55)
Femal	23(43.40)	87(49.15)	12(3.33)	98(50.52)	12(60.00)	70(56.45)

**H/A, height for age; *W/H, weight for height. ***W/A, weight for age.

Table 4: Univariate Analysis of Socio-Demographic Factors Associated with Stunting

Variables	stunting		OR	95% CI	p
	NO (n)	YES (n/N)			
Age range (year)					
[0-4]	30	9/230	1		
[5-9]	83	5/230	0.20	0.06; 0.64	**0.007**
[10-17]	81	22/230	0.90	0.37; 2.18	0.82
Number of brother and sister					
≤ 2 brothers or sisters	84	9/229	1		
> 2 brothers or sisters	110	26/229	2.20	0.98; 4.95	0.05
Number of brothers or sisters with SCA*					
0 brother or sister	136	23/229	1		
≥ 1 brother or sister	58	12/229	1.22	0.57; 2.62	0.60
Gender					
Female	98	12/230	1		
Male	96	24/230	2.04	0.96; 4.31	0.06
place of residence					
Rural	14	5/230	1		
Urban	180	31/230	0.48	0.16; 1.43	0.19
Educational level of father					
≤primary	67	26/230	1		
Secondary	63	7/230	0.28	0.11; 0.70	**0.007**
Higher-level	64	3/230	0.12	0.03; 0.41	**0.001**

(Table 4). Continued.

Variables	stunting		OR	95% CI	p
	NO (n)	YES (n/N)			
Educational level of mother					
≤primary	92	27/230	1		
Secondary	71	8/230	0.38	0.16; 0.89	**0.027**
Higher-level	31	1/230	0.10	0.01; 0.84	**0.034**
Occupation of father					
Other	3	0/230	1		
Farmer	20	8/230	4.93		
Trader	23	6/230	3.21	1.70; 14.30	**0.003**
Informal	37	13/230	4.33	1.04; 9.92	**0.042**
Employee	111	9/230	1	1.17; 10.95	**0.002**
Occupation of mother					
Other	10	1/230	1		
Housewife	82	25/230	3.04	0.37; 24.99	0.29
Trader	18	3/230	1.66	0.15; 18.21	0.42
Informal	15	0/230	1		
Employee	69	7/230	1.01	0.11; 9.13	0.01

*Sickle cell anemia (SCA).

Table 5: Univariate Analysis of Clinical and Biological Factors Associated with Underweight

Variables	underweight		OR	95% CI	P
	No (n)	Yes (n/N)			
EBF*					
No	80	11/144	1		
Yes	44	9/144	1.48	0.57; 3.86	0.41
Vaccine status					
Not Up-to-date	56	6/144	-		
Up-to-date	68	14/144	1.92	0.69; 5.32	0.20
Breastfeeding time (month)					
<24	79	10/143	1		
24	42	8/143	1.50	0.55; 4.09	0.42
> 24mois	3	1/143	2.63	0.24; 27.80	0.41
Weaning age (month)					
< 6	28	5/144	1		
6	81	10/144	0.069	0.21; 2.19	0.53
> 6	15	5/144	1.86	0.46; 7.48	0.37
Type of SCA					
Other(soArab,se,sbeta thal)	7	0/144	-		
sc	74	5/144	1		
ss	43	15/144	5.16	1.75; 15.19	**0.003**
Hg					
Normal*	33	1/133	1		
Moderate anemia	63	9/133	4.71	0.57; 38.82	0.14
severe anemia	19	8/133	13.89	1.61; 119.77	**0.01**
WBC					
Normal	85	10/133	1		
leukocytosis	30	8/133	2.26	0.81; 6.27	0.11

(Table 5). Continued.

Variables	underweight		OR	95% CI	P
	No (n)	Yes (n/N)			
Plt					
Normal	64	9/133	1		
thrombocytopenia	0	0/133	-		
thrombocytosis	51	9/133	1.25	0.46; 3.39	0.65
MCV					
Normocytic	67	11/133	1		
Microcytic	36	4/133	1.47	0.43; 4.97	0.52
Macrocytic	12	3/133	2.25	0.43; 11.52	0.33
MCHC					
Normochromia	105	16/133	1		
Hypochromia	10	2/133	1.31	0.26; 6.54	0.74
Food diversification score					
Bad	67	13/144	1		
good	57	7/144	0.63	0.23; 1.69	0.36
Minimum meal frequency					
Bad	16	3/144	1		
Good	109	16/144	0.80	0.21; 3.07	0.75
Number of vaso-occlusive crisis per year					
< 3	48	10/144	1		
≥ 3	76	10/144	0.63	0.24; 1.62	0.34

Abbreviations: Hb, hemoglobin; MCHC, mean cell hemoglobin concentration; MCV, mean cell volume; MPV, PLT, platelets; WBC, white blood cells.

p = 0.034) were associated as protective factors against stunting in univariate analysis; Table **4**. In multivariate analysis, only father level education was associated with stunting such as the higher the father's educational level, the more children were protected against stunting. OR = 0.28 (p = 0.008 CI95 = 0.11, 0.72) and OR = 0.13 (p = 0.002 IC95 = 0.03, 0.47).

Factors Associated with Underweight

In univariate analysis, the type of sickle cell disease SS, the hemoglobin level especially in severely anemic children are the variables that were associated as clinical risk factors to underweight (Table **5**).

In the multi-variable analysis, children with severe anemia were up to 23.74 times more likely (p<0.01) to be underweight than other children as well as children with at least 2 brothers were 4.6 times (p=0.01) more likely to be underweight.

DISCUSSION

In our study, children with sickle cell SC phenotype were the most represented with 130 or 56.52%. This figure is close to those found by Nacoulma *et al*. [9] in Ouagadougou and Yé *et al*. [10] in Ouagadougou. The predominance of the SC form is due to the high prevalence of the C allele in Burkina Faso (11.45%) compared to the S allele (ie 4.86%) but also by the high lethality of the form SS [3]. In our study, more than half of the children had moderate normochromic normocytic anemia and leukocytosis as in several studies in Africa [11-17]. In fact, anemia is caused by hemolysis [16], and sickle cell disease is an inflammatory disease, one of whose markers is leukocytosis [18].

Of the 3 types of malnutrition we encountered (wasting, stunting, underweight), wasting was the most common with a rate of 23.04% above the critical threshold of the World Health Organization of 10% [19]. Christopher in Nigeria [20], Boadu [21] and Bonsu [22] in Ghana, as well as Henderson in 1994 [42] in the United States, found respectively 6, 8%, 31%, and 11%. Kazadi *et al*. [23] in Congo found 50.3%, a figure which is higher than ours. This difference in prevalence may be due to differences in the proportions of age groups in each study.

We found 15.65% growth retardation, a frequency that is close to those reported in the literature [20-24]. This stunting could be explained by high resting energy expenditure, repetitive infections, micronutrient deficiency, chronic anemia and the chronic nature of sickle cell disease.

We obtained a prevalence of 13.89% for underweight, a prevalence lower than those found by Boadu and Bonsu [21, 13] in Ghana, Kazadi [22] in Congo who found respectively 20%, 37%, and 47.7%. The difference in prevalence may be explained by the fact that underweight is a reflection of wasting and stunting [25].

Factors Associated with Malnutrition in Sickle Cell Disease

In our study, children with leukocytosis had a high risk (p = 0.003) of being emaciated compared to children with normal leukocyte count or leukopenia. Christopher [20]. In Nigeria, the same observation (4.2 times) was made. As Boadu in Ghana [21], we did not find an association between minimum dietary diversity score and wasting.

The SS phenotype (p = 0.002), leukocytosis (p = 0.01), severe anemia (p = 0.02) and parental occupations ($p<0.05$) were associated as risk factors for growth retardation; On the other hand, the father's and mother's higher and secondary education levels were associated as a protective factor. These association variables have been found in several other studies [21, 26]. However, in our study, having a good minimum dietary diversification score was a protective factor against stunting as in the Hyacinth [27] study in Congo and Christopher [20] in Nigeria. We can explain this by the fact that in Burkina Faso, financial expenses in health for chronic pathologies are not reimbursed, which implies that having a salaried profession would be equivalent to having better access to health care and better nutritional intake.

As reported by some authors [13, 26], we noted a link between severe anemia (p = 0.01), SS phenotype (p = 0.003) and the occurrence of underweight. Similarly, children with more than two siblings were 4.6 times more likely to be underweight than those with one or two siblings (p = 0.016). In the context of poverty, the high number of children in the siblings exposes more difficulties of feeding in the center.

CONCLUSION

At the end of our study, the SC phenotype and emaciation were the most represented. About half of the children had moderate normochromic normocytic anemia. The determinants of malnutrition were leukocytosis for emaciation, leukocytosis, severe anemia, SS phenotype, age group 5-10, upper secondary education of father and mother, the occupation of parents, the duration of breastfeeding after 24 months for stunting and the SS phenotype, severe anemia, the number of children in the siblings greater than two for underweight. It is important to strengthen the nutritional monitoring of children with sickle cell disease for better management of the disease. For this, the nutrition directorate should include in the integrated management protocol for severe acute malnutrition the specific case of children with major sickle cell disease.

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