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RESEARCH ARTICLE

EPIDEMIOLOGICAL ASPECTS AND HEMOGLOBIN ELECTROPHORESIS STATUS OF SCHOOLCHILDREN IN BONDOUKOU (CÔTE D'IVOIRE)

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ABSTRACT

Background: Sickle cell disease is most frequent hemoglobinopathy in the world. It remains a public health issue in Côte d'Ivoire with 12% of the population that is affected. Despite the efficiency of primary prevention, the number of people with sickle cell disease continues to increase. Screening through hemoglobin electrophoresis in the newborns and during the prenuptial exams is one of the ways to reduce and eliminate this disease.
Objective: The study's aims was to establish the epidemiological aspects and the hemoglobin S prevalence of sickle cell disease of schoolchildren at the city of Bondoukou in Côte d'Ivoire.
Materials and methods: It was a prospective and descriptive study wich performed at the primary school of "Plateau 2" during the period of April 2013. We chosed 102 students randomly and in proportion to the number of the students in the school. After getting the authorization of National Research and Ethics Committee, the school's supervisor consent, the parents' consent and the children' consent, we collected the child's blood. Hemoglobin electrophoresis was measured using the technic of electrofocalisation in alkaline. Then we collected the data with a questionnaire. The parameters of our study was: age, sex, medico-surgical history and blood cell count.
Results: There were 63.7% female and 36.2% males. The average age was 11.1 years with the extremes of 5 and 16 years old. Malaria was the most reason of hospitalization of the schoolchildren with 44% of the cases. 29.4% and 55.6% of them had respectively joint pain and anaemia with hemoglobin between 7-12g/dl. Only 3.9% and (2.9%) had thrombocytopenia and leukocytosis. Anemia was observed with a hemoglobin rate between 7-11 g/dl in 55.6% of the cases, 3.9% of thrombocytopenia and 2.9% of leukocytosis. The electrophoresis phenotype showed AS 9.8% and AC 8.7%.
Conclusion: The existence of phenotype AS and AC involves the possibility of the unexpected arrival in the future of sickles disease in the population. So it is necessary to sensitize, educate and inform population about this disease. These actions of school children about the disease and a genetic culture to health awareness, source of prevention, reducing health risks for each individual of the society.

INTRODUCTION

Sickle cell disease is the most common genetic disease in the world. In Africa, the highest prevalence rates of sickle cell with phenotype AS are recorded between the 15th parallel north and the 20th south parallel, reaching between 10 and 400% of the population in some regions [1, 2, 3]. It constitued a public health problem in many African countries. In Côte d'Ivoire, the prevalence of the AS phenotype is 12%. in the general population [4] with unequal distribution across geographical areas. The prevalence is 8.8% in the Akans center, 15.2% in the Malinkés in the north and 25% in the East, mainly in the Koulangos, a locality in the Bondoukou region. Among the young population, this prevalence is relatively high as it affects

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16.3% of children under four years of age, 65.6% of school-aged children between 5 and 14 years old and 18, 2% of those over the age of 15 [5]. Its impact on school progress is reflected in the high frequency of absenteeism and drop-out [6,7]. Sickle cell disease is also responsible for physical, psychosocial and cognitive disturbances [6, 8]. In Côte d'Ivoire, the existence of an expanded vaccination program [5] contributes to the prevention of infectious complications of sickle cell disease. However, there is no systematic screening for sickle cell disease in children in general and students in particular. Knowledge of the status of hemoglobin electrophoresis should condition the choice of his or her partner in adulthood. This would help reduce the number of sickle cell disease.

MATERIALS ET METHODS

Study area

The city of Bondoukou, in the east of Côte d'Ivoire, is 424 km from the economic capital, Abidjan. The choice of this city was based on the prevalence of sickle cell with phenotype AS wich was estimated at 25% according to the study of Cabannes *et al* (1970) [4]. The public primary school of "Plateau 2" was the site of the study. The choice of this school was randomly in order to update the prevalence of sickle cell disease with phenotype SS.

Population and the inclusion criteria

The schoolchildren of public primary school of "Plateau 2" in Bondoukou were the focus of this study. The selection of these one, was done randomly. It covered 35% of the total's number of student of this school, wich was estimated at 282 students, whether 102 schoolchildren (this number was obtained in relation to the entrants at our disposal) without distinction of sex and level of education. To represent all levels of education in a sample, a progression step was determined for student selection. This one considered the total number of each class.

We included in the study, the children who had a official status of student at the level 1 and level 2 of elementary class without a distinction of sex. We did'nt include, the children who their parent or school supervision refused to give their consentment.

Data collection

The data was fill in a questionnaire with contained the sociodemographic characteristics, medical-surgical antecedents, family history, hemodynamic constants and the results of the clinical examination. School children were examined by a doctor. The qualitative approach consisted of a blood sample of at least 5 ml for each schoolchild using a single-use syringe and tube containing EDTA with the completion of blood cell count using coolter machin. Then we performed the rhesus blood group ABO according to the Beth and Vincent method and the hemoglobin electrophoresis on an alkaline and acidic medium.

Data processing

The treatment and analysis of the blood samples have undergone several stages. The study protocol included for each schoolchild the realization of the blood cell count, the determination of the rhesus blood group ABO by the method of Beth Vincent and Simonin and the electrophoresis of hemoglobin. Quantitative data has been captured and processed with the Statistical Package for Social Sciences software version 16.0. Its use has allowed both double data entry and control and the production of descriptive statistics.

Ethical provisions

Two authorizations were obtained to conduct the survey among schoolchildren: one of the National Ethics and Research Committee (NERC)) in Côte d'Ivoire (*N°7707/MSLS/CNER-dkn du 24 décembre 2012*)) so that the study can be carried out in the identified area; the other is the Regional Directorate for National Education and Technical Education (RDNETE) of Bondoukou, an authority representing the Ministry of National Education and Technical Education (MNETE). In the field of investigations, we had clearly explained to schoolchildren in French or in the local language, the purpose of the study through a fact sheet. Although the tools (questionnaire and EDTA tube) used to collect the data at the child level bore the identity of the respondents, the data were treated confidentially by assigning codes to each blood sample and questionnaire. The respondents were assured of data processing exclusively by the technical team (laboratory technicians, doctor and socio-anthropologist). The parents' consent of the schoolchildren, school officials was required and obtained verbally and / or in writing. All children with health problems were referred to the health center medical school for their care.

RESULTS

Sociodemographic characteristics of schoolchildren

The study involved 102 students. There were 63.7% girls and 36.3% boys with sex ratio of 0.6. The average age was estimated at 11.1 years with extremes of 5 and 16 years. That of girls was 10.8 years against 11.1 years for boys. Regardless of gender, the most represented age group was 10-14 years old with 66.2% for girls and 78.4% for boys. The socio-demographic characteristics are summarized in Table I.

Table I Distribution of students according to the sociodemographic characteristics

sociodemographic characteristics	female	male	Total
	Effective(%)	Effective(%)	Effective(%)
gender	**65** (63,7%)	**37** (36,3%)	**102** (100,0%)
	Age		
[5-9] years old	18 (27,7%)	7 (18,9%)	25 (24,5%)
[10-16]years old	47 (72,3%)	30 (81,1%)	77 (75,5%)
	school level		
Préparatoiry level (CP)	12 (18,5%)	4 (10,8%)	16 (15,7%)
Elémentairy level (CE)	17 (26,2%)	9 (24,3%)	26 (25,5%)
Average level (CM)	36 (55,4%)	24 (64,9%)	60 (58,8%)
	Ethnic group		
Kwa	28 (59,6%)	19 (40,4%)	47 (48,0%)
Gour	4 (66,7%)	2 (33,3%)	6 (6,1%)
Mandé	22 (64,7%)	12 (35,3%)	34 (34,7%)
Krou	7 (77,8%)	2 (22,2%)	9 (9,2%)
Sans réponse	1 (50%)	1 (50%)	2 (2,0%)
Non ivoiriens	3 (75,0%)	1 (25,0%)	4 (3,9%)

Clinical aspect of schoolchildren

The medical profile showed that 27.5% of school children had joint pain. These were more common among girls (64.3%) than boys (35.7%). 29.4% of school children had been hospitalized

in the last 12 months preceding the survey. The reasons for hospitalization were dominated by malaria (43.3%) the abdominal pain (20.0%), food intoxication and the osteoarticular pain. Among the children who was hospitalized, 11.8% had received a blood transfusion and it was more than 12 months before our investigation.

Result according to the blood cell count

The majority of students (97.1%) had a normal leukocytes count while 2.9% of them had leukocytosis (Table II).

Table II distribution of patients accordind to the blood cell count

	Age		
	[5-9] years old Effective (%)	*[10-16] years old* Effective (%)	*Total* Effective (%)
Leukocytes count			
4 000 -10 000 [10^3/mm^3]	23 (23,2%)	76 (76,8%)	99 (97,1%)
Leukocytosis	2 (66,7%)	1 (33,3%)	3 (2,9%)
Total	25 (24,5%)	77 (75,5%)	102 (100,0%)
Hémoglobin			
[7-11[g/dl	15 (26,3%)	42 (73,7%)	57 (55,9%)
≥ 11 g/dl	10 (22,2%)	35 (77,7%)	45 (44,1%)
Total	25 (24,5%)	77 (75,5%)	102 (100,0%)
Platelet Count			
Normal	18 (20,0%)	72 (80,0%)	90 (88,2%)
Thrombopénia	4 (50,0%)	4 (50,0%)	8 (7,8%)
thrombocytosis	3 (75,0%)	1 (25,0%)	4 (4,0%)
Total	25 (24,5%)	77 (75,5%)	102 (100,0%)

Anaemia with a hemoglobin level between 7 and 12 g / dl was found in 55.6% of the children. Anemia was observed in 84.2% in schoolchildren with a plot of electrophoresis of normal hemoglobin. Anemia was observed respectively 10.5% and 5.3% of children with AC and AS sickle cell. The platelets count was normal in 88.2% of schoolchildren. However, 7.8% had thrombocytopenia and 4% had thrombocytosis.

Status of hemoglobin electrophoresis in schoolchildren

No child was homozygous sickle cell disease. Nineteen students representing 18.6% had a abnormal hemoglobin electrophoresis. So 9.8% were AS phenotype and 8.8% were AC phenotyp (Table III).

Table IIII distribution of asymptomatic's patients according to the gender

Typ of gene	gender		
	Female	Male	Total
	Effective (%)	Effective (%)	Effective (%)
A1A2	51 (61,5%)	32 (38,6%)	83 (81,4%)
AS	6 (60,0%)	4 (40,0%)	10 (9,8%)
AC	8 (88,9%)	1 (11,1%)	9 (8,8%)
Total	65 (63,7%)	37 (36,3%)	102 (100,0%)

The most of girls had the asymptomatic phenotype. The 10-14 age group was the most common among asymptomatic phenotype, 58.7% from them were register at school. 39.8% of the schoolchildren had parents from the same village, 18.4% of whom were from the same family. 31.8% and 61.3% respectively came from the Kwa and Mandé ethnic groups.

The relationship between hemoglobin status and ethnicity showed that asymptomatic phenotype carriers were predominantly from the Kwa and Mandé ethnic groups (42.1%).

DISCUSSION

The socio-demographic analysis noted an average age of 11.1 years. In a study of a child population. Durand *et al* reported an average age similar to that of this study, estimated at 10 years [9]. This young age could be explained by the method selection of of our study represented by a primary school where almost all children are under 16 years old and the national context of schooling. If the prognosis of homozygous forms reduces the life expectancy of patients, asymptomatic phenotype have a life expectancy that is comparable to that of the general population. Quinn and Coworkers estimated in their study life expectancy at age 18 in subjects with homozygous sickle cell disease since 1990 [10]. This significantly improved life expectancy would result from the quality of the early management of the disease [11]. The improvement of life expectancy therefore requires early detection of hemoglobinopathy, hence the interest of this study in schoolchildren. The results for blood cell count showed a predominance of children with anemia (55.8%). On the other hand, no child had severe anemia (hemoglobin level less than 7 g / dl).

Anemia is almost constant to varying degrees in major sickle cell syndromes. Despite the absence of major form in our study, a high percentage of schoolchildren with anemia was observed. Koum D K *et al* in their study noted an anemia prevalence of 88.5%. This value is well above the 40% threshold defined by WHO for severe endemic anemia in a population [12].

Foote *et al*, in their series on the determinants of anemia in school-aged children in rural Kenya, reported 71.9% of children with hemoglobin levels below 11 g / dl and 8.4% of children with severe anemia [13]. The cause of anemia is multifactorial dominated by parasitosis like the malaria and other non-parasitic infections [14]. The causes of deficiency, notably intake deficiency, iron and folic acid deficiency, can be mentioned in view of the low socioeconomic level of the populations. Chronic hemolysis was observed in hemoglobinopathies are also implicated in the occurrence of anemia in these African children [12] but this was not the case in this study. Leukocytosis and thrombocytosis were observed in the age group 5 to 9 years in respective proportions of 66.7% and 75.0%. This predominance may be explained by the fact that the youngest children in the general population are more likely to have viral infections, which are mostly benign. The medical profile showed that 27.5% of school children had joint pain. These were more common among girls (64.3%) than boys (35.7%). Osteoarticular pain master symptom of sickle cell syndrome can be observed in other pathologies. 29.4% of school children had been hospitalized in the last 12 months preceding the survey. The reasons for hospitalization were dominated by malaria (43.3%) and the abdominal pain (20.0%), foodintoxication and osteoarticular pain. Hemoglobin electrophoresis results noted sickle cell with phenotype AS of 9.8% in cases and with phenotype AC of 8.8% in case. The prevalence of sickle cell trait varies widely by country [16]. So, they vary between 10 and 40% in Equatorial Africa, 15 to 30% in West Africa, 1 to 2% in North Africa and less than 1% in South Africa [17]. In Europe, the frequency of sickle cell disease remains low, ranging from 1 to 5% in southern Italy, Portugal, South Albania and Turkey [18]. The results obtained are different from those observed by Durand *et al* which

confirmed a prevalence of 21.7% of the sickle cell trait in the Bantu population against 12.1% in the Pygmy population [9]. The values of this study are similar to those of West Africa [17]. The marriage in the same family is an important factor in sickle cell disease. The results indicated a predominance of this factor among schoolchildren whose ancestors had direct family ties, particularly among the Akan and Mande families. These results are almost similar to those of Tolo *et al* [11], in adult homozygous sickle cell patients whose management characteristics [19] yielded respectively 50% of Kwa and a predominance of Kwa and Mandé ethnic groups. If the results of our study disprove the hypothesis of a high prevalence of Sickle cell disease in Bondoukou, they suggest the long-term possibility for asymptomatic individuals who are unaware of their status. About one in five schoolchildren is a healthy carrier who ignores their status at the time of study. Put in perspective with the total number of pupils in primary school, about half a thousand would be affected by the disease; which reinforces this problem in schools. The prospect of a union between healthy carriers could promote the occurrence of sickle cell disease in African contexts where the diagnosis of the disease is an uncommon practice before customary, legal and religious unions.

CONCLUSION

The existence of a relatively high percentage (19.6%) of abnormal hemoglobin electrophoresis was respectively 9.8% for sickle cell with phenotype AS and 8.8% for sickle cell with phenotype AC. This suggested the persistence of the risk of occurrence of major sickle cell syndrome in future generations of the population if preventive actions are not carried out and reinforced. This requires more information, education and awareness among the population in general and students in particular through textbooks, the media but especially the establishment of a national program to fight against sickle cell disease. In doing so, systematic screening by performing electrophoresis as part of the prenuptial assessment, in all children aged 6 months of life would contribute to a reduction or even disappearance of sickle cell disease.

Conflict of interest

The authors declared that they had no personal or financial relationship (s) that may have improperly influenced the writing of this article.

Authors' contributions

The design of the project was the work of N'Guessan Tenguel Sosthene, Boidy Kouakou, Bassirou Bonfoh and Dedy Seri. Boidy Kouakou had the idea of the article and proceeded to the selection of the interviewees, the blood sample, the interview, the documentary research and the writing of the manuscript.

N'Guessan Tenguel Sosthène did the documentary research, the data collection, the analysis and the revision of the manuscript. Packo dieu-le-veut Saint-Cyr Sylvestre performed the analysis and revision of the manuscript.

Toure Pecory Laurence did the data collection.
Bassirou Bonfoh, Dedy Séri and Tolo-Diebkilé Aïssata jointly revised the manuscript and provided additional information to enrich it. All authors have read and approved the final version of the manuscript.

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