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PREVALENCE OF PARASITIC INFECTIONS IN CHILDREN OF BOKE, GUINEA

Abdoul H. Beavogui[1,2], Mahamoud S. Cherif[1,3], Bienvenu S. Camara[1], Alexandre Delamou[1,4], Delphin Kolie[1], Ansoumane Cissé[1], Daouda Camara[1], Amadou Sow[1], Gnepou Camara[1], Mohamed Yattara[1], Nèma Goumou[1], Abdoulaye Doumbouya[1], Karifa Kourouma[1], Bassirou Diarra[5], and Abdoulaye Djimde[5]

[1] Centre National de formation et de recherche en Santé Rurale (CNFRSR) "Jean Senecal" de Mafèrinyah, Forécariah, Guinea.
[2] Bioclinical and Fundamental Sciences Chair, Department of Medical Sciences, Faculty of Health Science and Techniques, Gamal Abdel Nasser University of Conakry, Conakry, Guinea.
[3] Pediatric Chair, Department of Medicine, Faculty of Health Science and Techniques, Gamal Abdel Nasser University of Conakry, Conakry, Guinea.
[4] Department of Public Health, Faculty of Health Science and Techniques, Gamal Abdel Nasser University of Conakry, Conakry, Guinea.
[5] University of Sciences, Techniques and Technologies of Bamako, Bamako, Mali.
Correspondence should be sent to Abdoul Habib Beavogui (http://orcid.org/0000-0003-4950-6224) at: *beavoguia_h@yahoo.com*

KEY WORDS

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ABSTRACT

Helminthic and intestinal protozoan infections and malaria infections are common in children less than 15 yr old in sub-Saharan Africa, but little is known about these infections in Guinea. The aim of this study was to determine the prevalence of parasitic infections in children aged less than 15 yr and the relationship of these infections with anemia. The cross-sectional study was done in Dabbis sub-prefecture in the Boke region of Guinea from 18 to 26 March 2017. A simple random sampling at the household level was performed, and 1 child under the age of 15 was included per eligible household. A total of 392 children were included in the analysis. Clinical and parasitological information were assessed, including anthropometric measures (weight and height), disease symptoms, hemoglobin level, and malaria parasitemia. Helminthic and protozoan intestinal infections were present in 59.7% of the children surveyed. Malaria infection prevalence was 45.5% when assessed by microscopy and 43.6% when assessed by a rapid diagnostic test. *Plasmodium falciparum*, accounting for 84.2% of malaria infections, was the main malaria species infection. Gastrointestinal parasites were present in 19.1% of children. The main gastrointestinal parasites present included *Entamoeba coli* (5.4%) and *Giardia intestinalis* (5.1%). There was no association between the presence of anemia and the parasitic status of the children. Parasitic screening and mass treatment in this age group, as well as household awareness raising, would reduce cases of parasitic infections in rural Guinea.

Children's health is often compromised by preventable and treatable malnutrition and parasitic diseases (WHO, 2020). Malnutrition in Guinea is the result of both inadequate nutrition due to inappropriate dietary practices and the prevalence of infectious and parasitic diseases that develop under poor individual and collective environmental health conditions (WHO, 2011). Indeed, in sub-Saharan Africa, 45% of deaths in children under 5 yr of age are attributable to undernutrition (McGuire, 2015).

Parasitic infections, including intestinal parasites and malaria, are common in low-income countries, particularly in rural areas where water, hygiene, and health facilities are insufficient (Abossie and Seid, 2014). Sub-Saharan Africa, and Guinea in particular, have a significant lack of access, or low rate of use, of both hygiene facilities and health care services. In sub-Saharan Africa in 2010, only 24% of the rural population used latrines (Yimam et al., 2014). In Guinea, in 36% of cases, children's stools are either left in the open (8%), dumped in the sewers/gutters (6%), or thrown in the garbage (22%), thus increasing the risk of spreading parasitic intestinal diseases (INS, 2012). Worm infection occurs in more than half of the poor population in sub-Saharan Africa, including 40–50 million school-aged children (Hotez and Kamath, 2009; Gizaw et al., 2018; M'Bondoukwé et al., 2018; Mekonnen and Ekubagewargies, 2019).

Intestinal parasites (schistosomiasis and geohelminthiasis) are associated with anemia in children and cause an estimated 210 million cases of iron deficiency anemia worldwide (Assare et al., 2014). Data collected by WHO between 1993 and 2005 showed an anemia prevalence of 25.4% in children with pathologies such as malaria, intestinal parasites, and malnutrition (WHO, 2008; Hotez and Kamath, 2009; Jain and Jain, 2012; Bolka and Gebremedhin, 2019).

In sub-Saharan Africa, 56 to 69 million children infected with malaria, another parasitic infection common to the region, do not receive appropriate treatment; poverty and low education levels are the key determinants of lack of access to these services (WHO, 2008). In 2010, it was estimated that more than 500 million children are at risk of malaria, including 200 million in sub-Saharan Africa (Mazigo et al., 2010). In some countries of sub-Saharan Africa, malaria remains the leading cause of consultation for child health services (Houngbedji et al., 2015). A study that assessed the potential of anemia and malaria parasitemia comorbidity prevalence estimated that children with moderate/severe anemia had a four times higher risk of malaria infection in Rwanda (Papaioannou et al., 2019).

In Guinea, malaria is a significant public health problem and represents the leading cause of all age consultation (34%), hospitalization (31%), and death (14%) in public and private health facilities (Ministry of Health and Public Hygiene [Guinea]).

The prevalence of parasitic infections, quite common in children aged less than 15 yr, is not well studied in Guinea. Also not well understood is the relation between the prevalence of these parasitic infections and anemia in this population. The aim of this study was to determine the prevalence of helminth and protozoa intestinal infections, malaria infections, and anemia in children aged less than 15 yr in Dabbis sub-prefecture, Boke region, Guinea.

MATERIALS AND METHODS

Study setting, design, and population

This study was conducted in Dabbis sub-prefecture, located in the region of Boke, about 300 km from the capital city of Conakry, Guinea. The sub-prefecture of Dabbis had a population of 29,897 inhabitants at the time of the study, 51% of whom were women. We conducted a cross-sectional study from 18 to 26 March 2017. We included in this study randomly selected households from the national census database with children under the age of 15 yr. To qualify, household members must have been residing in the survey area for at least 6 mo, and parents must have consented to participate in the study. One child was included per eligible household.

Sample size was calculated using the formula $N = \frac{Z^2}{i^2}(P * Q)$, based on the national malaria prevalence in 2012 (INS, 2012), a confidence level of 95%, and a 5% precision. A total of 392 children were included in the study.

Data collection and statistical analysis

Data were collected in households, using structured and pre-tested questionnaires. Information on socio-demographic characteristics was collected from parents/caretakers and included the age and gender of the child and the parent/caretaker's relationship with the child, level of education, occupation, and marital status. Clinical and parasitological information was collected through a physical and paramedical examination and included anthropometric measures (weight and height), disease symptoms, hemoglobin level, and malaria parasitemia. Anthropometric measures were used to calculate the body mass index (BMI).

The data collection team included trained sociologists, physicians, and biologists. The parents/caretakers of the child were interviewed in local languages. A verbal and written informed consent was obtained from each parent/caretaker before data collection.

Clinical procedures

The clinical investigations of the children included general information for disease identification and an initial physical examination by doctors, which included measurement of weight, height, and axillary temperature, palpation, and auscultation. Splenomegaly was systematically searched for in all subjects and classified according to Hackett's classification (Laman et al., 2015). The clinical examination was completed by a laboratory examination done by biologists. A finger prick capillary blood sample, for malaria diagnosis, was taken from each subject using a sterile disposable lancet, after cleaning the finger with 70% alcohol.

Laboratory procedures

Malaria parasite (*Plasmodium*) was assessed through a rapid diagnostic test (RDT) or thick smear (TS) and the thin smear stained with Giemsa 10% according to the standard operating procedure (WHO, FIND, and CDC, 2018). The TS was used to determine the parasite, gametocyte, and parasite density. The thin smear was used to identify the parasite species. The parasite density was determined using the formula *parasitemia per microliter* = *(number of asexual parasites/300 counted leukocytes)* × *7,500*.

The slide was rated negative when the entire TS examination revealed no asexual *Plasmodium* form. The number of *Plasmodium falciparum* (asexual form) and gametocyte (sexual form) counts was based on white blood cells (WBCs). We used the WBC reference values established as 1 μl of blood containing 8,000 WBCs. An Olympus CX 21 binocular microscope (Olympus Corporation, Tokyo, Japan) with an electric light was used for slide reading at the Maferinyah National Center for Training and Research in Rural Health, Guinea. Patients who were tested positive for malaria were treated with artemether 20 mg with lumefantrine 120 mg.

The parasitological investigation, to identify helminthic and intestinal protozoan infections, was carried out by trained laboratory technicians using freshly collected patient stools. The identification process was carried out by combining 2 techniques: direct examination and the Willis concentration method (Pone et al., 2012; Eyamo et al., 2019; Isaac et al., 2019).

Data analysis

The study data were entered into EpiData software (EpiData Association, Odense, Denmark) by 2 independent coders. The data were reconciled and analyzed using STATA version 13 software (STATA Corporation, College Station, Texas).

Descriptive variables were presented as proportions with 95% confidence intervals or mean with standard deviation (SD). Factors associated with anemia were identified by comparing the proportion of anemia across socio-demographic variables and the parasitic status of children in the bivariate analysis. The Pearson chi^2 test and the Student's *t*-test were used for comparisons. All variables with a P value $\leq$ 0.20 were included in the logistic regression model, and the crude and adjusted odds ratios were derived. The significance level was fixed at 5%.

Ethical considerations

The study protocol was approved by the National Ethics Committee for Health Research, Guinea (No. 08/CNERS/17). Verbal and written informed consent were obtained from the parent/caretaker of each participant. The information collected was anonymous and coded before analysis.

Table I. Sociodemographic characteristics of children in Dabbis sub-prefecture, Boke region, Guinea (n = 392).

Variables	No.	% (95% of CI)
Gender		
Male	225	57.4 (52.4–62.2)
Female	167	42.6 (37.8–47.6)
Mean age (SD), months	392	78 (50)
Age group		
0–6 mo	16	4.1 (2.5–6.6)
7–11 mo	6	1.5 (0.7–3.4)
12–58 mo	121	30.9 (26.5–35.6)
>58 mo	249	63.5 (58.6–68.2)
Mean weight (SD), kg	392	23.1 (14.3)
Mean height (SD), cm	392	113.9 (31.1)
Body mass index (BMI)		
Underweight*	333	85 (81–88.2)
Normal weight**	48	12.2 (9.3–15.9)
Overweight/obesity***	11	2.8 (1.6–5)
Education level		
None	222	56.8 (51.8–61.2)
Primary or plus	169	43.2 (38.4–48.2)
Person in charge of child		
Mother/father	272	69.4 (64.6–73.8)
Other[a]	120	30.6 (26.2–35.4)
Parents' education level		
None	359	91.6 (88.4–94)
Primary or plus	33	8.4 (6–11.6)
Profession of parents		
Housewife/farmer	295	75.3 (70.7–79.3)
Other[b]	97	24.7 (20.7–29.3)
Marital status of parents		
Unmarried	5	1.3 (0.5–3)
Married	387	98.7 (97–99.5)

* BMI < 18.5 kg/m^2, ** BMI between 18.5 and 24.9 kg/m^2, *** BMI ≥ 25 kg/m^2.
[a] Adoptive parent, grandfather/grandmother, uncle/aunt, brother/sister.
[b] Worker, trader, teacher, student.

RESULTS

Sociodemographic characteristics of children

A total of 392 children under 15 yr of age were surveyed and analyzed. The children surveyed were predominantly male (57.4%) with a mean age of 78 ± 50 mo (6.5 ± 4.2 yr) (Table I). Children aged 59 mo or more were the most represented (63.5%). Most children did not attend school (67.6%) and were taken care of by their mothers or fathers (69.4%). The majority of mothers/caretakers of the children were married or in union (98.7%) and mostly housewives or farmers (75.3%), without any level of education (91.6%).

Clinical and biological characteristics of children

The main symptoms found in the children included abdominal bloating (35%), fever (30.4%), and cough (16.8%) (Table II). Pallor (7.1%), pruritus (6.4%), abdominal pain (4.1%), and splenomegaly (3.3%) were also found in some children. Anemia was detected in 40.6% of children. The BMI showed that the majority of children were underweight (85%). Those who were overweight or obese accounted for 2.8% of the study group.

Table II. Symptoms and hemoglobin levels among children living in Dabbis sub-prefecture, Boke region, Guinea (n = 392).

Variables	No.	% (95% of CI)
Symptoms		
Abdominal bloating	137	35 (30.4–39.8)
Fever	119	30.4 (26–35.1)
Cough	66	16.8 (13.4–20.9)
Whiteness	28	7.1 (5–10.2)
Pruritus	25	6.4 (4.3–9.3)
Abdominal pain	16	4.1 (2.5–6.6)
Splenomegaly	13	3.3 (1.9–5.6)
Headaches	4	1 (0.4–2.7)
Diarrhea	3	0.8 (0.2–2.4)
Edema	2	0.5 (0.1–2)
Hemoglobin level		
Anemia*	106	27.18 (23.0–77.0)
Average hemoglobin level (SD), g/dl	392	11.8 (1.5)

* Hemoglobin level: $<$ 11g/dl for under 5 yr, $<$ 11.5 g/dl for 5 to 11 yr, $<$ 12 g/dl for 12–14 yr, $<$ 13 g/dl for 15 yr or more.

Prevalence of intestinal parasite in children

Fifty-nine percent (59.7%) of children had parasitic diseases, of which 19.1% were intestinal (Fig. 1). The main intestinal parasites found in children included *Entamoeba coli* (5.4%) and *Giardia* (5.1%), followed by *Enteromonas* (2.3%), *Trichomonas intestinalis* (1.8%), and *Ancylostoma* (1.3%). A proportion of 1.3% of children had intestinal polyparasitosis.

Prevalence of malaria infection in children

When diagnosed by microscopy, 45.5% of children were diagnosed with malaria; when tested using RDT, 43.6% of children were diagnosed with malaria. *Plasmodium falciparum* was the main species, responsible for 84.2% of malaria infections (Fig. 2). *Plasmodium malariae* was responsible for 3.4% of cases. The remaining cases (12.4%) were considered as mixed infections by both *P. falciparum* and *P. malariae*).

Factors associated with anemia in children

The bivariate analysis showed that only age was associated with anemia in children. However, in the multivariate analysis, age and gender were associated with anemia. Age was negatively associated with anemia with an adjusted odds ratio of 0.78 (95% confidence interval [CI]: 0.71–0.85). Female children were 47% less likely to be anemic than male children (adjusted odds ratio: 0.53 [95% CI: 0.31–0.91]).

DISCUSSION

This study is one of the few studies to document the prevalence of helminthic and protozoan intestinal infections and malaria infection, and their association with anemia, among children under 15 yr of age in rural Guinea. The results show that malaria is very common in children, with *P. falciparum* being the main

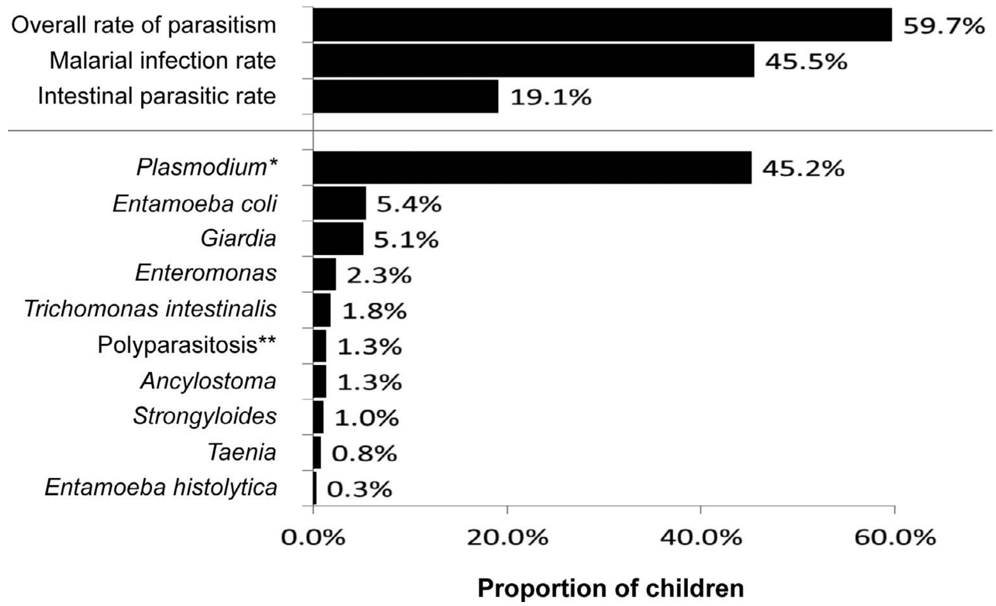

Figure 1. Parasitic prevalence among children residing in the sub-prefecture of Dabbis, Boke region, Guinea (n = 392). * Microscopy results (thick and thin blood smear); *Plasmodium* by rapid diagnostic test = 43.6%. ** *Entamoeba coli* + *Tania*, *E. coli* + *Ancylostoma*, *Strongyloides* + *Trichomonas intestinalis*, *Strongyloides* + *Giardia*, *T. intestinalis* + *Giardia*.

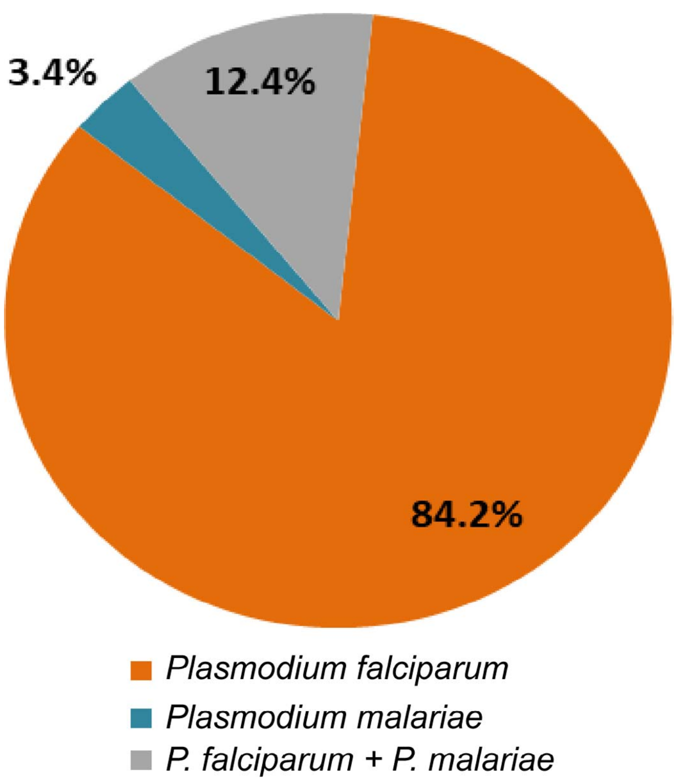

Figure 2. Species of *Plasmodium* infecting children with malaria in Dabbis sub-prefecture, Boke region, Guinea (n = 392). Color version available online.

malaria parasite species. Three out of 5 children have parasitic infections in this age group in the study region. *Entamoeba coli* and *Giardia intestinalis* are the main intestinal parasites responsible for gastrointestinal parasites. Although efforts have contributed to improving child health indicators in Guinea (Ministry of Health and Public Hygiene [Guinea]), these findings show that children in rural Guinea are still exposed to parasitic infections. Lack of prevention of these infections at the community level (Ministry of Health and Public Hygiene [Guinea]) for both asymptomatic and benign cases (CDC, 2015; WHO, 2015), and non-use of health services could contribute to high infection prevalence in rural environments. Action such as parasite screening and mass treatment in this age group, as well as household education, would help to reduce the parasitic infection burden in Guinea.

Malaria prevalence in the children surveyed was 45.5%. This prevalence is lower than that found among children under 5 yr old in rural Guinea in 2012 (57.5%). However, it is significantly higher than the prevalence in urban areas (15.7%) (INS, 2012). These indicators confirm the high risk of malaria among children living in rural areas and call for greater efforts for this age group, which represents the majority of Guinean children (INS, 2012). In addition, our results showed lower fever frequency (30.4%) compared to malaria infection prevalence. This implies that many children likely have asymptomatic malaria cases. Children living in endemic areas of malaria tend to develop immunity against *Plasmodium* invasions in the body and thus are asymptomatic carriers of malaria (Trampuz et al., 2003). As such, these children may not get treated and can spread malaria to others, promoting new infections. In addition, *P. falciparum* is the main parasite responsible for the majority of malaria infections in these children. Given the resistance of this species to some antimalarial drugs (Cui et al., 2015), it is of paramount importance to raise the awareness of rural communities against self-medication in case of fever, but also to facilitate their access to effective antimalarial drugs.

Intestinal parasitosis was present in 19.1% of children. This prevalence is far lower than that found in Nigerian rural students in 2015 (73.2%) (Nwalorzie et al., 2015) and in North Shoa, Ethiopia, where 17.4% of the children were infected with at least one protozoa parasite and/or helminth (Zemene and Shiferaw, 2018). The lower prevalence in Guinea than other countries in the region, such as Nigeria, might be due to the regular deworming campaigns targeting households in Guinea. However, sustaining these efforts and ensuring coprological surveillance of children over 5 yr of age would contribute more effectively to reducing parasitic infections among children in Guinea. It is also necessary to raise awareness of and to support rural communities for better prevention of these infections.

The majority of children surveyed were underweight, and about 3 out of 10 children were anemic. Malnutrition and anemia in children constitute a major public health problem in resource-limited settings (Raccurt et al., 2006; CDC, 2019). Malaria and intestinal parasites are known to cause anemia and malnutrition (Yang et al., 2012; WHO, 2015). Thus, in addition to interventions against parasitic infections, the fight against malnutrition, with a focus on children 5 yr and older, would substantially help improve the health of children in rural Guinea.

We expected an association between the presence of anemia and parasitic infections in children. However, multivariate analysis has shown that the parasite infection (malaria and/or intestinal parasites) does not predict the presence of anemia. However, anemia is known as a sign of severe malaria and intestinal parasitosis in children (Le et al., 2007; White, 2018). We can explain our result by the relatively small sample size, which makes it difficult to draw a generalizable conclusion on the determinants of malaria. In addition, this study was conducted in March, a period marked by a low incidence of malaria in Guinea.

We have observed less risk of anemia in girls compared to boys. This observation may be explained by the higher proportion of boys 65.6 % (118/180) with malaria than girls 34.4 (62/180) in this study. Malaria is known to play a major causative role in anemia (Castelli et al., 2014). Even though there was not any association found between malnutrition and anemia in this current study, it is well reported in Guinea that young boys are more malnourished than females, according to the 2012 Demographic and Health Survey (INS, 2012). Our study showed that girls were less likely than their male counterparts to be anemic. In contrast, Alvarez-Uria et al. (2014) concluded that the fact that gender differences in India were seen only after the menarche period in women indicates that iron deficiency was the main cause of anemia (Pasricha et al., 2010).

Older children were less exposed to anemia. The reasons for this association remain subject to more investigation. However, older children may be less vulnerable to malnutrition at this time, as it was mango season in the study area, meaning children can access the fruit easily and sufficiently. Some reported factors associated with the occurrence of anemia, such as iron deficiency, micronutrient deficiencies, and hemoglobinopathy, were not taken into consideration in this study.

The main limit of this study is that it focused on a single sub-prefecture and so may not show the reality in the other sub-prefectures of the country. However, it remains relevant for the rural context and has the potential to guide health interventions for children and stimulate further research on the topic.

CONCLUSION

The prevalence of parasite infections is high in children aged less than 15 yr in the Dabbis sub-prefecture, Boke region, Guinea. A proportion of 45.5% and 19.1% of these children are carrying malaria parasites and intestinal parasites, respectively. Systematic parasitic screening and mass treatment in this age group, as well as improved hygiene conditions and household awareness raising, are needed to reduce cases of parasitic infections in rural Guinea. Multicenter studies during the period of high malaria incidence would better explore the relationship between anemia and parasitic infections in children.

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